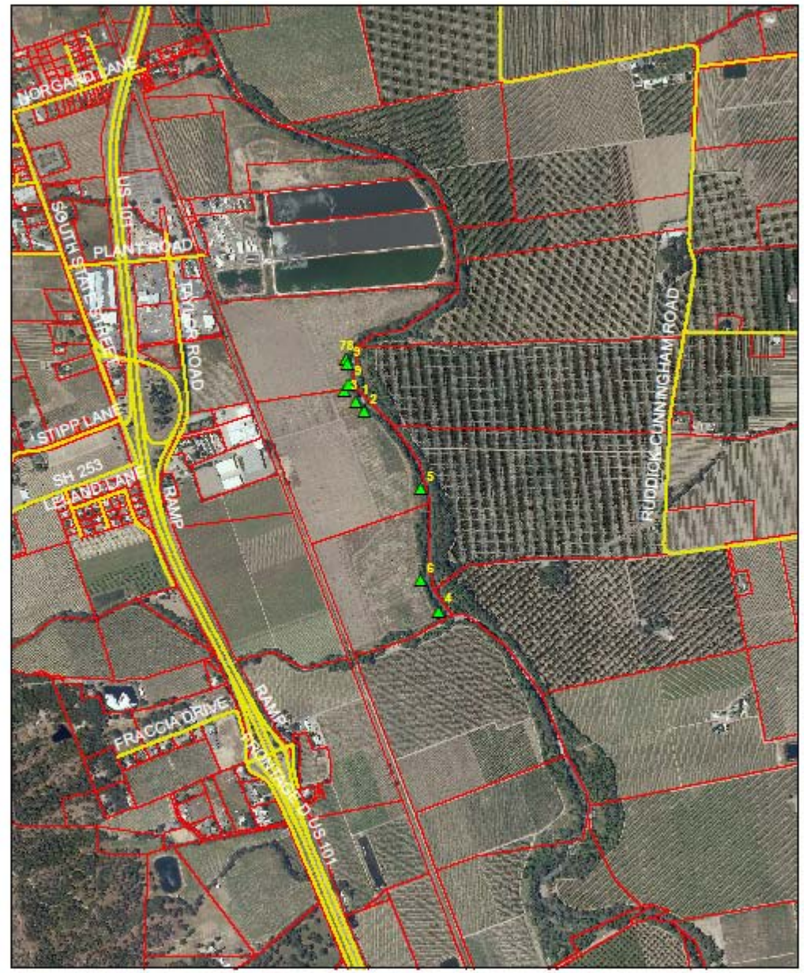
320 - Mendocino County Resource Conservation District, Working Landscapes Riparian Enhancement Project

Mendocino County Resource Conservation District Technical and Scientific Documentation Table		
Technical and Scientific Document Name	**Document Description**	**Relevant page #**
Denmark Creek Fish Barrier Removal and Riparian Enhancement Project, Phase II, MCRCD, 2012	Provides Riparian Restoration Component of project, with specifics about revegetating the site and plant species used.	Entire
Denmark Creek Fish Barrier Removal, Arundo donax Eradication and Riparian Enhancement Project, Phase II, Preliminary Design Plans, 2013	Site maps, structure plan view, preliminary revegetation list, planting notes, planting details	Entire
California Salmonid Stream Habitat Restoration Manual – Part XI, Riparian Habitat Restoration	This manual describes many methods and techniques used by habitat restoration specialists. The methods and techniques described here represent a starting point for project design and implementation. Specific sections used when developing project site-specific restoration plans include: Restoration of Native Riparian Habitats Chapter XI, Natural Regeneration and Exclusionary Fencing XI-13, Erosion Control XI-14, Riparian Revegetion XI-16, Non-native Invasive Plant Species XI-6	Please see descriptio n
Arundo Removal Technical Guide. Sotoyome Resource Conservation District. 2010	This guide describes many methods and techniques used to eradicate *Arundo donax*. The methods and techniques described here represent a starting point for project design and implementation.	Entire
Supporting Documents provided digitally via the BMS upload and by CD		
California Salmonid Stream Habitat Restoration Manual – Part VII – Project Implementation, Volume 4, 2010	This manual describes many methods and techniques used by habitat restoration specialists. The methods and techniques described here represent a starting point for project design and implementation. Specific sections used when developing project site-specific restoration plans include: Brush Checkdams VII-90, Willow Wall Revetment VII-78, Revegetation with Willow Sprigs VII-76, Native Material Revetment VII-75, Tree Revetment VII-73, Stream Bank	Please see descriptio n

	Stabilization VII-63,Brush Mattress VII-79.	
Russian River Coastal Integrated Coastal Watershed Management Plan, MCRCD 2012 http://mcrcd.org/publications/	The RRICWMP is a watershed-specific, planning document specific to the Russian River and contextualized within the North Coast Integrated Regional Water Management Plan framework. The plan was developed by conducting research and analyzing current and historic scientific, socioeco-nomic, and policy data, and enlisting stakeholders and watershed experts to identify key management issues.	84-86
Russian River Basin Fisheries Restoration Plan, CDFG 2002 http://www.northcoastirwmp.net/docs.php?oid=1000008649&ogid=1000002244	The goals of the restoration plan includes identifying and prioritizing high priority factors that may restore functionality to watershed systems or lifecycle patterns specifically for anadromous salmonids/	125-126
Russian River Biological Opinion, SCWA http://www.scwa.ca.gov/rrifr/	This Biological Opinion was developed pursuant to Section 7(a)(2) of the Federal Endangered Species Act (ESA). The SCWA and its partners have proposed to implement ongoing practices and operations related to flood control, water diversion and storage, regulation of flows in the Russian River and Dry Creek, estuary management, hydroelectric power generation, channel maintenance, and fish hatchery production. These actions likely affect Central California Coast (CCC) steelhead (*Oncorhynchus mykiss*), CCC coho salmon (O. kisutch), and California Coastal (CC) Chinook salmon (*O. tshawytscha*),	138
Navarro Watershed Restoration Plan Pages included	A comprehensive watershed plan developed by the State Coastal Conservancy, State Water Resources Control Board, the Mendocino County Water Agency, and the Anderson Valley Land Trust—in 1998. The Plan, conducted by Entrix, included input from stakeholders and identified restoration goals, recommended land management practices, and prioritized sub basins for treatments. The Plan is the basis for the TMDL Technical Support Documents, and provides guidance and a scientific basis for restoration activities.	5-4 - 5-7, 6-11,6-12, 8-1
Team Arundo del Norte Arundo Eradication Planning Packet (http://teamarundo.org/eradproject/planning_packet.html)	A web page with forms and reference documents available to enable development of a site-specific *Arundo* Revegetation and Restoration Plan	Entire web page



Working Landscapes Riparian Enhancement Project

Russian River
Arundo donax Eradication
and Riparian Restoration Project

Mendocino County
Resource Conservation District

Site Maps

WEST COAST WATERSHED

Project Activities and Techniques

The following techniques would be used to remove giant reed from the riparian corridors in the Russian River watershed, and to perform follow-up native plant revegetation in infested areas.

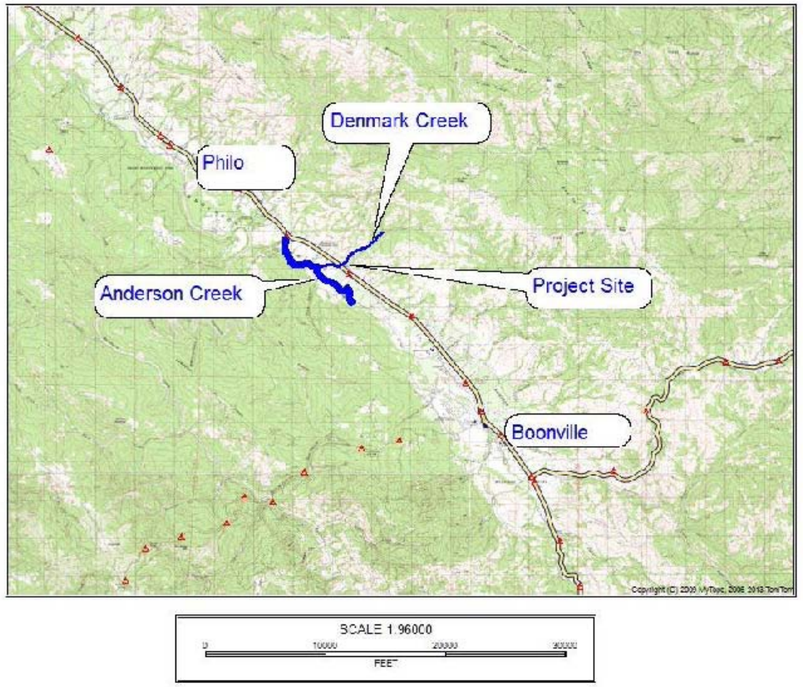
Phase I: Above-ground Biomass Removal (all seasons)
In all cases, the first phase of the project requires the removal of all above-ground giant reed biomass, to within 12 inches of the ground. Timing of above-ground biomass removal is dependent upon the Phase II treatment being applied (see below for detailed descriptions of Phase II treatments). If the tarping method is being used, biomass removal would take place in the spring and summer. If the herbicide method is being used, biomass removal would take place between July and October. If the root removal method is being used, biomass removal could take place at any time of the year, provided it does not create any environmental impact such as increased sedimentation, or harassment of sensitive wildlife species. Giant reed canes would be removed by hand with loppers or other cutting tools. All removed canes would be moved out of the floodway to a staging area, so that no cut canes could be transported into the riparian corridor during flood events, and re-sprout there. Canes placed in the staging area would be prevented from rooting by: a) placing a tarp or other root-impermeable lining under the canes, b) placing the canes on a substrate that is not conducive to rooting (such as concrete, dry gravel, etc). Canes stored in the staging area would be treated.

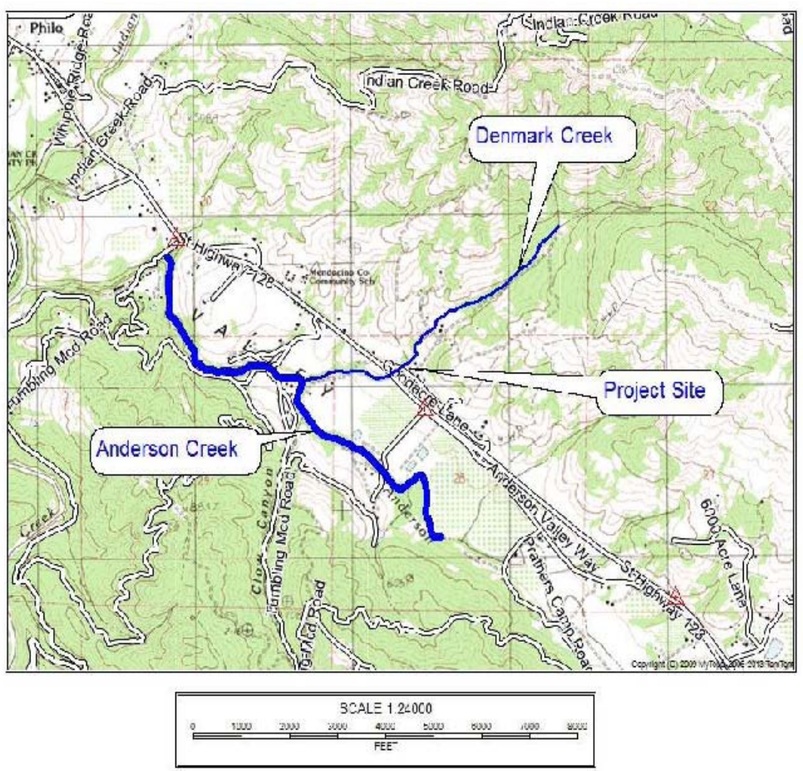
Phase II: Tarping (May-October)
The goal of tarping is to prevent all light from reaching any part of the giant reed plant. After removal of above-ground biomass, black tarps would be placed over the cut stems and secured with stakes or large would be brought into the riparian zone. Tarps would be checked on a regular basis to determine if there has been any modification to the initial placement as a result of flooding and to correct any problems. In the event that a tarp is removed by vandals, animals, or other environmental factors (such as wind), the tarps would be re-applied or recycled. Tarps would be removed prior to the rainy season, thereby preventing their movement into the stream. When tarps are removed, the treatment would be assessed for percentage of dead stems of giant reed. The site would be evaluated again the following spring and summer for re-growth of giant reed.

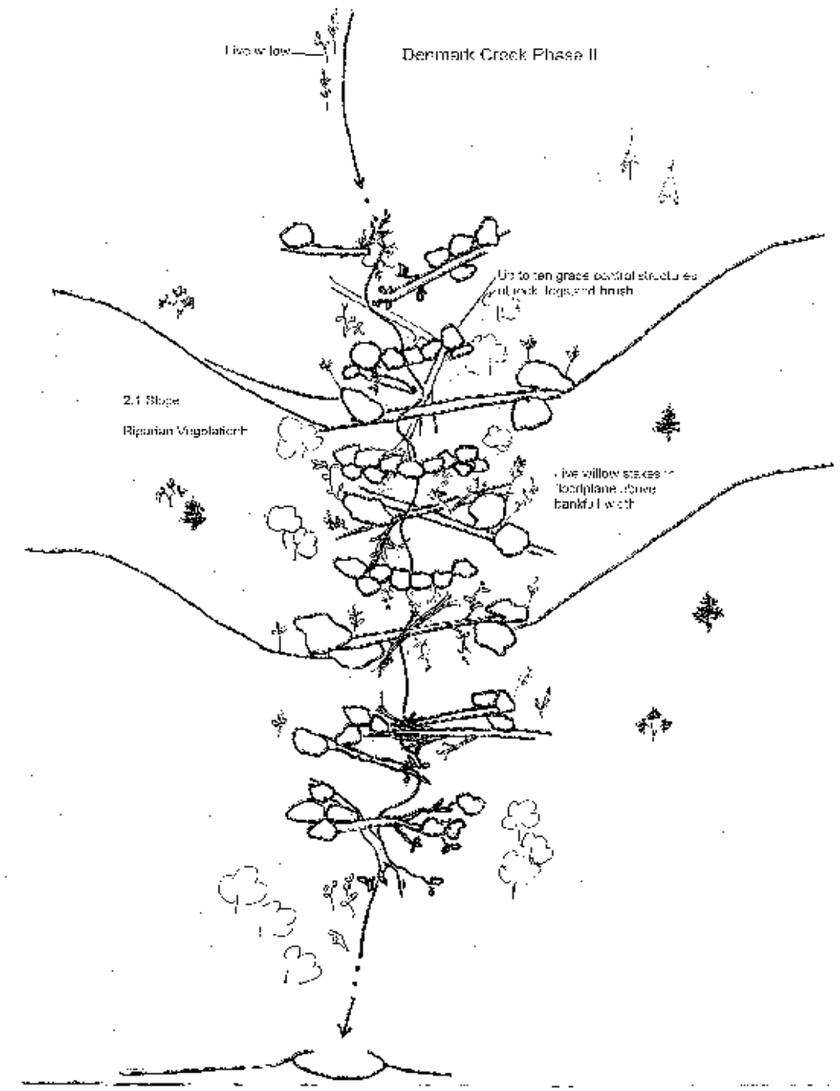
Phase II: Root Removal - manual
Hand removal of roots will be accomplished using hand tools such as picks, shovels and digging bars. The giant reed clumps shall be removed, including all roots and rhizomes, and the removal site shall be re-contoured, consistent with the surrounding soil level. No equipment shall be used in the riparian zone during the hand removal process. One dump truck may be used to transport roots/rhizomes and would only be driven on established access roads, and therefore would not impact existing native vegetation or riparian habitat. Roots and rhizomes shall be disposed of outside of the floodway.

Phase II: Herbicide application – cut and paint (August-November)
Herbicide would be applied to the stems of giant reed within 30 seconds of cutting. All label directions and applicable laws would be followed. The minimum amount of herbicide required for treatment would be used. Prior to applying herbicide, an emergency response plan would be developed.

WEST COAST WATERSHED







Denmark Creek
Structures View Plan

Working Landscapes Riparian Enhancement Project

Denmark Creek
Fish Barrier Removal
and Riparian Enhancement Project
Phase II

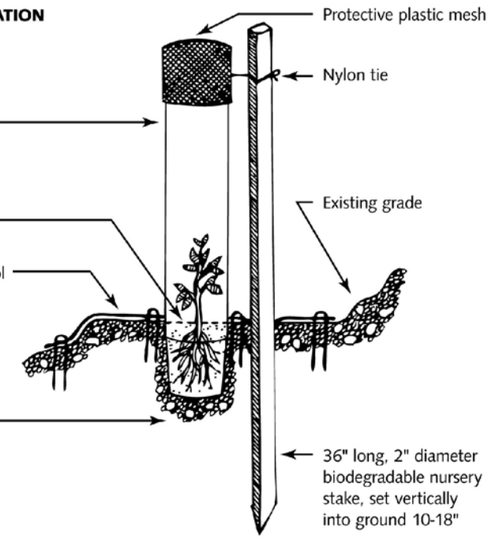
Mendocino County
Resource Conservation District

Site Maps

Denmark Creek
Structures View Plan

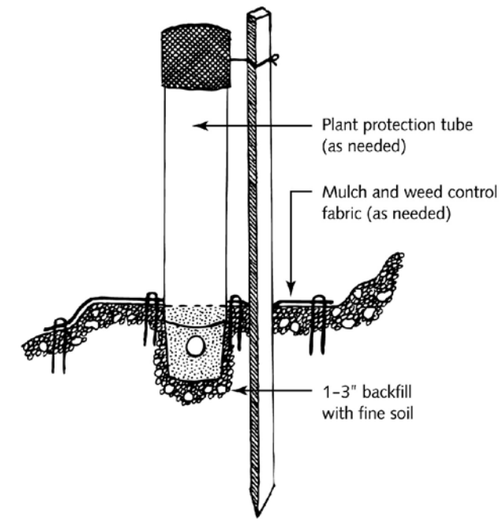
WEST COAST WATERSHED

PLANT PROTECTION TUBE INSTALLATION
(not to scale)



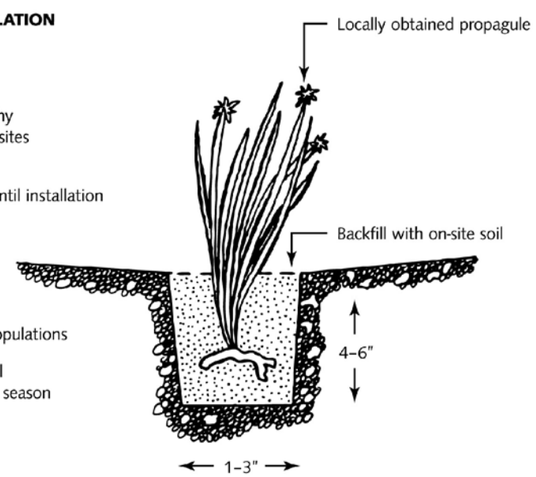
DIRECT SEED PLANTING DETAIL
(not to scale)

- Install native seeds from oaks, buckeye, bay or walnut from November–February
- Install when soil is moist to 10"
- Seed depth at installation = 1-3", depending on species
- Protect plant as needed with plant protection tube and/or fabric mulch *(see Plant Protection Shelter Detail)*



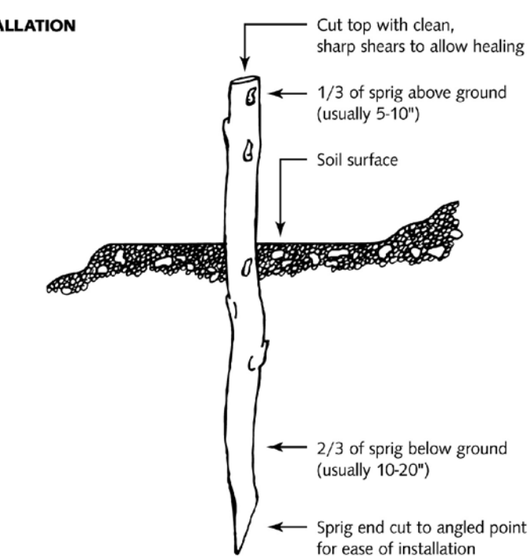
EMERGENT VEGETATION INSTALLATION
(not to scale)

- Excavate planting area
- Collect emergent plants from healthy populations on adjacent or nearby sites
- Keep emergent plants moist and protected form time of collection until installation
- Install emergent plants on same day as collected
- Collect emergent plants in discontinuous small areas to avoid excessive disturbance to existing populations
- Planting shall occur November-April during the dormant/quasi-dormant season



DORMANT WILLOW SPRIG INSTALLATION
(not to scale)

- Install in areas with a year round source of moisture
- Install only during full dormancy (normally December–January)
- Remove branches prior to installation
- Insert with buds pointing upward



Working Landscapes Riparian Enhancement Project

Denmark Creek
Fish Barrier Removal
and Riparian Enhancement Project
Phase II

Mendocino County
Resource Conservation District

Revegetation Details

WEST COAST WATERSHED

RIPARIAN RESTORATION COMPONENT

The project planting palette will follow the plant species list that was included in the Caltrans Mitigation and Monitoring Plan for Phase I, II, and III of the Culvert Replacement Project on State Routes 128/253 in Mendocino County, Caltrans District 1, November 2010.

For the project, the planting design consists of the following elements:

1) Revegetate the 2:1 slope with 100 native California trees and shrubs
2) Trees will be planted on 10-15 foot centers, shrubs will be planted on 4-8 foot centers
3) Apply Driwater to enhance irrigation, seed with native erosion control seed mix, and mulch with weed-free straw
4) Channel margins will be revegetated with live willow staking on 3-foot centers to revegetate disturbed soil areas.

Planting
Plant species for planting would be selected from the following table as appropriate.

Scientific Name	Common Name	Container Size
Trees		
Acer macrophyllum	Big leaf maple	Tree pot or 1 gallon
Aesculus californica	California buckeye	Tree pot or 1 gallon
Alnus rubra	Red alder	Tree pot or 1 gallon
Arbutus menziesii	Madrone	Tree pot or 1 gallon
Fraxinus latifolia	Oregon Ash	Tree pot or 1 gallon
Quercus kellogii	Black oak	Tree pot or 1 gallon
Quercus wislizenii	Interior live oak	Tree pot or 1 gallon
Umbellaria californica	California bay	Tree pot or 1 gallon
Shrubs		
Heteromeles arbutifolia	Toyon	Tree pot or 1 gallon
Rosa californica	California wild rose	Tree pot or 1 gallon
Rubus ursinus	California blackberry	Tree pot or 1 gallon
Salix spp.	Willow species	Cuttings
Sambucus Mexicana	Blue elderberry	Tree pot or 1 gallon
Symphoricarpos albus	Snowberry	Tree pot or 1 gallon

Invasive Species Removal:
Invasive plant species targeted for removal include: *Rubus discolor* (Himalayan blackberry). Invasive species will primarily be removed with heavy equipment as part of the design component of removing the sediment above the culvert, or otherwise manually where appropriate, no herbicides will be used.

REVEGETATION NOTES

1. Planting shall be installed in January, once rainfall has moistened the soil to a depth of 10 inches or greater. Planting shall be completed by March.
2. Planting technique shall be predominantly liner-sized seedlings, emergent transplants, direct and dormant willow cuttings (see Planting Details).
3. The planting will be installed by qualified restoration ecologists.
4. No individual plant locations are shown. The final design will be developed in the field by qualified restoration ecologists. Each planting spot shall be marked in the field with a color coded (to species) surveyor flag. Flags shall remain at each planting spot after plant installation.
5. Plants will be maintained on irrigation for two years, possibly a third depending on the rainfall, through the application of Driwater (decentralized slow release irrigation that does not require piping or pumping for irrigation). Driwater will be installed at the base of each plant by the end of April through the month of October. There will be two subsequent applications of 90 day slow release Dri-water per season per plant.
6. Plants should have all weeds removed from within the planting tube at least once in the spring and the fall of each year. Protective tubes and weed mats shall be removed after three to five years, depending upon plant maturity.
7. Regular monitoring of the planting site – including collection of data on plant survival, vigor and any potential problems with revegetation site viability – will be performed yearly, and summarized in a report.
8. Himalayan blackberry (*Rubus discolor*) is a highly invasive noxious weed that is present on the site, and should be removed from all planting zones prior to native plant revegetation. Wherever possible, alternatives to herbicide shall be used. These alternatives may include tarping and hand removal. The site should be carefully monitored for re-infestations of invasive species, and follow-up measures taken to avoid re-invasion.

Working Landscapes Riparian Enhancement Project

Denmark Creek
Fish Barrier Removal
and Riparian Enhancement Project
Phase II

Mendocino County
Resource Conservation District

Preliminary Revegetation Notes

WEST COAST WATERSHED

DENMARK CREEK STREAM RESTORATION PROJECT

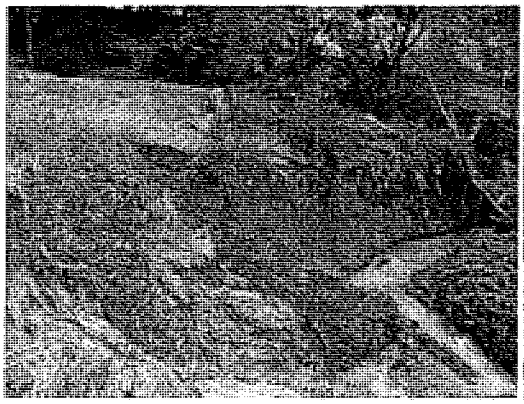
FINAL REPORT TO MENDOCINO COUNTY RESOURCE CONSERVATION DISTRICT 11-31-10

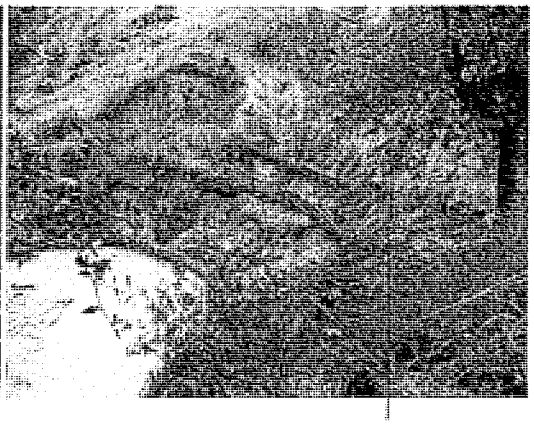
PREPARED BY:

Teri Jo Barber
Certified Hydrologist (American Institute of Hydrology #00H1535)

Anna Birkás
Watershed Ecologist

With design assistance from Elias Steinbuck (Registered Geologist #7538)





THIS PROJECT IS PART OF A LARGER NAVARRO RIVER WATERSHED SEDIMENT REDUCTION PROJECT SPONSORED BY THE MENDOCINO COUNTY RESOURCE CONSERVATION DISTRICT

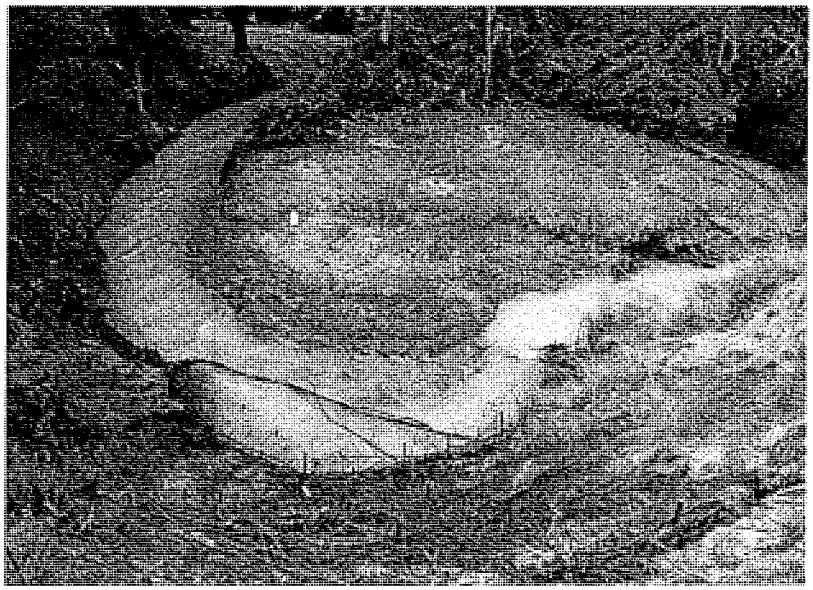
FUNDING: STATE OF CALIFORNIA'S WATER RESOURCES CONTROL BOARD AGREEMENT 07-502-551-0

TOTAL COST: $96,175 + 12 LARGE REDWOOD LOGS PROVIDED BY LANDOWNER

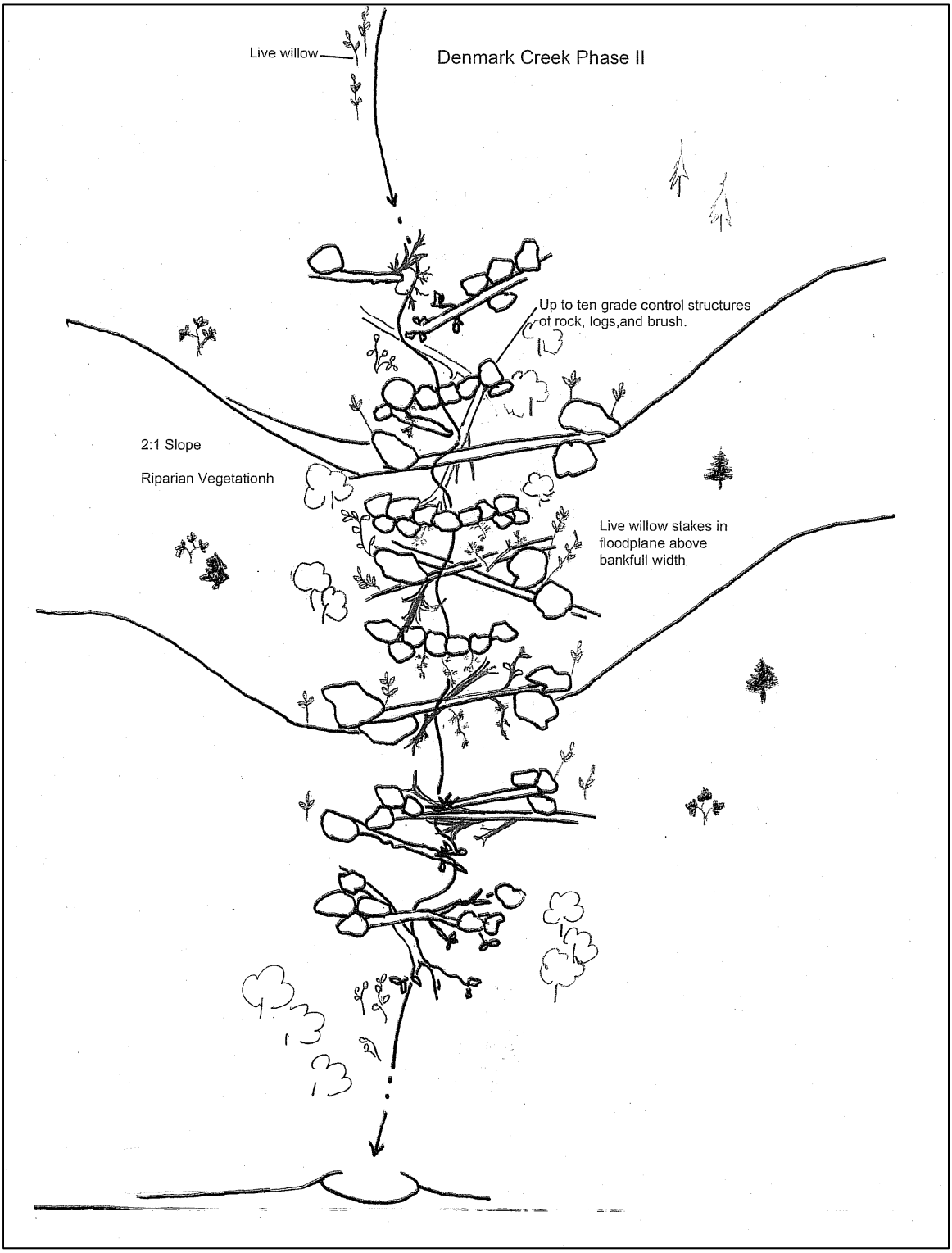
Recommendations

Ongoing volunteer monitoring is expected to continue in Denmark Creek for several years as the Ridge to River staff were invited to stop in at any time, a reflection of the excellent working relationship developed with the previously skeptical landowners.. If downcutting continues to be observed and especially if it threatens to undermine instream structure added in 2009 and 2010 then cross channel structures should be reconsidered. Cross channel structures encourage aggradation of bedload materials immediately upstream to the extent of their height in a process that reverses downcutting. Low elevation brush and cobble structures remain as viable cost-effective adaptive management tools to address or minimize downcutting now or in the future. These techniques applied where wood and boulder structures were added, especially at their downstream ends, would encourage deposition to maintain structural contact with the existing streambed elevation and thereby increase the longevity of the added instream structure.

As noted on the site map on page 5, there were originally 15 separate sites identified during the interdisciplinary project design team process. Of the original 15 sites identified just eight sites were implemented during the course of this project. Sites that were left untreated included several cross-channel structures that may have been difficult to permit and CDFG considered potential barriers to fish migration. Should additional funds be identified, the landowner wholeheartedly wants to continue and so it's recommended that that those sites which are still viable be addressed at that time. Future restoration efforts might be directed upstream of the treatment area where an abandoned stream crossing from Old Highway 128 is in a state of collapse and invasive non-native vegetation impairs riparian functions.



Denmark Creek Fish Barrier Removal and Riparian Enhancement Project Design Elements



Not to scale.

Plan view diagram of Denmark Creek – Phase II Restoration Project which shows the site after removal of culvert and associated fill, bank layback to 2:1 slope, and installation of bioengineered structures.

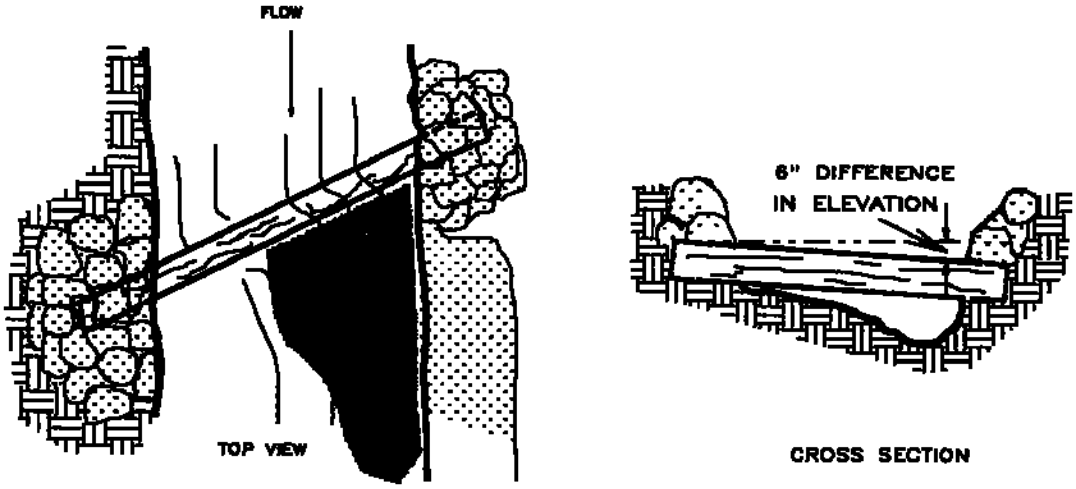


Figure VII-29. Diagonal log weir.

Upstream-V log weirs are used to scour deep pools. Principles of construction are the same for the various shapes of log weirs. These techniques of construction apply to other log weirs with some variations required to accommodate differences in configuration (Figure VII-30).

Rock Weirs and Rock Chutes

Rock structures, which include rock weirs or chutes, can withstand small shifts of material and continue to function as intended. They are made of individual rocks stabilized by weight of the material as well as contact with other rocks. Because they can withstand small deformations and continue to provide fish passage, these types of drop structures are better suited than rigid weirs to withstand downstream channel adjustments.

Because of the inherent irregularities in the surface of rock structures, they generally provide increased hydraulic diversity and better passage performance in comparison to rigid weirs. They can also be easily adjusted by moving individual rocks by hand or with small equipment.

Rock structures are typically designed to maintain lower slopes than rigid weirs. Because of construction methods and the ability for the rock to shift, larger tolerances must be incorporated into the design of the shape and placement of rock structures. The gaps between rocks make them more permeable than rigid weirs, requiring additional care and consideration during design and construction to seal the weirs and provide suitable passage conditions during low flows. Sealing of rock structures is enhanced by providing sufficient spacing between successive structures so bed material accumulates upstream of each structure.

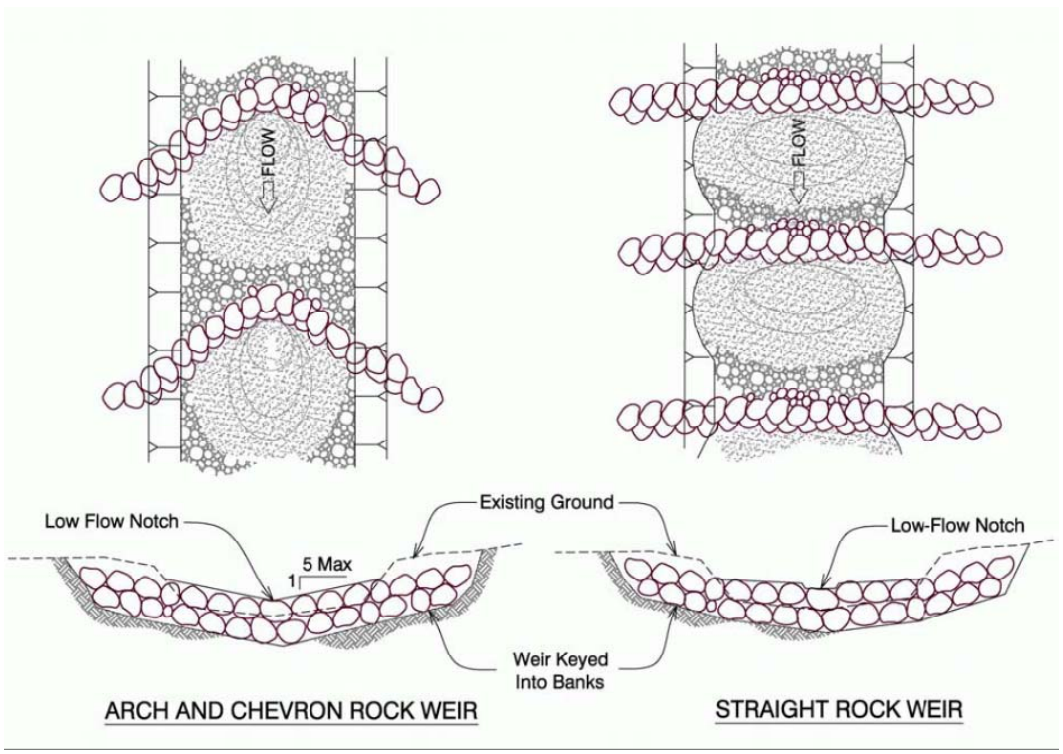


Figure XII-31. Examples of arch shaped rock weir and straight rock weir in planform and cross section.

Native Material Revetment

Native material revetments are alternatives to boulder riprap armoring and crib wall type structures. By combining boulders, logs, and live plant material to armor a stream bank fish habitat is enhanced, in addition to creating a natural looking bank stabilization structure. Native material revetments can provide toe protection for slides or eroding banks and can also be used to re- establish natural stream channel dimensions (Figure VII-55).

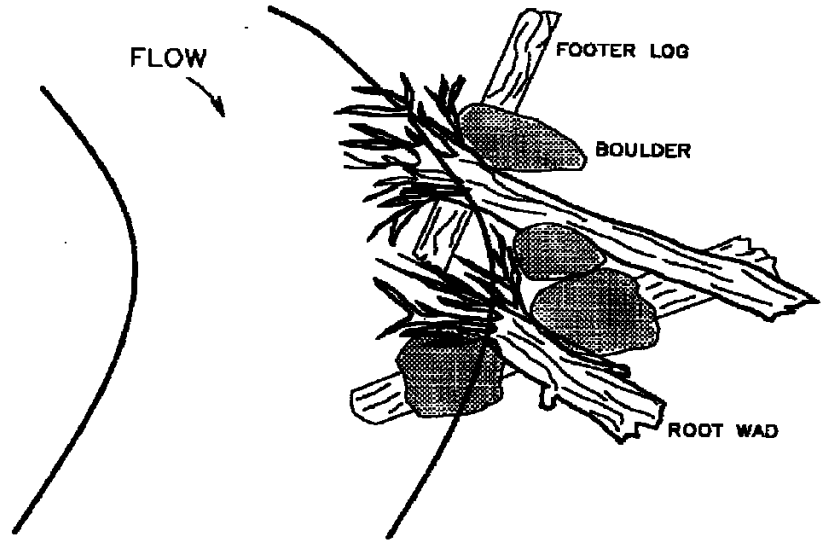


Figure VII-55. Plan view of native material revetment (Rosgen, 1993)

A backhoe or excavator are essential in construction of the revetment. The material sizes needed will vary depending on the stream size and hydrological factors. Logs, preferably redwood with root wads attached, boulders and live plant materials are placed in sequence to ensure stability and proper function of the structure.

Logs without root wads (footer logs) are set in a toe trench below the thalweg line, with the channel end pointed downstream and the butt end angled 45 to 60 degrees upstream. A second log with a root wad is set on top of the footer log diagonally, forming an "X." The root wad end is set pointing upstream and the butt end lying downstream 45 to 60 degrees. The apex of the logs are anchored with threaded rebar. Large boulders are secured in the spaces between the logs, at each apex. After all the logs and boulders have been set in place, any live plant material disturbed from the site along with recruited willows are placed within the spaces of the structure, behind the boulders. Once this has been done the excavated gravel and streambed materials can be placed
over the bank-end portion of the revetment (Figure VII-56).

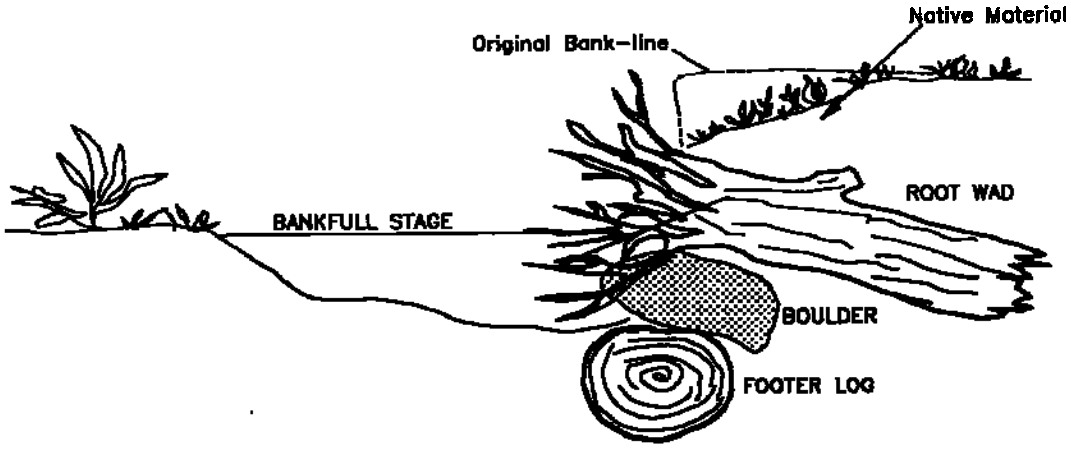


Figure VII-56. Native material revetment (Rosgen, 1993).

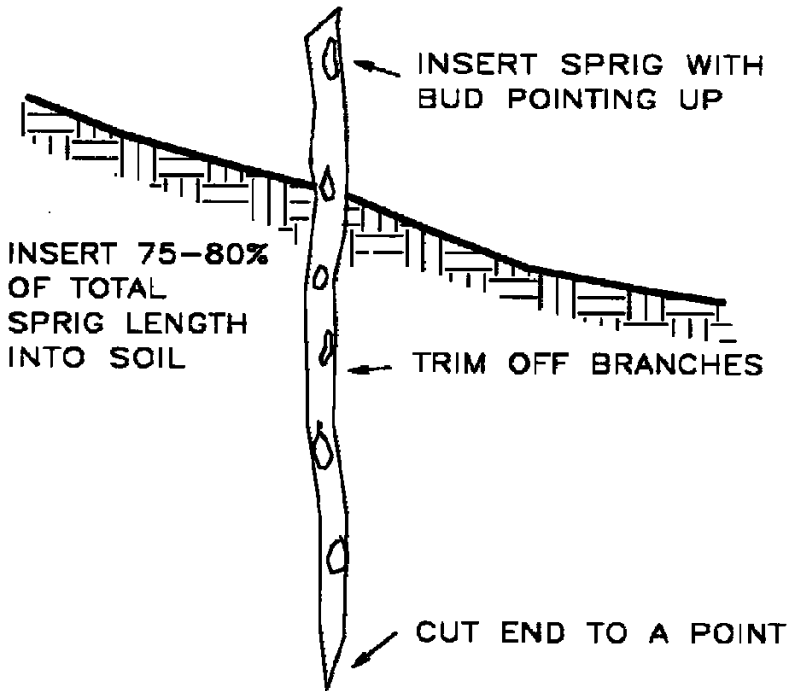


Figure VII-57. Willow sprigging. (Prunuske, 1987).

Plant the willows with the buds up, after sharpening the basal (bottom) end of the sprig with an axe or pruners right after it is cut from the tree. Sprigs should be driven into the soil 75 to 80 percent of their total length, at a slight angle downstream, to decrease their resistance to water flow. In hard soils an iron bar or a chain saw powered auger can be used to bore planting holes. After placing the cutting in the hole, tamp firmly around the cutting to remove air pockets in the soil. In soft soils, sprigs can be driven in with a wooden mallet or sledge hammer. Cut off the tops of the sprigs if they should split while hammering. Leave only one or two buds exposed.

In large rapidly eroding gullies, or along stream banks, appropriate spacing may be as close as one foot. In more stable gullies typical of relatively small watersheds, the sprigs can be placed 2 feet apart.

Cattle and deer tend to browse heavily on young willow. The revegetated areas may need protection by fencing, wire cones, or heavy netting.

Sotoyome RCD's Technical Guide for *Arundo donax* Removal on the Russian River and its Tributaries

December 2010

What is *Arundo* and how do you Identify it?

Arundo donax is a thick-stemmed plant in the grass family, resembling bamboo, that grows up to 30 feet tall. It forms many-stemmed clumps, spreading from thick, knotty roots called rhizomes (RYE-zomes) that grow horizontally, not downward. The root masses can spread over several acres, quickly forming large colonies that displace other plants. The stems of *Arundo* are tough and hollow, divided by nodes like bamboo. The pale green or blue-green leaves clasp the stem with a heart-shaped base. They are up to 1 foot long and arranged alternately along the stem (not opposite each other), each leaf pointing 180 degrees from the next one. In many areas, *Arundo* produces a tall plume-like flower-head at the top of its stems. Its stems often fade to brown during winter or drought. *Arundo* can be confused with bamboos and corn, and young stems can resemble some large grasses such as ryegrass and common reed (Phragmites). *Arundo* typically grows in riparian areas and floodplains. It can be found on wet streambanks, gravel bars, or dry banks far from permanent water. It prefers gently sloping streams over steeper, smaller, creek channels. Scattered colonies can be found in other moist sites such as springs, upper areas of coastal watersheds, drainage ditches, along rice field levees, and residential landscaping.

Important Biological and Ecological Facts About *Arundo*

In North America, *Arundo* is not known to produce fertile seed. It nonetheless spreads very rapidly by vegetative means. One method involves the rhizomes, which grow outward to expand a colony's size. The most common method is when rhizome fragments (as small as a few inches) are dispersed downstream during high stream flows. Fragmented pieces of rhizomes and stems take root, forming new plants and colonies. Removal efforts should begin upstream and work downstream to eliminate re-infestation of cleared areas.

Arundo is one of the fastest growing land plants in the world. During warm months with ample water, *Arundo* stems may grow up to four inches per day! *Arundo* is highly flammable during most of the year, creating a fire hazard for other vegetation, buildings, and people. It is fire-adapted, meaning it resprouts from its roots after fire. Thus, *Arundo* encourages fire along streams, and fires then spread *Arundo* further through the landscape, displacing other plant species. *Arundo* provides virtually no food or

habitat for native species of wildlife. The stems and leaves contain several toxic or unpalatable chemicals which probably protect it from most native insects and other grazers. Therefore, areas taken over by *Arundo* harbor very few native animals. Because they cannot eat it, native animals do not help control the spread of *Arundo*.

Techniques for Eradication

Different methods may be needed to control *Arundo*, depending on the size of the infestation, the amount of cane debris that must be dealt with, the terrain, the season, and whether the canes are mixed with desirable native plants. Where infestations are disparate and highly intermixed with native vegetation, as is the case for the tributaries of the Russian River, hand removal crews operating chainsaws and brush cutters have proven to be the best means of removal followed by herbicide application. Removal of *Arundo* at this scale, while time-consuming and costly, is the only way to conduct complete removal without impacting native riparian vegetation.

Where infestations are dense, and contain little or no native vegetation, such as the mainstem of the Russian River in Alexander Valley, mowing with heavy equipment, followed by herbicide application has proven to be the most effective technique. Mowing *Arundo* with heavy equipment is not applicable along the tributaries of the Russian River because *Arundo* is highly interspersed within the riparian vegetation and because of slope issues along the bank of the creek. Additionally, heavy equipment mowing should not be done within close proximity to the top of bank because of permit restrictions, safety issues, and to maintain bank stability. Cut canes should always be directed away from the watercourse to prevent canes from falling down the bank. Regardless of the removal method used, it is important that all *Arundo* clumps are clearly flagged and property boundaries are identified before any initial work begins. It is very important that all field crews stay within the project boundaries. Prior to accessing the project sites, the property owners or designated contact (such as the vineyard manager), are notified.

Eradicating *Arundo* is usually a multi-year effort. Three or more years of monitoring and re-treatment of the site may be necessary, depending on size and age of the infestation and other variables. Likewise, costs are highly variable depending on the slope of the site, the ease of access, who is doing the work, and the disposal method. Consider the effects of your work in the riparian zone on fish migration and bird nesting. This issue is critical, especially when rare, threatened, or endangered species may be present. Bird nesting is from about March to around July. Anadromous fish migrate from the ocean back to their home streams at various times throughout California. Consult the US Fish and Wildlife Service, the CA Department of Fish and Game, or the National Marine Fisheries Service to find out if protected species, especially salmon, steelhead, or other anadromous fish, may be present at your site. If they are, work carefully according to any guidance the agencies provide.

Cut, Resprout, and Spray (Foliar Herbicide Application)

The technique: This method requires removal of the canes, allowing the roots to resprout, and following up with foliar sprays. The “Cut” aspect of this method can be done with a heavy equipment mower in areas with large, pure stands of *Arundo*. Handcrews are needed in areas that are intermixed with native vegetation or where there are slope or access issues.

Equipment needs:
Mainstem Russian River: The majority of the *Arundo* infestations along the mainstem should be removed with the use of heavy machinery. The use of heavy machinery requires a licensed operator.

Russian River Tributaries: Cutting should be done with loppers, a chainsaw, or a power brushcutter. Chainsaws work well for some, but the fibrous stems can clog or derail the chain. A tight, sharp chain is crucial. Loppers are safest. Cutting the canes can be done by hand or power tools depending on the size of infestation. **Note**: Wear gloves. *Arundo* stems and leaves are sharp and can cut skin. The surfaces are abrasive. Avoid cutting canes at sharp angles. The cut edges can cause injury if someone falls on them. Watch the ends of the canes you are handling, so as not to hit or cut someone.

Personnel requirements:
For safety purposes and efficiency, a trained two person crew consisting of an equipment operator and a field assistant are needed during heavy equipment mowing. The field assistant is responsible for insuring the equipment operator avoids all native vegetation including hidden tree roots, and scoping out terrain and topography changes on site. In addition, the field assistant is responsible for moving and stacking the cut *Arundo* stalks as the mower is operating.

At least two people are required for hand removal efforts depending on the size of the infestation and the size of the site. Generally, it is most effective when at least one crew member is cutting *Arundo* while another team member clears and piles the cut canes. Use of power tools requires more space and therefore limits the number of workers in a given area. One person (preferably more) trained in the use and handling of herbicides is needed to spray (see Requirements for Herbicide Applicators).

Timing: The best time to cut *Arundo* to force resprouting is during the spring and summer.
The cutting should occur early in the growing season to allow time for resprouting in the same year. Follow-up spray should be scheduled when regrowth is still small and easy to reach, approximately two months after cutting. Foliar spray can be effective throughout *Arundo's* growing season, but fall is optimal. Over head spraying should not be done. The *Arundo* should be cut when it is approximately 2-4-feet tall.

Side-effects: The greatest risk when spraying standing *Arundo* is the potential for spraying desirable vegetation, particularly if there is wind. To eliminate over-spray, tarps can be used to cover desirable vegetation. Also, the branches of willows or other larger shrubs and tress can be trimmed back if they are very close to *Arundo* so that these plants have no contact with the herbicide. **Note**: If the average wind speed is over 6 mph, you should use the "Cut and Paint" technique described below. All handling, staging and application procedures should follow the herbicide label precautions and the CEQA document and permit guidelines.

Cost: Costs can be highly variable depending on slope, the degree of adjacent desirable vegetation and the scale of the *Arundo* infestations. In general the first year of removal is the most costly because it includes cutting the canes and herbicide application. In considering a budget for Arundo removal, money must be allotted for at least two years of follow up spraying after the initial removal.

Success rate: Foliar application has been found to be 50% effective the first year and 75% effective the first year and may take 3 years for complete eradication. Effectiveness depends on the herbicide mixture used, weather conditions, the time of year, and the amount of leaf coverage.

Appropriate use: The cut, resprout and foliar spray method is very effective and can be applied when there is adjacent vineyard land or native vegetation, assuming the described safety precautions are implemented to eliminate over head drift.

Cut and Paint

The technique: This method entails cutting the stalks off and applying an imazapyr-based herbicide directly to the stump. Sometimes, the canes are first removed by cutting the stalks off 1 to 2 feet from the ground. With the area cleared of canes, access is safer and easier. The stumps are then re-cut to within 2" or 3" from the ground and treated with herbicide. It is very critical to only re-cut what can be treated within a couple of minutes. The longer the wait, the less likely the cut plant will draw the herbicide down into its roots. Cut the canes off squarely to make herbicide application easier and to avoid dangerous spikes jutting out of the ground.

Equipment needs: Loppers, chainsaws, or brushcutters can be used to cut the canes. A paint brush or sponge dauber can be used to apply herbicide **(see Herbicide Usage and Handling)**. Use marking dye such as Markit, available at hardware stores, mixed with the herbicide to differentiate treated stems from untreated. A brush or spray-bottle is easily obtained. On larger jobs, a dauber may prevent back pain, since the applicator can stand upright while using it instead of bending over. A dauber can be made by adapting a standard watering wand: Remove the metal screen at the watering end, and replace it with a circular piece of sponge. Use fixtures available at a hardware store to make a tight cap for the handle end. Fill the wand with herbicide. A rubber squeeze-bulb, attached with hose-clamps on the handle end, will give better control of the flow of herbicide. Forestry Suppliers (1-800-647-5368) has a dauber-type device for sale called the Sideswipe Pro ($38.50).

Personnel requirements: A large group can do the initial cutting and removal of canes. Power tools require more space and therefore limit the number of workers in a given area. At least two people need to work together so that one crew member can cut the canes while the other quickly paints the freshly cut stumps One person trained in the use and handling of herbicides is needed to supervise all herbicide applications (see Requirements for Herbicide Applicators).

Timing: Cut Stump application can be done throughout the growing season, although effectiveness may be best when herbicide is applied in late summer or early fall before the plants enter dormancy. Application of herbicide should be done within approximately 2 minutes after re-cutting for best results.

Side-effects: There is a risk of spillage when using undiluted herbicide. Exercise caution when handling open containers; avoid carrying them onto the site. Using a sponge dauber poses very little risk to surrounding vegetation. Capped sponge applicator wands are the least likely to spill and more efficient than brushing.

Cost: Very little herbicide is wasted with this precise application method, but a greater volume and a higher concentration of herbicide is needed to complete the job. Non-target losses are avoided and follow-up is minimal. Property owners can save significantly by doing the work themselves. In general, the cut and paint method is more time consuming and costs more for labor and herbicide than the cut, resprout and foliar spray method.

Success rate: This method's effectiveness ranges from 50% to 75% in the first year. Expect complete eradication to take up to 3 or more years. The highly variable success rates are due to factors including the herbicide used, weather conditions, the time of year, and the thoroughness of coverage.

Appropriate use: This method should really only be used when average wind speed is greater than 6 mph, or when applying herbicide to *Arundo* patches that are in close proximity (10 feet or less) to a stream or other waterbody. It may also be used when there is a high concern for mortality of native vegetation due to stray herbicide from hand pump sprayers. This method is also ideal in remote or hard to reach areas. Return trips are minimized and it is not necessary to pack in heavy tools. It is appropriate for supervised volunteer groups because it is simple and is safe to work in close proximity. This method is not appropriate for larger stands of *Arundo*, due to its time-consuming nature and its associated labor costs.

A Comparison of Techniques for Eradication

Method	Best Use	Timing	Tools	Permits	Advantages	Disadvantages
Cut, Resprout and Spray	Mowing: Pure stands. Large infestations, with little native vegetation. Hand removal: Best for infestations intermixed with native vegetation	Cut in spring to summer. Spray regrowth in late summer/early fall when plant energy is transferred to roots	Mowing: Mechanized Mower Hand removal: Loppers or power brush cutter (steel-blade weed whacker). imazapyr-based herbicide appropriate for foliar application. Sprayer with directional nozzle.	DFG 1600 permit, 401 Regional Water Board Permit, County Ag Commission permit for pesticide application by non-landowner	Mowing: Fastest removal technique for large, pure stands of *Arundo*. Hand removal: Low soil disturbance. Less risk of non-target herbicide drift than when spraying full grown canes. Can use volunteers for cutting cane.	Mowing: Based on topography, distance from the top of the slope and extent of native vegetation; mowing activity is limited Both techniques: Takes a minimum 3 years of annual herbicide applications. Risk from drift and run-off to non-target plants.
Cut and Paint	Appropriate when average wind speed is greater than 6 mph, or when applying herbicide to *Arundo* patches that are 10 feet or less to a stream or other waterbody	Anytime during growing season. Best in late summer/early fall when plant energy is transferred to roots	Loppers or power brush cutter. Full-strength imazapyr-based herbicide. Wand or paintbrush applicator.	DFG 1600 permit, 401 Regional Water Board Permit, Fire permit if burning debris, County Ag Commission permit for pesticide application by non-landowner	Low soil disturbance. Low risk of non-target herbicide drift. Can use volunteers for cutting cane. Volunteers can work near applicator.	Requires a more concentrated application of imazapyr-based herbicide. Time consuming with larger stands and therefore the labor can be costly. Can require herbicide applications for at least 3 years

Herbicide Application Notes

Herbicide Application Method

Originally, herbicide application was a cut and paint technique, but this treatment method proved extremely time-consuming, cost prohibitive for long term project success, and in some cases was not as effective as foliar spraying. Additionally, foliar spraying can be applied during and outside of cut and paint desired application periods and can still be effective. Foliar spraying with imazapyr herbicide will usually require up to three years of treatment. For landowners not willing to allow herbicide use on their property, tarping areas of cut *Arundo* for one to two years for at least six months per year has proven an effective technique for controlling *Arundo.* Due to the high cost associated with materials and with deploying, monitoring, and maintaining the tarps, this option, while successful, is not the standard approach to *Arundo* treatment. When applying Imazapyr to regrowth at least 80% of the foliage should be treated.

Herbicide Use Issues

Arundo grows so aggressively that effective eradication efforts usually rely on a systemic herbicide such as Imazapyr, the active ingredient in Habitat®. Unlike contact-type herbicides that only kill the above-ground portion of plants, a systemic herbicide is absorbed by plant leaves and stems and is then transported to the plant's root system where it kills the entire plant, roots and all. Imazapyr is considered non-toxic to birds, mammals, fish, honeybees, aquatic invertebrates, and non-vascular aquatic plants, as determined through toxicity testing conducted by the EPA as part of its re-registration. It does not appear to bioaccumulate in these species (USEPA, 2006).

Herbicide Use and Handling

Pesticide safety training is advised for all applicators. Always read and follow specific label directions and safety precautions. Be extremely careful with open containers of herbicide. Ensure that herbicides are applied at concentrations that are considered safe for biological resources within and adjacent to the project area. Application should be done on dry days to avoid spreading the chemical where it's not wanted. Consult the National Weather Service and allow at least **four days** of dry weather before application of herbicide. If it rains within 24 hours of herbicide application, retreatment is necessary. When Arundo is 10 horizontal feet or less from an active channel, Imazapyr should be painted on rather than sprayed to eliminate run-off from entering a waterway. Herbicide applications should follow the guidelines set forth in the 401and 1600 permits and the CEQA document.

Requirements for Herbicide Applicators

The use of herbicides to remove Arundo on your own property generally does not require permits or other approvals. However, this may depend on the herbicide that will be used, the size of the project area and whether the applicator is the landowner. If you plan to use herbicides to control Arundo, you should contact your county Agricultural Commissioner's office for more information. If a volunteer group or an individual other than the property owner or a licensed applicator applies herbicide, that person or a representative of the group must have pesticide safety training, obtain a pesticide operator identification number, get a pest control recommendation, obtain a letter of authorization from the landowner, and file a monthly use report with the county Agricultural Commissioner's office. Have a licensed pesticide applicator conduct or oversee herbicide applications.

Removal and Disposal of *Arundo* Debris

Removing *Arundo* canes from the immediate work-site is a chore in itself on some sites. A choke chain or rope can be used to tie a bundle of canes before they are cut to prevent them from falling in the creek and to facilitate removal. A winch or a vehicle can be used to pull large bundles up steep slopes. Rope or twine can be used to bundle cut canes to ease hand removal. A tarp can be used to gather up smaller pieces and drag them to a disposal area. Minimize trampling of native vegetation by establishing

marked trails. Methods can depend on the degree of the infestation, accessibility of the cut canes and preferences expressed by the landowner.

Composting: A method for disposal is leaving cut canes on the ground to decompose. This method is ideal for remote areas and where there is room to spread out the canes. It is very important that the canes are spread out so that they dry out and do not resprout. Also the pile should be stacked far enough above the high water line so that the canes are not spread into the waterway and brought downstream. Also, the canes should stacked and piled where there is no chance that the canes would cause damage to adjacent structures or vineyards during a flood.

Chipping: The canes can be chipped on site, out of the creek, with a brush or tree chipper. It can then be piled and used on site. *Arundo* is fibrous and can get caught in the cutting blades of lightweight chippers. It will chip better when dry and brittle. When the *Arundo* is finely chipped it can be used as a mulch for various landscaping purposes. Also, a chipper should be used where large infestations have been removed and where there are large amounts of biomass. Often there can be a combination of chipping portions of the more accessible cut canes and leaving a portion of the canes to decompose on the forest floor.

Burning: The cut canes can be burned in a pile, but there are several restrictions. A burn permit must be secured from the fire department during the fire season and may be difficult to obtain. The burn area must be containable and far from brush and overhanging trees. The Air Quality Management District requires that any material to be burned must dry out for 60 days prior to igniting. The District must be contacted to confirm a burn day. Burning can be an ideal way of disposing of the canes if you have time to wait for the material to dry and for an appropriate burn day.

Dumping: Hauling and dumping large volumes of *Arundo* cuttings is time-consuming and can be expensive. Many cities and some counties have programs for pick-up of yard waste. Some disposal companies and dumps do not accept *Arundo* because it can be difficult to chip. Off site removal is recommended when other options are unavailable.

Revegetation After *Arundo* Removal

Areas that are stripped of *Arundo* may look devastated. The surest and cheapest way to restore native riparian vegetation is to let natural succession and flooding bring in appropriate plant material. Leave the site alone for one or two rainy seasons to see how well “passive” restoration will work. In riparian sites, the stream’s high flows will generally carry fresh sediment and new native plants to the lower streambanks naturally. Nearby native vegetation will often fill available spaces. This process is periodic and may take several years to complete. Often, natural processes will revegetate the lower part of the bank, but “active” methods are sometimes necessary to revegetate the higher, drier areas with native species such as oak trees, upland shrubs, and native perennial grasses. Keep in mind several considerations when considering whether to do “active” revegetation.

- You may want to postpone revegetation until you have achieved complete *Arundo* eradication, since it may be difficult to avoid harming desirable plants during follow-up herbicide treatments.

- If you are downstream of *Arundo* infestations, or near other invasive riparian plant species such as Himalayan blackberry, tree of heaven, vinca (periwinkle), or ivy, prompt revegetation with natives maybe necessary to prevent re-invasion of your site.

Revegetation costs are extremely variable, depending on the needs of the site, the intensity of planting, size of the area planted, and the labor source. If you've decided to actively restore the site, plan your project carefully. Restoration of native plant communities is an art and science unto itself, which cannot be adequately communicated in this document.

It is expected that a high level of natural recruitment processes typically in place in these disturbance-prone areas will be sufficient to recolonize the areas of removed *Arundo.* If removal of *Arundo* constitutes a risk of streambank instability, willow cuttings, cottonwoods, and alders will be installed to decrease the chance of bank loss and sediment inputs. Erosion from *Arundo* control is not expected, as mulch from removal activities is placed back onto the removal area, covering any bare soil that may result. Should bare soil be exposed, this area will be seeded with native grass and mulched.

To maximize fish and wildlife habitat, your long-term objectives should be to eventually shade the stream, stabilize the ground surface with native plants (not annual grasses), and provide a multi-leveled structure of greenery, from small shrubs to tall trees.

These sources may provide information or implementation:

- Local chapter or state office of the California Native Plant Society.
- Nurseries specializing in locally native species.
- Look for ecological restoration services in the yellow pages listings for Environmental, Conservation and Ecological Organizations, or Environmental and Ecological Services.
- Society for Ecological Restoration, California Chapter (SERCAL), at www.sercal.org or SERCAL, 915 L Street, #C-104, Sacramento, CA 95814, (805) 634-9228.

Monitoring

Effectiveness monitoring of removed *Arundo* to determine treatment success is a vital part of this control effort. At the site level, monitoring information is collected pre- and post- removal. This may be based on mapping the locations of the *Arundo,* taking photo documentation, and documenting native plant cover. Also, monitoring canopy cover and bank conditions can be used to demonstrate improvements to water quality and aquatic habitat and the scope of follow up treatments.

Russian River *Arundo donax* Removal and Riparian Restoration Program

The Sotoyome Resource Conservation District (RCD), in partnership with Mendocino County RCD and Circuit Rider Productions, Inc., developed a program to address the *Arundo* infestation, starting at the top of the watershed and working downstream, removing and treating *Arundo donax* populations throughout the basin. Building on the past success of this program the Sotoyome RCD continues to lead the control of *Arundo* in the Russian River watershed increasing overall riparian function and aiding in the species recovery of listed plants and animals throughout the region. Landowner support, a key component of this program, has grown as more awareness about the importance of riparian habitat has increased and the availability of cost share opportunities and programmatic permits have become available.

A great benefit of working with the Sotoyome RCD for *Arundo donax* removal is that the landowner can work under the RCD's permits, and avoid having to navigate through the complicated permitting process. The Sotoyome RCD can also assist with post-treatment monitoring, which is a very important step to ensure successful removal of *Arundo*. The RCD is a great resource for landowners to take

advantage of, and will continue outreaching and assisting new landowners in order to continue the success of the *Arundo* removal program.

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CALIFORNIA SALMONID STREAM HABITAT RESTORATION MANUAL

PART XI

RIPARIAN HABITAT RESTORATION

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Name and Title	**Role in Project**
Rob Evans, Restoration Projects Manager	principal plant and habitat photographer
Karen Gaffney, Restoration Ecologist	principal writer, miscellaneous photography
Katherine Gledhill, Environmental Educator	editing, desktop publishing
Cheryl Dean, Ecologist/Research Coordinator	research, editing, technical writing
Greg Fisher, Ecological Services Technician	research, technical writing

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PART XI. RIPARIAN HABITAT RESTORATION

INTRODUCTION

Natural riparian habitat includes the assortment of native plants that occur adjacent to streams, creeks and rivers. These plants are well adapted to the dynamic and complex environment of streamside zones.

Approximately 95% of the historic riparian habitat has been lost in California, making way for cities, agriculture, mining and other development. The riparian area provides one of the richest habitats for large numbers of fish and wildlife species which depend on it for food and shelter. Many species, including coho and Chinook salmon, steelhead, yellow-billed cuckoo and the red-legged frog, are threatened or endangered in California. Others are rapidly declining.

Most landowners wish to protect their riparian resources while optimizing the value and productivity of their property. These two goals sometimes seem to conflict. An understanding of riparian habitat and stream processes can help landowners conserve riparian resources, and still manage their property productively, and even enhance their property value.

California residents, landowners, land managers, and agencies are increasingly interested in conserving and enhancing watersheds and implementing management practices that are more fish friendly. The riparian corridor is the critical interface between terrestrial and aquatic systems. Increasing numbers of individuals and community groups are involved in habitat conservation and restoration projects in riparian areas. Part XI is intended to encourage and help facilitate the stewardship and restoration of riparian habitat in California watersheds.

In addition to providing basic information about riparian corridors, this Part is intended to assist agencies, landowners, schools and community groups with the planning and implementation of native plant revegetation projects. A plant identification section at the end of Part XI provides detailed descriptions and photographs of plants commonly found along central and north coast California rivers and streams.

STREAM PROCESSES AND RIPARIAN HABITAT

The plant species found in riparian communities differ widely depending upon the character of the watershed and the stream's location within the watershed. The composition of a riparian community is determined by many things, including the reach type, stream slope (gradient), channel confinement, aspect, light availability, water availability, flooding and soil conditions.

For example, at the headwaters of a stream, the gradient is often steep and the riparian vegetation may not vary from the surrounding forest plant community. Further downstream, as the gradient decreases, the riparian corridor begins to differ from the surrounding forest plant community. The riparian canopy is often dominated by trees such as alder, ash, maple, box elder, and oaks, while the surrounding forest may be dominated by conifers. In alluvial areas, sunny openings on gravel bars often provide habitat for species such as mulefat and willow.

Different age classes and species of riparian habitat at different elevations

Streams and their tributaries often cut through broad alluvial valleys. In these alluvial zones, where the substrate is dominated by sand, gravel and silt, the stream freely moves (meanders) back and forth over time, creating and removing riparian habitat naturally. The ability of the stream to move through this meander corridor is what allows the development of diverse riparian forests. Streams in these alluvial areas may have historically included a broad floodplain mature forest with backwater sloughs, oxbow lakes and floodplain wetlands. These diverse habitat features are important for salmonids and other wildlife. Riparian corridors that are wide enough to allow for stream meandering should require little maintenance over the long term. A substantial riparian zone can help to reduce erosion damage to adjacent lands, as well as filter sediment and pollutants. However, due to the high value of agricultural lands as well as the proximity of urban development and other land uses, natural stream movement may not be possible in all managed watersheds.

Russian River meander corridor

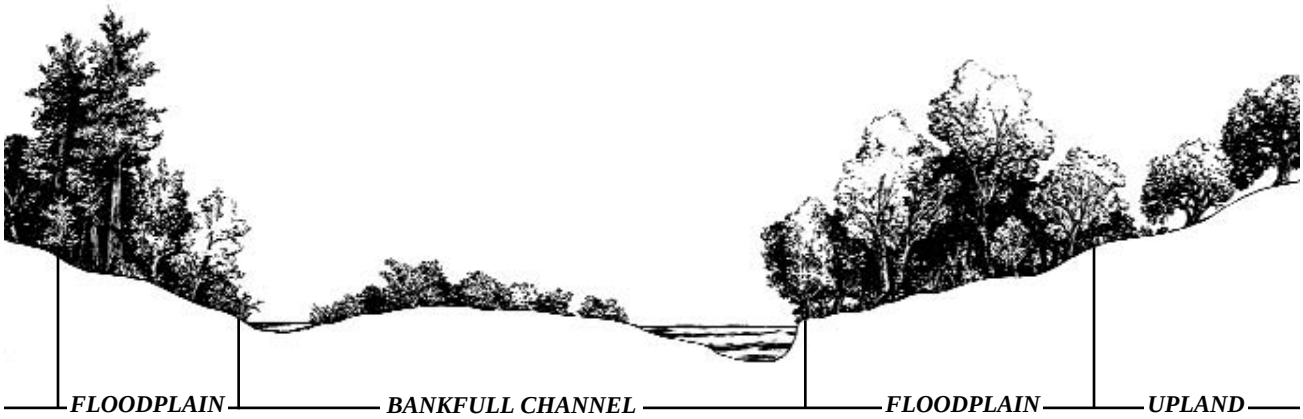
Within the bankfull channel (an area which is regularly flooded), plants are adapted to high levels of flood disturbance during the winter, while tolerating the hot, dry conditions of the gravel bars during the summer. Very few species have the ability to survive in this harsh channel environment; those that do include alder, willow, cottonwood and mulefat. They are called pioneer species, because they colonize recently disturbed sites.

Bankfull channel with small seedlings of pioneer species

The seeds of cottonwood and willow float through the air in the spring just as the water level is beginning to recede. Millions of seeds land on moist gravel bars and germinate there. As the summer progresses, the roots of these tiny seedlings follow the receding water table. Those plants that cannot stay connected to the water table face certain death on the desert-like gravel bar. Those plants that survive the summer drought and winter flood cycle will grow at incredible rates, up to 15 feet per year. As they grow, these pioneer species may begin to trap sediments, and can influence the movement of the stream.

The floodplain is elevated above the bankfull channel and is characterized by many more species than found in the bankfull channel. Floodplain areas support plants that are less adapted to flood scour and do not require as much summer moisture.

Floodplain riparian forests are some of the most important, *and the most impacted*, habitats in California. Intact riparian forests tend to be a dense tangle of large trees in the over-story, and smaller trees, vines, downed wood, and various herbs and fungi in the under-story. The diversity of plants and complexity of habitats in these mature riparian forest zones supports an incredible number of animal species.



Representative cross-section of riparian area

FISH AND WILDLIFE VALUES OF RIPARIAN HABITAT

Salmonids (including coho, Chinook and steelhead) rely on healthy riparian habitat. Riparian trees shade the stream channel, helping to cool the water and retain high levels of dissolved oxygen. Native streamside vegetation provides leaf litter which is eaten by many aquatic insects. These insects are in turn consumed by fish. Roots of riparian plants provide fish with shelter from predators. When large riparian trees fall into the stream, they supply an important structural element in creeks and rivers which helps form pools, sort the substrate, and provide shelter for fish and other aquatic organisms.

Salmonid

Salmonid

Riparian zones along intermittent streams also provide salmonid habitat. Coho salmon and steelhead spawn in the upper reaches of streams and their tributaries while they are flowing in winter. The fry emerge and migrate down to the perennial reaches before the tributaries dry up in summer. These tributaries also serve as important sources of food, spawning gravel, and woody debris that are flushed into the mainstem of a stream during storms. Therefore, alterations to the riparian zones of these seasonal tributaries can have a significant impact on salmonids.

Pacific tree frog (Hyla regilla)

In addition to the important role they play in the salmonid life cycle, riparian areas support an abundance of other wildlife species. Over half of the reptiles and three-fourths of the amphibians in California, including the western pond turtle, red-legged frog and various tree frogs, live in riparian areas. Large numbers of migratory and resident birds rely on streamside habitat. Over one-hundred native species of land mammals are dependent on the riparian zone, including raccoons, ringtails, and river otters. Black-tailed deer utilize riparian zones for fawning.

In an intact riparian corridor, there is a layering effect of plant sizes, shapes and ages that promotes wildlife diversity. A mature riparian forest has a low layer of groundcover, an intermediate layer of shrubs and small trees, and a high canopy of trees and vines. These different layers provide many sites for shelter and food for birds, insects and mammals. In addition, large trees will mature and die, leaving standing snags that provide habitat for cavity nesting birds and other terrestrial wildlife.

Bobcat

Finally, riparian areas act as wildlife corridors, providing important routes for the movement of aquatic species (fish, amphibians, insects), land animals (reptiles and mammals), and birds within a watershed. Stream corridors can be thought of as the circulatory system of the watershed, allowing terrestrial wildlife and fish to migrate up and downstream.

HUMAN VALUES OF RIPARIAN HABITAT

Riparian habitat provides many benefits to streamside landowners. For example, a wide strip of riparian vegetation can offset flood damage to adjacent agricultural lands by acting as a filter for trees and other debris that may wash in during large floods. Riparian vegetation also traps fine sediments and other pollutants contained in terrestrial runoff, thereby preserving instream water quality. Because of their deep roots and dense growth, riparian trees, shrubs, and grasses provide excellent protection against bank erosion, helping to stabilize streambanks.

In addition to assisting with flood protection and erosion control, riparian vegetation may play a role in integrated pest management. Cavity nesting riparian bird species such as kestrels and owls prey on rodents. Other cavity nesting birds such as wrens, tree swallows, oak titmice and bluebirds may help reduce populations of pest insects. Bobcats, coyotes and foxes also use riparian areas to prey on rodents.

Kestrel

Indigenous cultures have relied upon riparian plants for thousands of years, using streamside and wetland plants for basketmaking, as a source of food, and for medicinal purposes.

HUMAN IMPACTS TO RIPARIAN HABITAT

More than 95% of the historic riparian forests in California have been lost due to land use change since European settlement. Logging, urban development, dams, water diversions, gravel mining, and agriculture have all contributed to this loss.

The straightening of creeks for commercial, residential and agricultural activities, and floodplain development, has reduced the width and maturity of the riparian zone, and accordingly changed the river's form through erosional and depositional processes. Dams retain sediment, cut off critical salmonid spawning habitat and may either augment or reduce the natural flow regime. These changes have contributed to the decline of wild salmonids. California rivers once meandered across their forested floodplains, overflowing their banks as a result of winter rains, thus creating a complexity of habitat types. Currently many rivers and creeks have been severely confined, degraded and simplified, resulting in a significant loss of salmonid habitat and biological diversity in general.

Non-Native Invasive Plant Species

Humans have modified riparian areas throughout California in a variety of ways. One of the more serious impacts to native habitats is the introduction of non-native plant and animal species. Invasive plants are a topic of increasing concern for landowners and conservationists. Exotic or non-native plants, such as giant reed (*Arundo donax*) and tamarisk, have spread rapidly and taken over thousands of acres of streamside habitat. These invasive species exclude native vegetation, may increase fire danger and often use large amounts of water, decreasing available resources for fish, wildlife and humans.

Exotic plants usually do not support the same diversity of wildlife found in native riparian forests. If plants such as giant reed or periwinkle dominate the riparian zone, native riparian plants cannot become established. When this happens, the habitat values are often degraded or lost. For example, when an invasive grass such as giant reed becomes established in a riparian area, out-competing native trees such as bay laurel, cottonwood and big leaf maple, the long term consequence is that the large woody debris, shade canopy and leaf litter provided by native species are lost. This results in changes in stream temperature and modification of instream structure and the aquatic food chain. The once complex riparian forest that provided shade, food and structure for salmonids and other species is transformed into a monoculture of grass with very little habitat value. Because riparian species are not especially long lived (20-80 years is typical) invasive species can have extremely negative effects on riparian areas in a relatively short period of time.

Giant reed (Arundo donax)

The following species are common exotic invasive plants found in northern and central California riparian areas, and are pictured in Appendix XI-B:

Common Name	Latin Name	Plant Type
acacia	*Acacia* spp.	tree
cape ivy	*Delairea odorata*	vine
English ivy	*Hedera helix*	vine
eucalyptus	*Eucalyptus* spp.	tree
fennel	*Foeniculum vulgare*	herb
floating primrose	*Ludwigia peploides*	emergent/aquatic
giant reed	*Arundo donax*	grass
Himalayan blackberry	*Rubus discolor*	vine
pampas grass	*Cortaderia selloana*	grass
pepperweed	*Lepidium latifolium*	herb
periwinkle	*Vinca major*	vine
poison hemlock	*Conium maculatum*	herb
tamarisk	*Tamarix* spp.	shrub/tree
teasel	*Dipsacus fullonum*	herb
tree of heaven	*Ailanthus altissima*	tree
yellow star thistle	*Centaurea solstitialis*	herb

Agricultural/Riparian Interface: Pierce's Disease

Pierce's Disease is a fatal disease of grapevines caused by the bacterium *Xylella fastidiosa* which is transmitted by the blue-green sharpshooter insect (*Graphocephela atropunctata*). Certain riparian plants are hosts for the bacteria as well as feeding and breeding hosts for the blue-green sharpshooter. These plants include both native and non-native species and are listed below. In the past, a common practice was to remove all riparian plants adjacent to vineyards in an effort to reduce the incidence of Pierce's Disease. Recent practices have changed to reflect a more surgical approach to removal that only focuses on those plants that are systemic hosts for the bacteria. In systemic host plants, the *Xylella* bacteria spreads systematically throughout the plant after being bitten by the insect. However, in propagative host plants, the bacteria remain at the point of infection and do not spread systemically. Propagative host species are therefore not a high priority for removal. Species such as the invasive, non-native periwinkle (*Vinca major*) are systemic hosts for the bacteria and a breeding/feeding host for the blue-green sharpshooter. These plants are a high priority for removal from an economic perspective, and their removal benefits native riparian habitat as well.

Periwinkle (Vinca major)

The following perennial plants are the major breeding hosts for the blue-green sharpshooter and most are systemic hosts of Pierce's Disease in Napa, Sonoma, and Mendocino counties. Removal of these species has been shown to significantly reduce the number of blue-green sharpshooters in riparian areas and adjacent vineyards (The Pierce's Disease/Riparian Habitat Workgroup, 2000):

NON-NATIVE HOST PLANT LIST

Common name	Latin name
Himalayan blackberry	*Rubus discolor*
periwinkle	*Vinca major*
wild grape*	*Vitis* sp.

* (escaped cultivar or *Vitis californica* hybrid)

NATIVE HOST PLANT LIST

Common name	Latin name
blue elderberry	*Sambucus mexicana*
California blackberry	*Rubus ursinus*
California grape	*Vitis californica*
mugwort	*Artemisia douglasiana*
mulefat	*Baccharis salicifolia*
stinging nettle	*Urtica dioica*

Himalayan blackberry (Rubus discolor)

Mugwort (Artemesia douglasiana)

For more information on the complex topic of Pierce's Disease in north coast streams, visit *www.cnr.berkeley.edu/xylella*, or call your local University of California Cooperative Extension office.

CONSERVATION AND MANAGEMENT OF RIPARIAN HABITAT

Riparian zone in winter with leafless deciduous trees

Many landowners already have intact, healthy riparian corridors on their properties and simply want to preserve these areas in their present state. Others may have riparian areas that are in need of management, due to problems with invasive plants, Pierce's Disease or changes from upstream and downstream land uses. Many landowners are also interested in active restoration of native riparian habitats. The following sections discuss methods for preserving, managing and restoring healthy riparian corridors.

Conserving Riparian Habitat

Healthy riparian corridors require little maintenance over the long term. A stream system that has enough room to move around will sustain a diversity of plant and animal species. Leaving the stream enough elbow room may also protect adjacent land uses from excessive erosion or flood damage.

For those landowners who wish to preserve the integrity of their riparian zones, regular monitoring is recommended. Monitoring can be as simple as walking the stream yearly or seasonally, assessing changes in the stream after a storm or checking for invasive plants or trash that may have been carried in during a flood. More detailed habitat inventory methods are described in Part III of the *California Salmonid Stream Habitat Restoration Manual.*

Conservation of riparian habitat can also be accomplished by placing an easement over the stream corridor. Some conservation easements provide permanent deed guidelines for riparian land uses. Placement of a conservation easement may also provide a tax benefit to the landowner. Some land trust organizations purchase easements from willing sellers.

For more information about conservation easements and land trust organizations, visit the Land Trust Alliance website at *www.lta.org*.

Managing Riparian Habitats

Vegetation Management

In some cases, active management of the riparian zone may be required. Landowners who have concerns about Pierce's Disease may choose to remove certain plants from the riparian areas adjacent to their farming operation. Additionally, invasive plants, such as giant reed, ivy or tamarisk, should be removed before they become a significant problem.

Manual cutting of giant reed biomass

Surgical removal of native and non-native plants along with re-planting of natives is preferred to the wholesale removal of all riparian habitat. While planning for any riparian vegetation project, contact the Department of Fish and Game for technical assistance. Depending on the project, permits may be required from several different local, state or federal agencies. See Part VI for more information on permits.

The following non-toxic treatments require a significant commitment of time and labor. These treatments need to be based on an understanding of each plant's physiology (i.e., timing of flowering, size and structure of the root system, etc.). For example, a species such as yellow star thistle may be partially controlled by mowing, but the mowing treatment must take place prior to seed development, or it will cause seed dispersal and make the problem worse. Root removal options will vary according to the species. Young tamarisk or tree of heaven seedlings can be pulled using hand tools, but mature plants may require heavy equipment, potentially a cause of excessive disturbance and siltation in the riparian zone. Disturbed areas should be treated to prevent siltation to the stream. Species such as Himalayan blackberry and periwinkle may have extensive root

Riparian forest invaded by periwinkle

systems that are difficult to track down and remove. Burning may be accomplished with a backpack torch, but can only take place when there is no threat of wildfire. Tarping is usually implemented after the rainy season has ended. Tarps are then removed prior to the next rainy season. Removal of undesirable plants should be followed with a revegetation program using appropriate native plants which may help to prevent recolonization by other invaders.

There are a variety of non-toxic ways to remove unwanted plant species, and each option should be thoroughly evaluated. Listed below are some non-toxic control options for a variety of invasive non-native plant species. In general, invasive species control will take several years, and will require very careful monitoring and removal of re-growth to ensure success.

Common Name	Latin Name	Removal Options
acacia	*Acacia* spp.	root removal
cape ivy	*Delairea odorata*	root removal
English ivy	*Hedera helix*	root removal, burning
eucalyptus	*Eucalyptus* spp.	root removal
fennel	*Foeniculum vulgare*	root removal, mowing, burning
giant reed	*Arundo donax*	tarping, hand removal (gravel bars)
Himalayan blackberry	*Rubus discolor*	root removal, burning
pampas grass	*Cortaderia selloana*	root removal
pepperweed	*Lepidium latifolium*	root removal, mowing
periwinkle	*Vinca major*	root removal, tarping
poison hemlock	*Conium maculatum*	root removal, mowing, burning
tamarisk	*Tamarix* spp.	root removal, burning
teasel	*Dipsacus fullonum*	root removal, mowing
tree of heaven	*Ailanthus altissima*	root removal
yellow star thistle	*Centaurea solstitialis*	root removal, mowing, burning

If herbicide is being used for the control of invasive plants, extra care should be taken to avoid impacts to the aquatic environment, as well as overspray onto native vegetation. Soils in the riparian zone are very porous. The absolute minimum effective amount of herbicide (per the label) should be used, as excess herbicide is likely to be transported through the air or soils into the stream. Certain herbicides are specially formulated to be less toxic to aquatic organisms and are more appropriate for use in or near aquatic environments. Consultation with your local Agricultural Commissioner's office is required by law.

The following websites provide additional information about invasive species and control options:

http://www.caleppc.org (California Exotic Pest Plant Council)
http://www.cdfa.ca.gov/phpps/ipc/noxweedinfo/ (California Department of Food and Agriculture)
http://ceres.ca.gov/tadn/ (Team Arundo del Norte)
http://endeavor.des.ucdavis.edu/weeds/ (CalWeed Database)

Large Woody Debris

Riparian trees that fall into the stream play an important role in the aquatic system. They provide structure to the stream environment, helping to form pools as well as habitat for a variety of organisms. Large woody debris is an important factor in the recovery of salmonid populations. It is, therefore, desirable to retain a wide riparian corridor with large trees that may be recruited into the stream.

Historically, the approach by many agencies and landowners has been to keep the stream channel clean and open, by removing any log debris accumulation. It was believed that these large trees presented a passage problem for fish. It has since been recognized that fish, especially salmonids, are capable of passing over or through most debris accumulation. Substantial retention of sediment above debris accumulation may indicate a potential fish passage problem. Streams with large woody debris provide good quality salmon habitat.

Large woody debris creates pool habitat

Streamside landowners are understandably concerned that large fallen trees may divert the stream towards their banks, causing massive erosion and loss of land. In these cases, large trees are often removed from the system prior to the next flood event. In recent years, there has been a trend towards modification of large debris accumulation, rather than complete removal. An example of this might include pruning tree limbs and allowing the trunk to remain in the stream. This approach allows for the habitat benefits associated with large woody debris, while resolving problems such as fish passage. Contact the California Department of Fish and Game for more information on this topic. See Part VII on barrier modification and log structures for habitat enhancement.

Large woody debris provides structure to the stream environment

RESTORATION OF NATIVE RIPARIAN HABITATS

Natural Regeneration and Exclusionary Fencing

Riparian systems are often capable of rapid natural regeneration after a disturbance such as a flood, fire or other event causing modification to the landscape. The gravel bars and banks in the bankfull channel will often revegetate on their own within a year or two, provided there is an upslope or upstream source of seeds or plant material. Floodplain areas may take significantly longer and may warrant active revegetation to jump start the natural regeneration process.

Stream floodplain being grazed by livestock

In areas that are being grazed by livestock or are heavily impacted by other native grazing herbivores, exclusionary fencing can give the streambank enough protection to re-create healthy stands of native vegetation. Fencing may be temporary, maintained just long enough to allow native trees and shrubs to re-establish (ten years is often adequate).

Exclusionary fencing along stream headwaters

If fencing is used to allow for the regeneration of riparian habitat, it should be set back far enough to allow the stream to meander and create a diversity of habitat. Fences placed too close to the stream corridor may be damaged during high flows, wasting time and money.

Fencing design, including type of wire, gauge and spacing must be specific to the types of animals you are attempting to exclude. Many fencing supply stores have this information and can help you with construction specifics. Alternative water sources for livestock should be devloped to keep them out of the stream channel. If conditions require that livestock access the stream for pasturing or crossing between pastures, use specialized floating fences (which span the channel) to limit such access. When funding restoration projects, the Department of Fish and Game requires a riparian management plan to be developed and signed by the landowner. For more detailed information on exclusionary fencing, see Part VII.

Erosion Control

Large flood events may create the need for erosion control work in the riparian zone to prevent excess siltation into the stream or loss of land. Whenever possible, a vegetative method for reducing erosion such as bioengineering is preferable to a structural approach such as riprap. Structural approaches to stream bank erosion such as riprap tend to fix the stream in one place, exclude riparian vegetation, and prevent the natural movement that creates diverse habitats. Structural approaches are often more expensive, require permits, and may damage neighboring properties. Over the long term, structural approaches tend to fail or require excessive maintenance. If a structural approach is unavoidable, native vegetation should be incorporated into the structure. Bioengineering will increase the effectiveness of the erosion control method and provide some habitat value as well. See Part VII for descriptions of bioengineering.

Installation of erosion control

Planning and Implementing a Successful Revegetation Project

Revegetation using native plants is effective for enhancing habitat for numerous fish and wildlife species, as well as reducing upslope erosion and sedimentation to streams. Revegetation may include:

- broadcast seeding of native grass or forbs on hillslopes
- instream sprigging of dormant willow cuttings to increase cover and reduce bank erosion
- installation of plants propagated in a native plants nursery
- transplanting of emergent species such as rush, tule or sedge
- direct seeding of native species such as oaks or buckeyes.

The landowner, project personnel, or watershed organization should become acquainted with the stream processes and natural habitat of the area to create a plan that works within the local riparian ecosystem. While planning for any riparian vegetation project, contact the Department of Fish and Game or the Natural Resources Conservation Service for technical assistance. Depending on the project, permits may be required from several different local, state or federal agencies.

Creating and implementing a revegetation project can be a complex process, taking four to six months for design and approval, and several additional months for implementation. In some cases, involving a consultant or watershed group with expertise in the process can save time and be more cost effective. See Part VI for more information on permits.

Tree shelter installation

Riparian Revegetation Project Planning

A successful revegetation project will:

- establish a diversity of native plant types and plant species in the riparian area
- provide fish and wildlife habitat
- reduce erosion
- require minimal annual management.

Revegetation should attempt to replicate the natural system.
In the riparian zone, different species are adapted to distinct microsites, often based on elevation and proximity to the stream. Planning of a riparian revegetation project should take into account where each species occurs in the natural system. It can be helpful to draw a cross-sectional diagram of the riparian zone showing where different species occur. This can help determine planting sites based on elevation above the bankfull channel.

Diverse riparian and upland habitat

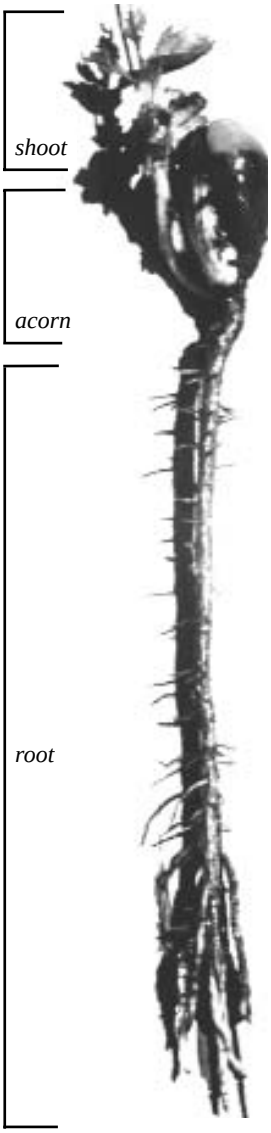
In general, container planting in the bankfull channel is not recommended.
If there is a severe bank erosion problem, or the system has lost all upstream sources of seed, some active channel revegetation may be warranted. Since the bankfull channel is subject to regular flooding, installed plants are likely to wash out prior to establishing a root system. Willows, whether as sprigs, a willow mattress or willow wall, are adapted to this flood prone environment, and can be an effective, relatively inexpensive way to stabilize a streambank or introduce cover to the stream. Plants installed in the bankfull channel should not have protective hardware, as it will likely be lost to flooding.

Seeds, cuttings or transplants should be collected as close as possible to the project site.
Local collection of plant material ensures that only genetically appropriate plants (i.e., those that are adapted to local conditions) will be used on site. Introduction of plant material from outside of the project watershed is not recommended. The use of local plant material usually results in higher survival rates.

Valley oak (Quercus lobata) an important native seed

Sources for Native Plant Material

Appropriate, site specific native plants are one of the most important aspects of a successful riparian restoration project. Project planning may need to begin up to 18 months in advance to obtain those species that must be grown in containers. For example, a particular species may have seed that ripens in July. After treatment of the seed and propagation in the nursery, the plant may not be ready for outplanting until the following fall/winter. This is often the most important phase of planning a successful restoration project. If you are not in a position to grow the plants yourself, it is a good idea to order plants from a local native plants nursery as soon as you have selected a restoration site.



Bare-root stock can also be used instead of container stock. However, bare-root stock is often difficult to locate because few nurseries produce it. Spacing of plants depends on the species, the goals of the project, desired densities, and many other factors. General spacing recommendations are included in Table XI-1, page XI-26.

Nurseries specializing in California native plants do things differently than typical landscape nurseries. California native plant nurseries usually custom collect site specific material for particular restoration projects, or at minimum, they track where the plant material was collected. This ensures that you can purchase plant material suitable for your project site.

The California Native Plant Society website, *http://www.cnps.org/links/grow links.htm* includes a variety of resources about California flora, including a list of native plant nurseries.

Common container sizes found in native plants nurseries are listed below:

Container Name	Size	Uses
6” and 8” supercell	1 1/8” x 6” 1 1/8” x 8”	Best for plants with fibrous root systems
deepots	2 1/2” x 10”	Good for trees and shrubs
treepot	4” x 14”	Generally used for trees
treebands	2 1/2” x 5”	Good for trees and shrubs

Native plants nurseries also use unique containers like treepots, deepots or supercells (shown to the left) to develop an optimum root-to-shoot ratio (see example photo, above right). This approach provides plants with a well established root system prior to outplanting at the revegetation site.

Emergent Transplant Installation

Plants such as rushes, sedges and tules are commonly called emergent plants, because they are often associated with creeks, wetlands and lakes, where they emerge from the water. They may reproduce from seed or from the spreading of underground rhizomes. This vegetative form of reproduction makes emergent species ideal candidates for transplantation into revegetation sites. These species are widely adapted to a range of environments, including high velocity bankfull channels, slow moving backwaters, seeps on hillslopes, and stable, relatively dry floodplains. It is important to identify the species to use and transplant them in an appropriate location. There are also some non-native species of emergents that should not be transplanted into riparian zones. Care should be taken to sensitively harvest these plants so the existing population is not seriously degraded. It is a good idea to take several small clumps from a variety of larger clumps, leaving the majority of each population intact to ensure genetic diversity.

Collecting emergent vegetation

Emergent vegetation, rhizomes exposed

Steps required to transplant emergent species:

- In the winter or early spring, carefully harvest rhizomes and the above-ground portions of the plant with a mattox, sharp trowel or shovel. Make sure one to several intact rhizomes remain for each transplant.
- Store the collected plant in a cool moist location until time for transplanting. Ideally, plants should be stored in moist soil, and should be transplanted as soon as feasible after collection.
- Dig a hole for the transplant that is large enough to accommodate the extended rhizome without bending or breaking it. Place dirt around the rhizome, pack it down, and water it in thoroughly to close any air holes around the rhizome.
- Trim back the above ground portions of the plant in order to stimulate rhizome growth.

Installation of emergent vegetation

Dormant Willow or Cottonwood Sprig Installation

Willows and cottonwoods are in the willow family (*Salicaceae*) and are generally adapted to bankfull channel environments. Species in this family form specialized roots along their stems, allowing for vegetative reproduction in riparian corridors. This feature makes them good candidates for installation as sprigs or dormant cuttings. In general, willows need significant amounts of light and a year-round source of moisture. They are good candidates for revegetation as long as their root zone remains moist during the summer. Because of their ability to withstand flood flows, they are often a good choice for bank stabilization projects in bankfull channel areas. There are many varieties of willow and cottonwood in California. Some (such as the curly willow and Lombardy poplar) are not native and should never be planted in riparian areas. They may not supply the same habitat values as the native plants, and may hybridize with them. Cuttings should be harvested from a variety of parent plants in order to avoid out-planting genetically identical material. These techniques result in a more successful project, will ensure genetic diversity, and do the least damage to the collection site.

Sharp, clean loppers produce high quality sprigs and cuttings

Typical dimensions for willow and cottonwood sprigs

Steps required to install dormant willow and cottonwood cuttings:

- Harvest cuttings during the winter months when plants are dormant (usually December-January). Although willows and cottonwoods will grow from cuttings at other times of the year, dormant cuttings are more resistant to disease, have higher survival rates, and do not require irrigation if planted in the appropriate location. Sprigs may be harvested using sharp, clean loppers, hand shears, or a chainsaw. The cuttings

Store cuttings in a moist environment

may be collected at a range of sizes (i.e., ½ inch to 4 inches diameter and up to 8 feet long). It is important to select material that has not become too woody, and that has several viable buds along the stem.

- Cuttings may be used immediately, stored on-site in the stream, or stored off-site in a bucket of cool water. Ideally, material should be harvested and installed the same day.

- Sprigs should be installed with buds pointing up, with approximately ¾ of the cutting in the soil, and ¼ exposed. Holes may be dug with a pick, with a piece of rebar, with an auger, or a backhoe (for large material). In areas with soft soil, you may avoid digging a hole by cutting the bottom at an angle and pounding it into the ground with a small sledge hammer. If the top is damaged by the hammer, cut off the top of the sprig to allow for clean healing or place a driving shield over the top to drive in the sprig.

Auger used for planting holes

Small sledge hammer for installing sprig

Clean, sharp loppers cut off damaged top of sprig

Container Plant Installation with Shelters
Container plants need to be ordered or propagated months in advance and may be grown by a native plants nursery or an individual practitioner (see page XI-16). Although the installation of container plant material requires more up-front planning than sprigging, emergent transplants and direct seeding, it also allows for the installation of a more diverse plant palette. Some projects use a two-phased approach, with cuttings, emergents and direct seeded species installed the first year, followed by installation of container plants the second year.

Steps required for installing container plants with shelters:

- Plants should be installed during the winter. Plants that will not be irrigated should be planted from December through February, after rains have thoroughly saturated the ground. Plants that will be drip irrigated can be installed at other times during the year. Because of the dangers of planting on the bank of a stream during high flow periods, when stream banks are slippery and the current swift, it may be best to delay some projects until conditions are safe.

- When installing plants, dig holes to twice the depth of the root-ball of the plant to be installed, crumbling any large soil clumps. Partially refill the hole, firmly tamping the soil to create a firm base for the new plant. Place the plant so the top of the root-ball is slightly above finish grade, to allow for future settling. Fill the hole and tamp firmly to remove any air pockets. Irrigate immediately, ensuring the water soaks deeply, unless the ground is already saturated.

Remove weeds from the planting area

Dig the planting hole twice the depth of the root ball

Water the plant immediately, ensuring that the water soaks deeply. If planting in low moisture conditions, plants should be watered during the planting process and therafter until rains begin.

- Where damage from domestic animals and wildlife is a concern, consider protecting plants with shelters (except those that will be in flood-scoured areas). Shelters should be firmly staked and tied so they will remain upright. There are a variety of shelters available, ranging from chicken wire enclosures (screen and collar, shown in photo at bottom) to plastic tubes (a.k.a., *supertubes*, shown in photo at right). All of these methods have proven successful, if they are maintained and weeds are controlled. Shelters should be removed as soon as the plants begin to outgrow them (3-5 years is typical for riparian plants).

- Weeds should be carefully controlled in revegetation areas before and after installation. Plants can become lost in the weeds, increasing maintenance costs and reducing project success. Mow tall weeds before installation, and consider using weed mats (3-foot-diameter sheets of specially designed woven or perforated plastic) around each new plant.

Installation of supertube on newly planted native seedling

Installation of weed mat

Installation of screen and collar protective hardware

Direct Seed Installation

Several riparian species are good candidates for direct seeding. These include large seeded species such as buckeye, native California black walnut, California bay laurel and the native oaks. Large seeds provide these species with a reserve of nutrients that can sustain them during the early phases of seedling development. Although some other seed producing species can be direct seeded under ideal conditions (including weed free environments with good soil moisture), it is generally not a successful technique. Additionally, many seeds are adapted to very specific conditions prior to germination, and may require treatment such as cold stratification or seed coat scarification. In order to ensure genetic diversity and maximize project success, seeds should be collected from several source plants.

Buckeye seed with developing root

Steps required for direct seeding:

- Collect the buckeye, bay, walnut or oak seeds when ripe (fall or winter, depending on the species). Ideally, seeds should be collected from the trees, rather than the ground in order to reduce damage from insects and bacteria. Seeds should come off easily. Check each seed for large numbers of insect holes or mechanical damage, and discard those that appear diseased or feel lighter than the others.
- Store seeds in a cool place until ready for out-planting. If seeds will be stored for more than a few days, they should be placed in plastic bags with perlite and refrigerated.
- Plant seeds in the winter, when soil moisture has reached a depth of 10 inches or more. Dig a shallow hole at each planting location, and cover seeds with one to two inches of soil. If seeds have begun to germinate, care should be taken to protect the tender new root. For buckeye, only one seed should be required, whereas for the other species you will want to install three to five seeds per planting spot. Once they have germinated, you can select the strongest seedling and clip the others with shears.
- If you choose to protect seedlings from deer browse, the techniques described on the following pages may be used.

Careful placement of buckeye seed

Cover seed with 1-2 inches of soil

Project Maintenance

Maintenance of native plant revegetation projects is critical to project success, and often requires an equal or greater expenditure of labor and resources than the installation phase. Maintenance usually includes weeding, watering and general monitoring.

Important maintenance tasks include:

- Regular hand weeding around individual plants during the height of growing season in spring and early summer, as well as one final weeding in the fall. In some cases, where tall weedy species like mustard, hemlock or fennel are present, the whole site may require mowing or mechanical weeding in order to ensure site access and reduce excess shading.

- Soil moisture should be checked on a regular basis during the first two to three growing seasons and plants evaluated for drought stress. The watering regime (whether hand irrigation or a drip system) should be scheduled according to plant needs, rather than an arbitrary schedule. Irrigation should include the minimum amount necessary to keep the plants healthy so they do not become dependent upon additional water. If the plants are appropriate to the location, and installed correctly at the right time of year, they should not require irrigation past year three. Watering should taper off as the plants mature.

- General monitoring should take place at each maintenance visit. Each plant should be checked for signs of disease, rodent or insect browse, and drought stress. Damaged plants should be replaced when possible. Encroachment by invasive species should also be monitored, and these species controlled before they take over the revegetation site.

Mechanical weeding of project site

Hand watering of individual plant

REGULATORY AGENCIES AND REQUIREMENTS

(excerpted from The Pierce's Disease/Riparian Habitat Workgroup, 2000
Riparian Vegetation Management for Pierce's Disease in North Coast California Vineyards)

Several federal, state, and local agencies have regulatory authority over work done in the riparian corridor and may need to be contacted for a revegetation project. It is the landowner's responsibility to be familiar with these agencies and notify them when a project is planned.

Different agencies may have jurisdiction over a project, depending on the character or extent of the project. Most revegetation projects will involve only the removal of specific non-native plants, and replanting of native plants. Such simple revegetation projects will require the least regulatory agency input. The one agency that will certainly require notification, even for a simple revegetation project, is the California Department of Fish and Game. In addition, the Regional Water Quality Control Board may need notification if the project would result in soil erosion, and/or runoff of pesticides into the stream (due to removal of a vegetative buffer).

Some revegetation projects may have a streambank stabilization component. If the stabilization involves re-contouring of the streambed and banks, the United States Army Corps of Engineers and NOAA Fisheries may need notification, in addition to the two agencies mentioned above. Streambank stabilization projects that use bio-technical approaches, such as live vegetation baffles and revetments, will have fewer negative impacts to natural resources and may need less regulatory agency involvement than projects with standard engineering and riprap. The use of standard engineering and riprap is generally discouraged in areas that contain threatened and endangered species, such as salmon and steelhead, because of the negative effects on habitat.

Formal agency notification typically involves completing a form that describes the project, often with a project design map and written description, and paying a fee. Talking to agency representatives about the project before this formal notification can save a significant amount of time. Most agencies encourage informal consultation in the early stages of project planning. The concerns of each party can be addressed, and potential roadblocks eliminated or reduced. In some cases, one agency may pass your project on for review by other agencies, but do not assume this will happen. The landowner and project manager is always responsible for informing all agencies. Many of these agencies charge fees to process the applications and permits. Call each agency for information and a current fee schedule.

Riparian revegetation project, Russian River watershed

Become familiar with the regulatory agencies described below. Even better, get to know the agency staff that work in your area and find out what their interests are, before designing your project (refer to Part VI, Project Planning and Organization).

Activity	**Agency to Contact**
Native plant revegetation	California Department of Fish and Game
Native plant bio-engineering	California Department of Fish and Game
Streambank stabilization (riprap, other structures)	United States Army Corps of Engineers California Department of Fish and Game
Earth moving & placement of fill	United State Army Corps of Engineers California Department of Fish and Game Regional Water Quality Control Board County Permit and Resource Management Dept. County Planning Department Natural Resources Conservation Service
Herbicide application	Agricultural Commissioners Office Regional Water Quality Control Board
Vegetation removal (native or non-native)	California Department of Fish and Game

Riparian corridor expansion project

Herbicide application

Table XI-1. Native Plants for Revegetation: Planting Location, Container Type and Spacing

The following plants are common in central and north coast watersheds and are recommended for use in riparian revegetation projects. Before choosing plants for a revegetation project, survey your area to determine the appropriate species, or consult with a native plant specialist. This table provides information about the typical location of riparian species, the revegetation approach (e.g., container, direct seed, dormant sprig or transplant) and general spacing suggestions.

COMMON NAME	LATIN NAME	PLANTING LOCATION	REVEGETATION APPROACH	SPACING feet-on-center	PAGE
BROADLEAF TREES					
Big Leaf Maple	*Acer macrophyllum*	floodplain	container	8 – 10’	A-1
Black Cottonwood	*Populus balsamifera* ssp. *trichocarpa*	channel	container, sprig	8 – 10’ 2 – 6’	A-2
Box Elder	*Acer negundo* var. *californicum*	floodplain	container	8 – 10’	A-3
California Bay Laurel	*Umbellularia californica*	floodplain	container	8 – 10’	A-4
California Buckeye	*Aesculus californica*	floodplain	container, direct seed	8 – 10’	A-5
Coast Live Oak	*Quercus agrifolia*	floodplain	container, direct seed	8 – 10’	A-6
Fremont Cottonwood	*Populus fremontii* ssp. *fremontii*	floodplain, channel	container, sprig	8 – 10’ 2 – 6’	A-7
Mountain Dogwood	*Cornus nuttallii*	channel	container	8 – 10’	A-8
No. CA Black Walnut	*Juglans californica* var. *hindsii*	floodplain	container	8 – 10’	A-9
Oregon Ash	*Fraxinus latifolia*	floodplain, channel	container	8 – 10’	A-10
Oregon Oak	*Quercus garryana* var. *garryana*	floodplain	container, direct seed	8 – 10’	A-11
Red Alder	*Alnus rubra*	floodplain, channel	container	8 – 10’	A-12
Sycamore	*Platanus racemosa*	floodplain	container	8 – 10’	A-13
Valley Oak	*Quercus lobata*	floodplain	container, direct seed	8 – 10’	A-14
Water Birch	*Betula occidentalis*	channel	container	8 – 10’	A-15
White Alder	*Alnus rhombifolia*	channel	container	8 – 10’	A-16
Willow	*Salix* spp.	channel, floodplain	container, sprig	8 – 10’ 2 – 6’	A-17
CONIFEROUS TREES					
California Nutmeg	*Torreya californica*	floodplain	container	8 – 10’	A-18
Coast Redwood	*Sequoia sempervirens*	floodplain	container	8 – 10’	A-19
Douglas Fir	*Pseudotsuga menzieii*	floodplain	container	8 – 10’	A-20
Pacific Yew	*Taxus brevifolia*	floodplain	container	8 – 10’	A-21
Western Hemlock	*Tsuga heterophylla*	floodplain	container	8 – 10’	A-22
SHRUBS AND SMALL TREES					
Blue Elderberry	*Sambucus mexicana*	floodplain	container	8 – 10’	A-23
California Blackberry	*Rubus ursinus*	floodplain	container	4 – 6’	A-24
California Hazelnut	*Corylus cornuta* var. *californica*	floodplain	container	4 – 6’	A-25
California Wild Rose	*Rosa californica*	floodplain	container	4 – 6’	A-26
Cascara	*Rhamnus purshiana*	floodplain	container	4 – 6’	A-27
Coffeeberry	*Rhamnus californica*	floodplain	container	4 – 6’	A-28

COMMON NAME	LATIN NAME	PLANTING LOCATION	REVEGETATION APPROACH	SPACING feet-on-center	PAGE
SHRUBS AND SMALL TREES					
Coltsfoot	*Petasites frigidus*	floodplain	container	4 – 6’	A-29
Creambush	*Holodiscus discolor*	floodplain	container	4 – 6’	A-30
Elk Clover	*Aralia californica*	floodplain	container	4 – 6’	A-31
Hawthorn	*Crataegus douglasii*	floodplain	container	4 – 6’	A-32
Mulefat	*Baccharis salicifolia*	floodplain	container	4 – 6’	A-33
Ninebark	*Physocarpus capitatus*	floodplain	container	4 – 6’	A-34
Osoberry	*Oemleria cerasiformis*	channel	container	4 – 6’	A-35
Pacific Wax Myrtle	*Myrica californica*	floodplain	container	4 – 6’	A-36
Red Elderberry	*Sambucus racemosa*	floodplain	container	8 – 10’	A-37
Red Flowering Currant	*Ribes sanguineum*	floodplain	container	4 – 6’	A-38
Red Twig Dogwood	*Cornus glabrata*	floodplain	container	4 – 6’	A-39
Salmonberry	*Rubus spectabilis*	floodplain	container	4 – 6’	A-40
Snowberry	*Symphoricarpos albus*	floodplain	container	4 – 6’	A-41
Spiraea	*Spiraea douglasii*	floodplain	container	4 – 6’	A-42
Stink Currant	*Ribes bracteosum*	floodplain	container	4 – 6’	A-43
Stream Dogwood	*Cornus sericea*	channel	container	4 – 6’	A-44
Thimbleberry	*Rubus parviflorus*	channel	container	4 – 6’	A-45
Toyon	*Heteromeles arbutifolia*	floodplain	container	4 – 6’	A-46
Twinberry	*Lonicera involucrata*	floodplain	container	4 – 6’	A-47
Vine Maple	*Acer circinatum*	floodplain	container	4 – 6’	A-48
Western Azalea	*Rhododendron occidentale*	floodplain	container	4 – 6’	A-49
Western Spicebush	*Calycanthus occidentalis*	floodplain	container	4 – 6’	A-50
Wild Mock Orange	*Philadelphus lewisii*	floodplain	container	4 – 6’	A-51
VINES					
California Wild Grape	*Vitis californica*	floodplain	container	4 – 6’	A-52
Dutchman's Pipevine	*Aristolochia californica*	floodplain	container	4 – 6’	A-53
Honeysuckle	*Lonicera hispidula* var. *vacillans*	floodplain	container	4 – 6’	A-54
Manroot	*Marah fabaceus*	floodplain	container	4 – 6’	A-55
Poison Oak	*Toxicodendron diversilobum*	floodplain	container	4 – 6’	A-56
Virgin’s Bower	*Clematis lasiantha*	floodplain	container	4 – 6’	A-57
EMERGENT AND HERBACEOUS PLANTS					
Bulrush	*Scirpus acutus* var. *occidentalis*	channel	container, transplant	1 – 2’	A-58
Cattail	*Typha latifolia*	channel	container, transplant	1 – 2’	A-59
Creeping Wild Rye	*Leymus triticoides*	floodplain	container, transplant	1 – 2’	A-60
Horsetail	*Equisetum* spp.	floodplain, channel	container, transplant	1 – 2’	A-61
Indian Rhubarb	*Darmera peltata*	channel	container, transplant	1 – 2’	A-62
Mugwort	*Artemesia douglasii*	floodplain, channel	container, transplant	1 – 2’	A-63
Rush	*Juncus* spp.	floodplain, channel	container, transplant	1 – 2’	A-64
Sedge	*Carex* spp.	floodplain, channel	container, transplant	1 – 2’	A-65
Spike rush	*Eleocharis* spp.	channel	container, transplant	1 – 2’	A-66
Stinging Nettle	*Urtica dioica*	floodplain, channel	container, transplant	1 – 2’	A-67

GLOSSARY

Achene: Dry, one-seeded fruit that often looks like a seed. Produced in a one-chambered ovary. Does not open to release the seed.

Allelopathic: Plant produces and releases a toxic substance that results in suppressed growth in other plant species.

Alternate: Describes growth pattern in which new structures develop singularly along axis. For leaves, only one leaf is produced per node so leaves appear to have "alternated" the side of the stem from which they grew (see opposite).

Annual: Plant completes entire life cycle, from germination to seed production and death, in one year or growing cycle (see biannual, perennial).

Asexual: Reproduction by a single individual using a process that is not sexual and does not involve the union of individual cells and the reassortment of genetic characteristics.

Biennial: Plant completes entire life cycle, from germination to seed production and death, in two years or growing cycles. Usually flowers are produced only during the second cycle (see annual, perennial).

Bisexual: Flowers have both female and male fertile reproductive structures (see unisexual, dioecious, monoecious).

Bract: A leaf-like or scale-like structure associated with and usually directly under a flower or cone.

Capsule: Dry, pod-like fruit with fused or partially fused chambers. When ripe, the fruit splits to release multiple seeds.

Catkin: An unbranched inflorescence of closely attached flowers. Flower petals and sepals are inconspicuous or absent but bracts can be showy. Flowers are all the same sex on each catkin.

Compound: Composed of two or more parts or repeating a structural pattern.

Deciduous: Leaves fall off naturally at the end of each growing season and re-grow after a period of leaf-less dormancy (see evergreen).

Dioecious: Male and female flowers produced on separate plants. Each plant produces either male or female unisexual flowers (see monoecious and bisexual).

Elliptic (al): Shaped like a flattened circle, widest at center and tapering almost equally at both ends.

Evergreen: Leaves remain green and on the plant throughout the year, and do not shed en-mass at the end of the growing season (see deciduous).

Gall: An abnormal outgrowth in plant tissue caused by certain parasitic insects, fungi, bacteria, or mechanical injury.

Inflorescence: A cluster of flowers and associated structures such as bracts, petioles and stems (does not include full sized foliage leaves).

Lanceolate: Lance shaped, width widest along lower half and tapers to a point at the tip.

Monoecious: Plant produces both male and female unisexual flowers (see dioecious and bisexual).

Oblong: Longer than wide, with almost parallel sides and rounded corners at each end.

Opposite: Describes a growth pattern in which new structures develop directly across from one another. In leaves, two leaves will grow per node on opposite sides of the stem (see alternate).

Ovate: Egg shaped, widest below middle, tip round or pointed.

Palmate: Radiating from a common point, similar to fingers from the palm of a hand.

Perennial: Plants live more than two years or growing cycles. For this text, description applies to plants that are non-woody above ground and also describes species that lose all above ground structures during dormancy and re-grow from roots (see annual, biannual).

Petiole: Slender stem that supports the leaf, i.e. the leaf stalk.

Pistil: Female reproductive structure of the flower. At the base is the ovary with one or more ascending stalk-like structures (styles) supporting the pollen receiving structure, the stigma (see stamen).

Sepal: Outer most structure of the flower. Similar to petals but usually green.

Stamen: Male reproductive structure of the flower. A stalk like structure (filament) with a pollen-producing anther at the tip (see pistil).

Stigma: Pollen receiving structure of the pistil. Usually located near the flower center, elevated above the ovary. The stigma is often sticky or hairy and sometimes lobed.

Terminal: At the end or tip of a structure.

Unisexual: Flowers that have either male or female fertile reproductive structures but not both (see bisexual, dioecious, monoecious).

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APPENDIX XI-A

CENTRAL AND NORTH COAST NATIVE RIPARIAN PLANTS

BIG LEAF MAPLE

Species Name: *Acer macrophyllum*
Family: Aceraceae (maple family)
Plant Type: Broad-leaf tree

Description: Tree, height to 90 feet, with a broad, rounded shape, deciduous with leaves turning yellow in the autumn.

Leaf: Palmate, opposite, width to 10 inches, with 3-5 deeply cut, irregularly toothed lobes, surface shiny green but paler underneath.

Flower: April-May, bisexual, also separate sexes: develop in long, drooping clusters of petaled, fragrant, greenish-yellow small flowers. Flowers appear after leaves.

Fruit/Seed: Distinctive paired achenes with wings, wings spreading <90°.

Typical Location: Floodplain, streamside, moist shady areas, riparian zone as well as hillsides outside the riparian zone, common; elevations below 5,000 feet.

Revegetation Approach: Container

Key Notes: Related to the box elder (*A. negundo*) and vine maple (*A. circinatum*). Easily distinguished by leaf shape.

Notes: Trees provide shade, shelter and roosting areas. Seedlings, leaves, buds, flowers and seeds provide forage for a range of mammals and birds.

leaf

whole plant

flower

seed

BLACK COTTONWOOD

Species Name: *Populus balsamifera* ssp. *trichocarpa*
Family: Salicaceae (willow family)
Plant Type: Broad-leaf tree

Description: Tree, height to 120 feet, branches wide spreading, forming massive crowns, deciduous.

Leaf: Ovate, base round and tip tapered to point, length to 4 inches, dark green above, silvery or rust colored below, margin finely scalloped.

Flower: February-April, dioecious (separate sex trees): male catkin length 1-5 inches; female catkin length 3 inches in flower, 10 inches at fruit.

Fruit/Seed: Capsule containing many tiny seeds with conspicuous white cottony tufts.

Typical Location: Alluvial bottomlands, floodplains, streamside; elevations below 9,000 feet.

Revegetation Approach: Container or cuttings. Care in correctly identifying species, see Key Notes.

Key Notes: Related to the native Fremont cottonwood, *P. fremontii*. Leaf shape differentiates between species. Also related to the non-native, cultivated Lombardy poplar, *P. nigra* (not shown). Care must be taken to correctly identify.

Notes: Important feature of mature riparian forest, provides habitat for osprey, herons and egrets, stream shading and leaf litter valuable for aquatic insects. Heavy limbed, brittle species. Tallest of the *Populus* species. Susceptible to galls.

leaf

whole plant

flower

seed

BOX ELDER

Species Name: *Acer negundo*
Family: Aceraceae (maple family)
Plant Type: Broad-leaf tree

Description: Tree, height to 65 feet, deciduous with bright autumn color.

Leaf: Compound leaf composed of 3-5 leaflets. Leaflet coarsely toothed, 3-5 lobed, length to 5 inches with the terminal leaflet longest.

Flower: March-April, dioecious (separate sex trees): female develops small, non-petaled greenish flowers on drooping stalks; male has clusters of small non-petaled flowers.

Fruit/Seed: Distinctive paired achenes with wings, achene initially reddish but ripens to a straw color in the autumn. Produces a substantial quantity of seed, which germinate in great numbers in open areas.

Typical Location: Common canopy species, streamsides, established floodplains, bottomlands; elevations below 6,000 feet.

Revegetation Approach: Container

Key Notes: Related to the vine maple (*A. circinatum*) and the big leaf maple (*A. macrophyllum*). Easily distinguished by leaf shape. *A. negundo* is the only compound leaf maple in North America.

Notes: Provides excellent shelter for wildlife. Seeds provide good forage for birds and small mammals.

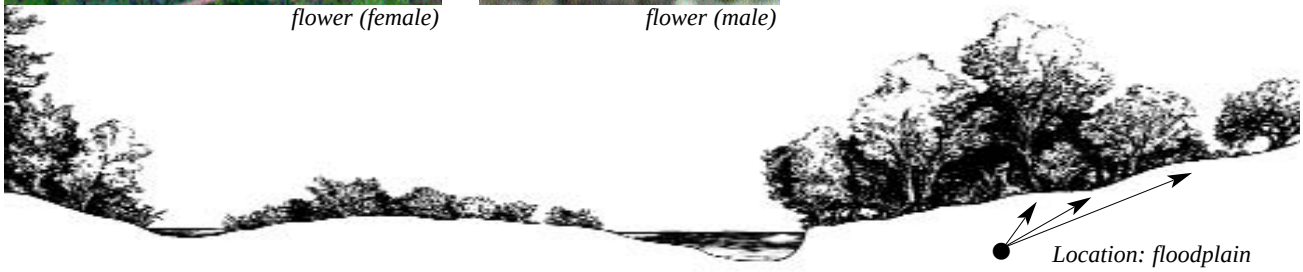
leaf

whole plant

flower (female)

flower (male)

seed



CALIFORNIA BAY LAUREL

Species Name: *Umbellularia californica*
Family: Lauraceae (laurel family)
Plant Type: Broad-leaf tree

Description: Tree, broad, round topped with height over 90 feet; also a shrub, especially on coastal bluffs, or in dry or poorly drained soils, evergreen.

Leaf: Oblong, length to 4 inches, alternate, highly aromatic when crushed.

Flower: December-May, bisexual, clusters of 6-10 small, greenish-yellow flowers, flowers petal-less, with 6 petal-like sepals, sepal length 1/8 inch.

Fruit/Seed: Round-oval stone fruit, greenish but ripening to dark purple, olive-like appearance, length to 1 inch, ripens in late autumn or winter.

Typical Location: Floodplains, mixed evergreen forests and upland habitat; elevations below 5,200 feet.

Revegetation Approach: Container, direct seed. Gather seed in October-December, remove thin fleshy coat and plant immediately.

Key Notes: Fragrance from crushed leaves is a notable characteristic.

Notes: Provides shade, shelter, roosting and nesting sites. Seeds provide forage for small mammals and birds. Source of large woody debris.

leaf

whole plant

flower

seed

CALIFORNIA BUCKEYE

Species Name: *Aesculus californica*
Family: Hippocastanaceae (buckeye family)
Plant Type: Broad-leaf tree

Description: Tree, height 15-40 feet, deciduous with leaves falling by late summer as a strategy against drought, new leaf growth begins in February.

Leaf: Compound, palmate leaf, generally with 5 leaflets, leaflet finely toothed, length 2-7 inches.

Flower: May-June: Spike-like cluster, length 6-8 inches, with small white to pinkish, sweet smelling flowers (length ½ inch). Pollen and nectar are toxic to honeybees.

Fruit/Seed: Large, pear shaped, grayish-brown, and leathery. Usually a single fruit is born at tip of flower spike and remains on tree after leaf fall. Fruit splits to reveal a large brown seed (said to look like a buck's eye). Seed round, large, diameter 1-2 inches, glossy brown, ripens in September.

Typical Location: Established floodplain forests, borders of streams, canyons, dry slopes; elevations below 5,600 feet.

Revegetation Approach: Container and direct seeding. Seeds easy to grow but toxic. Tolerant of urban pollution and salt spray.

Notes: All plant parts toxic, but seeds provide wildlife with some forage. Roots are good for binding soil. Native Americans used ground seeds to stun fish.

leaf

whole plant

flower

seed

seed

COAST LIVE OAK

Species Name: *Quercus agrifolia*
Family: Fagaceae (oak family)
Plant Type: Broad-leaf tree

Description: Tree, wide top, height 35-80 feet, large branches that often touch the ground, evergreen with leaves falling year round.

Leaf: Ovate, leathery, waxy, strongly convex, with small brownish hairs at the intersections of the primary leaf veins on the leaf underside, length to 3 inches, margin wavy, irregular, often spined.

Flower: Female flower tiny, singular or small clusters on new growth; male flower catkin, long, threadlike strand containing 25 - 100 male flowers, located on older growth.

Fruit/Seed: Acorn: slender, pointy tip, length to 1½ inches, wooly interior, ripens in autumn after 6-8 months growth. Cap large with thin, flat scales.

Typical Location: Established floodplain, valleys, mixed-evergreen forest, woodland; elevations below 5,000 feet.

Revegetation Approach: Container, direct seed. Hybridizes with *Q. kelloggii*, *Q. parvula*, *Q. wislizenii*.

Key Notes: Leaf and acorn morphology help distinguish from valley oak (*Q. lobata*) and Oregon oak (*Q. garryana*).

Notes: Trees provide shade as well as roosts and nesting sites for cavity nesting birds and bats. Acorns are an important food source for many wildlife species, especially woodpeckers and squirrels. Native Americans utilized acorns as a staple food crop. Wood made excellent charcoal and was massively harvested by European pioneers. Long-lived, commonly exceeding 250 years.

leaf

whole plant

seed

flower

FREMONT COTTONWOOD

Species Name: *Populus fremontii* ssp. *fremontii*
Family: Salicaceae (willow family)
Plant Type: Broad-leaf tree

Description: Tree, height to 90 feet, branches wide spreading, forming massive crowns, deciduous with leaves turning yellow in autumn but remaining on tree into late winter.

Leaf: Triangular, wider than long (length to 4 inches), abruptly narrowing to a point at apex, same color top and bottom, margin coarsely scalloped.

Flower: March-April, dioecious (separate sex trees), male and female: catkin, 1½-3 inches long, containing small greenish-yellow flowers that appear before leaves.

Fruit/Seed: Capsule containing many tiny seeds with conspicuous white cottony tufts. Seed ripen in early summer.

Typical Location: Alluvial bottomlands, stream channels, floodplains, wet areas; elevations below 6,500 feet.

Revegetation Approach: Container or cuttings. Care in correctly identifying species, see Key Notes.

Key Notes: Related to the native black cottonwood, *P. balsamifera*. Leaf shape differentiates between species. Also related to the non-native, cultivated Lombardy poplar, *P. nigra* (not shown). Care must be taken to correctly identify.

Notes: Important feature of mature riparian forests and provides habitat for osprey, herons and egrets. When young, found in large numbers on open gravel bars. Susceptible to mistletoe. Source of large woody debris.

leaf

whole plant

flower

seed

Location: floodplain, channel

MOUNTAIN DOGWOOD
PACIFIC DOGWOOD
WESTERN DOGWOOD

Species Name: *Cornus nuttallii*
Family: Cornaceae (dogwood family)
Plant Type: Broad-leaf tree

Description: Tree, one or more trunks, height to 80 feet, deciduous with yellow, pink and red autumn color.

Leaf: Elliptical, tapered at both ends, opposite, length 2½-5½ inches, leaf veins follow smooth leaf edges towards apex in curved pattern.

Flower: April-July, appearing before leaves, with second flowering in September, bisexual, petal-like bracts large (length 2 inches), showy, white to pinkish, surround cluster of small greenish flowers.

Fruit/Seed: April-July, autumn, clusters of crowded berries, berries elliptical in outline, ½ inch long, shiny bright red to orange-red, seed smooth.

Typical Location: Forests; elevations below 6,600 feet.

Revegetation Approach: Container.

Notes: Streambank stabilizer. Berries provide forage for small mammals and birds, especially band-tail pigeons. Native Americans used long slender branches to make baby baskets.

leaf

whole plant

flower

seed

NORTHERN CALIFORNIA BLACK WALNUT

Species Name: *Juglans californica* var. *hindsii*
Family: Juglandaceae (walnut family)
Plant Type: Broad-leaf tree

Description: Tree, height 50 to 80 feet, single trunk with broad crown, deciduous.

Leaf: Compound, alternate, with 11-19 leaflets. Leaflet lanceolate to ovate, pointed at tip, length 2-4 inches, margin toothed.

Flower: April-May, monoecious (separate sexes on same tree), female flowers small, petal-less, erect, born in clusters at tip of new growth; male catkin droops, length to 4 inches, grows on old growth.

Fruit/Seed: Round, smooth-shelled nut covered in a fibrous, fleshy black husk, ripens in autumn.

Typical Location: Floodplain, woodlands, valleys; elevations 160-2,000 feet.

Revegetation Approach: Container, direct seed. Hybridizes with the non-native English walnut making precise identification difficult. Care should be taken in collecting from a genetically pure source.

Key Notes: Young plants sometimes confused with the invasive non-native, tree of heaven (*Ailanthus altissima*). Seeds, flowers or careful inspection of leaf characteristics distinguish between species.

Notes: Provides forage, roosting and nesting sites (cavities) for wildlife. Nuts are forage for squirrels and rodents, as well as birds. Used as a rootstock for cultivated English walnut. Drought tolerant and oak-root fungus resistant.

leaf

whole plant

flower

seed

OREGON ASH

Species Name: *Fraxinus latifolia*
Family: Oleaceae (olive family)
Plant Type: Broad-leaf tree

Description: Tree, height to 80 feet, deep-rooted, deciduous.

Leaf: Compound, opposite, length to 12 inches, with 5-7 leaflets. Leaflet oblong to oval, broadest toward tip, tip abruptly pointed, length to 4 inches.

Flower: March-May, dioecious (separate sex trees): female and male flowers tiny, inconspicuous, petal-less, appearing in clusters with or before leaves.

Fruit/Seed: Winged achene, length to 1¾ inches, grows in clusters on female trees, matures in summer.

Typical Location: Floodplain, streambanks, woodlands; elevations below 5,600 feet.

Revegetation Approach: Container.

Notes: Functions as overstory or understory species in late successional areas. Tolerates standing water during winter.

leaf

whole plant

flower (female)

flower (male)

seed

OREGON OAK

Species Name: *Quercus garryana*
Family: Fagaceae (oak family)
Plant Type: Broad-leaf tree

Description: Tree, wide top, height to 65 feet, deciduous with reddish-brown autumn color.

Leaf: Length 2-6 inches, surface dark green, leathery, shiny, underside pale green to rusty with downy hair, margin with 5-7 deep, rounded lobes.

Flower: Female flower tiny, singular or small clusters on new growth; male flower catkin, long, threadlike strand containing 25-100 male flowers, located on older growth.

Fruit/Seed: Acorn: oval to spherical, rounded tip, length to 1 inch, smooth interior, ripens in autumn after 1-year growth (but abundant crop irregular, every 2-5 years). Cap small, shallow, cup-like with smooth to slightly bumpy scales.

Typical Location: Established floodplain, valleys; elevations 1,000 to 5,900 feet.

Revegetation Approach: Container, direct seed. May hybridize with other oak species.

Key Notes: Leaf and acorn morphology helps distinguish from valley oak (*Q. lobata*) and live oak (*Q. agrifolia*).

Notes: Trees provide roosts and nesting sites for cavity nesting birds and bats. Acorns are an important food source for many wildlife species, especially woodpeckers and squirrels. Native Americans utilized acorns as a food crop, but less favored than live oak. Trees harvested for lumber.

leaf

whole plant

flower and leaf

RED ALDER

Species Name: *Alnus rubra*
Family: Betulaceae (birch family)
Plant Type: Broad-leaf tree

Description: Tree, single whitish trunk, height to 80 feet, branches slim and drooping forming a narrow crown, deciduous.

Leaf: Elliptical to oval, length 2-6 inches, leaf midrib and major veins indented, surface gray-green, underside rust colored. Margins coarsely toothed and rolled under (look carefully).

Flower: March-April, monoecious (separate sexes on same tree), female catkin erect, length to ¾ inch, develops before leaves; male catkin long (3-7 inches), yellowish-green, develops before leaves, produces large quantities of pollen in February.

Fruit/Seed: Woody, cone-like catkin. Sheds seeds in autumn but cone can remain throughout winter.

Typical Location: Active channel, floodplain, wet areas; elevations sea level to 3,300 feet.

Revegetation Approach: Container.

Key Notes: Distinguish from white alder, *A. rhombifolia*, by carefully looking at leaf margins and vein structure. Only found near the coast and at lower elevations.

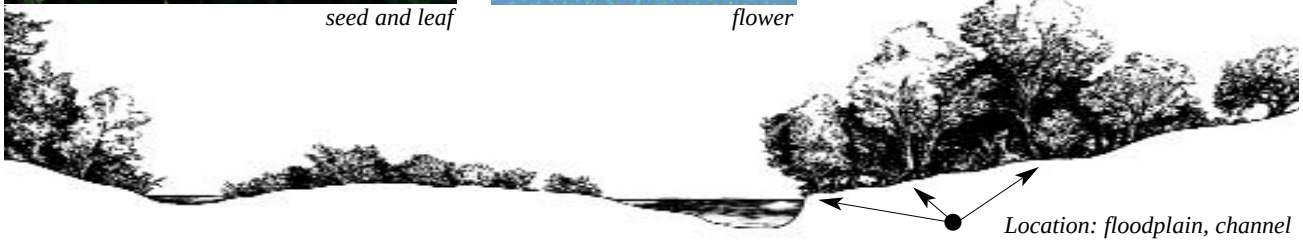
Notes: Important habitat for fish and aquatic insects by shading streams, providing shelter beneath undercut roots and providing a source of large woody debris. Seeds provide excellent forage for birds. Root nodules contain atmospheric nitrogen-fixing bacteria, actinomycetes. Leaf fall enriches the surrounding soils with nitrogen. Stabilizes soil. Tolerant of saline water.

leaf

whole plant

seed and leaf

flower



Location: floodplain, channel

SYCAMORE

Species Name: *Platanus racemosa*
Family: Platanaceae (sycamore family)
Plant Type: Broad-leaf tree

Description: Tree, height 115 feet, single base trunk, may form secondary trunk that leans and twists, bark peals in reddish-brown plates exposing whitish areas. Branches widely spreading with lower branches twisting.

Leaf: Palmate with 3-5 deep lobes, length to 10 inches, margins smooth edged. Leaves turn brown in early autumn but may remain on tree until new leaf growth.

Flower: February-April, monoecious (separate sexes on same tree), female and male flowers in unisex spherical clusters, 3-7 clusters per stalk, individual flowers tiny.

Fruit/Seed: Spherical cluster (diameter 1 inch) of spiny achenes, ripen in winter.

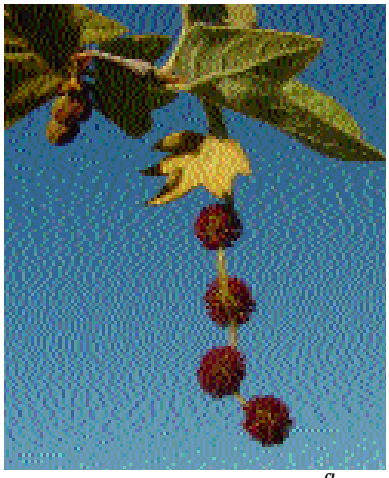
Typical Location: Floodplain, streamsides, canyons; elevations below 6,600 feet.

Revegetation Approach: Container.

leaf

whole plant

trunk



flower

seed

VALLEY OAK

Species Name: *Quercus lobata*
Family: Fagaceae (oak family)
Plant Type: Broad-leaf tree

Description: Tree, wide top, height 50-115 feet (often as wide), may have massive branches sometimes extending to the ground, largest North American oak, deciduous.

Leaf: Length 2-4 inches, surface dark green, underside pale green with felt-like hairs, margin with 6-10 deep, rounded lobes.

Flower: March-April, female flower tiny, singular or small clusters on new growth; male flower catkin, long, threadlike strand containing 25 - 100 male flowers, located on older growth.

Fruit/Seed: Acorn: long, conical, length to 2 inches (largest of California oaks), smooth interior, ripens in autumn after 1-year growth, germinates immediately. Cap with wart-like bumps on scales.

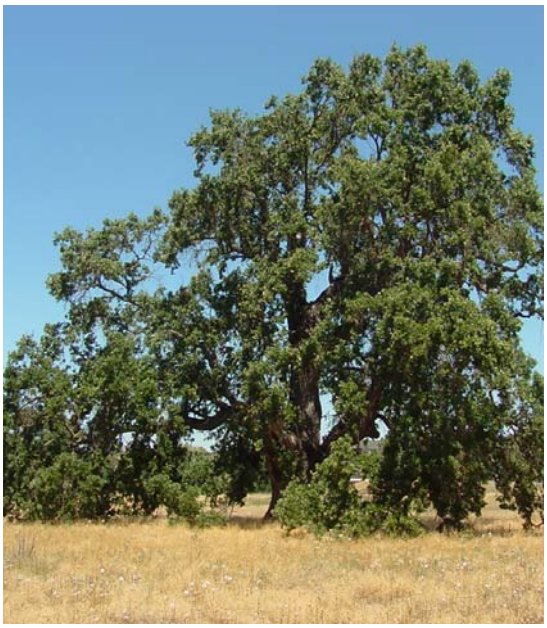
Typical Location: Established floodplain, valleys; elevations below 5,600 feet.

Revegetation Approach: Container, direct seed. Hybridizes with *Q. berberidifolia*, *Q. corneliusmulleri*, *Q. douglasii*, *Q. engelmannii*, *Q. garryana*, *Q. john-tuckeri*.

Key Notes: Leaf and acorn morphology help distinguish from live oak (*Q. agrifolia*) and Oregon oak (*Q. garryana*).

Notes: Trees provide roosts and nesting sites for cavity nesting birds and bats. Source of large woody debris. Acorns are an important food source for many wildlife species, especially woodpeckers and squirrels. Young branches may have dense clusters of spherical insect galls harboring small, native wasp larvae. Native Americans utilized acorns as a food crop. May live for 400- 600 years.

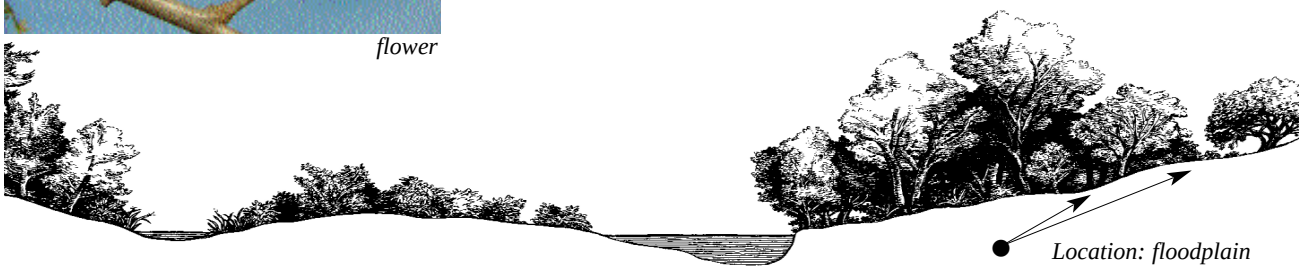
leaf



whole plant

seed

flower



WATER BIRCH

Species Name: *Betula occidentalis*
Family: Betulaceae (birch family)
Plant Type: Broad-leaf tree

Description: Tree or large shrub, usually with multiple trunks, height to 30 feet, bark smooth and dark brown/red, deciduous.

Leaf: Widely ovate, tip pointed, margins doubly toothed, length to 2 inches.

Flower: April-June, monoecious (separate sexes on same tree), female catkin erect, length ¾ to 2½ inches; male catkin elongate, length 1 to 2 inches.

Fruit/Seed: Many tiny, winged seeds inside catkin.

Typical Location: Streams, springs, moist areas; elevations 2,000 to 9,500 feet.

Revegetation Approach: Container.

Notes: Important wildlife forage and bank stabilizer.

leaf

whole plant

male catkin

seed

WHITE ALDER

Species Name: *Alnus rhombifolia*
Family: Betulaceae (birch family)
Plant Type: Broad-leaf tree

Description: Tree, single whitish trunk, height to 115 feet, branches slim and drooping forming a narrow crown, deciduous.

Leaf: Elliptical to oval, length 2-6 inches, leaf midrib and major veins not indented, surface gray-green, underside yellowish. Margins coarsely toothed and not rolled under (look carefully).

Flower: March-April, monoecious (separate sexes on same tree), female catkin erect, length to ¾ inch, develops before leaves; male catkin long (3-7 inches), yellow-greenish, develops before leaves, produces large quantities of pollen in February.

Fruit/Seed: Woody, cone-like catkin. Sheds seeds in autumn but cone remains throughout winter.

Typical Location: Active channel, floodplain, wet areas; elevations 300 to 8,000 feet.

Revegetation Approach: Container.

Key Notes: Distinguish from red alder, *A. rubra*, by carefully looking at leaf margins and vein structure.

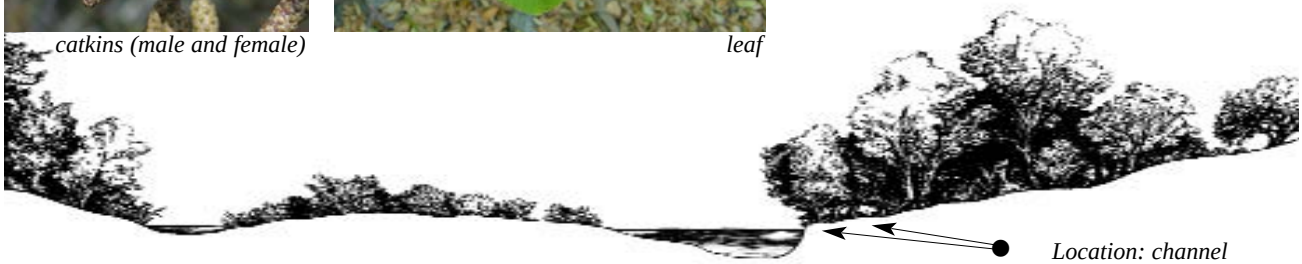
Notes: Important habitat for fish and aquatic insects by shading streams, providing shelter beneath undercut roots and providing a source of large woody debris. Seed provide excellent forage for birds. Root nodules contain atmospheric nitrogen-fixing bacteria, actinomycetes. Leaf fall enriches the surrounding soils with nitrogen. Stabilizes soils.

whole plant

whole plant

catkins (male and female)

leaf



WILLOW

Species Name: *Salix* spp.
Family: Salicaceae (willow family)
Plant Type: Broad-leaf tree

Description: Tree or shrub, stems slender, flexible, most hairy, bark reddish or yellowish brown, height to 50 feet, some species spread by roots (developing clonal thickets), deciduous.

Leaf: Elliptical, slender or wide (almost ovate), length variable (2-6 inches), hairy, one central vein, margins smooth or toothed, tip pointed or rounded.

Flower: February-May, dioecious (separate sex trees), female and male catkins on leafy shoot, length 1- 4 inches, appear just before or with leaves.

Fruit/Seed: Dry, 2 part fruit, length 1/4-1/3 inch, contains many tiny seeds. Seeds disperse by wind and water.

Typical Location: Active channel, streamsides, marshes, wet ditches, springs; elevations below 9,000 feet.

Revegetation Approach: Container or cutting.

Key Notes: Accurate identification requires an understanding of flower characteristics. Distinguish from mulefat (*Baccharis salicifolia*) by leaf vein pattern.

Notes: Excellent for streambank stabilization and habitat restoration. Dense growth provides excellent cover for aquatic organisms, terrestrial wildlife and birds. Native Americans used stems in basketry and bow making. Willows produce salicin, a chemical similar to acetylsalicylic acid (aspirin).

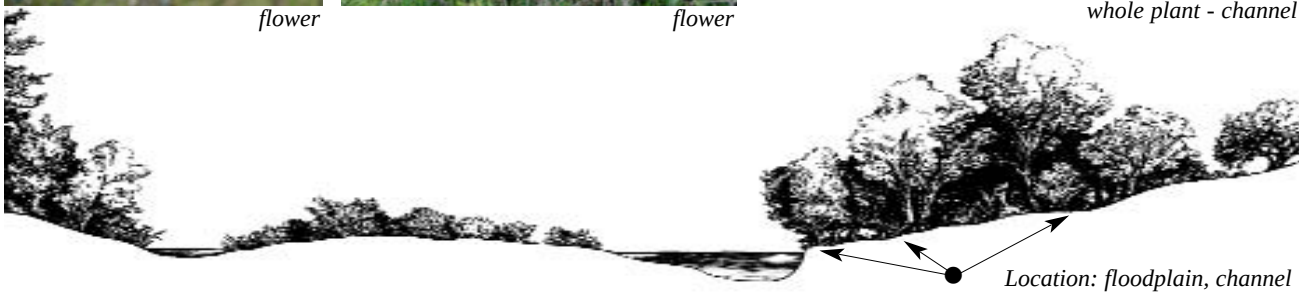
leaf

whole plant - floodplain

whole plant - channel

flower

flower



Location: floodplain, channel

CALIFORNIA NUTMEG

Species Name: *Torreya californica*
Family: Taxaceae (yew family)
Plant Type: Coniferous tree

Description: Conifer, pointed crown, rounding as it matures, widely spaced horizontal branches, height to 140 feet, aromatic leaves and fruit, evergreen.

Leaf: Needle, dark green, 2 white bands on underside, length 1-2¾ inches, rigid with slightly upturned tip, tip sharp, needles arranged in 2 almost parallel rows, aromatic.

Flower: Monoecious, female cone develops into olive shaped fruit, male cone a stalked cluster with 6-8 whirls.

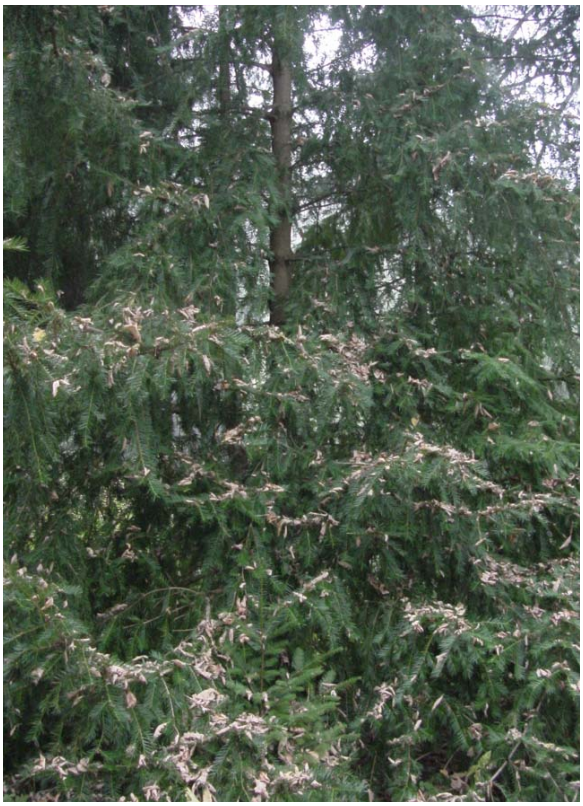
Fruit/Seed: Olive-like fruit, oblong, pale green with purplish markings, longitudinally grooved, length to 2 inches, seed completely contained within fruit.

Typical Location: Shady canyons in forest, woodland and chaparral; elevations 100 to 6,900 feet.

Revegetation Approach: Container.

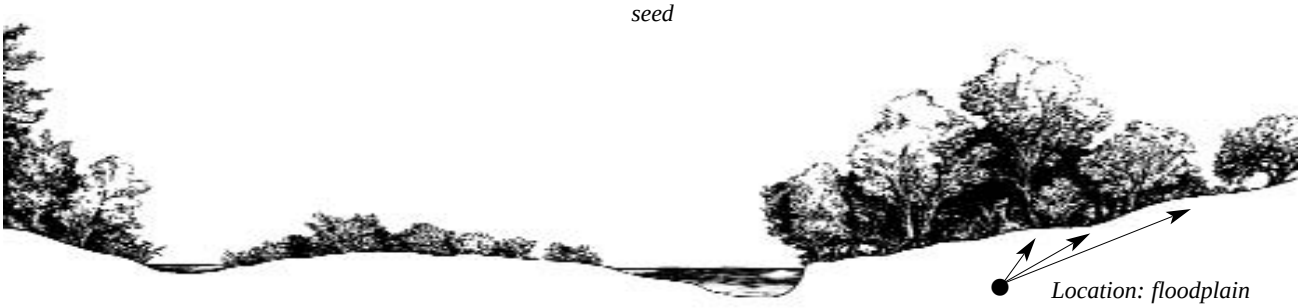
Notes: Trees provide shelter and habitat diversity in watersheds. Seeds are an important forage.

leaf



whole plant

seed



COAST REDWOOD

Species Name: *Sequoia sempervirens*
Family: Taxodiaceae (bald cypress family)
Plant Type: coniferous tree

Description: Tree, height to 350 feet, narrow crown, horizontal branches grow straight out from trunk and slightly upward at ends, mature trees generally free of branches in the lower half, red bark thick and fibrous, evergreen.

Leaf: Needle, length ½-¾ inch, branchlets with needles in 2 rows, arranged in one plane (feather-like).

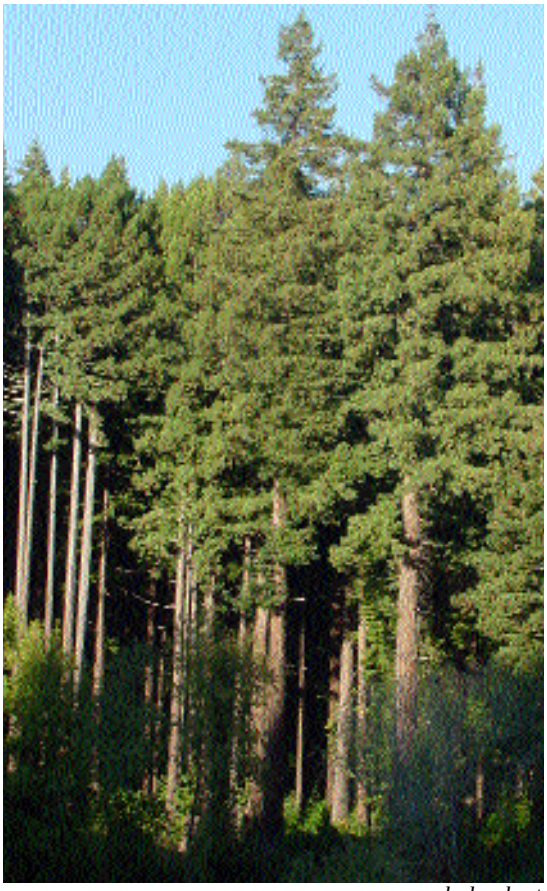
Fruit/Seed: Spherical, reddish cone, length 1¼ inch, found mostly near the top of the tree, clustered at the end of branchlets, ripens in autumn.

Typical Location: Northern California coastal drainages south to Monterey; elevations sea level to 3,600 feet.

Revegetation Approach: Container.

Notes: Long-term source of woody debris in streams, cools streams by providing dense shade, undercut roots provide vital aquatic shelter. Tallest trees in North America. Generally re-sprouts from cut stems or trunk, and after fire. Mainstay of the California lumber industry from 19th century to the early 20th century.

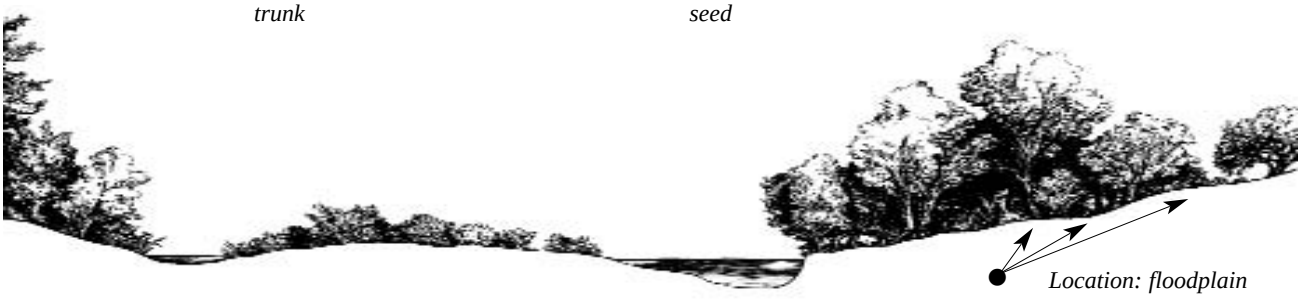
leaf



whole plant

trunk

seed



DOUGLAS FIR

Species Name: *Pseudotsuga menziesii*
Family: Pinaceae (pine family)
Plant Type: coniferous tree

Description: Conifer, height to 220 feet, rounded crown, large upper branches, branches typically curl upward, evergreen.

Leaf: Soft needles, flat, rounded tips, length ¾-1½ inch, blue-green to dark green, radiate in all directions from stem, persistent to eight years, fragrant.

Flower: Monoecious (separate sexes on same tree), female cone woody, reddish, near branch tip; male cone (bud like) small, oblong, reddish, not woody, near branch tip.

Fruit/Seed: Cone, reddish brown, length 2-3½ inches, scales rounded with distinctive 3-pronged bracts, hangs down, matures in August.

Typical Location: Mixed-evergreen, mixed-conifer forests; elevations below 7,200 feet.

Revegetation Approach: Container.

Notes: Trees provide shelter for wildlife, shading for streams and a source of large woody debris. Seeds are an important forage for small mammals and birds.

leaf

whole plant

seed

Douglas fir forest

PACIFIC YEW

Species Name: *Taxus brevifolia*
Family: Taxaceae (yew family)
Plant Type: coniferous tree

Description: Conifer, tree or large shrub, branches may droop slightly, height to 60 feet, trunk width often irregular, bark reddish-brown and often peels, leaves and fruit non-aromatic, evergreen.

Leaf: Needle, yellowish-green on top but lighter underneath, length up to 1 inch, tip pointed, needles arranged in 2 almost parallel rows that may spiral along stems, non-aromatic.

Flower: Dioecious, female cone small, singular, greenish, develops on branch underside; male cone a stalked cluster with 4-8 whirls, roundish, yellow, diameter 1/6 inch, develops on branch underside, numerous cones produced.

Fruit/Seed: Cup-like, fleshy, reddish, diameter up to 1/2 inch, contains one seed that is visible at the end. Fleshy coat is edible (sweet) but seed is poisonous to humans.

Typical Location: Understory of shady mixed-evergreen forests, slopes and canyon bottoms, tolerates shade; elevations 30-5,000 feet.

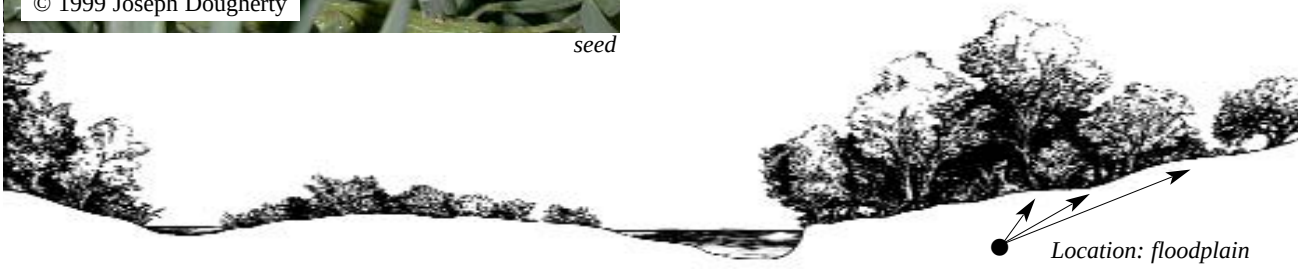
Revegetation Approach: Container.

Notes: Trees provide large woody debris, shelter, habitat diversity, and nesting sites, as well as shade that maintains cool water temperatures. Fibrous roots bind and stabilize soil. Seeds are an important forage for birds and small mammals. Leaves and bark provide forage for grazers. The cancer-fighting drug Taxol is produced in the bark and, to a lesser extent, in the leaves.

leaf

whole plant

seed



WESTERN HEMLOCK

Species Name: *Tsuga heterophylla*
Family: Pinaceae (pine family)
Plant Type: coniferous tree

Description: Conifer, crown conical and narrow, height to 160 feet, drooping branches, thin reddish-brown bark, stem hairy, evergreen.

Leaf: Needle, white bands on underside, tip rounded, 2 rows of short needles (length ¼-¾ inch), persistent for 4-7 years.

Flower: Monoecious (separate sexes on same tree), female cone oval, length ½-3 inches, hangs down from branch tip, immature greenish, ripens to brown and woody; male cone small, yellowish, not woody, occurs on previous year's growth.

Fruit/Seed: Woody oval cone, length ½-3 inches, hangs down from branch tip, scales open first season releasing seeds, seed length to ¾ inch.

Typical Location: Coastal conifer and mixed evergreen forests, especially in flat or low slope areas; elevations below 2,300 feet.

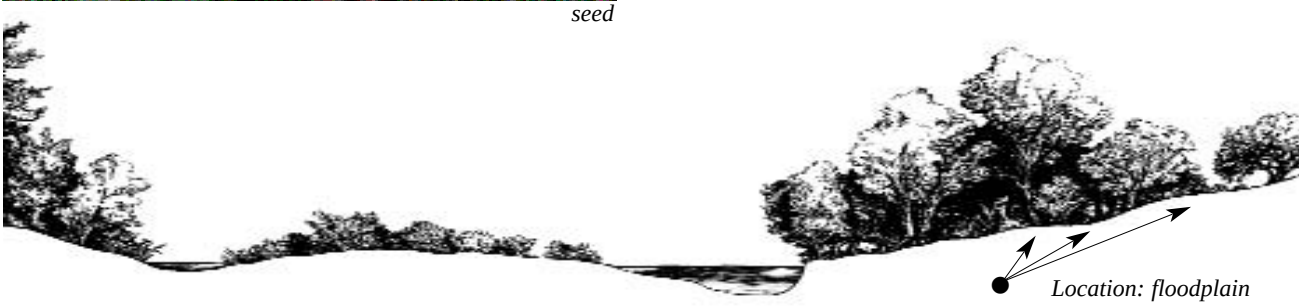
Revegetation Approach: Container.

Notes: Trees contribute large woody debris to stream and provide shelter, habitat and nesting sites (cavities) for wildlife. Foliage and seeds provide forage, especially for small mammals and birds. Harvested for paper pulp.

leaf

whole plant

seed



BLUE ELDERBERRY

Species Name: *Sambucus mexicana*
Family: Caprifoliaceae (honeysuckle family)
Plant Type: Shrub / small tree

Description: Shrub, lacking main trunk, height to 25 feet, often as wide as tall, deciduous.

Leaf: Compound, opposite with 3-9 elliptic to ovate, sharply toothed leaflets (length to 7 inches). Leaflet base often asymmetrical, terminal leaflet much longer than paired leaflets.

Flower: March-September, large (12 inches wide), showy, flat topped clusters of small white flowers.

Fruit/Seed: Clusters of round berries, berry diameter 1/3 inch, almost black with whitish bloom thus appearing bluish, contains 3-5 small seeds.

Typical Location: Streambanks, open areas in forest, established floodplains; elevations below 9,800 feet.

Revegetation Approach: Container.

Key Notes: Related to the red elderberry (*S. racemosa*). Distinguished by flower, fruit shape and fruit color.

Notes: Important source of forage for wildlife, especially for some species of migratory birds. Berries edible to human and used for jellies, pies and wine. Pierce's Disease host plant (see page XI-7 for more information).

leaf

flower

seed

whole plant

Location: floodplain

CALIFORNIA BLACKBERRY

Species Name: *Rubus ursinus*
Family: Rosaceae (rose family)
Plant Type: Shrub

Description: Mound building, vine-like shrub with tip rooting, running stems. Stems grayish with slender, delicate, straight thorns.

Leaf: Compound with 3 leaflets, leaflets irregularly toothed, length 1-4 inches.

Flower: March-June, generally dioecious (separate sex shrubs): Singular or clusters of white flowers, petal length to 1 inch.

Fruit/Seed: Blackberry (aggregate of black stone fruits), round to oblong, red ripening to black, highly edible, ripens in summer. Multiple small seeds inside a single blackberry.

Typical Location: Moist areas, shade, floodplain stream banks; elevations below 5,000 feet.

Revegetation Approach: Container, plants grow rapidly.

Key Notes: Often confused with the non-native Himalayan blackberry (*R. discolor*). Distinguished by leaf and thorn shape.

Notes: Dense growth provides excellent foraging, nesting and hiding habitat for wildlife. Edible berries are an important food source for many species of mammals and birds. Spreading growth binds soil for erosion control. Pierce's Disease host plant (see page XI-7 for more information on Pierce's Disease).

leaf and fruit

flower

stem

whole plant

CALIFORNIA HAZELNUT

Species Name: *Corylus cornuta var. californica*
Family: Betulaceae (birch family)
Plant Type: Shrub / small tree

Description: Shrub or small tree, spreading with multiple stems, open shape, height 5-13 feet, deciduous with bright yellow autumn color.

Leaf: Round to ovate, velvety hairy on both sides, length to 4 inches, coarsely toothed.

Flower: January-April, monoecious (separate sex on same plant): Female flower, tiny cluster (½ inch) containing 2 flowers with bright red stigma, grow as terminal buds, appear before leaves; male flower catkin, length to 2½ inches, remain after leaf fall.

Fruit/Seed: Smooth nut (1-inch-diameter) enclosed in 2 fused, papery, leaf-like bracts, ripen in early autumn.

Typical Location: Streamsides, moist, shady floodplain forests, often found in the understory of redwood and Douglas fir forests; elevations below 7,000 feet.

Revegetation Approach: Container.

Notes: Edible nut is an important food source for many species. It is related to the European hazelnut (filbert). Native Americans used the flexible stems in basket making.

leaf

male flower/catkin

seed

whole plant

CALIFORNIA WILD ROSE

Species Name: *Rosa californica*
Family: Rosaceae (rose family)
Plant Type: Shrub

Description: Thicket building shrub, height 3-8 feet, stems with compressed, curved thorns.

Leaf: Compound with 5-7 leaflets. Leaflets ovate to oblong, toothed, length to 1½ inch.

Flower: May-August, singular or in clusters, pinkish, ¾ inch petals.

Fruit/Seed: Round, reddish, fleshy rose hip, ¾ inch diameter.

Typical Location: Moist areas, streamsides; elevations below 5,300 feet.

Revegetation Approach: Container. Hybridizes with non-native cultivated roses, care must be taken in collection.

Notes: Important understory species, and good soil stabilizer. Species extremely variable. Rose hip high in vitamin C and important forage for wildlife.

leaf

flower

whole plant in flower

seed

CASCARA

Species Name: *Rhamnus purshiana*
Family: Rhamnaceae (buckthorn family)
Plant Type: Shrub / small tree

Description: Erect shrub or small tree, height to 30 feet, branch ends often tufted with leaves, deciduous showing yellow autumn color.

Leaf: Elliptic, alternate, prominent veins, length 2-6 inches, margin smooth.

Flower: May-June, bisexual, small cluster of greenish flowers develop at leaf axis.

Fruit/Seed: Round berry, black when ripe, diameter to 1/2 inch, contains 3 seeds.

Typical Location: Floodplains, coniferous forests, coastal scrub; elevations below 6,500 feet.

Revegetation Approach: Container.

Key Notes: Related to coffeeberry (*R. californica*).

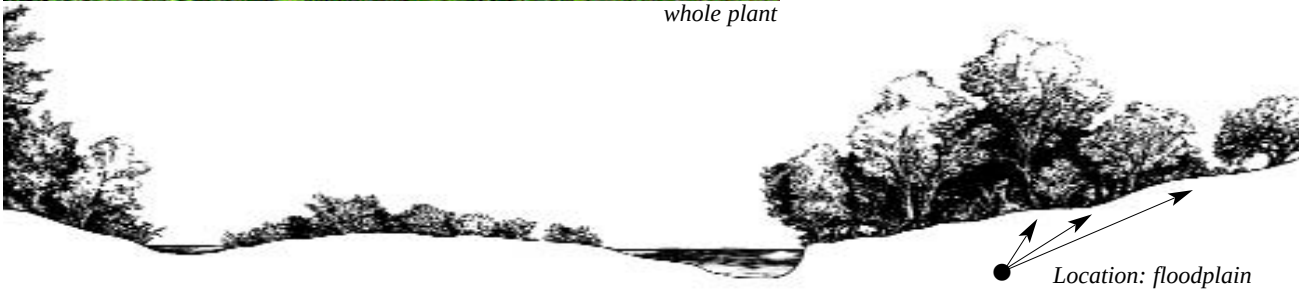
Notes: Berries are attractive forage for birds and mammals, including ringtail and raccoon. Can be toxic to small children.

leaf

flower

seed

whole plant



COFFEEBERRY

Species Name: *Rhamnus californica*
Family: Rhamnaceae (buckthorn family)
Plant Type: Shrub / small tree

Description: Shrub, erect or low and spreading, height to 16 feet, evergreen.

Leaf: Variable, elliptic, alternate, variable in thickness, length 1-3 inches, edges smooth or toothed.

Flower: April-June, bisexual, clusters of 5-60 inconspicuous flowers produced on new growth.

Fruit/Seed: Round berry, ripening from green to red then black when ripe, diameter to ½ inch.

Typical Location: All soil types, woodlands, forests, coastal scrub, chaparral; elevations below 7,500 feet.

Revegetation Approach: Container.

Key Notes: Related to cascara (*R. purshiana*).

Notes: Leaves and berries provide forage for deer, birds feed on berries as well.

leaf

seed

whole plant

flower

COLTSFOOT

Species Name: *Petasites frigidus*
Family: Asteraceae (sunflower family)
Plant Type: Shrub

Description: Perennial herb with creeping rhizomes, dormant in winter with erect stems appearing before leaves in spring, no branches, height 6-24 inches.

Leaf: Grow from stem base, palmate, roundish, multi-lobed, width 2-10 inches, edges coarsely toothed, underside densely hairy.

Flower: March-April, produced at top of a long stalk (length to 24 inches) before leaf-out. Clusters of small, disk-like, white-orange flowers, male and female usually not produced on same disk, sometimes dioecious (separate sex plants).

Fruit/Seed: Achene with thread-like bristles, length <¼ inch.

Typical Location: Streamside, wet soils, deep shade in wood areas; elevations below 1,300 feet.

Revegetation Approach: Container.

Notes: Rhizomatous growth helps stabilize soil.

leaf

flower

whole plant

seed

CREAMBUSH/OCEANSPRAY

Species Name: *Holodiscus discolor*
Family: Rosaceae (rose family)
Plant Type: Shrub / small tree

Description: Shrub, densely branched, stems hairy, bark light brown to gray and shredding with age, height 4-18 feet, deciduous. Has both long stems and short, each with different leaf size.

Leaf: Ovate, alternate, edges coarsely toothed or scalloped. Long stem leaf length 2-5 inches; leaf length ¾ to 1½ inch.

Flower: May-July, showy, large (length 4-10 inches) branched clusters of small, white flowers produced at the ends of mature branches.

Fruit/Seed: Achene, tiny.

Typical Location: Floodplains, moist woodlands, rocky slopes, variety of plant communities below 6,000 feet.

Revegetation Approach: Container.

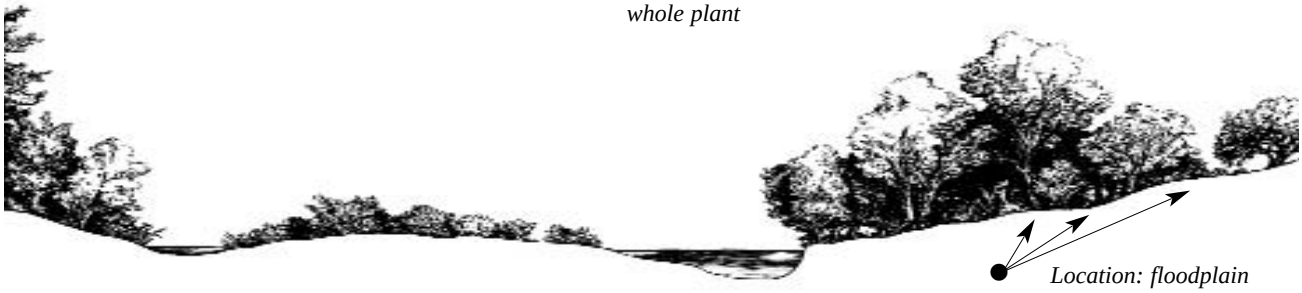
Notes: Showy flowers attract birds.

leaf

flower

whole plant

seed



ELK CLOVER

Species Name: *Aralia californica*
Family: Araliaceae (ginseng family)
Plant Type: Shrub

Description: Erect shrub, height 3-9 feet, deciduous. Roots large, contain milky juice.

Leaf: Compound, large with 3-5 leaflets. Leaflet ovate, tip pointed, margins small-toothed, length 6-12 inches.

Flower: June-August, long stalk (length 14-18 inches), multiple branches of small, ball-like clusters of white, sticky flowers.

Fruit/Seed: Berry, round, black, <¼ inch diameter.

Typical Location: Moist shady areas, streamsides, canyons; elevations below 6,500 feet.

Revegetation Approach: Container.

Notes: In same family as non-native English ivy, *Hedera helix*.

leaf

flower

seed

whole plant

HAWTHORNE
WESTERN BLACKHAW

Species Name: *Crataegus douglasii*
Family: Rosaceae (rose family)
Plant Type: Shrub / small tree

Description: Erect shrub or small tree, height to 30 feet, densely branched, armored with strong thorns (length over ½ inch), deciduous.

Leaf: Base wedge shaped, top lobed with double-toothed margin, length 1-3 inches, dark green, shiny.

Flower: May-July, clusters at branch tips, flowers cup-shaped, white, 5-petaled, width ½ inch, fragrant.

Fruit/Seed: Berry-like, black, fleshy, sweet, diameter to ½ inch, contains tiny nutlet.

Typical Location: Floodplains, meadow edges, forest, grassland, sagebrush scrub; elevations 2,300 to 5,500 feet.

Revegetation Approach: Container.

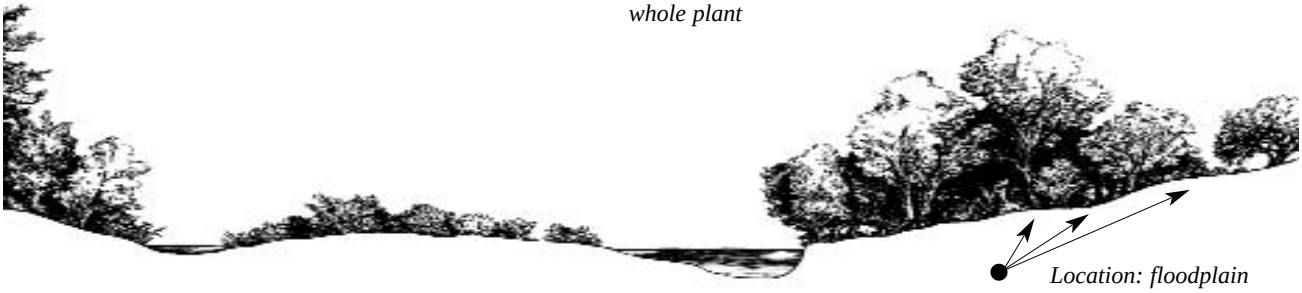
Notes: Fruit provides excellent forage for birds and flowers attract bees.

leaf and flower

flower

whole plant

seed



MULEFAT

Species Name: *Baccharis salicifolia*
Family: Asteraceae (sunflower family)
Plant Type: Shrub

Description: Erect shrub, spreads to form thickets, height 6-12 feet, evergreen.

Leaf: Lanceolate, length to 6 inches, margins smooth to slightly toothed, underside with 3 large veins.

Flower: March-July, dioecious (separate sex shrubs), clusters of small white disk flowers (width <¼ inch) form at the tips of lateral branches.

Fruit/Seed: Tiny, finely bristled achene.

Typical Location: Dry streambeds, active channel, gravel bars across California at elevations below 4,000 feet.

Revegetation Approach: Container.

Key Notes: Sometimes confused with young willow growth: mulefat has three large veins on the leaf, the willow only has one.

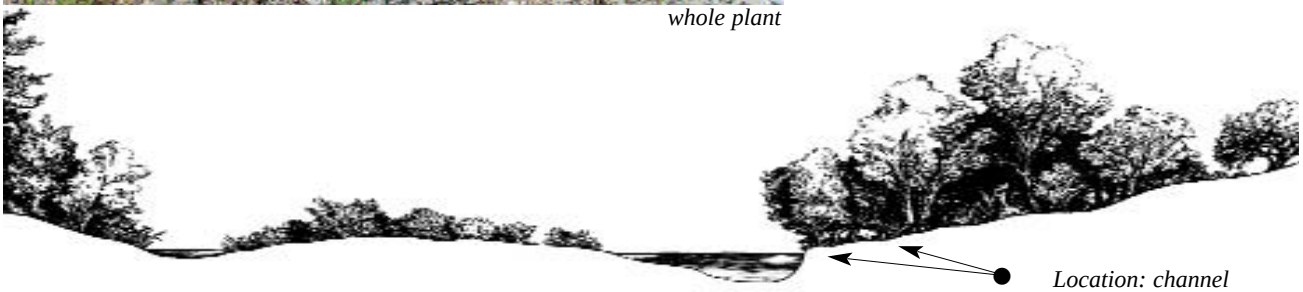
Notes: Important gravel bar colonizer and stabilizer. Native Americans used the straight-growing, woody stems for arrows.

leaf

flower

whole plant

seed



NINEBARK

Species Name: *Physocarpus capitatus*
Family: Rosaceae (rose family)
Plant Type: Shrub / small tree

Description: Erect, spreading shrub, height 3-8 feet, peeling bark distinctive, deciduous.

Leaf: Rounded palmate with 3-5 lobes, length to 5½ inches, margin toothed.

Flower: April-July, dense, round clusters of small, white flowers (petal length <¼ inch).

Fruit/Seed: Round clusters of dry, inflated fruit, fruit contain 2-4 seeds.

Typical Location: Moist banks, floodplains, coniferous forests; elevations below 4,600 feet.

Revegetation Approach: Container.

leaf

flower

whole plant in flower

seed

OSOBERRY

Species Name: *Oemleria cerasiformis*
Family: Rosaceae (rose family)
PlantType: Shrub / small tree

Description: Shrub or small tree, height to 15 feet, stems mostly straight and slender, bark gray to reddish, deciduous.

Leaf: Elliptical, alternate, length 2-5 inches, margin smooth, smells like cucumber when crushed.

Flower: January-April, dioecious (separate sex shrubs) with some bisexual flowers, hanging clusters (length 1-4 inches) of 5-10 flowers produced at branch ends, female and male flowers small, fragrant, petals white, clawed, blooms before leafing.

Fruit/Seed: Berry, bean-shaped, waxy, peach colored turning bluish when ripe, diameter ½ inch.

Typical Location: Floodplains, chaparral, shaded coniferous forest, streamsides; elevations below 5,600 feet.

Revegetation Approach: Container.

Key Notes: Name changed to *Oemleria* from *Osmaronia*.

Notes: Berries provide forage for birds.

leaf

flower

seed

whole plant

PACIFIC WAX MYRTLE

Species Name: *Myrica californica*
Family: Myricaceae (wax myrtle family)
Plant Type: Shrub / small tree

Description: Erect shrub or small tree, densely branched, height 6-30 feet, bark smooth and gray to light-brown, evergreen.

Leaf: Lanceolate to oblong, dark green, glossy, length to 5 inches, spicy scent.

Flower: March-April, monoecious (separate sexes on same shrub), female and male catkin scaly, length to 1 inch.

Fruit/Seed: Round, dark purple nut with pale waxy coating, diameter ¼ inch.

Typical Location: Coastal areas (including sand dunes) north of Santa Monica county into Washington, canyon walls and moist slopes below 500 feet.

Revegetation Approach: Container.

Notes: Wax myrtle berries are important forage for many bird species. The name comes from the waxy coating on the berries, which were historically used in the making of soaps and candles.

leaf and flower

seed

whole plant

RED ELDERBERRY

Species Name: *Sambucus racemosa*
Family: Caprifoliaceae (honeysuckle family)
Plant Type: Shrub / small tree

Description: Shrub, lacking main trunk, height to 20 feet, deciduous.

Leaf: Compound, opposite with 5-7 leaflets, leaflets ovate to lanceolate, base often asymmetrical, length to 6 inches, margin sharply toothed.

Flower: March-July, domed shaped clusters (width to 4 inches) of small whitish flowers.

Fruit/Seed: Clusters of berries, berry bright red, round, diameter ¼ inch, contains 3-5 small seeds.

Typical Location: Moist areas, coastal.

Revegetation Approach: Container.

Key Notes: Related to the blue elderberry (*S. mexicana*). Distinguished by flower and fruit shape.

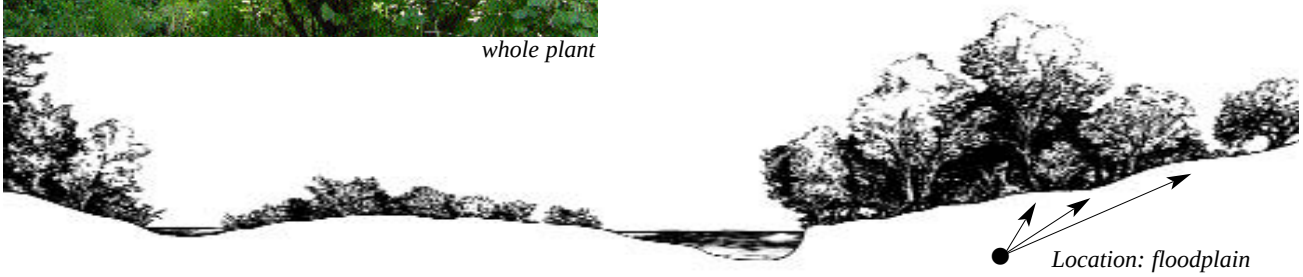
Notes: Important forage for birds. Berries bitter tasting to humans and sometimes toxic.

leaf

flower

seed

whole plant



RED FLOWERING CURRANT
PINK WINTER CURRANT

Species Name: *Ribes sanguineum*
Family: Grossulariaceae (gooseberry family)
Plant Type: Shrub / small tree

Description: Erect shrub, height to 12 feet, stems thin, spreading, deciduous.

Leaf: Palmate, dark green, finely haired, lobes rounded, margin irregularly toothed, length 2-4 inches.

Flower: January-June, bisexual, drooping clusters (length 2-4 inches) of 1-20 flowers, flowers small, red to pink.

Fruit/Seed: Berry, blue-black with whitish bloom, diameter to ½ inch.

Typical Location: Floodplains, open spaces, chaparral, woodland, mixed evergreen and closed pine forests; elevations to 6,000 feet.

Revegetation Approach: Container.

Notes: Flowers and fruit attract birds.

leaf

flower

branch

seed

RED TWIG DOGWOOD
BROWN DOGWOOD

Species Name: *Cornus glabrata*
Family: Cornaceae (dogwood family)
Plant Type: Shrub / small tree

Description: Shrub or small tree, generally forms dense thickets, height to 20 feet, stems slender, brown to red, deciduous.

Leaf: Lanceolate to elliptical, tapered at both ends, length to 2 inches, leaf veins in 3-4 pairs.

Flower: May-July, bisexual, flat topped clusters (2 inch width) of small, white flowers.

Fruit/Seed: Berry, white to bluish, length ¼ inch, seed with almost smooth sides, ripens in late summer.

Typical Location: Floodplains, moist areas; elevations below 5,000 feet.

Revegetation Approach: Container.

Key Notes: Leaf and seed morphology distinguish from stream dogwood (*C. sericea*).

leaf

flower

whole plant

seed

SALMONBERRY

Species Name: *Rubus spectabilis*
Family: Rosaceae (rose family)
Plant Type: Shrub / small tree

Description: Erect shrub, height 6-12 feet, branches with few short, straight thorns, mature branches woody, bark shredding, forms dense thickets, deciduous.

Leaf: Compound with 3 leaflets. Leaflets palmate with 3 shallow lobes, length 2-4 inches, edges irregularly toothed.

Flower: March-June, singular and clusters, petal length to ½ inch, red-purple, papery.

Fruit/Seed: Raspberry-like (aggregate of stone fruits), yellow to red, edible, ripen in summer.

Typical Location: Moist shady areas, streamsides; elevations below 5,000 feet.

Revegetation Approach: Container.

Key Notes: Related to the blackberry, raspberry and thimbleberry.

Notes: Edible berries provide forage for wildlife.

leaf

flower

whole plant

seed

SNOWBERRY

Species Name: *Symphoricarpos albus* var. *laevigatus*
Family: Caprifoliaceae (honeysuckle family)
Plant Type: Shrub / small tree

Description: Erect shrub, branching stems, height to 6 feet, spreads rhizomatously, deciduous.

Leaf: Oval to almost round, opposite, length ½ to 2½ inches.

Flower: May-June, cluster of 8-16 pinkish, bell shaped flowers, flowers hairy inside.

Fruit/Seed: Distinctive snow-white berry (½ inch diameter), ripens in autumn and persists on bare branches throughout winter. Two tiny seeds per berry.

Typical Location: Mature riparian forest, shady woods, streambanks, north facing slopes, well-drained soils; elevations below 4,000 feet.

Revegetation Approach: Container.

Notes: Provides erosion control. Important understory species in riparian floodplains. Berries are an important food source for wildlife but may be toxic to humans. Foliage and twigs browsed by deer. Native Americans used the wood for construction of ceremonial tobacco pipes.

leaf

flower

whole plant

seed

SPIRAEA

Species Name: *Spiraea douglasii*
Family: Rosaceae (rose family)
Plant Type: Shrub

Description: Erect shrub, height 3-6 feet, spreads rhizomatously forming large clumps, deciduous.

Leaf: Elliptic, alternate, rounded tip, length 1-5 inches, margin toothed.

Flower: June-September, inflorescence long (2-5 inch length), thin with clusters of small, rose pink flowers, develop at branch ends.

Fruit/Seed: Fruit pod-like, dry, small.

Typical Location: Moist areas, coniferous forests, valley flats, streamside, seeps; elevations below 6,500 feet.

Revegetation Approach: Container.

Key Notes: *Spiraea douglasii* is replaced by *Spiraea denisflora* at higher elevations.

Notes: Good ground stabilizer on moist banks. Rose color of flowers is unique to this shrub.

leaf

seed

whole plant

flower

STINK CURRANT

Species Name: *Ribes bracteosum*
Family: Grossulariaceae (gooseberry family)
Plant Type: Shrub / small tree

Description: Erect shrub, height to 13 feet, stems sparsely hairy, aromatic with an unpleasant odor.

Leaf: Deeply 5-7 lobed, length 1½-8 inches, upper surface shiny, dull below, margins toothed.

Flower: February to June, erect clusters of 20-50 flowers, flowers small, base saucer-like, petals small, white.

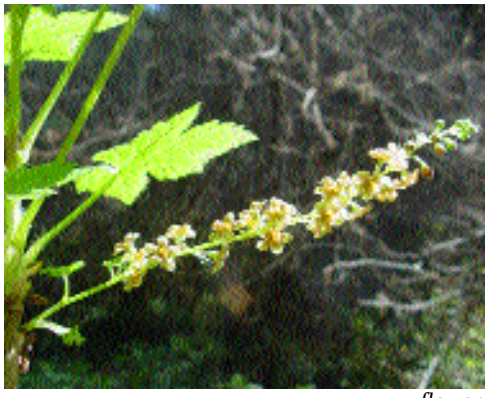
Fruit/Seed: Round berry, black with a whitish bloom, diameter to ½ inch.

Typical Location: Moist forests; elevations below 4,600 feet.

Revegetation Approach: Container.

Notes: Berries provide forage for wildlife.

leaf



flower

whole plant

seed

STREAM DOGWOOD

Species Name: *Cornus sericea*
Family: Cornaceae (dogwood family)
Plant Type: Shrub / small tree

Description: Shrub, spreads by branch tip rooting and underground stems, height to 15 feet, branches reddish to purple, deciduous with bright red autumn color.

Leaf: Lanceolate to elliptical, tapered at both ends, length to 4 inches, leaf veins in 4-7 pairs.

Flower: May-July, bisexual, flat topped clusters (2 inches wide) of small, white flowers appearing with and after leaves.

Fruit/Seed: Berry, white to cream colored, length to 1/4 inch, seed with grooved sides, ripens in late summer.

Typical Location: Active channel, streamsides, floodplains, moist areas; elevations below 9,000 feet.

Revegetation Approach: Container.

Key Notes: A good identifying characteristic is to look for thin latex threads when leaf is pulled apart. Leaf and seed morphology distinguish from red-twig dogwood (*C. glabrata*).

Notes: Seeds ripen in summer and persist into winter, making excellent wildlife forage. Native Americans used plant in basket weaving.

leaf

flower

seed

whole plant

THIMBLEBERRY

Species Name: *Rubus parviflorus*
Family: Rosaceae (rose family)
Plant Type: Shrub / small tree

Description: Erect shrub, height 3-6 feet, branches with soft hairs rather than thorns, mature branches woody, bark shredding, forms thickets, deciduous.

Leaf: Palmate with 5 unequal lobes, length 2-6 inches, surface soft, margin toothed.

Flower: March-August, clusters at branch ends, only a few per plant, petals length to 1 inch, white, floppy looking.

Fruit/Seed: Raspberry-like (aggregate of red stone fruits), dull red ripening to deep red, edible, ripens in summer.

Typical Location: Moist shady areas, streamsides, floodplains; elevations below 8,200 feet.

Revegetation Approach: Container.

Key Notes: Related to the blackberry, raspberry and salmonberry.

Notes: Edible berries provide forage for wildlife. Name derived from its distinctive berry, which looks like a thimble when removed from the plant.

leaf

flower

whole plant

seed

TOYON
CALIFORNIA HOLLY
CHRISTMAS BERRY

Species Name: *Heteromeles arbutifolia*
Family: Rosaceae (rose family)
Plant Type: Shrub / small tree

Description: Shrub or small tree, multi-trunked, height to 30 feet, bark gray, evergreen.

Leaf: Oblong, leathery, glossy, dark green, length to 4 inches, margin sharply toothed.

Flower: June-July, flat toped clusters, flowers white, small (petal length to <¼ inch), produced at ends of older branches.

Fruit/Seed: November-January, bright-red berry, fleshy, diameter ¼ inch, persistent, contains 3-6 brown seeds.

Typical Location: Chaparral, oak woodland, floodplains, mixed-evergreen forest, dry to semi-dry slopes and canyons; elevations below 4,200 feet.

Revegetation Approach: Container.

Notes: Vital forage for California birds, especially during late winter.

leaf

flower

whole plant

seed

TWINBERRY

Species Name: *Lonicera involucrata*
Family: Caprifoliaceae (honeysuckle family)
Plant Type: Shrub / small tree

Description: Erect densely foliaged shrub, branches slender, height to 10 feet, deciduous.

Leaf: Elliptical to ovate, length 2-4 inches.

Flower: March-July, paired tubular flowers (½ inch long), yellow with reddish tinge. "Leaf-like" bracts fuse to form cup underneath flower pair. Bracts darken to red or purple as flower matures.

Fruit: Distinctive paired round berries (1/3 inch diameter) containing tiny seeds, surrounded by colorful cup-like bracts.

Typical Location: Floodplains, moist, shady areas, streamsides; elevations below 9,500 feet.

Revegetation Approach: Container.

Notes: Close relative to the native honeysuckle, *L. hispidula* var. *vacillans*.

leaf

flower

seed

whole plant

VINE MAPLE

Species Name: *Acer circinatum*
Family: Aceraceae (maple family)
Plant Type: Shrub / small tree

Description: Small tree or shrub, often reclining, rooting and vine-like (especially in shaded areas), height to 20 feet in full sun, deciduous with bright autumn color.

Leaf: Palmate, 5-7 lobes, width 2-5 inches.

Flower: April-May, clusters of 4-10 small, inconspicuous flowers, sepals deep red, petals pale green.

Fruit/Seed: Distinctive paired achenes with wings, achene round, reddish, wings spreading almost 180°.

Typical Location: Shaded stream banks, floodplains; elevations below 5,000 feet.

Revegetation Approach: Container.

Key Notes: Related to the big leaf maple (*A. macrophyllum*) and box elder (*A. negundo*). Easily distinguished by leaf shape.

Notes: Foliage provides forage for deer. Flowers, buds and seeds provide forage for birds and small mammals. Squirrels will cache seeds.

leaf

flower

whole plant

seed

WESTERN AZALEA

Species Name: *Rhododendron occidentale*
Family: Ericaceae (heath family)
Plant Type: Shrub / small tree

Description: Erect shrub, densely branched with slender twigs, height 5-16 feet, deciduous.

Leaf: Elliptic, thin, mid-vein not sunken, length 1-3½ inches, edges smooth.

Flower: April-August, clusters of large, showy, white or pinkish flowers, length to 2 inches, 3-4 petals fused, strong fragrance.

Fruit/Seed: Dry capsule with many scale-like seeds.

Typical Location: Streambanks, seeps, floodplains, coniferous forests; elevations below 7,200 feet.

Revegetation Approach: Container.

Notes: *Rhododendron* is a Greek word meaning "rose tree", as signified by the showy, fragrant flowers.

leaf

flower

seed

whole plant

WESTERN SPICEBUSH

Species Name: *Calycanthus occidentalis*
Family: Calycanthaceae (sweet-shrub or calycanthus family)
Plant Type: Shrub / small tree

Description: Erect shrub, bushy round shaped, aromatic (described as old wine barrel smell), height to 9 feet, deciduous with yellow autumn color.

Leaf: Oval to oblong, opposite, length 2-6 inches, slightly hairy underneath, aromatic when crushed.

Flower: April-August, bisexual, terminal single flower, deep reddish-brown, diameter 2 inches, looks like a tiny water lily, smells "spicy".

Fruit/Seed: Oval, leathery, cuplike receptacle containing velvety, whitish-brown seeds that ripen in the autumn.

Typical Location: Moist, shady areas, floodplains, canyons, streamsides, seeps; elevations below 5,000 feet.

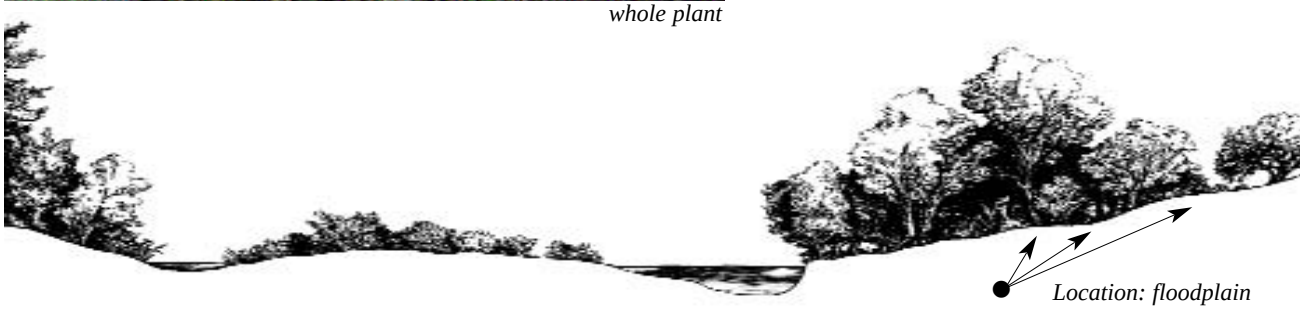
Revegetation Approach: Container.

leaf

flower

fruit with seed inside

whole plant



WILD MOCK ORANGE

Species Name: *Philadelphus lewisii*
Family: Philadelphaceae (mock orange family)
Plant Type: Shrub / small tree

Description: Erect shrub, loosely branched, many trunks, young bark reddish, older bark gray and peeling, height to 10 feet, deciduous.

Leaf: Ovate, opposite, margin partially toothed, length 1-3 inches.

Flower: May-July, terminal clusters of 6 or more flowers, white, width ¾-1 inch, numerous stamens, fragrant.

Fruit/Seed: Dry, multi-seeded capsule.

Typical Location: Slopes, canyons, forest openings, rocky slopes, canyons; elevations below 5,000 feet.

Revegetation Approach: Container.

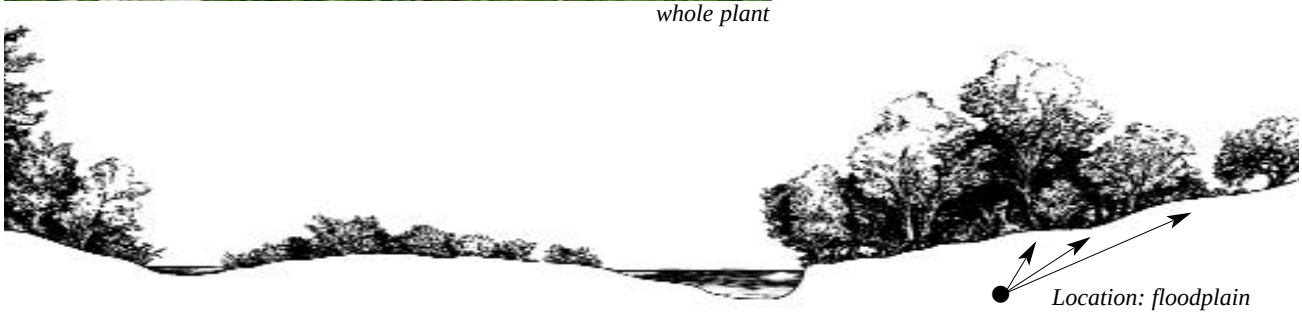
Notes: Dense growth provides good cover. Seeds eaten by quail and squirrels.

leaf

flower

seed

whole plant



CALIFORNIA WILD GRAPE

Species Name: *Vitis californica*
Family: Vitaceae (grape family)
Plant Type: Vine

Description: Sprawling woody vine, climbs surrounding vegetation, bush-like without support, tendrils produce opposite leaves, bark peeling, deciduous.

Leaf: Rounded with 0-3 shallow, palmate lobes, alternate, hairy especially on the underside, margins finely toothed.

Flower: May-July, numerous clusters of unisexual, greenish-yellow, small, fragrant flowers.

Fruit/Seed: Clusters of spherical berries, purple with whitish bloom, diameter ½ inch.

Typical Location: Streamsides, floodplains, springs, and canyons; elevations below 3,200 feet.

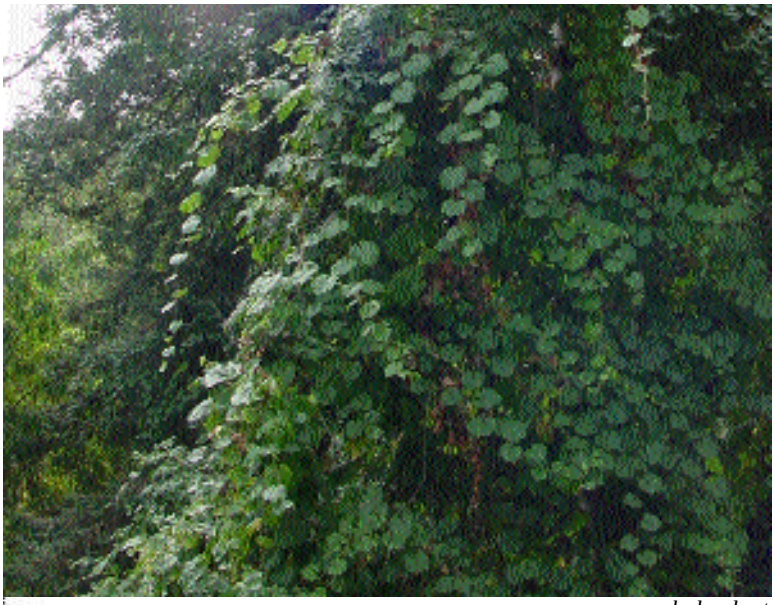
Revegetation Approach: Container, care in collection should be taken as the wild grape readily hybridizes with European imports.

Notes: Berries are an important forage for wildlife.

leaf

flower

seed



whole plant

DUTCHMAN'S PIPEVINE

Species Name: *Aristolochia californica*
Family: Aristolochiaceae (pipevine family)
Plant Type: Vine

Description: Semi-woody vine, slender stems with fine short hairs, twining stems, length to 16 feet, deciduous.

Leaf: Heart shaped, bright green, soft-hairy, alternate, length 1-6 inches, margins smooth.

Flower: January-April, U-shaped (pipe-like), hanging, green to brown, veins purple, interior lined with pink-red, length 1-1½ inches, appear before leaves, metallic fragrance.

Fruit/Seed: Capsule, angular, light green, length to 2 inch.

Typical Location: Streamsides, floodplains, forest, chaparral; elevations below 2,300 feet.

Revegetation Approach: Container.

Notes: Provides food for the pipevine swallowtail larvae and is, in turn, pollinated by the pipevine swallowtail butterfly. Produces a specialized glycoside, known to cause heart attacks in vertebrates, which provides swallowtail larvae with a defense against predators. Other butterflies mimic pipevine swallowtail coloration as a predator defense strategy.

leaf and seed

flower

whole plant

seed with pipevine swallowtail caterpillar

HONEYSUCKLE

Species Name: *Lonicera hispidula*
Family: Caprifoliaceae (honeysuckle family)
Plant Type: Vine

Description: Climbing vine, slender stems, length to 20 feet.

Leaf: Oblong, opposite, length to 3 inches, upper pairs connected around stem.

Flower: April-July, clusters of paired flowers, flowers funneled, double-lipped blooms, upper lip four-lobed, very fragrant, purple to pink, length to ½ inch.

Fruit/Seed: Round, red berry, diameter ¼ inch.

Typical Location: Streamsides, floodplain, wooded slopes, canyons; elevations below 3,600 feet.

Revegetation Approach: Container.

Notes: Related to the native twinberry, *Lonicera involucrata*.

leaf

flower

whole plant

seed

MANROOT
WILD CUCUMBER

Species Name: *Marah fabaceus*
Family: Cucurbitaceae (gourd family)
Plant Type: Vine

Description: Perennial vine, climbs, builds mounds and sprawls, stems soft/not-woody, sometimes with prickles, climbs using lateral tendrils, length to 21 feet, large root or tuber.

Leaf: Palmate, 5-7 lobes, large.

Flower: February-April, monoecious (separate sexes on same vine), female and male similar, white to yellowish-green, cup shaped, width to ½ inch, female flowers solitary, male flowers in clusters.

Fruit/Seed: Spiny gourd, rounded with pointed tip, diameter 1½-2 inches, contains 4 large, often flat, brown seeds.

Typical Location: Streamsides, floodplains, washes, shrubby areas, open areas, and slopes; elevations below 5,200 feet.

Revegetation Approach: Container.

Notes: The common name "manroot" relates to the very large tuber root that can grow 4-8 feet long. Native Americans traditionally used pounded root in tidepools and stream pools to stun fish.

leaf

flower

whole plant

seed

POISON OAK

Species Name: *Toxicodendron diversilobum*
Family: Anacardiaceae (sumac or cashew family)
Plant Type: Vine

Description: Shrub, occasionally tree-like (height 1½-14 feet) or vining (length to 85 feet) into tree canopies, gray to red-brown twigs, deciduous.

Leaf: Compound with 3 (occasionally 5) leaflets, leaflets resinous, smooth, shiny, red in autumn, lobed, terminal leaflet length to 3 inches, lateral leaflet length to 2¾ inches.

Flower: April-May, clusters of small, cream-colored flowers, petals ovate.

Fruit/Seed: Round berry, white, leathery, diameter <¼ inch.

Typical Location: Floodplains, canyons, slopes, chaparral, oak woodlands; elevations below 5,400 feet.

Revegetation Approach: Not recommend for cultivation.

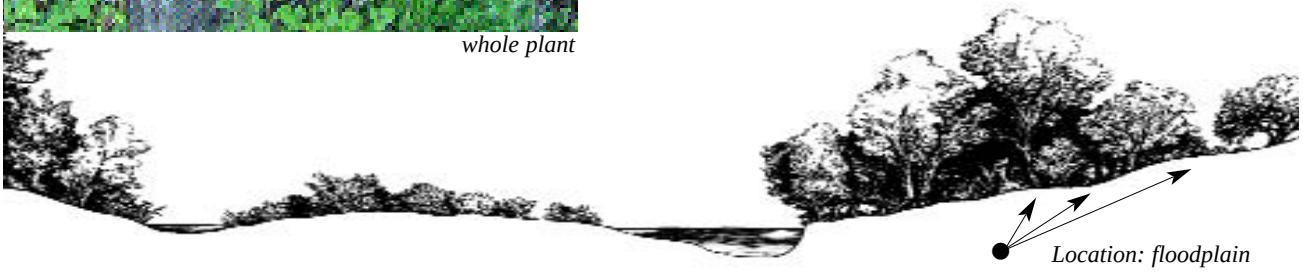
Notes: Resin on leaves, stems and flowers causes painful dermatitis to humans. Latin name means "poisonous tree". Fruit is an important winter forage for wildlife.

leaf

flower

seed

whole plant



VIRGIN'S BOWER PIPESTEM

Species Name: *Clematis lasiantha*
Family: Ranunculaceae (buttercup family)
Plant Type: Vine

Description: Semi-woody vine, stems slender, climbs surrounding vegetation with tendril-like leaf petiole, deciduous.

Leaf: Compound with 3-5 leaflets, leaflets elliptic/ovate, coarsely toothed or 3-lobed, length 1-2 inches.

Flower: January-June, single flower, showy, diameter 1¼ inch, no petals but 4 cream-colored sepals showy and petal-like.

Fruit/Seed: Head-like clusters of small achenes with distinctive long feathery tails.

Typical Location: Floodplains, hillsides, chaparral, open woodlands; elevations below 6,600 feet.

Revegetation Approach: Container.

leaf

flower

whole plant

seed

BULRUSH
TULE

Species Name: *Scirpus acutus* var. *occidentalis*
Family: Cyperaceae (sedge family)
Plant Type: Emergent

Description: Erect perennial, spreads by rhizomes forming dense clusters, stems round, width to ½ inch, height 5-13 feet.

Leaf: Reduced to a membranous flat blade along stem base, length to 3 inches.

Flower: May-August, bisexual, erect, 1-7 branched clusters, straw colored or orange to dark reddish brown, produced at stem tip, flowers spiny.

Fruit/Seed: Achene, slightly angled sides, beaked, gray-brown, wind and water dispersed.

Typical Location: Active channel, streamsides, marshes, lakes; elevations below 8,200 feet.

Revegetation Approach: Container or transplant.

Notes: May provide critical juvenile fish habitat. Important nesting and escape cover for small mammals, waterfowl and other birds. Seeds provide forage for waterfowl. Thick rhizome root system provides some river and lake bank stabilization. Native Americans used *Scirpus* roots for basketry.

flower

whole plant

CATTAIL

Species Name: *Typha latifolia*
Family: Typhaceae (cattail family)
Plant Type: Emergent

Description: Erect perennial, dense clumps of tall blades (height 5-10 feet), creeping rootstock.

Leaf: Blade, alternate, flat on the inside, rounded on the outside, interior spongy, tip pointed, height to over 6 feet.

Flower: June-July, cattail, terminal flowers on a round stalk, male flowers above female flowers, no separation between male and female clusters, female flowers green in flower, turn brown as seeds ripen.

Fruit/Seed: Tiny, brown nutlets, length 1/25 inch, released with white mass of wooly hairs, seeds disperse by floating on wind or water.

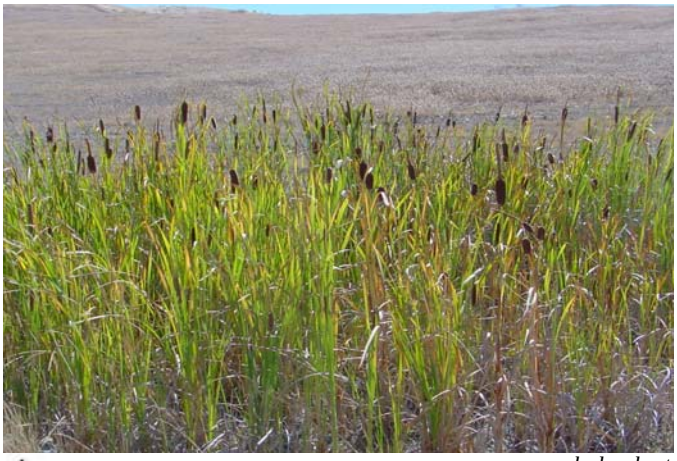
Typical Location: Lakes, marshes, any slow moving or stagnant water; elevations below 6,600 feet.

Revegetation Approach: Seed, transplant.

Notes: Nest building habitat and shelter for birds and waterfowl. Tolerates saline conditions.

leaf and flower

seed



whole plant

CREEPING WILD RYE

Species Name: *Leymus triticoides*
Family: Poaceae (grass family)
Plant Type: Herbaceous

Description: Mat forming grass, height 1½-4 feet, perennial, stems smooth to slightly hairy, spreads by rhizomes, may remain green even in dry season, leaf blades lean away from stem.

Leaf: Blade, flat, surface slightly rough.

Flower: Cluster of grass spikelets at end of tall stem (height 2-8 inches), spikelets 1-3 per node.

Fruit/Seed: Achene-like grain.

Typical Location: Streamsides, floodplains, moist meadows and areas subject to flooding; elevations below 7,500 feet.

Revegetation Approach: Container, transplant.

Notes: Useful in binding soil for erosion control, lies flat when flooded and recovers quickly. Tolerates saline conditions.

whole plant

whole plant

HORSETAIL
SCOURING RUSH

Species Name: *Equisetum spp.*
Family: Equisetaceae (horsetail family)
Plant Type: Emergent

Description: Perennial from spreading rhizomes, erect annual (some perennial) stems, stem is segmented with distinct rings, ring may have whirl of wiry leaf-like branches, spore producing non-woody cone forms at stem tips, may have separate sterile and fertile stems, height 4 inches to 6 feet.

Leaf: None or scale-like, close growing, brown (wiry branches are leaf-like, but not leaves).

Flower: None, sexual reproduction by a spore producing non-woody cone (not a flowering plant).

Fruit/Seed: Spore, spherical, green.

Typical Location: Streamsides, moist areas, roadside ditches, seeps, disturbed areas; elevations below 9,800 feet.

Revegetation Approach: Container or transplant.

Notes: Provides soil stabilization. Native Americans made tea for medicinal uses and used the fertile stems of *E. telmateia* as sandpaper. Outer surface has high silica content.

whole plant with branches

whole plant with fertile stems

INDIAN RHUBARB UMBRELLA PLANT

Species Name: *Darmera peltata*
Family: Saxifragaceae (saxifrage family)
Plant Type: Herbaceous

Description: Perennial herb, stemless, flowers and leaves from ground, flowers before leaves appear, spreads by rhizomes, height to 5 feet, leaves turn bright red in autumn.

Leaf: Palmate, multi-lobed, height to 5 feet, broad (width to 3 feet), stem attached towards center of leaf, margins with irregular teeth.

Flower: April-July, umbrella shaped cluster of small, white to pale pink flowers, grows on long stalk (length 1 to 5 feet) before leaves.

Fruit/Seed: 2 dry red follicles, length to ½ inch.

Typical Location: Rocky streambanks; elevations below 6,000 feet.

Revegetation Approach: Container, transplant.

Notes: The common name "umbrella plant" describes the leaves, which look like umbrellas blown inside out.

leaf

flower

whole plant

MUGWORT

Species Name: *Artemisia douglasiana*
Family: Asteraceae (sunflower family)
Plant Type: Herbaceous

Description: Perennial erect herb, stems in dense clump, height to 8 feet, spreads by rhizomes.

Leaf: Coarsely 3-5 lobed, evenly-spaced, alternate, underside hairy and grayish, aromatic (sage-like), length to 6 inches.

Flower: June to October, dense clusters on elongated leafy stems, length 4-12 inches, disk flowers small (diameter <¼ inch), bell shaped, greenish.

Fruit/Seed: Tiny dry achene.

Typical Location: Moist low places, open and shady places, drainages; elevations below 7,200 feet.

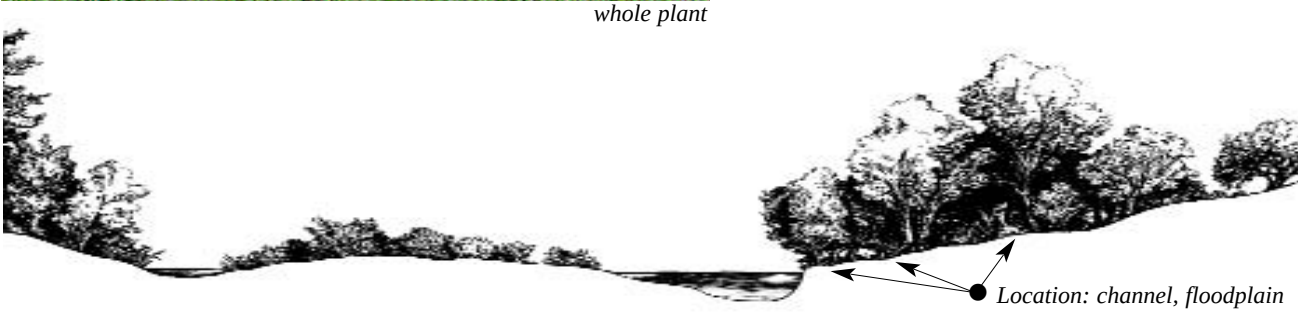
Revegetation Approach: Container.

Notes: Common, stabilizes soil. Pierce's Disease host plant (see page XI-7 for more information).

leaf

flower

whole plant



RUSH

Species Name: *Juncus* spp.
Family: Juncaceae (rush family)
Plant Type: Emergent

Description: Erect grasslike annual or perennial, usually spread by rhizomes forming dense clumps, stems wiry, round or flat, height to 4 feet.

Leaf: Wiry, round or flat, sometimes greatly reduced to just tip of stem.

Flower: May-August, bisexual, lateral clusters near stem tip, 1-50 flowers, flower green or purplish-brown, inconspicuous.

Fruit/Seed: Many, tiny beaked seeds.

Typical Location: Active channel, streamsides, marshes, seeps, springs; elevations below 12,000 feet.

Revegetation Approach: Container or transplant.

Key Notes: Accurate identification requires an understanding of flower characteristics.

Notes: Thick rhizome root system provides streambank stabilization. Native Americans used rushes for basketry and fish trap construction.

whole plant and flower

Juncus effusus

whole plant

SEDGE

Species Name: *Carex* spp.
Family: Cyperaceae (sedge family)
Plant Type: Emergent

Description: Perennial, bladed (grass-like) with 3-sided stems and flat blades, forms clumps or tufts, height to 4 feet, often evergreen, some species spread by rhizomes.

Leaf: Blade, usually flat, can be rolled, thick (width ¼-½ inch).

Flower: Unisexual, male spikelets sit above the female spikelets near the blade tip, flower stalk solid and without nodes.

Fruit/Seed: Tiny, 2-4 sided achene.

Typical Location: Depends on species: active channel, floodplain, wet areas, valley slopes, seasonally wet areas; elevations below 13,000 feet.

Revegetation Approach: Container, transplant.

Key Notes: Identification to species usually requires microscopic evaluation of flowering parts.

Notes: With over 1,000 species, sedges comprise one of the largest genera of plants in the world. Native Americans traditionally used certain species of *Carex* in basket weaving.

Carex nudata

Carex spp.

SPIKE RUSH

Species Name: *Eleocharis spp.*
Family: Cyperaceae (sedge family)
Plant Type: Emergent

Description: Erect annual or perennial, spreads by rhizomes, stems round, wiry, generally grooved, height to 3 feet.

Leaf: Generally without or reduced to sheath around stem, sometimes leaves from base.

Flower: Bisexual, erect, single cluster at stem tip, flowers few to many.

Fruit/Seed: Achene, 2-3 sided or round.

Typical Location: Streamsides, marshes, meadows; elevations below 8,500 feet.

Revegetation Approach: Container or transplant.

Notes: Stems, roots and seeds are all forage for waterfowl.

whole plant and flower

flower

whole plant

STINGING NETTLE

Species Name: *Urtica dioica*
Family: Urticaceae (nettle family)
Plant Type: Herbaceous

Description: Perennial erect herb, stems with fine hairs, spreads by rhizomes, height to 10 feet.

Leaf: Lanceolate to widely ovate, margin toothed, veins 3-5 originating at base, length to 1½ inches.

Flower: April, mostly dioecious flower clusters (length to 3 inches) in leaf axis, male and female flowers small, sepals greenish, without petals.

Fruit/Seed: Ovate achene.

Typical Location: Streambanks, woodland marshes, moist waste areas; elevations below 10,000 feet.

Revegetation Approach: Container.

Key Notes: A subspecies is native to Eurasia and naturalized in North America, care must be taken in identification.

Notes: This plant contains tiny hollow hairs, which, upon contact with human skin, releases an irritating, stinging acid (formic acid), hence the name. Pierce's Disease host plant (see page XI-7 for more information).

leaf

flower

whole plant

flower

APPENDIX XI-B

CENTRAL AND NORTH COAST INVASIVE NON-NATIVE PLANTS

ACACIA

Species Name: *Acacia* spp.
Family: Fabaceae (legume family)
Plant Type: Exotic invasive tree

Description: Tree, height to 40 feet, evergreen.

Leaf: Distinctive primary and secondary leaflets, silver-gray, hairy. Primary leaflet: 10-25 pairs of secondary leaflets; secondary leaflet: 20-50 pairs of tiny, thin, overlapping leaflets (length to <¼ inch).

Flower: Bisexual, spherical clusters of 25-30 tiny, bright yellow flowers.

Fruit/Seed: Pod, straight or slightly curved, slightly indented between seeds, length 2-3 inches.

Typical Location: Disturbed areas, roadsides, elevations below 1,600 feet.

Revegetation Approach: Do not plant in riparian areas! Remove where feasible.

Key Notes: Members of the family Fabaceae have root nodules that contain atmospheric nitrogen-fixing bacteria.

Notes: Ornamental species brought from Australia. Highly invasive and has little wildlife value. Chemicals leaching from trees may cause allelopathic effects resulting in reduced or inhibited germination and growth in native plants.

leaf

flower

seed

whole plant

CAPE IVY

Species Name: *Delairea odorata*
Family: Asteraceae (sunflower family)
Plant Type: Exotic invasive vine

Description: Perennial vine, stems green or purple, older stems woody, ground cover develops to 30 inches high, climbs to considerable heights, spreads by runners that root at nodes.

Leaf: Palmate with 5-9 pointed lobes, shiny, greenish-yellow, length 1-3 inches.

Flower: Spring blooming, disk-like flowers, bright yellow, numerous.

Fruit/Seed: Achenes, tiny, wind dispersed, mostly sterile in California.

Typical Location: Moist forest, riparian areas, seasonal wetlands, coastal areas; elevations below 650 feet.

Revegetation Approach: Do not plant in riparian areas! Remove where feasible.

Key Notes: Name changed to *Delairea odorata* from *Senecio mikanioides*.

Notes: Native to South Africa. Highly invasive and grows rapidly. Extreme pest with climbing behavior resulting in smothering and exclusion of native vegetation.

leaf

whole plant

flower

ENGLISH IVY

Species Name: *Hedera helix*
Family: Araliaceae (ginseng family)
Plant Type: Exotic invasive vine

Description: Woody vine, ground cover or climber with aerial rootlets, spreads by runners, evergreen.

Leaf: Variable shape, palmate with 3-5 lobes to ovate or diamond shaped, length to 4 inches, base width to 4 inches, edges smooth.

Flower: Branches with small, ball-like clusters of greenish flowers.

Fruit/Seed: Round berry, black, diameter <¼ inch.

Typical Location: Moist shady areas, elevations between sea level to 3,300 feet.

Revegetation Approach: Do not plant in riparian areas! Remove where feasible.

Key Notes: Very similar to non-native Algerian ivy (not pictured), *H. canariensis*, although Algerian ivy has larger leaves (width 5-8 inches) that are more widely spaced.

Notes: Non-native, planted as soil stabilizing ground cover, introduced from Europe, highly invasive. Prevents native plant germination. Ground cover and vining behavior kill both understory and overstory native plants by shading. Harbors slugs, snail and rodents.

leaf

flower

whole plant

EUCALYPTUS GUM TREE

Species Name: *Eucalyptus* spp.
Family: Myrtaceae (myrtle family)
Plant Type: Exotic invasive tree

Description: Tree, tall and slender, height 30-150 feet, peeling bark, evergreen.

Leaf: Variable among species, always longer than wide (length 2-8 inches), leathery, usually lanceolate, edges smooth, pointed at tip, highly aromatic containing volatile oil.

Flower: Mostly spring/summer, sometimes through autumn, bisexual, cup-like receptacle contains flower, petals inconspicuous but stamen showy white, yellow, pink or red.

Fruit/Seed: Woody capsule, angular sides, flat top, contains many tiny seeds.

Typical Location: Disturbed areas; elevations below 1,000 feet.

Revegetation Approach: Do not plant in riparian areas! Remove where feasible.

Notes: Native to Australia and imported as a wood source. Removal sometimes controversial because native wildlife, especially birds and Monarch butterfly, use tree for roosting or nesting. Allelopathic and shading effects result in reduced and inhibited native plant germination and growth. Thick leaf, bark and limb litter create fire hazard.

leaf

whole plant

flower

seed

FENNEL

Species Name: *Foeniculum vulgare*
Family: Apiaceae (carrot family)
Plant Type: Exotic invasive herb

Description: Perennial herb with large taproot, erect, solid stems, height 3-10 feet, woody dry stems with seed heads remain visible after winter die back, new leaves form from base in late winter. Entire plant has strong licorice or anise-like aroma.

Leaf: Large triangle leaf, finely divided into thread like sections.

Flower: May-September, bisexual, umbrella like clusters (width to 4 inches) with 15-40 rays containing clusters of small, yellow flowers.

Fruit/Seed: Oblong, ribbed, length 1/8 inch, seed face flat.

Typical Location: Streamsides, roadsides, disturbed areas; elevations sea level to 1,200 feet.

Revegetation Approach: Do not plant in riparian areas! Remove where feasible.

Notes: Native to Europe, escaped from cultivation. Spreads rapidly and excludes native vegetation. Disturbed, open soil encourages establishment. Dispersal of seeds by water result in downstream invasions.

whole plant

flower

whole plant in flower

seed

FLOATING PRIMROSE, WATER PRIMROSE

Species Name: *Ludwigia peploides/Ludwigia hexa-petala*
Family: Onagraceae (evening primrose family)
Plant Type: Exotic invasive emergent/aquatic

Description: Perennial herb, spreads by rooting nodes over stream edges and water forming floating mats (roots in water up to 18 inches deep, 10-15 feet from shore). Stems straight or branching, prostrate or erect, length 1-10 feet.

Leaf: Oblong to round, alternate, length to 2½ inches.

Flower: May-October, bisexual, showy, bright yellow, petal length to 1 inch. Flowers on stalks arising from leaf axis (point where leaf joins stem).

Fruit/Seed: Capsule, hard, long, cylindrical, 5-sided, with tiny seeds embedded in fruit walls.

Typical Location: Stream banks, ditches, ponds; elevations below 3,000 feet.

Revegetation Approach: Do not plant in riparian areas! Remove where feasible.

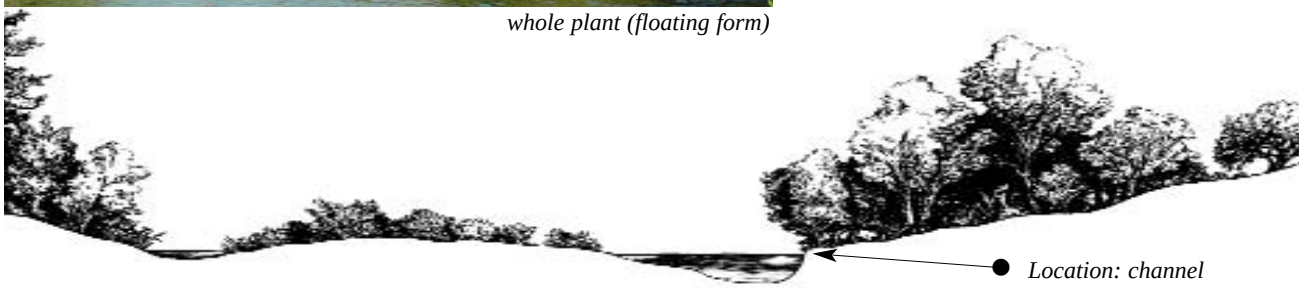
Notes: Native to Southern U.S., cultivated as ornamental for landscaped ponds. Floating aquatic and emergent, depending on season and water level.

leaf and flower (erect fom)

flower

whole plant (floating form)

whole plant (floating form)



GIANT REED

Species Name: *Arundo donax*
Family: Poaceae (grass family)
Plant Type: Exotic invasive grass

Description: Many stemmed, dense clumps of cane or bamboo-like grass, stem hollow but divided by partitions at nodes (like bamboo), height 9-30 feet, spreads by rhizomes and rooting at nodes, semi-dormant in winter (turns brownish).

Leaf: Blade-like, flat, length to 3 feet, width to 2 inches at base, tapers to point at tip, alternate, arranged in a single plane (corn-like).

Flower: March-September, plumed terminal cluster, length 1-2 feet, brown or purple.

Fruit/Seed: No viable seed produced in North America.

Typical Location: Streamside, floodplains, drainages, ditches; elevations below 1,600 feet.

Revegetation Approach: Do not plant in riparian areas! Remove where feasible.

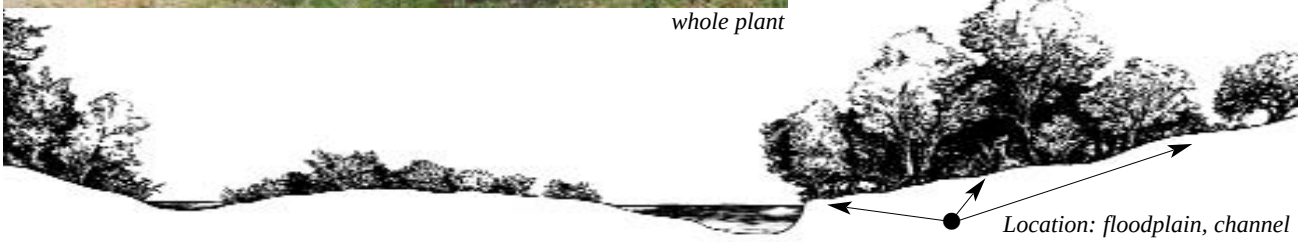
Notes: Introduced from Asia and one of the greatest vegetative threats to the health of California's waterways. It is highly flammable, provides limited stream shading, and minimal habitat for native wildlife. Forms dense monocultures that may exclude native vegetation.

leaf

whole plant

node

whole plant



HIMALAYAN BLACKBERRY

Species Name: *Rubus discolor*
Family: Rosaceae (rose family)
Plant Type: Exotic invasive vine

Description: Thicket forming, mound building (height to 10 feet or more), sprawling, vine-like, cane length to 20 feet, stems 5 angled, thorns large and curved, stem tips root.

Leaf: Compound with 5 leaflets, leaflet ovate, margins sharply toothed, length 2-4 inches.

Flower: April-June, clusters of white to pale pink flowers, petal length 1/2 inch.

Fruit/Seed: Blackberry (aggregate of black stone fruits), oblong, red ripening to black, highly edible, ripening in summer. Multiple small seeds inside single blackberry.

Typical Location: Common, disturbed moist areas, streamsides, roadsides, fencerows; elevations below 5,200 feet.

Revegetation Approach: Do not plant in riparian areas! Remove where feasible.

Key Notes: Often confused with the native California blackberry (*R. ursinus*). Distinguished by leaf and thorn morphology.

Notes: The dense brambles choke out native vegetation and dominate the riparian forest floor. Thickets provide shelter and forage for wildlife, and erosion control. Removal requires revegetation with native vegetation. Pierce's Disease host plant (see page XI-7 for more information).

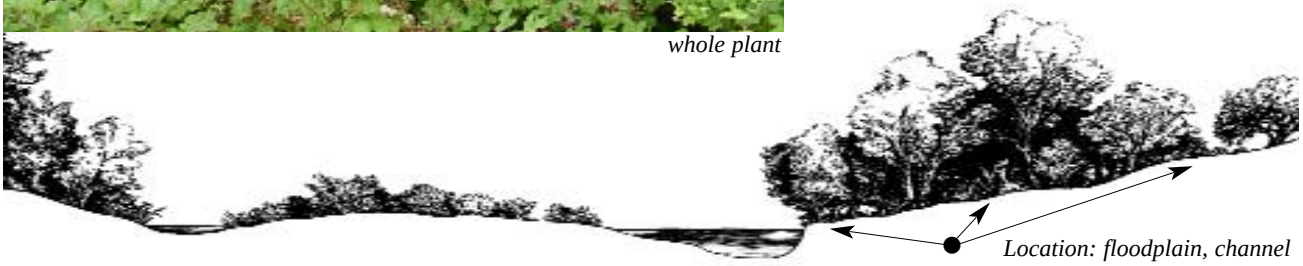
leaf

flower

seed

stem

whole plant



PAMPAS GRASS

Species Name: *Cortaderia selloana*
Family: Poaceae (grass family)
Plant Type: Exotic invasive grass

Description: Perennial grass, dense clumps, height 6-14 feet, width 12 feet.

Leaf: Blades greenish-gray, width 1-3 inches, tapering at tip, sharp edges can cut.

Flower: Summer, dioecious (separate sex grasses) but can reproduce asexually, long stalks (length to 14 feet) with distinctive plum-like silvery flower head.

Fruit/Seed: Tiny seeds, wind dispersed, ripen in autumn.

Typical Location: Moist areas, disturbed sites, elevations below 1,000 feet.

Revegetation Approach: Do not plant in riparian areas! Remove where feasible.

Notes: Ornamental brought from South America. Produces wind-born seeds asexually, results in rapid spread. Dominates landscape and excludes native vegetation.

Pampas grass

whole plant

seed

PEPPERWEED

Species Name: *Lepidium latifolium*
Family: Brassicaceae (mustard family)
Plant Type: Exotic invasive herb

Description: Perennial herb, erect, branching, height to 6 feet. Spreads by creeping roots (rhizomes) up to 10 feet from original plant. Dies back during winter months.

Leaf: Lanceolate, toothed or entire, waxy, distinctive white veins, lower leaves larger (length to 1 foot, width 2-3 inches) than upper leaves (width to 1 inch).

Flower: May-July, bisexual, dense clusters of tiny, white, 4 petaled flowers produced at stem tips.

Fruit/Seed: Round, pod-like, slightly hairy, diameter 1/12 inch, contains 2 tiny, reddish-brown seeds, spread by wind, water and possibly waterfowl.

Typical Location: Riparian areas/wetlands, roadsides, disturbed areas, saline soils; elevations below 6,200 feet.

Revegetation Approach: Do not plant in riparian areas! Remove where feasible.

Key Notes: Flowers have 4 petals, a characteristic of the mustard family.

Notes: Native to Eurasia, accidentally brought to U.S. Successful competitor in riparian and wetland areas forming dense clusters that exclude native vegetation. Does not hold soil well resulting in streamside erosion. Reproduces and spreads by seeds and root fragments.

leaf

flower

whole plant

whole plant

PERIWINKLE

Species Name: *Vinca major*
Family: Apocynaceae (dogbane family)
Plant Type: Exotic invasive vine

Description: Spreading, low growing, with erect flowering stems (height 9-20 inches) and trailing non-flowering stems (length to 6 feet), stems root at tips, deciduous. Stems produce milky latex if broken.

Leaf: Oval, tip pointed, opposite, length to 3 inches.

Flower: Spring-Summer, bisexual, single flowers, diameter 1-2 inches, light blue-purple, produced from leaf axis (point where leaf joins stem).

Fruit/Seed: Rarely produces viable seed in California.

Typical Location: Sheltered places, floodplains, streamsides usually escaped from cultivation; elevations below 650 feet.

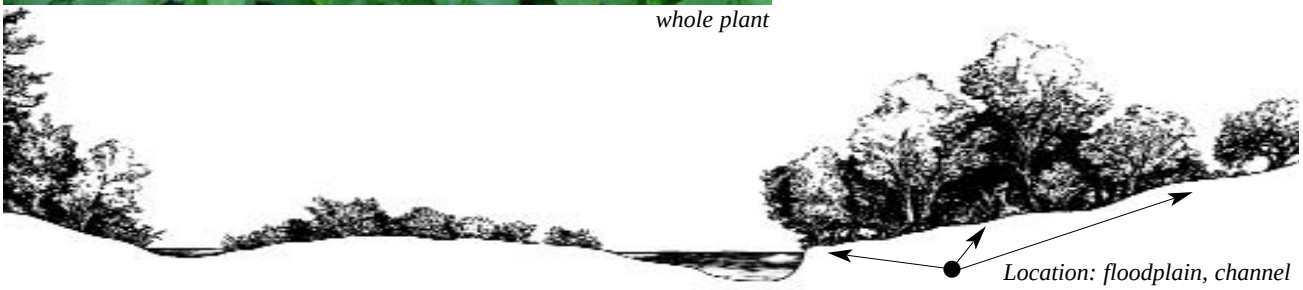
Revegetation Approach: Do not plant in riparian areas! Remove where feasible.

Notes: Native to Mediterranean region, commonly planted as ground cover. Low value to native wildlife and insects. The scientific name, Vinca, translates in Latin to "bind or conquer". Vinca lives up to its name with an aggressive, spreading growth that prevents native plants from becoming established. Pierce's Disease host plant (see page XI-7 for more information).

leaf and flower

flower

whole plant



POISON HEMLOCK

Species Name: *Conium maculatum*
Family: Apiaceae (carrot family)
Plant Type: Exotic invasive herb

Description: Perennial herb, erect, branched, stems hollow, generally purple spotted/striped, height 2-10 feet, taproot solid, whitish, parsnip like. Plant gives off unpleasant "mouse-like" odor when bruised.

Leaf: Compound, length 2-12 inches. Leaflets very small, finely divided, delicate.

Flower: May-September, bisexual, umbrella like clusters (width 1-2 inches) with 5-15 rays containing clusters of small, white flowers.

Fruit/Seed: Round to ovate, sides ribbed, diameter <¼ inch.

Typical Location: Wet areas; elevations below 3,200 feet.

Revegetation Approach: Do not plant in riparian areas!

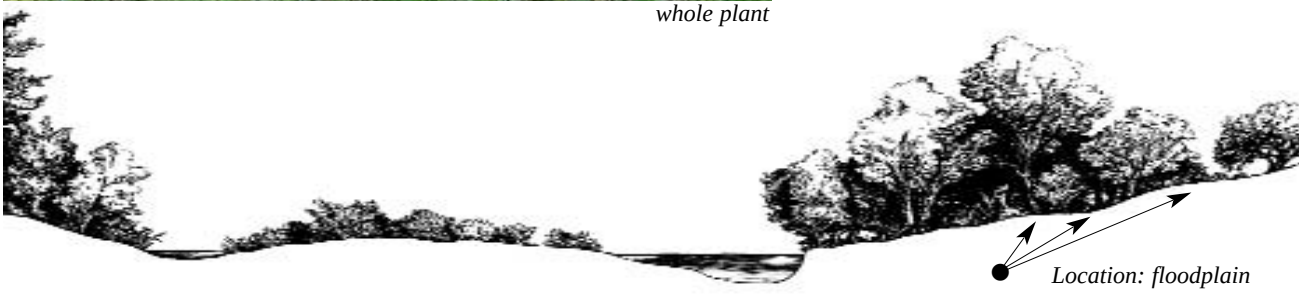
Notes: Native to Europe. Very toxic if eaten, all parts (leaves, seeds, roots) contain high levels of conine and related pyridine-type alkaloids. The Greek philosopher Socrates was executed by drinking prepared poison hemlock. May have allelopathic effects that suppress germination of native plants.

leaf

flower

whole plant

seed



TAMARISK
SALT CEDAR

Species Name: *Tamarix* spp.
Family: Tamaricaceae (tamarisk family)
Plant Type: Exotic invasive shrub

Description: Shrub or small tree, thin, narrow crown, height to 26 feet, branches jointed and often drooping, deep taproot, spreads extensively by rhizomatous roots, deciduous.

Leaf: Scale-like, tiny (length to <¼ inch), overlap, can excrete salt.

Flower: March-September, small cluster (length to 2 inches) of small, pink, short- petaled (length to ¼ inch) flowers, insect pollinated, highly fecund.

Fruit/Seed: Seeds tiny, tuft of hair at one end, spread by wind and water.

Typical Location: Floodplains, riverbanks, ditches, marshes; elevations below 2,600 feet.

Revegetation Approach: Do not plant in riparian areas! Remove where feasible.

Notes: Native to Asia. Invades wet areas especially after human disturbance, requires great quantities of water, can lower water table. Spreads by seed, rhizomes and re-rooting of fractured root fragment. Accumulates salt in leaves, falling leaves may result in accumulation of salt in topsoil. May be long lived (50-100 years). Excludes native vegetation, provides little value to native wildlife and insects, and may change soil and water conditions.

leaf and seed

flower

seed

whole plant in flower

whole plant

TEASEL

Species Name: *Dipsacus fullonum*
Family: Dipsacaceae (teasel family)
Plant Type: Exotic invasive herb

Description: Biannual herb/small shrub, stems branched, armed with thorns, height to 6 feet.

Leaf: In pairs, partially fused around stem, toothed.

Flower: Early spring to late autumn, bisexual, flower head egg-shaped, spiny. Flowers small, lavender-white, appear in rows around head.

Fruit/Seed: Achene, hairy, box-like, length ¼ inch.

Typical Location: Roadsides, pastures, moist sites; elevations below 5,600 feet.

Revegetation Approach: Do not plant in riparian areas! Remove where feasible.

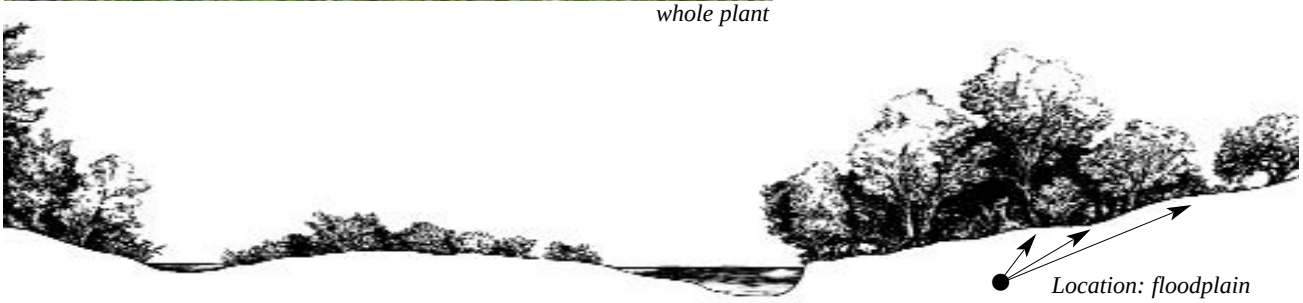
Key Notes: Distinctive bristly dried flower heads persist through winter.

Notes: Native to Europe. Imported in 19th century and grown for the bristly flower head. The dried flower head was used to brush woolen fabrics to bring up the nap.

whole plant

flower

whole plant



TREE OF HEAVEN

Species Name: *Ailanthus altissima*
Family: Simaroubaceae (quassia or simarouba family)
Plant Type: Exotic invasive tree

Description: Tree, bark gray-brown and thin, height to 65 feet, fast growing, often grows in clumps, deciduous.

Leaf: Compound, length 1-3 feet, with 13-25 leaflets. Leaflets lanceolate, margins with few teeth, pointed at tip, length 3-5 inches, produce a bad smell when crushed.

Flower: April-July, dioecious (separate sex trees), occasionally bisexual, female and male flowers similar, non-descript, yellow-green. Flowers grow in 3-8 inch clusters. Male flowers have unpleasant odor.

Fruit/Seed: Winged achene, green-yellow or showy orange-red, seed at center, length 2 inches, wind dispersed, female trees produce large quantities, ripen September-October.

Typical Location: Disturbed areas, roadsides, tolerant of pollution; elevations below 4,100 feet.

Revegetation Approach: Do not plant in riparian areas! Remove where feasible.

Key Notes: Young plants sometimes confused with the native black walnut (*Juglans californica*). Seeds, flowers or careful inspection of leaf characteristics distinguish between species.

Notes: Brought to California from Asia during the gold rush era. Highly invasive, grows rapidly and spreads both vegetatively and by seed.

leaf

whole plant

flower

seed

YELLOW STAR THISTLE

Species Name: *Centaurea solstitialis*
Family: Asteraceae (sunflower family)
Plant Type: Exotic invasive herb

Description: Annual, early spring growth from taproot, green, low to ground; in late spring through autumn the plant bolts to become stiff branched, bluish-green, develops stem leaves and flowers, height to over 3 feet.

Leaf: Lower leaves lobed, length 2-6 inches, bristly, lost before flowering; upper leaves not lobed, narrow, leaf ridge extends down stem past point of attachment (winged appearance), bluish-green, length to over 1 inch.

Flower: May-December, numerous, solitary, ovoid flower head with long spines (length to 1 inch), bright yellow, can have 2 flowering seasons per year (spring then autumn).

Fruit/Seed: Achene, 2 types, outer seedhead achenes are dark brown, inner are light brown with tiny bristles.

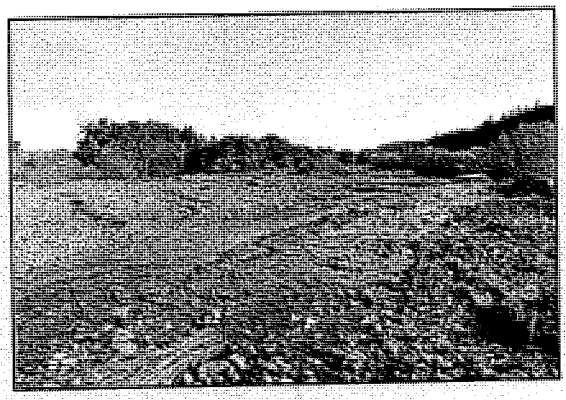
Typical Location: Pastures, roadsides, grasslands, woodlands, disturbed areas; elevations below 4,200 feet.

Revegetation Approach: Do not plant in riparian areas! Remove where feasible.

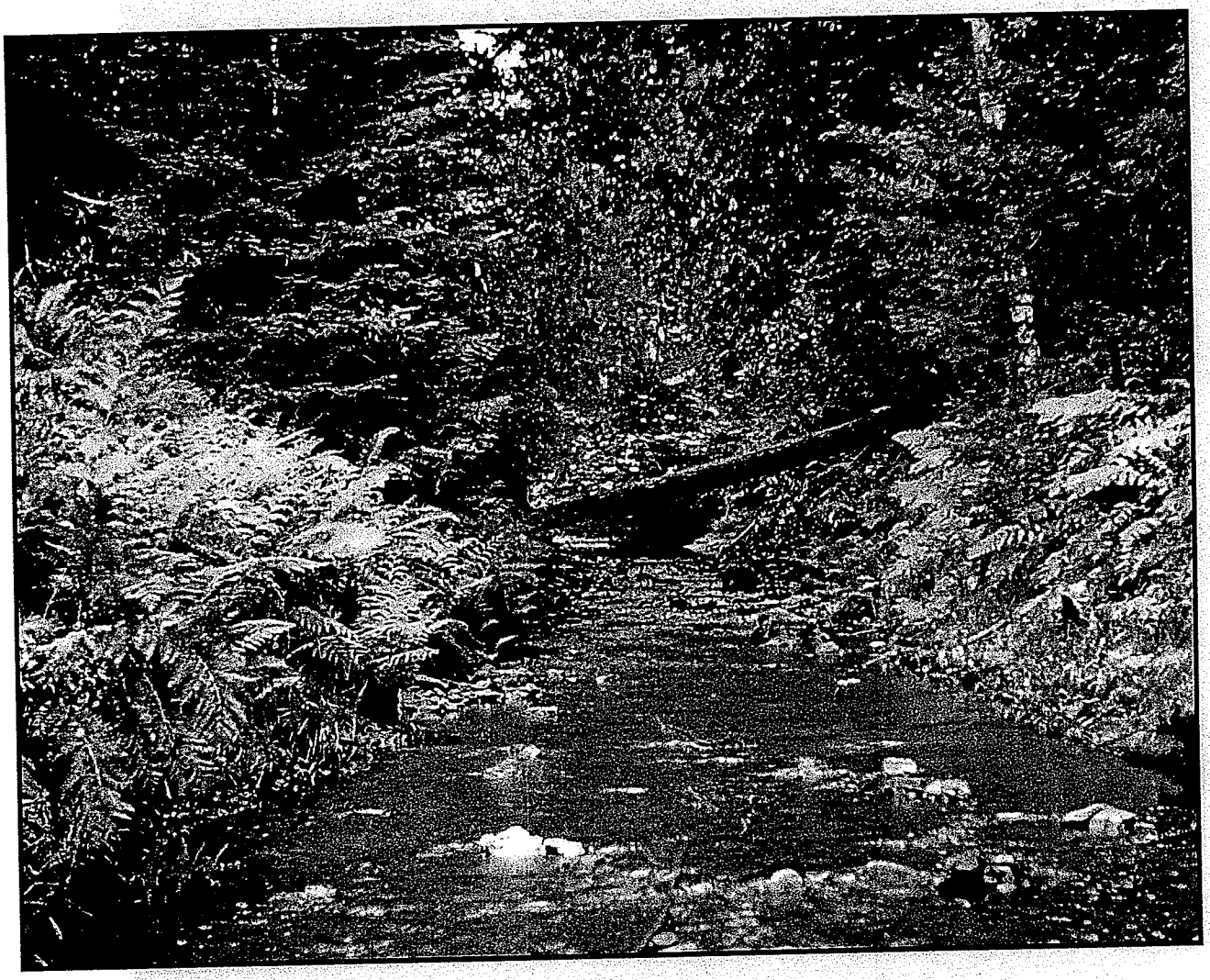
Notes: Introduced from southern Europe, believed to be accidentally moved with livestock feed. Considered one of the western United States' most noxious weeds. Displaces native plants and animals, and reduces soil moisture reserves in grasslands. Long spines limit access to recreational areas. Reduces land value, poisonous to horses and poor forage for livestock.

flower

whole plant in flower



NAVARRO WATERSHED RESTORATION PLAN



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Channel Conditions

Channel conditions vary according to the specific tributary. Several second order tributaries, such as John Smith Creek and Flynn Creek, provide relatively good pool habitat with large woody debris. Dutch Henry Creek is believed to have similar habitat conditions, however there is no available data on this sub-basin. The North Branch of the North Fork has a more complex, branching channel pattern, compared to the South Branch of the North Fork. Spawning sites in tributaries are not as prone to scouring compared to sites with similar gravel sizes in the larger channels. The North Branch of the North Fork is likely to provide better incubation and over-winter habitat due to more stable channel beds. Most of the channels are relatively low gradient streams trending either northwest or northeast. Good spawning habitat was observed during field surveys on the Little North Fork Navarro River.

Overall, habitat conditions are considered to be suitable, and are presently supporting the main population of coho salmon in the Navarro River watershed. The North Fork basin also supports steelhead populations.

Fisheries

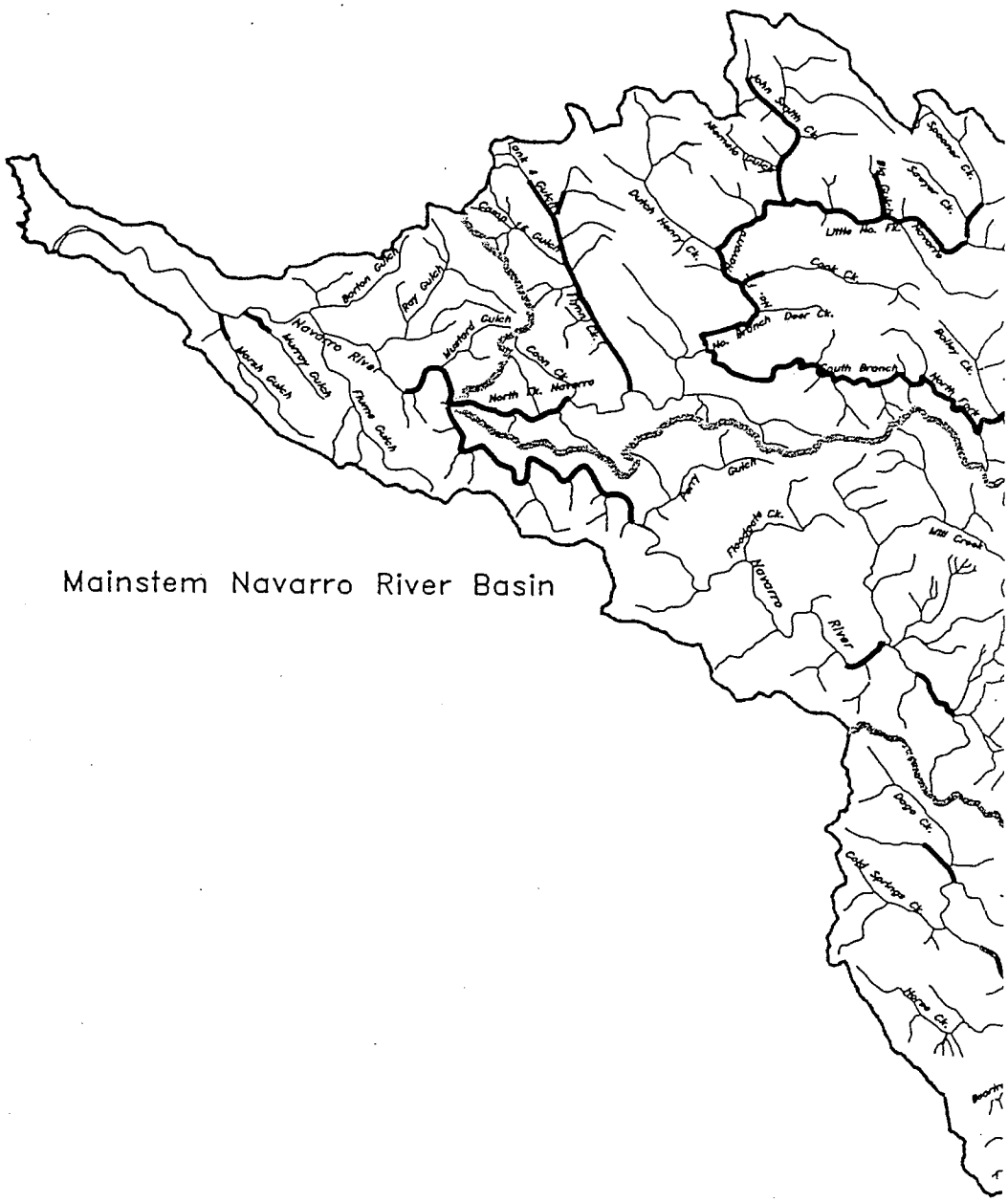
Coho salmon and steelhead have recent and historical records of occurrence in this basin. Coho salmon are known to occur in Dead Horse Gulch, Flynn Creek and tributaries, North Fork Navarro, North Branch of the North Fork, Cook Creek, John Smith Creek, and the Little North Branch of the North Fork up to the confluence with Bottom Creek (Figure 5-2). Steelhead, but no coho salmon, have been recently observed in Bottom Creek and Low Gap Creek. The South Branch of the North Fork had coho salmon in the late 1980's up to the Sawyer Creek confluence, but surveys conducted in the mid-1990's found coho salmon in the South Fork only near the confluence with the North Branch North Fork.

The North Fork Navarro sub-basin is presently supporting the majority of the coho salmon population using the Navarro River system. There is no other basin that is consistently used by juvenile coho salmon within the Navarro watershed. Therefore, it is important to maintain the habitat in these streams for the long-term conservation of coho salmon and steelhead and to improve habitat conditions to increase production of anadromous fish. Coho salmon from this basin may ultimately provide the "seed" fish to re-establish coho salmon runs in other basins of the watershed.

5.2.2 ANDERSON CREEK BASIN

Stream Temperatures

In the Anderson Creek basin, summer stream temperatures are generally too warm, often with extreme daily fluctuations, or streamflows are not persistent at locations where temperatures are suitable to provide conditions that would support coho salmon. Stream temperatures are considered to be marginal to unsuitable for steelhead in much of the



ENTRIX

Figure 5–2

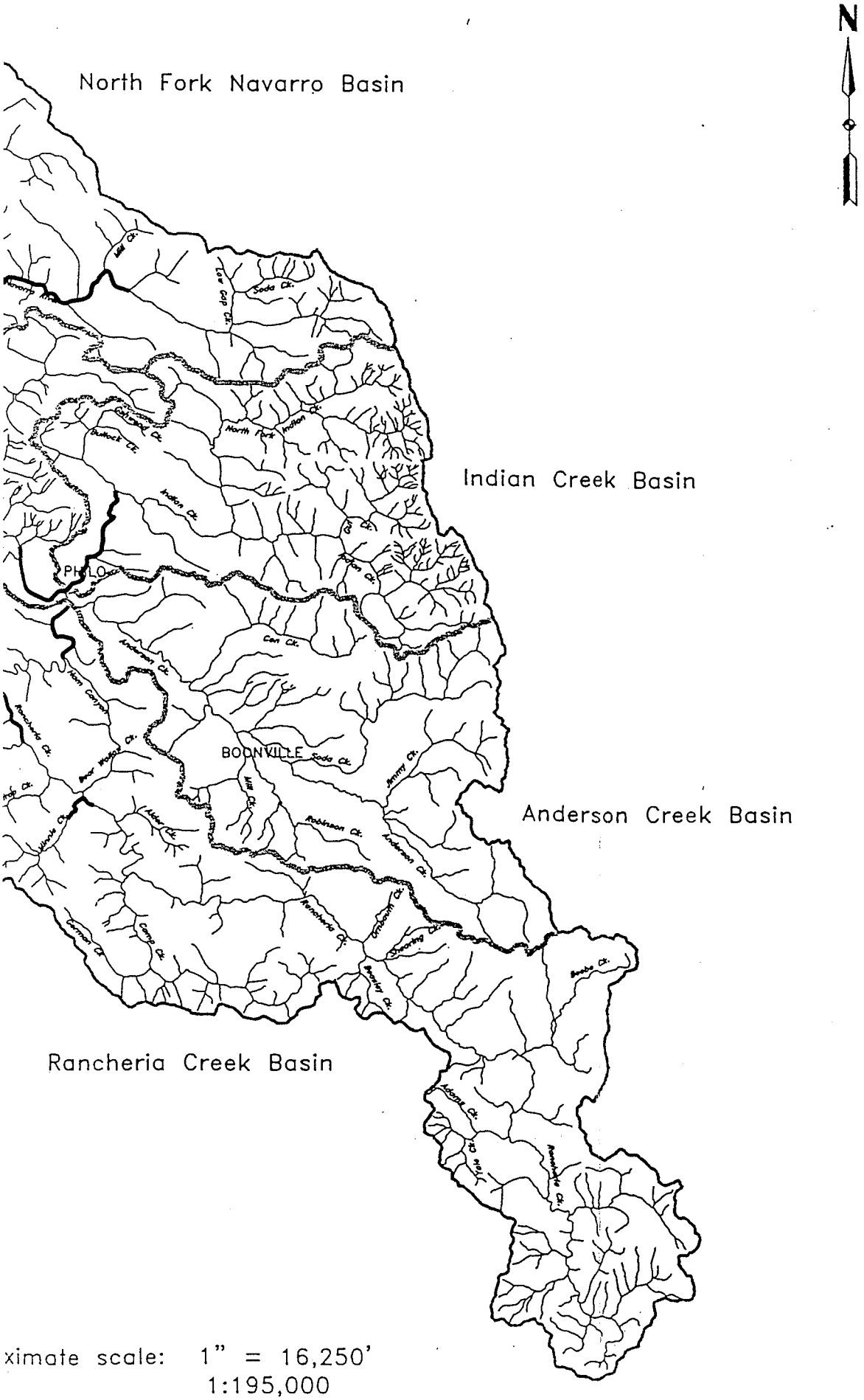
Recent Distribution of Coho Salmon
1988–1996

Navarro Watershed Restoration Plan

Legend

Recent Distribution of Coho Salmon Based on Surveys Conducted Between 1988–1996

Approx



ximate scale: 1" = 16,250'
1:195,000

lower and upper mainstem of Anderson Creek. Temperatures in Con Creek are unsuitable for coho and marginal for steelhead. Temperatures may be more suitable for steelhead in Jimmy Creek and in Anderson Creek above the confluence with Jimmy Creek, however, no temperature data is available for these upper watershed reaches. In Robinson Creek temperatures are unsuitable for coho salmon, and appear to be marginal for steelhead.

Stream Flow

Stream flow is very low during the summer months and occasionally influenced by the diversion of surface or sub-surface flow. Mainstem Anderson Creek has the lowest streamflow accretion rate, approximately .01 cfs/mi^2 (based on 1995 data). Streamflow monitoring indicates that diversions in lower Anderson Creek reduce surface flow to 0 cfs, leaving isolated pools. Loss of surface flow has serious consequences for fish which are forced into crowded pool habitats where oxygen depletion can occur. In Robinson Creek, streamflow dried up early in the summer season (1995), and may therefore be insufficient to support summer habitat for steelhead. Streamflow monitoring indicates that upper Soda Creek (at Soda Spring) also went dry in 1995. Streamflow in Con Creek (near confluence with Anderson Creek) was low, but probably sufficient to support summer habitat for steelhead upstream of the alluvial valley reach.

Land Use

This is the most urbanized area in the Navarro River watershed. Grazing of open oak woodlands by sheep and cattle, orchards, row crops and viticulture are common, widespread agricultural uses.

Sediment Production

Much of the Anderson Creek basin is in the melange-grassland terrane, which has the highest sediment production rates in the watershed, approximately 2,000 tons/mi^2/yr (see Section 3.0). Bank erosion and shallow landsliding along larger streams (3rd to 6th order) are the principal sources of sediment production, responsible for about 50% of sediment production in the basin. Gullies are the next largest source, accounting for about 23% of total sediment production.

Anderson Creek is actively aggrading with coarse sediments, and as a result, is eroding its streambanks. In-channel structures to improve fish habitat are likely to be ineffective restoration treatments on the mainstem Anderson Creek in Anderson Valley, and are therefore not recommended. The best means to reduce active aggradation and bank erosion in Anderson Creek is to reduce sediment production delivered from upstream tributaries. Therefore, streambank stabilization treatments on tributary streams such as Con Creek, Soda Creek, and Jimmy Creek will become important erosion control measures. Gully erosion control treatments in the melange grassland terrane should also be established to reduce sediment production to Anderson Creek as well as to the tributary streams.

Channel Conditions

Along much of the lower portions of Anderson Creek, the channel has widened and aggraded, causing unstable bars and bank erosion. Pool habitat is present, but not abundant. Large woody debris is not typically a feature found in the streams draining the Anderson Creek basin since the vegetative community is predominantly comprised of oak woodland or grassland. Tributaries and portions of Anderson Creek upstream of the alluvial valley reaches provide suitable habitat for steelhead, but are likely too warm during summer and do not have sufficient pool habitat and woody debris to support coho salmon.

Fisheries

There are current records for steelhead, but no recent or historical records for coho salmon in this basin. Steelhead are not part of the summer fish fauna in the reach of Anderson Creek near Boonville. Low flow, warm temperatures, and barriers to some tributaries may limit the extent of steelhead habitat. In Con Creek, habitat is generally suitable for steelhead, but there may be a barrier at the confluence with Anderson Creek preventing access to anadromous fish. It is important to maintain and improve spawning and rearing habitat for steelhead in the Anderson Creek basin to prevent fragmentation and potential loss of steelhead habitat. All information examined in our assessment of conditions in the Anderson Creek watershed indicate that it is not likely a suitable stream to support coho salmon. However, there may be locations within the basin that could provide spawning and incubation habitat. It would be of value to manage locations that may provide spawning opportunities for coho salmon for future use, if the existing coho salmon population can be increased to the point that such a spawning area would provide some value to the Navarro River Watershed.

Tributaries such as Con Creek are extremely steep (6% gradient) and are unlikely to be suitable for coho salmon, but provide steelhead habitat. Frequency and size of pools and poor spawning habitat probably limits the present-day steelhead population in Con Creek. Soda Creek has been documented to have steelhead, however very low flows probably limit summer rearing habitat in upper Soda Creek.

Sub-basins Which Require Additional Information

Information on temperatures, streamflow, and habitat conditions were insufficient in the Jimmy Creek, Donelly Creek, and upper Anderson Creek (above Jimmy Creek) sub-basins to consider in the prioritization screening process. Additional surveys should be performed in these areas to identify their appropriateness for management and restoration as steelhead streams.

Conservation Easements - Anderson Valley Land Trust.

The Navarro study team members preparing RLMP sections are as follows:

Streambank Stability and Aquatic Habitat Protection - Mitchell Katzel, ENTRIX, Inc.

Water Conservation – Dan Sicular, Project Coordinator

Riparian Corridor Integrity - Karen Gaffney, Circuit Rider Productions, Inc.

Roads - Bill Weaver, Pacific Watershed Associates.

Hillslope Erosion Control Practices - Bill Weaver, Pacific Watershed Assoc., and Mitchell Katzel, ENTRIX Inc.

Conservation Easements - Connie Best, Anderson Valley Land Trust.

6.4 STREAMBANK STABILITY AND AQUATIC HABITAT PROTECTION

This section offers RLMP's for preventing and restoring unstable, eroding streambanks. Streambank erosion is the single largest source of sediment production in the Navarro watershed (see Section 3.0, Figure 3-2). Prevention and control of streambank erosion begins with appropriate planning and design considerations which are discussed in RLMP 6.5.1, *Stream Protection and Stabilization Planning.* An overview of the various types of approaches to streambank erosion control is also provided in this RLMP. Recognizing, preserving, and understanding the importance of large woody debris as a critical element in fish habitat protection is discussed in RLMP 6.5.2, *Preserving Large Woody Debris.* Several detailed examples of bio-engineering methods which can be used to control erosion are provided in the following RLMP's:

6.4.3 *Brush Mattress*
6.4.4 *Live Willow Fascine*
6.4.5 *Live Staking*
6.4.6 *Vegetative Geogrid*

RLMP 6.4.7, *Streambank Protection Using Hard Armoring Techniques*, describes measures which use inert construction materials, but do not rely on vegetation as a primary means for controlling erosion. RLMP 6.4.8, *Gravel Extraction*, discusses how gravel mining can affect aquatic habitat, and provides a general approach to the management of gravel extraction in the Navarro River watershed. RLMP 6.4.9, *Water Conservation and Storage*, describes methods to improve summer streamflow needed to support riparian habitat and aquatic life during low-flow periods.

6.4.1 STREAM PROTECTION AND STABILIZATION PLANNING

Description & Purpose

Stabilization of streambanks is an effective treatment to reduce sediment loading to streams, and to prevent the loss of land or structures. Advanced planning and design, particularly in consultation with knowledgeable professionals and resource agencies, will enhance the likelihood of project success. There are many different types of methods which can be used to protect and stabilize streambanks from erosion (Table 6-2). Different methods may be suited to different types of problems. Technical guidelines and a comparison of the suitability of selected structural and vegetative treatments to stabilize stream channels and streambanks are provided in this RLMP.

Planning Criteria & Applicability

Streambank erosion is the largest single source of sediment production to streams in the Navarro watershed. Methods for reducing streambank erosion will improve water quality, as well as pool and spawning habitat for coho salmon and steelhead trout.

Each stream is unique, so streambank protection and erosion control measures must be installed according to a plan which is adapted to the specific site. The following methods describe a general approach to planning a streambank erosion control and protection project.

1. Establish the project objectives. Objectives may include multi-purposes, incorporating elements of fish habitat restoration by providing shade, cover, or scouring pools, as part of the project. Select alternative methods of streambank erosion control which best meet the objectives of the project. Table 6-3 provides a comparative evaluation of the relative benefits from various streambank protection measures.

2. Identify the initiating causes of streambank instability. There may be various, or even multiple causes for streambank instability. A common cause of erosion and instability in the Navarro watershed is the removal of riparian vegetation. Has riparian vegetation been removed from the project site? Reviewing aerial photography (available at the Anderson Valley library, and at the County Assessors office and NRCS) over a 10, 20, or even longer time period, can often answer this question. Another cause of streambank instability and erosion is channel incision (downcutting into the channel bed). This type of problem is evident on Robinson Creek. Channel incision undermines the toe of bank slopes causing streambank collapse. Channel aggradation (gradual filling of the streambed with sediment), can also cause unstable banks, as in Anderson Creek. Aggradation tends to cause the stream channel to laterally migrate against channel banks which causes erosion.

8.1 INTRODUCTION

Implementation of the Navarro Watershed Restoration Plan will require involvement of the whole Anderson Valley Community. It is therefore essential that Anderson Valley residents have a clear understanding of the findings and recommendations contained in the Plan. An informed Anderson Valley populace, conversant in watershed concepts and issues, will be effective in organizing creative, workable solutions to the problems facing the Navarro's fishery and water quality. This section describes several existing and planned means that may be used to inform Anderson Valley residents of the Plan's results, and for involving residents in implementation of the Plan.

8.2 DEMONSTRATION PROJECTS

The Plan includes designs for several demonstration projects (see Section 7.0). Most of the sites for these projects are in areas easily accessible to the public. The landowners involved in the demonstration projects have agreed to allow interested members of the public on their property to observe the results of the projects.

These demonstration projects, if implemented, will serve as study sites for those interested in performing restoration work. Site plans and before and after photographs will be available at the project's document repository (see Section 8.4). The demonstration project sites may be visited by individuals, elementary and high school classes, and participants in restoration workshops.

8.3 ANDERSON VALLEY UNIFIED SCHOOL DISTRICT

The Anderson Valley Unified School District (AVUSD) is host to the Watershed Project. The Project seeks to include in the elementary, middle, and high school curricula watershed concepts, a greater understanding of the ecology of the Navarro Watershed, and skills for building the community and improving the environment. The Watershed Project is co-sponsored by the AVUSD, Americorps, the California Conservation Corps, the Fish and Wildlife Foundation, the Annenburg Foundation, the North Coast Rural Challenge Network, and private donors.

The Watershed Project has a program coordinator who works with interested teachers to include watershed concepts and activities in their lesson plans, and who works directly with students on classroom and outdoor lessons. Lessons stress the interconnectivity of watershed elements, the effects of changes in the landscape on salmon and steelhead, and the natural history of Anderson Valley. The Project has developed a nature trail and outdoor classroom at Anderson Valley Elementary School that is used for classes and

RUSSIAN RIVER
INTEGRATED COASTAL WATERSHED
MANAGEMENT PLAN

JUNE 2012

Mendocino County Resource Conservation District
with funding: Department of Water Resources

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This **Russian River Integrated Coastal Watershed Management Plan** (RRICWMP) was developed for the **Mendocino County Resource Conservation District** by **West Coast Watershed**, with research and technical writing conducted by **Reza Environmental**, **ECONorthwest** and **Woods Biological Research and Services**. The RRICWMP was developed in conjunction with the **RRICWMP Technical Advisory Committee**, and with funding from the **California Department of Water Resources**.

EXECUTIVE SUMMARY

The Russian River Integrated Coastal Watershed Management Plan (RRICWMP) is a watershed-specific, planning document specific to the Russian River and contextualized within the North Coast Integrated Regional Water Management Plan framework. The plan was developed by conducting research and analyzing current and historic scientific, socioeconomic, and policy data, and enlisting stakeholders and watershed experts to identify key management issues. A Technical Advisory Committee (TAC) provided input into development of the RRICWMP and its goals, objectives and priorities. This RRICWMP is the culmination of years of effort by public and private groups including the Russian River Watershed Council and US Army Corps of Engineers; it builds on previous efforts including the Russian River Plan of Action, Russian River Watershed Baseline Assessment and Data Synthesis, and Russian River Information System.

GOALS AND OBJECTIVES

Goals and Objectives were developed by the RRICWMP TAC to address issues identified by experts and stakeholders. Seven goals associated with a total of 60 objectives were identified; these integrate DWR standards as outlined in the Integrated Regional Water Management Program (IRWMP) guidelines. The goals are listed below.

- Goal I: Enhance Watershed Processes and Improve Land Use
- Goal II: Protect and Enhance Hydrologic Function and Water Supply
- Goal III: Protect and Improve Water Quality
- Goal IV: Protect and Enhance Native Biodiversity and Ecosystem Processes
- Goal V: Develop and Maintain Public Stewardship
- Goal VI: Engage in Scientific and Technical Assessment and Planning

PHYSICAL AND BIOTIC CHARACTERISTICS

The Russian River watershed is located in the North Coast Hydrologic Region (Region 1, as defined by the State Water Resources Control Board (SWRCB). It drains an area of approximately 1,485 square miles with the 100-mile main stem channel flowing southerly from the Laughlin Range about 15 miles north of Ukiah, and flowing south-southeast until Forestville, where it abruptly bends southwest, crosses the coast range, and drains into the Pacific Ocean near the town of Jenner. Elevation ranges from zero at the Pacific Ocean to 4,343 feet at Mount St. Helena in the Mayacamas Mountains (NCRWQCB 2005). Nine sub-basins containing fifty-seven valleys comprise the watershed. The watershed spans Mendocino and Sonoma Counties; it is bounded to the north by Humboldt county, the east by Lake and Napa Counties,

Technical Advisory Committee Member Organizations

California Department of Fish and Game (CDFG)
CA Department of Forestry and Fire Protection (CAL FIRE)
CA Geologic Survey
California Senate
Forest, Soil & Water
Mendocino County Water Agency (MCWA)
Occidental Arts & Ecology Center (OAEC)
Regional Water Quality Control Board (SWRCB)
Russian River Watershed Council
Sonoma State University (SSU)
Sonoma County Water Agency (SCWA)
Sotoyome Resource Conservation District (SRCD)
US Environmental Protection Agency (USEPA)
US Army Corp of Engineers (USACE)
United Wine Growers
University of California Cooperative Extension

the south by Marin County, and the west by the Pacific Ocean to three nautical miles. It is contained within the Central California Coast ESU for coho and steelhead, and the California Coast ESU for Chinook. The watershed is within the North Coast Resource Conservation and Development Council and within the boundaries of three Resource Conservation Districts: Mendocino, Gold Ridge, and Sotoyome RCDs. These agencies work with local stakeholders to facilitate environmental and economic improvements throughout the watershed.

The Russian River watershed has a Mediterranean climate with hot, dry summers and wet winters. Average precipitation varies across the watershed with generally wetter conditions in the north and west. Summer temperatures can reach over 100° F in inland valleys for weeks at a time, with coastal conditions cool and moist. Drought and severe storms occur periodically but mostly unpredictably; El Niño/ La Niña Southern Oscillation (ENSO) climatic conditions can exacerbate climatic extremes.

The watershed is hydrologically and geomorphologically diverse, containing 238 streams, 23 named springs, 14 natural lakes, 15 named reservoirs, all or portions of 13 groundwater basins, steep ridges, ephemeral streams, rolling hills, and wide alluvial valleys. Plant communities in the Russian River watershed include redwood forest, mixed evergreen forest, oak woodlands, interior chaparral, riparian forest, coastal scrub, mixed grasslands, streams, lakes, wetlands, estuary/lagoon, and near shore coast. Several habitats have been identified for protection by the state of California, these include riparian, coastal prairie, serpentive soils, and instream habitat. In addition to loss of native species, a number of nonnative invasive species now occur in the watersheds. These include the plant pathogen *Phytophthora ramorum* that causes Sudden Oak Death (SOD), giant reed, yellow starthistle, French broom, and water primrose. Invasive animals, such as American bullfrogs, zebra mussel, and Quagga mussel further threaten the integrity of native ecosystems.

SOCIOECONOMICS

Human population centers in the watershed tend to be in or along the floodplain of the Russian River mainstem, which is comprised of a series of alluvial valleys separated by narrow bedrock channels. Human land uses and associated changes to natural systems have altered the dynamic equilibrium between river channel size and morphology; sediment transport and deposition; and flow volume and velocity in the Russian River. Currently, summer flows in the main stem are heavily regulated by releases from the two water storage reservoirs in the basin: Lake Sonoma and Lake Mendocino. Under this regime, flows are kept artificially high during summer months and low during winter months under all but the most extreme rain events. Augmentation from the Eel River through a tunnel near the headwaters of the Eel River into the East Branch of the Russian River has also increased flow in the river.

Water supply and flood control infrastructure include Coyote Valley and Warm Springs dams, which were constructed in 1959 and 1983 respectively. These dams, along with the Potter Valley Project on the Eel River, supply electricity through hydropower. Flood control levees along the Alexander Valley reach protect communities in the Russian River floodplain, and during periods of high flows in the lower Russian River, Sonoma County Water Agency (SCWA) breaches the sandbar at the mouth of the lagoon. To supplement water supplies, SCWA operates six collector wells adjacent to the Russian River. Reclaimed water is a standard method for bolstering water supplies; it is mainly used for landscape irrigation and to supply The Geysers geothermal power plants.

Primary land uses in the watershed are rural residential, mixed agriculture, and small municipalities (upper reaches); wine grape cultivation (middle reaches); and mixed agriculture, rural residential, and recreational tourism (lower reaches (CDFG 2002). Most of the land in the watershed is privately owned (89.78%), with federal (5.41%), state (2.59%), local (2.15%) and tribal lands (0.08%) making up the remaining owner-

ship. Land cover is primarily open space with fifty-one percent of the watershed having less than one housing unit per 160 acres, although more than 4,000 miles of roads intersect much of the landscape. Just over 10% of the watershed is conserved through designation as open space preserves, state and local parks, conservation easements, or other formal means.

Economic trends in the watershed reflect a slowing national economy with a decline in economic sectors such as timber, manufacturing and commercial fishing while wine production, tourism and organic farming have experienced increases. Small businesses are a major part of the Russian River's economy; in Sonoma County, businesses with 1 — 4 employees made up 70% of all businesses and in Mendocino County, companies with 10 or fewer employees made up over 80% of all businesses (Pacific Municipal Consultants 2003, Center for Economic Development CSU Chico 2007). Communities within the watershed span the entire socioeconomic spectrum with much of the Upper Reach and portions of the Lower Reach containing communities that qualify as disadvantaged according to the state (Median Household Income less than $37,994). Recreational tourism has historically been an important industry within the watershed, and that importance continues to the present day — it is repeatedly cited as a local economic driver in the Sonoma County General Plan 2020. Recreational fishing is an important component of tourism throughout the watershed; it contributes to local economies from Jenner to Calpella. Agricultural tourism is an emerging economic sector in the watershed.

Recreational tourism

PLANNING CONSIDERATIONS

Watershed condition for this planning document was assessed largely based on an analysis of conditions for salmonids — particularly endangered Central California Coast coho salmon — in recognition that virtually all land practices and habitat attributes (upland and instream) will affect coho salmon. Three ecosystem attributes — habitat condition, water quality, and water quantity — and two technical attribute categories — regulatory framework and data availability are assessed in the context of coho salmon survival. The North Coast region is developing a Data Management Plan as part of the North Coast Integrated Regional Water Management Plan; this is expected to provide a framework for planners and managers to integrate existing data sources and complement and enhance existing programs and plans.

Stakeholders and experts identified a number of key watershed management issues: salmonid population decline, native biodiversity and habitat loss, stream flow and water supply reliability, water quality, climate change, and public stewardship. Climate change projections show substantial warming, especially during spring, with an increase in the magnitude and frequency of heat waves while extreme storm events are expected to decline. Sea level increases up to 45 cm are expected by 2050. These changes in climate will affect plant and animal distribution, reducing the watershed's biodiversity even further, and affecting crop productivity and quality. An increased sea level will affect Lower Russian River communities, both through the direct increase and the potential for increased flood-related damages during storm events. The final key watershed management issue, public stewardship, was identified given that over 90% of the watershed is privately owned. With such a large area in private ownership, landowner stewardship is essential for successful watershed management; fortunately, there are many watershed groups and public-private partnerships at work improving both publicly and privately owned lands to benefit salmonid habitat and improve watershed health.

For each of six topics (Natural Resources and Land Management, Water Supply Reliability, Flood Risk Management, Water Quality Protection and Improvement, Climate Change Adaptation and Mitigation, and Recreation and Public Access), one or more Resource Management Strategies (RMSs), RMS Recommended Approaches, and Priority Recommendations were developed to address

key watershed issues. RMSs to address natural resources and land management consist of Ecosystem Restoration, Environmental and Habitat Protection and Improvement, Watershed Planning, and Wetlands Enhancement and Creation. To ensure water supply reliability, RMS consist of water demand reduction strategies of Agricultural Water Use Efficiency, Urban Water Use Efficiency, operational efficiencies to Regional and Local Conveyance, System Reoperation, and Water Transfers, and water supply increases that include Conjunctive Management and Groundwater Storage, Recycled Municipal Water, and Surface Storage. Flood risk management consists of a single RMS — Flood Risk Management — that consists of projects and programs to manage peak storm flows and prepare, respond to, and recover from flood events. Water quality improvement RMSs consist of Drinking Water Treatment and Distribution, Groundwater and Aquifer Remediation, Matching Water Quality to Use, Pollution Prevention, Urban Runoff Management, and Salt and Salinity Management. Climate change adaptation and mitigation consists of the Climate Change Adaptation and Mitigation RMS that provides specific actions for climate change mitigation and adaptation in the watershed. The recreation and public access topic contains the Recreation and Public Action RMS. The Cost-Benefit Analysis section provides a framework for defining and evaluating the benefits and costs of implementing each RMS. A preliminary assessment of changes in values that could be expected from RMS implementation based on a survey of peer-reviewed economic literature is also provided.

1 PLANNING APPROACH

1.1 PLAN FRAMEWORK AND CONTEXT

The Russian River watershed is located in California's North Coast Hydrologic Region, as defined by the Department of Water Resources (DWR) and the State Water Resources Control Board (SWRCB). The watershed thus falls under the jurisdiction of the North Coast Integrated Regional Water Management Plan (NCIRWMP), the northernmost representative of the statewide integrated regional water management (IRWM) program. The IRWM program, initiated in 2002, mandates development of region-specific plans (i.e. North Coast region), which may themselves subsume plans for individual watersheds (i.e. Russian River watershed). The NCIRWMP coordinates the region's efforts to enhance the beneficial uses of water and declining salmon populations; address failing water and wastewater infrastructure in economically disadvantaged communities; support local and sustainable economic development; and synchronize federal, state, and local priorities. The NCIRWMP also proposes a draft Data Management Plan for the North Coast Region (intended to include the Russian River watershed as well; see Section 8). Convened in 2004, the NCIRWMP represents over fifty tribal jurisdictions, all or part of seven Counties (Del Norte, Trinity, Siskiyou, Modoc, Humboldt, Mendocino, and Sonoma), and 53 coastal watersheds or hydrologic areas.

Distinct from but aligned with the NCIRWMP, the Russian River Integrated Coastal Watershed Management Plan (RRICWMP) is contextualized within the North Coast region planning framework as a watershed-specific, high resolution planning document customized for the Russian River watershed. The RRICWMP informs and supports the regional effort, while affording Russian River planners an opportunity to identify the most suitable priority projects for local implementation using NCIRWMP program funds. It long has been necessary to extrapolate Russian River watershed conditions from those for the North Coast (due, for example, to sampling and/or data dissemination constraints), hampering conservation and management efforts. Emphasizing Russian River watershed-specific data, conditions, issues, strategies, and stakeholder priorities is a central tenet of the RRICWMP.

1.2 PLAN DEVELOPMENT PROCESS

Development of the RRICWMP began with research, documentation, and analysis of current and historic scientific, socioeconomic, and policy data for the Russian River watershed. This preliminary data analysis and description was followed by stakeholder and professional consultation to identify key management issues for the watershed. Then, an extensive list of potential management recommendations to address these issues was compiled from review of over 40 agency and peer-reviewed documents and 24 interviews with watershed experts; a Technical Advisory Committee (TAC) provided support and oversight during the review process. Cost/benefit analysis identified a subset of priority strategies intended to address management issues at the watershed and sub-watershed level to achieve the goals set forth in the RRICWMP. Since its inception, the RRICWMP has been guided by standards set forth in the IRWM program legislation and standards for

project implementation established by the DWR and SWRCB as outlined in the IRWM Program Guidelines.

1.2.1 Early Planning Efforts

The current RRICWMP is the culmination of years of effort by public and private groups interested in addressing watershed health at the local level. A previous iteration of this current draft was called the "Russian River Watershed Adaptive Management Plan." The addition of "Integrated" and "Coastal" are deliberate refinements to emphasize (1) the intent of the RRICWMP (integration of human and ecosystem needs; integration of California's myriad resource and data management systems) and (2) the physical connection of this watershed to the near-shore and marine environments. Below are brief descriptions of some sources that fostered early versions of this document and that continue to inform its ongoing development.

Russian River Watershed Council

The RRICWMP began with The Russian River Watershed Council (RRWC). The RRWC was formed by the US Army Corps of Engineers (USACE) with a mission to protect, restore, and enhance the biological health of the Russian River and its watershed through a community-based process to facilitate communication and collaboration among watershed stakeholders. Primary goals of the RRWC are (1) to ensure the recovery of the Russian River and its watershed to a condition such that the native wild anadromous fishery recovers to a healthy and sustainable level;(2) to ensure a strong, healthy, and diverse economy in the Russian River region; and (3) to promote stewardship of the Russian River and its watershed by developing an informed and engaged citizenry. As intended, the goals of the RRICWMP and North Coast IRWMP are closely aligned with those of the RRWC.

Russian River Plan of Action

The USACE and RRWC contracted with planning consultants MIG, Inc. to develop the "Russian River Plan of Action (POA)." The document articulates critical issues in the Russian River watershed and identifies a suite of potential conservation and management actions to address these issues; these issues and actions have been integrated into the RRICWMP.

Russian River Watershed Baseline Assessment & Data Synthesis

In an effort to build a strong foundation for watershed planning in the Russian River watershed, the Russian River Watershed Council in partnership with the US Army Engineers Research and Development Center embarked upon a Baseline Watershed Assessment. The assessment was not completed due to loss of USACE funding. More information about the Russian River Watershed Baseline Assessment and a copy of the *Baseline Watershed Assessment Synthesis Report 2008 Review Draft* can be found at http://www.northcoastirwmp.net/Content/10415/Russian_River_Watershed_Baseline_Assessment.html. Applicable data from the report have been integrated into the RRICWMP.

The Baseline Watershed Assessment was undertaken to 1) collect spatial and nonspatial scientific information about the Russian River and catalog it for future use, and 2) use that information to evaluate, compare, and rank discrete areas in the Russian River watershed. The collected data were organized into the Russian River Database Catalog, which categorizes each piece of information by topic, source, status, filename, unique identifier, and brief description. To complete the geographic comparison, 1798 discrete watershed assessment areas (WAAs) were defined using a procedure based on stream order, geologic, geomorphic, vegetation, land use/ land cover characteristics, and stream inventory data. Each WAA was subdivided into an upland, riparian, and stream component; these were evaluated in terms of primary assessment criteria including ecological condition, vulnerability, conservation potential, and restoration potential. Knowledge bases to further evaluate and rank the WAAs were developed using a variety of sources including existing watershed and stream assessment methods, existing knowledge bases, and expert opinion. By incorporating this information into a modeling system known as the Ecosystem Management Decision Support System (EMDSS), each WAA was assessed and ranked, with the results provided in a spreadsheet and as watershed maps.

Russian River Watershed Information on the Internet

The USACE and the RRWC contracted with Circuit Rider Productions, Inc. to develop a web-based information system known as the *Russian River Integrated Information System (RRIIS)*. Circuit Rider Productions collaborated with MIG and UC Cooperative Extension to build the RRIIS. To ensure ongoing website maintenance and support the information and data has been incorporated into the NCIRWMP website (http://www.northcoastirwmp.net/). This system includes multiple web pages with information regarding the North Coast region and Russian River watershed, an interactive mapping application, a library of documents, calendar of events, polling features, a listing of current funding opportunities and a project upload tool.

1.2.2 Technical Advisory Committee

The development of the RRICWMP was guided by a Technical Advisory Committee (TAC; members below). The TAC met as a group twelve times from 2006 to 2009. The TAC reviewed data and analyses; evaluated the plan outline; reviewed draft plan elements; and informed the expert interviews and public outreach processes. In addition to full TAC meetings, there were numerous sub-committee meetings to discuss specific technical issues and plan elements. A restoration working group meeting was held in the spring of 2008 to review restoration and flow strategies. Currently, the TAC does not formally meet but members were consulted individually to provide input and technical advice during RRICWMP development.

The members of the RRICWMP Technical Advisory Committee:

- Derek Acomb, (CDFG)
- Bob Anderson (United Wine Growers)
- Bill Cox (CDFG)
- Earle Cummings (Sotoyome RCD)
- Brock Dolman (Occidental Arts & Ecology Center)
- Fred Euphrat (Forest, Soil & Water)
- Wayne Haydon (CA Geologic Survey)
- Bob Klamt (RWQCB)
- David Lewis (UC Cooperative Extension)
- Suzanne Marr (USEPA)
- Karen Rippey (USACE)
- Dennis Slota (MCWA)
- Rich Walker (CAL FIRE)
- Fred Euphrat, Senator Patricia Wiggins
- Chuck Vaughn, UC Cooperative Extension
- Zeno Swijtink (Sonoma State University)
- Chuck Conner, Russian River Watershed Council
- Tod Schram (SCWA)
- Keenan Foster (SCWA)
- Roland Sanford (MCWA)
- Janet Olave (MCRCD)

1.2.3 Stakeholder Participation

The RRICWMP incorporates substantial input from the general public and from local resource experts via the mechanisms described below:

General Public

- Presentations and input gathering at Russian River Watershed Council meetings;
- Draft plan review with stakeholders conducted by Mendocino RCD Watershed Coordinator, and identification of potential projects that implement the plan;
- Data and information dissemination via RRIIS and NCIRWMP websites, including information about the planning process; how to participate; preliminary data; management strategy recommendations; and draft plan for public review;
- Web-based project identification and upload process (resulting in new information to inform adaptive management) and opportunities for implementation funding via NCIRWMP and other funding sources;
- 320 geospatial data layers and metadata developed and posted to RRIIS for download;
- 290 non-spatial reference materials posted to RRIIS for download;
- Russian River Blue Circle Gathering (11/12/08) to learn about and discuss the planning process, preliminary data, results of analyses, and proposed management strategies;
- Conference presentations, including the UC Berkeley Watershed Forum (4/10/08), Salmonid Restoration Fund Conference

(3/9/07), Redwood Chapter American Society of Civil Engineers (7/11/07), NCIRWMP Conference (10/10 through 10/12/2007), and ongoing presentations to and input from the Russian River Watershed Association (RRWA) and County Boards of Supervisors.

Local Resource Experts

Interviews with Russian River Stakeholders

In order to obtain firsthand input into watershed management in the Russian River, the Mendocino County Resource Conservation District conducted interviews with a diverse mix of watershed stakeholders. These twenty-four respondents represent fourteen stakeholder categories (see Figure 1.1, Interviewee Stakeholder Categories), with many of the interviewees representing multiple groups.

Interviewees' areas of expertise covered a wide range of topics, including agriculture, economic development, fisheries, land use planning, Native American Culture/ Heritage, and water quality and supply (see Table 1.1, Interviewees' Areas of Expertise).

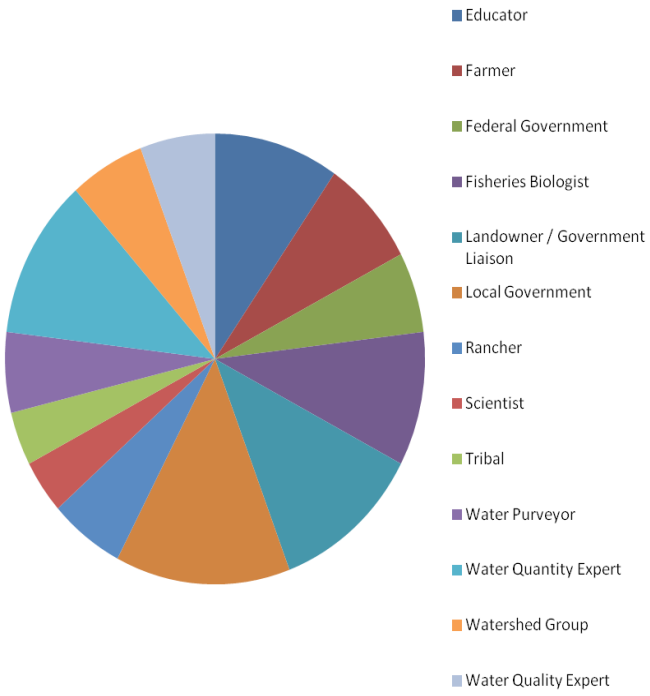


Figure 1.1 Interviewee Stakeholder Categories

TABLE 1.1, INTERVIEWEES' AREAS OF EXPERTISE
Agriculture
Agricultural Water Supply Issues
Applied Research
Climate Change
Economic Development
Fisheries
Forestry
Flood Control
Gravel Mining
Habitat: Aquatic and/or Terrestrial
Hydrology/Fluvial Geomorphology
Land Conservation
Land Use Planning
Land/ Water Use Policy
Low Impact Development
Native American Culture/ Heritage
Plant Ecology
Stormwater Management
Watershed Ecology
Watershed Education
Watershed/ Habitat Restoration
Water Supply
Water Quality

Issues of Concern to Russian River Stakeholders

The biggest problem affecting natural hydrologic and ecologic function of the Russian River is, according to over half the respondents (15), the presence of un-regulated and often illegal stream diversions from tributaries and the mainstem. Interviewees stated that instream flow management in tributaries has altered hydrographs to the point where natural processes — such as meander — are no longer supported. Other common areas of concern included habitat loss due to human activity (including agriculture, urban expansion, road systems, and gravel mining), impacts to river hydrology and geomorphology due to reduced riparian habitat, urban development, dams, pumps, diversions, and wells. Several (8) interviewees expressed concern that the Russian River's fluvial geomorphology has been altered by changes to flow regime, hydrologic disconnection from the flood plain, physical limits to meander, and gravel harvest with gravel renourishment limited by Coyote and Warm Springs dams. High turbidity was also identified as a challenge facing the watershed by several (8) interviewees. Other challenges identified by respondents included lack of surface storage, increasing human population, water quality, salmonid passage, frost protection, groundwater management, forest fuel management, and watershed education.

For a complete account of interview responses, please see Appendix 1, Summarized Expert Interviews.

Economic Challenges

Interviewees (11) identified decreases in federal, state, and county budgets as the top economic challenge to sustainable function of the Russian River. These cutbacks have delayed permit processing time, reduced conservation and restoration programs, and minimized infrastructure maintenance. Several respondents identified a need for increased funding and community support for agriculture and open space to preserve remaining ecological function in the watershed. Increasing economic viability through provision of a secure water supply, investment in stormwater runoff management, and investment in riparian restoration on private lands were identified by interviewees as unmet economic needs in the watershed. Investment in improved recycled water distribution was suggested as a worthy investment in supply reliability. One interviewee suggested that the "true cost" of water has been neglected in Mendocino County, while Sonoma County Water Agency has built into their rate structure the ability to mitigate, monitor, and manage habitat.

Solutions

Ideas about how to surmount the challenges facing the Russian River watershed are as diverse as the interviewees. Many respondents stated that the Mediterranean climate causes the watershed to be "storage scarce" rather than "water scarce." They propose de-centralized water management, with small-scale storage in appropriate locations throughout the watershed. Several examples of this approach exist, i.e. Coho Partnership, Bodega Fire Hall Project, AWEP, and the Mattole watershed. Other proposed solutions include establishment of a water budget and instream flow monitoring; expanded groundwater monitoring; a concerted, cohesive watershed-wide education program; application of the *Streamway Concept* at the watershed scale; continued and expanded invasive plant removal; and continued salmonid recovery actions.

Interviewees for the RRICWMP are listed below (see Appendix 1, Summarized Expert Interviews).

- Hattie Brown (Laguna de Santa Rosa Foundation)
- Richard Campbell (Coyote Valley EPA)
- Bob Coey (NOAA Fisheries)
- Phil Giles (Resource Conservation & Development Council)
- Brock Dolman (Occidental Arts & Ecology Center)
- Charlette Epifanio (Natural Resources Conservation Service Sonoma County)
- Kara Heckert (Sotoyome RCD)
- Lisa Hulette (Gold Ridge RCD)
- Shelley Janek (Mendocino County RCD)
- Devon Jones (Mendocino County Farm Bureau)
- Bill Koehler (Redwood Valley Water District)
- Tony Linegar (Mendocino County Agricultural Commissioner)
- Carol Mandel (National Resources Conservation Service)
- David Manning (Sonoma County Water Agency)
- Don McEnhill (Russian River Keeper)
- Glenn McGourty (UC Cooperative Extension)
- Helen Menasian (Redwood Valley Outdoor Education Project)
- Adina Merenlender (UC Cooperative Extension)
- Jan Olave (Mendocino County RCD)
- Shawn Pady (Hopland Band of Pomo Indians)
- Janet Pauli (Mendocino County Inland Water &Power)
- Tito Sasaki (Sonoma County Farm Bureau)
- Joe Scriven (Mendocino County RCD)
- Roland Sanford (Mendocino County Water Agency)
- Dennis Slota (Mendocino County Water Agency)
- Sean White (Russian River Flood Control &Water Conservation Improvement District)

1.3 DOCUMENT OVERVIEW

The themes revisited throughout this document are presented in roughly the same order across Sections 2-8: (1) ecosystems and natural resources; (2) water supply and quality; (3) climate change considerations; and (4) data management

and assessment. The RRICWMP is divided into 8 Sections, outlined below (Section 9 is References).

Section 1 - Planning Approach: Describes how the current RRICWMP document was initiated and developed, with ongoing stakeholder and technical input from the TAC, general public, and resource experts. This section also summarizes the responses of surveyed stakeholders who identified priority watershed management and conservation issues and/or suggested potential Resource Management Strategies.

Section 2 - Goals and Objectives: Lists the six formal goals of the RRICWMP and articulates a set of 60 objectives to achieve the goals set forth in this document.

Section 3 - Russian River Watershed Description: Describes the abiotic and biotic elements that comprise the Russian River watershed. These are: physical features (boundaries, climate, geology, soils, hydrology, and geomorphology); land ownership and land use (jurisdictions, open space, population centers, transportation infrastructure, timberlands, agricultural lands, rangelands, aggregate mining, and recreation (emphasis on recreational fisheries); native biodiversity and habitats (vegetation and wildlife diversity, invasive species, special-status species, and sensitive habitats); cultural and historical resources; and demographic/ socioeconomic status and trends.

Section 4 - Authorities, Agencies, and Watershed Groups: Lists the primary land and resource management and conservation entities with formal jurisdiction in the Russian River watershed. Also included is a listing the local Watershed Groups and the various cooperative watershed efforts underway there; hyperlinks to each groups' data, documents, and background information are provided.

Section 5 - Watershed Condition Assessment: Describes current statewide efforts to integrate traditional measures of water quantity and quality with emerging bioindicator-based data assessment. Central California Coast Coho salmon (*Onchorhynchus kisutch* or just "coho") provide the primary source of bioindicator data in the RRICWMP, based on National Marine Fisheries Service recently published synthesis of salmon data, which they summarized by watershed in the central coast (NMFS 2010). Coho are endangered in the Russian River watershed; are sensitive to anthropogenic stressors (e.g. water diversion, habitat alteration); are relatively well-documented; and are the focus of intense recovery efforts by federal, state, and local authorities. The following attributes of the Russian River watershed are analyzed in Section 5: habitat condition (uplands, floodplain and riparian zone, stream channel, estuary/ lagoon, and near shore marine), water quantity (surface water, groundwater, flood control), water quality (surface, ground, reclaimed waters), and formal/ legal regulatory compliance (policies & plans, beneficial uses of water, state objectives & standards).

Section 6 - Watershed Management Issues: Describes management and conservation issues identified by local experts and the literature related to Russian River watershed viability. Issues described in detail are: biodiversity and habitat loss (again, with special focus on salmonids as a case study/bioindicator); water quantity (surface, ground, and reclaimed water supply); water quality (drinking water, nonpoint pollution, and impaired beneficial uses of water); climate change (adaptation and mitigation); and socioeconomic and resource stewardship challenges.

Section 7: Resource Management Strategies: Lists and analyzes potential Resource Management Strategies (RMSs) and associated RMS-Recommendations that were compiled for the RRICWMP from hundreds of reports, datasets, and interviews and are meant to address issues specific to the Russian River watershed. For each RMS, applicable policies are described and the anticipated costs and expected benefits listed. Criteria for determining which RMS to include in the RRICWMP are described. A final list of highest-priority issues and associated RMS is provided.

Section 8: Data Management and RRICWMP Performance Evaluation: Outlines the state's proposed Data Management Plan for the North Coast region (including the Russian River watershed). The Data Management Plan presents a framework for integrated data collection and management, and describes how a performance indicator system (based on both physiochemical and bioindicator data) will ensure the RRICWMP achieves its stated goals and objectives (i.e. by evaluating ecosystem responses to watershed improvement projects). An adaptive management approach is advocated. Specific elements of this section are: data availability and management (sources and gaps) and an outline of the proposed performance indicator framework.

2 GOALS AND OBJECTIVES

The following goals and objectives were developed by the RRWICWMP Technical Advisory Committee to address the conservation and management issues discussed in Section 6. They integrate DWR standards as outlined in the Integrated Regional Water Management Program (IRWMP) guidelines and as described in Section 5 (e.g. beneficial uses of water, TMDL development, and stakeholder engagement). A total of 60 objectives are associated with the six goals. See Section 7 for listing and cost/benefit analysis of potential Resource Management Strategies (RMSs) and specific recommendations to achieve RRICWMP goals and associated objectives.

2.1 GOAL I: ENHANCE WATERSHED PROCESSES AND IMPROVE LAND USE

"Protect and enhance important watershed processes, natural resource functional values, and socio-economic and cultural values by maximizing land conservation, promoting best management practices (BMPs), and emphasizing low impact development."

Objectives to Enhance Watershed Processes and Improve Land Use

1. Support BMPs such as agency approved conservation practices or low impact Pierce's Disease vegetation management.
2. Review and recommend watershed protection and enhancement measures that can be incorporated into land use policies, general plan updates, grading ordinances, and building permit requirements, including but not limited to: (1) integrated approaches to sediment and erosion control; (2) flood control; (3) water reliability and conservation; (4) invasive species management; and (5) design standards for rural and forest roads.

3. Promote land conservation and programs that protect sensitive habitat areas and watershed functionality, including habitat connectivity.
4. Promote policies and programs that create incentives for low impact developments and design.
5. Encourage the implementation of appropriate land use and development programs that address stormwater discharges.
6. Promote policies that encourage protection of flood plains and provide funding for removal of floodplain development where feasible.
7. Promote policies, programs, and projects that provide for climate change adaptation addressing hydrologic changes, ecosystem resiliency, and socio-economic resiliency.
8. Promote policies, programs and projects that provide for climate change mitigation including but not limited to: (1) carbon sequestration (e.g. forests, riparian floodplains, wetlands, agricultural ponds); (2) alternative energy (e.g. methane biogas, solar,), and (3) water conservation and water recycling.
9. Promote policies, programs and projects that (1) identify benefits of watershed-based planning and management; and (2) provide financial

incentives and regulatory relief approaches to enhance watershed planning and stewardship.

10. Restore degraded upland and riparian habitats and processes utilizing peer-reviewed stream corridor protection and watershed management methods, including but not limited to: (1) approaches that restore or enhance functional processes; (2) invasive species removal and management; (3) sensitive species enhancement; and (4) habitat enhancement and native plant revegetation.
11. Reduce catastrophic fire susceptibility via strategic fuel treatment programs that protect biological diversity and native habitats.
12. Reduce the negative effects of flooding via floodplain protection; protection and enhancement of riparian corridor processes and functions; and scientifically based habitat enhancement.

2.2 GOAL II: PROTECT AND ENHANCE HYDROLOGIC FUNCTION AND WATER SUPPLY

"Protect and maintain groundwater quantity and surface water flows to ensure the beneficial uses of water as well as wetland and riparian corridor integrity."

Objectives to Protect and Enhance Hydrologic Function and Water Supply

13. Promote options, policies, and BMPs (e.g. use of recycled water) that enable the delivery of more reusable water for commercial and agricultural uses and habitat restoration.
14. Support and promote consumer and business incentives that promote water conservation and recycling.
15. Support incentives for multi-objective hydrologic management that enhance socio-economic values and ecosystem function.
16. Investigate environmentally beneficial technological alternatives for water recharge and retention potential (e.g. low and pulse flow mechanisms, new pipelines, inflatable dams, and infiltration ponds).
17. Identify and evaluate ecologically sensitive recharge and retention sites to provide opportunities to store seasonal peak flows, sequester carbon, and provide climate change mitigation.
18. Investigate upland groundwater recharge and infiltration opportunities to reduce excessive run-off, improve soil infiltration, and increase water-holding capacity in the watershed.
19. Identify and recommend practices that manage flow for economic and ecological benefits and establish a flow regime that is appropriate for listed species and riparian habitat integrity.
20. Identify, evaluate, and effectively manage groundwater for beneficial uses.
21. Develop groundwater resource evaluations for each basin, with an analysis of bedrock areas, including utilization and impacts of utilization.
22. Develop economic benefit analyses of various hydrologic management regimes.
23. Establish water budgets for the Russian River watershed and its sub-basins.
24. Increase the areal and temporal coverage of stream-flow gauging and precipitation monitoring and correlate with soils, geology, vegetation, and land uses by sub-basin.

Riparian habitat restoration — Forsythe Creek

2.3 GOAL III: PROTECT AND IMPROVE WATER QUALITY

"Protect and improve ground and surface water quality by minimizing point and nonpoint sources (NPS) pollutants to enhance beneficial uses of water including anadromous fish, aquatic organisms, recreation, and public drinking water."

Objectives to Protect and Improve Water Quality

25. Promote community involvement in the water quality evaluation process including review and input on Clean Water Act section 303(d) listings, findings of TMDLs, NCRWQCB Watershed Management Initiative, the water quality planning process, and the stormwater and NPS programs.
26. Continue existing wastewater reuse approaches and explore other creative alternatives for treating and reusing wastewater in the watershed.
27. Improve and support land management practices that promote soil retention and protect riparian and instream conditions (e.g. grading ordinances, riparian buffers, and septic system requirements).
28. Encourage development of erosion control ordinances and programs to support improved land management practices and protect water quality.
29. Encourage and support instream projects aimed at improving water quality and beneficial use attainment.
30. Address 303(d) listed impairments by supporting appropriate development and implementation of TMDLs through NCRWQCB programs (e.g. Watershed Management Initiative, NPS, grant funding opportunities) and local initiatives.
31. Address other identified water quality problems, such as stormwater, sediment, nutrient, pathogen, and toxic contamination of surface water and groundwater in the Russian River watershed.
32. Increase the spatial and temporal coverage of surface water and groundwater quality monitoring, exploring opportunities for local involvement.
33. Document and showcase successes among diverse land use types within the watershed.

2.4 GOAL IV: PROTECT AND ENHANCE NATIVE BIODIVERSITY AND ECOSYSTEM PROCESSES

"Protect biological diversity via the conservation and enhancement of native plant communities, terrestrial and aquatic wildlife by performing assessments, enhancing habitat, reducing or eliminating habitat impacts, and conserving critical habitats."

Objectives to Protect and Enhance Native Biodiversity and Ecosystem Processes

34. Promote policies and practices that conserve and enhance native fish and wildlife habitat in an integrated fashion.
35. 35. Protect and enhance sensitive species, their habitats, and the ecosystem processes on which they depend.
36. 36. Identify opportunities to reverse habitat fragmentation and promote habitat connectivity.
37. 37. Address limiting factors for salmonids and other sensitive aquatic species including but not limited to large woody debris recruitment, sediment reduction, and canopy cover.
38. 38. Maintain and enhance salmonid population levels to allow for the resumption of Tribal, recreational, and commercial fisheries.
39. 39. Increase resiliency of sensitive habitats and populations to climate change through enhancement of biodiversity, habitat connectivity, and ecological function.
40. 40. Document the historic and current distribution, quality, and abundance of sensitive plant and wildlife species and communities, and the habitats and ecosystem processes on which they depend.

2.5 GOAL V: DEVELOP AND MAINTAIN PUBLIC STEWARDSHIP

"Develop and maintain public understanding, stewardship, and support for natural resource processes and a healthy watershed."

Objectives to Develop and Maintain Public Stewardship

41. Promote community involvement in agency processes and planning, including the evaluation of agency data, management plans, and recommendations.
42. Promote and foster more involvement and support by agencies in local watershed, General Plan, and municipal planning efforts.
43. Promote market-based approaches that encourage the protection of watershed resources and BMPs.
44. Engage in North Coast Integrated Regional Water Management Plan and incorporate the approach of the IRWM program.
45. Encourage public education and learning opportunities such as K-12 curriculum development, and informational workshops involving agencies, landowners, stewards, community groups, and sub-watershed groups.
46. Identify partnerships and community relationships that leverage resources, funding, and media opportunities about restoration activities.
47. Offer effective hands-on opportunities for training, input, and participation (e.g. volunteer restoration and water monitoring).
48. Provide readily available technical and information-based resources.
49. Coordinate and develop protocols for identifying standard habitat and wetland protections to be used during land use planning and development decisions across counties, municipalities, and special districts.

2.6 GOAL VI: ENGAGE IN ONGOING TECHNICAL ASSESSMENT AND ADAPTIVE MANAGEMENT

"Engage in ongoing technical monitoring, assessment, and data reporting to support and promote sound adaptive management of the watershed."

Objectives to Engage in Ongoing Technical Assessment and Adaptive Management

50. Conduct ongoing comprehensive and integrated assessments to describe the physical, chemical and biological characteristics of the Russian River watershed and its sub-basins (e.g. vegetation cover at the watershed scale, riparian corridor extent and quality, sub-basin analyses, current and historic fluvial geomorphology, landslide and erosion inventory, sediment budget, and invasive species).
51. Develop change detection analyses for prioritized set of key questions.
52. Perform analyses of biological and fluvial alterations to the mainstem and tributaries.
53. Evaluate the interaction between geomorphic indicators of slope instability and/or erosion potential (e.g. geologic structure, terrain type, landslides, and landslide susceptibility) and riparian function (e.g. bed and bank material composition, bankfull/low flow channel function, meander belt development, fluvial geomorphic changes, and LWD potential).
54. Identify and fill data gaps to promote adaptive watershed management.
55. Perform monitoring of implementation activities and adapt management plans based on new data acquired.
56. Monitor and study stormwater, nutrient contributions, and toxic contamination in areas where septic systems are common.
57. Maintain, enhance, and update Russian River GIS content for analysis and develop a data repository.
58. Maintain a web-based mechanism for ongoing data input (spatial and non-spatial), data dissemination, and community discussion.
59. Maintain TAC review body for ongoing information input, exchange, analysis, prioritization, criteria, review of projects, and plan development.
60. Promote information exchange mechanisms to provide local expertise input to the TAC and the RRICWMP planning process.

3 RUSSIAN RIVER WATERSHED DESCRIPTION

Section 3 provides an overview of the Russian River watershed features: its physical (abiotic) components; land use and ownership; biological resources; cultural and historical resources; and demographic and socioeconomic status. The current condition of these features, based on the latest data and analyses, is presented separately (Section 5).

3.1 PHYSICAL FEATURES AND PROCESSES

Described and summarized below are the physical (i.e. abiotic) features of the Russian River watershed.

3.1.1 Watershed Boundaries and Size

The Russian River watershed is one of many large coastal watersheds in the North Coast Hydrologic Region (Region 1, as defined by SWRCB), which comprises watersheds that drain to the Pacific Ocean from northern Marin County to the Oregon-California border. The North Coast region encompasses approximately 19,390 square miles (31,205 square km) and includes all of the Counties of Del Norte, Humboldt, Trinity and Mendocino; large parts of Siskiyou and Sonoma Counties; and small parts of Glenn, Lake, Marin, and Modoc Counties (see Figure 3.1).

Within the North Coastal basin, the Russian River watershed drains an area of approximately 1,485 square miles (3,846 km). The river originates from all the ridgelines of the 1,485 square miles (3,846 km) basin, which shed water via tributaries down upland slopes to the mainstem (i.e. it does not "spring from" the Laughlin Range). The 110-mile (177 km) main stem channel flows southerly from the Laughlin Range about 15 miles (24 km) north of Ukiah, and flows south-southeast until Mirabel Park (Forestville), where it abruptly bends southwest, crosses the coast range, and drains into the

Figure 3.1 North Coast Region
Data source: US Census Bureau TIGER Line Data; USGS Digital Elevation Model Data

Pacific Ocean near the town of Jenner, about 20 miles (32 km) west of Santa Rosa (NCRWQCB 2005).

A varied terrain of mountain ranges, ridges, peaks, basins, and valleys comprises the Russian River watershed topography. The watershed is bounded to the north by the Laughlin Range, the east by the Mayacamas Mountains, the south by the Sonoma Mountains, and the west by the Coast Ranges (see Figure 3.2). Elevation in the watershed ranges from zero feet at the Pacific Ocean to a high of 4,343 feet (1,319 meters) at Mount St. Helena in the Mayacamas Mountains (NCRWQCB 2005). Other significant summits around the Russian River watershed include: Mahnke Peak (3,560 feet; 1,085 meters), Red Mountain Summit (3,386 feet; 1,032 meters), Monument Peak (3,284 feet; 1,001 meters), and Laughlin Range Summit (3,281 feet; 1,000 meters) in Mendocino County; and Geyser Peak (3,455 feet; 1,053 meters) in Sonoma County. In all, there are 94 named peaks in the watershed, with an average elevation of 1,883 feet (574 meters; USGS Geonames

Figure 3.2 Russian River Watershed
Data source: California Department of Fish and Game; USGS Digital Elevation Model Data

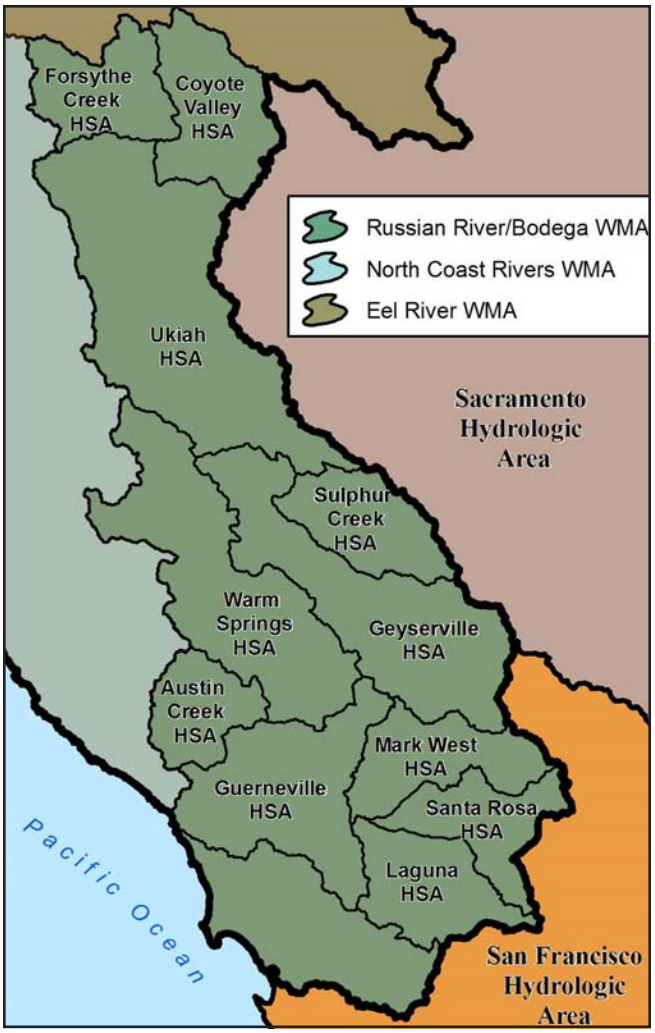


Figure 3.3 HSAs and WMAs
Date source: California Interagency Watershed Mapping Committee (Calwater)

database 2009). As this distribution of peaks by county suggests, the northern portion of the watershed is more rugged, with relatively high elevations and steeper slopes than in the southern portion.

TABLE 3.1. CALWATER WATERSHED DESIGNATIONS (LARGEST TO SMALLEST)HYDROLOGIC REGION (HR)
Hydrologic Unit (HU)
Hydrologic Area (HA)
Hydrologic Sub-Area (HSA)
Super Planning Watershed (SPWS)
Planning Watershed (PWS)

Fifty-seven valleys are recognized (e.g. Alexander, Franz, Hidden, Potter, Redwood, and Sanel Valleys). These may occur at low elevations (e.g. Jenner Gulch at 10 feet; 3 meters) or high elevations (e.g. Tyler Valley at 2,228 feet (679 meters). Nine sub-basins comprise the watershed: High Valley, Lost Valley, and Pine Lake Basin in Mendocino County; and Big Basin, Grass Valley, Knights Valley, Oat Valley, Press Valley, and Rincon Valley in Sonoma County (USGS Geonames database 2009).

In California, watershed delimitation follows CalWater 2.2 which reflects a six level hierarchy of increasing specificity (see Table 3.1, CalWater Watershed Designations). The Russian River watershed is considered part of the North Coastal Basin and encompasses most of the Russian/ Bodega Watershed Management Area (WMA), the southern-most WMA in the North Coast Region (North Coast Regional Water Quality Control Board; NRWQCB 2005). CalWater further

divides the WMAs into Hydrologic Units (e.g. Russian River HU, equivalent to "Russian River watershed"). The Russian River HU contains numerous Hydrologic Areas (HAs) and Sub-Areas (HSAs). The watershed contains eleven HSAs: Forsythe Creek, Coyote Valley, Ukiah, Warm Springs, Geyserville, Austin Creek, Guerneville, Mark West, Santa Rosa, and the Laguna de Santa Rosa (see Figure 3.3). Watersheds that drain into the San Pablo Bay lie along the southeast boundary.

3.1.2 Climate

The Russian River watershed has a Mediterranean climate with hot, dry summers and wet winters. Average precipitation varies across the watershed, from 30-80 inches (762 mm-2,032 mm; generally wetter in north and west) Within ten miles of the coast, summers are moist and cool with temperatures increasing and humidity decreasing as one travels further inland. Summer temperatures can reach beyond 100° Fahrenheit (38° C) in the inland valleys, for weeks on end. Drought and severe storms occur periodically but mostly unpredictably. Extreme El Niño/ La Niña - Southern Oscillation (ENSO) climatic conditions sometimes prevail, with the warm high pressure (El Nino) phase alternating with cold low pressure (La Nina) phase every few years.

3.1.3 Geology

The Russian River watershed is underlain predominantly by the Franciscan formation, which is a highly erodible mélange that formed during the Jurassic-Cretaceous age. The Franciscan Assemblage forms the bulk of the coast range; the sediment consists of muddy sandstones and cherts jumbled together and layered with basalt lava flow. This lithology is very unstable with landslides common throughout the mountainous regions of the basin (CDFG 2002) (see Figure 3.4).

The watershed features a series of wide valleys separated by narrow bedrock channels (see Section 3.1.4.2). Many of the streams within the basin, including the upper mainstem Russian River, follow the northwest to southeast orientation of geologic faults. The Maacama Fault, a recently active fault, runs along the eastern side of Ukiah Valley from south-southeast to north-northwest (Chocholak 1992).

The length of the river mainstem is divided into nine reaches. Delineation of reaches is based on geological features (e.g. narrow constrictions alternated with wide valleys) (see Figure 3.4 and Table 3.2). For example, downstream of Ukiah and Hopland, at the

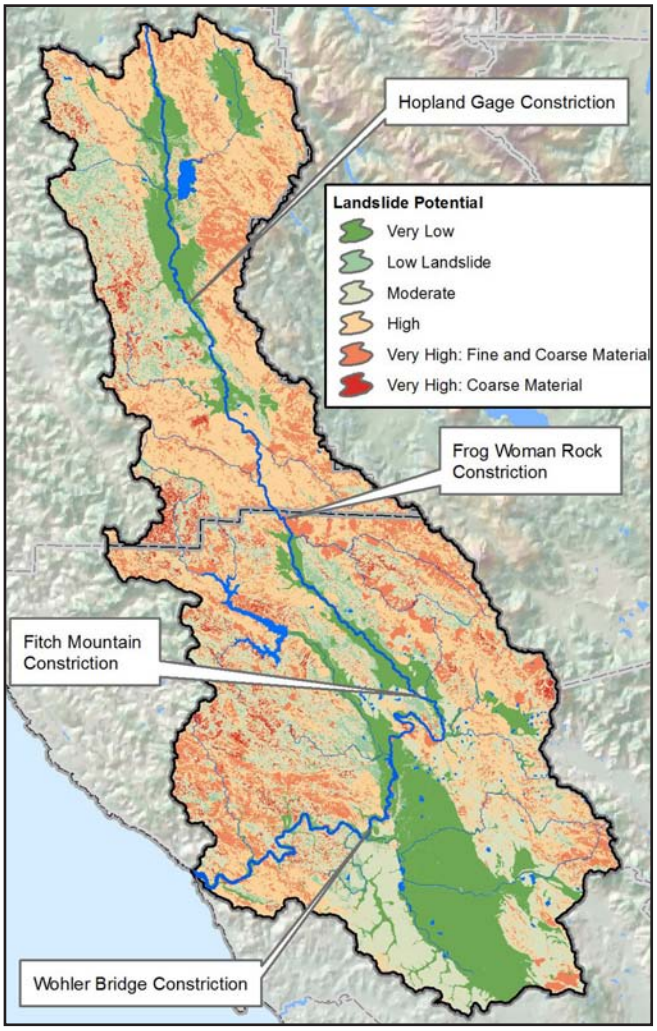


Figure 3.4 Landslide Potential and Stream Reaches
Data source: Department of Conservation, California Geological Survey

Alexander Valley reach, the river enters a mountainous area east of Healdsburg known as the Fitch Mountain Constriction where it is confined by steep bedrock banks. The section of the river in the Healdsburg Valley downstream to Wohler Bridge, where another bedrock constriction occurs, is called the Middle Reach. The Middle Reach contains several permanent in-stream structures including the Healdsburg Dam, two bridges in Healdsburg, Wohler Bridge, and Highway 101 (Simons, Li & Associates 1991). The Lower Reach is a narrow alluvial valley that ends at the Pacific Ocean, near the town of Jenner.

TABLE 3.2. REACHES IN THE RUSSIAN RIVER BASIN (AFTER FLORSHEIM AND GOODWIN 1995)	
Name	**River Mile**
Ukiah Valley	96 — 84.5
Hopland Gage Constriction	84.5 — 79
Hopland Valley	79 — 74
Frog Woman Rock[1] Constriction	74 — 63
Alexander Valley	63 — 46
Fitch Mountain Constriction	46 — 32
Middle Reach	32 — 23
Wohler Bridge Constriction	23 — 21
Lower Reach	21 — 0
[1] Formerly "Squaw Rock"	

3.1.4 Hydrology and Geomorphology

Hydrologically and geomorphologically diverse, the watershed contains 238 streams, 23 named springs, 14 natural lakes, 15 named reservoirs, and all or portions of 13 groundwater basins (USGS Geonames database 2009). The watershed presents a full spectrum of hydro/geomorphological features, from steep ridges and ephemeral streams through low rolling hills and wide alluvial valleys of the floodplain. The mouth of the river is closed throughout most of the year due to a sandbar that forms at the outlet of the Russian River, forming a lagoon (note that when the sandbar is breached, the "lagoon" becomes an "estuary;" these present quite different ecosystem conditions). Hydrologic and geomorphological features, and the ecosystem processes that produce and maintain them, are described in more detail below.

3.1.4.1 Hydrogeomorphological Regime

Historically, the alluvial valleys of the Russian River watershed contained numerous side channels and sloughs, and the main channel commonly featured riffles and deep pools. The channel was dynamic, relatively shallow, and wide; its shape and position changed as it meandered across the alluvial valleys in response to natural hydrologic and geologic processes. Winter flows were high and episodic, cycling with storm events, and summer flows were very low or

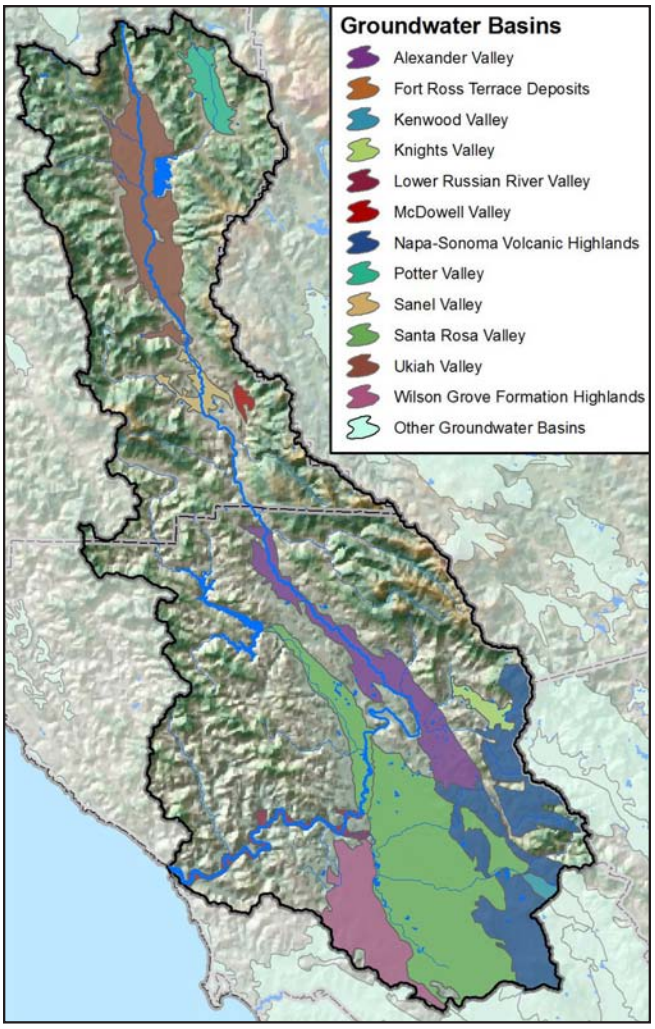


Figure 3.5 Groundwater Basins
Data source: Department of Water Resources

apparently absent, with the river consisting of isolated deep pools fed by flow traveling under the superficially dry gravel bed (subsurface flow). See Appendix 2, An Oral History of the Russian River Watershed for a summary of historic conditions in the Russian River watershed as described through interviews conducted in 1992 with 25 residents of the area.

Approximately 95 percent of stream flow occurs between November and April (CDFG 2002, NCRWQCB 2005); during the summer months, main channel flow greatly decreased with side sloughs and deep holes providing refuge for fish and other aquatic organisms (Florsheim and Goodwin 1993).

Mean annual discharge (flow volume) in the Russian River is measured at a USGS gauging station #11467000 (near Guerneville in Sonoma County; 0.1 upstream from

Hobson Creek), the only available gauging station for the mainstem, as the vast majority are established on tributaries. For 1940 through 2011, mean annual discharge was estimated at 1,637,181 acre feet. The maximum mean annual discharge was 4,269,957 acre feet (1983); the minimum was 64,215 acre feet (1977) (USGS 2012, National Water Information System web interface).

Anthropogenic land uses (e.g. flow diversions, gravel extraction, and dam construction) and associated changes to natural systems have altered the dynamic equilibrium between river channel size and morphology; sediment transport and deposition; and flow volume and velocity in the Russian River. To compensate for these changes, particularly the loss of sediment load, the river slope and cross-sectional shape have adjusted, resulting in channel incision and degradation of instream habitat. Channel degradation has been documented at many sites since the 1980s, including in Dooley Creek; the lower portions of Forsythe and Robinson Creeks; in the mainstem Russian River near Highway 175 (Florsheim and Goodwin 1995); Feliz Creek; and the mainstem at the Talmage Road Bridge (Laurel Marcus and Associates 2004).

Currently, summer flows in the main stem are heavily regulated by releases from the two water storage reservoirs in the basin: Lake Sonoma and Lake Mendocino. Under the regulated regime, flows in the Russian River main stem are kept artificially high during the summer months and low during the winter months under all but the most extreme rain events. Since 1912, Russian River flow has been augmented by water diverted from the Eel River in the Eel River watershed through a tunnel from near the headwaters of the Eel River into the East Branch of the Russian River (this is the Potter Valley Project, PVP). Water diversions from the Eel River increased with the completion of Scott Dam, which impounded the Eel River and created Lake Pillsbury. The Lake Pillsbury component of the PVP converted the Russian River East Fork and (to a lesser extent) the Russian River main stem into perennial water courses.

3.1.4.2 Floodplain/ Riparian Zone

The Russian River floodplain is the relatively flat land adjacent to the river bank formed by the river's dynamic processes over time. The floodplain subsumes the riparian zone (riparian habitat is discussed separately in Section 3.3) and extends from the banks of the mainstem channels to the base of the valley walls that surround it: the region above the floodplain is "upland." By definition, the historic floodplain experiences flooding during periods of high flow discharge, inundating low-lying areas with nutrient-rich waters, depositing gravel, and sculpting landscape features. Well-functioning floodplains may support particularly diverse ecosystems (e.g. riparian vegetation in a variety of successional stages, and riparian-associated wildlife). They also support human settlements: floodplains are attractive to people because the rich alluvial soils are suitable for agriculture and the gentle topography is convenient for residential and commercial development. Thus, the watershed's population centers tend to be in or along the floodplain of the Russian River main stem and tributaries.

The floodplain of the Russian River is composed of a series of alluvial valleys separated by narrow bedrock channels ("reaches" in Table 3.2). Examples of alluvial valleys on reaches of the Russian River include the Ukiah Valley and Middle Reach in Mendocino County and the Alexander Valley, Healdsburg Valley, and Santa Rosa Plain, and Lower Reach in Sonoma County; the lower reach of the Russian River is a narrow alluvial valley that ends at the Pacific Ocean near Jenner.

3.1.4.3 Groundwater

The Russian River watershed overlies all or portions of 13 groundwater basins (see Figure 3.5). Groundwater supplies the municipalities of Rohnert Park, Santa Rosa, Sebastopol, Ukiah, and Windsor (NCRWQCB 2007a). An aquifer in the terrace adjacent to the Russian River exchanges water with the river during fluctuations in annual flow (i.e. they recharge each other throughout the year). Because surface water is highly regulated while groundwater is not (yet), there is some degree of controversy as to what constitutes "groundwater" in the Russian River watershed: it can be very difficult to determine definitively if so-called groundwater is being drawn from an underground basin (groundwater), or flows through subterranean gravel of subsurface streams (surface water).

TABLE 3.3. RUSSIAN RIVER WATERSHED GROUNDWATER RESOURCES

GROUNDWATER BASIN	HECTARES	% OF WATERSHED
Alexander Valley	12,551.11	3.27
Fort Ross Terrace Deposits	34.51	0.0089
Kenwood Valley	825.40	0.21
Knights Valley	1,654.97	0.43
Lower Russian River Valley	2,688.18	0.70
McDowell Valley	602.00	0.16
Napa-Sonoma Volcanic Highlands	23,047.65	5.99
Potter Valley	3,335.82	0.87
Petaluma Valley	2.96	0.00077

TABLE 3.3. RUSSIAN RIVER WATERSHED GROUNDWATER RESOURCES		
Sanel Valley	2,255.08	0.59
Santa Rosa Valley	40,661.03	10.58
Ukiah Valley	15,190.83	3.95
Wilson Grove Formation Highlands	11,271.95	2.93
TOTAL	**114,121.49**	**29.68967**
(Source: California Department of Water Resources 2004)		

3.1.4.4 Surface Waters

Streams

At least 238 named streams (USGS Geonames database 2009) totaling approximately 1873 miles (3013 km) occur in the Russian River watershed. The principal tributaries of the mainstem Russian River are Ackerman Creek, Austin Creek, Big Sulphur Creek, Cummiskey Creek, Dry Creek, Dutch Bill Creek, East Fork Russian River, Feliz Creek, Forsythe Creek, Green Valley Creek, Hensley Creek, Maacama Creek, Mark West Creek, McNab Creek, Morrison Creek, Orrs Creek, Parsons Creek, Pieta Creek, Porter Creek, Robinson Creek, Sausal Creek, Sulphur Creek, Willow Creek, and York Creek (see Figure 3.6).

Lakes and Reservoirs

The Russian River watershed contains two large man-made reservoirs: Lake Mendocino (687 hectares; 1,698 acres) retained by Coyote Valley Dam on the East Fork Russian River and Lake Sonoma (1068 hectares; 2,639 acres), retained by Warm Springs Dam on Dry Creek (*see section, 3.1.4.5 Water Supply and Flood Control Infrastructure*). Other significant reservoirs in the region are: Russian River Reservoir, and Walker Lake in Mendocino County; and Brush Creek Reservoir, Fountaingrove Lake, Frog Lake, Lake Ilsanjo, Lake Orth, Lake Ralphine, Matanzas Creek Reservoir, Pine Creek Reservoir, Roberts Lake, and Santa Rosa Creek Reservoir in Sonoma County. There are more than a dozen naturally-occurring named lakes in the region: Coon Lake, Hagan Lake, Hog Lake, and Leonard Lake in Mendocino County; and Dugan's Pond, Jenner Pond, Lytton Lake, Merlo Lake, Moonshine Pond, Mud Lake, Onion Pond (historical), Preston Lake, Redwood Lake, Toole Pond, and Vineyard Lake in Sonoma County (USGS Geonames database 2009).

Lake Mendocino

The total areal coverage of the watershed's mapped lakes and reservoirs is 2,347 hectares (5,801acres); an additional 306 hectares (756 acres) comprise water treatment ponds for a total area of 2,654 hectares (6,558 acres) (US Geologic Survey National Hydrologic Dataset date 2006). Numerous smaller reservoirs have been created on private property to impound water for agricultural purposes (e.g. for crops and livestock). The actual number and volume of such reservoirs is undetermined as a significant proportion of these waterbodies are unappropriated (e.g. not officially approved or regulated by the SWRCB); thus the total area of standing surface water indicated above for the Russian River watershed is likely underestimated.

Other Surface Waters

Other surface waters in the Russian River watershed include freshwater and saltwater wetlands; riparian vegetation; estuary and lagoon; and near shore coastal habitats. All of these warrant special management attention. They are each described Section 3.3.7 ("Sensitive and Protected Habitats") and their condition assessed in Section 5.1 ("Habitat Condition").

3.1.4.5 Water Supply and Flood Control Infrastructure

Various forms of water supply infrastructure and flood control systems exist in the Russian River watershed. These are described below: major dams, small surface storage, hydropower, flood control, collector wells, and reclaimed/recycled water.

Major Dams

Two large dams were built on the Russian River to create reservoirs for water supply storage and to protect communities from flood damage. These are Coyote Valley Dam (which created Lake Mendocino on the East Fork Russian River north of Ukiah) and Warm Springs Dam (which created Lake Sonoma on Dry Creek west of Healdsburg). Lake Mendocino, with a maximum storage capacity of 122,500 acre-feet

Figure 3.6 Russian River Dams
Data source: Department of Water Resources; CalFish, California Fish Passage Assessment Database

stores water imported from the Eel River through the Potter Valley Project. Of that amount, 70,000 acre-feet are allocated for water supply. Lake Sonoma has a maximum storage capacity of 381,000 acre feet with 212,000 acre feet allocated for water supply (NCRWQCB 2007a). Numerous smaller dams are scattered throughout the watershed (see Figure 3.6).

Coyote Valley Dam at Lake Mendocino was the first multi-purpose dam project undertaken by the San Francisco District of the Army Corps of Engineers (USACE). The dam was constructed in 1959 with three goals: flood control, water conservation, and recreation. The dam was designed to be constructed in two stages with the intent that the second stage would be completed when the first stage no longer met water supply needs. The first stage of construction provided a total storage capacity of about 118,000 acre feet with a water supply pool of about 70,000 acre feet (SCWA 2006b); the second stage increased Lake Mendocino's water storage capacity by 62 percent, to 199,000 acre feet. The USACE began a feasibility study in 2007 to determine if the second stage is cost effective and practicable under new seismic safety requirements (CEIC 2007, Anderson 2007). Sonoma County Water Agency (SCWA) has the right to determine releases from the water supply pool in the lake, but once the water reaches the flood control pool, USACE Engineers determine releases (SCWA 2006b). The Russian River Flood Control and Water Conservation Improvement District has rights to 8,000 acre feet of the water stored in the water supply pool (UCCE 2004).

Warm Springs Dam at Lake Sonoma was completed in 1983. Like Coyote Valley Dam, it was built by the USACE and serves the threefold purpose of flood control, water supply, and recreation. The dam was placed on Dry Creek, one of the Russian River's major tributaries, at its confluence with Warm Springs Creek. The dam provides 212,000 acre feet per year for water supply, with a total capacity of 381,000 acre feet. In an effort to mitigate for fish passage, the Congressman Don Clausen Fish Hatchery was built next to the dam. The hatchery is operated by the California Department of Fish and Game (Faghih 1999). (See Recreation, Section 3.2.10).

Small Surface Storage

Small surface storage consists of ponds and small reservoirs landowners fill during high winter flows, for use during the dry season. There has been a recent paradigm shift in water management in the North Coast region and Russian River watershed, placing greater emphasis on stored, versus directly-diverted water supplies. Some level of water storage development in Mediterranean-climate regions is not only appropriate, it is probably necessary for the long-term protection of freshwater ecosystems. Surface storage offers the opportunity to provide simultaneously for human uses (e.g. irrigation of vineyards, frost protection) and adequate environmental flow, making this approach not only appropriate, but likely necessary for long-term protection of freshwater ecosystems (Grantham 2010). The expansion of winter storage capacity to meet human water demands is a potentially controversial view given the ecological impacts caused by impoundments. The challenge is in determining

the correct number, size, and placement of surface storage ponds in the watershed and the optimal storage capacity in a given watershed that will satisfy a significant proportion of human demands while maintaining adequate streamflows to protect environmental benefits. The model created by Merenlender et al. (2008) and analyzed by Grantham et al (2010) was developed with Russian River watershed data and will help planners decide how best to implement small surface storage in the context of this watershed.

Hydropower

The Potter Valley Project (PVP) is a 9.4 megawatt water storage and diversion project operating mainly in the Eel River watershed that has been in service for over 90 years. The Project uses two dams and a diversion from the Eel River to generate hydroelectricity. The diversion, which is downstream from the dams, is funneled through a 5,826 foot (1,776 meter) tunnel near the headwaters of the Eel River into the East Branch of the Russian River. The Eel River diversion has pumped at a rate of approximately 300 cubic feet per second into the East Fork Russian River since operation began in 1908. The tunnel was enlarged in 1950 to provide for a maximum capacity of 345 cubic feet per second. As it is released into the headwaters of the East Branch of the Russian River, the diverted water powers turbines in powerhouse facilities located there (FOER 2002). The Potter Valley Project has been relicensed by the Federal Energy Regulatory Commission; however, fishery interest groups argue that the diversion from the Eel River has impacted the river's fishery and the decision is currently being litigated (DWR 2005).

The two water storage dams in the watershed also provide small amounts of electricity through hydropower. Coyote Valley Dam on the East Fork of the Russian River produces a combined capacity of 3.5 megawatts of power through two power generation units. Warm Springs Dam on Dry Creek has a 2.6 megawatt power generation facility (NCRWQCB2005b).

Flood Control

In the 1930s, USACE Engineers constructed levees along the Alexander Valley Reach of the Russian River (river mile 63 to river mile 45; see Table 3.2). The levees extend from the Crocker Road Bridge downstream to the Sonoma County Airport on the west side, and from the mouth of Big Sulphur Creek downstream to Asti along the east side. Levee construction was intended to provide flood control to protect communities in the Russian River floodplain.

In addition to the levees, both Warm Springs and Coyote Valley Dams provide flood control in the Russian River watershed. During the winter of 1996/97, it is estimated that the dams prevented 40 million dollars in damages to the Russian River watershed (Faghih 1999). As a means of flood control for the Lower Reach of the river, Sonoma County Water Agency (SCWA) periodically breaches the Russian River sandbar at the mouth of the lagoon, creating an estuary with flow released to the sea.

Local natural features (e.g. riparian forest, wetlands, intact stream hydrogeomorphology, floodplain function) provide another means for flood control. The aerial extent and viability of these wetland features determines their efficacy with respect to flood control. According to indicators associated with coho salmon (NMFS 2010), the flood controlling capacity of riparian systems in the Russian River watershed is mostly poor (e.g. for riparian percent cover, corridor size, canopy size, stand age, and floodplain complexity/connectivity).

Collector Wells

To supplement water supplies, SCWA operates six collector wells adjacent to the Russian River: two collectors are located near the Wohler Bridge and four collectors are located at Mirabel Park (Forestville). The collectors extract water from the deep gravel underflow of the Russian River (i.e. groundwater). SCWA also operates a well field near the Mirabel collectors; an inflatable rubber dam that is raised during spring when water demand increases; and chlorination, pH adjustment, and corrosion control facilities. To transport the water, an aqueduct system was developed that consists of storage tanks, pipelines, pump stations, and emergency wells (SCWA 2006b). The city of Ukiah collects ground water from beneath the Russian River to supply its customers, using "ranney collectors." These devices are designed to draw water from subsurface aquifers, which are hydrologically connected to surface waters (e.g. streams). Because of this connection, the designation of water they collect as "groundwater" (currently unregulated, relative to surface water) is somewhat controversial. The SCWA is now developing a Groundwater Management Plan (GMP) for the Santa Rosa Plain that aims to resolve the ground versus surface water ambiguity.

Reclaimed/ Recycled Municipal Water

Reclaiming water, which is treating wastewater from homes and businesses and reusing it for non-potable applications, has become a standard method for

bolstering water supplies in the Russian River watershed. The extent to which reclaimed water is allowed to be used is dependent upon the amount of treatment the water has received, with the highest level of treatment providing for the greatest flexibility in use. For example, tertiary recycled water that has been disinfected can be used for irrigating food crops while disinfected secondary reclaimed water may not be used on food crops (SCWA 2006c). Municipalities and agencies in the Russian River watershed that distribute reclaimed water include the Town of Windsor, the Airport-Larkfield-Wikiup Sanitation Zone, and the city of Santa Rosa. Uses for reclaimed water are mostly for landscape irrigation; however, the city of Santa Rosa delivers eleven million gallons of reclaimed water per day to The Geysers geothermal power plants owned and run by Calpine Corporation (Calpine undated).

3.2 LAND OWNERSHIP AND LAND USE

Land ownership in the Russian River watershed is predominantly private (i.e. not federal, state, local, or tribal land) and land use is varied. The primary land uses in the watershed are rural residential, mixed agriculture, and small municipalities (upper reaches); wine grape cultivation (middle reaches); and mixed agriculture, rural residential, and recreational tourism component (lower reaches) (CDFG 2002). Extensive agriculture (e.g. orchards, row crops, vineyards, and ranching) is established within the alluvial valleys and lower elevations of the watershed; increasingly, agriculture is encroaching into higher elevations, as well, as vineyards are developed in upland areas (e.g. east and north of Cloverdale in Mendocino County. Industrial uses include high-tech industry, petroleum distribution facilities, light manufacturing, wrecking and salvage yards, and construction. Urban areas are located mainly within the floodplain, but rural residential development also extends into uplands and ridge tops. The highest population density occurs in the southern part of the watershed, due in part to proximity to the San Francisco Bay.

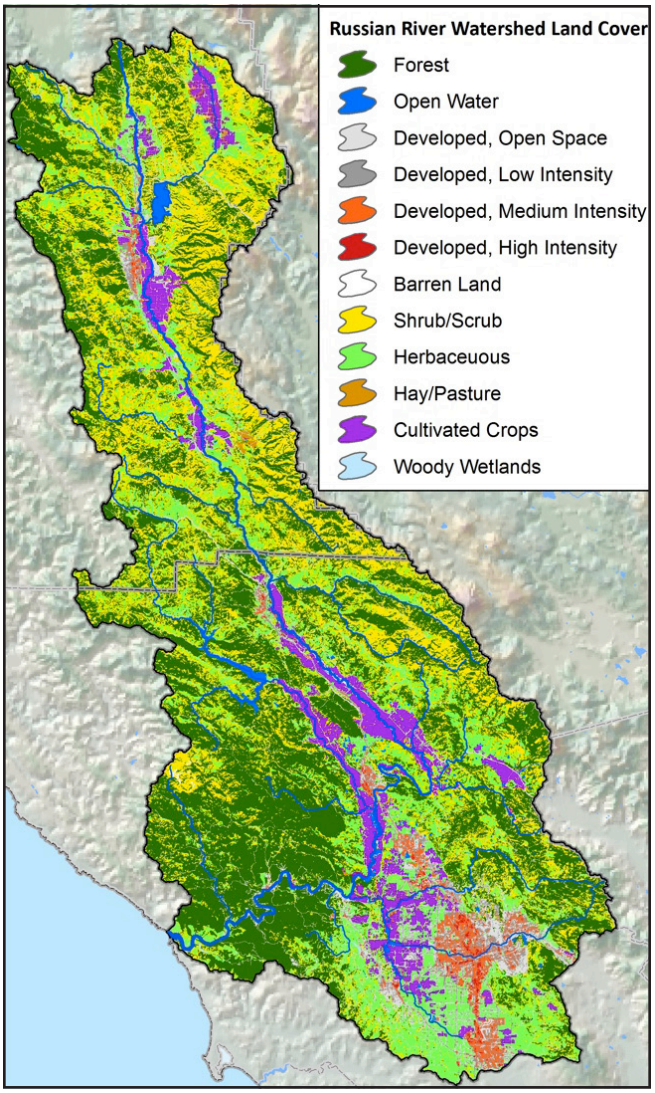


Figure 3.7 Russian River Watershed Land Cover
Data source: U.S. Geological Survey, National Land Cover Database

Common land uses and their areal coverage are described below for the Russian River watershed (see Figure 3.7, Russian River Watershed Land Cover) and summarized in Table 3.4. Management issues associated with these land uses are discussed in Section 6.

TABLE 3.4 SUMMARY OF LAND COVER IN THE RUSSIAN RIVER WATERSHED

TYPE	HECTARES	% OF WATERSHED
Open Water	2,848.95	0.73%
Developed, Open Space	23,287.32	5.99%
Developed, Low Intensity	8,835.93	2.27%
Developed, Medium Intensity	6,364.89	1.64%
Developed, High Intensity	699.66	0.18%
Barren Land	632.79	0.16%
Deciduous Forest	9,485.01	2.44%

TABLE 3.4 SUMMARY OF LAND COVER IN THE RUSSIAN RIVER WATERSHED		
Evergreen Forest	95,395.41	24.52%
Mixed Forest	43,163.01	11.09%
Shrub/Scrub	106,342.20	27.33%
Herbaceous	68,555.25	17.62%
Hay/Pasture	708.66	0.18%
Cultivated Crops	21,594.24	5.55%
Woody Wetlands	1,023.84	0.26%
Emergent Herbaceous Wetland	134.01	0.03%
TOTAL	**389,071.17**	**100%**

3.2.1 Land Ownership

Landownership in the Russian River watershed is overwhelmingly local/ privately-owned (91.93 percent; Table 3.5). A small proportion can be classified as federal, state, or tribal land.

Local Lands

Local lands in the Russian River watershed total approximately 357,656 hectares and comprise 91.93 percent of its total area (see Table 3.5).

TABLE 3.5. RUSSIAN RIVER WATERSHED LOCAL LANDS		
TYPE	**HECTARES**	**% OF WATERSHED**
Private ("Unclassified")	349,296.66	89.78%
City	1,237.77	0.32%
County	1,145.32	0.29%
Non Governmental Organization	3,696.99	0.95%
Special District	2,279.62	0.59%
TOTAL	**357,656.36**	**91.93%**
(Source: California Protected Areas Database, GreenInfo Network)		

Federal Lands

Federal lands in the Russian River watershed total approximately 21,042 hectares and comprise 5.41 percent of its total area (see Table 3.6).

TABLE 3.6. RUSSIAN RIVER WATERSHED FEDERAL LANDS		
TYPE	**HECTARES**	**% OF WATERSHED**
Bureau of Land Management	13,237.98	3.40%
Department of Defense (USACE)	7,748.72	1.99%
USDA Forest Service	55.05	0.01%
TOTAL	**21,041.75**	**5.41%**
(Source: California Protected Areas Database, GreenInfo Network)		

State Lands

State lands in the Russian River watershed total approximately 10,062 hectares and comprise 2.59 percent of its total area (see Table 3.7).

TABLE 3.7. RUSSIAN RIVER WATERSHED STATE LANDS		
TYPE	**HECTARES**	**% OF WATERSHED**
CA Department of Fish and Game	508.41	0.13%
CA Department of Parks and Recreation	7,449.57	1.91%
Other State	2,103.65	0.54%
TOTAL	**10,061.64**	**2.59%**
(Source: California Protected Areas Database, GreenInfo Network)		

Tribal Lands

Native American tribal lands in the Russian River watershed total approximately 302 hectares (746 acres) and comprise 0.078 percent of its total area (see Table3.8).

TABLE 3.8. RUSSIAN RIVER WATERSHED TRIBAL LANDS		
NAME	**HECTARES**	**% OF WATERSHED**
Coyote Valley Reservation	34.72	0.0090
Dry Creek Rancheria	32.58	0.0084
Guidiville Rancheria	17.54	0.0046
Guidiville Trust Land	0.95	0.00025
Hopland Rancheria	31.27	0.0081
Hopland Trust Land	32.76	0.0085
Pinoleville Rancheria	42.20	0.011
Redwood Valley Rancheria	109.53	0.028
TOTAL	**301.55**	**0.078**
(Source: US Census Bureau — Tiger/ Lines Files 2008)		

3.2.2 Jurisdictional Boundaries

The Russian River watershed is in the North Coast Hydrologic Region (Region 1, as defined by the SWRCB) and spans Mendocino and Sonoma Counties: approximately 500 square miles (1295 square km) of the watershed are located within Mendocino County with the remaining 1,000 square miles (2590 square km) in Sonoma County (Sommarstrom 1986 in UCCE 2004). It is bounded to the north by Humboldt County, the east by Lake and Napa Counties, the south by Marin County, and the west by the Pacific Ocean to three nautical miles. The watershed subsumes the boundaries of several municipalities, including the cities of Cloverdale, Cotati, Healdsburg, Rohnert Park, Santa Rosa, Sebastopol, Ukiah, and Windsor. Many small towns are located on the river, particularly in the Lower Reach ("Population Centers," below). Authorities and agencies with jurisdiction in the Russian River watershed are listed in Section 4.0.

The Russian River Hydrologic Unit is wholly contained in the following Evolutionarily Significant Units (ESUs) for salmonids, according to the Federal ESA: Central California Coast ESU for coho and steelhead; California Coast ESU for Chinook. The watershed belongs to the North Coast Resource Conservation and Development Council (NCRC&DC), and three Resource Conservation Districts (RCDs, formerly "Soil Conservation Districts"): the Mendocino County

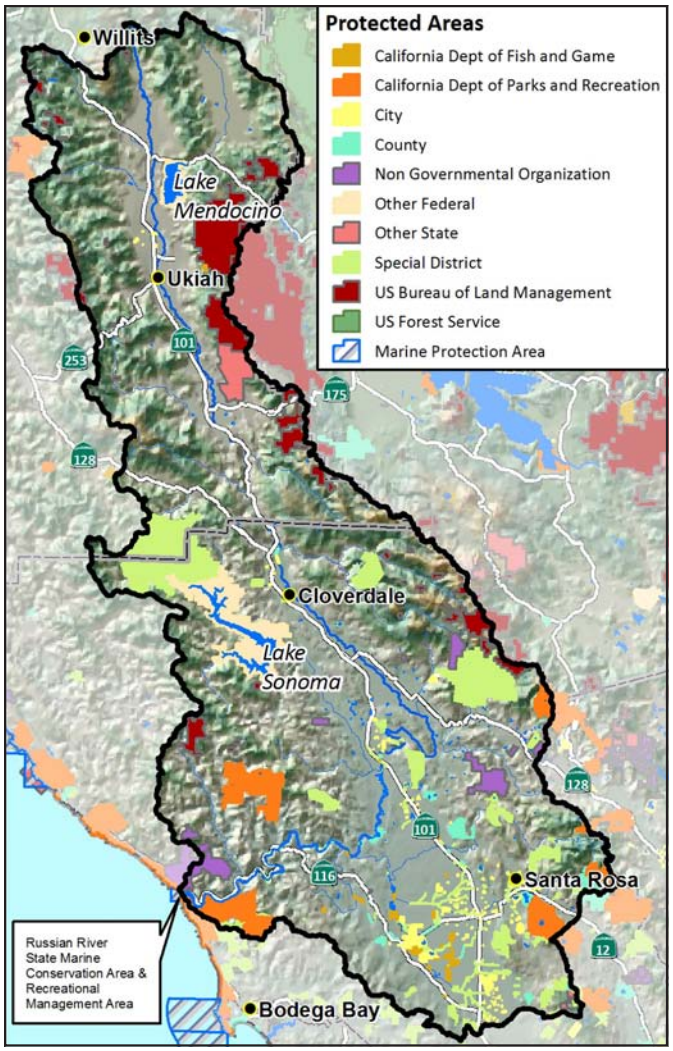


Figure 3.8 Open Space and Protected Areas
Data source: California Protected Areas Database, GreenInfo Network; Sonoma County Agricultural Preservation & Open Space District; California Department of Fish and Game, MarineBIOS, Marine Life Protection Act

RCD and, for Sonoma County, the Gold Ridge and Sotoyome RCDs (NCIRWMP, Phase 1). The NCRC&D and the RCDs work with local stakeholders to facilitate environmental and economic improvements throughout the Russian River watershed.

3.2.3 Public Ownership and Easements

In the Russian River watershed, land cover is primarily open space (i.e. vegetation). Fifty-one percent of the watershed has less than one housing unit per 160 acres (65 hectares) although roads intersect much of the landscape. Of particular importance to watershed managers are the large and/or contiguous parcels that provide wildlife corridors, protect rare or sensitive habitat, and allow for natural ecosystem function.

In the Russian River, 10.2% percent of the watershed (see Figure 3.8) is conserved through designation as open space preserves, state and local parks, conservation easements, or other formal means. Local organizations such as Sonoma County Agricultural Preservation and Open Space District (SCAPOSD), Sonoma Land Trust (SLT), and Mendocino Land Trust (MLT) identify ecologically important natural areas and working landscapes and conserve them, either through outright land acquisition or via the purchase of conservation easements, which stipulate conditions on land use and management that are tied to the property's deed. Both Mendocino and Sonoma Counties' General Plans contain Open Space policies that designate zoning and other policies to protect natural resources, increase recreational opportunities, and maintain public health and safety.

3.2.4 Population Centers

Urbanization in the watershed increased rapidly after the 1950s; in 1950 the basin's population was 65,000 while in 1980, it had more than tripled to 215,800 (SEC 1996). Residential development has occurred throughout the watershed, with the majority of the population living in the southern portion. Urban development and industrial activities are mainly concentrated in the alluvial valleys in both Mendocino and Sonoma Counties. The larger cities are (south to north): Santa Rosa (County seat), Cloverdale, Healdsburg, Windsor, Rohnert Park, and Sebastopol in Sonoma County; and Cloverdale and Ukiah (County seat) in Mendocino County. The smaller towns are (south to north): Jenner, Guerneville, Rio Nido, Graton, Cotati, Forestville, Fulton, Lytton, Geyserville, Hopland, Talmage, Calpella, Redwood Valley, and Potter Valley. Santa Rosa is the principal commercial distribution center for the entire North Coast and the Santa Rosa Plain area, with six incorporated communities, is the most densely populated area in the watershed (CDFG 2002).

3.2.5 Transportation

The Russian River watershed is threaded with more than 4,000 miles of roads, including approximately 100 miles (162 km) of major roads (i.e. highways and state routes); 4,007 miles (6,449 km) of local roads, and myriad rural unpaved roads (US Census Bureau Tiger/ Lines Files 2008). Road density is estimated at three miles of road per square mile of watershed (NMFS 2010). Railroads connect portions of the watershed. The airports serving the region are in Ukiah (Ukiah Municipal Airport), Windsor (Charles M. Schulz, Sonoma County Airport), Cloverdale

(Cloverdale Airfield and Cloverdale Municipal Airport), and Healdsburg (Healdsburg Municipal Airport).

3.2.6 Timberlands

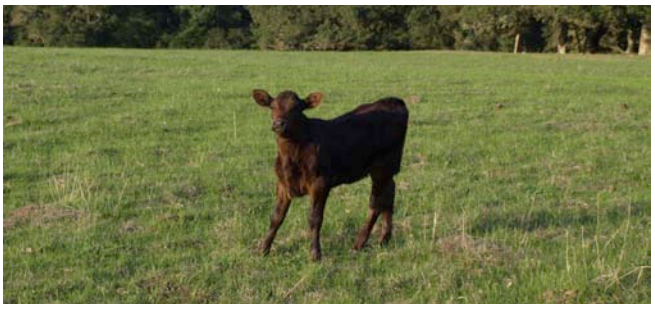
Areal coverage by currently-harvested timberlands is low in the Russian River watershed. Extensive timber harvest occurred in the Russian River watershed the mid-1800s, peaked by the mid-1900s, and continues into the twenty-first century (albeit at a reduced scale). The Russian River watershed today contributes less than 5 percent of the total timber harvested in the North Coast Region (NCRWQCB 2005) with Mendocino Redwood Company currently the largest industrial timber company in operation there..

3.2.7 Agricultural Lands

Although urban areas are growing rapidly, agriculture remains the primary land use within the Russian River basin with the recent trend toward the conversion of historic crops, ranches, orchards, and forests to vineyards. Silage (high moisture forage for cattle and sheep) remains an important crop in the open areas of the Santa Rosa Plains and cattle and sheep ranching still is widespread in Mendocino County, especially in oak woodlands and coastal prairie habitat (CDFG 2002).

3.2.8 Rangelands

More than half of Russian River watershed land is considered "rangeland" and may be grazed by domestic livestock such as cattle and sheep. The watershed's bottomlands and uplands both are utilized extensively for livestock grazing. According to the California Department of Conservation Farmland Mapping and Monitoring Program (FMMP) the total area of designated rangeland in the Russian River watershed is 218,647 hectares (540,289acres) (56.88% of the watershed); these data are being updated in 2011 (not available as of 27April2012; see http://redirect.conservation.ca.gov/dlrp/fmmp/product_page.asp).



3.2.9 Aggregate Mining

In-channel gravel mining began in 1940 and sand and gravel production became the principal mining industry from Healdsburg north to Ukiah in the early 1950s (CDFG 2002). Gravel from the Russian River was used for concrete construction and road repair/construction throughout the watershed and was exported to the San Francisco Bay Area (Chocholak 1992). Gravel mining operations moved into adjacent terraces along the river in 1970 and both sand and gravel mining continue today (CDFG 2002). Most gravel mining activity today occurs along river miles 23 to 33 (the Middle Reach) and miles 44 to 63 (the Alexander Valley Reach; Simons, Li & Associates 1991). Gravel bar skimming (versus in-channel extraction) has been common in the Alexander Valley Reach (Florsheim and Goodwin 1995) and open pit mines can be found in the Middle Reach and in the Ukiah Valley (Russian River Keeper 2006).

Aggregate mining and recreation along the Russian River

3.2.10 Recreation

Recreational tourism remains an important industry within the Russian River watershed and is repeatedly cited as a local economic driver in the draft Sonoma County General Plan 2020. Opportunities exist throughout the watershed for sport fishing, birding, boating, swimming, hiking, biking, and more. In the Lower Reach, the communities of Guerneville, Rio Nido, and Monte Rio have been outdoor recreation destinations since the early 1900s. Lake Sonoma and Lake Mendocino remain popular recreation destinations for swimming, boating, and fishing. In addition to recreational tourism, agricultural tourism (e.g. for wine

enthusiasts) is emerging as an important economic sector in the Russian River watershed (Sonoma County Economic Development Board and Sonoma County Workforce Investment Board 2008). Recreational fishing contributes to local economies from Jenner to Calpella, whose merchants provide fishing licenses, tackle, bait, food, beverage, and fuel to tourists.

The Russian River was renowned as a world-class recreational fishery up through the 1950s, but as steelhead (*Oncorhynchus mykiss*) populations declined in California, the draw for recreational anglers to experience the Russian River has decreased. Currently, the mainstem is considered by many anglers as a "fair" steelhead fishing experience in the winter. Many people fish the mainstem Russian River in the summer and fall, when adult steelheads are not present, presumably catching juvenile steelhead (and calling them "trout"). Other fish that can be caught in the river include three bass (*Micropterus* spp.), catfish (*Ictalurus catus*), sunfish (*Lepomis spp.*), crappie (*Pomoxis* spp.), and American shad (*Alosa sapieissima*). Non-game fish include suckers (*Catostomus* spp.), pikeminnow (*Ptychocheilus* spp.), hardhead minnow (*Mylopharodon conocephalus*), and carp (several genera and species). Crustaceans people harvest include crayfish (*Procambarus clarkia* and *Pacisastacus leniusculus*) and freshwater clams and mussels.

Anglers' fishing access and opportunities vary depending on location in the watershed, as various CDFG regulations apply throughout. Sport anglers must know the rules to fish the river because gear and bait restrictions, and species protections are always in place to prevent harm to the threatened and endangered fish they may encounter. In general, fishing Lakes Mendocino and Sonoma, their tributaries, and the mainstem Russian River below the confluence of the East Fork Russian River is permissible in season; however, tributaries to the mainstem are closed to fishing all year. CDFG's *2011-2012 Sportfish Regulations* provide details regarding which reaches and water bodies permit fishing. Anglers are reminded that the river and many streams in both counties cross private property and access is subject to landowner approval. In Sonoma County, public access is generally good, with access points at Jenner, Monte Rio, Guerneville, Forestville, Healdsburg, and Cloverdale.

All tributaries to the mainstem that are accessible by anadromous salmonids are closed to all fishing in order to protect juvenile salmonids. Streams that are above reservoirs and thus inaccessible to anadromous fish are open to angling during the typical trout season. Lakes Mendocino and Sonoma provide year-round angling opportunities for bass species, catfish, sunfish, and rainbow trout. Several farm and ranch ponds scattered throughout the watershed contain the bass/catfish/sunfish assemblage for family recreation, and a few ponds host stocked populations of rainbow trout. Licensed sport anglers may pursue fish in ponds and reservoirs during any season, as long as bag limits are followed. Fishing for other species such as Chinook (*O. tshawytscha*) and coho salmon is strictly prohibited. Catching and keeping an adult steelhead is allowed if the fish is of hatchery origin, and if the angler possesses the proper steelhead endorsement on the fishing license.

To supplement dwindling stocks, these species now are reared and stocked in the watershed by the California Department of Fish and Game (CDFG). Each year, the Congressman Don Clausen Fish Hatchery at Lake Sonoma's Warm Springs Dam and the Bill Townsend Conservation Fish Hatchery at Coyote Valley Dam release millions of juvenile steelhead and salmon into the Russian River. The fish hatcheries were built to mitigate for the salmon and steelhead spawning grounds impacted by construction of the dams. The Coyote Valley Dam Egg Collection Facility at Lake Mendocino sends fertilized steelhead trout eggs to the Warm Springs Dam facility to be grown prior to release in the upper Russian River. Hatchery raised juvenile steelhead (i.e. rainbow trout) are released into Mill Creek Pond east of Ukiah for a recreational fishery. Hatchery supplementation began in 1870; since that time, about 40 million hatchery-reared salmonids have been planted in the Russian River system. Initially, most fish stocks were from out of basin, such as the North Coast, Sacramento, Klamath or Wisconsin. Beginning in 1980 the importance of genetic integrity was recognized and efforts were made to utilize locally returning fish (SEC 1996).

3.3 BIODIVERSITY AND HABITATS

3.3.1 Plant Diversity

3.3.1.1 Historical Records

There are no reliable records quantifying the historic range of vegetation in the Russian River watershed prior to habitat alteration by previous and current land uses. However, it is documented that up to ten thousand years ago, indigenous people manipulated the landscape to suit their subsistence needs,

by burning, planting, and harvesting plants. In the 19th and 20th century, immigrants from Europe and other lands began to manipulate habitats and extract resources at a more intensive rate. The results have been broad and sweeping changes in the extent and condition of the region's native vegetation.

Big leaf maple

Apparent changes to historic vegetation discussed throughout the RRICWMP include reduced quality and/or extent of the following: (1) riparian habitat due in part to habitat conversion and disruption of natural hydrological/ geomorphological processes; (2) redwood and coniferous forest due in part to (particularly past) timber harvest, altered flood frequency, and fire suppression; (3) oak woodland due in part to habitat conversion, lack of regeneration, and disease (4) coastal prairie/ native perennial grassland due in part to fire suppression, overgrazing, and invasion by exotic plant species; and (5) aquatic habitats due in part to altered hydrology. Some other vegetation ranges have increased in recent times (e.g. invasive plant species and rangeland/ annual grassland species). In some cases, plant species have been locally extirpated from the watershed or are entirely extinct throughout their range. A number of species are today considered special-status (i.e. endemic, rare, threatened, or endangered; See 3.3.3).

3.3.1.2 Recent Data and Classification

The ranges of a diverse suite of plant species comprise the vegetation of the Russian River watershed, carpeting uplands and floodplain alike (outside urban and agricultural areas). All these species have been taxonomically classified, grouped into various classification schemes. In California, different datasets and

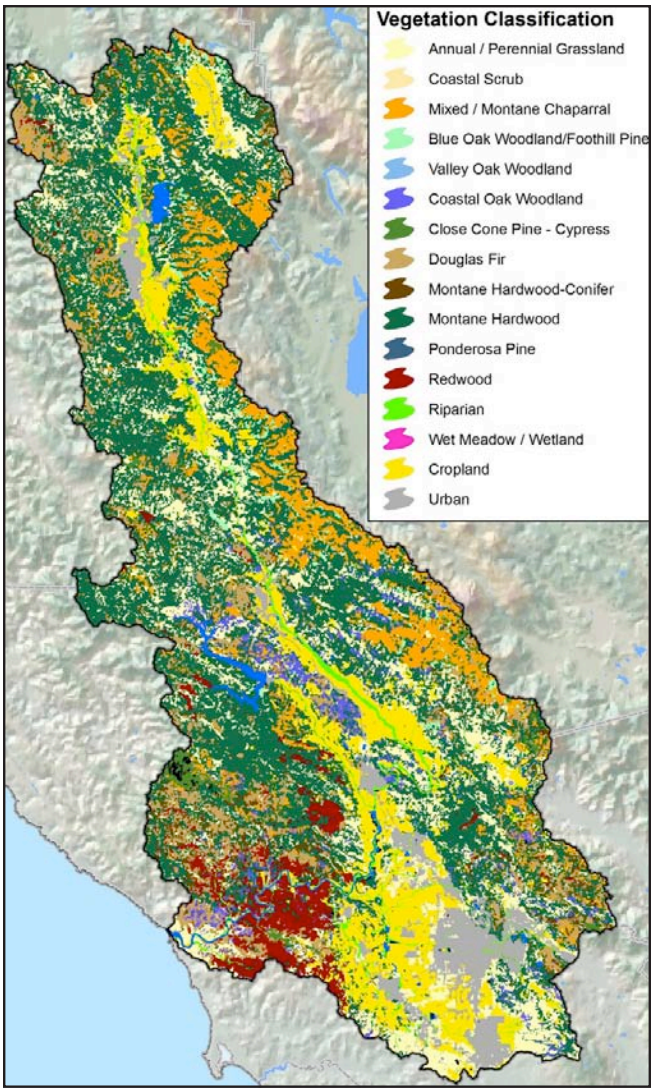


Figure 3.9 Vegetation Classification
Data source: USDA Forest Service, Remote Sensing Lab

reports define "vegetation" differently, based in part on the scale of interest, resolution of available data, and the database that populates it[1]. For example plant species groupings like "alliances," "series," "associations," "stands," "communities," and "habitats," are very different in scale and level of refinement, but are all encountered in even a casual review of the literature. In the current RRICWMP, the general term of "vegetation community" will be used to describe ecologically significant groupings of plant species. For

1 For example: CDFG List of California Vegetation Alliances (2007) by CNPS and CNDD, at http://www.dfg.ca.gov/biogeodata/vegcamp/pdfs/NaturalCommunitiesList_Oct07.pdf ; alliances listed by Sawyer and Keeler-Wolf 1995 and Sawyer, Keeler-Wolf, and Evens 2009 in *A Manual Of California Vegetation* (2nd Edition list at http://www.cnps.org/cnps/vegetation/pdf/mcv2_veglist_sn_200911.pdf)

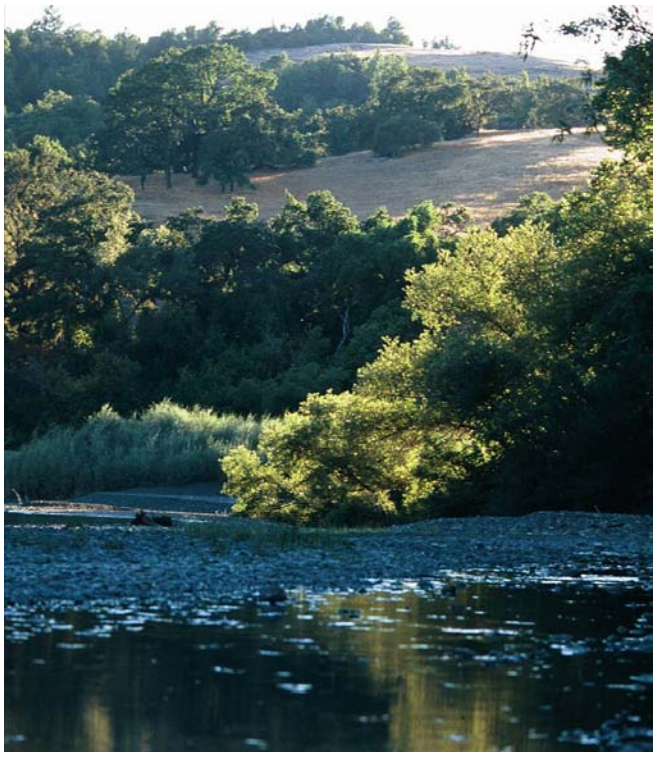
the purposes of planning at the watershed scale and above, this loose terminology may or may not be a critical issue. However, there is no doubt that the *data* upon which these groupings are based need to be developed and applied systematically in the state, region, watershed, and at the local-project level. Vegetation cover data of a scale that can reflect current conditions and fine scale changes (e.g. those resulting from implementation of management and conservation actions) is needed, but does not yet exist. This need is acknowledged and updates are occurring (e.g. of CalVeg for some portions of the North Coast up to 2003).

Figure 3.9 illustrates the approximate extent of some vegetation types in the Russian River watershed (based on CalVeg; see footnote). The plant communities of the Russian River watershed include (categories are descriptive, not strictly taxonomic): riparian forest, wetlands, oak woodlands, grasslands, mixed evergreen forest, redwood forest, interior chaparral, and coastal scrub. Vegetation strictly associated with aquatic habitats is described in Section 3.3.7 (streams, lakes, wetlands, estuary/lagoon, and near shore coast)[2]. These form a mosaic pattern that reflects environmental conditions (such as soil type, wind exposure, distance from the coast, disturbance regime, aspect, elevation, slope, and rainfall) and landuse patterns.

Native grasslands — upper watershed

Riparian Forest and Freshwater Wetland

Figure 3.9: See "Riparian" and "Wet Meadow/ Wetland"
Riparian forest is the more-or-less terrestrial component of riparian habitat (which technically also includes an in-stream component). Riparian forest comprises a dense, multi-layered canopy that is directly dependent on the fluvial geomorphic processes of the stream channel. Riparian areas exist throughout the watershed, particularly along the river and streams that sustain year-round flow. Riparian forest occurs at various successional stages, depending upon elevation and distance from the stream, as well as disturbance regimes related to flooding. Early successional riparian habitat is typically found in areas of high flood disturbance such as the active channel, while mature riparian forests (also known as late successional riparian habitat) is mostly found on the floodplain. Early successional forests tend to have a few species and consistent structure, whereas late successional riparian habitat is often comprised of a diverse set of species and structural layers — including a canopy of large trees, with an understory of smaller trees, shrubs and vines. These mature riparian forests are also characterized by dead standing trees which are important for hole nesting species, as well as downed wood which creates habitat for various vertebrate and invertebrate species.



Many riparian trees are broad-leaved deciduous species that actively grow during the summer season and shed their leaves into and along streams during the winter (this input of organic matter is important to stream ecosystem function). Riparian tree

2 These are aligned with, but present slight revisions on, the versions of the vegetation classification proposed in the Biodiversity Action Plan for Sonoma County (CFSC and SCWA 2010), at http://www.sonomalandtrust.org/pdf/Biodiversity_Action_Plan_2010_reduced.pdf

species are distributed along a moisture gradient — moisture-loving trees such as willow (*Salix* spp.), white and red alder (*Alnus rhombifolia* and *rubra*) and Fremont cottonwood (*Populus fremontii*) grow along river and creek banks where the water table is between 10 to 20 feet and flooding is frequent, while Oregon and valley oak are present where the soil is drier, with the water table at about 35 feet, and infrequent flooding. Other common native riparian species include black walnut (*Juglans californica* var. *hindsii*), big leaf maple (*Acer macrophyllum*), Oregon ash (*Fraxinus latifolia*), box elder (*Acer negundo*), and California bay (*Umbellularia californica*) in the overstory and California blackberry (*Rubus ursinus*) and snowberry (*Symphoricarpos albus*) in the understory.

Fresh and saltwater wetlands that are not part of the riparian system also occur in the watershed. See Section 3.3.7.3 for description of non-riparian wetlands; saltmarsh is included in that section's description of estuary habitat.

Wetlands at willow creek

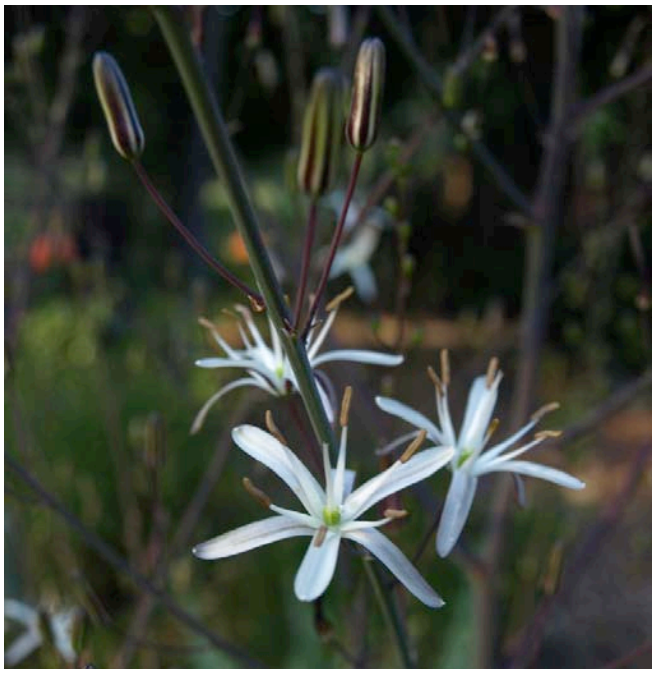
Oak Woodland

Figure 3.9: See "Valley Oak Woodland" and "Coastal Oak Woodland"
Several types of oak woodlands occur in the Russian River watershed including Northern, Valley, Foothill, and Live Oak woodlands. These woodlands differ in dominant oak species, spacing of trees, and location in the watershed. Interrelationships between soil, slope, precipitation, aspect, and temperature determine type and structure of these habitats. In Valley Oak woodlands, the structure is savannah-like with widely scattered valley oak (*Quercus lobata*) within a vast grassland. This habitat type occurs extensively within the Laguna de Santa Rosa, other valleys and mesic areas within the watershed; valley oak can tolerate the anaerobic conditions caused by waterlogged soils. The structure of Northern Oak Woodland contains closely spaced Oregon oak (*Q. garryana*) while foothill woodlands are dominated by blue oak (*Q. douglasii*). Live oak woodlands occur on dry soils and contain coast live oak (*Q. agrifolia*), although live oak is also found in riparian forests and coastal areas.

Oak woodlands

Grasslands

Figure 3.9: See "Annual/ Perennial Grassland"
Coastal prairies occur along the coast on terraces and hills where soils are deep and well-drained in the Lower Russian River watershed. Perennial grasslands occur in multiple locations in the Russian River watershed — most of which are remnants of historic populations that are now dominated by annual grasses and forbs. Most grassland in the watershed comprises a mixture of perennial, annual, native, and exotic grass species; in most cases these are completely integrated, so patches of true native perennial grassland are indeed quite rare. Remnant perennial grasses can also be found in annual grassland habitats and within valley oak woodland, the Laguna de Santa Rosa, and other habitats where deep well-drained soils occur.



Soaproot

Grasslands

Mixed Evergreen and Coniferous Forest

Figure 3.9: See "Closed Cone Pine-Cypress," "Douglas Fir," and "Ponderosa Pine"
Mixed evergreen forest is sometimes called a transition forest because it occurs between dense coniferous forests and montane hardwood, mixed chaparral, or open savannahs. Mixed evergreen forest is a widespread plant community both within the Russian River watershed and throughout the state. This forest is extremely common in the western portion of the watershed and occurs on north facing slopes and within cooler canyons in the eastern portion. Like redwood forest, mature mixed evergreen forest is a dense, multilayered forest with conifers in the overstory (mainly Douglas-fir) and hardwoods such as black oak, coast live oak, tanbark oak, bay, madrone in the understory. The shrub layer is very sparse and consists of shrubs such as hazel nut and snowberry (*Symphoricarpos alba*) This habitat often occurs in a mosaic pattern with small pure stands of conifer interspersed with small stands of hardwoods.

Mixed evergreen forest

Redwood Forest

Figure 3.9: See "Redwood"
Redwood forests are common within coastal canyons and along the Lower Reach of the Russian River, but are restricted to northerly slopes and canyons in the eastern part of the watershed. These are multilayered forests. Shade-loving herbaceous plants comprise the understory. Redwood dominates this habitat along the coast within 2 to 10 miles (3 to16 km) of the oceans and Douglas-fir becomes dominant further inland with tanbark oak and madrone as major associates (CDFG and California Interagency Wildlife Task Group 2005). As elevation increases and soil moisture content decreases, the species composition of redwood forests shifts. Douglas-fir becomes co-dominant, then dominant, in the overstory and bay and madrone (*Arbutus menziesii*) become more common than tan oak in the understory. Finally, redwood will drop out of the species mix and the forest type changes to coniferous or mixed evergreen forest.

The occurrence of fog, flood, and fire explains the regional and local distribution of redwood trees. The coastal fog provides a layer of cool, moist air that reduces evaporation from the leaves, which are sensitive to desiccation because their stomata — the cellular openings that enable respiration — do not close completely. Flooding causes periodic inundation and siltation. Redwood trees have adapted to these

conditions; their roots, which are seldom deeper than six feet, have the capacity to sprout new roots from buds beneath the surface. When the soil becomes compacted and anaerobic with floodwaters, the root buds will grow closer to the soil surface where gas exchange can occur. Other trees associated with this forest cannot survive periodic inundation — they literally suffocate — so where flooding has historically been frequent, pure stands of redwood occur. Redwood trees have also adapted to fire; bark is thick and resistant to fire and the roots are capable of resprouting if the main trunk is killed. Fire also clears the thick litter layer from the forest floor and sterilizes the soil, increasing the survival of redwood seedlings, which are very susceptible to fungus. Thus, both locally within the watershed and regionally along the western coast of the United States, the occurrence of fog, floods, and fires combine to create conditions under which redwood trees outcompete the other species within coastal forests.

Interior Chaparral

Figure 3.9: See "Mixed/ Montane Chaparral"
Chaparral ecosystems are composed of a dense mix of evergreen, sclerophyllous shrubs that form a single-level canopy with sparse understory. Chaparral typically occurs on infertile, rocky, shallow soil on south-facing slopes and ridge tops in the Russian River watershed. This ecosystem is more common in the middle and eastern sections of the watershed; in the western portion, coastal scrub occurs on the poor, xeric soils. The most common plant species include chamise (*Adenostema fasciculatum*), manzanita (*Arctostaphylos* spp.), *Ceanothus* spp., toyon (*Heteromeles arbutifolia*), scrub oaks (*Quercus* spp.), and knobcone pine (*Pinus attenuata*). Serpentine chaparral occurs only on serpentine soils throughout the county with a mix of plant species that are often endemic to soil type, such as leather oak (*Quercus durata*), Sargent cypress (*Cupressus sargentii*), foothill pine (*Pinus sabiniana*), and yerba santa (*Eriodictyon californicum*). Baker's manzanita (*Arctostaphylos bakeri*) — a state listed rare species — occurs in serpentine chaparral habitat in the Cedars area above Big Austin Creek.

Chaparral is a fire climax ecosystem; prior to extensive anthropogenic fire suppression, the fire frequency in chaparral was about every ten to twelve years. Typical chaparral fires are canopy fires — because the plants and litter are very dry and possess volatile oils, the entire ecosystem is very flammable. Many of the plants in chaparral possess serotinous seeds, which require the heat of fire to break dormancy, and most will resprout. Fires cleanse the soil by incinerating the leaf litter, which can harbor pathogens and contains waxy substances that inhibit water penetration. Much of the chaparral in the Russian River watershed has not experienced fire disturbance in almost a century.

Coastal Scrub

Figure 3.9: See "Coastal Scrub"
Coastal scrub habitat is composed of a dense overstory of evergreen shrubs to about two meters with an understory of smaller shrubs, herbs, and grasses. In the Russian River watershed, coastal scrub occurs on rocky slopes, gullies, and bluffs along the coast and extending inland. This vegetation type intergrades with coastal dunes, grasslands and forests, generally dominating when sites have poor soil, steep slopes, and/or wind exposure. Typical coastal scrub species include coyote brush (*Baccharis pilularis*), California coffeeberry (*Rhamnus californica*), wax myrtle (*Myrica californica*), salal (*Gaultheria shallon*), yellow bush lupine (*Lupinus arboreus*), live forever (*Dudleya farinosa*), and coast buckwheat (*Eriogonum latifolium*).

Coastal scrub and near shore marine

3.3.2 Exotics and Pathogens

The Russian River watershed contains a number of invasive plant species that interfere with both economic activities and ecologic functions.

Invasive Plants Species

A list of non-native plants that occur in the Russian River watershed and their invasive potential is provided in Appendix 3, Russian River Watershed Non-Native Plant Species. Of those plants, a relative few particularly threaten native ecosystem function and structure. These include: giant reed (*Arundo donax*), yellow starthistle (*Centaurea solstitialis*), jubata grass and pampas grass (*Cortaderia* sp.), Scotch broom, (*Cytisus scoparius*), cape-ivy (*Delairea odorata*), French broom (*Genista monspessulana*), *Tamarisk* species, *Vinca* species, water primrose (*Ludwigia* sp.), smooth cordgrass (*Spartina alterniflora*) dense-flowered cordgrass (*Spartina densiflora*), Spanish broom (*Spartium junceum*), pepperweed (*Lepidium latifolium*), and gorse (*Ulex europaeus*).

Cape ivy

Throughout the North Coast region, governmental and non-governmental agencies are collaborating to eradicate non-native plant populations where possible and stop their spread where eradication is not practicable. As part of a statewide effort to control agricultural and "wildland" weeds, the state legislature passed Assembly Bill 1168, establishing Weed Management Areas (WMAs, not to be confused with Water Management Areas), local organizations that provide a forum for stakeholders (private, city, county, state and federal) in an area to coordinate efforts and share expertise on local non-native invasive plant control (CDFA IPCB 2006). The WMAs also serve as a vehicle for obtaining funding for non-native invasive plant control and for establishing local priorities for weed eradication. In the North Coast, each county is a member of at least one WMA (CDFA 2008).

Himalayan blackberry

Water primrose

3.3.2.1 Sudden Oak Death (SOD)

The plant pathogen *Phytophthora ramorum* that causes Sudden Oak Death (SOD), which was identified in 2000, is an invasive organism that is causing extensive mortality in coast live oak (*Quercus agrifolia*), California black oak (*Quercus kelloggii*) and tanbark oak (*Lithocarpus densiflora*) populations throughout coastal California. The dieback was first observed in Marin and Santa Cruz counties in 1995, but has since

spread as far north as Humboldt County in California and as far south as Monterey County. Although it is most common in the species listed above, *P. ramorum* can also damage or lie dormant in other native plant species including California bay laurel (*Umbellularia californica*), Douglas-fir (*Psuedotsuga menziesii*), and coast redwood (*Sequoia sempervirens*). The pathogen also infects common ornamental plants such as rhododendrons and camellias.

Sonoma County has developed a plan for responding to the dangers of SOD, which include increased fire risk, hazards from falling trees, loss of wildlife food and habitat, and loss of soil stability as well as the aesthetic loss of heritage oak trees. Currently, the Sonoma County plan calls for hazardous tree removal and efforts to minimize the spread of the pathogen (UCCE et al. 2008). The California Oak Mortality Task Force offers SOD Preventative Treatment Training Sessions in which participants learn integrated pest management practices for managing SOD, how to select trees for and apply the preventative treatment.

3.3.3 Special-Status Plants

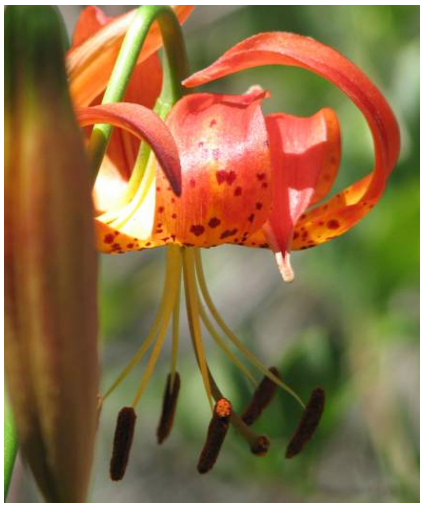
Numerous special-status (e.g. rare, endemic, threatened, and/or endangered) plant species are documented to occur throughout the Russian River watershed (listed in Appendix 4, Russian River Watershed Special Status Plant Species). Twenty-two species of plants in the watershed are included on state and/or federal protection lists (e.g. Federal Endangered Species Act, FESA; California Endangered Species Act, CESA). These are listed below with notes on their status and distribution. Some species descriptions are found in CDFG 2007a, USFWS 2007, and Best et al. 1996; currently, the best up-to-date information on the occurrence, status, and threats to these species is provided by the California Native Plant Society (CNPS) online Inventory of Rare and Endangered Plants.

Wetland Plants

Species: White Sedge (*Carex albida*)
Status: Endangered (FESA and CESA)
Note: Endemic to moist sites adjacent to freshwater marshes and creeks in Sonoma County.
Species: Pitkin Marsh Indian Paintbrush (*Castilleja uliginosa)*
Status: Endangered (FESA and CESA)
Note: May be extirpated; only one plant was known to exist in the wild in the late 1970s, at the privately owned Pitkin Marsh.

Pitkin Marsh

Species: Pitkin Marsh Lily (*Lilium pardalinum* Kellogg ssp. *pitkinense*)
Status: Endangered (FESA)
Note: Occurs in freshwater marshes and wet meadows in Sonoma County.



Leopard lily

Species: Kenwood Marsh Checker-Mallow (*Sidalcea oregana ssp. valida*)
Status: Endangered (FESA)
Note: Occurs in only two locations, both in Sonoma County (Kenwood Marsh and Knights Valley). Inhabits freshwater marshes within a matrix of grasslands in association with Himalayan blackberry (*Rubus discolor*), tule (*Scirpus acutus*), willow (*Salix* spp.), pennyroyal (*Mentha pulegium*) and sedges (*Carex* spp.).

Species: Sonoma Shortawn Foxtail (*Sonoma alopecurus)*
Status: Endangered (FESA)
Note: Perennial grass found in moist soils in freshwater marshes. It is declining due to loss of habitat, competition from non-native species, and mismanaged cattle grazing/ trampling (USFWS 2007).

Species: Sonoma Sunshine (*Blennosperma bakeri*), Burke's Goldfields (*Lasthenia burkei*), Sebastopol Meadowfoam (*Limnanthes vinculans*).
Status: Rare
Note: Three species found in association in the vernal pools, shallow depressions, and intermittent swales on the Santa Rosa Plain.
Species: Many-Flowered Navarretia (*Navarretia leucocephala*)
Status: Endangered (FESA and CESA)
Note: Only occurs in volcanic ash vernal pools and open wet ground in the eastern portion of the middle reach of the Russian River in Sonoma County, in only a few locations.

Species: North Coast Semaphore Grass (*Pleuropogon hooverianu*)
Status: Threatened (CESA)
Note: Inhabits moist sites amid forest habitat and at the margins of vernal pools.

Species: Two-fork Clover (*Trifolium amoenum*)
Status: Endangered (FESA)
Note: Annual legume has been associated with low, wet swales, grasslands, and grassy hills. The federal government reports this plant extirpated from its 24 historically known locations.

Chaparral and Serpentine Plants
Species: Baker's Manzanita (*Arctostaphylos bakeri*)
Status: Rare
Note: Occurs in the lower watershed, mainly on serpentine soils in chaparral vegetation.

Species: Vine Hill Manzanita (*Arctostaphylos densiflora*)
Status: Endangered (CESA)
Note: The only known population occurs on the California Native Plant Society's (CNPS) one-acre Vine Hill Preserve's "Sonoma Barren," an area of acid marine sand deposits in the lower Russian River watershed western in Sonoma County.

Species: The Cedars Manzanita (*Arctostaphylos bakeri ssp. sublaevis*)
Status: Rare
Note: Occurs on serpentine soil on the divide above Big Austin Cree in an area known as The Cedars

Species: Vine Hill Clarkia (*Clarkia umbricata*)
Status: Endangered (FESA and CESA)
Note: Annual herb occurs in chaparral with sandy loam soils only in the Vine Hill area in the lower Russian River. A transplanted population of Vine Hill clarkia has been established on the CNPS Vine Hill Preserve.

Species: Pennell's Bird's-Beak (*Cordylanthus tenuis ssp. capillaris*)
Status: Endangered (FESA and CESA)
Note: Annual herb occurs in open sites within serpentine chaparral, found in association with Baker's manzanita.

Species: Geyser's Dichanthelium (*Dichanthelium lanuginosum*)
Status: Endangered (CESA)
Note: Perennial grass found only in the Big Sulfur Creek drainage of the middle Russian River watershed. Usually occurs in closed-cone pine forest, but only grows where the acid soil is moist and warm due to proximity to near surface active geothermal sites (CDFG 2007, Calflora 2007).

Cedar's Globe Lily (courtesy of Sonoma Land Trust)

Woodland, Grassland, and Coastal Plants
Species: Clara Hunt's Milk-Vetch (*Astragalus clarianus*)
Status: Endangered (FESA and CESA)
Note: Annual legume that inhabits rocky clay soils in openings within blue oak woodland and grassland.

Species: Tidestrom's Lupine (*Lupinus tidestromii*),
Status: Endangered (FESA and CESA)
Note: Low-growing perennial herb that occurs on coastal dunes and bluffs, including documented sites on the south side of the mouth of the Russian River.

3.3.4 Wildlife Diversity

3.3.4.1 Historical Records

Historically, a wide variety of wildlife species inhabited the Russian River watershed; many still do. In fact, the Mendocino-Sonoma County region today is a well-known native biodiversity hotspot. Reliable records are spotty, but it is likely that the diversity of species and the size of their ranges were significantly higher. Much of the biodiversity observed in the region is due to the landscape's heterogeneity (i.e. the mosaic of adjacent habitat types available for wildlife). The widespread conversion of California's natural areas and large-scale resource extraction, beginning in the 19th century, often has come at the expense of high quality wildlife habitats. In many cases, once-viable habitats have been fragmented into smaller and more isolated islands less suitable for sustaining wildlife populations (e.g. large mammals, woodland and riparian birds). In other cases, species have been targeted more directly (e.g. control of predators, overfishing of wild stocks, extirpation of beavers).While native salmonids, amphibians, reptiles, birds, and mammals have seen declines throughout the watershed, some other taxa have thrived. Unfortunately, they are the introduced invasive species that prey upon, outcompete, and spread diseases to wild populations: rats, cats, dogs, and feral pigs are among the non-native "wildlife" species that threaten local wildlife.

The familiar story of Russian River salmonids, which were once more diverse and plentiful, exemplifies the constriction of historic wildlife ranges. Endangered coho, and threatened Chinook and steelhead population declines have been apparent for decades: since 1940, these species numbers have dropped 80 percent, 65 percent, and 64 percent, respectively (Citizen's Advisory Committee on Salmon and Steelhead Trout and the California Department of Fish and Game Staff Working Committee 1971 in: CDFG 1998). The historic regional trend is apparent today in the Russian River watershed: in 2007, the Russian River experienced the smallest run of chinook salmon in the eight years the population had been monitored (Norberg 2007). Subsequent listing by federal and state governments of Coho (endangered), Chinook (threatened), and steelhead (threatened) have focused attention on improving the habitat conditions that limit salmonid survival. See Section 5 for an indicator-based condition assessment of salmonids and their habitats (based on NMFS 2010), and Section 6.1 for description of likely sources of the decline.

The extirpation of some species (e.g. pink salmon), the artificial stocking of others (i.e. the "native" status of Chinook salmon in the river is contested), and the wholesale decline of all three have been driven by the loss and degradation of critical habitat, including upstream spawning sites in the Russian River's cold-water tributaries. Historically, nearly all streams in the watershed were suitable for spawning and rearing. For example, before the construction of Warm Springs Dam, thousands of steelhead, coho salmon, and other anadromous species migrated across Dry Creek; the dam now blocks the upstream migration of these runs. The Congressman Don Clausen Fish Hatchery at Warm Springs and the Bill Townsend Conservation Fish Hatchery at Coyote Valley werebuilt to help mitigate dam-related habitat impact. Each year, hundreds of thousands of hatchery-raised steelhead trout (threatened) and salmon (endangered coho and threatened Chinook) are released by the CDFG into the Russian River to supplement wild populations. It is unclear what the effect of these stocking activities will be.

As described above, a diverse range of wildlife taxa range throughout the Russian River watershed: invertebrate, amphibian, reptile, bird, and mammal populations in the region remain among

California's most diverse, despite continuing alteration and loss of habitats and, for some species, relatively severe population declines. In part, these changes in wildlife populations are represented by the changes to their habitats, which are shown in Figure 3.9, Vegetation Classification. The CDFG Wildlife Habitat Relationships database has data for the Russian River watershed that predict the occurrence of various wildlife species based on the presence and distribution of their associated habitats/plant communities (http://www.dfg.ca.gov/biogeodata/cwhr/).

3.3.4.2 Recent Data and Classification

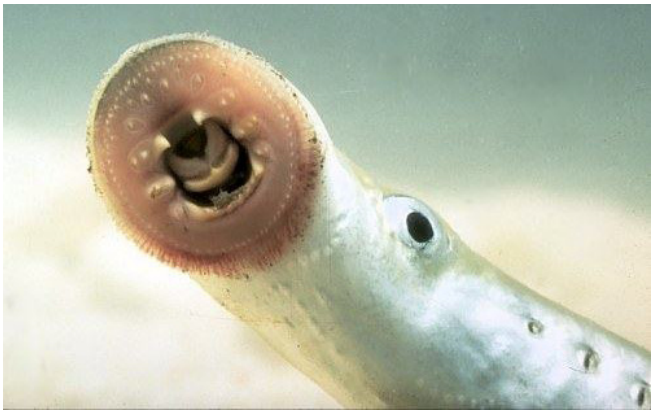
The Russian River watershed, with its mild climate and diverse landscape provides habitat for many species of wildlife. The California Department of Fish and Game Wildlife and California Interagency Wildlife Task Group Habitat Relationships Database (WHR) (2005) predict that 391 species spend at least a portion of their life cycle in the major habitat types in the watershed. This diversity is due in part to the landscape heterogeneity within the watershed — plant communities form a mosaic in response to slope, soil, aspect, elevation, disturbance regime, and distance from the coast — which provides a variety of habitats in close proximity, allowing wildlife to meet shelter, forage and reproductive requirements by utilizing multiple habitat types.

Aquatic Wildlife

Russian River waterways provide habitat for many species of aquatic wildlife (Appendix 5, Aquatic Wildlife Documented in the Russian River Watershed). In addition to three species of protected salmonids and one species of protected crustacean (*Syncaris pacifica*), many other native and non-native species inhabit the wide variety of aquatic habitats in the watershed.

Steelhead trout

The 2002 Draft Russian River Basin Fisheries Restoration Plan provides an excellent description of finfish species within the Russian River watershed (CDFG 2002). Anadromous fish such as salmon hatch and develop in fresh water and then migrate into the ocean for one to several years before returning to their natal streams to spawn. Suitable salmonid spawning habitat consists of loosely compacted gravel in cool water that contains enough dissolved oxygen and intergravel flow to provide oxygen to eggs. Fertilized eggs hatch in about 50 to 60 days and the young, known as alevin, remain in the gravel for several weeks, emerging as fry when the egg yolk sac that they hatch with is almost absorbed. Juveniles remain within freshwater habitat for a few months to several years prior to ocean outmigration. The brackish estuarine habitat is important for rearing purposes of marine and anadromous species such as flatfish, salmonids, and sturgeon. Freshwater environments in the mainstem river and tributaries contain a relatively short list of native fishes compared to several species of non-natives (Appendix 5, Aquatic Wildlife Documented in the Russian River Watershed).



Lamprey

Most native invertebrate species of crawfish, shellfish, and snails in the Russian River watershed have not been as extensively studied or have received such high profile media coverage as native salmonids. The California freshwater shrimp (*Syncaris pacifica*) is a small, native crustacean found in the Santa Rosa Plain that has been the focus of several scientific studies and media reports primarily due to the federal protections associated with that species' remaining habitats. Benthic macroinvertebrates are a group of aquatic animals that also do not receive much public exposure, but do serve an important role in describing the quality of aquatic habitats. Macroinvertebrate

sampling for bio-assessments is a commonly used protocol to describe the biodiversity and water quality of water bodies throughout the world. In general, native aquatic animals within the Russian River watershed have declined in their range and abundance due to impacts from habitat alteration and introduction of non-native species, and widespread efforts are underway throughout the basin to reverse this negative trend.

Herpetofauna

Twenty species of amphibians are predicted to occur within the Russian River watershed including California tiger salamander (*Ambystoma californiense*) and California red-legged frog (*Rana draytonii*), are federally listed species which occurs in Sonoma County (see Appendix 6, Herpetofauna Predicted to Occur in the Russian River Watershed). Foothill yellow-legged frogs inhabit streams with gravel or sandy bottoms and open sunny banks while tailed frogs occur in cold water perennial streams in steep walled valleys with dense canopy cover (CDFG and California Interagency Wildlife Task Group 2005). California slender salamanders (*Batrachoseps attenuatus*) inhabit grasslands with scattered trees such as those in the Willow Creek marsh area while Pacific tree frogs (*Pseudacris regilla*) utilize chaparral and grassland habitats (Goodwin et al 1993). Other amphibians which occur in the watershed include the California giant salamander (*Dicamptodon ensatus*), western toad (*Anaxyrus boreas*), red-bellied newt (*Taricha rivularis*), California newt (*Taricha torosa*), rough-skinned newt (*T. granulosa*), ensatina salamander (*Ensatina eschscholtzii*), and the introduced American bullfrog (*Rana catesbeiana*), which preys upon and competes with other species of amphibians.

California tiger salamander

California red legged frog

According to the WHR (CDFG and California Interagency Wildlife Task Force 2005), twenty-one species of reptiles are predicted to occur within the Russia n River watershed (see Appendix 6, Herpetofauna Predicted to Occur in the Russian River Watershed). The common garter snake (*Thamnophis sirtalis*) forages on land or in still waters in a variety of habitats and can be found throughout the watershed while the less abundant night snake (*Hypsiglena torguata nuchalata*) occurs in rocky outcrops in arid habitat. Rubber boas occur in montane forest habitats in the vicinity of streams or wet meadows. The western pond (*Actinemys marmorata*), a state Species of Special Concern, is associated with permanent or nearly permanent ponds, lakes, streams or pools. Several species of lizards inhabit the watershed, including the ubiquitous western fence lizard, sagebrush lizard, and both northern and southern alligator lizards. Other reptiles that inhabit the Russian River watershed include striped racer, long-nosed snake, gopher snake, ring-necked snake, and the western rattlesnake.

Western pond turtle

Birds

The WHR predicts that 270 species of birds inhabit the watershed during at least part of the year (CDFG and California Interagency Wildlife Task Force 2005). Waterbirds, shorebirds, raptors, passerines, and other land birds representing 51 families are predicted to occur (see Appendix 7, Birds Predicted to Occur in the Russian River Watershed). Many birds are year-round residents, utilizing specific habitats within the watershed. For example, hairy woodpeckers are permanent residents of mixed conifer and riparian forests. Other birds are present in the watershed only part of the year. The Laguna de Santa Rosa and riparian forests throughout the watershed serve as an important stopover for the Pacific Flyway, the annual migratory route of thousands of birds.

Black crowned night heron

Mammals

Eighty mammals are predicted to occur within the Russian River watershed (CDFG and California Interagency Wildlife Task Force 2005) and are listed in Appendix 8, Mammals Predicted to Occur in the Russian River Watershed. These include over thirty species of rodents, several species of bats, and several carnivores. Many of these mammals are generalists and occur throughout the watershed while others are restricted to specific habitat types. Still others occur within a specific area — for example, the fog shrew can be found in diverse habitats from forests to meadow to freshwater emergent marshes, but only within the coastal zone. Other mammals that inhabit the watershed include the bobcat, northern river otter, mule deer, common porcupine, western spotted and striped skunk, and the seldom seen mountain lion.

River otter

mountain lion cub

mountain lion adult

3.3.5 Exotic/ Invasive Animals

The Russian River watershed is home to many invasive non-native animal species, both aquatic and terrestrial. When successful, these organisms pose a threat to ecosystem structure and function; without their native predators, populations of some of these generalist species — such as American bullfrogs (*Rana catesbeiana*) — can grow relatively unchecked, threatening the survival of native populations indirectly, through competition, or directly, by predation. Introduced species can also transfer parasites or diseases for which the native populations have no immunity or cause physical or chemical changes to habitat that make it less suitable for natives. The zebra mussel (*Dreissena polymorpha*) releases toxins that affect other aquatic species; its presence has not been confirmed north of the San Justo Reservoir in San Benito County. Another bivalve, the Quagga mussel (*Dreissena bugensis*), is of serious threat to Lake Mendocino. The New Zealand Mudsnail (*Potamopyrgus antipodarum*) has been confirmed to the east in the Sacramento Headwaters HUC in Lake Shasta, and southeast in the San Pablo Bay HUC. The Russian River watershed currently provides habitat for many non-native invasive fish, including many east coast species, such as bluegill (*Lepomis macrochirus*) and Eastern brook trout (*Salvelinus fontinalis*). In the Russian River, 43% of fish species found in the river (see Appendix 5, Aquatic Wildlife Documented in the Russian River Watershed) during two surveys in the early and mid-1990s were not native to the Russian River watershed. These results indicate a change in fish species composition away from cold water and toward warm water species, such as the Sacramento pikeminnow (*Ptychocheilus grandis*), a native species that competes with and preys upon other fish including juvenile salmonids. Non-native warm water species also impact salmonids through competition and predation; this trend is likely to continue as long as increased summer flows associated with the Coyote and Warm Springs dams continue (SEC 1996).

There are many established species of non-native mammals in California. Of these, there are several that occur as pests within the Russian River watershed (see Table 3.9). Virginia opossum (*Didelphis virginiana*) is ubiquitous in coastal north coast forests, and red fox occurs (*Vulpes vulpes*) throughout the region. In the absence of coyotes (*Canis latrans*) as top predators, the red fox poses a serious threat to ground-nesting birds (CDFG Undated). Some areas in the region have problems with feral cats; feral cat colonies generally occur near human population centers where they are fed supplemental food by well-intentioned community members (Ogan and Jurek 1997). Cats can out-compete their native counterparts due to the supplemental food and also transmit diseases to wild animals and humans. As predators, they severely impact birds, amphibians, and reptiles. There are 21 infectious diseases associated with domestic cats that can be transmitted to humans (Roberto 1995). Although usually not fed by humans, feral dogs can pose similar serious threats to both human and wildlife populations. Rats (genus) and house mice (genus species) are common near any population center. Feral pigs pose a serious threat to native ecosystems as well as generating a large economic impact. Rooting and wallowing by pigs has been associated with restricted timber growth, agricultural losses, wildlife losses, the loss of understory vegetation, destabilized soils, erosion, and compaction. The disturbances created by pigs' wallowing and rooting activities provide excellent habitat for weedy species, many of which are invasive. Additionally, feral pigs can consume almost all available oak mast (Coblentz and Bouska undated) with potentially extreme impacts on oak populations already in peril from Sudden Oak Death (SOD; discussed above).

TABLE 3.9. NON-NATIVE INVASIVE MAMMALS OF THE NORTH COAST

COMMON NAME	SCIENTIFIC NAME	CDFG PROVISIONS
Virginia opossum	*Didelphis virginiana*	nongame, not protected
Black rat	*Rattus rattus*	not regulated
Norway rat	*Rattus norvegicus*	not regulated
House mouse	*Mus musculus*	not regulated
House cat	*Felis catus*	not regulated, except as nongame on State F&G refuges
Red fox	*Vulpes vulpes*	nongame, not protected
Domestic dog	*Canis familiaris*	not regulated, except as nongame on State F&G refuges
Feral pig	*Sus scrofa*	Game; season open all year; no bag limit

Sources: California Department of Fish and Game. 2008.

3.3.6 Special-Status Wildlife

The Russian River watershed is home to 25 species of special-status wildlife and species (e.g. endangered, threatened, or of special concern). The watershed contains six species of fish, a crustacean, four species of herpetofauna, eight species of birds, and six species of mammals considered special-status (e.g. Federal ESA, California ESA, and/or state "Species of Special Concern")(see Appendix 4, Listed Animal and Plant Species in the Russian River Watershed).

Aquatic Species

Species: Coho Salmon (*O. kisutch*)
Status: Endangered (FESA and CESA)
Note: Coho usually return to the river between November and January as two year olds and die after spawning. They generally spawn in the tributaries of the lower mainstem and the young spend a year in freshwater prior to outmigration.

Species: Chinook Salmon (*Oncorhynchus tshawytscha*)
Status: Threatened (FESA)
Note: In the Russian River, Chinook usually return between August and January as two to four year old adults. They primarily spawn in the mainstem and Dry Creek and die after spawning. Juvenile Chinook begin to outmigrate as fry, almost immediately after emerging from the gravel. Recent monitoring at fish ladders near Forestville have revealed a population of Chinook in the Russian River, now recognized as having the North Coast's most significant run of wild Chinook (Norberg 2007). There is uncertainty, however, regarding whether the population is "natural" or the result of stocking activities conducted sporadically since 1881 (SCWA 2006a).

Chinook salmon spawning — Alexander Valley

Species: Steelhead "Trout" (*O. mykiss*)
Status: Threatened (FESA)
Note: Steelheads usually return to the Russian River during December through April and spawn high in the tributaries with some adults surviving and returning to the ocean as many as five times. Juveniles rear in freshwater from one to four years; preferred habitat contains cool water with abundant cover. Steelhead outmigration usually occurs in early spring (Steiner Environmental Consulting 1996).

Species: Pink Salmon (*O. gorbuscha*)
Status: Unknown but likely functionally extinct within the basin
Note: Last spawning was documented in 1955, although individual fish are occasionally reported; Steiner Environmental Consulting 1996.

Species: Green Sturgeon (*Acipenser medirostris*)
Status: Endangered (FESA)
Note: Suitable habitat may exist in the Russian River estuary but a spawning population is not documented to exist anywhere within the Russian River basin. The species is thought to spend most of its life in nearshore ocean waters, bays, and estuaries and occasionally the fish do make non-spawning movements into coastal estuaries during the late summer and fall (USFWS undated).

Species: Navarro Roach (*Lavinia symmetricus navarroensis*)
Status: State Species of Special Concern
Note: Usually found in small, warm intermittent streams and isolated pools. This fish is considered abundant in the Russian River with population monitoring recommended (CDFG 2007a).

Species: Russian River Tule Perch (*Hysterocarpus traskii pomo*),
Status: State Species of Special Concern
Note: Specifically adapted to the variable flow regime of the Russian River system (Baltz and Moyle 1982, in USFWS 2000). This fish requires deep pool habitat, clear, flowing water, and abundant cover.

Species: California Freshwater Shrimp (*Syncaris pacifica*)
Status: Endangered (FESA and CESA)
Note: Inhabits low gradient tributary streams in the lower Russian River. Preferred habitat is 1 to 3 feet deep streams bordered by overhanging vegetation or exposed root systems (USFWS 2007b).

Herpetofauna

Species: California Tiger Salamander (*Ambystoma californiense*); Sonoma County population
Status: Endangered (FESA)
Note: California endemic with the Sonoma County population apparently geographically isolated from the rest of the population for more than 700,000 years (USFWS 2007c). Restricted to grassland and foothill regions with preference for ephemeral pools, such as

those which occur on the Santa Rosa Plain (This is one of several species targeted for protection in the Santa Rosa Plain Conservation Strategy, discussed above).

Species: California Red-Legged Frog (*Rana draytonii*)
Status: Threatened (FESA) and State Species of Special Concern
Note: Associated with shrubby or emergent riparian vegetation and deep, still or slow moving water.

Species: Western Pond Turtle (*Actinemys marmorata* or *Emys marmorata)*
Status: State Species of Special Concern
Note: Associated with more-or-less permanent surface water sources (e.g. ponds and lake margins).
Species: Yellow-Legged Frog (*Rana muscosa*)
Status: State Species of Special Concern
Note: Prefer shallow, flowing water in smaller streams with at least some cobble-sized substrate.

Birds

Species: Marbled Murrelet (*Brachyramphus marmoratus*)
Status: Endangered (FESA)
Note: Associated with mature coniferous forest, the species nests high in old growth trees with horizontal limbs

Species: Northern Spotted Owl (*Strix occidentalis caurina*)
Status: Endangered (FESA)
Note: Utilize the multi-species, multi-story canopy typical of old growth coniferous forest and may occur in the remote northwestern part of the watershed.

Species: Northern Goshawk (*Accipter gentilis*
Status: State Species of Special Concern
Note: Associated with large patches of mature old-growth forests with large trees, high canopy cover, and an open understory (CDFG 2005).

Species: Burrowing Owl (*Athene cunicularia*)
Status: State Species of Special Concern
Note: Occupies open dry grasslands and range lands in the Russian River watershed.

Species: Yellow Warbler (*Dendroica petechia*)
Status: State Species of Special Concern
Note: Inhabit riparian areas in the watershed and vulnerable to brown-headed cowbird parasitism (CDFG 2007a).

Species: Yellow-Breasted Chat (*Icteria virens*)
Status: State Species of Special Concern
Note: Inhabit riparian areas in the watershed and vulnerable to brown-headed cowbird parasitism (CDFG 2007a).

Species: Tri-Colored Blackbird (*Agelaius tricolor*)
Status: State Species of Special Concern
Note: Prefer sites near water with abundant emergent vegetation, mainly cattail (*Typha* ssp.) and tule (*Scirpus* ssp.); increasingly turning to agricultural fields for nesting, foraging, and shelter (Beedy and Hamilton 1997).

Species: Osprey (*Pandion haliaetus*)
Status: State Species of Special Concern
Note: Occurs throughout the watershed near open bodies of water with safe nest sites, usually in mixed conifer habitats. Nests are constructed on structures capable of supporting them, which include snags, buoys, power poles and nest platforms (California Interagency Wildlife Task Group 2005).

Mammals

Species: Townsend's Big-eared Bat (*Corynorhinus townsendii*)
Status: State Species of Special Concern
Note: Inhabit forests and woodlands, with a preference for mesic (moist) areas and require caves, mines, tunnels, or buildings for roosting. Roosting colonies are very sensitive to human disturbance and maternity colonies are even more so; a single visit by humans can cause all the bats to abandon the site (CDFG 2007a, CDFG and California Interagency Wildlife Task 2005).

Species: Pallid Bat (*Antrozous pallidus*)
Status: State Species of Special Concern
Note: Inhabit grasslands, shrublands, woodlands, and mixed conifer forests with a preference for rocky outcrops, cliffs and crevices above open habitats. Commonly roosts in rock crevices, caves, and tunnels and occasionally hollow trees or buildings.

Species: Hoary Bat (*Lasiurus cinereus*)
Status: State Species of Special Concern
Note: Solitary bat that utilizes woodlands and forest with medium to large trees and dense understory. Roosts within medium to large trees with thick foliage, but prefers to forage in open habitats (CDFG and California Interagency Wildlife Task Group 2005).

Species: Red Tree Vole (*Arborimus longicaudus*)
Status: State Species of Special Concern
Note: Found in coastal coniferous forest habitats, living, nesting, and feeding in the forest

canopy. While males are partly terrestrial, females are rarely found on the ground.

Species: Pacific Fisher (*Martes pennanti*)
Status: State Species of Special Concern and proposed candidate for federal listing, although listing was formally rejected in 2010.
Note: Inhabit coniferous and deciduous riparian forests with medium to large sized trees and at least 50 percent canopy cover. They are mainly carnivorous, hunting prey on the ground and in trees.

Species: American Badger (*Taxidea taxus*)
Status: State Species of Special Concern
Note: Occur in lower and upper Russian River watershed (CDFG 2007b) and utilize a diversity of habitats as long as soil is friable, prey species are present, and the ground is relatively open and uncultivated.

3.3.7 Sensitive and Protected Habitats

The vegetation and wildlife described in the previous sections occupy a suite of habitats that comprise the mosaic landscape of the Russian River watershed. Some species (i.e. all those listed above) occupying these habitats are endemic, rare, threatened, endangered, or otherwise of special concern. In addition to supporting native biodiversity, certain habitats are recognized by the state as supporting the maximum range of beneficial uses of water (SWRCB 2010; see Section 5.4.2 for more about beneficial uses of water). Beneficial uses of water in the Russian River Hydrologic Unit/ watershed are assigned to specific waterbodies: minor coastal streams; ocean waters; bay; freshwater wetlands; saline wetlands; and estuary. The sensitive and protected habitats categories below integrate all these different priority aquatic habitat types, plus some critical terrestrial habitats, too.

3.3.7.1 Instream Habitat

Freshwater instream habitat includes the aquatic and geologic components of the streams in the Russian River watershed, plus submerged vegetation and the stream water. The instream habitats of the watershed are inextricably linked to the riparian forest (below) that lines them. Stream banks, stream bottom, substrate, large woody debris, pools, riffles, runs, and other elements are all dynamic and variable components of instream habitat. Most aquatic organisms prefer or require instream habitat of sufficient complexity to support ecosystem function and population viability. In addition to geomorphology, water quality characteristics (e.g. temperature, turbidity, pH, salinity, and composition of the flow) will influence the assemblage of plant and wildlife species and alliances occupying instream habitat. All these variables defining instream habitat influence the viability of aquatic ecosystems and species (e.g. coho salmon; NMFS 2010 and Section 6.1 herein).

3.3.7.2 Lacustrine Habitat

Lacustrine habitats in the Russian River watershed consist of the myriad open bodies of standing water including small ponds to large reservoirs, such as Lakes Mendocino and Sonoma. Depth can vary from a few centimeters (vernal pools) to many meters (reservoirs) and they may be intermittently dry or wet all year. While many of these habitats were developed for use by humans (e.g. for agriculture and recreation), they also constitute important habitat, exhibiting many biological features and supporting natural ecosystems and processes. Phytoplankton is the dominant suspended organisms within ponds, lakes, and reservoirs, and provides the base of the aquatic food chain. A wide variety of native and exotic aquatic plants exist in these settings, including duckweed (*Lemna valdiviana*), common cattail (*Typha latifolia*), tule (*Scirpus californicus*), and other emergent vegetation that occurs along the margins of this habitat.

3.3.7.3 Riparian and Wetlands

Wetlands, including fresh- and salt-water marsh and riparian habitat, occur throughout the Russian River watershed. Riparian forests and the streams they bound together comprise the riparian zone and ecosystem. As previously described, streamside forests are part of very dynamic riparian systems that have evolved with periodic disturbance (flooding). These ecosystems serve as transitional areas between aquatic and upland

terrestrial habitat and provide valuable wildlife habitat. In California, about 50% of reptile species and 75% of amphibian species depend upon riparian habitat. It also provides necessary shelter and forage opportunities for both resident and migratory birds (CRP 1994), and is critical to the life cycle of aquatic organisms.

Protection of riparian zones is now required in the California Forest Practice Rules (2005) for forest management activities and most counties and municipalities in the Russian River watershed contain goals and policies to promote riparian forest protection. Although formerly unregulated, riparian habitat is currently protected through municipal and county ordinances in Sonoma County and protections are identified in the Mendocino County General Plan. Such protection seeks to balance "the need for agricultural production, urban development, timber and mining operations, flood control and other land uses with the preservation of riparian vegetation, water resources and habitat functions and values (Sonoma County Permit & Resource Management Department 2007)."

Wetlands removed from the riparian system occur amid various habitat types/ vegetation associations in the Russian River watershed. The freshwater Laguna de Santa Rosa is the largest of these. The Laguna has been prioritized for preservation and restoration by local, state, and federal agencies. It is an abundant wildlife area and is one of few remaining locations where vernal pool ecosystems occur. Vernal pools are found throughout the Laguna de Santa Rosa, but are sparsely distributed in the rest of the basin. Additionally, the Laguna is home to several species of endangered and threatened species and is the only known habitat for the Sonoma County population of the California tiger salamander. In recognition of the importance of the Laguna as habitat for these organisms, a team of local, state, and federal agencies and stakeholders developed the Santa Rosa Plain Conservation Strategy[3]. The Conservation Strategy creates a long-term program to mitigate potential adverse effects on listed wetland-associated species from future development on the Santa Rosa Plain.

3.3.7.4 Estuary/Lagoon

The Russian River Estuary is a seven-mile segment between Duncan Mills and the Pacific Ocean. The mouth of the estuary is defined as a line connecting the following points: 38° 27.16Ð North latitude 123° 07.91Ð West longitude and 38° 27.01Ð North latitude 123° 07.74Ð West longitude. At the estuary mouth, a coastal lagoon forms when the enclosing sandbar breaches. Tidally influenced and functionally connected to the marine environment, the estuary is part of a new California Marine Protected Area (MPA; see 3.3.7.6). A sandbar forms across the mouth of the Russian River estuary during late summer and fall when flows are low and ocean currents cause a buildup of sand in the mouth, however it occasionally forms during winter and spring. During this time, the estuary is technically a lagoon (the two have distinct ecosystem characteristics). This barrier causes pooling of the river behind the sandbar, increased water level, and salinity stratification (California Resources Agency 2007). In order to protect low-lying properties in the town of Jenner, the barrier is artificially breached by the Sonoma County Water Agency when water level exceeds 4.5 feet (Martini-Lamb 2001). When the river mouth is open, tidal conditions in the estuary can extend to 7.3 miles upriver (California Resources Agency 2007).

Russian River estuary at Jenner

Willow Creek drains into the Russian River about 2.3 miles upstream of the mouth. It can be considered a part of the estuary since it contains a well-developed tidal marsh at its mouth. High flows on the Russian River cause water to back up in the channel and floodplain of Willow Creek, causing sediment deposition to occur as the floodwaters in the Willow Creek watershed encounter the standing backwater from the Russian River. This deposition occurs at the upstream edge of the backwater and the majority of the sediment remains where it was deposited,

3 City of Santa Rosa (2005) available at http://ci.santa-rosa.ca.us/departments/communitydev/boards/SR_Plain_Conservation/Pages/default.aspx

requiring subsequent flows to transport it out of the watershed (Prunuske Chatham, Inc. 2005).

The Russian River estuary/ lagoon hosts large breeding colonies of sea birds (e.g. double-crested cormorant ((*Phalacrocorax auritus*)), Brandt's cormorant (*Phalacrocorax penicillatus*), pelagic cormorant (*Phalacrocorax pelagicus*), Western gull (*Larus occidentalis*), and pigeon guillemot (*Cepphus columba*) (NCCOS 2003) breed there. Marbled murrelets (*Brachyramphus marmoratus*), which are endangered, roost in colonies to the north and south of the river mouth. The estuary supports at least twenty-four fish species, eight crab species, and five shrimp species (CDFG 2007). Anadramous fishes (e.g. salmonids and Pacific lamprey *Lampetra tridentata*) must migrate through the estuary to complete their life cycle. Both adult and juvenile fishes use the brackish estuary as a staging area for physiological adjustments during outmigration.

3.3.7.5 Near Shore and Coastal Habitat

For planning purposes, and because they are functionally linked, the boundary of the Russian River watershed shall also include the coastal and nearshore habitats just outside the estuary/lagoon. On May 1, 2010, a new marine protected area (MPA) network went into effect in California's North Central Coast. Included in this new MPA are two in the Russian River watershed: (1) Russian River State Marine Conservation Area (SMCA), which the river enters at Jenner; and (2) Russian River State Marine Recreational Management Area (SMRMA) (see Figure 3.8 Open Space and Protected Areas). The SMRMA includes the waters of the river below the mean high tide line eastward of the mouth of the Russian River estuary and west of the Highway 1 Bridge (CDFG 2010a). In the 0.35 square mile Russian River SMRMA, take of all living marine resources is prohibited except for recreational hunting of waterfowl in accordance with existing hunting regulations. In the 0.86 square mile Russian River State MCA, take of all living marine resources is prohibited except recreational and commercial take of Dungeness crab by trap and recreational take of surf smelt using hand-held dip nets or beach nets (CDFG 2010b).

Rocky intertidal

Critical Coastal Areas are not designated for the Russian River watershed; however, three are located to the south in the Bodega HU. In addition, the SWRCB designates and protects ocean areas that host an unusual diversity of aquatic life as State Water Quality Protection Areas (SWQPAs) or, formerly, Areas of Special Biological Significance (ASBS). Nearby SWQPAs are found to the south at the Bodega and Bird Rock and to the north at Gerstle Cove.

Near shore marine habitat

3.3.7.6 Coastal Prairie

Coastal prairie, or northern coastal grassland, is a habitat type characteristic of much of the upland coast and bluffs in Russian River watershed. Dominated by perennial grasses, these habitats feature variable shrub and tree components, depending on local disturbance conditions (e.g. fire, grazing, wind, salt spray). Coastal prairie supports extremely high species diversity (Stromberg et al. 2002) but is also utilized for livestock grazing,

since many of the constituent plant species remain green and palatable essentially year-round.

3.3.7.7 Serpentine Soils

Serpentine grasslands and chaparral occur on soils derived from rock that is composed of a mixture of serpentine minerals. These soils usually contain high concentrations of nickel, chromium, and magnesium and low concentrations of nutrients important to plant growth — nitrogen, phosphorus, potassium, and calcium (California Academy of Sciences 2005). Plants that grow in serpentine soil have adapted to the harsh conditions on serpentine — low nutrient concentrations, high concentrations of heavy metals, limited water availability, and exposure to high light. As a result, they tend to be stunted and exhibit features characteristic of xeric species: thick leathery or hairy leaves, silver hairs, prostrate forms, or other high light — low moisture adaptations. In the Russian River watershed, both serpentine grasslands and serpentine chaparral occur. Serpentine chaparral can be found in The Cedars area above Austin Creek and in select areas of Mendocino County.

3.4 CULTURAL RESOURCES

Within the boundaries of the Russian River watershed are numerous resources of architectural, historical, archeological, and cultural significance. These sites are described in this section and Appendix 9 list the designated cultural resources in the Russian River watershed.

California Register of Historical Resources

There are two types of designated cultural resources on the state's *California Register of Historical Resources*: California Historical Landmarks and California Points of Historical Interest. California Points of Historical Interest are sites, buildings, features, or events that are of local (city or county) significance and have anthropological, cultural, military, political, architectural, economic, scientific/ technical, religious, experimental, or other value. California Historical Landmarks are buildings, structures, sites, or places in California with statewide historical significance that meet certain criteria.

National Register of Historic Places

Authorized under the National Historic Preservation Act of 1966, the National Register is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect historic and archeological resources. Sites listed in the National Register are automatically included in the California Register. Appendix 9, Russian River Watershed Designated Cultural Resources lists 47 sites designated in the California Register of Historical Resources (i.e. Historical Landmarks and California Points of Historical Interest) and National Register of Historic Places that occur in the Russian River watershed (40 are in Sonoma County, seven are in Mendocino County). These sites may be subject to environmental review under CEQA.

Hop Kiln Winery Historic Landmark

3.5 DEMOGRAPHICS AND SOCIOECONOMICS

The most accurate way to provide watershed-specific demographic and socioeconomic information about "human resources" is GIS analysis using United States Census Bureau data available at publication. Tables below include total population and population density; age groups; income ranges; employment types and percentages (e.g. for agricultural, natural resources, construction, manufacturing, trade, transportation and utilities; financial, professional and business services information; education and health services; leisure and hospitality; and government); education; and housing (single family, multiple family, mobile homes, and vacancy) information. The summary tables make evident some of the distinctions between Mendocino and Sonoma Counties (i.e. Sonoma County generally has experienced positive population growth, higher population density, and greater income than Mendocino County) and the watershed relative to the rest of California.

3.5.1 Population Census

Some demographic characteristics of the two counties that comprise the Russian River watershed are summarized in Table 3.10.

TABLE 3.10: SAMPLING OF POPULATION CENSUS DATA FOR RUSSIAN RIVER WATERSHED COUNTIES			
	MENDOCINO COUNTY	SONOMA COUNTY	CALIFORNIA
Population (2010)	87,841	483,878	37,253,956
% Population change (2000-2010)	1.8%	5.5%	10.0%
Persons per square mile (2010)	25.1	307.1	239.1
% Age under 18 years old (2010)	22.2%	22.0%	25.0%
% Age 65 years and older (2010)	15.4%	13.9%	11.4%
Housing Units (2010)	40,323	204,572	13,680,081
Persons per household (2010)	2.49	2.52	2.89
(Source: U.S. Census Bureau, State & County Quick Facts, accessed 2012)			

3.5.2 Economic Census

Some economic data for the Russian River watershed are summarized in Table 3.11 and trends are described in Section 3.5.3.

TABLE 3.11. SAMPLING OF ECONOMIC CENSUS DATA FOR RUSSIAN RIVER WATERSHED COUNTIES			
	MENDOCINO COUNTY	SONOMA COUNTY	CALIFORNIA
Median household income (2006-2010)	$43,759	$63,274	$60,883
Per capita income (2010)	$23,357	$32,597	$29,188
% Persons below poverty level (2006-2010)	17.1%	10.3%	13.7%
Median value of owner-occupied housing units (2006-2010)	$410,600	$524,400	$458,500
(Source: U.S. Census Bureau, State & County Quick Facts, accessed 2012)			

3.5.3 Economic Trends

The economic trends experienced by both Mendocino and Sonoma Counties approximate the span of economic conditions represented within the watershed. An increased cost of living, a slowing national economy, and a recent drop in local housing prices may portend rough economic times ahead for residents of the Russian River watershed as people cut back on extras such as vacations. However, the attendant drop in housing prices may lead to a cost of living that is more closely aligned with existing salaries in the watershed.

Mendocino County has seen a steady decline in traditional economic sectors. Wine production, tourism, and organic farming have experienced increases while the timber industry and commercial fishing industry have experienced significant declines. Government and non-profit organizations are the largest sectors remaining in the traditional economy. Tourism and the hospitality industry have been on the rise (County of Mendocino 2004). More than 80 percent of the jobs in Mendocino County are supplied by companies with 10 or fewer employees, in part due to the county's remote location and lack of infrastructure. Trade, services, government, manufacturing, and agriculture were the major economic sectors in 2000 (Pacific Municipal Consultants 2003). Recognizing the need to expand its economic base, the County has taken actions to diversify. In 2004, it adopted a plan that includes taking steps toward energy self-sufficiency; addressing and solving water quality and supply issues; and embracing the cultural diversity the county enjoys (County of Mendocino 2004).

Sonoma County, nearer the San Francisco Bay region, generally has had the more diverse economy. Trade, transportation, utilities, and the government sectors were the two largest employment clusters in Sonoma County industries in 2006. Other important sectors in 2006 were manufacturing (in decline) and professional and business services; health services; leisure and hospitality; and construction (all experiencing increases; Sonoma County Economic Development Board and Sonoma County Workforce Investment Board 2008). Sonoma County has a strong trend of small local businesses; at the end of 2006, businesses with one to four employees made up 70 percent of all businesses (Center for Economic Development California State University Chico 2007).

3.5.4 Disadvantaged Communities

The Russian River watershed contains a mix of communities spanning the entire socioeconomic spectrum. Most of the Upper Reach and portions of the Lower Reach contain communities which qualify as disadvantaged according to the state ("disadvantaged communities" or DACs are those with Median Household Income (MHI) below the defined threshold of $48,706. These exist within matrix of high concentrations of affluent residents in the Middle and Lower Reaches of the watershed. DACs in the watershed are Guerneville, Rio Nido, and Ukiah as well as the most of the unincorporated Upper Reach in Mendocino County.

TABLE 3.12. DESIGNATED PLACES IN THE RUSSIAN RIVER WATERSHED WITH INCOMES LESS THAN $48,706.	
Disadvantaged Communities	**MHI**
Cazadero CDP	$40,938.00
Guerneville CDP	$39,318.00
Hopland CDP	$44,583.00
Monte Rio CDP	$41,094.00
Talmage CDP	$24,948.00
Ukiah city	$42,657.00
(Source: US Census Bureau's American Community Survey, 2010)	

4 AUTHORITIES, AGENCIES, AND WATERSHED GROUPS

There are numerous federal and state authorities and agencies whose jurisdiction overlaps all or portions of the Russian River watershed and who may provide data and support to local decision-makers and the public. Additionally, there are dozens of independent entities working within the watershed (e.g. watershed groups and public-private partnerships; see Table 4.1). They provide data and support to local decision-makers; implement stewardship activities (e.g. sediment reduction or habitat enhancement/ restoration); perform educational activities; conduct research; promote environmental justice; or build community capacity. Some groups work collaboratively with agencies to focus on salmonid recovery and improvements to watershed health. For example, the Russian River Coho Water Resources Partnership is currently focusing on five priority watersheds identified by the NMFS Draft Coho Recovery Plan to utilize water storage options, frost protection alternatives, and stream habitat restoration projects to reduce the impact of dry season water diversions from streams on aquatic habitat (RRCWRP 2011).

Principal authorities, agencies, and watershed groups are listed below. Sections 7 and 8 describe how data and recommendations (respectively) from these and other organizations are integrated into the RRICWMP document and process.

4.1 GEOLOGY, SOILS, AND HYDROGEOMORPHOLOGY AUTHORITIES

- U.S. Army Corps of Engineers http://www.usace.army.mil/Pages/default.aspx
- U.S. Geological Survey http://www.usgs.gov/
- U.S.D.A. Natural Resources Conservation Service http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/home

4.2 WATER QUALITY AND SUPPLY AUTHORITIES

- U.S. Environmental Protection Agency http://www.epa.gov/
- California Department of Water Resources http://www.dwr.water.ca.gov/
- California Environmental Protection Agency http://www.calepa.ca.gov/
- State Water Resources Control Board http://www.waterboards.ca.gov/
- North Coast Regional Water Quality Control Board (Region 1) http://www.waterboards.ca.gov/northcoast/
- Russian River Flood Control and Water Conservation Improvement District http://rrfc.net/
- Sonoma County Water Agency http://www.scwa.ca.gov/
- Mendocino County Water Agency http://www.co.mendocino.ca.us/water/

4.3 LAND USE AND MANAGEMENT AUTHORITIES

- U.S. Army Corps of Engineers' Lake Mendocino http://www.spn.usace.army.mil/mendocino/ and Lake Sonoma http://www.spn.usace.army.mil/lake_sonoma/index.html
- U.S.D.A. Forest Service http://www.fs.fed.us/
- U.S. Fish and Wildlife Service Pacific Southwest Region http://www.fws.gov/cno/fisheries/
- California Department of Fish and Game Northern Region (Mendocino County) and Bay-Delta Region (Sonoma County) http://www.dfg.ca.gov/regions/
- California Department of Parks and Recreation Northern Region http://www.parks.ca.gov/parkindex/region_info.asp?id=1&tab=1
- California State Academic Institutions
- California State Lands Commission http://www.slc.ca.gov/
- California Department of Boating and Waterways http://www.dbw.ca.gov/

- California Department of Conservation http://www.conservation.ca.gov/Index/Pages/Index.aspx
- California Department of Forestry and Fire Protection http://www.fire.ca.gov/
- County of Mendocino http://www.co.mendocino.ca.us/
- Mendocino Land Trust http://www.mendocinolandtrust.org/?Land_Conservation
- County of Sonoma http://www.sonoma-county.org/
- Sonoma County Agricultural Preservation and Open Space District http://www.sonomaopenspace.org/
- Sonoma Land Trust http://www.sonomalandtrust.org/

4.4 BIOLOGICAL RESOURCES AUTHORITIES

- NOAA Fisheries/ National Marine Fisheries Service http://www.noaa.gov/fisheries.html
- U.S. Fish and Wildlife Service Pacific Southwest Region http://www.fws.gov/
- California Department of Conservation Farmland Mapping and Monitoring Program http://www.conservation.ca.gov/dlrp/FMMP/Pages/Index.aspx
- California Department of Fish and Game Northern Region (Mendocino County) https://r1.dfg.ca.gov/portal/
- California Department of Fish and Game Bay Delta Region (Sonoma County) http://www.dfg.ca.gov/delta/
- California Department of Fish and Game Habitat Conservation Programs http://www.dfg.ca.gov/habcon/
- California Department of Fish and Game Wildlife Habitat Relationships http://www.dfg.ca.gov/biogeodata/cwhr/
- California Department of Food and Agriculture Noxious Weed Management Program http://www.cdfa.ca.gov/phpps/ipc/noxweedinfo/noxweedinfo_hp.htm
- California Resources Agency http://resources.ca.gov/departments.html

4.5 CULTURAL AND HISTORICAL RESOURCES AUTHORITIES

- California State Office of Historic Preservation (California Register of Historical Resources) http://www.parks.ca.gov/?page_id=21238
- National Park Service (National Register of Historic Places) http://nrhp.focus.nps.gov/natreghome.do?searchtype=natreghome

4.6 SOCIOECONOMICS AND DEMOGRAPHICS AUTHORITIES

- United States Census Bureau http://www.census.gov/

4.7 WATERSHED GROUPS AND LOCAL COLLABORATIONS

Table 4.1 lists some of the dozens of watershed groups, community partnerships, and collaborative processes working in and around the Russian River. Diverse in their scope, these entities' collective knowledge, advocacy, and outreach facilitate watershed-wide conservation and management. They are important supplementary sources of watershed-specific data (e.g. stream monitoring data), integrating their datasets with federal and state agencies' existing and developing frameworks and disseminating data results to the public.

Habitat restoration — Mark West Creek

Most watershed groups perform stewardship activities such as sediment reduction or habitat enhancement and restoration. Others perform educational activities, conduct research, promote environmental justice, or build community capacity. All perform important services that improve quality of life for residents of the Russian River watershed and/or that directly benefit watershed ecosystems. Many of the groups focus on salmonid recovery. The Russian River Coho Water Resources Partnership is one pilot project currently working collaboratively in the Russian River and other priority watersheds identified by the NMFS (2010) Draft Coho Recovery Plan. They mean to utilize water storage options, frost protection alternatives, and stream habitat restoration projects to reduce the impact of dry season water diversions from streams on aquatic habitat (RRCWRP 2011).

In addition to watershed group efforts, some agencies partner with individuals or groups to achieve shared goals (e.g. the Sotoyome, Gold Ridge, and

Mendocino County Resource Conservation Districts (RCDs) regularly collaborate with individual landowners to implement projects that are environmentally beneficial and improve resource management practices).

TABLE 4.1. WATERSHED GROUPS & LOCAL COLLABORATIONS	
NAME	**FOCUS**
Alexander Valley Winegrowers	Outreach about Alexander Valley and its wines
Atascadero-Green Valley Watershed Group	Protection, restoration and education in the Atascadero/ Green Valley Watershed
California Native Plant Society, Dorothy King Young Chapter	Preserve the native flora of CA and to add to the knowledge of members and the public at large
California Native Plant Society, Milo Baker Chapter	Conserve California native plants and their natural habitats, and increase understanding, appreciation, and horticultural use of native plants (Milo Baker is Sonoma County's chapter)
Community Alliance with Family Farmers	Advocate for California's family farmers and sustainable agriculture, create locally based economic vitality, improve human and environmental health
Community Clean Water Institute	Identifies pollution sources via water quality data collection/ analysis, shares information with government regulatory agencies and the public, and engages in education and community outreach
Dutch Bill Creek Watershed Group	Not available— see Community Clean Water Institute (above) project in Dutch Bill Creek
Environmental Center of Sonoma County	The Environmental Center of Sonoma County is a project of the SCCC. It is operated jointly with the Sierra Club's Redwood Chapter, Sonoma Group and serves as an information and referral service and provides opportunity for ad hoc groupings to work on specific issues
Friends of Gibson Creek	Dedicated to the health and appreciation of local creeks/ watershed, performs creek cleanup, restoration, and outreach
Friends of the Mark West Watershed	Dedicated to preserving, protecting, and restoring the Mark West Creek and its watershed, including Coho recovery efforts
Friends of the Russian River	See "Russian Riverkeeper," below
Friends of Santa Rosa Creek Nature Preserve	Outreach to preserve the scenic and wildlife values of rural Santa Rosa Creek west of Fulton Road
Gold Ridge Resource Conservation District	Help landowners address environmental concerns, involve landowners in NRCS projects, and support/implement restorative programs and practices with state and federal monies
The Jenner Community Website	[in development] Information about coastal town of Jenner
Laguna de Santa Rosa Foundation	Protection, restoration, education regarding Laguna de Santa Rosa, including Management Plan
Madrone Audubon Society	Promote education, enjoyment, and protection of the natural world, especially birds; advocacy and stakeholder outreach
Mendocino County Resource Conservation District	Help landowners with conservation and restoration of resources, dedicated to use of BMPs, and provides outreach
Mendocino Environmental Center	Educational outreach, nonviolent direct action, and litigation to promote environmental and social justice
Mendocino Land Trust	Works with private landowners, governmental agencies, and community groups to establish ecoregional priorities and strategies using fee acquisitions or conservation easements; conserve natural resources and open space
Mendocino Winegrowers Alliance	Outreach about local wines, emphasis on participating in FFF program to implement protocols protecting native fish populations, restore habitat, and improve water quality
Occidental Arts and Ecology Center	Organizing/ education center with organic farm, established the WATER Institute (Watershed Advocacy, Training, Education, & Research)
Russian Riverkeeper	Pursue conservation and protection of the river's main stem, tributaries and watershed through public education, citizen action, scientific research and expert advocacy; keeps online list organizations serving each of RRW tributaries (formerly "Friends of the Russian River")
Russian River Chamber of Commerce	Information on accommodations and recreational events/activities in the watershed (focus on mainstem and major tributaries)
Russian River Coho Water Resources Partnership	Systematic approach to improve streamflow and water supply reliability in five Russian River tributaries: Dutch Bill Creek, Grape Creek, Green Valley Creek, Mark West Creek, and Mill Creek. Funded by the NFWF and SCWA
Russian River Environmental Forum	Ceased in 2005; see "Russian Riverkeeper," above
Russian River Valley Wine Growers Association	Outreach on local wine, emphasizing sustainable grape growig
Russian River Watershed Association	Promotes cooperation and implementation of projects that protect watershed resources, restore fisheries, and improve water quality
Russian River Watershed Cleanup Committee	Promote stewardship, coordinate cleanup and removal of trash in the Russian River and its tributaries between Cloverdale and Jenner
Russian River Watershed Council	Protect, restore, and enhance the biological health of the Russian River and its watershed through a community-based process facilitating communication/ collaboration. [no website information]
Russian River Watershed Directory	Guide to resources and services provided by Sotoyome RCD on behalf of the USACE and RRWC; for management and stewardship of the Russian River Watershed for landowners, professionals, educators, organizations, governmental agencies, and individuals (see "Russian Riverkeeper" above)
Russian River Watershed Protection Committee	Works from Guerneville on issues including water supply, general plan policies, water diversions, flooding, water quality, RWQCB waste discharge requirements, ESA issues, toxics, agricultural irrigation, and more (formerly "River Citizens Sewer Committee)
Salmon Creek Watershed Council	Works on restoration, enhancement, and maintenance of the natural resources and communities in the Salmon Creek Watershed
Sierra Club Redwood Chapter, Mendocino Group	Outreach regarding Sierra Club opportunities (activities, education) in Mendocino County
Sierra Club Redwood Chapter, Sonoma Group	Outreach regarding Sierra Club opportunities (activities, education) in Sonoma County

TABLE 4.1. WATERSHED GROUPS & LOCAL COLLABORATIONS	
Sonoma County Conservation Council	Pooling resources to protect and restore our environment, a federation of local groups formed the Sonoma County Conservation Council in 1984. Eventually SCCC became incorporated as a 501(c)(3) charitable nonprofit. [see Environmental Center of Sonoma County]
Sonoma County Grape Growers Association	Outreach about local wine, emphasis on sustainability (supports Code of Sustainable Winegrowing)
Sonoma County Transportation and Land Use Coalition	Outreach about alternative transportation in Sonoma County, in context of natural areas preservation
Sonoma County Water Coalition	Educate members, decision-makers and the public; advocate for effective policies to repair ecosystem damage; and ensure clean water supplies
Sonoma Land Trust	Conserves scenic, natural, agricultural and open land in Sonoma County via restoration, easement, education/outreach, produced "Biodiversity Action Plan" for the county
Sotoyome Resource Conservation District	promote responsible natural resource management through voluntary community stewardship and technical assistance (education, assessment, planning, implementation, evaluation); Russian River Watershed Directory
Town Hall Coalition	Outreach and advocacy to public regarding water, soil erosion, pesticide drift, habitat degradation, grading, forest conversions to vineyards, industrial vineyard and wine factory development, subdivisions, logging, and other issues
Trout Unlimited	Conserve, protect and restore North America's trout and salmon fisheries and their watersheds, perform outreach, education, activities

5 WATERSHED CONDITION ASSESSMENT

Assessment Protocol

Section 5 examines the current condition of the Russian River watershed by characterizing, summarizing, and integrating available data for three watershed ecosystem attributes (Habitat Condition, Water Quality, and Water Quantity). Watershed condition is determined herein largely on the basis of an analysis of conditions for salmonids, particularly endangered Central California Coast (CCC) Coho salmon (e.g. NMFS 2010), compared to state standards (e.g. SWRCB 2010). It is widely recognized that virtually all land practices and habitat attributes (upland and instream) will affect coho salmon, so the condition of this species and its habitat reveals much about the overall and constituent conditions of the Russian River watershed[4].

Together, the three ecosystem attributes provide a fair representation of condition for the watershed's constituent vegetation, wildlife, geomorphology, hydrology, and beneficial uses of water. In addition to these natural resource attributes, current socio-economic status and trends, will be considered prior to and during plan implementation. However, the scope of Section 5 is currently the condition of natural resources in the Russian River watershed. The regulatory conditions protecting public and environmental health (i.e. policies, plans, standards, objectives, goals) are also described here because they provide the statutory context in which the RRICWMP must be implemented; essentially, the degree to which the Russian River watershed is "compliant" with current regulatory requirements will provide an additional (albeit abstract) indicator of local watershed condition.

4 The Coho Recovery Plan also contains site-specific management actions, which are relevant to this RRICWMP document, Section 7, "Resource Management Strategies." See NMFS 2010 http://swr.nmfs.noaa.gov/recovery/coho/Chapter_10_Recovery_Actions_Russian.pdf

Determination of Russian River watershed condition is a complex undertaking and is the function of many parameters that are, of course, highly interconnected and variable in time and space. Thus, the interrelated watershed attributes are defined and discussed separately in sub-sections 5.1-5.3 only to facilitate document organization. In practice, integration across all these landscape, biotic, hydro/geomorphological, and physiochemical features is necessary before, during, and after RRICWP implementation. Key management and conservation issues related to the impairment or degradation of the watershed conditions are discussed in detail in Section 6.

Watershed Attributes and Indicators

Watershed attributes are the various components of the viable ecological systems, functioning landscapes, and beneficial uses of water that comprise a healthy Russian River watershed. For the RRICWMP, the attributes being assessed are habitat condition (upland, riparian, stream channel, estuary, and coastal), water quantity (surface waters, ground waters, and flood control), and water quality (surface, ground, and reclaimed/recycled). The condition of watershed attributes is determined by identifying, assessing, and monitoring specific condition indicators associated with them. Indicators[5] are the specific features of watershed attributes expected to change over time, for example in response to management actions or anthropogenic stressors (Young and Sanzone 2002). A representative portfolio of attributes and indicators, when compared to accepted objectives, standards, and/or benchmarks will (1) characterize current and changing field conditions; (2) reveal the source of existing management issues; (3) flag emerging issues;(4) prove the efficacy of implemented management actions; and (5) demonstrate progress toward RRICWMP goals and objectives. See Appendix 10, Summary of Potential Indicators for a listing of attributes and indicators that may be used to assess Russian River watershed condition.

5 Sometimes called "metrics," "parameters," or "measures" (e.g. USEPA 2003).

Traditionally, indicators of the physical and chemical environment (e.g. temperature, toxicity) have been used to assess condition. While these indicators are essential, they are now considered inadequate to fully protect and enhance aquatic resources and watershed health (SWRCB 2010). The physiochemical indicators that currently define state water quality objectives and standards should be (and are being) supplemented with biological indicators ("bioindicators"). Bioindicators are plant or animal species, communities, or habitats whose function, population, or status can be used to directly determine ecological integrity/viability. Use of multiple of bioindicator taxa is recommended as each may respond differently to anthropogenic and environmental factors (CWQMC 2008). Appropriate taxa may include bacteria, algae, plant communities (e.g. wetland/ riparian, invasives), benthic macroinvertebrates (BMIs), mollusks, fishes, amphibians, or birds.

Assessment of condition using bioindicators ("bioassessment") offers the potential to efficiently integrate information about biotic and abiotic conditions across a variety of spatial scales and taxonomic levels. California is in the process of developing a standardized statewide framework to define indicator categories with biological objectives and numeric benchmarks (SWRCB 2010). The goal is to establish multiple biological indicators and objectives with numeric benchmarks for all waterbodies in the state. This will allow local resource managers and stewards to define "condition" more consistently, objectively, and accountably than has been possible in the past and to coordinate the numerous existing federal, state, and local monitoring programs with greater efficiency.

Salmonids as Integrators of Watershed Condition

"Species and Habitat Recovery," particularly for native fishes, is identified as a primary strategy area in the Russian River Watershed Council's Draft Plan of Action (RRWC 2002, the progenitor of this RRICWMP). In the Russian River watershed, anadromous fish (i.e. salmonids) offer significant potential as bioindicators of a whole host of habitat and water attributes, as well as indicators of condition across the watershed's different habitat types and beneficial uses of water. Salmonids integrate the many complex and inter-related physical, biological, and socioeconomic issues that must be addressed to assure their recovery (NOAA/NMFS 2009) and overall watershed viability. Federally and state-listed salmonids in the watershed include endangered coho (*Oncorhynchus kisutch*) and threatened Chinook salmon (*O. tshawytscha*) and steelhead (*O. mykiss*). Recently, the National Marine Fisheries Service (NMFS) released a comprehensive, collaborative plan (NMFS 2010) for restoration of endangered Central California Coast (CCC) Coho salmon[6].

In their analyses, NMFS 2010 summarizes conclusions by watershed. This allows statements of condition herein to apply specifically to the Russian River watershed, a clear benefit for the RRICWMP (see NMFS 2010 for data, maps/figures, and technical references[7]). The draft NMFS analysis subsumes all the relevant quality data on Russian River watershed habitats and waters. For example, it integrates the 2004 California Department of Fish and Game (CDFG) Recovery Strategy for Coho Salmon and incorporates CDFG data and protocols (e.g. stream surveys, habitat inventories, biological inventories; Flosi et al. 1998); recommendations (e.g. in the Russian River Basin Fisheries Restoration Plan, CDFG 2002); fish habitat requirements (e.g. adult migration, spawning, embryo development, juvenile rearing, emigration) ; limiting factors (e.g. migration barriers, gravel quality/quantity, water quality/quantity, riparian stability, water temperature, habitat availability); and numeric habitat objective benchmarks related to pools, riffles, canopy, shelter, habitat diversity, water temperature. In addition to the CDFG datasets, the NMFS plan incorporates data, objectives, and standards from SWRCB, North Coast RWQCB, and other federal, state, and local natural resource databases.

NMFS' report for the Russian River produced current watershed-specific condition ratings (i.e. Poor, Fair, Good, and Very Good) of habitat attributes relative to desired conditions. The ratings are based on indicator data relative to numeric benchmarks/ thresholds that have been established by the USEPA, California Department of Public Health (CDPH), State and Regional Water Boards, and other regulatory authorities. The NMFS CCC Coho salmon condition ratings are included throughout Section 5 to summarize the condition of habitat and water attributes for the Russian River watershed. Complementing the condition statements in the summary tables are a suite of individual attribute indicators developed by various federal, state, and regional regulatory authorities for assessment and monitoring of watershed conditions. These are

6 A new multi-species recovery plan has been drafted by NMFS but has not been released for public comment as of 02Dec2011. Check NOAA/NMFS for availability (Charlotte Ambrose, CCC Recovery Coordinator 707-575-6068).

7 See http://swr.nmfs.noaa.gov/recovery/coho/Appendices/Appendix%20F/Appendix_F-Russian_Watershed.pdf

listed in Appendix 10, Summary of Potential Indicators along with their sources. The regulatory objectives and standards for many of these indicators (particularly of water quality) are discussed in Section 5.5.2.

5.1 HABITAT CONDITION

Numerous vegetation communities and habitat types comprise the Russian River watershed (see Figure 3.9 Vegetation Classification). The condition of these is described in Section 5.1 in the following broad categories (again for organization's sake; integration is necessary in practice): Upland Habitats, Riparian/ Floodplain, Stream Channel, and Coastal Waters/ Estuary. Summary tables present recently-developed condition statements or ratings (e.g. Poor, Fair, Good, or Very Good) for the watershed's habitats, based on accepted state standards (e.g. for water quality and quantity) and the habitat requirements of Russian River coho salmon.

5.1.1 Uplands

"Upland" is a generalized term for the areas that occur above the river's channel and floodplain. Uplands comprise the transition zone between the floodplain and ridge tops. The majority of the watershed consists of upland habitats, which support a variety of vegetation and associated wildlife as well as land use practices. "Uplands Restoration" is identified as a primary strategy area in RRWC 2002 ("Draft Plan of Action"). The reason for focusing on such a broad "habitat" is to recognize the effects upland activities (e.g. roads, development, grading, paving, or vegetation removal) have on the Russian River watershed tributaries, native species, and their habitats (RRWC 2002). Regardless of dominant vegetation, all upland habitats have the characteristic of shedding water (and its constituents, including sediment and other pollutants) downslope to the floodplain/riparian/stream zone, to groundwater, to the estuary, and (when the estuary is breached) to nearshore habitats and the open ocean. Fifty-eight percent of the watershed has soils with moderate to high erodability (considering slope, precipitation, and susceptibility of underlying geology to erosion; NMFS 2010). By definition, "upland habitat" specifically excludes bottomlands: riparian forests, in-stream habitat, the estuary/ lagoon, and the coastal marine area at the mouth of the Russian River are treated separately throughout 5.1. However, it is recognized that bottomland and instream habitats are interconnected physically and functionally with each other and with uplands.

Table 5.1 lists the primary watershed attributes associated with upland habitats and the condition of those attributes in the Russian River watershed.

TABLE 5.1. CONDITION OF UPLAND HABITAT

HABITAT ATTRIBUTE	INDICATOR	CONDITION RATING
Land Disturbance	% Agriculture	GOOD
Land Disturbance	% Timber Harvest	VERY GOOD
Impervious Surfaces	% Cover	VERY GOOD
Potential Sediment Transport	Road Density	POOR
Erodability	Score	MODERATE [1]

Source: NMFS 2010

[1] Rating: 0=low slide potential, 10=High slide potential. Fifty percent of the watershed rates 6 or7 (thus "Moderate" herein); none rates 9 or 10. Twenty-five percent of watershed was not evaluated.

5.1.2 Floodplain and Riparian Zone

The floodplain (including the riparian zone), is the area adjacent to the stream formed by the river that is normally inundated during periods of high flow. Riparian habitat is the assortment of native plants that occurs in and immediately adjacent to streams, creeks, and the mainstem of the river. Riparian zones are prone to flooding and land movement and the plant species found here are well adapted to this ever-changing environment (Circuit Riders 1998). For regulatory purposes, riparian forests are considered "wetlands" by the state, which defines the term as "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support…a prevalence of vegetation typically adapted for life in saturated soil conditions" (NCRWQCB 2011). "Stream Corridor Restoration" is identified as a primary strategy area in RRWC 2002 ("Draft Plan of Action").

Only about five percent of native riparian habitat remains in California (RHJV 2000). Historical descriptions and photographs indicate that the Russian River formerly consisted of a wide, shallow channel that meandered across broad natural floodplains flanked by extensive riparian vegetation, amidst a profusion of side channels, deep pools, sand bars, islands and (Florsheim and Goodwin 1995). Although portions of the active channel went dry during the summer and fall, isolated pools typically persisted throughout the summer and fall and provided cool water refugia for juvenile salmonids and other aquatic life, as well as a source of water for maintaining riparian vegetation. Human activities over the last 100 years have transformed the Russian River into a much narrower, straightened and incised channel that is flanked by a comparatively narrow band of riparian vegetation (Florsheim and Goodwin 1995). Introduced plant

species, most notably the giant reed *Arundo donax*, have changed the composition of the riparian plant community and in turn the habitat types and quality of riparian habitat available for wildlife species and the beneficial uses supported by viable riparian habitat.

Riparian habitat invaded by giant reed

Table 5.2 lists the primary watershed attributes associated with riparian and floodplain habitats and the condition of those attributes in the Russian River watershed.

TABLE 5.2. CONDITION OF RIPARIAN AND FLOODPLAIN HABITAT

HABITAT ATTRIBUTE	INDICATOR	CONDITION
Riparian Vegetation	Species Composition	FAIR
Riparian Canopy	% Cover	POOR
Riparian Canopy	DBH North/South	POOR
Riparian Vegetation Maturity	Stand Age	POOR
Floodplain Function	Complexity	POOR
Floodplain Function	Connectivity	POOR
Source: NMFS 2010		

5.1.3 Stream Channel

Stream channel habitat is the portion of the physical stream or riverine system that is not water: the stream/river bottom and its banks. Stream channels throughout the Russian River have been altered from their natural, historic form and function, causing large and small-scale changes in stream habitat. The construction and operation of the watershed's two major dams, in conjunction with instream gravel mining, has reduced the supply of sediment to downstream portions of the Russian River, which has prompted downcutting of the active channel by as much as 10 to 20 feet (3 to 6 meters), creating vertical banks, lowering the groundwater table and isolating flood plains. Tributary streams, in response, have also eroded to match the new, lower elevation of the Russian River mainstem. The result has been creation of vertical stream banks, lowering of the groundwater table, associated loss of riparian vegetation, and decreased stream bank stability.

According to NMFS (2011), there are over 500 small dams on the Russian River and its tributaries (SEC 1996) that, along with 2,314 other barriers (diversions, roads, small structures), block salmonid migration throughout the watershed. Other features of the stream channel are presented in Table 5.3, which lists the primary watershed attributes associated with physical stream channel habitats and the condition of those attributes in the Russian River watershed.

TABLE 5.3. CONDITION OF STREAM CHANNEL HABITAT

HABITAT ATTRIBUTE	INDICATOR	CONDITION
Gravel Quality	Size Distribution	GOOD
Sediment	Embeddedness	POOR
Spawning Gravel	Amount	FAIR
Large Woody Debris Frequency	Size Distribution (small LWD)	POOR
Large Woody Debris Frequency	Size distribution (large LWD)	FAIR
Summer Pools	Depth	POOR
Summer Pools	Distribution	POOR
Adult Coho Passage	Physical Barriers	VERY GOOD
Source: NMFS 2010		

Maacama Creek — late summer

5.1.4 Near Shore Coastal and Estuary/ Lagoon

Coastal waters are those subject to tidal action and include near-shore ocean waters outside the estuary ("lagoon" when the sand bar is intact) as well as

the estuary itself (NCRWQCB 2011). The Russian River Estuary is the seven-mile-long tidally influenced segment between the river's confluence with the Pacific Ocean and the community of Duncan Mills. The estuary is part of a new California Marine Protected Area (MPA; see Section 3.3.7 and Figure 3.8, Open Space and Protected Areas). As previously described (Section 3.3.7.4), there are two Marine Protected Areas at or near the river's confluence with the Pacific. These are the Russian River State Marine Conservation Area (SMCA) and the Russian River State Marine Recreational Management Area (SMRMA). Both are afforded special protections: In the SMRMA, take of all living marine resources is prohibited except for recreational hunting of waterfowl; in the State MCA, take of all living marine resources is prohibited except recreational and commercial take of Dungeness crab by trap and recreational take of surf smelt using hand-held dip nets or beach nets (CDFG 2010b). In addition to the MPAs, there are three Critical Coastal Areas and three Areas of Special Biological Significance (aka State Water Quality Protection Areas) in the HU's adjacent to the Russian River HU.

The historic conditions of the Russian River estuary are not well documented but it has been speculated that it, like estuaries along the California coast, was biologically productive and provided extensive rearing habitat for juvenile salmonids and a variety of other freshwater and marine species (ESA 2010; NMFS 2009). Topographic maps prepared by the U.S. Coast and Geodetic Survey in 1886 and historic accounts by Russian setters at Fort Ross indicate that the estuary was frequently separated from the ocean by a sand bar during the summer months (technically, making it a lagoon), when Russian River stream flows were typically low, and continued to be separated from the ocean until the onset of high winter stream flows, which would breach the sand bar.

Despite major landuse changes in the past century, limited bathymetric surveys and historic aerial photos suggest overall estuary morphology and volume are considered largely unchanged (Phillips Williams and Associates 1993). However, estuary function has been altered by regular mechanical breaching of the sandbar (e.g. for flood control). The increased frequency with which the sand bar is breached is significant from a biological perspective. In general, the biological productivity of estuarine systems is typically highest when the estuary is either open to ocean tides and predominately a saline environment, or closed and predominately a freshwater environment. During transition periods, when the estuary is either converting to or from a freshwater environment, biological productivity is typically reduced (NMFS 2009).

Table 5.4 lists the primary watershed attributes associated with estuarine and near-shore ocean habitats and the condition of those attributes in the Russian River watershed.

TABLE 5.4. CONDITION OF ESTUARINE AND COASTAL HABITAT

ATTRIBUTE	INDICATOR	CONDITION
Estuary Condition	Estuary Function	FAIR
Coastal Habitat Condition	Tbd	Tbd

Source: NMFS 2010

5.2 WATER QUANTITY

"Water Supply, Quantity, and Storage" is identified as a primary strategy area in RRWC 2002 ("Draft Plan of Action"). Russian River surface and groundwater sources supply potable water for over 500,000 people (NCRWQCB 2005). The NCRWQCB has determined that there is sufficient water supply within the watershed to meet projected demands "for the foreseeable future (NCRWQCB 2007a)." However, demand is increasing and water supplies may become more variable and less dependable as climate change becomes manifest. Anthropogenic activities (particularly diversions, impoundments, and releases) have altered the timing and variability of flows. Increased summer flows eliminated formation of the stratified pool habitat in the mainstem that had provided cold water refugia for juvenile salmonids. Additionally, Coyote Valley Dam acts to decrease flood peaks and increase the duration of high flows caused by storm events (Philip Williams et al. 1997).

Water quantity in the Russian River watershed is examined separately below for surface inland waters, groundwater, and flood control (5.3.1-5.3.3).

5.2.1 Surface Water Quantity

There are approximately 3,830 miles (6,164 km) of naturally-occurring waterways (intermittent and perennial streams) in the Russian River watershed (NMFS 2010). The Russian River and its tributaries constitute the principal surface water supply for portions of Mendocino, Sonoma and Marin counties. Augmenting the Russian River and contributing to the overall reliability of the watershed's water supply, particularly during dry years, are inter-basin water diversions from the adjacent Eel River drainage. While a significant volume of water is diverted

directly from the Russian River and its tributaries, and used immediately for a variety of beneficial uses, much of the Russian River water supply is captured and impounded in publically and privately owned water storage facilities: Lake Pillsbury and the Potter Valley Project; Lake Mendocino and Coyote Valley Dam; Lake Sonoma and Warm Springs dam; and numerous privately owned stock ponds and small reservoirs.

Importation of Eel River stream flows and the construction of Coyote Valley and Warm Springs dams have changed the Russian River flow regime, reducing and prolonging high winter stream flows for flood control management purposes, and greatly increasing summer flows for wildlife habitat and other purposes. Although intended to benefit salmonids, elevated summer stream flows, which quickly warm to ambient air temperatures, effectively dilute and thereby reduce the availability and quality of cool water refugia. The U.S. Geological Survey (USGS) maintains stream flow gaging stations in the Russian River basin (47 and counting; NMFS 2010). The SWRCB provides a listing and maps delineating fully-appropriated streams, including for Mendocino and Sonoma Counties in the Russian River watershed.[8]

Table 5.5 lists the primary watershed attributes associated with surface water availability and the condition of those attributes in the Russian River watershed.

8 Critical Reach of Stream Systems declared by SWRCB to be Fully Appropriated http://www.swrcb.ca.gov/waterrights/water_issues/programs/fully_appropriated_streams/

TABLE 5.5. CONDITION OF SURFACE WATER QUANTITY

HABITAT ATTRIBUTE	INDICATOR	CONDITION
Summer Rearing Base Flow	Score	POOR
Smolt Passage Flow	Passage Flows	POOR
Smolt Passage Flow	# of Diversions	FAIR
Spawning Adult Passage Flow	Score	FAIR

Source: NMFS 2010

5.2.2 Groundwater Quantity

Groundwater (defined in Section 5.2.2) is an important source of agricultural, industrial, and domestic water in the Russian River drainage, particularly in rural areas. Although Russian River surface flow is the principle source of domestic water for the region's urban centers, most rural areas are served by groundwater. In 2002, there were approximately 40,000 groundwater wells in Sonoma County, with 42 percent of the county's population dependent, at least in part, on groundwater supplies. (Sonoma County Permit & Resource Management Department 2012). Eight economically significant groundwater basins and five sub-basins are delineated in the Russian River drainage (see Table 3.3, Section 3.1). Water levels are considered generally stable, although data are insufficient to characterize some basins (see Table 5.6).

Groundwater is used for municipal supply by Ukiah, Windsor, Santa Rosa, Rohnert Park, and Sebastopol and unincorporated areas outside of Santa Rosa (NCRWQCB 2007a).The aquifer in the terrace adjacent to the Russian River recharges the river during low and medium flows while during high flow events, the river recharges the aquifer. Changes in groundwater levels measured between the 1950s and 1990s indicate that the Middle Reach aquifer level has decreased about 5 to 10 feet (1.5 to 3 meters) while there is little change in Mendocino County and the Alexander Valley Reach (Florsheim and Goodwin 1995).

Except for groundwater flowing in subterranean streams, there is no statewide statutory regulation of groundwater extraction in California. Litigation has resulted in court decrees regulating groundwater use in some cases. In response to reports that groundwater levels have declined in some areas, Sonoma County has initiated a long term program to increase the available data on groundwater resources and to systematically organize and use it as development is planned and new well permits are sought. Programs are underway to assess the available groundwater in the County's major basins.

Table 5.6 provides general groundwater quantity (elevation) statements for basins in the Russian River drainage.

TABLE 5.6. GROUNDWATER ELEVATION FOR BASINS IN THE RUSSIAN RIVER DRAINAGE			
DWR #	BASIN NAME	SURFACE AREA (ACRES)	GROUNDWATER QUANTITY
1-50	Knights Valley	4,100	INSUFFICIENT DATA
1-51	Potter Valley	8,240	GENERALLY STABLE
1-52	Ukiah Valley	37,500	GENERALLY STABLE
1-53	Sanel Valley	5,570	GENERALLY STABLE
1-54	Alexander Valley		GENERALLY STABLE
1-54.02	Cloverdale Area Subbasin	6,500	GENERALLY STABLE
1-54.01	Alexander Subbasin	24,500	GENERALLY STABLE
1-55	Santa Rosa Valley		GENERALLY STABLE
1-55.02	Healdsburg Subbasin	15,400	GENERALLY STABLE
1-55.03	Rincon Valley Subbasin	5,600	GENERALLY STABLE
1-55.01	Santa Rosa Plain Subbasin	80,000	GENERALLY STABLE
1-60	Lower Russian River Valley	6,600	GENERALLY STABLE
Source: DWR			

5.2.3 Flood Control

Annual stream flows in the Russian River drainage are highly variable, responding quickly to rainfall events. Flows have historically ranged from as little as four percent of normal to as much as 265 percent of normal (1977 and 1983, respectively; USGS 2012, National Water Information System). Stream flows are highly responsive to rainfall events and as a result, flood conditions can change rapidly. Efforts to minimize flood damage (e.g. construction of flood control levees) date back to the 1930's. Both Coyote Valley Dam and Warm Springs Dam are multiple use facilities, providing flood control as well as water supply benefits. In 1958 the Sonoma County Flood Control and Water Conservation District initiated construction of the Central Sonoma Watershed Project, which consists of nearly 20 miles (32 km) of stream channel and five flood flow retention reservoirs. Collectively, the two USACE dams and SCWA's Central Sonoma Watershed Project comprise the principle man-made flood control features in the Russian River drainage. Natural features, including the Laguna de Santa Rosa (which serves as a flood flow retention basin), intact riparian zones, and fresh or saltwater wetlands also can reduce the frequency and severity of flooding.

Table 5.7 lists the primary watershed attributes associated with surface water availability and the condition of those attributes in the Russian River watershed.

TABLE 5.7. CONDITION OF FLOOD/STORMWATER CONTROL FEATURES		
HABITAT ATTRIBUTE	INDICATOR	CONDITION
Riparian Vegetation	Species Composition	FAIR
Riparian Canopy	% Cover	POOR
Riparian Canopy	DBH North/South	POOR
Riparian Vegetation Maturity	Stand Age	POOR
Floodplain Function	Complexity	POOR
Floodplain Function	Connectivity	POOR
Source: NMFS 2010		

5.3 WATER QUALITY

"Water Quality" is identified as a primary strategy area in RRWC 2002 ("Draft Plan of Action"). The quality of waters in California is highly regulated and is evaluated for the USEPA by state and regional water boards according to the objectives and standards outlined in Section 5.4. Water quality standards are defined for inland surface, estuary, coastal, and ground waters in the North Coast's Water Quality Control Plan ("Basin Plan," NCRWQCB 2011). Specific indicators for surface and groundwater are identified and reclaimed/recycled water quality/availability is discussed.

5.3.1 Surface Water Quality

Inland surface waters consist of rivers, streams, lakes, reservoirs, and inland fresh or saltwater wetlands. Subterranean streams are treated as surface water (not as groundwater). Natural and artificial impoundments are used throughout the watershed for irrigation, municipal water supply, recreation, and hydroelectric power generation (NCRWQCB 2011). In the Russian River watershed, the major surface water impoundments are Lake Mendocino and Lake Sonoma, both administered by the USACE.

Water quality sampling programs conducted for the past 20 years show significant improvements to surface water quality, due primarily to point and nonpoint source pollution control efforts (NCRWQCB 2005). However, water quality in the Russian River watershed is still impacted by several issues, including sedimentation in streams, mercury in lakes (naturally occurring), destruction of riparian habitat, high water temperatures, low dissolved oxygen, and bacterial contamination. These issues are exacerbated by low flows and hydromodification. Russian River watershed segments that do not meet current water quality standards (see Section 5.4) are listed as "impaired" on the section 303(d) List of Impaired Waterbodies. Table 5.13, Geographic Distribution of Water Quality Impairments lists the impaired segments and provides their geographic location in the watershed.

Table 5.5 lists the condition of surface water quality (temperature and toxicity) based on NMFS' assessment of endangered coho salmon (NMFS 2010). Thresholds are being developed by the state to describe the condition (e.g. "High" "Moderate" and "Low" quality) of water quality in state waters and to guide the assessment of monitoring results (SWAMP 2010). However, these are not yet available for all indicators, nor are indicators available for every beneficial use in every water body combination.

TABLE 5.8. CONDITION OF SURFACE WATER QUALITY

HABITAT ATTRIBUTE	INDICATOR	CONDITION
Water Quality	Temperature (Summer)	POOR
Water Quality	Toxicity (Acute)	FAIR

Source: NMFS 2010

5.3.2 Groundwater Quality

Groundwater is subsurface water in soils and geologic formations that are fully saturated all or part of the year. Groundwater does not include subterranean streams, which are treated for regulatory purposes as surface water (NCRWQCB 2011). Groundwater quality in the Russian River drainage is considered generally good. However, municipal supply wells for the Sebastopol and Santa Rosa have been shut down due to toxic chemical contamination and many individual wells have been contaminated, especially in the West College Avenue area of Santa Rosa. In other areas, data are insufficient to characterize condition (NCRWQCB 2005).

Table 5.9 provides general groundwater quality statements for basins in the Russian River drainage.

TABLE 5.9. GROUNDWATER QUALITY FOR BASINS IN THE RUSSIAN RIVER DRAINAGE

DWR #	BASIN NAME	SURFACE AREA (ACRES)	QUALITY
1-51	Potter Valley	8,240	GENERALLY GOOD
1-52	Ukiah Valley	37,500	GENERALLY GOOD
1-53	Sanel Valley	5,570	GENERALLY GOOD
1-56	McDowell Valley	1,500	INSUFFICIENT DATA
1-54	Alexander Valley		GENERALLY GOOD
1-54.02	Cloverdale Area Subbasin	6,500	GENERALLY GOOD
1-54.01	Alexander Subbasin	24,500	GENERALLY GOOD
1-50	Knights Valley	4,100	INSUFFICIENT DATA
1-55	Santa Rosa Valley		GENERALLY GOOD
1-55.02	Healdsburg Subbasin	15,400	GENERALLY GOOD
1-55.03	Rincon Valley Subbasin	5,600	GENERALLY GOOD
1-55.01	Santa Rosa Plain Subbasin	80,000	GENERALLY GOOD
1-60	Lower Russian River Valley	6,600	GENERALLY GOOD

Source: DWR

5.3.3 Reclaimed Water Quantity and Quality

Reclaimed (or recycled) water is municipal wastewater and/ or captured stormwater that has been treated to remove solids and chemical constituents that may pose a threat to public health, and then reused for certain applications, most commonly to irrigate landscapes and to recharge (replenish) groundwater basins. The state's Recycled Water Policy (2009) strongly encourages the use of recycled water as an alternative to potable water, when relevant water quality standards are fulfilled.

Reclaimed Water Availability

Reuse of treated municipal wastewater (or stormwater) in the Russian River watershed can improve water availability/ quantity by increasing sustainability of groundwater supplies and providing alternatives to use of potable water in these instances. In order to supplement existing surface and ground water supplies to help meet water needs in California, it is State policy to promote reclaimed water use to the maximum extent possible. The state authorizes and encourages indirect potable uses of partially or fully treated wastewater, namely for use in Groundwater Replenishment Reuse Projects. A GRRP is a project involving the planned use of recycled municipal wastewater that is operated for the purpose of replenishing a groundwater basin designated in the Water Quality Control Plan (NCRWQCB 2011) for use as a source of municipal and domestic water supply. GRRPs use fully or partially treated wastewater to recharge groundwater basins. This is accomplished via surface application (with or without full treatment) or subsurface injection (with full treatment). The water used at a GRRP is called "recharge water." Recharge water is recycled municipal wastewater or the combination of recycled municipal wastewater and diluent water that is applied at a GRRP facility. One of the primary conditions on the use of reclaimed water is protection of public health. See 5.2.3 for a brief discussion of reclaimed water quality.

Reclaimed Water Quality

To supplement already strained water supplies, the state authorizes and encourages indirect potable uses of partially or fully treated wastewater, namely for use in Groundwater Replenishment Reuse Projects (GRRPs; see 5.3.3). Reuse of treated wastewater in the Russian River watershed can improve local and regional water quality by preventing what would otherwise be discharges of effluent (albeit treated) into surface waters.

Water reclamation involves several activities that have potential impacts on public health: introduction of pollutants into wastewater collection systems; wastewater treatment; storage and distribution of reclaimed water; and use of reclaimed water (CDHS/ SWRCB MOA 1996). All these activities require oversight to ensure protection of public health. The treatment and application of reclaimed water is not regulated by the EPA but by the state of California (i.e. CDPH, SWRCB, and NCRWQCB). State policies (see Table 5.10) require Regional Water Quality Control Boards (i.e. the NCRWQCB) to conduct reclamation surveys and actions to ensure compliance with water quality standards of the California Department of Public Health (CDPH). The CDHS, CDPH, SWRCB, and NCRWQCB collaborate to promote and encourage the use of reclaimed water and to ensure compliance with permit and discharge requirements related to reclaimed water. CDPH uses direct and "surrogate parameters" (indicators) to measure physical and chemical properties of reclaimed water and monitor the efficacy of treatment or indicate if treatment processing has failed. Reclaimed water constituents that are monitored and controlled for include total nitrogen, total organic carbon, pathogenic microorganisms, inorganic chemicals, radioactivity, organic chemicals, disinfection byproducts, lead, and copper.

5.4 REGULATORY FRAMEWORK

In California, protection and enhancement of habitat and water conditions falls mainly under the jurisdiction of the State Water Resources Control Board (SWRCB) and the Regional Water Quality Control Boards (RWQCBs, e.g. the North Coast RWQCB), as directed by the U.S. Environmental Protection Agency (USEPA) and the state Department of Water Resources (DWR). These and other state and federal agencies require and ensure regulatory accountability for waters and habitats in the state. Policy initiatives at all levels are necessary to implement many of the habitat and water enhancement actions identified in local (e.g. RRICWMP), regional (e.g. North Coast IRWMP), state, and federal plans.

Major federal and state legislation (i.e. Acts) as well as various decisions, policies, and plans are summarized in Table 5.10. Appendix 11, Descriptions of Plans, Policies, and Programs contains descriptions of these policies and plans. Weblinks to the original documents are provided in the References (Section 9).

TABLE 5.10. SELECT POLICIES AND PLANS FOR RUSSIAN RIVER WATERSHED ATTRIBUTES

TITLE	AGENT	DATE	WATERSHED ATTRIBUTE
OVERARCHING LEGISLATION			
Coastal Zone Act Reauthorization Amendments	State Water Resources Control Board (SWRCB)	1990	Water Quality
California Endangered Species Act (CESA)	CA Department of Fish and Game (CDFG)	1984 (Federal 1973)	Habitat Condition Water Quality Water Quantity
California Environmental Quality Act (CEQA)	CDFG	1970	Habitat Condition Water Quality Water Quantity
Clean Water Act (CWA)	USEPA	1987	Water Quality
Porter-Cologne Water Quality Control Act	SWRCB	1969,2011 Amended	Water Quality
POLICIES			
The Irrigated Lands Regulatory Program (ILRP) to regulate discharges from irrigated agricultural lands.	North Coast Regional Water Quality Control Board (NCRWQCB)	2011	Water Quality
Draft Regulations for Groundwater Replenishment with Recycled Water	California Dept. Public Health (CDPH)	2011 Draft	Water Quality Water Quantity
Recycled Water Policy	SWRCB	2011	Water Quality Water Quantity
Policy for Water Quality Control for Recycled Water	CDPH	2009	Water Quality Water Quantity
Russian River Frost Protection Regulation Policy	SWRCB	2011 2012 EFFECTIVE	Water Quantity
Wetland and Riparian Area Protection Policy (WRAPP) Phase I: Wetland Area Protection Policy and Dredge and Fill Regulations	SWRCB	2011 Phase I	Habitat Condition Water Quality
Policy for Maintaining Instream Flows in Northern California Coastal Streams (North Coast Instream Flow Policy)	SWRCB	2010	Habitat Condition Water Quality Water Quantity
Policy on the Use of Coastal & Estuarine Waters for Power Plant Cooling	SWRCB	2010	Habitat Condition
Policy for Compliance Schedules in National Pollution Discharge Elimination System (NPDES) Permits	SWRCB	2008	Water Quality
Water Quality Control Policy for Addressing Impaired Waters: Regulatory Structure and Options (TMDL Policy)	SWRCB	2005	Water Quality
Policy for Regulation of Discharges of Municipal Solid Waste	SWRCB	2005	Water Quality
Water Quality Control Policy for Developing California's Clean Water Act Section 303(d) list	SWRCB	2004	Water Quality

TABLE 5.10. SELECT POLICIES AND PLANS FOR RUSSIAN RIVER WATERSHED ATTRIBUTES			
Policy on Sources of Drinking Water	SWRCB	1988	Water Quality
Policy with Respect to Water Reclamation in California	SWRCB	1977	Water Quality
Statement of Policy with Respect to Maintaining High Quality Waters in California (Antidegradation Policy)	SWRCB	1968	Water Quality
Water Quality Control Policy for Siting, Design, Operation, and Maintenance of Onsite Wastewater Treatment Systems	NCRWQCB	2011 DRAFT	Water Quality
Pathogens in the Russian River Policy	NCRWQCB, Sonoma Cty. Dept. of Health Services	1996	Water Quality
Policy on the Disposal of Shredder Waste	NCRWQCB	1987	Water Quality
Timber Policy	NCRWQCB, CAL FIRE, State Board of Forestry	1972	Water Quality
PLANS			
California Water Plan (CWP) Update 2013	Department of Water Resources (DWR)	2011 in Development	Habitat Condition Water Quality
Workplan for Developing Biological Objectives for Perennial Wadeable Streams in the State of California	SWRCB	2010 DRAFT	Habitat Condition Water Quality
Public Draft Recovery Plan for Central California Coast Coho Salmon (*Oncorhynchus kisutch*) Evolutionarily Significant Unit	National Marine Fisheries Service (NMFS)	2010	Habitat Condition Water Quality Water Quantity
Sonoma County General Plan 2020: Water Resources Element	County of Sonoma	2008	Habitat Condition Water Quality Water Quantity
Plan for California's Nonpoint Source Pollution Control Program (Program Plan)	USEPA, SWRCB	2000	Water Quality
Mendocino County General Plan: Resource Element, Coastal Element	County of Mendocino	1998 (updating 2011-2012)	Habitat Condition Water Quality Water Quantity
Water Quality Plan for Ocean Waters of California (Ocean Plan)	SWRCB	1972 1990 UPDATE	Water Quality
Water Quality Control Policy for the Enclosed Bays and Estuaries of California (Antidegradation Policy)	SWRCB	1974 1995 UPDATE	Water Quality
Nonpoint Source Management Plan	SWRCB	1988	Water Quality
Water Quality Plan for the Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California (Thermal Plan)	SWRCB	1972	Water Quality

5.4.1 Existing Policies and Plans

For the Russian River watershed ICWMP, project implementation will be guided by — and plan performance evaluated relative to — the overarching regional and state standards set forth in the State's North Coast IRWMP and its proposed Data Management Plan[9]. Section 8 describes the draft Data Management Plan (DMP) and how it is integrated into (and integrates) the RRICWMP. Many federal and state policies have been adopted and are being implemented in the North Coast region by the SWRCB and NCRWQCB for the purposes of protecting and/or enhancing various water quality and reliability attributes, as well as overall ecosystem and environmental health[10]. A policy adopted by the state or a regional representative is akin to regulation and carries enforcement authority. Several policies that will have direct, long-term management implications for the Russian River watershed, including new frost protection and minimum instream flow restrictions, are described in Appendix 12, Key Regulatory Policies and Decisions: Management Implications.

5.4.2 Beneficial Uses of Water

The various purposes for which water is used in the Russian River watershed are defined by the state as the "beneficial uses of water." Beneficial uses are currently attained (E, for existing) or potentially attainable through remedial or other action (P, for potential). The designation of beneficial uses constitutes the foundation upon which the development and implementation of state water quality objectives and water quality standards are based. Water quality objectives are established to define the general water quality characteristics needed to protect and preserve a given beneficial use while water quality standards provide specific criteria that must be achieved to meet the stated objectives.

The North Coast Regional Water Quality Control Board (NCRWQCB) has designated 22 beneficial uses for the surface and ground waters of the Russian River drainage, including the Russian River estuary/lagoon and the adjacent coastal waters. These beneficial uses and their associated water quality objectives and standards are described in the NCRWQCB's Water Quality Control Plan for the North Coast Region (NCRWQCB

9 Draft document available for download at http://www.northcoastirwmp.net/Content/10377/North_Coast_Assessment_Monitoring_and_Data_Management.html

10 The Sonoma County Water Agency has produced a 12-page listing of reports for the county (in the Russian River watershed) that have been generated by SCWA, DWR, US Army Corps of Engineers, and many others. See http://www.scwa.ca.gov/files/docs/outreach/reports.list-INTERNET.pdf

2011). The list of beneficial uses designated for the Russian River watershed can be found in Appendix 13, Descriptions of Beneficial Uses and reflects human and ecosystem demands on the water resources of the North Coast Region and its Russian River watershed. Five new categories specific to the North Coast Region recently have been added: Flood Peak Attenuation/ Flood Water Storage, Native American Cultural, Subsistence Fishing, Water Quality Enhancement, and Wetland Habitat. Beneficial Uses identified for hydrologic sub-areas and waterbodies of the Russian River Watershed are summarized in Appendix 14.

In the Russian River watershed, in many instances, the quality of the waters for which beneficial uses have been designated surpasses the associated minimum water quality standards required by regulations. Arguably, the quality of these waters could be allowed to degrade until the prevailing water quality conditions match minimum water quality standards. However, both the Federal and State of California Antidegradation policies, which have been enacted pursuant to the Federal Clean Water Act, generally prohibit such a degradation of water quality. They state, in essence, that whenever the existing quality of a given water body exceeds relevant water quality standards, the existing water quality level will become the new minimum water quality standards associated with that water body.

5.4.3 Water Quality Objectives and Standards

Physiochemical Objectives

Under federal terminology, physical and chemical water quality standards for the Russian River watershed consist of (1) the beneficial uses of water, (2) water quality objectives to protect those uses, (3) implementation of Federal and State policies for antidegradation, and (4) general policies for application, permitting, and implementation set forth in the North Coast Region's Water Quality Control Plan ("Basin Plan") and Plans therein (NCRWQCB 2011). Water quality objectives are designed to satisfy all state and federal clean water requirements. Water quality objectives form the basis for establishment of waste discharge requirements, waste discharge prohibitions, and maximum acceptable cleanup standards for all individuals and dischargers. Objectives are achieved primarily through the establishment of waste discharge requirements (point and non-point sources) and through the implementation of the North Coast Basin Plan (NCRWQCB 2011).

In addition to a general objective related to its Antidegradation Policy, the North Coast region has defined specific physiochemical water quality objectives (numeric or narrative) for state waterbody types in three categories: inland surface waters, enclosed bays, and estuaries; groundwaters; and ocean waters. These are outlined in Table 5.11. Objectives for the Russian River watershed are in Table 5.12. See NCRWQCB 2011 for complete listings of narrative objectives and numeric thresholds. The SWRCB hosts a searchable database that summarizes numeric water quality thresholds from the literature for over 860 chemical constituents and water quality parameters.[11]

TABLE 5.11. WATER QUALITY OBJECTIVES FOR INLAND SURFACE, GROUND, AND OCEAN WATERS OF CALIFORNIA

		INLAND SURFACE WATERS, ENCLOSED BAYS, ESTUARIES	GROUND WATERS	OCEAN WATERS
OBJECTIVE CATEGORY	OBJECTIVE TYPE	WATERBODY TYPE		
Bacteria	Numeric	X	X	X
Bioaccumulation	Numeric			X
Biostimulatory Substances	Narrative	X		
Chemical Constituents	Numeric	X	X	X
Color	Narrative	X		X
Dissolved Oxygen (DO)	Numeric	X		X
Floating Material	Narrative	X		
Nutrients	Numeric			X
Oil and Grease	Narrative	X		X
Pesticides	Numeric	X		
pH	Numeric	X		X
Radioactivity	Numeric	X	X	X
Sulfide	Numeric			X

11 See http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/

TABLE 5.11. WATER QUALITY OBJECTIVES FOR INLAND SURFACE, GROUND, AND OCEAN WATERS OF CALIFORNIA				
Suspended Material	Narrative	X		
Tastes and Odors	Numeric	X	X	
Temperature	Numeric	X		
Toxicity (Concentration)	Numeric	X		
Turbidity	Numeric	X		X
Source: NCRWQCB 2011				

TABLE 5.12. SPECIFIC WATER QUALITY OBJECTIVES FOR THE RUSSIAN RIVER WATERSHED (NCRWQCB 2007A).									
WATER BODY	SPECIFIC CONDUCTANCE (MICROMHOS) AT 77ºF		TOTAL DISSOLVED SOLIDS (MG/L)		DISSOLVED OXYGEN (MG/L)			HYDROGEN ION (PH)	
	90% UPPER LIMIT[1]	50% UPPER LIMIT[2]	90% UPPER LIMIT[1]	50% UPPER LIMIT[2]	MIN	90% LOWER LIMIT[1]	50% LOWER LIMIT[2]	MAX	MIN
Upstream Russian River[3]	320	250	170	150	7.00	7.50	10.00	8.5	6.5
Downstream Russian River[4]	375[5]	285[5]	200[5]	170[5]	7.00	7.50	10.00	8.5	6.5
Laguna de Santa Rosa	-	-	-	-	7.00	7.50	10.00	8.5	6.5
[1] 50% upper and lower limits represent the 50th percentile values of the monthly means for a calendar year. 50% or more of the monthly means must be less than or equal to an upper limit and greater than or equal to a lower limit									
[2] 90% upper and lower limits represent the 90th percentile values for a calendar year. 90% or more of the values must be less than or equal to an upper limit and greater than or equal to a lower limit.									
[3] Upstream Russian River refers to the mainstem river upstream of its confluence with the Laguna de Santa Rosa									
[4] Downstream Russian River refers to the mainstem river downstream of its confluence with the Laguna de Santa Rosa									
[5] These values do not apply to the Russian River estuary									

Biological Objectives

Physiochemical objectives, as described above, are certainly necessary to protect water quality but they alone are inadequate to preserve or enhance watershed conditions (Davis and Simon 1995, Karr and Chu 1999, NRC 2001). Supplementation of traditional water quality indicators with responsive biological indicators is recommended. However, California has set no numeric objectives for determining condition of instream biota and for assessing watershed health using biological indicators. Currently responding to this need, the SWRCB is working with partners to develop a suite of bioindicators, bioassessment techniques, and biological objectives for standardized use throughout the state and within watersheds. Their draft Workplan (SWRCB 2010) states that:

(1) *The state should have biological objectives for all waterbody types*. Because the state has begun to include stream bioassessment monitoring in a variety of regulatory permits, the first priority has been bioassessment monitoring of wadeable perennial streams. This is being achieved via the Surface Water Ambient Monitoring Program (SWAMP). The process used for creeks, streams, and rivers will be a framework for other waterbodies (e.g. lakes, riparian/wetland, estuaries, coastal waters).

(2) *The state should use multiple indicators for biological objectives*. Different indicators respond differently to different stressors so integration across a variety of taxa will provide the most holistic assessment of water and watershed condition. Because SWAMP has collected thousands of stream samples for benthic macroinvertebrates (BMIs) statewide, BMIs are the current starting point. The process used for BMIs will be a framework for bioindicators in other taxa (e.g. bacteria, algae, riparian/wetland habitat, amphibians, fishes, and/or birds).

(3) *The state should develop biological objectives with numeric endpoints.* Numeric biological objectives provide for consistent quantitative assessment and interpretation. They also offer the potential to trigger enforcement and remedial actions that narrative objectives do not. The state currently frames physiochemical narrative and numeric objectives but not (yet) biotic objectives.

5.4.3.1 Impaired Water Bodies

Section 303(d) of the Federal Clean Water Act requires each state to identify water bodies that do not meet set water quality standards and are therefore not supporting their beneficial uses. Water bodies that do not meet designated standards are designated "Impaired Water Bodies" and placed on the federal "303(d) List of Impaired Water Bodies" (USEPA 2010). By law, the 303(d) List of Impaired Water Bodies must identify the pollutant or stressor causing impairment of a given water body and establish a schedule for developing a control plan to correct the identified water quality impairment (e.g. via development of a TMDL). Total Maximum Daily Load (TMDL) is the maximum amount of a specified pollutant that a water body can contain and still achieve water quality standards (e.g. support beneficial uses). For impaired water bodies, strategies must be implemented to reduce the pollution load, achieve the TMDL, and move the water body toward compliance with water quality standards.

In the 2010 update of California's 303(d) List of Impaired Water Bodies the following water quality

impairments were identified in the Russian River Hydrologic Unit (RRHU): sedimentation/siltation, high water temperatures, bacterial contamination, mercury, low dissolved oxygen, specific conductivity, nitrogen and phosphorous (USEPA 2010). Some water impairments, such as sedimentation/siltation, occur throughout the drainage while other water quality impairments, such as mercury and bacterial contamination, are limited to specific tributary drainages. In the RRHU, TMDLs are being developed for indicator bacteria (Lower RRHA, Middle RRHA), dissolved oxygen, nitrogen, phosphorus, sediment/ siltation, temperature (Middle RRHA), and mercury (Lower RRHA). A TMDL for dissolved oxygen and nitrogen was established for portions of the Middle RRHU in 1995.

The geographic distribution of listed water quality impairments in the Russian River drainage is summarized in Table 5.13.

TABLE 5.13. GEOGRAPHIC DISTRIBUTION OF WATER QUALITY IMPAIRMENTS

LOCATION	WATER QUALITY IMPAIRMENT
UPPER RUSSIAN HYDROLOGIC AREA	
Forsythe Creek Hydrologic Subarea (HAS)	Sedimentation/Siltation High Water Temperature
Coyote Valley HSA	Sedimentation/Siltation Mercury (in Lake Mendocino)
Ukiah HSA	Sedimentation/Siltation
MIDDLE RUSSIAN HYDROLOGIC AREA	
Warm Springs HSA	Sedimentation/Siltation High Water Temperature
Big Sulphur Creek HSA	Sedimentation/Siltation High Water Temperature Specific Conductivity
Warm Springs HSA	Mercury (in Lake Sonoma)
Geyserville HSA	Sedimentation/Siltation High Water Temperature Bacterial Contamination
Mark West Creek HSA	Sedimentation/Siltation High Water Temperature
Santa Rosa Creek HSA	Sedimentation/Siltation High Water Temperature Bacterial Contamination
Laguna de Santa Rosa HSA	Sedimentation/Siltation High Water Temperature Bacterial Contamination Low Dissolved Oxygen Nitrogen and Phosphorus Mercury
LOWER RUSSIAN HYDROLOGIC AREA	
Austin Creek HSA	Sedimentation/Siltation High Water Temperature
Guerneville HSA	Sedimentation/Siltation High Water Temperature Bacterial Contamination Low Dissolved Oxygen (in Green Valley Cr.)

Source: USEPA 2010

5.4.3.2 Pollution Point Sources

Pollution point sources in the Russian River watershed discharge wastewater of predictable quantity and quality at a discrete source, usually the end of a pipe (NCRWQCB 2011). Point sources may include municipal and industrial releases; urban/ stormwater runoff (see Table 5.14); publically-owned treatment works (i.e. wastewater treatment plants — WTPs; see Table 5.15); underground petroleum storage tanks; and confined animal feeding operations. Point source waste discharges, except as stipulated elsewhere, are prohibited in all surface freshwater impoundments and tributaries; all bays, estuaries, intertidal reaches of the coast; drainageways that flow directly to the ocean; areas of Special Biological Significance; and the Russian River and tributaries from May 15 to September 30 (or whenever flow is inadequate to receive discharges).

The North Coast Basin Plan (NCRWQCB 2011) includes action plans and policies regulating point sources of pollution in the Russian River area to meet water quality objectives and protect beneficial uses. The specific targets of regulation in the North Coast are: (1) Waste discharges from underground petroleum tank systems and cleanup of such polluted groundwaters; (2) Low threat discharges (e.g. from work on geothermal wells, hydrostatic testing of water supply infrastructure; others that pose low threat but technically must be regulated); (3) Stormwater discharges (see Table 5.13); On-site waste treatment and disposal; (4) Solid waste disposal; (5) Agricultural wastewater management; (6) Mining wastes; (7) Fish hatcheries/ aquaculture operations; (8) Power plant cooling; and (9) Residual wastes (e.g. raw sewage from wastewater treatment plants)

TABLE 5.14. NPDES STORM WATER RUNOFF PERMITTEES

LOCATION	NPDES PERMIT TYPE
Upper Russian	
Ukiah and parts of Mendocino County	Phase I
Middle Russian	
Healdsburg	Phase I
Windsor	Phase I
Santa Rosa and parts of Sonoma County	
Rohnert Park	Phase II
Cotati	Phase I
Sebastopol	Phase I

TABLE 5.15. PUBLICALLY-OWNED TREATMENT WORKS IN THE RUSSIAN RIVER DRAINAGE				
DISPOSAL FACILITY/ WWTP	**METHOD**	**LOCATION**	**TREATMENT CAPACITY**	**TREATMENT LEVEL**
Calpella Wastewater Treatment Plant (WWTP)	Percolation Pond	Upper Russian	0.04 million gal/ day	Secondary
Ukiah WWTP	Percolation Pond	Upper Russian	3.01	Secondary/ Tertiary
Hopland WWTP	Percolation Pond	Upper Russian	0.09	Secondary
Cloverdale WWTP	Percolation Pond	Middle Russian	1.00	Secondary
Geyserville WWTP	Percolation Pond	Middle Russian	0.09	Secondary
Healdsburg WWTP	Basalt Pond	Middle Russian	1.40	Tertiary
Windsor WWTP	Store/Reclaim	Middle Russian	2.25	Tertiary
Airport WWTP	Store/Reclaim	Middle Russian	0.90	Secondary/ Tertiary
Oakmont WWTP	Store/Reclaim	Middle Russian	0.06	Secondary
Laguna WWTP	Store/Reclaim	Lower Russian	21.30	Tertiary
Forestville WWTP	Store/Reclaim	Lower Russian	0.13	Tertiary
Graton WWTP	Store/Reclaim	Lower Russian	0.14	Secondary
Russian River WWTP	Reclaim/Land	Lower Russian	0.71	Tertiary
Occidental WWTP	Agricultural Irrigation	Lower Russian	0.02	Secondary

According to the NCRWQCB (2011), California has achieved significant improvements in controlling point source discharges (e.g. municipal or industrial wastewater). In many areas, nonpoint sources (below) are now the primary source of contaminant discharge to surface and ground waters.

5.4.3.3 Pollution Nonpoint Sources

Nonpoint sources of water quality degradation are diffuse in origin and more variable in quantity and quality than point sources. Examples of nonpoint sources include streambank erosion, runoff from rural roads, agricultural runoff (cultivated fields, confined animal feeding operations), faulty septic systems, and failed petroleum storage tanks. Because of their diffuse and variable nature, management of nonpoint discharges is more challenging than for point sources: it requires design and implementation of an array of control techniques customized to local watershed conditions (NCRWQCB 2011). The state is required to assess and regulate the impact nonpoint sources have on local waterbodies. As such, the SWRCB and has adopted the Nonpoint Source Management Plan (1988) and the Water Quality Assessment (1990).

Bank erosion

The North Coast Basin Plan (NCRWQCB 2011) includes action plans and policies regulating nonpoint sources of pollution in the Russian River area to meet water quality objectives and protect beneficial uses. The specific targets of regulation in the North Coast are: (1) Logging, construction, and associated activities (organic waste like sawdust, bark, and silt); and (2) Discharges of herbicide wastes from silvicultural (grape-growing) applications.

6 WATERSHED MANAGEMENT ISSUES

This section discusses major water and watershed management and conservation issues specific to the Russian River watershed. Key issues were identified by experts interviewed[12] for the RRICWMP and by review of the agency and scientific literature for this region/ watershed. Although highly interconnected and overlapping, the issues fall into the following broad categories: habitat and biodiversity loss (as exemplified by salmonids); water quantity; water quality; climate change; and socioeconomic conditions. Strategies to ameliorate these problems are analyzed and proposed in Section 7.

Key Management Issues in the Russian River Watershed

According to a majority of the tribal representatives, scientists, farmers, ranchers, educators, and government authorities interviewed for the RRICWMP, the most pressing issue challenging the viability of ecosystems, processes, and water supplies in the Russian River watershed is the presence of un-regulated (often illegal) direct diversions from tributaries and the river's mainstem. Additional concerns related to natural resources are: habitat loss due to human landuse (e.g. agriculture, urban expansion, road systems, and gravel mining); reduced riparian vegetation and resultant impacts to river hydrology and geomorphology; dams as physical barriers for substrate and salmonids; unsustainable numbers of pumps, diversions, and wells;); inadequate surface storage to offset direct diversion (e.g. for frost protection and summer irrigation); altered flow regime and fluvial geomorphology (e.g. hydrologic disconnection from the flood plain, physical limits to meander, and gravel harvest); lack of groundwater regulation; impaired water quality (particularly turbidity); and forest fuel management practices.

Common areas of concern related to socioeconomics include: increasing human population size; unmet economic needs in disadvantaged and rural communities; and need to further educate public stewards and decision-makers about what the watershed offers — and what it requires. The number one economic factor hindering sustainable function of the Russian River watershed is pronounced and ongoing decreases in federal, state, and county budgets. This lack of systematic and reliable funding hampers permitting, compromises infrastructure maintenance, and constrains (sometimes eliminates) conservation and restoration programs.

6.1 BIODIVERSITY AND HABITAT LOSS

The Russian River watershed is located within the California floristic province, one of 34 regions in the world identified as a "biodiversity hotspot" and one of only four identified in North and Central America (Conservation International 2007). With its mosaic of habitat types and Mediterranean climate, the watershed supports a wide range of vegetation and wildlife species and communities (see overview in Section 3.3). Habitats and species in the watershed may be rare, common, isolated, or widespread: all contribute to local biodiversity and thus support sustainable watershed function. High biodiversity is thought vital for ecosystem resiliency: the ability of natural systems to bounce back from disturbances apparently improves when biodiversity is high. Generally, this is because in diverse ecosystems multiple species are likely to occupy similar niches and so declines in one species are somewhat compensated for by increases in another with little net loss of function. When an ecosystem with reduced bioiversity experiences a species decline there may be no other that performs the same task, resulting in decreased ecosystem function. In one recent example, researchers demonstrated that high algae biodiversity may buffer local ecosystems against the impacts of nutrient pollution

12 See Section 1.2.3 and Appendix 2 for more about interviewees and their responses.

(Cardinale 2011), a finding with direct and profound implications for the Russian River watershed.

Degraded habitat condition and associated biodiversity declines result from both wholesale habitat loss (i.e. land conversion and urban development) and incremental habitat fragmentation (e.g. by instream barriers, roads, and unsuitable habitat). In the Russian River watershed, a significant (but unquantified) amount of actual and potential wildlife habitat has been converted to agricultural, industrial, residential, or urban uses. Barriers such as roads and dams impede migration and access to habitat for both aquatic and terrestrial animals. Although converted landscapes may offer scenic vistas, they do not provide the same habitat functions as undeveloped areas. For example, wildlife species (large mammals in particular) require sufficiently wide riparian corridors to facilitate movement between fragmented habitat parcels; increasingly, intact riparian corridors along streams provide the only functional linkage between the relatively large parcels of protected lands that remain (Hilty and Merenlender 2004).

As the human population continues to grow in the Russian River watershed, so does demand for water and other natural resources that are extracted from natural habitats. Urbanization in the watershed, which increased rapidly after the 1950s (SEC 1996), exacerbates these problems: urbanization and concomitant population growth fuel demand for water, gravel, and other natural resources; increase impermeable surface coverage (which increases runoff); and accelerate new construction (associated with habitat loss, increased sedimentation, and establishment of exotic invasive plant species). Vineyards are increasingly the dominant agricultural crop due to economic incentives to replace forest, orchards, and other lands with grapes and the present trend is to utilize as much land as possible in grape production to maximize profits (Dybas 2004). Timber harvest, agricultural production, livestock grazing, and gravel mining continues, but application of these land uses has changed substantially, with greater emphasis on protecting natural resources and preserving ecosystem function.

Case Study/ Bioindicator: Russian River Watershed Salmonids

For the North Coast region, the NCIRWMP has as its first objective to: "conserve and enhance native salmonid populations by protecting and restoring required habitats, water quality, and watershed processes (NCRP 2007) and a number of the beneficial uses of water identified for the Russian River watershed (listed in Section 5.4.2) were developed with salmon habitat requirements in mind (e.g. COLD, MIGR, SPAWN). By nature of these requirements; their range throughout the watershed (tributaries to ocean and back); sensitivity to land use practices; applicability across geographic scales; vulnerability to climate change; protected status; and need for coordinated public stewardship, this group of anadromous fishes intersects with and integrates a suite of regional and local, terrestrial and aquatic watershed issues. As previously described (Section 5), many habitat attributes for salmonids (Coho, in this case) are characterized as degraded ("Fair" or "Poor," NMFS 2010) and require improvement.

Three species of threatened or endangered salmonids occupy the Russian River watershed and each has experienced major and ongoing population declines throughout the North Coast region (Section 3.3.6). In the twenty first century, the realization that historic land use practices have decimated salmonid habitat and populations has led to development and implementation of BMPs, regulations, and policies that ameliorate impacts and protect or restore salmonid habitat. The California Department of Fish and Game (CDFG) produced the California Salmonid Stream Habitat Restoration Manual (1998) as a guide for salmonid habitat restoration. CDFG has also provided grant funds to implement thousands of salmonid habitat restoration projects. The North Coast Regional Partnership (NCRP) is addressing salmonid habitat restoration as one of six key objectives in the NCIRWMP.

The decline of native salmonid populations in the watershed is generally linked to changes to stream flow (Grantham et al. 2012); increased water temperature; construction of dams for flood control and water supply; channel incision and other geomorphological changes; trends in ocean productivity; hatchery supplementation (which can reduce genetic diversity and introduce disease; SEC 1996); presence of invasive species; and human land use practices. The way people continue to use and manage land and waters in the Russian River watershed will directly and indirectly impact salmonid habitats and the terrestrial systems that feed into them. A growing body of regulatory mechanisms and best management practices (BMPs) is aimed at modifying land use practices in order to avoid, decrease, or ameliorate impacts from these stressors to salmonids' habitats. Unfortunately, legacy effects of past prac-

tices remain to be addressed and determination of "natural" or baseline conditions is far from easy.

Although changing ocean conditions and excessive commercial harvest have played a role in the decline of Russian River salmonids, impacts to freshwater and estuarine habitats are commonly the focus of salmonid recovery efforts. This is because intact instream habitats and surface water quantity are identified by researchers and authorities as critically important in limiting salmonid survival (e.g. CDFG 1998, Grantham et al. 2012). Stream characteristics that may individually and/or synergistically affect salmonids, and which are a focus of the RRICWMP, include the following: stream flow regime, water temperature, substrate quality, habitat complexity, migration passage, and estuary conditions. Refer to Section 5 for current condition assessment ratings (e.g. Good, Fair, or Poor) for these and other watershed attributes, based on Coho salmon bioindicator data in the Russian River watershed (NMFS 2010).

Coho salmon

6.1.1 Altered Stream Flow Regime

Condition of Surface Flow: Poor to Fair

The success of each new cohort of salmonid is dependent upon adequate and timely stream flow; recruitment declines and mortality increases in years of low-flow. Sufficient water flowing at the proper rate and during the right time is necessary to support all freshwater life stages: adults require sufficient water to successfully migrate upstream; eggs, fry, and smolts require the same to provide dissolved oxygen, appropriate temperatures, summer refugia, and passage back downstream. High flow provides the disturbance necessary to create and maintain salmonid habitat: recruiting large woody debris into the stream channel; changing channel structure; creating new side channels and pool; transporting gravel downstream; and flushing fine sediment from stream beds. High flow periods also provide access to upstream habitat that is not accessible during periods of low flow. However, flood events can also scour redds and wash juveniles downstream before they are ready to outmigrate (CRP and NOAA CSC 2004). Thus, while a severe flood may be deleterious to the present cohort of juveniles, it may still improve habitat for future generations.

The maintenance of instream flows is critical to the conservation of aquatic ecosystems and species (e.g. *Oncorhynchus* salmonids. It is recommended that an integrated approach to address both ecosystem and human water demands be implemented (Grantham et al. 2010). According to the latest research (Grantham et al. 2012) surface water quantity in North Coast streams is potentially a limiting factor to juvenile steelhead survival, suggesting that protecting summer streamflow quantity and timing is required for this species (and other salmonids, by extension) to persist. Uncertainty in predicting how natural systems will respond to flow variability has hampered successful implementation of successful flow management. A recently-developed GIS-based computer model (Merenlender et al. 2008) is allowing planners to better understand the complex relationship between flow regime and salmonid persistence; the model is particularly appropriate for application in semiarid regions such as Mediterranean California, where streamflows are seasonally limited, highly variable, and - increasingly - strained to meet human water demands (Grantham et al. 2012).

Low flows naturally occur during summer months, with water quantity becoming a critical factor later in the summer (in the watershed, a period of no precipitation). In streams that maintain flows year-round, reduced summer water quantity may lead to increased water temperatures, passage barriers, reduction in habitat availability, and decreased invertebrate (food) production (Stillwater Sciences 1997). Some attempts to control floods and modify instream flow (e.g. manipulating flow intensity, timing, and frequency) have led to unintended downstream changes in stream channel morphology, sediment regimes, water temperature, and water chemistry (FOER 2002, Steiner Environmental Consulting 1996). The SWRCB is in the process of developing a policy for maintaining instream flows in coastal streams to protect native fish populations, particularly salmonids (SWRCB 2008).

6.1.2 Increased Water Temperature

Condition of Summer Water Temperature: Poor

Water temperature plays an important role in all freshwater stages of the salmonid life cycle. Cool water temperatures are necessary for egg development, fry maturation, juvenile growth, and at extreme temperatures, adult salmonid survival. Water temperature also influences distribution, smoltification, adult migration, juvenile emigration, and adult health. While all species of salmonids are considered cold-water fish, coho salmon are particularly sensitive to increases in water temperatures, with temperatures above 82º F (28º C) being lethal. Slightly lower temperatures allow survival, but increase metabolism, thus increasing the need for dissolved oxygen and prey (CDFG 2002). Optimal water temperatures for coho and Chinook salmon and steelhead (depending upon life cycle stage and species), are between 41º F (5º C) and 59 º F (15º C); coho salmon generally require the coolest temperatures (Thompson and Larsen 2004).

Land use practices that impact water temperature include water diversions, stream flow alteration, and riparian forest removal. These practices, particularly those that increase summer flow volume, have shifted habitat conditions in the Russian River to benefit warm-water fish species (e.g. game fish and non-native species) over cold-water species like salmon. Water diversions for municipal, residential, and agricultural purposes may decrease water depth, leading to higher instream temperatures. Stream flow alteration due to gravel extraction, agriculture, or flood control efforts can change stream morphology (e.g. by eliminating or reducing pools which serve as thermal refugia). Loss of riparian vegetation results in increased solar radiation, which warms streams. Thus, efforts to ameliorate warm stream temperatures include riparian forest revegetation and decreasing water diversions through substitution of other water sources or conservation efforts.

6.1.3 Reduced Substrate Quality

Condition of Substrate Quality: Good (size distribution) to Fair (amount) to Poor (embeddedness)
The size and distribution of substrate in the Russian River watershed is a critical factor in salmonid life history. Sufficiently coarse substrate (e.g. gravel) is required for successful egg hatching and development of young (aelvin). Fertilized eggs remain in gravel nests (redds) for between 30 and 40 days prior to hatching, during which time it is vital that the eggs are exposed to dissolved oxygen; concentrations of 1.74 ml/L or greater are optimal (CDFG 2002). If fine sediment is deposited within the spaces between gravel or if coarse gravel is unavailable for redd construction, the eggs may suffocate before they develop. After hatching, the aelvin remain in the gravel, absorbing their yolk sacs and continue to grow. At this stage adequate oxygen in the substrate is vital for survival (CRP and NOAA CSC 2004). Sedimentation can reduce water movement, limiting oxygen and preventing emergence from the gravel when absorption of the yolk sac is complete. Coarse gravel is also a necessary element in the life cycle of many of the macro-invertebrates on which juvenile salmonids feed. Sediment deposition is a natural process with sedimentation rates and sediment distribution patterns dependent in part upon watershed geology, vegetation patterns, and weather events. In the Russian River watershed, as throughout the North Coast region, human activities and infrastructure greatly altered the natural rate, timing, location, and substrate size of sedimentation processes. Roads are of special concern with respect to erosion and sediment delivery to streams because they serve as both a source of sediment (unpaved roads) and a route for sediment delivery (paved or unpaved). Other causes of changed sediment characteristics include instream mining, dams, and timber management.

The Army Corps of Engineers installed Kellner jacks (jetty jacks) for erosion control on the upper Russian River in Mendocino County in the mid-20th century. Due to channel incision, these jacks lost their ability to stabilize banks. Many have come loose and now pose navigational hazards within the river, impacting recreational use. Efforts are underway to removal navigational hazards caused by the fragmented jacks.

Kellner jack

Gravel and other aggregates currently are mined from streams in the Russian River watershed. Poorly managed, it can lead to flow diversion toward the banks, resulting in excessive bank loss and meander loops, while excessive removal of gravel bars can cause channelization (Simons, Li & Associates 1991). In the Russian River, instream dredging, which began on a wide scale in the 1940s, had mostly ceased by the 1970s; it is currently ongoing in several reaches of the river and Austin Creek (NCRWQCB 2007b). As an alternative, skimming from bars and extraction from pits in the terrace has mostly replaced the instream mining operations (CDFG 2002 Florsheim and Goodwin 1993). In the upper Russian River, channel incision has resulted in exposure of the clay underlying the gravel in Forsythe Creek and in the West Fork Russian River near Calpella. Eroding clay and silt from gravel pit walls in upper Robinson Creek is also increasing fine sediment deposition to the stream system (Chocholak 1992). Combined with channel modifications and land use activities, backwater deposition at the estuary has caused lower Willow Creek to aggrade, becoming a sediment sink (repository) for coarse material originating upstream.

The watershed's two large dams block massive amounts of sediment from passing to the downstream environment (Steiner 1996). Coyote Valley dam and Warm Springs Dam block approximately 200,000 tons and 400,000 tons of sediment per year, respectively (Florsheim and Goodwin 1995). To compensate for this sediment deprivation, the river's flow lifts gravel from downstream streambed and banks, resulting in downcutting. In the Public Review Draft Work Plan to Control Excess Sediment in Sediment-Impaired Watersheds (2007b), the NCRWQCB has identified the need to address dam-induced downcutting.

Timber harvest in the Russian River watershed peaked by the mid-20th century (CDFG 2002). However, legacy effects continue to impact the streams there. As a result, local landowners have been planning and implementing voluntary actions to address erosion and other timber-associated concerns (see Section 4.7, Watershed Groups & Local Collaborations).

Downcutting incision at bridge

6.1.4 Reduced Habitat Complexity

Condition of Stream Channel Habitat: Fair (large LWD) to Poor (small LWD, pool depth/ distribution)

Historically, instream habitat structure in the Russian River watershed was characterized by complex structural features such as side channels, riffles, pools, and rocks, large woody debris (LWD), and overhanging branches of riparian forests. These habitat features provide cover and forage opportunities for juvenile salmonids; protect streams from solar radiation; filter pollutants; absorb precipitation during storm event; provide nutrient input; add structural complexity; and support benthic macroinvertebrate communities (the prey base of salmonids). The presence of LWD and other instream structural elements create heterogeneous stream flow, increase pool development, and enhance gravel retention. The resulting microhabitats provided shelter and forage for salmonids at different stages in their life cycles e.g. creating habitat complexity, providing cover, and collecting and retaining sediment; Flosi et al. 1998). Table 6.1 provides an overview of instream habitat features required by salmonids at different life-stages.

TABLE 6.1. FRESHWATER HABITATS AND THEIR ASSOCIATION WITH SALMONID LIFE STAGES, ESPECIALLY COHO SALMON (AFTER CDFG 2002).

FRESHWATER HABITAT TYPE	LIFE-STAGE
Flat water riffle	Fry, juveniles, spawning adults
Flat water	Juveniles, spawning adults
Gravel streambed	Eggs, alevin, yolk-sac fry, spawning adults
Pool	Fry, juveniles, migrating adults
Side channel	Fry, juveniles
Stream bank	Fry, juveniles
Submerged vegetation and LWD	Juveniles

Over two centuries of land use have degraded habitat structure in California salmonid-bearing streams. Prior to the adoption of the Revised Forest Practice Act of 1973, timber harvest practices which severely impacted instream habitat were routinely implemented. These harvest methods included tractor yarding, LWD removal, flash dams, removal of riparian vegetation, and clear cutting. Additionally, riparian vegetation was routinely removed to increase arable land. The effect of these activities has been loss of channel complexity and reduced instream habitat heterogeneity. Residential and urban development resulted in the construction of roads, culverts, ditches, and storm drains that further simplified the natural complexity of instream habitat. Both large and small dam construction has blocked sediment movement, causing a downstream loss of spawning gravel and changes to downstream channel morphology, further impacting salmonid habitat (Steiner Environmental Consulting 1996).

6.1.5 Instream Barriers

Physical Barriers — Adult Coho Passage: Very Good
Access to spawning and rearing habitats is critical to adult salmon as they migrate upstream to spawn and likewise, it is necessary that juveniles and adult steelhead have clear passage for migration to the estuary and sea. Salmonids are adapted to overcome some natural obstacles, such as large debris accumulations, which usually provide only a partial barrier and are transitory, breaking down within a few seasons. Anthropogenic barriers (e.g. bridges, culverts, low-water crossings, diversions, weirs, and dams) may present more permanent and complete barriers. Culverts and bridges tend to channelize stream flow and prevent natural channel migration, which affects stream hydrology, sediment movement, and stream structure (Thompson and Larsen 2004). Due to road build-up, culverts may be placed at an elevation too high for salmonids to access and the high velocity flow due to channelization may be too strong for salmonids to swim upstream. Debris accumulation within a culvert or at its mouth may also prevent fish passage. Diversions, if left unscreened, may cause fish to be entrained (i.e. they may enter the diversion and be unable to escape; CDFG 2002).

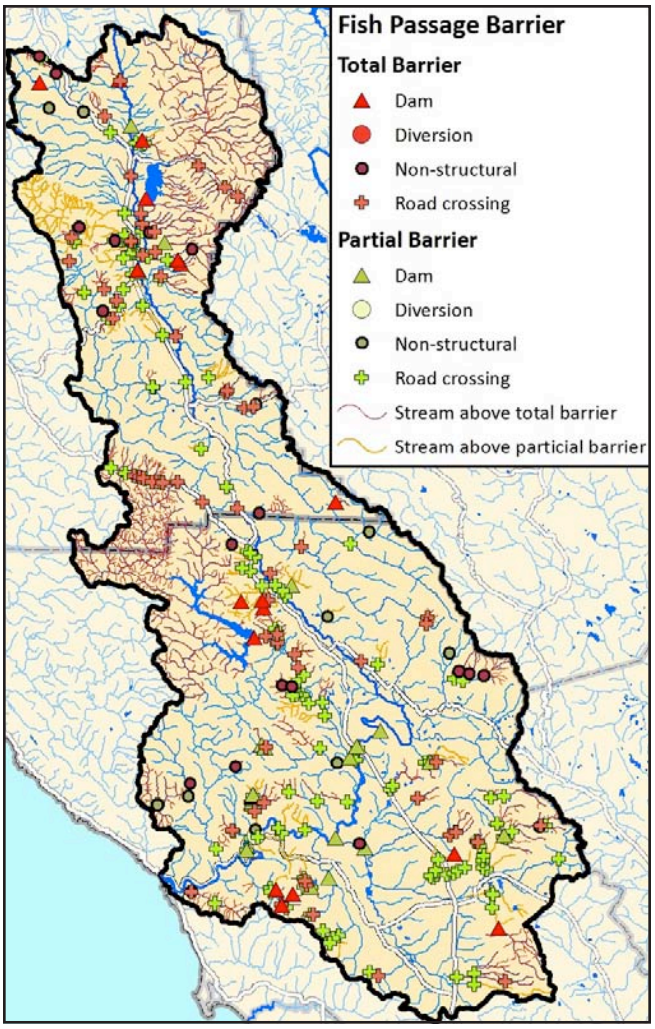


Figure 6.1. Fish Passage Barriers in the Russian River Watershed
Data source: CalFish, California Fish Passage Assessment Database; US Army Engineer Research and Development Center using the Russian River Stream Crossing Inventory and Fish Passage Evaluation by Ross Taylor and Associates, 2003

Low-water crossing

Dams fragment rivers, creating barriers to flow migration, altering channel morphology, and impacting habitat heterogeneity. Construction of the Coyote and Warm Springs dams blocked access to between 86 and 169 miles of valuable spawning and rearing habitat for salmonids (SEC 1996). Unless fish passage is provided, large dams like these present a complete barrier to passage, year-round. Like the large dams, small dams block migration; increase water temperature and sedimentation; and contribute to aggradation, incision, disruption of flow paths, and channel movement (Simons, Li & Associates 1991). For example, the Healdsburg Dam was built in 1952 to hold flashboards to create a deep swimming pool during the summer months; subsequent incision that occurred downstream from the dam led to its damage and repair during the floods in December 1955 and December 1964.

The problem of fish passage is being addressed in many ways throughout California, the North Coast region, and the watershed. CalFish, a cooperative anadromous fish and habitat data compilation and dissemination program, has created an interactive Fish Passage Assessment Database (PAD) that contains spatial and site-specific information about barriers to passage throughout the state (*see Figure 6.1. Fish Passage Barriers in the Russian River Watershed*). The information has been compiled from a variety of sources at various levels of specificity, from highly detailed to very general and contains a tool for local and regional experts to update or correct the database (CDFG NCNCR-ISB undated). The Coastal Conservancy, CDFG, and other agencies have provided millions of dollars in grant funds to improve fish passage throughout the state. CDFG (1998) provides step-by-step instructions for fish passage assessment at stream crossings and Caltrans has developed Fish Passage Design for Road Crossings (2007). Additionally, CDFG and NMFS have established non-regulatory fish screen design criteria to protect juvenile salmonids. CDFG has initiated an inventory of water diversions and fish passage problems on coastal streams and rivers beginning with the Russian River in 2000 and 2001.

6.1.6 Altered Estuary Conditions

Condition of Estuary: Fair

The Russian River estuary provides critical habitat for two life stages of salmonids: adults that are returning to spawn and juveniles that are preparing to out-migrate. Adult salmonids use estuaries as a staging area during the fall to allow their physiology to adjust to freshwater while they await the rising river flows associated with fall and winter storms. Juveniles use estuaries year-round as the last stage in their journey to the ocean, adapting to salt water conditions and utilizing the estuary's abundant food resources. Chinook salmon are most dependent on estuarine habitat, but all juvenile salmonids benefit from rearing in estuaries. Studies have shown that fish that rear in estuaries attain larger size and have a higher survival rate and return percentage (CDFG 2002, CRP 2005). Normally brackish, the estuary converts to a freshwater lagoon during the summer due to the formation of a sandbar at the mouth of the river that blocks flow to the ocean. The Sonoma County Water Agency (SCWA), which has managed estuary water levels since 1994, breaches the sandbar under two scenarios: low-flow estuary management and storm-flow estuary management. SCWA's goal is to maintain a closed system during the summer low-flow season with the intent of improving summer salmonid rearing habitat and to manage the estuary as an open system during the wet winter season to minimize flooding to local property. Currently, however, the sandbar must be breached periodically during the summer to accommodate minimum flow requirements at Hacienda near Guerneville and avoid subsequent flooding that would occur were the sandbar left in place (Cook 2006). Breaching the sandbar during the summer months can impair water quality due to salinity stratification, which is associated with temperature increases and low dissolved oxygen (DO) concentrations.

6.1.7 Coastal and Nearshore Protections

To the extent that local salmonids depend on intact estuary habitat, they are affected by the status and conditions of the coastal and nearshore habitats to which they are connected, physically and functionally. As described in Section 3.3.7.4, the Russian River watershed subsumes two new Marine Protected Areas: the Russian River State Marine Conservation Area (SMCA) and the Russian River State Marine Recreational Management Area (SMRMA). Challenges to management of the Russian River estuary and nearshore environment as an MPA include political, environmental and social factors. The Marine Life Protection Act Process (MLPA), which resulted in the designation of the Russian River SMCA and SMRMA, has been controversial since the California Legislature established the Marine Life Protection Act in 1999 (amended in 2004). Although the process has been touted as transparent and inclusive of all stakeholders, allegations of hidden agendas, a rushed process, and

more recently closed door meetings, have plagued the process (Bacher, 2010, Bradley 2011, Hernan 2011). Recently, the United Anglers of Southern California, the Coastside Fishing Club, and Robert C. Fletcher filed a petition with the San Diego Superior Court against the California Fish and Game Commission, stating that the "privatized MLPA process, directed by the Resources Legacy Fund Foundation, did not follow the requirements of the 1999 Marine Life Protection Act (Lewallen 2011)." The petition requests that the results of the MLPA process be nullified because the process did not follow state transparency laws. Regardless of outcome, this type of controversy has implications for stakeholder buy-in to the SMCA and SMRMA designations and adherence to their rules.

6.2 WATER QUANTITY

Issues specific to surface flows, groundwater supplies, surface-ground connections, and recycled/reclaimed water usage are described in this section. Grantham et al. (2010, "Table 1") presents a good summary of the hydrologic and ecological impacts of water management operations on freshwater ecosystems in Mediterranean regions. Concerns about water supply and availability are paramount in the Russian River watershed, both to support human populations and ecosystem functions, and are particularly urgent considering the variability of precipitation in the watershed. Maintenance of natural flows is known to be necessary for the conservation of freshwater ecosystems worldwide (e.g. Arthington et al. 2006, Dudgeon et al. 2006, King and Brown 2006). The complexity of the situation in the Russian River watershed (e.g. conflicting water needs, variable climate, multiple management schemes) requires new water management approaches that consider both societal and ecosystem needs in a coupled, integrated fashion (Grantham et al. 2010 and references therein; Wallace, Acreman, and Sullivan 2003).

6.2.1 Surface Water Quantity

The surface water supply in the North Coast region is dependent upon precipitation and the degree of subsequent water cachement (e.g. to small ponds or tanks) and redistribution. Most residents depend on small local surface water and ground water systems and, in rural areas in the watershed, it is often necessary to import water for individual residences in tanker trucks during years when rainfall is less than average. There are also several large water supply projects in the region: the Klamath Project (U.S. Bureau of Reclamation); the Russian River Project (U.S. Army Corps of Engineers), which is Lakes Mendocino and Sonoma; and Ruth Reservoir (Humboldt Bay Municipal Water District). These reservoirs are used for water supply, instream flows, recreation, and, with the exception of Ruth Reservoir, to generate hydropower (DWR 2005).

Despite significant annual rainfall, only about 10 percent of the total runoff in the Russian River occurs during the summer months and most of the region is water-limited during this time. The smaller surface water supply projects do not yet supply enough potable water during periods of extended drought and when these occur, water conservation measures are put into effect. In 2007, limited water supplies in Lakes Sonoma and Mendocino were a cause for concern for local residents and water agencies. The SWRCB in June 2007 ordered the SCWA to reduce withdrawals from the Russian River by 15% in order to ensure enough instream flow to accommodate the fall salmon run. These shortfalls in water supply were made up through a combination of increased groundwater withdrawals, turning to other surface water sources, and water conservation measures. Because of the cooperation of contractors and citizens, more stringent measures, such as allocations and rationing did not have to be instituted. In addition to reductions in use, an increase in the use of recycled wastewater and city wells offset the reduced diversions.

There are over 600 documented diversions along the Russian River mainstem with about 800 diversions along tributaries (SCWA 1996b in RRWC 2006), including numerous agricultural diversions that provide water for crops and livestock. Such diversions from tributaries are documented to reduce downstream flows during times when salmonids are migrating through the watershed (Deitch et al. 2009). Municipalities and agriculture account for most diversions with the SCWA as the largest single diverter, with a total allowable amount set at 75,000 acre-feet per year (AFY) at a maximum rate of 180 cfs (SCWA 2004 in RRWC 2006). The total amount of diversion demand is between 110 — 120 thousand AFY with about 41 — 49 thousand AFY occurring upstream of Dry Creek for mostly agricultural purposes (RRWC 2006). The SWRCB has declared several tributaries to the Russian River fully appropriated during certain times of the year in Board Order WRO 98-08 (see Table 6.2. Fully Appropriated Stream Systems in the Russian River Watershed). In 2000 and 2001, CDFG performed an inventory of water diversions in the

Russian River from Lake Mendocino to the mouth of the river. The study identified a total of 196 diversions, dams and weirs with approximately 64% of the diversions less than 10 inches in diameter (outside), about 20% between 11 and 20 inches in diameter (outside), and the remaining 16% of unknown size and greater than 20 inches diameter (outside). A concerted effort was launched between the diverters and the Natural Resources Conservation Services to screen the diversions resulting in 36% being screened according to CDFG criteria (CDFG 2002).

Excess of precipitation (in the form of flood and stormwater) presents management challenges, too. Current flood control measures, which have mostly been adequate to protect life and property, may not bear up to multiple, sequential large storms, and areas which are currently flood-prone may become uninhabitable. Federal, state, and local agencies as well as interested stakeholders are developing strategies to contend with the challenges posed by these anticipated changes and further, to develop the flexibility in management and crisis response to cope with changes that are currently unanticipated.

Russian River watershed is within the geographic scope of the SWRCB's new policy for maintaining stream flows (SWRCB 2008), which establishes guidelines for maintaining sufficient instream flows and stipulate protective measures regarding season of diversion, minimum bypass flow, and maximum cumulative diversion. However, these criteria do not apply to water diversions from 1) the Russian River downstream of Lake Mendocino or 2) Dry Creek downstream of Lake Sonoma, although criteria pertaining to on-stream dams and other aspects of the policy will apply to these river reaches. The SWRCB has already established instream flows for these reaches in Decisions 1030 and 1610 which are implemented through permits held by SCWA.

TABLE 6.2. FULLY APPROPRIATED STREAM SYSTEMS IN THE RUSSIAN RIVER WATERSHED

FULLY APPROPRIATED STREAM SYSTEMS IN THE RUSSIAN RIVER WATERSHED. FROM SWRCB BOARD ORDER 98-08.

STREAM NAME	TRIBUTARY	SEASON BEGIN - END	CRITICAL REACH	DECISION NUMBER	COUNTY
Russian River	Pacific Ocean	7/1 - 10/31	The boundary area of the Mendocino County RR Flood Control and Water Conservation Improvement District crosses the RR a short distance north of the Mendocino/Sonoma County line upstream, excluding all tributaries except the West Fork Russian River and the East Fork Russian River excluding Potter Valley. These restrictions on the main stem of the RR do not apply to uses commencing prior to 1/28/49.	1110,1610, WR 74-30	Mendocino
Robinson Creek	Russian River	7/1 - 10/31	From the confluence of Robinson Creek and the Russian River upstream *	1516	Mendocino
Feliz Creek	Russian River	8/1 - 10/31	From the confluence of Feliz Creek and the Russian River upstream *	1545	Mendocino
Mark West Creek	Russian River	5/1 - 10/31	Mark West Creek from where it crosses Highway 101 located in Section 29, T8N, R8W, MDB&M upstream *	0302	Sonoma
Green Valley Creek	Russian River	6/15 - 10/31	From the confluence of Green Valley Creek and the Russian River upstream *	0663	Sonoma
Atascadero Creek	Green Valley Creek	6/15 - 10/31	From the confluence of Green Valley Creek upstream *	0709	Sonoma
Laguna de Santa Rosa	Mark West Creek thence Russian River	6/1 - 10/31	From Laguna de Santa Rosa and North of Molino (Occidental) Road located within Section 26, T7N, R9W, MDB&M upstream *	0852, 0691	Sonoma
Santa Rosa Creek	Laguna de Santa Rosa	6/1 - 10/31	From Santa Rosa Creek located at the point within Section 18, T7N, R8W, MDB&M upstream *	1038	Sonoma
Unnamed Stream	Russian River	6/1 - 10/31	From the point of diversion immediately downstream and upstream *	1537	Sonoma
Unnamed Stream	Gill Creek thence Russian River	6/1 - 9/30	From the confluence of Gill Creek and the unnamed stream located within Projected Section 1, T10N, R10W, MDB&M upstream *	1608	Sonoma

*This order should be consulted for other conditions under which applications to appropriate water from the listed stream systems may be accepted for filing.

6.2.2 Groundwater Quantity

The Russian River watershed contains 12 groundwater basins and subbasins (DWR 2003; Figure 3.5, Groundwater Basins). Groundwater development in much of the watershed is limited due to the small number of large aquifers. However there is a large basin underlying Santa Rosa in the south. With the exception of these aquifers, most groundwater development in the watershed consists of Ranney collectors - small wells installed adjacent to rivers (DWR 2005). Groundwater quantity is dependent upon rainfall and infiltration rates and the amount of water withdrawal occurring. Withdrawal amounts are partly dependent on the amount of surface water available for municipalities and agricultural enterprises that use both sources. When surface water becomes limited, users switch to groundwater. Unlike surface water, there are currently no regulations regarding groundwater withdrawals in California. As populations increase and available surface water decreases due to drought or instream flow

regulations, greater pressure is predicted to be put on groundwater resources in the Russian River watershed.

Groundwater management occurs in three ways in California: local agency management under authority granted in the California Water Code, local government groundwater ordinances or joint powers agreements, and court adjudications. When local agencies manage groundwater resources, they are required to first assess the extent of the resource and then develop Groundwater Management Plans (GMP) according to DWR guidelines under AB 3030 (DWR 2003). In 2011, SCWA convened a diverse 25-30 member Basin Advisory Panel to collaboratively develop a Santa Rosa Plain Groundwater Management Plan. The plan will be informed by a U.S. Geological Survey groundwater study of the Santa Rosa Plain and is expected to be completed in 2013 (SCWA 2012).

6.2.3 Reclaimed/Recycled Water

Reclaimed (aka recycled) water is an option to which more and more municipalities are turning to enhance water supply reliability. Reclaimed water is currently used within the watershed to irrigate industrial parks, golf courses, and public facilities landscaping. SCWA is currently proposing two projects to utilize recycled wastewater, not only to bolster water supply, but to comply with state requirements that limit wastewater discharge to the Russian River during the spring and summer months. The North Sonoma County Agricultural Reuse Project is located within Alexander Valley, Dry Creek Valley, and the Middle Reach of the Russian River and proposes to supply reclaimed water for agricultural irrigation. The proposed Russian River County Sanitation District Equalization Basin Storage Project would include a 3.6 million gallon earthen equalization basin and structures built and maintained to minimize the potential for National Pollutant Discharge Elimination System permit violations by increasing wastewater storage capacity. In the upper watershed, the City of Ukiah has plans to expand the existing wastewater treatment plant to provide reclaimed water for irrigation for both the plant and the nearby municipal airport.

Reclaimed wastewater infrastructure

6.3 WATER QUALITY

Many water bodies in the Russian River watershed are affected by excess sedimentation, increased water temperature, low dissolved oxygen, and increased pH, which affect their value as habitat. Most of the major tributaries to the Russian River and the main stem are listed as impaired under Section 303(d) of the Clean Water Act (NCRWQCB 2007b). Overall water quality for Coho salmon in the Russian River watershed is considered "Fair" (NMFS 2010, based on "acute toxicity"). The primary pollutants of concern are PCE, petroleum hydrocarbons, pesticides, nutrients, bacteria, and sediment (NCRWQCB 2005).The NCRWQCB water quality goals primarily focus on protecting beneficial uses of surface and groundwater in the Russian River watershed. Beneficial uses of water identified for the Russian River watershed are listed in Section 5.4.2 and uses for specific waterbodies and units of the watershed are in Appendix 13, Descriptions of Beneficial Uses.

Maintaining regulatory activities concerning point source waste discharges to both surface and groundwater from municipal and industrial sites is a high priority for the SWRCB, with the focus on facilities with the highest threat and/or impact on water quality. In general, all Russian River basin water bodies have restrictions on the type and amount of waste discharged in order to maintain high quality waters (NCRWQCB 2007a). Targets have been established for the Russian River HU and the Laguna de Santa Rosa for specific water quality parameters (see Table 5.12, Specific Water Quality Objectives for the Russian River Watershed).

The Russian River provides potable water for more than 600,000 residents in Sonoma and Marin counties through the SCWA water supply system consisting of well collectors, chlorination facilities, corrosion control facilities and an aqueduct system. The city of Ukiah withdraws water from underneath the Russian River as well as using other groundwater sources to supply its customers. Most rural residents in the Russian River watershed are supplied with drinking water through private groundwater wells, where water quality is typically high. In some areas in the watershed, water quality impairments affect drinking water supplies through failing or leaking septic systems, groundwater contamination, and other point and nonpoint pollution sources. Groundwater supplies in the Cities of Sebastopol and Santa Rosa have been contaminated with toxic chemicals, resulting in closure of some of the municipal supply wells.

Individual private wells have also experienced contamination, especially in the West College Avenue area at Clover Drive in Santa Rosa (NCRWQCB 2005).

6.3.1 Nonpoint Sources of Pollution

Primary nonpoint source (NPS) pollutant concerns are sedimentation, nutrients, and destruction of riparian habitat (NCRWQCB 2005). Unlike point source pollution where discharge of pollutants is at a known, discrete point and of known concentration, nonpoint sources of pollution are dispersed throughout the landscape and variable in concentration. Nonpoint sources of sedimentation in the Russian River watershed include land disturbing activities such as timber harvest, agriculture, gravel extraction, construction, road building, and rural (unpaved) road use, and leaking and failing septic systems, particularly in older homes originally built as vacation residences in the Lower Reach of the river. Destruction of riparian habitat increases NPS pollution through the loss of the sequestering and filtration services provided by intact riparian habitat.

Toxic substances have not often been detected in the water column with the exception of high zinc concentrations downstream from urbanized areas. However, sampling in resident fish or freshwater clams does occasionally detect pesticides or heavy metals, with the most significant toxin being mercury in fish from Lakes Sonoma and Mendocino. TMDLs will be developed for mercury for these lakes (NCRWQCB 2005).

Urban stormwater runoff is another significant source of NPS pollution; it drains over impervious surfaces such as parking lots, streets, and buildings, picking up and carrying with it debris, chemicals, sediment, and other pollutants into the storm drain system, and from there into tributaries or the river itself. The more urbanized areas of the watershed — Ukiah, Windsor, Healdsburg, Santa Rosa, Sebastopol, Rohnert Park, and Cotati — produce the most significant amounts of stormwater runoff. Stormwater runoff is a potential contributor to high ammonia and low dissolved oxygen levels in the Laguna de Santa Rosa (DWR 2005). Most stormwater discharges are considered point source discharges by the federal government and require a National Pollutant Discharge Elimination System (NPDES) permit, which in California is issued by the state. Stormwater discharges are usually managed through the implementation of BMPs identified in a municipality's Stormwater Management Plan (SWMP). Each of the cities identified above has filed a SWMP with the state.

NCRWQCB regulatory emphasis has been increased on animal facility waste control, erosion control, riparian improvements, and fishery habitat enhancement. The NCRWQCB is currently developing the Agricultural Lands Program, a regulatory framework for addressing the runoff from agricultural lands, and also promotes NPS pollution reduction through timber harvest inspections, outreach, grants, and promoting land management practices that protect beneficial uses (NCRWQCB 2005).The SWRCB Nonpoint Source Management Plan (1988) emphasizes cooperation with local governments, other agencies, and stakeholders to promote voluntary implementation of Best Management Practices (BMPs).

6.3.2 Impaired Beneficial Uses of Water

As previously explained, waters in California that do not meet standards set by the state are classified as "impaired." In 2008, certain reaches of the Russian River and several of its tributaries are 303(d) listed for impairment by one or more of several pollutants, including sediment, temperature, dissolved oxygen, nitrogen, pathogens and phosphorus (see Section 5.4.2.4, Table 5.12). The North Coast Regional Water Quality Control Board is currently developing Total Maximum Daily Load (TMDL) limits for the Laguna de Santa Rosa to address sediment, temperature, dissolved oxygen, nitrogen and phosphorus impairments with an expected draft completion date of 2012. Mercury monitoring is planned for the Laguna, but the completion of the TMDL for this pollutant is not yet scheduled. Pathogen TMDLs for the Middle and Lower Russian River and Santa Rosa Creek are in development, but no completion date has been scheduled. The NCRWQCB is also developing mercury TMDLs for Lake Mendocino and Lake Sonoma; however, no completion dates have yet been scheduled. The Upper, Middle, and Lower Russian River temperature and sediment TMDLs are not yet in development (pers. comm. M. St. John, NCRWQCB March 2008).

6.4 CLIMATE CHANGE

Regulatory Setting

Climate change has become an important factor in planning decisions for governments, businesses, and NGOs. Federal, state, and local governments have been incorporating climate change considerations into planning for at least the past decade. The Intergovernmental Panel on Climate Change (IPCC) is an international scientific body created in 1988 to provide a clear scientific view of the current state of

knowledge in climate change (IPCC 2012). It reviews, assesses, and disseminates the most recent scientific, technical and socio-economic information throughout the world relevant to understanding climate change. Its most recent reports include *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation* and *Renewable Energy Sources and Climate Change Mitigation*. The United States government initiated its US Global Change Research Program (USGCRP) to coordinate and integrate federal research on changes to the global environment and their societal implications in 1989 (USEPA 2011). The EPA has issued regulatory actions under the Clean Air Act and other statutory authorities to address issues related to climate change and developed a website to disseminate scientific and policy information to communities, individuals, businesses, states, and local governments (http://www.epa.gov/climatechange/).

California is a recognized leader in climate change adaptation and mitigation — its plan for adapting to climate change (Natural Resources Agency 2009) was the first of its kind in the US. California's Climate Action Team (CAT) is composed of members of various state agencies who work to coordinate statewide efforts to implement GHG emission reduction programs and the State's Climate Adaptation Strategy. The Water Energy Climate Action Team (WET-CAT) Working Group includes representatives from the Department of Water Resources (DWR) and State Water Resources Control Board (SWRCB). It is tasked with coordinating efforts on GHG emission reduction and adaptation actions related to energy use involving storage, transport, and delivery of water for agricultural, residential, and commercial needs (State of California 2012). The California Department of Water Resources (2008) has developed its climate change adaptation strategies, which include investing in and developing integrated regional water management, increasing water use efficiency, promotion of integrated flood management, enhancement and protection of ecosystems, expanding water storage and conjunctive water management, and planning for and adaptation to sea level rise. Additionally, the state not only requires state agencies to address climate change in all planning activities, it has also begun to require local governments receiving state funding or operating under state regulations — for example, Urban Water Management Plan development — to incorporate mitigation and adaptation into planning activities (see *Section 7.1.5 Climate Change Adaptation and Mitigation* for a description of local agency efforts in the Russian River watershed).

Projections for the Russian River Watershed

In an effort to facilitate local and regional planning, the state has developed Cal-Adapt (www.cal-adapt.org), a web portal that provides recent, relevant information including local climate projections, interactive maps and charts, research, and access to the raw data used to develop the site (California Energy Commission 2011). The site was developed using downscaled data models, which have been developed in recent years to generate locally relevant projections of long-term weather patterns by layering local-level data over larger-scale climate models. Although useful, for planning purposes, downscale models — like all simulation models — inherently contain uncertainties (e.g., future levels of GHG emissions); however, in downscale models, uncertainty cascades through each stage (Cooney 2012). To obtain optimal results, the average of a number of climate models is consistently more accurate than individual results, and projects are consistently underway to improve understanding of local processes that affect Northern California. As better downscaling methods and enhanced climate models are developed, more accurate local-level climate projections will be possible (Ray et al. 2008).

Solar energy — a tool in climate change mitigation

Current downscaled projections (several models, averaged) for Northern California show steadily increasing temperatures (averaging about 2°C to 5°C by 2100) with substantial warming during the hydrologically sensitive spring period. The warmer temperatures are expected to be both seasonally and spatially asymmetric, with winter temperatures between 1°C to 4°C warmer and summer temperatures expected to increase between 1.5° C to 6° C. Summer inland temperatures may be as much as 4° C higher than within 50 km of the coast (Cayan et al. 2009). Heat waves are expected to increase in frequency, magnitude, and timing; they historically occurred mainly in July and August but will likely begin in June and could continue to occur through September (Gershunov and Douville 2008, Miller et al. 2008, Cayan et al. 2009). By the last 30 years of the twenty-first century, heat waves are also predicted to last longer, with events lasting five days or more occurring up to twenty times more frequently than at present (Cayan et al. 2009).

Multiple runs of several models indicate somewhat drier conditions with the number of significant storms (as indicated by number of days per year when sea level pressure equals of falls below 1005 millibar) in decline along the coast in both the San Francisco and Crescent City regions. The occurrence of high daily precipitation events (as indicated by daily precipitation of at least 25 mm) predicted by the models varies, but remains about the same as the simulated historical record (Cayan et al. 2009). After modifying methodology to incorporate observed sea level changes over the past century, Cayan et al. (2009) predict a sea level rise ranging from 30 to 45 cm by 2050 relative to the 2000 sea level. Sea level rise will cause an increase in high sea level events that occur during high tides, winter storms, and El Niño occurrences (Cyan et al. 2008).

Impacts to the Russian River Watershed

Climate change will affect plant and animal distribution, ecosystem function, and a number of human activities in the Russian River watershed. About two-thirds of the native plant species endemic to California are projected to experience range reductions over 80 percent by the end of the century (Loarie et al. 2008). Vegetation patches near the edge of their climate envelope are likely to change relatively rapidly. Topography will have a strong influence on rate of change, with mountainous habitats experiencing a more gradual migration because short distances up or down slope can result in large temperature changes (Loarie et al. 2009). Complexity arising from topography will also affect species distribution. For example, in the San Francisco Bay Area, blue oak distribution is predicted to increase on north-facing slopes while decreasing on south-facing slopes (California State University 2010). Complex topography is also likely to provide a spatial buffer to range loss — heterogeneous landscapes provide a greater climatic heterogeneity and thus support a greater diversity of vegetation types, potentially preserving biodiversity. The topographical complexity of the mountainous areas of the Russian River watershed, may slow changes in species distribution and help to preserve watershed biodiversity.

Extreme events — particularly storms and wildfires — are predicted to increase in severity and frequency. Russian River riparian ecosystems have evolved as highly disturbed systems; however increased magnitude and frequency of episodic storm events is likely to have a profound effect on the flora and fauna of these systems. Coho and steelhead populations, which are declining due to anthropogenic and oceanic conditions, may not be able to withstand further stressors. Climatic fluctuations could cause extreme conditions that could be catastrophic to these salmonids. Although they evolved with variable habitat conditions, extreme changes combined with low population numbers, habitat reduction, and habitat degradation may cause an irrecoverable decline in local populations or an entire species. Increased wildfires will consume forest and shrublands resulting in short-term conversion to grassland (Lenihan et al. 2006). Loss of native vegetation could lead to a greater incidence of nonnative invasive plants; the type of vegetation that succeeds a native ecosystem depends on the mortality of existing mature plants and propagule sources for replacement species (California State University 2010). An increased sea level will affect Lower Russian River communities through the potential for increased flood-related damages during storm events.

Forest fires are predicted to increase with climate change

Impacts to human activities include impacts to agriculture and other natural resources-based industries, human health, increased electricity demand, increased pollution, and increases in infectious diseases. Increased temperatures and changes to water availability will have important effects on agricultural crops. For example, wine grapes, which are an important agricultural commodity in the watershed, can ripen prematurely due to high temperatures, affecting grape quality. By the end of the century, wine grapes could ripen as much as one to two months earlier than at present, which could affect grape — and therefore wine — quality in the watershed (California Energy Commission 2011). Karl et al. (2009) estimate losses of up to 40% for wine, table grapes, and similar commodities throughout the state by 2100. Temperature and CO_2 increases are also likely to lead to proliferation of pests, disease outbreak, and increased need for water as well as causing changes to crop phenology — the timing of flowering and fruit set. These changes may disrupt pollination processes if crop phenology becomes unsynchronized with pollinator life cycles, which also may experience climate-related changes. Timber harvest, another important natural resources-based industry in the watershed, will also be impacted by the rapidly changing climate. Individual tree growth rates are likely to change, insect outbreaks and pathogens are likely to become more prevalent, and shifts in species ranges and forest composition will occur. Hannah et al. (2009) predict decreases of 4.9 percent to 8.5 percent in the value of timber harvested in the state by 2100. Impacts to human health will be borne disproportionately by children, the elderly, and poor. Native American populations, which are tied by culture and poverty to specific land areas, are also considered vulnerable. In the Russian River watershed, several groups of Pomo people are working to restore cultural integrity; environmental changes could prevent renewal of certain cultural activities, such as plant and salmon harvest.

6.5 SOCIOECONOMIC AND STEWARDSHIP CHALLENGES

According to the stakeholder experts interviewed for the RRICWMP, the number one economic factor hindering sustainable function of the Russian River watershed is pronounced and ongoing decreases in federal, state, and county budgets. This lack of systematic and reliable funding hampers permitting, compromises infrastructure maintenance, and constrains (sometimes eliminates) conservation and restoration programs. Other challenges related to economic realities include the economically disadvantaged communities of the watershed (who are often procedurally underrepresented) and the overall need for greater support of community agriculture, restoration projects, and stewardship programs.

This RRICWMP has as Goal V "to develop and maintain public understanding, stewardship and support for natural resource processes and a healthy watershed." In 2002, 92 percent of the Russian River was privately owned with federal ownership accounting for six percent and the remaining two percent owned by the state (NMFS 2009). At just 607 acres, the amount of land in local ownership — city and county parks — did not even amount to one percent of the watershed's area. With such a large area in private ownership, community involvement and stewardship is essential for successful watershed management. Fortunately, there are many watershed groups and public-private partnerships at work improving both publicly and privately owned lands to benefit salmonid habitat and improve watershed health (see Section 4.7, Watershed Groups & Cooperative Efforts). Despite the many groups actively working towards very similar goals, challenges exist.

The extensive geographic area, multiple municipalities, and large, diverse populace make communication of even simple messages throughout the watershed difficult. However, utilization of existing mechanisms and partnerships that seek to leverage resources, funding, and media opportunities will facilitate this effort. The North Coast Regional Water Management Plan (NCIRWMP) provides a framework for stakeholder outreach to all watershed entities (from individuals, to non-governmental groups, to local, state and federal agencies) the NCIRWMP "incorporates the unique issues, information and planning approaches of local areas within a framework that integrates statewide planning priorities (NCIRWMP 2007)." By utilizing this mechanism when appropriate, it will be possible to synchronize local goals and activities with regional goals and statewide programs and directives. For example, concerns within a small sub-watershed — such as agricultural water availability for frost protection on Grape Creek — can be linked to statewide priorities such as reduction of conflict between water users and implementation of Regional Water Quality Control Board policies. With this in mind, vineyard owners may be able to frame their needs and concerns in a way that collaborates with and conforms to, rather than struggling against, state policies.

By becoming familiar with the efforts and activities of others working within the watershed, duplication of effort can be avoided and it would be possible to combine resources and synchronize efforts to get the biggest "bang for your buck." Utilizing a framework such as the NCIRWMP to accomplish this will tie efforts in the Russian River to the larger regional work being accomplished to bring reliable water supply, high quality water, enhanced watershed health, and environmental and social justice to residents of the entire North Coast.

Since the 1970s, regulations and incentives have resulted in the development of Best Management Practices (BMPs) and Management Measures (MM) to reduce and mitigate environmental impacts associated with many human activities (see Appendix 16, Management Measures for the Russian River Watershed). Additionally, a growing public awareness of the importance of a healthy environment resulted in more laws and regulations to preserve and protect environmental quality and the formation of non-governmental and governmental agencies to acquire and protect wild lands. The Mendocino Land Trust, which has as its mission "to conserve important natural resources of Mendocino County including working farmlands and forests, wildlife habitat, open space, scenic vistas, watersheds, and to facilitate public access (MLT 2009)," was incorporated in 1976. The Sonoma Land Trust has been fulfilling a similar mission in Sonoma County since 1976. Other entities in both counties (e.g. smaller watershed groups) (see Table 4.1, Watershed Groups & Local Collaborations) as well as larger regional and national groups (e.g. Trout Unlimited and Save-the-Redwoods League), have been working to protect natural resources in the watershed. Approximately 3525 hectares of the Russian River watershed are protected through easements or fee title purchases (see Figure 3.8, Open Space and Protected Areas).

In 2005, a group of stakeholders representing local governments, state and federal agencies, and local interest groups developed the Santa Rosa Conservation Strategy, which identifies conservation areas and preserve systems, outlines conditions for translocations and criteria for habitat improvement. Local governments are in the process of completing the implementing ordinances for the plan and the USFWS is approving new conservation banks to assist conservation efforts (USFWS 2010).

7 RESOURCE MANAGEMENT STRATEGIES

7.1 STRATEGY IDENTIFICATION AND ORGANIZATION

Methodology

Section 7.1 presents a series of Resource Management Strategies (RMSs), RMS Recommended Approaches and Priority Recommendations developed during the RRICWMP process, to address key issues in the Russian River watershed. Potential RMSs and associated RMS-Recommended Approaches are identified and categorized; briefly described; and each analyzed to weigh benefits and costs (see Section 7.2 Cost Benefit Analysis of Resource Management Strategies). Priority Recommendations for the Russian River watershed were derived from an analysis of the existing data, report literature, planning documents and expert interviews in the Russian River watershed. The RMSs proposed herein were compiled and refined for the RRICWMP via:

- Evaluation of numerous datasets and 40 planning, agency and peer reviewed documents for the Russian River watershed, development of a database to cross-reference 1353 recommended management strategies and measures outlined in these documents, and to determine recommended management strategies and priority actions at the watershed and sub-watershed scale (see Appendix 15, Recommendations for the Russian River Watershed from Agency and Peer-Reviewed Documents and Expert Interviews)
- Synthesis of 195 recommendations and management strategies from interviews with experts in the watershed (see Appendix 15);
- Analysis and screening of management recommendations using the goals and objectives identified by the TAC (see Section 2) to determine Priority Recommendations for each Resource Management Strategy.
- Review and evaluation of potential management strategies and Priority Recommendations by the RRICWMP Technical Advisory Committee; and
- Public review and comment on management strategies and Priority Recommendations.

Appendix 15, Recommendations for the Russian River Watershed from Agency and Peer-Reviewed Documents and Expert Interview, lists the 1548 recommendations by Resource Management Strategy.

Classification

The synthesis of potential strategies described above resulted in 22 groups of RMSs subsuming 140 specific RMS Recommended Approaches, arranged more or less hierarchically and with as little redundancy as possible. Proposed management strategies deliberately integrate a diversity of management and conservation issues across the watershed, and it is recognized that overlap between the different Resource Management Strategies is unavoidable. However, for the sake of organization, RMSs below are assigned to broad headings: Natural Resources and Land Management (7.1.1), Water Supply Reliability (7.1.2), Flood Risk Management (7.1.3), Water Quality Improvement (7.1.4), Climate Change Adaptation and Mitigation (7.1.5), and Recreation and Public Access (7.1.6). These are intended to address the issues identified in Section 6 related to salmonid and other biodiversity concerns; habitat loss; water supply; beneficial uses of water; climate change; and public stewardship. They also subsume all Section 2.0 Goals and Objectives regarding watershed processes and land use; hydrologic and geomorphologic function; water supply and quality; native biodiversity; public stewardship; and technical assessment.

At the finest scale, a set of Best Management Measures associated with each strategy is included in Appendix 16, Management Measures for the Russian River

Watershed, and a matrix of RRICWMP Management Measures to implement Resource Management Strategies is provided in each RMS section.

To conform to statewide management classification systems, the RMSs identified for the RRICWMP align with DWR Resource Management Strategies developed for the Water Plan Update (http://www.waterplan.water.ca.gov/cwpu2009/index.cfm#volume2). RRICWMP Management Measures identified to implement RMSs in the Russian River watershed, follow where possible the SWRCB Management Measures developed for the California Nonpoint Source Pollution Control Program and described in the Nonpoint Source Encyclopedia (http://www.waterboards.ca.gov/water_issues/programs/nps/encyclopedia.shtml).

Strategy Screening Criteria

In order to prioritize and screen the management strategies and recommendations listed above, the project team evaluated the 1548 recommendations in a database of information, reports, plans and peer reviewed literature from the Russian River watershed, as well as results from the expert interviews. Information gathered for each of the recommendations include: source document, agency publisher and date of publish; interviewee name and agency they represent; primary and secondary recommendation type (assessment, planning or implementation); primary and secondary subject; hydrologic sub-area and specific location information; and appropriate RMS. Ranking and prioritization was achieved by the project team screening the recommendations against the 60 goals and objectives identified by the RRICWMP TAC.

Results

The management strategies identified are considered the highest priority issues and management recommendations for the Russian River watershed. Although these Priority Recommendations are prioritized based on the quantitative analysis described above, watershed groups, agencies and landowners may decide to implement some of the lower priority strategies due to opportunities, cost, or personal preference. Tables 7.1 — 7.4 provide a summary to the analysis findings.

For each of topics 7.1.1-7.1.6, one or more RMS is presented and each RMS includes a suite of specific RMS Recommended Approaches and the top-ten Priority Recommendations from agency and peer-reviewed documents and interviews with watershed experts. A full listing of the 1548 prioritized recommendations can be found in Appendix, 15. Recommendations for the Russian River Watershed from Agency and Peer-Reviewed Documents and Expert Interview which is organized by Resource Management Strategy. Section 7.2 discusses the cost-benefit analysis of the Resource Management Strategies.

TABLE 7.1. NUMBER OF RUSSIAN RIVER RECOMMENDATIONS BY RESOURCE MANAGEMENT STRATEGY AND RECOMMENDATION TYPE

RESOURCE MANAGEMENT STRATEGIES	TOTAL	RECOMMENDATION TYPE		
		ASSESSMENT	PLANNING	IMPLEMENTATION
Natural Resources and Land Management	998	218	81	699
Water Supply Reliability	145	35	10	100
Flood Risk Management	48	3	26	19
Water Quality Protection and Improvement	309	89	19	201
Climate Change Adaptation and Mitigation	7	1	2	4
Recreation and Public Access	41	1	7	33
	1548	**347**	**145**	**1056**

TABLE 7.2. NUMBER OF RUSSIAN RIVER RECOMMENDATIONS BY RECOMMENDATION TYPE AND SUB-RECOMMENDATION TYPE

RECOMMENDATION TYPE	RECOMMENDATION SUB- TYPE	# OF RECOMMENDATIONS
Assessment	General	4
	Management	21
	NPS	29
	Restoration	14
	Science	222
	Socioeconomic	7
	Spatial	50
Assessment Total		347
Planning	General	6
	Management	21
	Policy	51
	Public Outreach	1
	Restoration	22
	Science	24
	Socioeconomic	20
Planning — Total		145
Implementation	General	50
	Management	173
	NPS	111
	Public Outreach	95
	Policy	153
	Restoration	321
	Science	44
	Socioeconomic	109
Implementation — Total		1056

TABLE 7.3. NUMBER OF RUSSIAN RIVER RECOMMENDATIONS BY LOCATION AND HYDROLOGIC SUB-AREA	
LOCATION	**# OF RECOMMENDATIONS**
Forsythe Creek HSA	48
Coyote Valley HSA	9
Ukiah HSA	42
Warm Springs HSA	56
Sulphur Creek HSA	5
Geyserville HSA	101
Mark West HSA	25
Santa Rosa Creek HSA	81
Laguna de Santa Rosa HSA	237
Guerneville HSA	174
Austin Creek HSA	35
Mainstem Russian River	83
Russian River HU	652
	1548

TABLE 7.4. PRIORITY RRICWMP GOALS AND OBJECTIVES

Priority RRICWMP Goals and Objectives were determined by the number of times the goals/objectives were selected when cross-walked with the 1548 RRICWMP recommendations identified for the Russian River watershed from agency and peer-reviewed documents and expert interviews.

ID	GOAL	OBJECTIVE DESCRIPTION	% *
404	Native Habitat, Fish and Wildlife	Address limiting factors for salmonids and other sensitive populations including but not limited to large woody debris recruitment, sediment reduction and canopy cover.	76%
606	Scientific and Technical Assessment and Planning	Perform monitoring of implementation activities and adapt management plans based on new data acquired.	76%
402	Native Habitat, Fish and Wildlife	Protect and enhance sensitive species, populations, communities, their habitats and the ecosystem processes on which they depend	75%
309	Water Quality	Document and show-case successes.	70%
407	Native Habitat, Fish and Wildlife	Document the historic and current distribution, quality and abundance of sensitive plant and wildlife species and communities, and the habitats and ecosystem processes on which they depend	70%
601	Scientific and Technical Assessment and Planning	Conduct ongoing comprehensive and integrated assessments to describe the physical, chemical and biological characteristics of the Russian River watershed and its sub-basins (e.g., vegetation cover at the watershed scale, riparian corridor extent and quality	70%
401	Native Habitat, Fish and Wildlife	Promote policies and practices that conserve and enhance native fish and wildlife habitat in an integrated fashion	68%
109	Watershed Land Use and Management	Promote policies, programs and projects that identify benefits of watershed-based planning and management, provide financial incentives and regulatory relief approaches to enhance watershed planning and stewardship.	68%
406	Native Habitat, Fish and Wildlife	Increase resiliency of sensitive habitats and populations due to climate change through enhancement of biodiversity, habitat connectivity and ecological function.	67%
403	Native Habitat, Fish and Wildlife	Identify opportunities to reverse habitat fragmentation and promote habitat connectivity.	64%
405	Native Habitat, Fish and Wildlife	Maintain and enhance salmonid population levels to allow for the resumption of Tribal, recreational and commercial fisheries.	62%
605	Scientific and Technical Assessment and Planning	Identify and fill data gaps to promote adaptive watershed management.	62%
110	Watershed Land Use and Management	Restore degraded upland and riparian habitats and processes utilizing peer-reviewed stream corridor protection and watershed management methods	57%
303	Water Quality	Improve and support land management practices that promote soil retention and protect riparian and instream conditions (e.g., grading ordinances and septic system requirements).	52%
307	Water Quality	Address other identified water quality problems, such as stormwater, sediment, nutrient, pathogen, and toxic contamination of surface water and groundwater in the Russian River watershed.	51%

7.1.1 Natural Resources and Land Management

Effective natural resources and land management involves the integration of multiple management strategies to respond to opportunities and constraints presented by local environmental conditions and to enhance and protect ecological benefits and habitat value. Natural Resources management strategies are of four main types: 1) Ecosystem Restoration; 2) Environmental and Habitat Protection and Improvement; 3) Watershed Planning; and 4) Wetlands Enhancement and Creation. The Russian River watershed provides opportunities to pursue each of these types of natural resources management strategies; these are discussed in detail below. Priority RRICWMP recommendations identified for the Russian River watershed related to Natural Resources and Land Management from agency and peer-reviewed documents and expert interviews are provided in Section 7.1.1.5. Also listed are appropriate management measures for the suite of Resource Management Strategies which are described in greater detail in Appendix 16, Management Measures for the Russian River Watershed.

7.1.1.1 Ecosystem Restoration

According to the Federal Interagency Stream Working Group (2000), ecological restoration is the "process of *returning an ecosystem as closely as possible to pre-disturbance conditions and functions." Implicit in this definition is that ecosystems are naturally dynamic. The restoration process reestablishes the general structure, function, and dynamic behavior of the ecosystem.* Often the ecosystem requiring restoration has been

degraded, damaged, transformed, or entirely destroyed directly or indirectly by human activities. These systems have generally been changed so drastically for so long that restoration to their pre-disturbance condition is not possible, either due to existing structures and land uses or because many species within them have been locally extirpated. Instead, as defined above, efforts focus on restoring important elements of the structure and function of that ecosystem to improve overall watershed health. These can include reproducing natural flows in streams and rivers, removing barriers to fish migration in rivers and streams, and restoring the hydrologic regime to formerly filled-in wetlands.

Ecosystem restoration attempts to return an ecosystem to its historic trajectory, therefore, historic conditions are the ideal starting point for restoration design. However, the historic trajectory of an extremely modified ecosystem may be difficult or impossible to determine. Thus, land managers often approximate the historic trajectory utilizing a combination of knowledge of the damaged system's pre-existing structure, composition and function coupled with studies of comparable intact ecosystems and analysis of other ecological, cultural, and historical information. In the Russian River watershed, historic accounts of natural resources are evaluated along with information available about similar watersheds that have not been as heavily impacted by agricultural and urban activities.

Restoration is generally undertaken with an emphasis on recovery of at-risk species and natural communities. In the Russian River watershed, most restoration efforts focus on increasing endangered coho salmon and threatened steelhead salmonid populations, thus, they focus on instream and riparian ecosystem restoration. However, opportunities for upland habitat restoration — both terrestrial and wetlands — exist throughout the watershed. For implementation actions, see Section 7.1.1.5 for Priority RRICWMP Recommendations and Appendix 16, Management Measures for the Russian River Watershed: Terrestrial Habitat Restoration and Management. Pursuit of these opportunities would provide groundwater recharge, off stream flood attenuation, carbon sequestration, and potentially habitat connectivity benefits. Because of the strong federal, state, regional and local focus on salmonid habitat restoration, this section will focus on instream and riparian restoration.

Instream and riparian restoration is a complex undertaking and in addition to reestablishing native plant species, stream bank stabilization, and other geomorphic and habitat alterations, restoration can include sediment reduction, water quality enhancement, improving instream flow, and habitat acquisition projects (see Appendix 16, Management Measures for the Russian River Watershed: Instream Habitat Protection, Restoration, and Management; Streambank Erosion Control, Flow and Temperature Maintenance, and Fish Passage Enhancement). Each of the activities that comprise an ecosystem restoration plan can also be performed individually to improve and protect habitat.

Effective salmonid habitat restoration requires rigorous multi-disciplinary assessment and planning, an adaptive approach to post-restoration habitat management, and a long-term commitment of both time and resources to the process. An important attribute of sustainable riparian corridors and instream habitat in the Russian River has historically been the dynamic interaction between hydro-geomorphic and biological processes (see Section 5.1.2, Floodplain and Riparian Zone and 5.1.3, Stream Channel). The Laguna de Santa Rosa and other, smaller floodplains in the watershed historically included a broad floodplain gallery forest with backwater sloughs, oxbow lakes and floodplain wetlands — which all contributed to the maintenance of water quality and the sustainability of aquatic organisms. The dynamic physical processes that produced these features — such as flooding and meandering — were the foundation for aquatic and riparian habitat structure and function. Higher in the watershed, high-gradient woodland streams, oak grasslands, and coniferous forest formed a matrix of interdependent ecological units that provided instream habitat structure and upland habitat for a wide variety of plants and animals. High gradient streams did not meander as much, but during periods of high flow, they overtopped streambanks, and uprooted trees, creating a zone of disturbance where only vegetation adapted to periodic disturbance would persist. Woody debris created during such events would travel downstream and at times lodge instream, creating the deep pools and cover essential for juvenile salmonid survival (see Section 6.1 Salmonid Population Decline).

Since human and natural impacts affect individual habitat features as well as landscape practices, it is imperative to plan restoration efforts at an appropriate spatial and temporal scale. In some cases, relatively rapid and site-specific actions such as removing a passage barrier or reestablishing riparian cover may be sufficient to restore instream and riparian habitat. In other cases, disruption of landscape scale processes is so profound that site-specific

actions will not be successful unless the underlying cause of the habitat disturbance is addressed, which is often a large-scale, resource intensive, long-term process that involves multiple agencies and jurisdictions. In the Russian River watershed, site-specific actions are much more likely to be successful in relatively undeveloped tributaries whereas restoration efforts on the mainstem or highly impacted tributaries are much less likely to produce their intended effects without concurrent changes in land use practices or changes to existing infrastructure.

Current Activities

Many efforts to restore riparian and instream habitat have been undertaken by watershed groups, agencies, and landowners throughout the watershed over the past forty years. These have included removing invasive non-native plant species such as *Arundo donax* and Himalayan blackberry *(Rubus armeniacus*), replanting riparian vegetation, and removing fish passage barriers. However, because of the large dams —Coyote and Warms Springs Dams (see Section 3.1.4.5 Water Supply and Flood Control Infrastructure)— it is not possible to fully restore the historic hydrologic processes of the watershed; continued operation of these dams continues to affect the watershed's hydrology (see Sections 3.1.4 Hydrology and Geomorphology, and 6.1 Salmonid Population Decline).

In 2008, the National Marine Fisheries Service (NMFS) issued a Biological Opinion for the Russian River (NMFS 2008) that finds current dam operations under SWRCB Decision 1610 (D1610) — which establishes minimum flows for both Dry Creek and the Russian River — to be detrimental to steelhead recovery. Current high flows in Dry Creek during summer months exceed tolerances of rearing juvenile steelhead and likewise, high flows in the East Fork Russian River during summer months affects 34 miles of juvenile steelhead habitat in the upper river. As SCWA implements the changes directed in the Biological Opinion, the return of flows that more closely mimic historic flows may compliment riparian and instream restoration efforts, allowing for greater success in reestablishing historic habitat. However, sediment will remain trapped behind the dams and other land use practices that impact geomorphology and hydrology will continue to impact aquatic and riparian habitat (see Sections 3.1.4 Hydrology and Geomorphology, and 3.2 Land Ownership and Land Use).

The Russian River Coho Water Resources Partnership is also attempting to restore hydrologic conditions to several tributaries in the Lower Russian River (RRCWRP 2011). This group is exploring options for rainwater catchment, stormwater catchment, and groundwater recharge in order to leave more water instream for environmental beneficial uses during summer, when low instream flows and high water temperatures limit salmonid habitat availability.

Potential Benefits of Ecosystem Restoration

Water Quality

The ability of riparian ecosystems to sequester pollutants and improve water quality is well-documented (Lowrance et al. 1997, SWRCB and CCC 2000, US EPA 2010). Streamside riparian forests prevent erosion and subsequent stream sedimentation and provide habitat for terrestrial wildlife. Additionally, by dropping detritus and supplying large wood, riparian ecosystems provide the basis for the instream food chain and enhance instream habitat structure.

Sustainability

When water and flood management projects incorporate ecosystem restoration, they are more likely to be sustainable than those that do not (DWR 2009). Less maintenance will be required of projects that work with, rather than against, natural processes that distribute water and sediment, resulting in cost savings over the life of the project.

Restoration can increase ecosystem resilience, and therefore sustainability, if it increases biodiversity within an ecosystem. Resilience is an ecosystem's ability to bounce back after disturbance. When an ecosystem has high biodiversity, multiple species perform the same task; this redundancy allows the ecosystem to continue to function if a single species experiences a decline (see Section 6.1 Biodiversity and Habitat Loss).

Climate Change Amelioration

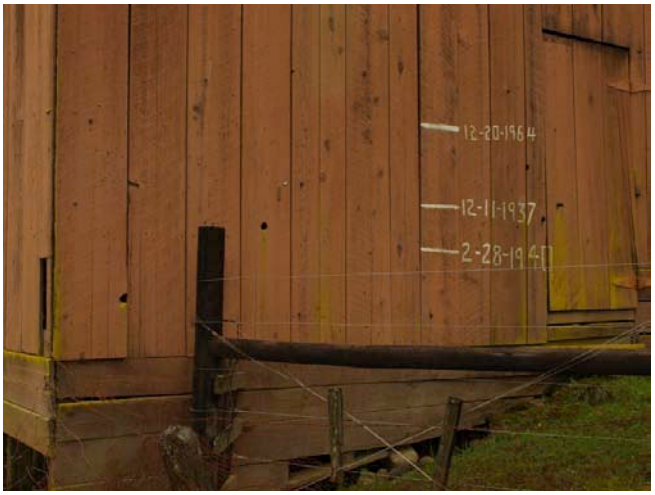
Climate change predictions for the North Coast of California include increases in frequency and severity of weather events including storms and heat waves, rising temperatures, and decreased moisture availability. Ecosystem restoration can mitigate for carbon emissions by sequestering carbon. Growth rates in trees in low-elevation riparian forests in California are among the highest in the world, thus, significant expansion of riparian forest could serve as a carbon sink and significantly contribute to carbon emissions reductions targets set by local governments (DWR 2009). Restored riparian forests are also likely to play an important

role in buffering developed areas from the flooding events that are expected to become more severe.

Wetlands restoration (see Section 7.1.1.4, Wetland Restoration, and Appendix 16, Management Measures: Wetland Restoration and Management), may also serve an important role in climate change mitigation. Wetlands, particularly tidal marshes, are extremely productive habitats that capture significant amounts of carbon from the atmosphere and store them in the soil (Trulio et al. 2007). Created wetlands, however, do not accumulate as much carbon in the soil or plant biomass as existing wetlands and may take up to 300 years to sequester the amount of soil organic carbon contained in a natural wetland (Hossler and Bouchard 2010).

Flood Management

Many of the actions implemented to accomplish ecosystem restoration will have benefits for more sustainable flood management. Utilization of floodwater bypasses and setback levees — as opposed to dams and levees — allows for conveyance of floodwater into floodplain habitat. When that floodplain habitat is restored to approximate historic composition, structure, and function, greater flood control and ecosystem benefits result. The presence of riparian and wetland plants will prevent setback levee erosion and strengthen levee structure by reducing the force of floodwaters against the levee. Floodwater bypasses can be designed to restore native grassland and shrub habitat that will tolerate seasonal flooding and that will provide juvenile salmonid habitat when flooded. Setback levees can also be designed to provide salmonid habitat when flooding occurs; juveniles can utilize this habitat to shelter from strong instream flows. These systems can be contoured to drain water and fish back to the river as floodwaters recede in order to prevent fish stranding. These techniques have been successfully used on the Lower Bear River and the Feather River in Sutter County and may be successfully employed on portions of the mainstem Russian River, particularly where flooding is frequent.



Flood levels in Alexander Valley (1937, 1940 and 1964)

Other Benefits

Ecosystem restoration of any type enhances habitat value, promotes biodiversity, and provides habitat for all types of wildlife, which has recreational as well as intrinsic value. Additionally, ecosystem restoration can provide multiple benefits. For example, when riparian forests are restored to floodplain they historically occupied, a more natural floodplain process is restored to the watershed, habitat for migratory birds and other fauna is increased, and carbon is sequestered. Nonpoint source pollution is sequestered, soil is stabilized, and erosion is reduced. Additionally, depending upon the distribution of wildlife habitat on the landscape scale, the restored forest may provide connectivity for wildlife with large home ranges, such as mountain lions, black bears, and bobcats.

Other Issues

Climate change poses a significant challenge to restoration. In addition to the challenge of restoring plants, animals, and in some cases, hydro-geologic conditions that have been absent from a site for decades, resource managers must now attempt the process in the face of significant increases to atmospheric temperature and decreases in water availability during the summer months. Juvenile salmonids require cold-water habitat (see Section 6.1), thus, more water may be needed for environmental beneficial uses just to maintain existing habitat. Plans to expand habitat availability will require creative solutions in the face of greater competition between competing demands.

Lack of knowledge about how much water is enough to provide sufficient amounts of cold-water habitat further hamper water allocation and habitat restora-

tion efforts. The California Department of Fish and Game has set restoration of adequate instream flows and channel and floodplain structure and function as a statewide priority. The agency has legal mandates to determine adequate environmental instream flows and make recommendations to the SWRCB, which in turn is responsible for allocating sufficient water for environmental beneficial uses. Both agencies are hampered by limited knowledge about the status of present-day instream flows, and environmental needs or how climate change will affect both.

Wetlands restoration has the potential for producing methyl mercury, a highly toxic substance that accumulates in the food chain and presents a human health threat. Seasonal and permanently flooded wetlands can convert elemental mercury to methyl mercury; this may be of concern in the Laguna de Santa Rosa, which is 303(d) listed for mercury impairment (SWRCB 2010).

Policies

The California Forest Practice Rules (FPR), California Fish and Game Code, California State Endangered Species Act (CESA), and federal Endangered Species Act (ESA) are some of the policies that regulate present-day timber harvest practices. FPRs require that timber operations are conducted within the context of the watershed conditions in which they are located, reduce cumulative impact, and increase habitat value to support biodiversity (CDF 2006). The CESA and ESA seek to protect and restore threatened species by placing restrictions on timber activities conducted near known reproductive or rearing sites of protected species and on the "incidental take" of protected species during management operations. Additionally, the CDFG Recovery Strategy for Coho Salmon (2004) recommends the use of soil mapping, road design, Timber Harvest Plans (THPs), and other activities that can reduce erosion.

RMS-1: ECOSYSTEM RESTORATION

RMS-1 Recommended Approaches

1. Develop restoration plans that take predicted effects of climate change into account.
2. Develop restoration plans that benefit both ecosystems and water and flood management.
3. Re-connect rivers to their historic floodplains.
4. Increase the use of setback levees and floodwater bypasses.
5. Expand riparian forest acreage to create continuous corridors to benefit salmonids, improve water quality and provide corridors for wildlife movement.
6. Restore upland grasslands and forests to provide space for floodwaters and recharge aquifers.
7. Remove fish passage barriers or install fish ladders or other structures that allow for fish passage.
8. Promote multidisciplinary approaches to water and flood management
9. Increase financial incentives for agricultural interests to restore and manage fully functioning ecosystems such as riparian corridors.
10. As funding becomes available, conduct a comprehensive assessment to determine current instream flow, identify instream flow needs, and make scientifically defensible recommendations for instream flows to protect fish and wildlife.
11. When necessary, utilize California Water Code Section 1707, which allows any person entitled to use water, whether based upon appropriative, riparian, or other right, to petition the SWRCB to implement a change to preserve or enhance wetlands habitat, fish and wildlife, or recreation in or on the water. This is usually accomplished by foregoing the right to divert water from a stream, but ownership of the right is retained.
12. Conduct research to reduce human and ecosystem exposure to mercury in the Laguna de Santa Rosa and other wetland ecosystems while still accomplishing objectives to restore ecosystem structure and function.

7.1.1.2 Environmental and Habitat Protection and Improvement

For the purposes of this document, environmental and habitat protection will be considered to include acquisition and other actions such as easements that set land aside for environmental and habitat purposes. Environmental and habitat improvement will refer to activities that public and private property owners can implement to increase environmental benefits and habitat value on their land (see Section 7.1.1.5,

Priority RRICWMP Recommendations and Appendix 16, Management Measures: Habitat Protection).

Environmental and Habitat Protection

Methods of protecting land for environmental and habitat protection include acquisition of fee simple title (purchasing the land), purchase of development rights, and conservation easements. Fee simple title is absolute ownership of the land; once purchased, the land belongs to the purchaser in perpetuity until it is sold. Purchase of development rights is usually associated with agricultural land at risk of being developed for residential or commercial uses. It entails purchasing the property owner's right to subdivide a property — the first step in selling it for development. Once development rights are purchased, the property owner continues to own the property including the right to keep land in agricultural production, apply chemical fertilizers or pesticides, prevent trespass, sell the land, or pass it on to heirs. The value of development rights is calculated by determining the difference between the agricultural value of the land and its value if sold for development.

The term "conservation easement" refers to the donation or sale of development rights by the landowner; however, the severance of development rights is usually referred to as a conservation easement regardless of whether rights were sold or donated. If a property has important habitat values or viewsheds, the state or private funders may purchase a conservation easement for the property. Conservation easements can apply to all or a portion of the property and, if donated, can provide the property owner with potentially significant tax savings. Conservation easements are tailored to individual properties and landowners' needs and desires. Often, a landowner will donate a conservation easement for a property prior to selling it to another agricultural landowner, thus gaining shelter from any capital gains realized by the sale (Wright and Skaggs 2002).

Conservation easements have benefits for both individuals and communities. In both Sonoma and Mendocino Counties, young farmers are often unable to purchase farmland due to high land prices. A supply of proven agricultural land without development rights (and therefore only marketable at agricultural land prices) can allow new famers to enter the industry. Conservation easements benefit communities by keeping land in private ownership rather than being turned over to state or local government as conservation land, which does not remain on the tax rolls. In addition, maintaining existing agricultural lands in production may also maintain the critical level of regional output necessary to support agricultural processing, suppliers, and other related industries, which would retain jobs.

Two land trust organizations that are working to protect and improve other habitat in the Russian River watershed are Sonoma Land Trust (SLT) and Mendocino Land Trust (MLT). SLT has acquired several properties in the watershed including land in the Cedars region, which has been identified by scientists as "one of the most unusual geological and biological sites on the planet (SLT undated)," and Lower Pitkin Marsh, a wetland property that contains several rare plant species. SLT also holds several conservation easements on properties throughout the lower watershed. MLT has protected large portions of oak woodlands on Ridgewood Ranch just south of Willits on Highway 101. It also holds several conservation easements in the middle watershed (MLT 2009).

Environmental and Habitat Improvement

Individual property owners — from urban dwellers to commercial property owners to large agricultural landowners — can each play a part in improving watershed health. Urban and rural residential and commercial landowners can contribute to environmental and habitat improvement through implementation of management measures for urban property owners (see Appendix 16, Management Measures for the Russian River Watershed: Urban/Rural Residential Management Measures). Practices such as integrated pest management (IPM) to reduce chemical pesticide use, harvest of rainwater for dry season irrigation and contouring landscapes to slow rainwater and sink it *in situ* would improve water quality and habitat in area creeks and ultimately, the Russian River. Agricultural and industrial property owners, who usually own larger parcels of land, could also implement management measures to improve environmental quality and habitat (see Appendix 16, Management Measures for the Russian River Watershed: Agriculture Management Measures). These measures include most practices that residential and commercial landowners could practice in addition to activities such as planting native plant species, large-scale erosion control, wetlands and other ecosystem restoration and management, and large-scale invasive plant eradication.

In the watershed, municipal and county Departments of Public Works have adopted BMPs to prevent or minimize fine sediment delivery to streams. The

Five Counties Salmonid Conservation Program has produced a Roads Maintenance Manual (available at: http://www.5counties.org/) for county roads in northwestern California that has been approved by the National Oceanic and Atmospheric Administration (NOAA). The Handbook for Forest and Ranch Roads also provides recommendations to reduce road-associated delivery of sediment to streams.

Rural ranch roads may be enhanced to reduce sediment to streams

Current Activities

In the Russian River watershed, which is close enough to the San Francisco Bay area for commuting, land historically in agriculture has increasingly been converted to rural residential development, especially in the middle of the watershed along the Highway 101 corridor in Sonoma County. As the small family farms that historically operated here experience economic hardship, they often see no option but to sell their farmland for development because the value of land in agricultural use is significantly less than the value of land sold for development. These sales affect the watershed and its residents by changing the character of the landscape from rural to urban; however, the very qualities that make the watershed attractive to new residents result in part from the pastoral beauty of its landscape. In recognition of this fact, the residents of Sonoma County in 1990 voted to create the Agricultural and Open Space District (District) to protect forever the working farms and ranches, scenic hills, and natural areas that provide the stunning vistas residents had come to associate with life in the county. Since that time, the District has permanently preserved over 33,500 hectares (83,000 acres) of open space and agricultural land. The District focuses its land acquisition efforts on strategic additions near existing protected lands to create a connected network of protected areas (see Figure 3.8 Open Space and Protected Areas).

Environmental and habitat improvement is ongoing throughout the watershed from individual homeowner efforts to large-scale multi-stakeholder restoration efforts. The USFWS is overseeing habitat conservation efforts in the Santa Rosa Plain for five endemic endangered species. Federal, state and local stakeholders have developed a conservation strategy that includes implementation actions to protect and enhance habitat for California Tiger Salamander (*Ambystoma californiense*) and four plant species. Mendocino County Resource Conservation District (RCD), Sotoyome RCD and Gold Ridge RCD work with willing landowners to improve habitat and environmental quality through implementation of projects including road sediment reduction, riparian fencing, and agricultural best management practices (BMPs). Watershed and landowner groups throughout the watershed are implementing fish passage enhancement, sediment reduction, and water quality improvement projects. Additionally, cities, towns, and smaller communities in the watershed are pursuing various projects to improve environmental quality and habitat such as use of recycled water for irrigation, incentives to reduce water consumption and use of drought tolerant landscape plants.

Potential Benefits of Environmental and Habitat Protection and Improvement

Environmental and habitat protection and improvement provide multiple benefits. These include improved water quality through pollutant sequestration and BMP implementation, provision of habitat and food for wildlife, reduction in erosion, and recharge areas protection, which can increase groundwater supply. Efforts to protect and improve environmental quality through BMP implementation at all levels in the watershed — from individuals, to agricultural and industrial enterprises, to municipalities — can have significant cumulative impacts on air, water, and habitat quality. Improved and protected habitat is more likely to have resilience and thus withstand changing conditions associated with climate change.

Major Issues

In order to realize optimal benefits from implementation actions to protect and improve environmental quality and habitat, it is necessary to maximize participation by watershed residents, which will present challenges. Education and outreach to a very diverse citizenry would be time consuming, and some implementation actions will require more effort than some are willing to provide. Additionally, costs associated with some implementation actions may make

them prohibitive regardless of level of interest. Lack of agreement as to the relative value of competing land or resource uses may also hinder conservation efforts. For some lands, protections may be put in place that explicitly weigh different land values (e.g. via conservation easement), allowing determination of the correct balance between outright land closure and uninhibited resource extraction.

Science based environmental education

RMS-2: ECOSYSTEM PROTECTION AND IMPROVEMENT

RMS-2 Recommended Approaches

1. Conduct outreach to all watershed residents to promote opportunities for implementation of management measures that protect and improve environmental quality and habitat.
2. Provide incentives — such as Santa Rosa's "Cash for Grass" program, which pays homeowners to remove turf and install drought tolerant landscaping — to individuals and businesses to implement actions that protect and improve environmental quality and habitat.
3. Develop templates for individual property owners to assess their property to determine potential BMPs to foster environmental and habitat protection and improvement.
4. Incorporate BMPs for environmental and habitat protection and improvement into county and city land use, zoning, and building codes.
5. Cities and counties in the watershed should lead by example and incorporate BMPs for environmental and habitat protection into their everyday operations.

7.1.1.3 Watershed Planning

The term "watershed" describes a geographic area in which all surface water drains to one river or stream system. Watershed management is "the process of creating and implementing plans, programs, projects, and activities to restore, sustain, and enhance watershed functions (DWR 2009)." A relatively new paradigm for natural resources management, it began with community stakeholder groups and grew to include participation of and promotion by state and federal agencies. California's Department of Water Resources, State Water Resource Control Board and Department of Conservation advocate the management of water using watersheds as an organizing unit because it is at an appropriate scale to coordinate and integrate management of the physical, chemical, and biological processes that comprise a river basin.

In the Russian River watershed, watershed management is well established. For example, Mendocino County in 2009 adopted its General Plan, which utilizes a watershed approach to natural resources management (PMC 2009). Additionally, community-based watershed groups are operating at the Hydrologic Sub-Area (HSA) scale (e.g., Austin Creek HSA, Mark West HSA) and smaller (e.g., Atascadero-Green Valley Creek Watershed Group, Dutch Bill Creek Watershed Group, Salmon Creek Watershed Council) and both community and multi-stakeholder groups are operating at the HU scale (e.g., Russian River Watershed Association, Russian River Protection Committee). In implementing projects to meet local needs, many of these groups are also contributing towards attainment of regional and state priorities such as salmonid population recovery and TMDL implementation (see Section 4.7, Watershed Groups and Local Collaborations).

The North Coast Integrated Regional Water Management Plan (NCIRWMP) is an ongoing effort in the North Coast HR that provides a framework for addressing local needs while meeting statewide priorities (see http://www.northcoastirwmp.net/). By coordinating ongoing efforts in Russian River sub basins with this regional effort, it is hoped that greater benefits will accrue, not only locally, but throughout the watershed and the entire region.

Potential Benefits of Watershed Management

Watershed management can provide benefits to water supply, ecosystem health (and thus, ecosystem services such as water filtration, pollination, nutrient cycling, seed dispersal, pest and disease control, and carbon sequestration), and flood man-

agement. By utilizing a watershed approach, natural resource managers have the capability to avoid problems such as those occurring when upstream water users are unaware of the effects that their water use and water treatment activities may have on downstream water users. A watershed approach requires resource managers to look beyond their jurisdictions to consider the movement of water through the watershed; in this way, actions that affect water quality and water supply can be evaluated to determine an optimal management strategy.

Promotion of watershed management techniques in the Russian River watershed is likely to result in greater collaboration and communication between all entities in the watershed, which will lead to optimal use of scarce funding. By fostering communication and consideration of the watershed as a whole, rather than individual parts, watershed management can have very significant positive effects on natural resource management in the Russian River.

A watershed approach is likely the best way to prepare for and adjust to increased temperature and decreased summertime water availability predicted in climate change models. For example, by considering the watershed as a whole, resource managers may be able to determine optimal locations for flood bypasses and/or setback levees to restore a semblance of natural function to the watershed while protecting existing property from floodwaters.

Challenges

Challenges to watershed management include the difficulty of coordinating inter-jurisdictional watershed management. It is sometimes difficult for a single entity to agree on goals or action items; when two or more overlapping jurisdictions are involved, the process may become cumbersome. Additionally, there may be extra expenses involved in travel and coordination; however, these costs may be offset by economies realized when cooperative efforts occur. By "plugging in" to or borrowing from the existing NCIRWMP framework, entities involved in watershed planning in the Russian River watershed may be able to avoid some of these challenges.

RMS-3: WATERSHED PLANNING

RMS-3 Recommended Approaches

1. Use a watershed approach for land use planning, forest management, agricultural stewardship, and other activities.
2. Design and select projects within a watershed context; consider how a project will effect and be affected by upstream and downstream conditions.
3. Consider water quality, water supply, groundwater recharge, and flooding issues from a watershed perspective.
4. Promote communication and collaboration between sub watershed groups to discover complimentary goals. Explore the potential for combined efforts to maximize benefits for overall watershed health.
5. Restore and maintain riparian habitat that is compatible with stream and river functions and that is compatible with upslope habitat and land use.
6. Provide appropriate educational materials to educate residents about watershed management and how water, pollutants, and other materials travel through the watershed.

7.1.1.4 Wetlands Enhancement and Creation

The U.S. Army Corps of Engineers defines wetlands as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions." In the Russian River watershed, wetlands include vernal pools, freshwater marshes, the Laguna de Santa Rosa, which is a complex of wetland and upland habitat, and tidal marsh at the mouth of Willow Creek. Wetlands provide important ecosystem services; they increase water quality by filtering pollutants from the water column and retaining them in soils or biomass, reduce shoreline erosion by providing a vegetation buffer, reduce flood damage by providing for short-term water storage, and promote biodiversity by providing habitat and food for all types of animals. Approximately 75 percent (by weight) of commercially harvested fish and shellfish are dependent on estuaries and their wetlands (Interagency Workgroup on Wetland Restoration 2003).

Wetlands enhancement, restoration, and creation improve the condition of currently modified landscapes and biological communities to enable them to provide the benefits listed above and increase their resilience to disturbances and effects of climate change. Wetlands restoration is the rehabilitation of a degraded wetland or the reestablishment of a

destroyed wetland back to a close approximation of the original natural condition that existed prior to modification (see Appendix 16, Management Measures: Wetland Restoration and Management). Wetlands enhancement is the rehabilitation of a degraded wetland or the reestablishment of a destroyed wetland to augment specific site conditions to favor a specific species or function, possibly at the expense of other species or functions. For example, an increase in water depth or hydroperiod or significant changes to the original plant community composition would be considered an enhancement. Wetlands creation is the creation of a wetland on a site that did not historically support a wetland. This type of wetland construction typically has the highest cost of implementation and management and usually only performs a single function, such as wildlife habitat, educational opportunities, or water quality improvement (USDA NRCS 2008).

Current Activities

Wetlands restoration and rehabilitation projects have been undertaken on the mainstem Russian River, in the Laguna de Santa Rosa, and on other tributaries throughout the watershed. A major restoration of the Laguna restored a portion of the waterway to the configuration that existed prior to channelization. The project created new habitat and included construction of approximately two acres of slough, two acres of upland habitat, eight hundred linear feet of channel and four hundred linear feet of swales through the rearrangement of more than seven thousand cubic yards of soil material (GVCE 2010). The Laguna de Santa Rosa Foundation has developed an overall plan for the Laguna that stresses a science based stepwise process by which to restore the Laguna through invasive plant removal, recontouring channels to more closely resemble historic structure, and reducing water pollutants (Honton and Sears 2006). Additionally, as described in Section 7.1, Natural Resources and Land Management, the Sonoma County Water Agency has been charged with restoring a more natural flow regime to the Russian River estuary (NMFS 2008). Management Measures for wetland restoration and management can be found in Appendix 16, Management Measures for the Russian River Watershed.

Potential Benefits of Wetlands Restoration, Enhancement, and Creation

Creation, restoration and enhancement of wetlands in the Russian River will provide multiple benefits. As stated above, wetlands improve water quality, provide habitat and food for wildlife, reduce erosion, and provide flood attenuation. If used in conjunction with other recommended flood management techniques such as floodwater bypasses ad setback levees, wetlands restoration, enhancement and creation will lower structural maintenance costs by buffering structures from floodwaters. The restoration of wetlands to serve as a floodwater bypass can serve a dual purpose as rearing habitat for salmonids. Additionally, restoration, enhancement, and creation of wetlands are likely to increase groundwater recharge, which will contribute to water supply reliability.

Restored and enhanced wetlands are more likely to be sustainable than if left in their present state, allowing them to recover from disturbance and potentially adjust to changing temperature patterns and water availability associated with climate change. Wetlands sequester carbon at high rates compared to other ecosystems. Carbon fixation under the anaerobic soil conditions in wetlands provides conditions for long-term carbon storage; however, this sequestration process is linked to methane emissions from wetlands that contribute to global atmospheric CO2. Tidal wetlands release only small amounts of methane and fix carbon at very high rates. In fact, one study found that estuarine wetlands sequester carbon at a rate about 10-fold higher per area than other wetland ecosystems due to high sedimentation rates, high soil carbon content, and constant burial as sea levels rise (Brigham et al. 2006). Thus, while freshwater wetlands may not be important for climate change mitigation, restoration, enhancement, and creation of tidal wetlands near the estuary may have positive effects.

Major Issues

As mentioned in Section 7.1.1.1, Ecosystem Restoration, wetlands have the potential for producing methyl mercury, a highly toxic substance that accumulates in the food chain and presents a human health threat. Seasonal and permanently flooded wetlands can convert elemental mercury to methyl mercury; this may be of concern in the Laguna de Santa Rosa, which is 303(d) listed for mercury impairment as well as elsewhere in the watershed where people obtain food such as fish from wetland systems (SWRCB 2010).

One of the anticipated effects of climate change is a gradual increase in sea level. The International Panel on Climate Change estimates an average seal level rise of between 0.18 and 0.59 m (0.6 and 2 ft) during the 21st century (EPA 2011). As the sea rises, the outer boundary of the tidal wetlands in the estuary and river mouth will erode and new wetlands will form

inland as previously dry areas become permanently flooded. The rate of wetland migration, however, may not be able to keep up with the pace of sea level rise, and may eventually be halted by man-made structures such as bulkheads and other structures designed to protect property from storm surges, resulting in the net loss of this important ecosystem.

Although wetlands restoration, enhancement, and creation have been studied extensively, there are significant gaps regarding their historic location in the watershed and their interrelationships with other native ecosystems as well as much uncertainty about how they will interact with the existing landscape, including human land uses. This lack of information hinders planning and underscores the need for ongoing scientific assessment and adaptive management of wetland implementation projects.

RMS-4: WETLANDS ENHANCEMENT AND CREATION

RMS-4 Recommended Approaches

1. Develop wetlands restoration, enhancement, and creation plans that take predicted effects of climate change into account.
2. Develop wetlands restoration, enhancement, and creation plans that benefit both ecosystems and groundwater and flood management.
3. Utilize wetland restoration, enhancement and creation in conjunction with setback levees and floodwater bypasses.
4. Restore, enhance and create upland wetlands in locations where they will recharge groundwater.
5. Promote multidisciplinary approaches to water and flood management.
6. Increase financial incentives for agricultural and other interests to restore, enhance, and create fully functioning ecosystems, especially vernal pools in the Santa Rosa Plain.
7. Conduct research to reduce human and ecosystem exposure to mercury in the Laguna de Santa Rosa and other wetland ecosystems while still accomplishing objectives to restore ecosystem structure and function.

7.1.1.5 Priority RRICWMP Recommendations and Management Measures

TABLE 7.5. NATURAL RESOURCES AND LAND MANAGEMENT RECOMMENDATIONS				
SOURCE AGENCY. DATE PUBLISHED. SOURCE DOCUMENT	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
ASSESSMENT				
Laguna de Santa Rosa Foundation. 2006. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California	Expand and coordinate multiagency research and planning efforts evaluating Laguna hydrology and hydraulics at the scale of the entire watershed as well as in targeted planning areas, to provide sound information on which to base water management decisions involving restoration, flood protection, water quality and quantity, water conservation measures, groundwater withdrawals, and recycled water discharges.	Science	Laguna de Santa Rosa HSA	47
Sonoma County Water Agency. 2003. Russian River Action Plan	Forsythe Creek Watershed Implementation	Habitat Availability	Forsythe Creek HSA	46
California Coastal Sediment Management Workgroup. 2008. California Coastal Sediment Master Plan Status Report	Assist local/regional entities establish priorities, and coordinate regional strategies for each of the state's coastal regions and littoral cells.	Resource Management	Russian River HU	42
California Coastal Sediment Management Workgroup. 2008. California Coastal Sediment Master Plan Status Report	Develop Regional Sediment Management Plans that emphasize and reflect regional differences across CA.	Resource Management	Russian River HU	42
Sonoma County Farm Bureau. 2011. Expert Interview	If salmonid survivability is the hottest topic of the day, we should do Research and Development on improving the species' survival chance against catastrophic natural or man-made changes in the water quantity and quality and the River morphology.	Fisheries Protection	Russian River HU	41
Laguna de Santa Rosa Foundation. 2006. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California	Examine the historical record to support our ability to restore and manage the Laguna's natural resources. Examine historic maps, photographs and sketches to understand the history behind landscape changes and to help develop sustainable restoration projects. Determine the extent to which freshwater wetlands and adjacent floodplains have been lost. Use site-specific research to determine the feasibility and advisability of recreating historic wetlands. Examine the written record of the early explorers, settlers, and naturalists to develop an understanding of what has been extirpated. Use this understanding to establish realistic objectives for native habitat restoration. Examine the pre-contact evidentiary record, including anthropological and archeological artifacts to understand the role of indigenous people in the active management of their landscape. Use this understanding to further refine our own management practices.	Resource Management	Laguna de Santa Rosa HSA	39
Mendocino County Water Agency. 2011. Expert Interview	Current status of invasive plant communities in watershed. Mapping of colonies and plans for removal and assessment need to be updated and/or communicated to the community.	Habitat Availability	Ukiah HSA	38
Sotoyome RCD. 2008. Upper Mark West Watershed Management Plan Phase 1: Watershed Characterization and Needs Assessment.	Assess, protect & enhance riparian and wetland habitat.	Habitat Protection	Mark West HSA	35
Sonoma County Water Agency. 2011. Expert Interview	Water quality and habitat conditions in the estuary.	Habitat Availability	Mainstem Russian River	35
Sonoma County Water Agency. 2011. Expert Interview	The effects of water demands on aquatic habitats and how salmonids respond to existing water management needs to be understood.	Habitat Protection	Mainstem Russian River	35
PLANNING				
California Department of Water Resources. 2005. California Water Plan 2005 Update	Regional efforts should incorporate integrated resource planning to meet multiple water management objectives consistent with the principles advanced in this water plan.	Socio-economic	Russian River HU	59
Mendocino County Water Agency. 2011. Expert Interview	The future of water agencies is to become resource management agencies. They don't just treat and deliver water. They pull the water from a natural system, so have a direct link that needs to become part of the management strategy. Several water districts throughout the state are heading in this direction; SCWA is one.	Resource Management	Russian River HU	49
CDFG. 2004. Recovery Strategy for California Coho Salmon	Upgrade the Russian River Basin Plan to benefit coho salmon	Coho Population Recovery	Russian River HU	48

TABLE 7.5. NATURAL RESOURCES AND LAND MANAGEMENT RECOMMENDATIONS				
SOURCE AGENCY. DATE PUBLISHED. SOURCE DOCUMENT	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
California Department of Water Resources. 2005. California Water Plan 2005 Update	Local and regional planners diversify and increase the resource management strategies in their integrated regional water management plans.	Socio-economic	Russian River HU	46
California Coastal Sediment Management Workgroup. 2008. California Coastal Sediment Master Plan Status Report	Help facilitate long term solutions to Sediment Management such as bypassing around dams, removal of developments/setback policies for floodplains, and restoration of natural creek environment.	Resource Management	Russian River HU	43
Sotoyome Resource Conservation District. 2005. Maacama Creek Watershed Assessment	Watershed - based restoration and land management approach is necessary	Resource Management	Geyserville HSA	43
Sonoma County Water Agency. 2011. Expert Interview	The process of addressing planning and environmental compliance issues needed to do projects should be improved so beneficial projects are not seen as burdens. For instance, mutually beneficial projects associating agriculture and water storage could get more support and implementation. Landowners need incentives to gain their long term support. Agencies need a more holistic approach with landowners to attain improvements in long term management of private lands.	Resource Management	Mainstem Russian River	33
Mendocino County Water Agency. 2011. Expert Interview	First on the list should be to maximize the use of the financial resources we have. We will have to identify the direction and follow it as a team, even if we do lose part of the flock in the process. We need a regional approach. For instance, the Rohnert Park groundwater plan to reduce river diversions may keep more water in the river, but could over draft the aquifer if relied upon too heavily. Managing outflow at Coyote Dam to dilute the leaky septic systems in Cazadero seems un-necessary. Why not fix the septic systems and save the water? A regional approach to financial resources management will make a difference in improving the watershed's functions.	Resource Management	Russian River HU	33
Laguna de Santa Rosa Foundation. 2006. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California	Sustainable urban creek restoration depends on careful planning to balance human and environmental needs. Support existing urban creek restoration projects, including full implementation of the Santa Rosa Creek Master Plan, and the Santa Rosa Citywide Creek Master Plan. Expedite a Creek Master Plan process for the southern Laguna (Rohnert Park and Cotati).	Habitat Availability	Laguna de Santa Rosa HSA	32
Mendocino County Water Agency. 2011. Expert Interview	How do we get going in the same direction? This is hopefully what the RRWAMP can do. So many plans sit on the shelf and do no good. In this watershed the long term commitment has been lacking. We need to increase the commitment and communication to get projects accomplished, as with the NCIRWMP.	Socio-economic	Russian River HU	32
IMPLEMENTATION				
CDFG. 2004. Recovery Strategy for California Coho Salmon	Implement high-priority coho salmon habitat restoration programs and projects.	Coho Population Recovery	Mainstem Russian River	57
Sonoma County Water Agency. 2003. Russian River Action Plan	Russian River Tributary Restoration and Landowner Outreach	Socio-economic	Russian River HU	55
Southwest Regional Office National Marine Fisheries Service. 2010. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft	Restore or minimize impacts to watershed processes (e.g., riparian, sediment transport, hydrology and estuary function).	Coho Population Recovery	Russian River HU	55
Laguna de Santa Rosa Foundation. 2006. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California	Expand abilities to provide financial assistance and technical advice to private landowners and grassroots groups conducting conservation or restoration activities.	Socio-economic	Laguna de Santa Rosa HSA	54
CDFG. 2004. Recovery Strategy for California Coho Salmon	Implement measures to improve instream coho salmon habitat conditions.	Habitat Availability	Mark West HSA	53

TABLE 7.5. NATURAL RESOURCES AND LAND MANAGEMENT RECOMMENDATIONS				
SOURCE AGENCY. DATE PUBLISHED. SOURCE DOCUMENT	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Southwest Regional Office National Marine Fisheries Service. 2010. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft	Improve survival at all life stages by improving the spatial and temporal pattern of surface flows throughout spawning, rearing, and migration areas.	Coho Population Recovery	Russian River HU	53
California Department of Water Resources. 2008. California Water Plan 2005 Update	DWR will adapt its expertise, resources, and existing programs and develop new ones to give incentives and technical assistance to regional and local agencies and governments to prepare comprehensive, integrated water management plans that include actions to protect public trust resources and promote efficient, beneficial water use. DWR will develop the necessary tools to assist local and regional agencies be successful with the integrated regional water management and planning and will monitor the development and implementation of these plans to ensure an equitable distribution of technical and financial assistance in planning efforts. Data from these plans can be integrated into future California water plan updates.	Socio-economic	Russian River HU	52
Sotoyome Resource Conservation District. 2005. Austin Creek Watershed Assessment	Watershed restoration and management is needed to address aquatic habitat issues	Habitat Protection	Austin Creek HSA	51
CDFG. 2002. 2002 Draft Russian River Basin Fisheries Restoration Plan	Develop county strategies for "prioritizing fishery protection and restoration actions within individual watersheds throughout the counties (Harris et al. 2001)."	Fisheries Protection	Russian River HU	50
CDFG. 2004. Recovery Strategy for California Coho Salmon	Implement appropriate recommendations to offset impacts from county policies and operations, as developed by the FishNet program.	Habitat Protection	Russian River HU	50

TABLE 7.6. NATURAL RESOURCES AND LAND MANAGEMENT MEASURES					
		NATURAL RESOURCES AND LAND MANAGEMENT RMS			
RUSSIAN RIVER ICWMP MANAGEMENT MEASURES		ECOSYSTEM RESTORATION	ENVIRONMENTAL AND HABITAT PROTECTION & IMPROVEMENT	WATERSHED PLANNING	WETLANDS ENHANCEMENT AND CREATION
Agriculture	Erosion and Sediment control	•	•	•	•
	Animal Waste Management	•	•		
	Nutrient Management	•	•		
	Pest and Weed Management	•	•		
	Grazing Management				•
	Irrigation Water Management	•	•		
	Groundwater Protection				
Urban/Rural Residential	Watershed and Groundwater Protection			•	
	Flood Control			•	
	Stormwater Management			•	•
	Low Impact Development	•	•	•	
Forestry	Road Management/ Reconstruction	•	•	•	
	Fire Management	•		•	
Hydromodification	Gravel Mining	•	•		
	Dam Construction and Operation	•	•	•	
	Streambank Erosion Control	•	•	•	
	Flow and Temperature Maintenance	•	•	•	
Natural Environment & Open Space	Fish Passage Enhancement	•	•	•	
	Habitat Protection	•	•	•	•
	Terrestrial Habitat Restoration & Management	•	•	•	•
	Instream Habitat Restoration & Management	•	•	•	
	Invasive non-native Vegetation Control	•	•	•	•
	Recreation and Public Access			•	
	Water Quantity Management	•	•	•	
	Water Quality Management	•	•	•	•
	Wetland Restoration/Management	•	•		•

7.1.2 Water Supply Reliability

Water supply reliability is a measure of a system's ability to sustain the social, environmental, and economic systems that it serves whether the year is a wet or dry year (DWR 2009). Water reliability planning involves evaluating water supply management strategies to maintain or increase supply reliability and then comparing the costs of implementing those strategies to the costs of accepting less water supply reliability. According to the California Water Plan Update 2009, accepting the costs of the adverse effects of less than 100 percent reliability could be a legitimate planning decision - "providing full water supply to meet 100 percent of projected future water demand is not the planning goal, rather, the goal is to find the justified level of reliability (DWR 2009)." This section examines existing and potential water supply strategies for the Russian River watershed.

As noted in its definition, water supply reliability has different connotations depending upon water availability. During wet years, when surface water is readily available, water supply reliability has not been an issue in the Russian River watershed; however, when precipitation and runoff are much less than average, supply reliability becomes an essential consideration. During extended dry periods, water conservation and implementation of shortage contingency measures — both public and private — become increasingly important. The recent drought cycles and the cataclysmic decline of native salmonid populations in the basin due in part to habitat impairment and low instream flow has underscored the need for increased water resources in the basin.

During the drought years of 2007 — 2009, water supply reliability was an issue for the watershed. Water Year 2007 was termed "dry" with a statewide drought declared in both June 2008 and February 2009 by Governor Arnold Schwarzenegger (DWR undated). Governor Jerry Brown proclaimed an end to the California drought in March 2011 after above-average winter precipitation (Lien-Mager 2011).

Langridge et al. (2006) analyze three communities in the Russian River watershed (Potter Valley, Redwood Valley, Santa Rosa) and one in the Eel River watershed (Round Valley Tribes). Santa Rosa is considered to have the most secure water supply under three water shortage scenarios due to contractual water rights with the Sonoma County Water Agency (SCWA). SCWA, an institution established in 1949, is the largest water distributor in the North Coast and has considerable

financial and political resources. The Redwood Valley community is considered to have limited potential resilience — the ability to bounce back — from any of the scenarios, while the other two communities possess resilience that is contingent upon external forces. In the case of Potter Valley, water supply reliability is contingent on the community's ability to maintain the Eel River diversion and/or obtain access to other sources. The Round Valley Tribes' resilience is contingent upon their ability to maintain access to tribal legal resources. Langridge et al. suggest that to provide a more equitable distribution of resilience to water supply shortages, the focus should shift away from legal rights and toward "strengthening and diversifying the full array of structural and relational access mechanisms." This shift may be occurring; in the past two years, emphasis has been placed on harvesting rainfall during the winter rainy season and storing it for use in the summer dry season, thus freeing instream flows for environmental beneficial uses (RRCWRP 2011). With a strong emphasis on scientific inquiry, the Coho Partnership is committed to developing solutions that balance the needs of water users and protected salmonids. It is focusing on five priority watersheds in the Lower Russian River watershed (Dutch Bill, Grape, Green Valley, Mark West, and Mill), chosen because low stream flow has been identified in these streams and each has been labeled critical to the recovery of coho salmon (NMFS 2010). The Town of Windsor has embraced the use of recycled water in new residential and commercial development, and SCWA, County of Sonoma, Cities of Santa Rosa, Rohnert Park, Sebastopol, and Cotati, Town of Windsor and Cal-American Water Company have partnered to explore the capacity and conjunctive management possibilities associated with the Santa Rosa Plain groundwater basin. Throughout the watershed, individuals and entities are recognizing the challenges of maintaining water supply reliability in the face of a warmer, drier climate and increasing population pressure and are working together to determine optimal solutions on local, watershed, and regional scales.

According to the California Urban Water Agencies (1992), water supply reliability is "the degree to which water consumers receive their Full-Service Demand within acceptable quality and service standards (CUWA 1992)." It involves the integration of multiple management strategies to respond to opportunities and constraints presented by local environmental conditions and regulatory requirements to meet human and environmental water demand. The newly formed Russian River Independent Science Review Panel (ISRP) will supply scientific leadership for evaluating existing data, developing conceptual models for physical and ecological processes, and reviewing water management efforts in the watershed. Water supply management strategies are of three main types: 1) water demand reduction; 2) operational efficiency and transfers improvement; and 3) water supply increases. The Russian River watershed has options to pursue each of these types of water management strategy; these are discussed in detail below. Priority RRICWMP recommendations identified for the Russian River watershed related to Water Supply Reliability from agency and peer-reviewed documents and expert interviews are provided in Section 7.1.2.4. Also listed are appropriate management measures for the suite of Resource Management Strategies which are described in greater detail in Appendix 16, Management Measures for the Russian River Watershed.

7.1.2.1 Water Demand Reduction

7.1.2.1.1 Agricultural Water Use Efficiency

Agricultural water use efficiency involves reducing the amount of water used for agricultural operations to make more water available for other uses while maintaining or improving crop yield. It is an important management strategy in the Russian River watershed because of the importance of agriculture to the watershed's economy and culture.

Agricultural water use efficiency has been mandated by state law for the past twenty years. In 1990, AB 3616, the Agricultural Water Suppliers Efficient Water Management Practices Act, established guidance for improving agricultural water use efficiency. Passed by state legislature in 2006, AB 1404, Water Measurement Information was added to the California Water Code. It requires agricultural users to report water use data to DWR. In 2010, the state legislature passed SBx7 7, which requires agricultural water suppliers who provide water to 10,000 or more irrigated acres to develop and adopt a water management plan and implement cost-effective management practices to increase water use efficiency. Additionally, by July 31, 2012, agricultural water suppliers are required to accurately measure the volume of water delivered to customers and adopt a pricing structure based on quantity of water delivered.

Agricultural water efficiency includes improvements in the technology and management of water on the farm and at the irrigation district level. It primarily occurs

through three mechanisms: 1) improving irrigation and water delivery system infrastructure, 2) improving management of irrigation and water delivery systems, and 3) reducing non-beneficial evapotranspiration (see Appendix 16, Management Measures: Irrigation Water Management). Infrastructural limitations of irrigation and water delivery systems can prevent application of optimal amounts of irrigation water, leading to waste. On the farm, improvements such as integrated supervisory control and data acquisition systems (SCADA), canal automation, regulating reservoirs, and other hardware upgrades provide greater delivery flexibility, allowing growers to specify timing, quantity, and duration of water delivery. Other improvements include lining head ditches, using micro-irrigation systems, and converting traditional irrigation systems to pressurized systems. Water suppliers are increasingly upgrading and automating their systems, lining canals, developing spill recovery and tail water return systems and improving pump efficiency.

Management improvements include advanced technologies such as GIS, GPS, satellite crop and soil moisture sensing systems and weather forecasting systems, which allow for automation tailored to real-time conditions. Growers can also query the California Irrigation Management Information System (CIMIS), which provides evapotranspiration data from DWR's weather station program. For water suppliers, advancements in real-time communication networks allow transmission of data to a centralized location, allowing staff to monitor and manage water flow without the need to manually monitor and control individual sites. These systems vastly improve communication and enable flexible and accurate water delivery, distribution, and monitoring.

Evapotranspiration (ET) is the sum of evaporation from the soil and transpiration from plants. It can be reduced by utilizing a soil cover to decrease soil evaporation and eliminate weed ET, shifting to crops that have a lower water demand, and utilizing deficit irrigation. Deficit irrigation is the practice of providing water to a crop during drought-sensitive growth stages, but restricting water during drought-tolerant stages. In addition to reducing water use, deficit irrigation can potentially improve crop quality, decrease disease or pest infestation, and reduce production costs.

Benefits of improving agricultural water use efficiency include an increase in existing water supplies, thus increasing drought preparedness. Unused water can remain in reservoirs or groundwater basins, increasing the amount of water available during dry years. Environmental beneficial uses can also benefit from increased instream flow during periods of high demand and potential water quality benefits include reduced water temperatures and reduced contaminant loads. Economic benefits can include the avoided costs of developing a new water supply, reduced costs of pumping and water transport, and increased operational life of conveyance infrastructure. Reduced pumping and water transport may also mitigate climate change by reducing carbon emissions.

Potential costs associated with increased agricultural water use efficiency include the costs of implementing infrastructural improvements and development of management operations that take advantage of available technology. Some water use efficiency improvements would require additional energy — for example, conversion to pressurized irrigation systems would increase energy use. Pressurized systems also need pipelines, pumps, filters and filtration systems, chemicals for cleaning, and replacement and disposal of hardware.

Funding agricultural water use efficiency is a major hurdle to accomplishing this management strategy in the Russian River watershed. Although state and federal agencies provide grants, competition for these funds is fierce and smaller water districts and individuals may not have the technical expertise or resources to compete successfully. Fortunately, the Gold Ridge, Sotoyome, and Mendocino County Resource Conservation Districts have a long history of successfully obtaining funding to implement water supply and quality improvements on agricultural lands in the Russian River watershed.

Implementation of agricultural water use efficiency is complicated by several factors. Technical feasibility, cost-effectiveness, availability of technical assistance, the ability and willingness of growers and water suppliers all factor in to the success of efficiency measures. Willingness — or unwillingness — of growers to implement efficiency strategies may be linked to concerns about water rights. Many believe that if the water is not used, water rights will be lost; however, this is not the case for agencies implementing efficiency measures (DWR 2009).

The relationship between agricultural water use efficiency and energy use is complex. As discussed above, some aspects of water use efficiency implementation will reduce greenhouse gas (GHG) emissions while other aspects will increase emis-

sions. The net impact of reducing water use and increasing water use efficiency is in need of further study and quantification and it is possible that the carbon footprint of agricultural water use efficiency will need to be determined on a site-specific basis.

Climate change is likely to affect agricultural water use efficiency. First, weather events are expected to become extreme, resulting in longer droughts and increased peak flows. Rising air temperatures will result in higher ET and greater crop water use requirements.

Data gaps — particularly farm-gate irrigation water delivery data — present an obstacle to assessing irrigation systems for efficiency and planning improvements and a potential regulatory issue. Farm-gate delivery data is a measure of the volume of water delivered to customers at the delivery point. In 2009, DWR was developing the report format and schedule for this mandatory requirement (DWR 2009), which was codified into the California Water Code in 2007.

RMS-5: AGRICULTURAL WATER USE EFFICIENCY

RMS-5 Recommended Approaches

1. Encourage partnerships between local resource agencies, farmers, and irrigations districts to pursue state grant funding for technical, planning, implementation, and monitoring.
2. Increase collection, management, and dissemination of data to growers, water suppliers, and water resource planners.
3. As feasible, encourage the development and expansion of sustainable, dry farm, or other types of farming that embrace resource conservation while contributing to the economy and preserving the history and agricultural heritage of the Russian River watershed.
4. Encourage partnerships between state and local entities including DWR, local RCDs, UC Cooperative Extension Service, farm advisors, irrigation districts, and the agricultural industry to improve agricultural water use efficiency through the provision of outreach and training programs to educate about benefits, costs, and risks of efficiency improvements and provide technical assistance with planning and implementation.
5. Regularly review water efficiency approaches to meet irrigation needs during dry years; explore the feasibility and cost-effectiveness of previously infeasible or un-cost-effective options, such as crop switching and regulated deficit irrigation.

7.1.2.1.1 Urban Water Use Efficiency

In the Russian River watershed, increases to urban water use efficiency improve water supply and water quality through technological improvements and behavioral changes that decrease indoor and outdoor residential, commercial, industrial, and institutional water use. Human demand and environmental demand occur during the dry summer months, when instream flow is most limited. During the drought that occurred between 2007 and 2010, Russian River residents and businesses were called upon to reduce summer water consumption to meet instream environmental beneficial uses for endangered salmonids. In both the upper (Ukiah area) and middle (Cloverdale south to Santa Rosa) watershed, conservation methods combined with changes to scheduled releases from Lake Mendocino resulted in sufficient instream water to meet regulatory requirements (Cinek 2009). However, with weather extremes predicted to become more frequent due to global climate change, it is likely that greater improvements to urban water use efficiency will be necessary.

The need for increased water conservation in California has been recognized by state government for the past decade. In 1990, during the fourth consecutive year of drought, the California legislature passed AB 325, the Water Conservation in Landscaping Act, and in 2004, AB 2717 was passed to remediate deficiencies found in AB 325, including issues with irrigation maintenance. In 2008, Governor Schwarzenegger called for the development of "a plan to achieve a 20 percent reduction in per capita water use statewide by 2020 (DWR 2009)." Senate Bill x7 7, Water Conservation, was enacted in 2009 requiring the State to achieve a 20 percent reduction in urban per capita water use by the end of 2020. To ensure incremental progress towards this goal, the State must achieve a reduction in per capita water use of at least 10 percent by the end of 2015. These targets are expected to be met through the efforts of urban water suppliers, who are required to set interim and final water use targets and implement practices meet them.

Each urban water supplier that either provides over 3,000 acre-feet of water annually or serves more than 3,000 connections is required to submit an Urban Water Management Plan (UWMP); several municipalities in the Russian River watershed file these plans (see Table 7.7, BMPs Implemented by UWMPs

in the Russian River Watershed). Urban water suppliers must consider a range of fourteen Demand Management Measures (DMM)/Best Management Practices (BMPs) specified by DWR and the California Urban Water Conservation Council MOU (see Table 7.7, BMPs Implemented by UWMPs in the Russian River Watershed). The MOU requires all signatory water suppliers to commit to implement the DMM/BMPs as part of their urban water conservation program. DWR has developed eligibility requirements for urban water supplier grants and loans based on implementation of the DMM/BMPs unless economic assessments prove them "not locally cost effective (DWR 2011)."

TABLE 7.7 BMPS IMPLEMENTED BY UWMPS IN THE RUSSIAN RIVER WATERSHED

BMP NAME	MUNICIPALITY (DATE OF UWMP)						
	CITY OF COTATI (2006)	CITY OF HEALDSBURG (2005)	CITY OF ROHNERT PARK (2010)	CITY OF SANTA ROSA (2010)	CITY OF UKIAH (2010)	SONOMA CO WATER AGENCY (2010)	TOWN OF WINDSOR (2005)
Water Survey Programs for Residential Customers	•		•	•	•	n/a	•
Residential Plumbing Retrofit	•		•	•		n/a	•
Water System Audits	•	•		•	•	•	•
Metering with Commodity Rates	•	•		•	•	n/a	•
Landscape Irrigation Programs	•	•	•	•	•		•
Washing Machine Rebate Program	•		•	•		n/a	•
Public Information	•	•	•	•	•	•	•
School Education	•			•	•	•	•
Commercial, Industrial, and Institutional Programs	•		•	•	•		•
Wholesale Agency Programs	n/a	n/a	n/a	n/a	n/a	•	n/a
Conservation Pricing	•	•		•	•	•	•
Water Conservation Coordinator	•	•		•	•	•	•
Water Waste Prohibition	•			•	•	n/a	•
Ultra Low Flush Toilet Replacement	•			•	•	n/a	•

There are several potential benefits of urban water use efficiency. It lowers demand and stretches existing supplies, thus increasing drought preparedness. Unused water can remain in reservoirs — such as Lakes Sonoma and Mendocino — to store water for use during drought years. Water use efficiency is at the foundation of sustainability. Environmental benefits accrue directly, in the form of increased instream flow, and indirectly, by increasing the overall amount of developed water available for human use at no added cost economically or environmentally. A method of estimating economic benefits include estimating avoided costs of developing a new supply at both the water agency (distribution systems, treatment facilities, and wastewater treatment facilities) and water user (on-site treatment, wastewater disposal) levels, including energy costs, which are a substantial component of water development, delivery, treatment, and use costs.

Urban water suppliers in the Russian River watershed are implementing all locally cost-effective conservation measures (Table 7. 7 BMPs Implemented by UWMPs in the Russian River Watershed), which is expected to significantly decrease unit costs of implementing these measures. Since costs of increased urban water use efficiency are currently lower than other supply options, such as recycling, desalination, or new surface water development, it is likely to be an increasingly important component of urban water supply.

Funding is a major challenge to urban water use efficiency planning, especially to small and disadvantaged communities, such as Ukiah. Additionally, as urban water use efficiency increases, customers will use less water, thus resulting in a decrease in revenue. Several communities in the Russian River watershed have raised water rates, in part due to the success of increased conservation efforts (e.g. Mason 2011; Norberg 2011; UDJ Staff 2011). Implementation of urban water conservation programs can be challenging; not only is it necessary to change traditional water use fixtures and technologies to more efficient and advanced technologies, it is necessary to induce end consumers to change water use behavior. Demand hardening is another challenge that faces urban water suppliers — demand hardening refers to the difficulty in further water use reductions after most of the technological water efficiency retrofits have been completed. Landscapes remain a significant water use; current legislation (AB 1881) tries to address this issue, however, increased public education regarding landscape irrigation and urban water efficiency is necessary.

RMS-6: URBAN WATER USE EFFICIENCY

RMS-6 Recommended Approaches

Urban water suppliers in the Russian River watershed should continue their strong efforts to meet state legislative requirements. Urban residents should continue to institute behavioral and technological changes that will conserve water. Water suppliers should consider innovative actions such as:

1. Conservation Offset. Approval of a project includes the requirement that the developer must implement or financially contribute to actions that will conserve water at or above the demand level of the project.
2. Use of Ambient Information Systems to Influence Water Use Behavior. The use of receivers to gather water use information daily and provide it to consumers as feedback on behavioral modifications.
3. Peak Demand Water Use. Educate the public about information on the best time to irrigate landscapes.
4. Gray Water and Rain Water Capture. Educate the public about and encourage the use of these systems where appropriate for landscape irrigation and other uses.
5. Public Outreach. Continue existing public outreach efforts and participate as appropriate with state funding and other efforts.
6. Certification Programs. Participate as appropriate with Landscape Contractors Association's Water Management Certification Program and other programs that increase landscape water managers' knowledge.
7. Technical Assistance. Partner with and obtain funding from relevant state and federal agencies including the California Department of Water Resources; maintain and strengthen local and regional partnerships such as the North Coast Integrated Regional Water Management Plan.

7.1.2.2 Operational Efficiency and Transfers Improvement

7.1.2.2.1 Regional and Local Conveyance

Water supply conveyance in the Russian River watershed is mainly accomplished by the Sonoma County Water Agency, which utilizes water from the Russian River and water diverted from the Eel River into the Russian River watershed (through the Potter Valley Project) to supply water to much of Sonoma County and north Marin County. Water from the Eel River is released into the Potter Valley Project, which generates hydroelectricity for the City of Ukiah. This water is stored in Lake Mendocino until release into the Russian River in Mendocino County. Water from Dry Creek and Warm Springs Creek is stored in Lake Sonoma; SCWA water releases from Lake Sonoma continue on to the Russian River mainstem through Dry Creek (SCWA 2011a). The Biological Opinion (2008, discussed in Sections 6.2, Biodiversity and Habitat Loss, and 7.1.1.1 Ecosystem Restoration) determined that flows through Dry Creek during summer months have been too high and too fast moving to provide juvenile salmonid habitat (NMFS 2008), so summer flow releases will be reduced in conjunction with habitat restoration in Dry Creek in an effort to improve juvenile salmonid habitat (Wilkison 2011). Water from the mainstem Russian River is collected in infiltration ponds and storage tanks and pumped via pipeline to SCWA customers, who convey the water to end users in the middle and lower Russian River watershed. In the upper watershed, the City of Ukiah primarily meets demand from four ground water wells that capture underflow from the Russian River (City of Ukiah 2011).

Water conveyance facilities — such as the dams and pipelines utilized in the Russian River watershed — provide benefits to flood management, environmental uses, water quality improvement, recreation, operational flexibility, and groundwater basin recharge. Benefits that expanded and improved conveyance could provide in the Russian River include:

- Flood Management. When conveyance systems are enlarged and properly maintained, they increase flood control capability and increases in storage retention ponds can decrease the magnitude of peak storm events, benefitting both infrastructure and habitat (see Appendix 16, Management Measures: Flood Control).
- Environmental Uses and Water Quality. Enhanced conveyance systems could enable diversion of more water during high river flows with less competitive use periods, reducing the pressure on instream flow during low flow, highly competitive use periods (see Appendix 16, Management Measures: Water Quantity Management).
- Operational Flexibility. An improvement to conveyance capacity can increase the amount of available surplus water that can be transported to a conjunctive use project.
- Groundwater Basin Recharge. The use and enlargement of spreading basins that slow overland storm event outflows increase retention, enhancing groundwater recharge and water quality (see Appendix 16, Management Measures: Agriculture, Groundwater

Protection and Urban/Rural Residential, Watershed and Groundwater Protection).

In the Russian River watershed, potential costs for water conveyance include both facility and operating costs. Distance and timing of water conveyance and improvements to and expansion of existing infrastructure factor into costs. As conveyance capacity increases, the ability to use flexible management can offset costs — for example, an entity may choose to move water during off-peak energy demand periods to take advantage of reduced power costs.

The maintenance and management of the Russian River's water conveyances systems requires adaptability. In addition to upgrading and repairing aging infrastructure to meet increasingly stringent environmental regulations and projected increases in demand, management must also address fisheries habitat deficiencies — such as those identified in the Biological Opinion (NMFS 2008) — and prepare water supply reliability strategies to respond to a constantly evolving understanding of anticipated effects of climate change. At a minimum, to maintain current levels of conveyance capacity for natural and constructed facilities, water providers must substantially reinvest in existing infrastructure. With expected population increases and fluctuation of timing and severity of precipitation events, conveyance infrastructure is likely to experience higher demand, necessitating a greater investment of resources. In order to provide supplies for expected growth as well as unpredictable emergencies, greater investment in conveyance systems could provide water supply reliability under changing conditions.

Science and planning represent another challenging frontier for regional and local water conveyance. Much remains to be understood regarding the relationships among hydrogeomorphology, hydrodynamics, flow timing, fish timing and movement, water temperature, water quality, environmental responses, and global climate change. In addition, conveyance infrastructure must maintain compliance with diverse laws, regulatory processes and statues such as the Public Trust Doctrine, Area of Origin statutes, California Environmental Quality Act, National Environmental Policy Act, the Clean Water Act, and the Endangered Species Act (DWR 2009).

RMS-7: REGIONAL AND LOCAL CONVEYANCE

RMS-7 Recommended Approaches

1. Water Supply Reliability. Assure adequate resources to improve and maintain conveyance facilities. Implement actions to increase water supply reliability, such as increased interconnections of independent water systems.
2. Maintenance and Management. Upgrade aging distribution systems to reduce energy needs, accommodate increased flows, and improve water quality. Ensure continued compliance with regulatory framework.
3. Planning. Monitor using established performance metrics and share lessons learned. Keep abreast of current scientific information regarding ecological, biological, and geomorphic relationships in the conveyance system. Incorporate vetted scientific information and monitoring results into conveyance management and development.

7.1.2.2.1 System Reoperation

System reoperation refers to a change in existing operation and management procedures for existing reservoirs and conveyance infrastructure to increase the water related benefits they provide. It may involve the improvement of water use efficiency or the emphasis of one use over another. Reoperation is often regarded as an alternative to construction of new water facilities but some physical modifications may be necessary to enable reoperation capabilities. In the Russian River watershed, there are three basic purposes of reoperation: 1) to address specific existing needs, 2) to improve operational efficiency and water supply reliability and 3) to anticipate and adapt to future changes.

Reoperation to address specific needs occurs regularly in the Russian River watershed. For example, the recent Biological Opinion (NMFS 2008, discussed in Sections 6.1, Biodiversity and Habitat Loss, and 7.1.1.1 Ecosystem Restoration), specifies changes in discharges from Lake Sonoma into Dry Creek during summer low flow conditions. Water managers throughout the watershed are continually seeking ways to improve operational efficiency and water supply reliability. Methods relevant to the watershed include the use of Forecast-Coordinated (FCO) and Forecast-Based Operations (FBO). The use of FCO utilizes advanced techniques to forecast precipitation and river flows to allow for drawdown of flood management reservoirs in anticipation of peak runoff events. FBO involves using forecasts of reservoir inflows to manage flood and water supply storage dynamically to achieve increased water supply, enhanced operational flexibility, and

improved drought and flood preparedness. Climate change is likely to bring about changes that alter both the physical environment and patterns of resource use, making the flexibility associated with system reoperation an important component of water supply reliability.

Benefits of system reoperation are generally project-specific and integrated. Multiple resource management strategies such as surface storage, conveyance facilities, conjunctive management and ecosystem restoration are can be integrated in system reoperation to provide flood protection, improve water quality, ensure supply reliability, support water dependent recreation, and provide ecosystem benefits (see Appendix 16, Management Measures).

Direct costs for implementing system reoperation are generally project-specific. They can include feasibility studies, completion of permitting requirements, materials, labor, and ongoing maintenance and operations costs. Potential costs also include loss of revenue from reduction in sale of hydropower or water supplies and other opportunity costs associated with changed operations practices.

Challenges facing the increased use of system reoperation include gaps in scientific knowledge, competing beneficial uses, physical and institutional constraints and implementation costs. As with Regional and Local Conveyance, a greater understanding of relationships between instream flow and aquatic ecosystems is necessary for optimal management of system reoperation. Lack of baseline data also hinders management; however, data collection is ongoing in the watershed, especially with respect to fisheries, instream flow, and water quality parameters. As mentioned previously, the Biological Opinion (NMFS 2008) has provided guidance on specific changes in operation to benefit juvenile salmonids; it also requires data collection and assessment. Competing beneficial uses are very familiar in the Russian River watershed, particularly the conflict between environmental and agricultural beneficial uses, such as the use of instream water for frost protection of crops. Both direct and indirect impacts should be considered when evaluating such tradeoffs. Institutional constraints can present challenges that make it difficult and time consuming to evaluate system reoperation potential. For example, environmental regulations — both existing and upcoming — may limit flexibility and contractual obligations may constrain some choices.

RMS-8: SYSTEM REOPERATION

RMS-8 Recommended Approaches

1. Integrated Planning. Utilize integrated planning to achieve the greatest benefits for environmental and consumptive beneficial uses.
2. Assessments and Planning. Continue baseline data collection and monitoring of relevant environmental and biological parameters.
3. Cooperative Efforts. When feasible, local, state, and federal agencies should collaborate in planning and project implementation.

7.1.2.2.1 Water Transfers

Water transfers involve the voluntary change in the way water is distributed among water users Ð usually for agricultural purposes Ð in response to water scarcity. According to California Water Code (CWC § 1725 et seq.), temporary water transfers occur for one year or less while long-term water transfers have a duration of longer than one year. There are five major types of water transfer: (1) Transferring water from storage that would have otherwise been stored into the following year with the expectation that the storage reservoir will refill during subsequent wet seasons; (2) Groundwater substitution — pumping groundwater instead of using surface water delivery — and transferring the surface water rights; (3) Transferring previously banked groundwater either by direct pumping or utilizing the groundwater locally and transferring surface water that would have instead been used; (4) Reducing the existing consumptive use of water through crop idling, crop shifting, or water use efficiency measures; and (5) Reducing return flows or seepage that would otherwise be irrecoverable from water conveyance systems.

Although water transfers may be seen merely as moving water from one beneficial use to another, they actually contribute to system reoperation and are linked to other water management strategies including surface and groundwater storage, conjunctive management, conveyance efficiency, water use efficiency, and water quality improvements (see Appendix 16, Management Measures). In the Russian River watershed, options exist for the utilization of water transfers to support beneficial uses through an increase in surface storage (Merenlender et al. 2008, Grantham et al. 2010).

Water transfers have the potential to improve both economic stability and environmental conditions. Costs include direct costs, such as conveyance storage, and

treatment costs associated with the transfer from one agricultural user to another. Costs for increasing off stream storage would include the construction and maintenance of additional storage facilities.

Challenges to water transfers include regulation and water rights, maintaining agricultural productivity, cumulative environmental effects, and infrastructural and operational limits. Because water transfers can occur between private individuals, there is some concern that oversight may not be adequate to protect the environment, public trust resources, and broader social interests that could be affected. Conversely, efforts to more closely regulate water transfers may unnecessarily restrict transfers that provide multiple benefits with few impacts. Potential environmental consequences of transfers include impacts on habitat, water quality, and wildlife by changing location, timing, and quantity of surface diversions as well as overdraft if groundwater is used. The Russian River watershed is most severely limited by infrastructure and operational limits — the ability to optimize benefits of water transfers depends on access to and capacity of existing conveyance and storage facilities.

RMS-9: WATER TRANSFERS

RMS-9 Recommended Approaches

1. Implement monitoring programs that evaluate potential impacts — both cumulative and specific — and that provide data with which to test current stream flow and demand models.
2. Develop groundwater management plans to inform implementation of water transfers that rely on groundwater withdrawals or that could impact groundwater quality.
3. Encourage community participation and multi-stakeholder collaboration to minimize conflict.

7.1.2.3 Water Supply Increases

7.1.2.3.1 Conjunctive Management and Groundwater Storage

Conjunctive management involves the planned, coordinated management of surface water and groundwater resources to maximize water supply reliability, water quality, and other management objectives. Historically, there has been a disconnect between management of surface water and groundwater; however, a more recent understanding of their hydrologic interconnection and potential for coordinated management to achieve multiple benefits has resulted in a growing interest in managing them conjunctively. Conjunctive management allows for efficient use of both resources through the coordinated operation of a groundwater basin and a surface water storage system linked by conveyance infrastructure. Water can be stored in the groundwater basin when excess supply is available and drawn upon later, when surface water is limited. In the Russian River basin, the use of conjunctive management will not only increase water supply reliability, but is likely to achieve multiple benefits including flood management, environmental water use, and improvement of water quality.

Conjunctive management consists of three fundamental elements: 1) groundwater management, 2) project construction, and 3) capacity building (DWR 2009). There are several groundwater basins in the Russian River watershed. The Ukiah Valley Groundwater basin is the largest and supplies water to several water districts in the upper watershed, however groundwater management planning has not been initiated for this basin (DWR 2004a). The Santa Rosa Plain groundwater basin underlies much of the lower watershed and groundwater planning has been ongoing since 2010 (SCWA 2011b). These groundwater basins are an important water source for municipal drinking water, agriculture, and individual water users in the lower Russian River watershed. In the rural areas of the watershed, many residents rely on several smaller groundwater basins for potable water supplies. Groundwater storage is an important component of water supply reliability because it is less susceptible to adverse impacts from and requires less maintenance than surface storage (see Appendix 16, Management Measures).

Project construction, another element of conjunctive management, could include construction of treatment or conveyance facilities, production of recharge basins, or installation of monitoring, production, and injection wells. Capacity building is the process of improving the performance capabilities of participants — usually agencies — through provision of technical assistance, funding or other resources, and employee training.

Conjunctive water management projects in the Russian River watershed can be used to meet multiple objectives including supply reliability, environmental beneficial uses, improved water quality, and increased flood protection. Conjunctive management can be combined with several other management strategies in the watershed including conveyance, system reoperation, recycled municipal water, and

ecosystem restoration, using multiple management strategies to achieve optimal benefits.

Costs associated with implementation of conjunctive management and groundwater storage include facilities construction, operations, and maintenance and may be negligible or extensive depending upon the extent of new construction or modifications.

Ground water and surface water are connected — both physically and through the hydrologic cycle, and resource use that affects one also affects the other. During the hot, dry summer months, groundwater discharges to streams throughout the watershed, contributing — potentially significantly — to instream flow. During wet months, groundwater is recharged through infiltration from streambeds. This close relationship means that degradation of surface water quality may result in degradation of the associated groundwater or conversely, that polluted groundwater may cause water quality impairment in surface water. Although this concept is readily understood, the site-specific details of these relationships are not completely understood and researchers are working at the local, state, and federal level to develop a better understanding.

Most precipitation in the Russian River watershed occurs during the winter months, and the capacity of existing conveyance and storage facilities to capture and recharge high volume, short duration storm flows is limited. Additionally, because storm flow is very turbid, the quality of captured water will be compromised. Environmental considerations are also important. Floodwaters serve an important function in river ecosystems by moving large materials in the stream and reshaping stream channels. If natural peak flows are diminished, the dynamic natural state of the river ecosystem may be compromised and habitat values and other environmental benefits may be impacted.

Although computer models are useful tools to investigate potential impacts of different decisions, it can be difficult to establish their accuracy in predicting future conditions. Because our knowledge of the physical and environmental systems is incomplete and local, site-specific data is often unavailable, models may not provide an accurate portrayal of future conditions under differing management scenarios. At this time, most of the computer models used by the state are not at a fine enough resolution to be used at a local scale.

Recharging groundwater can involve the use of water from different sources — such as captured storm water, recycled municipal water, or surface water — which is usually a different quality than the receiving water in the groundwater basin. There is uncertainty in the regulatory status of water quality of recharging and receiving waters; this increases the uncertainty associated with conjunctive planning and could possibly cause costs to rise to a point where a project is infeasible.

Groundwater quality can be impacted by surface water quality. Our constantly changing understanding of water quality contaminants — and their environmental and health impacts — leads to water quality standards that are constantly changing. Although this is positive for both human health and the environment, it adds to uncertainty when planning for conjunctive management.

Issues with regulation may arise with conjunctive management because unlike surface water, groundwater use in California is not regulated by the state. Surface water appropriative rights have been subject to a statutory permitting process since 1914; however, most of the laws governing groundwater in California have evolved in a piecemeal fashion through a series of court decisions that began in the early 1900s (DWR 2009), with the most relevant occurring in the past twenty years (Table 7.8, *Groundwater Legislation in California*). Groundwater management is seen as a primarily local responsibility with the State in a position of providing technical and financial assistance. In addition to the different types of laws governing them, more than 20 types of local agencies are authorized by state statute to provide water to individuals or entities. Furthermore, tribal rights pertaining to both surface water and groundwater may pose further complications. Finally, like surface water, groundwater basins span local and regional jurisdictional boundaries, but unlike surface water, it can underlie watershed boundaries, necessitating inter-watershed planning in addition to inter-jurisdictional cooperation.

TABLE 7.8. GROUNDWATER LEGISLATION IN CALIFORNIA		
DATE	LEGISLATION	INTENT
1991	AB 255	Authorized local agencies overlying basins subject to critical overdraft to establish voluntary groundwater management plans within their service areas.
1992	AB 3030	Encouraged local agencies to adopt groundwater management plans for managing their groundwater resources regardless of overdraft conditions.
2002	SB 1938	Established new requirements for local agency groundwater management plans and required adoption of such plans to be eligible for state funding for groundwater projects.
2009	SB 6	Required local agencies monitor and report the elevation of their groundwater basins. In regions where local agencies do not implement groundwater monitoring programs, DWR will implement one.

RMS-10: CONJUNCTIVE MANAGEMENT AND GROUNDWATER STORAGE

RMS-10 Recommended Approaches

1. Continue and expand upon research that seeks to elucidate site-specific relationships between groundwater basins and the associated surface water systems.
2. Collect data in a format compatible with DWR's Integrated Water Resources Information System
3. Use an adaptive process — with monitoring data and other feedback as important tools in the decision making process — to incorporate the principles of groundwater/surface exchange to maximize beneficial uses of conjunctive management.
4. Determine the extent of tribal water rights in the Russian River basin and work to address them substantively to ensure water supply reliability, ecosystem health, and environmental justice throughout the basin.
5. Maximize the capture and storage of excess water during wet months while minimizing environmental or other impacts.
6. Utilize risk management to buffer against the uncertainty in future water demand and climate conditions.
7. Utilize a conjunctive management computer-aided tool to help identify and quantify benefits and risks.
8. Institute land use planning that will protect and improve natural recharge areas.
9. Identify and evaluate opportunities to reduce runoff and increase recharge in unpaved urban areas, such as residential development, schools, and parks.
10. Manage entire groundwater basins as single units. Ensure that all relevant jurisdictions — local, state, federal, tribal — are included and that all watersheds affecting a groundwater basin are considered.
11. Initiate robust public education and outreach campaigns to foster greater public understanding of groundwater and surface water relationships and the importance of individual action to protecting water supply and quality.
12. When appropriate, coordinate conjunctive management activities with groundwater remediation to achieve multiple benefits for water supply and quality.

7.1.2.3.1 Recycled Municipal Water

Recycled water, also called reclaimed water, is wastewater (agricultural or municipal) that has been treated to a specified quality standard and intended for reuse. In the Russian River watershed, recycled municipal water is used by the Town of Windsor, the Airport-Larkfield-Wikiup Sanitation Zone, and the City of Santa Rosa (SCWA 2004). Uses include landscape and agricultural irrigation and injection into The Geysers steamfields where it contributes to local energy generation. Individual agricultural operations may recycle water for on-farm use; however, this section deals solely with recycled municipal water.

The State of California, recognizing the importance of recycled water to supply reliability, has enacted legislation, and created policies to encourage and mandate its development and use (Table 7.9, *Recycled Water Use Codes, Policies, and Regulations*). Several sections of the California Water Code (CWC) promote recycled water and even require it under certain circumstances. State regulations mandate that those who produce and consume recycled water comply with rules to protect pu blic health and water quality; the three recycled water providers in the Russian River watershed treat water to tertiary recycled water standards, which is the highest level of treatment defined by the state. Water treated to this level can be used for irrigation of parks, schools, and residential landscapes and may be appropriate for industrial applications or toilet flushing. The Town of Windsor has embraced the possibilities for recycled water use: the new Vintage Greens sub-

division utilizes recycled water to irrigate front and back yard residential landscapes, parks and sports fields, and the Windsor High School uses recycled water for toilet flushing and landscape irrigation.

TABLE 7.9. RECYCLED WATER USE CODES, POLICIES, AND REGULATIONS	
LEGISLATION	**INTENT**
CWC § 1211	Requirement that prior to implementation, SWRCB must review any changes to point of discharge, and place or pupose of use of recycled water to ensure potential impacts to beneficial uses are considered.
CWC § 13050	Promotion of the use of recycled water from municipal sources in accordance with state and federal water quality laws.
CWC § 13142.5(e)	In water limited coastal areas, requires an explanation for the discharge of wastewater to the ocean without recycling.
CWC § 13510	Declaration of interest and support in development of recycled water facilities.
CWC § 13550 et seq.	Declaration that use of potable water for nonpotable purposes can be considered an unreasonable use if recycled water is available.
AB 32, 2006	Requires the development and implementation of wastewater recycling plans to replace imported water with the goal of reducing greenhouse gas emissions.
AB 1481, 2007	Requires Regional Water Boards to set waste discharge requirements for landscape irrigation using recycled water.
Recycled Water Policy, 2009	Sets SWRCB policy to increase the use of recycled water in accordance with state and federal water quality laws.
California Dual Plumbing Code, 2009	Establishes statewide standards to install both potable and recycled water plumbing systems in all types of buildings as determined by the State Department of Public Health.

Indirect reuse occurs when a downstream entity withdraws water from a river and a portion of that water is wastewater from upstream discharge that has comingled with the ambient stream flow. This occurs in the middle and lower Russian River watershed. This type of indirect reuse is termed "unplanned," however planned indirect reuse can occur if groundwater is replenished with recycled water. While recharge of groundwater basins is not actively practiced in the Russian River watershed, it is a strategy that may be economically and technically feasible in the future.

Because of its potential for indirect reuse when discharged to a river that provides downstream users with water supplies, recycled water use does not necessarily increase water supply, but rather achieves greater use of existing water. The exception is treated wastewater discharged to the ocean or other saline bodies, which is considered "irrecoverable water." When water recycling captures municipal water that would otherwise be irrecoverable, it is considered to increase water supply. This distinction is potentially important for future municipal growth in the lower watershed. As communities in the upper and middle watershed increase recycled water generation and use, however, the volume of water discharged into the Russian River will be reduced, potentially adversely affecting downstream instream flow or water rights. In recognition, CWC § 1211 requires approval by the SWRCB prior to any changes in the point of discharge and place or purpose of use to ensure that potential impacts to downstream beneficial uses are considered.

Potential benefits of water recycling in the Russian River watershed include increased supply reliability and availability of potable water and decreased costs. Additionally, recycled water can potentially provide locally produced water at a lower energy cost than the development of new water supply infrastructure. Although the provision of recycled water to tertiary treatment levels requires significant amounts of energy, the high level of commitment of watershed entities to climate change mitigation and adaptation (i.e., SCWA's Carbon Free Water by 2015 Program, Applied Solutions, Climate Protection Campaign, Regional Climate Protection Authority, etc.) makes it likely that benefits of recycled water will outweigh potential carbon emissions costs.

Climate change is predicted to alter climate conditions, particularly the seasonal availability of water. Municipal water recycling, combined with other water supply reliability strategies, can provide the flexibility for water supply management that is necessary to ensure reliability. Although not available for potable use, recycled water can increase the amount of locally available potable water by serving as a substitute in applications that do not require potable water quality.

Recycled water could also preserve instream flow during periods of high environmental demand and human use. For example, regulations currently limit agricultural water withdrawals for vineyard frost protection. Recycled water treated to tertiary treatment levels could substitute for instream water withdrawals, protecting endangered salmonids during a critical life stage while also protecting vineyard operators from potential crop damage or regulatory noncompliance.

Funding shortages and costs of recycled water treatment and conveyance facilities can make recycled water projects infeasible, particularly at the local level. Potential costs of recycled water include the cost to construct or expand, operate, and maintain treatment and conveyance facilities. Matching treatment level to intended use could be used to reduce costs. Intended uses that require advanced water quality or have public health concerns will incur greater costs. Regulatory constraints prohibit the convey-

ance of recycled water and potable water in the same pipelines, so recycled water must be conveyed in a separate, labeled, purple pipe system that is easily distinguished from potable water lines. Thus, extending recycled service to areas located at a distance from treatment plants can be cost prohibitive.

One of the major hurdles to recycled water use is public acceptance, which depends on confidence in its safety. Of particular concern are microbiological quality, salinity, heavy metals, and organic and inorganic substances, which include pharmaceuticals, household chemicals, fertilizers, and animal growth hormones. When utilizing recycled water for irrigation or commercial uses, microbiological pathogens are the primary concern. Salinity is of concern when recycled water is to be used for irrigation or commercial or industrial processes. Heavy metals and organic and inorganic chemicals are of concern when recycled water is being used to recharge groundwater that provides drinking water. Matching water treatment to intended use will address these concerns; however, public outreach and education must also occur to increase public acceptance of recycled water use, particularly in public areas, on agricultural food crops, and eventually to increase potable groundwater supplies.

As discussed above, implementation of water recycling in the upper watershed would reduce the volume of treated wastewater entering the Russian River, thus reducing water available for use downstream. This situation could present inequities in the watershed or prevent recycling efforts in upstream communities (e.g., Ukiah) if the downstream users have rights to the use of discharged wastewater (e.g., Healdsburg).

The potential for cross-connections is a major challenge for the dual pipeline systems that differentiate potable from recycled water despite color-coding and labeling developed to keep them separate. The accidental connection of potable and nonpotable systems could contaminate potable water systems and the likelihood of such an error increases as greater numbers of residences, commercial buildings, and agencies utilize the system. In recognition of this issue, the Building Standards Commission in 2009 approved the California Dual Plumbing Code, which establishes statewide standards for the installation of potable and recycled water plumbing systems in different types of buildings.

RMS-11: RECYCLED MUNICIPAL WATER

RMS-11 Recommended Approaches

1. Support the establishment of local ordinances requiring upgrades from single to dual water distribution systems (purple pipe) in new and renovated construction to bolster acceptance and implementation of recycled water projects.
2. Conduct feasibility analyses regarding the use of constructed satellite water recycling facilities to provide recycled water to users who are located at distances from existing water recycling facilities.
3. Regularly evaluate the socioeconomic and environmental feasibility of expanding conveyance systems and construction of satellite facilities to meet needs of potential users who are located at distances from existing facilities.
4. Support micro-site water recycling — the development of local ordinances regulating residential gray water systems, which allow homeowners to reuse kitchen and laundry water for landscape irrigation.
5. Encourage partnerships between local resource agencies and governments and property owners to identify and pursue funding opportunities that expand or enhance recycled water use in the watershed.
6. Encourage partnerships between state and local entities including DWR, local governments, RCDs, UC Cooperative Extension Service, property owners, and the construction industry to where feasible increase recycled water use through the provision of outreach and training programs to educate about benefits, costs, and risks.
7. Provide technical support to entities interested in planning and implementing recycled water use projects.
8. Initiate a robust public education and outreach campaign to help the public understand the issues associated with recycled water use and foster a spirit of cooperation and collaboration between stakeholders in the basin.
9. Ensure that treatment levels are appropriate for specific uses and that treatment addresses newly identified constituents of concern are evaluated and addressed.

7.1.2.3.1 Surface Storage

Surface storage — the practice of using reservoirs to collect water for later release and use — is a water supply reliability option that is receiving much attention in the Russian River watershed. Traditionally, this water management strategy has played an important role in California because timing of precipitation and maximum water are not synchronous; in fact, the greatest demand on water supplies occurs during the months when precipitation is most limited. In the Russian River basin, withdrawals of surface water during the warm summer months when instream flow is limited have contributed to salmonid habitat decline. Large surface water diversions — Lakes Sonoma and Mendocino — supply municipal, industrial, and agricultural uses in the basin year-round in conjunction with groundwater, but these systems do not serve the entire watershed and are insufficient to meet demand during multiple dry years. The addition of surface water storage in some areas of the basin may increase supply reliability while protecting summer environmental beneficial uses; research shows that normal-year stream discharge during the wet season exceeds average yearly water demand by an order of magnitude (Merenlender et al. 2008).

The Russian River Coho Water Resources Partnership (RRCWRPP) has identified five tributaries in the lower Russian River — Dutch Bill, Grape, Green Valley, Mark West, and Mill Creeks — in which to develop a "systematic approach to improve streamflow and water supply reliability (RRCWRP 2011)." This approach relies heavily on water storage in the form of roof water catchment systems, domestic water storage tanks, and off-stream ponds. The RRCWRP is committed to finding scientific solutions that protect salmonid habitat while ensuring sustainability of water supplies for human uses. To that end, they employ a science-based approach, using streamflow, coho, and habitat monitoring data to evaluate cumulative impacts using GIS models. In studies in the upper watershed, Grantham et al. (2010) state that the challenge in this basin is determining the number, location, and size of winter storage ponds to offset summer water demands without significantly impacting the ecological function of winter storms.

Agricultural operations in the watershed, particularly in upper reaches, have increasingly consisted of new or converted vineyards. Vineyards require summer water, which is usually fulfilled by surface water diversions — whether permitted or not — and require frost protection during late spring freezes. This results in removal of instream water during critical periods for salmonid migration and survival. In 2008 and 2009, water removed from the river for frost protection stranded and killed coho salmon and steelhead in the basin (Digitale 2011). In response, the State Water Resources Control Board has developed and adopted regulations limiting the amount of water that can be diverted for frost protection and requiring records of diversions (Frederiksen 2011). These regulations have caused controversy and resulted in at least one lawsuit from grape growers (Bussewitz 2011).

Additional surface storage in the Russian River watershed would allow for greater flexibility in water supply reliability management. Potential benefits include flood management, ecosystem management, salmonid habitat improvement, sediment transport management, water supply augmentation, and emergency water supply. Not only can surface storage reduce downstream flood impacts by decreasing peak discharge during storm events, it can also enhance groundwater management by capturing runoff that can be stored in groundwater basins. Surface storage enhancement in the basin would enable increased adaptability to the uncertainties associated with climate change — with more water in reserve for use during summer scarcity, more water can be left instream, potentially buffering stream ecosystems from more extreme heat waves.

Potential costs of surface storage include the costs of construction and maintenance of offstream storage as well as the costs of technical support and monitoring necessary to evaluate environmental and fisheries responses to management actions.

A major challenge facing construction of additional surface storage facilities in the watershed is funding. Since most of the need for additional surface storage is located in rural areas that are not serviced by water suppliers, landowners are likely to be responsible for most of the funding. However, the benefits of additional surface storage benefit the entire watershed — and the state and nation at large — by protecting salmonid habitat. Fortunately, state and federal agencies recognize the importance of protecting both fish and agriculture and have provided — and are likely to continue to provide — grant funding for project planning and implementation.

Additional surface storage can affect flow up- and downstream from diversions. Peak flows provide a necessary function for stream ecosystems — they move large materials and provide the hydrologic energy needed to create and maintain habitat het-

erogeneity. Regulations require surface storage to mitigate potential impacts to streamflow regimes, potential water quality issues, potential changes to stream geomorphology, potential loss of fish and wildlife habitat, and risk of failure during seismic and other events. In recognition of the regulatory challenges, the SWRCB has streamlined the application process to allow vineyard and orchard operators to establish off-stream water storage ponds of up to twenty acre-feet per year (Benefield 2011).

RMS-12: SURFACE STORAGE

RMS-12 Recommended Approaches

1. Choose sites for new surface storage with care and carefully manage diversions to minimize impacts to adult salmon passage.
2. Consider rehabilitation and/or enlargement of existing dams and infrastructure as an alternative to development of new reservoirs.
3. Conduct comprehensive monitoring of environmental responses to each new or rehabilitated surface storage structure.
4. Practice adaptive management utilizing monitoring data be to optimize benefits to water supply and salmonid habitat
5. Utilize a computer-aided tool such as a surface water balance model to help identify potential construction sites and evaluate potential impacts of flow reduction.
6. Initiate a robust public education and outreach campaign to help the public understand the complexities associated with surface storage, agricultural water uses, and fisheries and foster a spirit of cooperation and collaboration between stakeholders in the basin.

7.1.2.3.1 Climate Change Considerations

All measures that increase water use efficiency allow for adaptation to a potentially drier climate and mitigate of GHG emissions through the reduction of water and energy use. Water use efficiency serves as an adaptive strategy that increases supply reliability by lowering demand, which effectively stretches existing water supplies. Water use efficiency lowers GHG emissions through reduction in the energy required to produce, convey, treat, and distribute water.

Precipitation patterns in the Russian River are expected to change — although frequency of storms may decrease, an increase in intensity is expected, leading to an increase in peak flows, which may overburden already stressed flood and conveyance infrastructure. Existing reservoir capacity in the watershed may not be sufficient to store excess water during times of low demand to replace instream flows during periods of peak demand. Conjunctive management may be of use to capture the increased peak flows, minimizing their environmental effects while enhancing water supply reliability.

RMS-13: CLIMATE CHANGE CONSIDERATIONS

RMS-13 Recommended Approaches

1. Incorporate into all water supply reliability management strategies a "comprehensive educational, informational and awareness element regarding sustainability of consumption of local products... (DWR 2009)." Reduction of long distance transport and importation of goods will reduce energy use and greenhouse gas emissions.

7.1.2.4 Priority RRICWMP Recommendations and Management Measures

TABLE 7.10 WATER SUPPLY RELIABILITY RECOMMENDATIONS				
SOURCE AGENCY. DATE PUBLISHED. SOURCE DOCUMENT	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE
ASSESSMENT				
Mendocino County Water Agency. 2011. Expert Interview	Data Needs: Who, what, where, and when water is used. No one seems to have a good idea of who uses water from the Russian River, how much they use, where it is used, and when. Lake Mendocino and Lake Sonoma are the two systems that are used for flow management. Operations need to improve to be based on real time to meet obligations, and not release excess amounts based on so many unknown "fudge factors." A lot of water is being released from the two reservoirs, in excess of actual needs. There is a lot of slop in the process. Without knowing what diverters are doing downstream, we cushion our management to prevent damage to the river. A better use of funds would be to track water instead of raising Coyote Dam. This would address the quantity issue for human uses and environmental needs.	Water Quantity	Russian River HU	42
Potter Valley Irrigation District and Upper Russian Stewardship Alliance. 2011. Expert Interview	We need to determine what baseline flow data is for tributaries to manage for frost protection and to address AB 2121.	Water Quantity	Forsythe Creek HSA	37
Sonoma County Water Agency. 2011. Expert Interview	Research by the UC Coop Extension and National Fish and Wildlife Foundation Russian River Coho Water Resources Partnership: fisheries research and hydrologic modeling in subwatersheds.	Water Quantity	Mainstem Russian River	36
Mendocino County Water Agency. 2011. Expert Interview	The frost protection effort is a great example of improved management and communication in this area. Expanding this type of communication to the rest of the calendar year and to the rest of the river will increase knowledge about water needs. This could free up 10,000 to 30,000 AF each year just by improving efficiency of communications and outflow management. This approach is probably the most cost effective way to increase water quantity available to human users and the environment. The details of how the frost protection program with URSA operates could be applied to the Russian River as a whole.	Water Quantity	Russian River HU	35
Agriculture Department, County of Mendocino. 2011. Expert Interview	The amount of water used for frost protection needs to be monitored and known. Meters need to be installed on all pumps to know the effect on the Russian River. Minimizing the impact of frost protection on the river is the main goal of documenting water use during frost protection periods.	Water Quantity	Russian River HU	34
CDFG. 2002. 2002 Draft Russian River Basin Fisheries Restoration Plan	The NCRWQCB and SWRCB along with DFG and other agencies should obtain data and locations watershed-wide on water diversions, riparian water rights, water right permits, groundwater and well-water usage, and aquifer conditions in order to make safe and protective decisions on continued water quantity impacts on salmonids.	Water Quantity	Russian River HU	31
The Conservation Fund. . Conservation Prospects for the North Coast	Identify water diverters, and request that SWRCB review or modify water use based on the needs of coho salmon and authorized diverters. Monitor and identify problems, and prioritize needs in terms of changes to water diversion, in particular Green Valley and Dutchbill creeks, which have been identified as current or potential coho streams s that often go dry.	Water Quantity	Russian River HU	30
CDFG. 2004. Recovery Strategy for California Coho Salmon	Review, and modify if necessary, water use based on the needs of coho salmon and authorized diverters.	Water Quantity	Russian River HU	28
Laguna de Santa Rosa Foundation. 2011. Expert Interview	Understanding the water use, demand, and recharge.	Water Quantity	Laguna de Santa Rosa HSA	28
California Department of Water Resources. 2005. California Water Plan 2005 Update	The degree and nature of the need for more groundwater and surface water storage varies from region to region; therefore, DWR will work with regional entities to evaluate the best ways to meet their groundwater and surface storage needs and the possible means of sharing storage capacity among regions.	Water Quantity	Russian River HU	27
PLANNING				
Southwest Regional Office National Marine Fisheries Service. 2010. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft	Develop new policies, regulations and programs to provide suitable flow conditions for CCC coho salmon.	Water Quantity	Russian River HU	46

TABLE 7.10 WATER SUPPLY RELIABILITY RECOMMENDATIONS				
SOURCE AGENCY. DATE PUBLISHED. SOURCE DOCUMENT	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE
Laguna de Santa Rosa Foundation. 2006. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California	Salmon and steelhead need year-round water in creeks where they spawn. Although some ephemeral streams have deep pools where juveniles can survive the summer, creeks need to be deep enough that the water stays sufficiently cool, and so that fish can travel up them in the fall and down in the spring. In the Laguna tributaries, channel down-cutting and groundwater pumping threaten the sustainability of summertime flows. Water budgets should be developed for salmonid-bearing streams to evaluate their current status and future needs. This is an issue on which it pays to be proactive with land use decisions and water conservation planning.	Water Quantity	Laguna de Santa Rosa HSA	40
CDFG. 2002. 2002 Draft Russian River Basin Fisheries Restoration Plan	Attend SCWA's "Water Supply" workshops for discussion on watershed management, water supply, and groundwater/gravel mining.	Water Quantity	Mainstem Russian River	36
CDFG. 2002. 2002 Draft Russian River Basin Fisheries Restoration Plan	Support the addition of a water resources component to the Sonoma County General Plan.	Water Quantity	Mainstem Russian River	33
California Floodplain Management Task Force. 2002. California Floodplain Management Report	Permitting agencies should consider the impacts of land-use decisions on the capacity of the floodplain to recharge groundwater.	Flood Plain Management	Russian River HU	29
Hildreth Farms, Inc.. 2011. Expert Interview	Addressing water supply for all users is going to be a big issue in the near future. Much bigger of an issue than it currently is. Before the tunnel in Potter Valley, the river bed was used as a wagon road in some locations because the gravel bars and riffles went dry. The diversion from the Eel created a year around flow in the Russian. This year around flow is artificial, but over time has allowed agriculture and residential growth in Mendocino and Sonoma Counties. It would be hard to go back to pre-diversion conditions now.	Water Quantity	Ukiah HSA	26
Southwest Regional Office National Marine Fisheries Service. 2010. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft	All local and state planning and development should consider, and provide contingencies for, droughts in a manner compatible with CCC coho salmon recovery needs.	Water Quantity	Russian River HU	25
Community Foundation Sonoma County and Sonoma County Water Agency. 2010. Biodiversity Action Plan: Priority Actions to Preserve Biodiversity in Sonoma County	Require water supply and treatment projects to provide multiple benefits.	Water Quantity	Guerneville HSA	16
Southwest Regional Office National Marine Fisheries Service. 2010. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft	Support the development and implementation of regulations for activities that intercept groundwater recharge (e.g., use of subsurface tiles in vineyards, impervious surfaces, etc.).	Water Quantity	Russian River HU	11
Southwest Regional Office National Marine Fisheries Service. 2010. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft	Work with counties to develop and implement ordinances (e.g. Santa Cruz County Code 2008) to restrict subdivisions by requiring a minimum acreage limit for parcelization in concert with limits on water supply and groundwater recharge areas.	Water Quantity	Russian River HU	10
IMPLEMENTATION				
California Department of Water Resources. 2005. California Water Plan 2005 Update	DWR will use its technical and financial assistance programs (including Proposition 50 funded programs) to effectively and equitably support planning and implementation of local and regional water use efficiency, water recycling, groundwater storage and management, ecosystem restoration, urban streams, flood management, and related planning efforts.	Socio-economic	Russian River HU	51
California Department of Water Resources. 2008. California Water Plan 2009 Update Pre-Administrative Draft Volume I The Strategic Plan	State, federal, Tribal, regional, and local governments and agencies, pubic and private organizations, and water users should implement the actions of California Water Plan Update 2009 to achieve its goals and objectives. They should in partnership adopt an integrated, collaborative, multi-benefit, and transparent approach toward resource planning and management. Californians, acting as individuals, make daily choices that can impact water quality and prevent water waste. State government should create incentives for citizens to aggressively participate in water protection and conservation efforts. These efforts may be modeled after energy conservation efforts conducted by the State.	Water Quantity	Russian River HU	50
UC Berkeley & Hopland Research & Extension Center, Environmental Science Policy and Management. 2011. Expert Interview	We need collective basin plans, like in Napa or in the Salinas basins. A collective arrangement to allow for management on a larger scale. Points of diversion need to be coordinated when water is planned for withdrawal.	Water Quantity	Russian River HU	49

TABLE 7.10 WATER SUPPLY RELIABILITY RECOMMENDATIONS				
SOURCE AGENCY. DATE PUBLISHED. SOURCE DOCUMENT	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE
California Department of Water Resources. 2005. California Water Plan 2005 Update	DWR will develop the necessary tools to assist local and regional agencies be successful with the integrated regional water management and planning and will monitor the development and implementation of these plans to ensure an equitable distribution of technical and financial assistance in planning efforts. Data from these plans can be integrated into future California water plan updates	Water Quantity	Russian River HU	44
California Department of Water Resources. 2005. California Water Plan 2005 Update	Local governments and agencies should improve coordination between land use planning and water planning and management to ensure that new infrastructure has adequate water supply and that land uses are protective of water quality.	Water Quantity	Russian River HU	43
Southwest Regional Office National Marine Fisheries Service. 2010. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft	Avoid and/or minimize the adverse effects of water diversion on CCC coho salmon by establishing a more natural hydrograph, by-pass flows, season of diversion, and off-stream storage (DFG 2004).	Water Quantity	Russian River HU	42
California Department of Water Resources. 2005. California Water Plan 2005 Update	DWR will develop guidelines for technical and financial assistance and templates for integrated regional water management plans, urban and agricultural water management plans, and drought contingency plans.	Socio-economic	Russian River HU	41
CDFG. 2002. 2002 Draft Russian River Basin Fisheries Restoration Plan	Develop county programs to protect and increase instream flows for anadromous fish, working with water districts on conservation issues and conduct regional water management planning. Counties should also condition development which would divert or store surface water on the applicants having received appropriative rights from the SWRCB.	Water Supply	Russian River HU	41
CDFG. 2002. 2002 Draft Russian River Basin Fisheries Restoration Plan	Significant impacts can be avoided if the season of diversion is limited to December 15 through March 31, reservoirs are built offstream, specific bypass flow are provided during the diversion season, and the natural hydrograph is protected to avoid cumulative impacts due to flow reduction in the watershed. See Guidelines for Maintaining Instream Flows to Protect Fisheries Resources Downstream of Water Diversions in mid-California Coastal Streams (CDFG & NMFS 2000), Staff Report, Assessing Site Specific and Cumulative Impacts on Anadromous Fisheries Resources in Coastal WAtersheds in Northern California (SWRCB 2001).	Water Quantity	Mainstem Russian River	41
The Conservation Fund. 2005. Conservation Prospects for the North Coast	Manage summer flows in the mainstem of the Russian River to the benefit of rearing coho salmon and of the estuary, while ensuring that all existing legal water uses and rights are accounted for.	Water Quantity	Russian River HU	41

TABLE 7.11 WATER SUPPLY RELIABILITY MANAGEMENT MEASURES				
		WATER SUPPLY RELIABILITY RMS		
RUSSIAN RIVER ICWMP MANAGEMENT MEASURES		WATER DEMAND REDUCTION	OPERATION EFFICIENCY AND TRANSFERS IMPROVEMENT	WATER SUPPLY INCREASES
Agriculture	Erosion and Sediment control			•
	Animal Waste Management			
	Nutrient Management			
	Pest and Weed Management			
	Grazing Management			•
	Irrigation Water Management		•	
	Groundwater Protection		•	
Urban/Rural Residential	Watershed and Groundwater Protection		•	
	Flood Control		•	
	Stormwater Management		•	•
	Low Impact Development	•	•	
Forestry	Road Management/ Reconstruction			
	Fire Management			
Hydromodification	Gravel Mining			
	Dam Construction and Operation	•	•	
	Streambank Erosion Control			
	Flow and Temperature Maintenance		•	
Natural Environment & Open Space	Fish Passage Enhancement			
	Habitat Protection			•
	Terrestrial Habitat Restoration & Management			•
	Instream Habitat Restoration & Management			
	Invasive Non-native Vegetation Control			•
	Recreation and Public Access			
	Water Quantity Management	•	•	
	Water Quality Management			•
	Wetland Restoration/Management			•

7.1.3 Flood Risk Management

In the Russian River watershed, several communities have been identified as vulnerable to flood risk; these include Guerneville, the Laguna de Santa Rosa, Potter Valley, Ukiah, and Sanel Valley (DWR 2009a). Flood Risk Management consists of projects and programs that assist individuals and communities to manage peak storm flows and to prepare, respond to, and recover from flood events (see Appendix 16, Management Measures: Flood Control). This approach to flood management considers land and water resources from a watershed perspective, employing both structural and nonstructural measures to maximize benefits provided by floodplains while minimizing losses from flooding. It includes recognition of the ecological importance of flooding to stream and floodplain ecosystem function and potential for groundwater basin recharge provided by standing water resulting from periodic flooding. It involves integration with several other water management strategies to achieve an acceptable flood risk for the watershed; other water management strategies that are integral to flood management in the Russian River watershed include Surface Storage, System Reoperation, Conjunctive Management and Groundwater, Ecosystem Restoration, and Urban Runoff Management.

Traditional flood risk management has focused on physical structures to divert or reduce floodwaters such as stream channel modification, dams and surface impoundments, levees, and other structures to confine or alter natural waterways. This focus has shifted in the past twenty years to utilize integrated flood management — a mix of structural and nonstructural methods that include development restrictions to minimize floodplain and low-lying coastal development and enhancement of undeveloped floodplains and low-lying areas to absorb, store, and slowly release floodwaters. Today's flood risk management recognizes a range of strategies — including water supply strategies — that when combined effectively minimize flood risk in an area. These strategies can be grouped into three categories: 1) structural approaches; 2) land use management; and 3) disaster preparedness, response, and recovery (DWR 2009b).

Structural approaches to flood risk management include dams and reservoirs, levees and flood embankments, channelization, high flow diversions and bypasses, coordination of flood operations, and facilities maintenance. In the Russian River watershed, Lake Sonoma and Lake Mendocino are the main reservoirs that provide flood control. Extensive channelization and other structures, such as levees, have been utilized on the mainstem and tributaries. Lakes Sonoma and Mendocino collect storm flows and release water downstream slowly enough so that bank capacity is usually not exceeded. When the reservoirs are full, stored water is released slowly following a storm event to increase storage capacity for future storms, but when they are not at capacity, storm water is stored for future beneficial use, such as water supply. Management of the reservoirs must include consideration of flood control, water supply, and environmental demand. During periods of

peak flow when the reservoirs are at capacity, communities in the lower Russian River are at risk from recurrent flooding due to the seasonal sandbar that closes the mouth of the river, preventing floodwaters from reaching the ocean. The estuary created by the sandbar provides valuable habitat for juvenile salmonids and other aquatic species; breaching it to provide flood control endangers these organisms (see Sections 3.1.4.5 Water Supply and Flood Control Infrastructure and 3.3.7.3 Wetlands and Riparian). In an effort to continue to provide flood protection and protect aquatic species utilizing the estuary, the Sonoma County Water Agency in 2010 revised its method for breaching the sandbar (SCWA 2011).

Land use management includes floodplain restoration, floodplain regulation, development and redevelopment policies, housing and building codes, and flood insurance. Land use management strategies may be combined with structural approaches to increase floodwater protection. Floodplain restoration involves restoring natural ecosystem function, which is to receive, hold, and slowly release floodwaters. This can be accomplished through purchase of floodplains or the acquisition of flood easements from willing landowners (see Appendix 16, Management Measures: Habitat Protection). Floodplain regulation involves the establishment of land use policies to guide development in areas adjacent to streams that have been identified as subject to periodic flooding or inundation. These policies may include restrictions on floodplain development, requirements that new development result in no adverse flood impacts to existing structures, or directives to acquire undeveloped floodplain lands for restoration. Development policies include land use practices developed to reduce flood risks, reduce the severity of floods, and expedite recovery after a flood. These policies may include stream protection ordinances, storm water management practices, open space preservation, and watershed management programs — all of which are well developed in both Mendocino and Sonoma Counties. Sonoma County has designated the Russian River, Laguna de Santa Rosa, and Mark West Creek as floodways, which facilitates enforcement of floodplain building ordinances. Redevelopment policies include those that restrict or constrain future development, encourage reduction of impervious areas, and long-term stream and floodplain restoration. Housing and building codes promote measures such as rooftop exits and elevated roads or floodproofing, which consists of actions to make buildings less vulnerable to floods. Flood Insurance, provided by the National Flood Insurance Program that was established by Congress in 1968 enables property owners to buy insurance to protect against flood losses. Flood insurance is available in communities that adopt and enforce a federally approved floodplain management ordinance.

Disaster preparedness, response, and recovery involve educating the public, preparing for disaster, enhancing emergency response capabilities, and post-flood recovery. Public education can be a powerful tool to modify the impact of flood events, especially if early warning systems are in place. Preparing for disaster includes development of flood response plans and implementation activities to reduce future risks. Enhancing emergency response consists of all actions taken by responsible parties during a flood emergency. By law, response is organized under the National Incident Management System and the State Standardized Emergency Management System using Incident Command System methods. The intensity of the flood event will determine the level of response — be it local, regional, state, or federal. Post-flood recovery involves actions such as utility service restoration, provision of public facilities and community services, levee repairs, individual aid, and other forms of individual and community assistance. Recovery planning can also include post-flood reconstruction decisions and provision of grants and loans.

Potential Benefits

The primary potential benefits of flood risk management are reduced risk to lives and infrastructure from flood events. Reducing or eliminating flood damage can reduce recovery-related costs. Nonstructural methods to reduce flood risk provide the additional benefit of restored ecosystem function and water quality improvements — when floodplains are restored to their natural hydrologic function to provide flood control, they can serve as wildlife habitat and filter runoff. They can also provide recharge areas for groundwater basins. Additionally, the reservoirs that provide flood control throughout the watershed also provide recreational opportunities, wildlife habitat, and water supply benefits.

Potential Costs

Potential costs of flood risk management are those associated with construction of flood control facilities and the costs of acquiring land and conducting ecological restoration. There is little likelihood of construction of large flood control structures in the watershed in

the future, but the potential for construction of additional surface storage is likely to provide flood control benefits. Planning and coordinating disaster preparedness, response, and recovery will have low costs that require long-term funding to ensure that programs, equipment, and training remain relevant and effective. Additionally, revision of land use plans and regulations to respond to flood risk is a time-consuming, expensive, and data-intensive task being called for at a time when local governments are experiencing reduced revenue from federal, state, and local sources.

Challenges

Flood risk management can only reduce intensity and frequency of flooding; it cannot prevent it. Structural measures can be exceeded by large storm events or be subject to failure, thus residents protected by flood control remain at risk. Global climate change is expected to result in an increase in the intensity of storms, which further threatens communities subject to recurring floods. Communities in the lower Russian River watershed within the zone of tidal influence will be at even greater risk - sea level rise could increase the potential for high tides that coincide with storm surges to inundate low-lying coastal areas. The extent of the need for flood management and age and condition of existing flood management facilities may not be well documented or publicly accessible, making it difficult to prioritize maintenance and planning activities or accurately understand risk.

Routine maintenance of flood control infrastructure such as channel clearing could potentially impact sensitive habitat and protected species, but it can also provide benefits through removal of invasive species, such as *Arundo donax*. Integration of restored floodplains into the existing flood control infrastructure may be challenging; present-day hydraulic characteristics of the Russian River may not provide the hydrologic conditions required to sustain floodplain habitat. Careful monitoring of ecosystem function — particularly as it relates to flood control — will be needed and ultimately some form of management may be necessary.

Post-disaster recovery planning and implementation does not tend to be well organized in the state. A major flood could result in increased costs due to lack of pre-disaster planning.

RMS-14: FLOOD RISK MANAGEMENT

RMS-14 Recommended Approaches

1. Develop and disseminate technical information about flood risk in vulnerable communities including hydrology and hydraulics of streams and rivers, accurate delineation of areas subject to inundation, and calculations of probabilities of loss at various flood levels.
2. Conduct studies to determine the age and condition of existing flood management activities.
3. Disseminate flood related information broadly to the local government agencies and the public, especially those living in flood prone locations.
4. Utilize a computer-aided tool such as a hydrologic model to help identify potential flood risks under different scenarios and determine optimal risk management strategies.
5. Flood proof vulnerable structures in the Russian River floodplain, especially those within the zone of tidal influence.
6. Support redevelopment policies that restrict redevelopment in flood prone areas, especially those within the zone of tidal influence.
7. Support the strengthening of land use regulations that restrict developments from floodplains, especially in flood-prone areas.
8. Consider rehabilitation and/or enlargement of existing dams and infrastructure as an alternative to development of new flood control infrastructure.
9. Regularly evaluate flood risk management strategies as part of integrated water management planning to ensure the inclusion of all feasible practices.
10. Promote the preservation of existing floodplains and restoration of natural floodplain functions where feasible.
11. Monitor and evaluate ecosystem function of restored floodplains to ensure adequate provision of flood control and other desired benefits.
12. Encourage partnerships between local governments, flood control agencies, state agencies, and communities in flood prone areas to develop disaster preparedness and response plans.

7.1.3.1 Priority RRICWMP Recommendations and Management Measures

TABLE 7.12 FLOOD RISK MANAGEMENT RECOMMENDATIONS				
SOURCE AGENCY. DATE PUBLISHED. SOURCE DOCUMENT	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE
ASSESSMENT				
Sonoma County Water Agency. 2003. Russian River Action Plan	Laguna De Santa Rosa Feasibility Study	Flood Plain Management	Laguna de Santa Rosa HSA	29
Sonoma County Water Agency. 2003. Russian River Action Plan	Santa Rosa Creek Watershed Feasibility Study	Flood Plain Management	Santa Rosa Creek HSA	26
Laguna de Santa Rosa Foundation. 2006. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California	Very little is known about how salmonids and other fish species use inundated floodplains and small drainages. Flooded areas are likely an important source of nutrients, especially during warmer, late-season events when animals have increased metabolic rates. However, when waters recede, floodplains may be a source of fish mortality, and a rich hunting ground for fishing animals and birds. We need studies evaluating the role of floodplains in the ecosystem, and comparing the role of grassland floodplains to flooded riparian forests.	Flood Plain Management	Laguna de Santa Rosa HSA	19
PLANNING				
California Floodplain Management Task Force. 2002. California Floodplain Management Report	While providing for public safety and flood damage reduction, flood management programs and projects should maximize opportunities for agricultural conservation and ecosystem protection and restoration, where feasible. When land is being considered for use in a flood management project or program, the following should be addressed equitably: Conserve productive agricultural land and natural habitat; Promote the recovery and stability of agriculture; Promote the recovery and stability of native species populations, and overall biotic community diversity; Provide for natural, dynamic hydrologic, and geomorphic processes; Increase and improve the quantity, diversity, and connectivity of native habitat; Eliminate or mitigate negative redirected impacts to neighboring landowners; and Evaluate and address economic impacts to local communities and regions.	Flood Plain Management	Russian River HU	48
CDFG. 2002. 2002 Draft Russian River Basin Fisheries Restoration Plan	In the remaining "natural" waterways/channels where the county has jurisdiction, flood control practices should be kept to a minimum, and only utilized when necessary as documented with monitored cross sections which show an unacceptable rise in the elevation in the 100 year flood height or as shown to significantly reduce flood capacity. In these channels, additional alternatives should be developed, such as: offset levees to increase floodplain and reduce flood control maintenance, adding floodplain level culverts to increase floodplain draining at culvert crossings, active tree planting and irrigation to increase shading which will reduce growth of brushy and exotic species to increase capacity and add stability, and purchase of riparian easements to allow floodplain flooding and stream meandering.	Floodplain Management	Russian River HU	42
California Floodplain Management Task Force. 2002. California Floodplain Management Report	State and local agencies should approach flood management as part of multi-objective watershed management. Where feasible, these projects should provide adequate protection for natural, recreational, residential, business, economic, agricultural, and cultural resources and protect water quality and supply.	Flood Plain Management	Russian River HU	36
California Floodplain Management Task Force. 2002. California Floodplain Management Report	In planning new or upgraded floodwater management programs and projects, including structural projects, local and State agencies should, where appropriate, encourage nonstructural approaches and the conservation of the beneficial uses and functions of floodplains. It is recognized that some structural approaches provide needed flood protection and opportunities for agricultural conservation and ecosystem protection and restoration.	Flood Plain Management	Russian River HU	35

TABLE 7.12 FLOOD RISK MANAGEMENT RECOMMENDATIONS				
SOURCE AGENCY. DATE PUBLISHED. SOURCE DOCUMENT	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE
California Floodplain Management Task Force. 2002. California Floodplain Management Report	State and local agencies should manage floodplains proactively and adaptively by periodically adjusting to current environmental, economic, hydraulic, and biological conditions and in response to new scientific information and knowledge. If new or additional flood management projects alter the size of a floodplain, cities and counties should evaluate all of their objectives for the area removed from or added to that floodplain.	Flood Plain Management	Russian River HU	31
California Floodplain Management Task Force. 2002. California Floodplain Management Report	As with other types of floodplains, local agencies should assess the risks of the reasonably foreseeable flood instead of relying solely on the 100-year flood.	Flood Plain Management	Russian River HU	30
California Floodplain Management Task Force. 2002. California Floodplain Management Report	State and local governments should increase and leverage federal programs, as appropriate, and encourage local, State, federal, public, nongovernmental, and other private cost sharing to achieve equitable and fair financing of multi-objective floodplain management actions and planning.	Flood Plain Management	Russian River HU	30
California Floodplain Management Task Force. 2002. California Floodplain Management Report	Flood-prone communities should (1) develop and publish potential evacuation routes for the whole community, specifically including those areas developed with flood protection levees, (2) provide real-time multi-lingual information on flood risk to its population to minimize loss of life and property, (3) conduct periodic flood simulation exercises, and (4) include community input and involvement.	Flood Plain Management	Russian River HU	28
California Floodplain Management Task Force. 2002. California Floodplain Management Report	Planning and development of ecosystem restoration projects should consider costs and impacts with respect to vector control and monitoring related to mosquito-transmitted diseases.	Flood Plain Management	Russian River HU	27
California Floodplain Management Task Force. 2002. California Floodplain Management Report	Entities involved in land-use planning for alluvial fans, distinct from FEMA mapping, should address the following: Alluvial fan flood flows are generally unpredictable, and a site analysis should be performed to determine all reasonably foreseeable flood apex flow paths. Flood flow depths and velocities should be determined for these flow paths. Any debris and scour associated with reasonably foreseeable apex flood flow should be determined. Land-use agencies should be encouraged to ensure that new development will not be damaged by the special risks associated with alluvial floods. These risks include velocities, debris, and scour associated with reasonably foreseeable floods.	Flood Plain Management	Russian River HU	26
IMPLEMENTATION				
California Department of Water Resources. 2008. California Water Plan 2009 Update Pre-Administrative Draft Volume I The Strategic Plan	State agencies should ensure Environmental Justice in all communities and equal access to State funding for water and flood projects.	Socio-economic	Russian River HU	45
California Department of Water Resources. 2008. California Water Plan 2009 Update Pre-Administrative Draft Volume I The Strategic Plan	State government should provide effective leadership, assistance, and oversight for California's water and flood planning and management activities.	Socio-economic	Russian River HU	42
Laguna de Santa Rosa Foundation. 2006. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California	Encroaching development reduces the area of open land on the floodplain, and interferes with natural hydrological processes. Support the public purchase of lands or conservation easements in the floodplain to retain open space for seasonal flood storage areas, while still allowing compatible uses such as agriculture, parks and wildlife habitat. Use floodplain models to evaluate where setting back levees or other actions can reclaim historical floodplain areas.	Flood Plain Management	Laguna de Santa Rosa HSA	36
California Department of Water Resources. 2008. California Water Plan 2009 Update Pre-Administrative Draft Volume I The Strategic Plan	California should maintain, rehabilitate, and improve its aging water and flood infrastructure.	Socio-economic	Russian River HU	32
NRCS - Sonoma and Marin Counties. 2011. Expert Interview	We need to focus more energy on stormwater management to address flood damage as well as improving summer supply. Reducing excess stormwater runoff through capture, infiltration, and management will reduce sediment deposition to the stream channels.	Flood Plain Management	Mainstem Russian River	31

TABLE 7.12 FLOOD RISK MANAGEMENT RECOMMENDATIONS				
SOURCE AGENCY. DATE PUBLISHED. SOURCE DOCUMENT	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE
CDFG. 2002. 2002 Draft Russian River Basin Fisheries Restoration Plan	The "constructed flood control channels" should be managed or restored to improve hydrologic function where possible. This could include: removal of onstream levees and construction of offset levees to increase floodplain and reduce flood control maintenance, moving or raising structures in frequently flooded areas, adding floodplain level culverts to increase floodplain draining at culvert crossings, and purchase of riparian easements to allow floodplain flooding and stream meandering. Local bond measures could be developed to cost-share these activities with county and other funds.	Floodplain Management	Russian River HU	28
Laguna de Santa Rosa Foundation. 2006. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California		Flood Plain Management	Laguna de Santa Rosa HSA	28
Southwest Regional Office National Marine Fisheries Service. 2010. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft		Flood Plain Management	Russian River HU	28
California Department of Water Resources. 2008. California Water Plan 2009 Update Pre-Administrative Draft Volume I The Strategic Plan		Socio-economic	Russian River HU	26
Sotoyome Resource Conservation District. 2002. Copeland Creek Watershed Assessment		Flood Plain Management	Laguna de Santa Rosa HSA	24

TABLE 7.13 FLOOD RISK MANAGEMENT MEASURES		
RUSSIAN RIVER ICWMP MANAGEMENT MEASURES		FLOOD RISK MANAGEMENT RMS
Agriculture	Erosion and Sediment control	
	Animal Waste Management	
	Nutrient Management	
	Pest and Weed Management	
	Grazing Management	
	Irrigation Water Management	
	Groundwater Protection	
Urban/Rural Residential	Watershed and Groundwater Protection	•
	Flood Control	•
	Stormwater Management	•
	Low Impact Development	•
Forestry	Road Management/ Reconstruction	•
	Fire Management	
Hydromodification	Gravel Mining	
	Dam Construction and Operation	•
	Streambank Erosion Control	•
	Flow and Temperature Maintenance	
Natural Environment & Open Space	Fish Passage Enhancement	
	Habitat Protection	
	Terrestrial Habitat Restoration & Management	•
	Instream Habitat Restoration & Management	
	Invasive non-native Vegetation Control	•
	Recreation and Public Access	
	Water Quantity Management	
	Water Quality Management	
	Wetland Restoration/Management	•

7.1.4 Water Quality Protection and Improvement

Water quality is an important and complex component of overall watershed health. It is important to — and influenced by — most human activities within the Russian River watershed. Clean, high-quality water supports activities such as agricultural irrigation, commercial and industrial processes, recreation, cleaning, and dining. The cleanliness of that water is influenced by nearly every human activity within the watershed as well as legacy impacts from past land use practices. From recreational activities to agricultural operations to day-to-day rural and urban living, human activities displace sediment and introduce chemicals and other substances into waterways. Historic land use practices to support agriculture, timber harvest, and urbanization such as clear-cutting timber and stream channelization also affect present-day water quality.

Management Strategies to improve and maintain water quality are governed by several state and federal regulations, including the federal Clean Water Act's (CWA) Antidegradation Policy and Total Maximum Daily Loads (TMDLs) and the North Coast Regional Water Quality Control Board's Water Quality Control Plan (Basin Plan) and Watershed Planning Chapter (see Table7.14, Policies, Laws, Plans and Regulations Affecting Water Quality in the Russian River Watershed). The federal CWA requires each state to adopt and implement an anti-degradation policy which requires that where surface waters are of higher quality than necessary to protect beneficial uses, the quality of such waters must be maintained except as otherwise provided. California's Antidegradation Policy, which was adopted in 1968, requires that the highest quality water consistent with the greatest benefit to the people of California be maintained. This policy has been integrated into each Regional Water Board's Basin Plan, which establish "a comprehensive program of actions designed to preserve, enhance, and restore water quality in all water bodies within the State of California (DWR 2009)." To maximize benefits to all California residents, particularly with respect to environmental justice, the state has adopted the precautionary approach — when threats to human or environmental health are involved, precautionary measures are taken even if some of the cause and effect relationships have not been fully established.

The federal CWA §305 (b) requires each state to report on the quality and conditions of its waters to the USEPA every two years. Additionally, under CWA § 303 (d), each state must submit a list of those waters that do not meet water quality standards and establish priority rankings of the listed water bodies. For California, this combined report is called the California 303(d)/305(b) Integrated Report. Each state is responsible for developing Total Maximum Daily Loads (TMDLs) for each listed water body for every pollutant that exceeds water quality standards. A TMDL identifies all sources of a pollutant in a waterbody, allocates numerical targets for pollutant loads that will allow the waterbody to meet water quality objectives, and identifies implementation actions to meet those targets. Federal law requires that each TMDL be incorporated into the Basin Plan.

TABLE 7.14 POLICIES, PLANS, LAWS, AND REGULATIONS AFFECTING WATER QUALITY IN THE RUSSIAN RIVER WATERSHED		
POLICY, REGULATION, OR LAW	AGENCY	DATE
Porter-Cologne Water Quality Control Act	CA Legislature	1969
Clean Water Act	US Legislature	1972
Coastal Zone Management Act	US Legislature	1972
California Safe Drinking Water Act	CA Legislature	1974
California Thermal Plan — Water Quality Control Plan for Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California	SWRCB	1998
NPS Program Plan	SWRCB	2000

TABLE 7.14 POLICIES, PLANS, LAWS, AND REGULATIONS AFFECTING WATER QUALITY IN THE RUSSIAN RIVER WATERSHED		
Policy for the Implementation and Enforcement of the Nonpoint Source Pollution Control Program	SWRCB	2004
North Coast Watershed Planning Chapter	NCRWQCB	2005
Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California Policy	SWRCB	2006
California Water Works Standards	CDPH	2008
Water Quality Control Plan for Enclosed Bays and Estuaries of California Part 1 — Sediment Quality	SWRCB	2009
Supplemental Environmental Project Policy	SWRCB	2009
Recycled Water — Adoption of a Policy for Water Quality Control	SWRCB	2009
Policy for Maintaining Instream Flows in Northern California Coastal Streams	SWRCB	2010
Water Quality Enforcement Policy	SWRCB	2010
North Coast Water Quality Control Plan (Basin Plan)	NCRWQCB	2011 (updated)
Russian River Frost Protection Regulation	SWRCB	in development
Proposed Revision to the Bacterial Standards for Water Contact in Fresh Waters of California	SWRCB	in development
Proposed Wetlands and Riparian Area Protection Policy	SWRCB	in development
Proposed Methyl mercury Water Quality Objectives	SWRCB	in development

In the *California Water Plan Update 2009, t*he DWR identifies six Resource Management Strategies that improve water quality and all pertain to the Russian River watershed. These are: 1) Drinking Water Treatment and Distribution; 2) Groundwater and Aquifer Remediation; 3) Matching Water Quality to Use; 4) Pollution Prevention; 5) Urban Runoff Management; and 6) Salt and Salinity Management. Each of these RMS is discussed in more detail below as they pertain to the Russian River Watershed. Priority RRICWMP recommendations identified for the Russian River watershed related to Water Quality Protection and Improvement from agency and peer-reviewed documents and expert interviews are provided in Section 7.1.4.7. Also listed are appropriate management measures for the suite of Resource Management Strategies which are described in greater detail in Appendix 16, Management Measures for the Russian River Watershed.

7.1.4.1 Drinking Water Treatment and Distribution

The provision of a reliable supply of safe drinking water is the primary goal of water providers in the Russian River watershed and throughout California. This RMS is linked to several RMS including Pollution Prevention, Watershed Management, Surface Storage, Urban Water Use Efficiency, and Groundwater and Aquifer Remediation. Water purveyors are dependent on many other agencies and organizations to protect and maintain the quality of raw water utilized for drinking water supply; high quality raw water means that less treatment is necessary to provide safe drinking water. Both public and private water systems operate in the Russian River watershed, but regardless of ownership, the California Department of Public Health regulates all water systems with respect to water quality.

The most significant issues facing drinking water treatment and distribution in the Russian River watershed include deteriorating infrastructure, source water protection, a lack of financial resources to address water treatment and infrastructure issues, and a lack of geographic connectivity — especially disadvantaged communities — that could lead to economies of scale. The lack of geographic connectivity leads to environmental justice issues; many of the outlying communities in the watershed are disadvantaged, leading difficulties providing with adequate operator training and upgrading treatment technologies to obtain compliance with new regulations at affordable per-household costs. Additional issues of concern include climate change, water use efficiency, treatment residuals disposal, drinking water facility security, and existing and emerging contaminants.

The Regional Strategy for Small Disadvantaged Water and Wastewater Providers was founded by the NCIRWMP to improve the capacity and quality of service of small water and wastewater services providers in the North Coast Region. Water purveyors in the watershed who join the effort will benefit from shared resources, experience and information, and the potential for pooled resources and efficiencies of scope and scale.

RMS-15: DRINKING WATER TREATMENT AND DISTRIBUTION

RMS-15 Recommended Approaches

1. Develop sustainable sources for funding water supply, treatment and infrastructure projects.
2. As much as possible, regionalize and consolidate water systems to achieve economies of scale for operations and maintenance of existing facilities as well as future needs. Encourage water purveyors to join the Regional Strategy for Small Disadvantaged Water and Wastewater Providers to further this goal by providing the opportunity to pool resources for training and technological upgrades as well as providing a network of professional contacts and technical resources.

3. Encourage water purveyors to develop and utilize rate structures that encourage conservation and discourage waste; where (if) needed encourage the installation and use of meters.
4. Fully evaluate residual disposal issues when planning new water treatment facilities.
5. Encourage public water systems to join the California WARN program, which can provide mutual aid and assistance.
6. Develop education strategies to control the release of pharmaceuticals and personal care products into the water supply.
7. Address the release of pharmaceuticals and personal care products into the water supply through improved wastewater treatment methods.

7.1.4.2 Groundwater and Aquifer Remediation

Groundwater remediation is necessary when groundwater becomes degraded to the point that it does not support beneficial uses, particularly the provision of drinking water — both for private use and public supply. This strategy is associated with several RMS including Drinking Water Treatment and Distribution, Matching Water Quality to Use, Pollution Prevention, Conjunctive Management and Groundwater, and Agricultural Lands Stewardship. Groundwater remediation involves the removal of contaminants through either active or passive remediation. Such contaminants may either occur naturally or have anthropogenic causes; examples of naturally occurring contaminants include heavy metals, radioactive constituents, and high concentrations of salts from specific geologic formations or conditions. For example, in 2008, three Russian River public water systems — two in Santa Rosa and one in Healdsburg — were out of compliance with arsenic regulations due to high levels of arsenic in groundwater (Sonoma News Today 2008). Anthropogenic sources include industrial compounds, mining operations, leaking fuel tanks, dairies, septic systems, and urban and agricultural activities; common anthropogenic contaminants in the Russian River watershed include gasoline and motor oil, volatile organic compounds, pesticides and herbicides, and bacteria.

Passive remediation leaves contaminants in an aquifer, allowing them to degrade or disperse naturally over time while active remediation involves either treating contaminated groundwater within the aquifer or extracting the groundwater and then treating it. Methods of treatment vary depending upon the contaminant; however, the by-products of treatment must be accounted for through disposal as hazardous waste or permits from the local air district. Most remediation in California involves active treatment of extracted groundwater. In the case of private wells, private well owners have the responsibility to ensure the safety of their well water.

Remediation is complicated by the many unknowns involved with groundwater — the size and extent of groundwater basins and their geologic and hydrologic characteristics and the concentration and extent of contamination. Costs can also complicate remediation — determining the responsible party and the extent of the contaminant delay remediation while contaminants continue to spread, further increasing costs.

RMS-16: GROUNDWATER AND AQUIFER REMEDIATION

RMS-16 Recommended Approaches

1. Implement source water protection measures to protect recharge areas from contamination.
2. Utilize land use planning to protect recharge areas from contamination by delineating buffer zones and utilizing LID techniques in new development.
3. Utilize available resources (from state and other sources) to determine responsible parties and remediate known contaminated sites.
4. Utilize available resources (from state and other sources) to identify historic commercial and industrial sites with contaminant discharge and determine the responsible parties to assess and remediate any contamination.

7.1.4.3 Matching Water Quality to Use

Matching water quality to use takes into account that different uses of water require different levels of water quality. For example, water utilized for drinking water and environmental beneficial uses must be high quality, while lesser quality water may be adequate for other uses, such as some industrial processes or landscape irrigation. RMS linked to matching water quality to use include Drinking Water Treatment and Distribution, Groundwater and Aquifer Remediation, Recycled Municipal Water, and Land Use Planning and Management. Matching water quality to use involves both existing and "new" sources of water such as recycled water; high quality groundwater may be used to provide drinking water

while recycled water can be treated to the level of purity needed for its intended use. In this way, a municipal supplier can reduce disinfection byproducts in drinking water while providing recycled water in a range of purities that match intended uses.

For many of the beneficial uses of water, matching water quality to use is important because except for municipal and industrial uses, water is usually utilized "as-is" — without treatment. Non-consumptive uses such as navigation, hydropower generation, and recreation do not use treated water; however, these uses require differing degrees of water quality. Contact recreation and ecosystem uses require higher quality water than do navigation and hydropower generation. Consumptive uses, such as agricultural irrigation and municipal and industrial use can also utilize differing degrees of water quality. Some industrial uses such as manufacture of computer components — require water treated to a higher degree of purity than drinking water, while other industrial uses such as cooling water require minimal treatment. By treating water only to the level of purity needed for a specific beneficial use, water purveyors can conserve resources. In this way, water purveyors will be able to ensure that high quality source water — which needs minimal treatment — is utilized for beneficial uses such as drinking water and ecosystem uses while recycled and less pure natural sources can be treated to the quality level necessary for other intended uses.

In the Russian River watershed, recycled water is currently utilized to recharge The Geysers geothermal energy plant and provide some landscape irrigation. The Sonoma County Water Agency, which provides water to several municipalities within the southern portion of the watershed, is currently conducting a feasibility study for expanded use of recycled water in Windsor and analyzing options for additional recycled water projects (Sonoma County Water Agency 2010). The use of recycled water for vineyard and other agricultural irrigation has been proposed as a way to protect environmental beneficial uses (Mason 2010). The use of recycled water for irrigation would allow water currently used for agricultural irrigation to be left instream, potentially providing sufficient instream flow to protect the coldwater fisheries beneficial use.

It is important to note that matching water quality to use may increase or decrease energy use, which can affect climate change mitigation efforts. For most applications of this strategy, energy use would be reduced due to avoiding treating water to a higher quality than needed for specific uses, however, in some cases, costs of transporting water of appropriate quality to the usage point would result in higher energy usage. These factors should be carefully considered during planning.

RMS-17: MATCHING WATER QUALITY TO USE

RMS-17 Recommended Approaches

1. Encourage and facilitate partnerships between upstream and downstream users to minimize impacts of nonpoint source runoff and treated wastewater discharges.
2. Incorporate water quality concerns into dam and reservoir operations with respect to timing and amount of water releases.
3. Encourage local water agencies and local planning efforts to manage water supply to match water quality to the highest possible use and to the appropriate treatment technology.

7.1.4.4 Pollution Prevention

A major component of pollution prevention is implementation of land use management practices to decrease pollutant loading to water sources (see Appendix 16, Management Measures: Water Quality Management). Past emphasis on point sources such as wastewater treatment facilities, industrial, construction, or municipal runoff has resulted in the regulation and control of these sources through National Pollution Discharge Elimination System (NPDES) permits, and General Waste Discharge Requirements (State GWDRs) and so attention has turned to reduction of polluted runoff due to different land use practices. Pollutants are generated from land uses including: agricultural practices, forestry practices, urban runoff, hydromodification, and wetlands management. Because there is no one point at which these pollutants can be identified (in contrast to wastewater treatment facilities or industrial operations), they have been termed "nonpoint source (NPS)" pollution and are regulated through the development and implementation of TMDLs. This RMS is linked to other RMS including Drinking Water Treatment and Distribution, Matching Water Quality to Use, Urban Runoff Management, Agricultural Lands Stewardship, Forest Management, Recharge Areas Protection, and Watershed Management.

Both surface and groundwater quality are affected by NPS pollution — surface water receives polluted runoff and groundwater becomes polluted through infiltration of polluted rainwater or irrigation. Both groundwater

and surface water quality can be improved through the implementation of TMDLs, NPDES permits and GWDRs. Protection of groundwater can also occur through the protection of recharge areas, which allow water to percolate to groundwater. When recharge areas are protected, pollutants can be prevented from entering an aquifer, thus avoiding costly and time-consuming treatment to improve water quality. Land use planning can be used to protect recharge areas in conjunction with implementation of land use practices to improve the quality of runoff from various land uses, protecting both surface and groundwater quality (see Appendix 16, Management Measures: Agriculture: Groundwater Protection and Urban/ Rural Residential: Watershed and Groundwater Protection).

The State has developed a Nonpoint Source Program that addresses NPS pollution through the promotion of management measures and management practices for each of the following land uses: agriculture, urban, forestry, marinas and recreational boating, hydromodification, and wetlands; these have been adapted for relevance to the Russian River watershed (see Table 7.16, Water Quality Protection and Improvement Management Measures). Management measures serve as general goals for controlling and preventing polluted runoff while management practices are the specific activities that are used to achieve these goals (Appendix 16, Management Measures for the Russian River Watershed). The SWRCB and NCRWQCB develop and adopt successive five-year plans to implement the State's NPS strategy. Currently, a major focus for the NCRWQCB is utilizing NPDES permits and GWDRs to regulate dairy waste, particularly in the Laguna de Santa Rosa, where concerns have increased in recent years about dairy contributions of nutrients, sediment, bacteria, temperature, and other pollutant to surface waters (NCRWQCB 2011). Other issues of concern include high bacteria content in the Lower Russian River attributed to failing septic systems and TMDLs for sediment, temperature, and dissolved oxygen throughout the watershed.

Several impediments to successful NPS pollution control exist. In addition to known pollutants such as sediment, temperature, and known chemicals used for agricultural, urban, and forestry uses, there are a number of unregulated chemicals and compounds that are being discovered to have unexpected health and environmental effects, such as pharmaceuticals and discarded elements of nanotechnology. Additionally, air deposition of many pollutants is increasingly recognized as a potentially significant contributor to water pollution. Most of these pollutants have not yet been assessed and will not be regulated for years to come, if ever. Barriers to nonpoint source pollution control include institutional barriers — many agencies at all levels of government must share resources and information to effectively implement planning and management activities. Fortunately, the North Coast Integrated Regional Water Management planning effort offers a framework that can be utilized for planning and implementation of local projects that includes committed partners from all levels of government. Finally, the widespread nature of NPS pollution necessitates the involvement of both private and public landowners, which can pose challenges related to outreach, access and funding sources for implementation efforts.

RMS-18: POLLUTION PREVENTION

RMS-18 Recommended Approaches

1. Utilize a watershed approach to planning and implementation of pollution prevention management measures and management practices.
2. Incorporate drinking water source and wellhead protection programs to protect drinking water sources and recharge areas into local land use plans and policies.
3. In communities that rely on groundwater, identify and address potential pathways for contamination.
4. Prioritize projects and funding for source water protection activities, focusing on building institutional capacity for watershed planning and improvements to wastewater treatment operations.

7.1.4.5 Urban Runoff Management

Urban runoff management involves activities to manage stormwater and dry weather irrigation or other runoff. Urban runoff management is linked with RMS including Pollution Prevention, Land Use Planning and Management, Watershed Management, Urban Water Use Efficiency, Recycled Municipal Water, Recharge Area Protection, and Conjunctive Management. A watershed approach is increasingly utilized for urban runoff management; this approach consists of a series of BMPs designed to reduce pollutant loading, decrease runoff velocity and volume and mimic the pre-development hydrograph. Such BMPs may consist of facilities or structures to capture and treat urban runoff to recharge groundwater basins or store for

later irrigation, public education campaigns focused on stormwater pollution prevention and technical assistance and training for municipalities (see Appendix 16, Management Measures: Erosion and Sediment Control, Water Quality Management, Dam Construction, Operation, and Maintenance, Flow and Temperature Maintenance, and Stormwater Management Measures). BMPs utilized will depend upon site-specific conditions, management goals, and funding availability.

Low Impact Development (LID), which utilizes design techniques to infiltrate, filter, store, evaporate, and detain runoff close to the source of rainfall, is being advanced by the State Water Control Board as an alternative to conventional storm water management. LID principals are now incorporated into permits and projects incorporating LID techniques are receiving funding through voter-approved bond funds. LID practices that utilize stormwater to recharge groundwater supplies or capture rooftop runoff for onsite use reduce energy use and GHG emissions associated with water supply.

Potential issues around urban runoff are effects of runoff on groundwater quality, nuisance problems such as mosquitoes, protection of recharge areas, lack of public, elected official and policy maker understanding, and existing codes and ordinances.

RMS-19: URBAN RUNOFF MANAGEMENT

RMS-19 Recommended Approaches

1. Utilize LID in public works projects
2. Engage local agencies, governments, and development communities in identifying opportunities to address urban runoff management — including LID — in development and re-development projects
3. Integrate urban runoff management with other RMS
4. Review codes and ordinances to determine if there are impediments to managing urban runoff and amend as appropriate
5. Coordinate urban runoff management with local water purveyors to ensure that goals and activities are complementary
6. Provide incentives for the installation of LID features at the lot level for new and existing developments

7.1.4.6 Salt and Salinity Management

Salt is naturally present in almost all water supplies. Salt consists of dissolved minerals and salinity is defined as the presence of those dissolved minerals carrying an electrical charge. Salt and salinity can be caused by natural sources, such as dissolution or weathering of rocks and soil or anthropogenic sources such as fertilizers, soil amendments, or personal care products. Salinity is a concern when salts become concentrated to levels that impact beneficial uses. This can occur when water is recycled — each use subjects the water to evaporation, which increases salt buildup — or when salt water intrusion contaminates coastal wells.

The SWRCB 2009 Recycled Water Policy requires that Salt and Nutrient Management Plans be developed to manage compounds found in recycled water on a watershed or basin-wide basis. The City of Santa Rosa Board of Public Utilities contracted with RMC Water and Environment to prepare a Salt and Nutrient Management Plan for the Santa Rosa Plain. Originally scheduled for completion in March 2011, a revised completion date of May 2012 is currently scheduled for consideration during the May 19 Board of Public Utilities meeting (http://ci.santarosa.ca.us/doclib/agendas_packets_minutes/Pages/BPUDocuments.aspx). Documents pertaining to the contract and its extension do not indicate that salt or salinity is considered a problem on the Santa Rosa Plain.

Neither salt nor salinity has been identified as a constituent of concern in the Russian River watershed. The Water Quality Control Plan (NCRWQCB 2007) and North Coast Watershed Management Initiative Chapter (NRWQCB 2005) do not mention salt or salinity, although several other water quality concerns are identified for the watershed (Sections 6.3 Water Quality, and 6.3.2 Impaired Beneficial Uses of Water).

MANAGEMENT STRATEGIES 20: SALT AND SALINITY MANAGEMENT

RMS-20 Recommended Approaches

1. If the Salt and Nutrient Management Plan or any other assessment indicates that salt or salinity becomes a concern, the utilization of adaptive management in the watershed and the region will allow corrective management measures to be implemented nearly immediately.

7.1.4.7 Priority RRICWMP Recommendations and Management Measures

TABLE 7.15. WATER QUALITY PROTECTION AND IMPROVEMENT RECOMMENDATIONS				
SOURCE AGENCY. DATE PUBLISHED. SOURCE DOCUMENT	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE
ASSESSMENT				
Russian River Watershed Council. 2002. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan	Identify, map and support efforts at the sub-basin level to reduce impacts including, but not limited to, sedimentation, run-off, dissolved oxygen, and high water temperature.	Water Quality	Russian River HU	46
Russian River Keeper. 2011. Expert Interview	Stormwater quality data from urban areas	Water Quality	Russian River HU	39
Coyote Valley Tribal EPA Department. 2011. Expert Interview	Monitoring water quality and quantity in Forsythe Creek and the West Fork Russian River needs to continue and should be expanded.	Water Quality	Forsythe Creek HSA	35
Russian River Keeper. 2011. Expert Interview	Assess sediment loads and sources	Water Quality	Russian River HU	35
Sotoyome Resource Conservation District. 2011. Expert Interview	Rural road sediment source assessments - RRIP	Water Quality	Russian River HU	32
National Marine Fisheries Service. 2007. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT	Identify and reduce fine sediment input to the stream	Water Quality	Geyserville HSA	30
UC Cooperative Extension. 2011. Expert Interview	Improved water monitoring needs to occur, with more gaging stations on the river and metered diversion pumps where appropriate. More information about rural, urban, and agriculture water users needs to be gathered.	Water Quality	Mainstem Russian River	30
North Coast Regional Water Quality Control Board. 2002. Regional Water Board Staff Work Plan to Control Excess Sediment in Sediment-Impaired Watersheds	Identify most egregious excess sediment sources using aerial and road-based reconnaissance, complaints, staff observations, general knowledge, and other information. Focus initial reconnaissance efforts on watersheds that currently support coho salmon. Austin Creek, Dry Creek, Dutch Bill Creek, Fife Creek, Forsythe Creek, Freezeout Creek, Green Valley Creek, Jenner Gulch, Maacama Creek, Mark West Creek, Mill Creek, Mission Creek, Sheephouse Creek, Turtle Creek, Willow Creek, and York Creek.	Water Quality	Russian River HU	29
Russian River Watershed Council. 2002. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan	Collaborate with agency staff and County representatives (e.g., County personnel, citizen, economic environmental and other groups) to identify model erosion control and bank stabilization ordinances, programs and practices that lead to improved water quality.	Water Quality	Russian River HU	29
Sotoyome Resource Conservation District. 2004. Coastal Tributary Improvement Program Final Monitoring Summary Report Agreement No. 03-214-551-0	Conduct sediment source assessment and reduction projects throughout the Austin and Fife Creek watersheds with an emphasis on unpaved rural road improvements. Work with private landowners to conduct inventories and improvement projects.	Science	Austin Creek HSA	29
PLANNING				
Laguna de Santa Rosa Foundation. 2006. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California	Initiate a Laguna TMDL process as a comprehensive and inclusive basin-scale study of factors influencing water quality in the Laguna, involving diverse stakeholders in both identifying problems and developing solutions to water quality impairments. Process should include a stratified and standardized water quality monitoring program, a study of beneficial uses, land-use factors, and the development of policies and management practices to expedite improvements, increase public awareness, responsibility and participation.	Water Quality	Laguna de Santa Rosa HSA	43
Southwest Regional Office National Marine Fisheries Service. 2010. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft	Develop a Road Sediment Reduction Plan that prioritizes sites and outlines implementation and a timeline of necessary actions. Begin with a road survey focused on inner gorge roads followed by roads in other settings.	Gravel Quality	Russian River HU	27
CDFG. 2002. 2002 Draft Russian River Basin Fisheries Restoration Plan	Collaborate with the State Water Resources Control Board, Division of Water Rights to evaluate the water rights permitting process and its effects on salmonids and macro invertebrates.	Water Quality	Mainstem Russian River	25
CDFG. 2002. 2002 Draft Russian River Basin Fisheries Restoration Plan	A sediment budget needs to be developed for the river and a sustainable mining plan needs to be developed. County Aggregate Resource Mining Plans would then need to be modified to reflect source and replenishment issues and local jurisdiction.	Gravel Quantity	Mainstem Russian River	24
CDFG. 2002. 2002 Draft Russian River Basin Fisheries Restoration Plan	Follow and provide comment to the NCRWQB's Russian River sediment objective amendment to the NCRWQCB's Basin Plan.	Water Quality	Mainstem Russian River	24

TABLE 7.15. WATER QUALITY PROTECTION AND IMPROVEMENT RECOMMENDATIONS				
SOURCE AGENCY. DATE PUBLISHED. SOURCE DOCUMENT	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE
Southwest Regional Office National Marine Fisheries Service. 2010. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft	Develop site-specific recommendations, including incentives, to remedy high temperatures and implement (DFG 2004) initially in core areas, following with phase 1 and 2 areas. Russian River - core areas - Sheephouse Creek area of the Willow Creek planning watershed; Freezeout Creek area of the Freezeout Creek Planning watershed; Dutch Bill, Felta, Wallace, Palmer, and Upper East Gray Creek planning watersheds; Purrington Creek area of the Purrington Creek planning watershed.	Water Quality	Guerneville HSA	23
CDFG. 2002. 2002 Draft Russian River Basin Fisheries Restoration Plan	Continue discussion within the Russian River Watershed Temperature Committee to develop the most protective temperature objective for the NCRWQCB Basin Plan amendment.	Water Quality	Mainstem Russian River	22
CDFG. 2002. 2002 Draft Russian River Basin Fisheries Restoration Plan	Alternatives for mitigation to unavoidable site specific impacts could also be discussed such as : the length of the streams modified through these activities could be mitigated for on streams where channel capacity is not an issue, through native re-vegetation efforts and floodplain easements in other coho drainages of the Russian River.	Floodplain Management	Russian River HU	21
CDFG. 2002. 2002 Draft Russian River Basin Fisheries Restoration Plan	Integrate the California Coastal Commission's "Model Urban Runoff Program" in Russian River watershed communities.	Water Quality	Mainstem Russian River	21
CDFG. 2002. 2002 Draft Russian River Basin Fisheries Restoration Plan	Habitat Inventory reports contain point-source descriptions of stream bank erosion. Implementation plans should prioritize them according to present and potential sediment yield.	Gravel Quality	Russian River HU	20
IMPLEMENTATION				
Community Foundation Sonoma County and Sonoma County Water Agency. 2010. Biodiversity Action Plan: Priority Actions to Preserve Biodiversity in Sonoma County	Protect streams, wetlands, and riparian areas in order to safeguard future water quality and quantity (simultaneously protecting habitat connectivity, enhancing areas with disproportionately high concentrations of sensitive species, and moderating local temperatures).	Water Quality	Guerneville HSA	53
Russian River Watershed Council. 2002. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan	Collaborate with property owners, agencies and educational institutions to establish appropriate watershed-wide control of unnatural erosion through run-off protocols, better management practices and activities that promote water resource sustainability (e.g., groundwater recharge).	Water Quality	Russian River HU	51
California Department of Water Resources. 2005. California Water Plan 2005 Update	DWR will help resolve long-standing water quality issues in the state, such as Delta salinity, dissolved oxygen in San Joaquin River (SJR) near Stockton, salinity at Vernalis, and ecosystem restoration flow needs, extending from the Klamath River in the north to Salton Sea in the south.	Water Quality	Russian River HU	45
CDFG. 2004. Recovery Strategy for California Coho Salmon	Remedy priority water diversion problems for current or potential coho streams that go dry in some years.	Water Quality	Guerneville HSA	45
CDFG. 2004. Recovery Strategy for California Coho Salmon	Implement appropriate recommendations to offset impacts from county policies and operations, as developed by the Five County effort.	Water Quality	Russian River HU	44
Mendocino County Water Agency. 2011. Expert Interview	Implementing sediment reduction projects is the 2nd highest priority.	Gravel Quality	Ukiah HSA	42
CDFG. 2002. 2002 Draft Russian River Basin Fisheries Restoration Plan	Assist organizations and agencies in obtaining grant funding for water quality improvement activities and implementation projects in the watershed.	Water Quality	Mainstem Russian River	39
Russian River Keeper. 2011. Expert Interview	Municipal awareness has improved, but can improve significantly more throughout the basin with more public education as we are all part of the problem and need to be part of the solution, cities can't do it alone without huge costs. We need to improve our focus on urban storm water runoff so we don't ruin our future like other Central Valley watersheds.	Water Quality	Russian River HU	39
Sotoyome Resource Conservation District. 2002. Copeland Creek Watershed Assessment	Reduction in sources of fine sediment in the watershed	Water Quality	Laguna de Santa Rosa HSA	38
CDFG. 2004. Recovery Strategy for California Coho Salmon	Implement Sotoyome RCD's Fish Friendly Farming Program	Water Quality	Warm Springs HSA	37

TABLE 7.16. WATER QUALITY PROTECTION AND IMPROVEMENT MANAGEMENT MEASURES							
		WATER QUALITY PROTECTION AND IMPROVEMENT RMS					
RUSSIAN RIVER ICWMP MANAGEMENT MEASURES		DRINKING WATER TREATMENT AND DISTRIBUTION	GROUNDWATER AND AQUIFER REMEDIATION	MATCHING WATER QUALITY TO USE	POLLUTION PREVENTION	URBAN RUNOFF MANAGEMENT	SALT AND SALINITY MANAGEMENT
Agriculture	Erosion and Sediment control				•		
	Animal Waste Management				•		
	Nutrient Management				•		•
	Pest and Weed Management				•		
	Grazing Management				•		
	Irrigation Water Management		•	•	•		•
	Groundwater Protection	•	•		•		
Urban/Rural Residential	Watershed and Groundwater Protection		•		•	•	
	Flood Control		•		•	•	
	Stormwater Management		•		•	•	
	Low Impact Development		•		•	•	
Forestry	Road Management/ Reconstruction				•		
	Fire Management						
Hydromodification	Gravel Mining				•		
	Dam Construction and Operation						
	Streambank Erosion Control				•		
	Flow and Temperature Maintenance						
Natural Environment & Open Space	Fish Passage Enhancement						
	Habitat Protection				•		
	Terrestrial Habitat Restoration & Management				•		
	Instream Habitat Restoration & Management						
	Invasive non-native Vegetation Control				•		
	Recreation and Public Access						
	Water Quantity Management	•		•			
	Water Quality Management	•		•	•		
	Wetland Restoration/ Management				•		

7.1.5 Climate Change Adaptation and Mitigation

Climate change will affect every aspect of life in the Russian River watershed, including implementation and outcomes of Resource Management Strategies (RMS). Implementation of RMS will be complicated by predicted effects of climate change such as increased variability and severity of storms, and increased temperatures and sea level, and constrained by efforts to reduce GHG. In addition to contributing toward achieving specific management objectives such as reduced water demand, increased water supply, or improved water quality, the RMS can also contribute towards climate change adaptation and/or mitigation efforts. Adaptation efforts reduce vulnerability to changing conditions or increase resiliency — the ability to bounce back from those changes — while mitigation efforts reduce GHG. Mitigation and adaptation efforts can be complementary or conflicting (Table 7.17 Complementary and Conflicting Adaptation and Mitigation Actions). Coordinated efforts are necessary to ensure that unintended negative consequences do not occur. For example, replanting harvested forests with non-native species will aid mitigation efforts through carbon sequestration, but will hamper the resiliency of native ecosystems, which are dependent upon specific tree species to perform ecosystem services such as nutrient sequestration, and provision of wildlife habitat. Both mitigation and adaptation measures are necessary in a holistic climate change strategy — mitigation efforts will produce immediate air quality benefits and cost savings but take decades to provide climate benefits so adaptation responses to climate changes already set in motion are necessary to maintain Russian River ecosystems and the economy as well as the welfare of all residents.

TABLE 7.17 COMPLEMENTARY AND CONFLICTING ADAPTATION AND MITIGATION ACTIONS (AFTER CALIFORNIA NATURAL RESOURCES AGENCY 2009)			
Favorable for Adaptation and Mitigation Efforts	Favorable for Mitigation, but Unfavorable for Adaptation Efforts	Favorable for Adaptation, but Unfavorable for Mitigation Efforts	Unfavorable for Adaptation and Mitigation Efforts
Energy demand management	Forestry with non-native species	Meeting peak energy demand with fossil fuels	Development in floodplains
Energy efficient buildings	Urban forestry (shade trees) with high water demand	Wastewater recycling and desalination	Traditional "sprawl" development
Water conservation	Some biofuels production	Groundwater banking	Development in hotter regions
Biodiversity-oriented forestry		Increased air conditioner use	

TABLE 7.17 COMPLEMENTARY AND CONFLICTING ADAPTATION AND MITIGATION ACTIONS (AFTER CALIFORNIA NATURAL RESOURCES AGENCY 2009)			
"Smart Growth"		Use of drainage pumps in low-lying areas	
Development in cooler regions			

Planning Considerations

The State Assembly enacted AB32, the California Global Warming Solutions Act, in 2006. The bill set limits to GHG emissions for the State of California and established the regulatory framework to achieve those targets. Limits were set at the state's 1990 GHG emissions level to be achieved by 2020 and the California Air Resource Board (CARB) was identified as the agency that would develop GHG emissions reporting procedures (Bedsworth and Hanak 2008). The CARB was further directed to establish rules and regulations for reducing emissions by January 2011 that would be enforceable by January 2012. In 2008, SB 375 was signed into law; this law established planning concepts to reduce individual vehicle travel through promotion of "smart development" in an effort to curb a major source of GHG emissions (County of Mendocino 2009).

In the Russian River watershed, climate change mitigation planning is well established. Sonoma County was the first community in the United States to have all local governments commit to the principles of the Cities for Climate Protection program. In 2005, all nine Sonoma cities and the County adopted the most ambitious GHG target in the nation — emissions at 25% below 1990 levels by 2015 (Climate Protection Campaign 2008). Mendocino County, in its General Plan (2009), identifies near term energy —reducing policies to reduce GHG emissions and sets a goal to develop a comprehensive GHG reduction plan for County operations and other activities within the watershed. To date, much effort has been spent on mitigating the effects of climate change; state and local agencies are now beginning to turn to adaptation strategies to prepare infrastructure, policy, and the natural environment for predicted conditions. Adaptation efforts have focused primarily on generating information about the climate-related risks facing California and are now turning to physical and behavioral strategies that will enable California to adapt (Bedsworth and Hanak 2008). Although this RMS focuses on climate change adaptation and mitigation strategies, it is important to recognize that each RMS presented in this RRWICWMP has implications with respect to climate change that should be carefully considered during its planning and development.

Mitigation

As mentioned above, climate change mitigation efforts are already well underway in the Russian River watershed. The Sonoma County Community Climate Action Plan and the Mendocino County General Plan (2009) present concrete, readily implementable measures to achieve energy and water efficiency, shift transportation from fossil fuel vehicles to other modes of transportation, invest in renewable energy sources, and sequester carbon (CPC 2008, County of Mendocino 2009). Cities throughout the watershed are in the process of implementing applicable actions to the extent that they are capable. Upon implementation, many of these activities will provide additional benefits — for example, improving efficiency of pumping operations for water and wastewater will and reducing end-user demand will leave more instream water for environmental beneficial uses and water-dependent recreational activities, improving habitat value and tourism potential. Table 7.18, Mitigation Planning and Implementation in the Russian River watershed, presents some of the planned and ongoing activities to reduce GHG.

TABLE 7.18 MITIGATION PLANNING AND IMPLEMENTATION IN THE RUSSIAN RIVER WATERSHED (CPC 2008)	
GOAL	**ACTIONS**
Improve energy and water efficiency	Retrofit existing buildings
	Maximize water efficiency
	Mandate green building standards
	Improve water and wastewater pumping operations
Develop smart transit and land use practices	Build the SMART train
	Implement the Sonoma County Comprehensive Transportation Plan
	Strengthen transit-oriented, mixed-use development
	Use urban growth limits to control sprawl
	Strengthen zoning laws to protect lands that sequester carbon
	Institute demand pricing policies for fuel
	Create an electric car share fleet
	Encourage business leadership and reduce regulatory barriers
	Convert open-air lagoon dairy waste systems to closed-system anaerobic digestion
	Incentivize replacement of older, highly polluting wood stoves in existing homes with EPA certified clean burning appliances
Invest in local renewable energy	Conduct a phased rollout of local renewable energy sources
	Replace natural gas and propane with electric and solar heat sources
	Incentivize small-scale solar, wind, and hydro installations
	Generate short-term energy through the use of closed landfill methane recovery
Protect lands that sequester carbon	Encourage, incentivize, and mandate carbon sequestration practices
	Generate electricity from agricultural solid waste
	Generate energy from biogas produce on dairy farms
	Improve operational efficiency in the agriculture sector, especially water efficiency
	Use conservation easements to protect agriculture and forest lands
	Implement the Sonoma County Integrated Waste Management Plant and collect landfill biogas for energy generation
	Incentivize replacement of older, highly polluting wood stoves in existing homes with EPA certified clean burning appliances

Adaptation

In the Russian River watershed, adaptation activities will need to address predicted changes such as sea level rise (in the lower watershed), increased frequency and severity of storm events (leading to increased flooding potential), potential for catastrophic fires (in wildlands), surface water scarcity, changes to ecosystem services, and air and water temperature changes (see Section 6.4 Climate Change). These predicted changes will affect nearly every sector of the economy and almost all activities within the watershed. The Public Policy Institute of California (Bedsworth and Hanak 2008) identifies six areas of concern in California with respect to climate change adaptation: water resources, electricity, coastal resources, air quality, public health, and ecosystem resources.

Water Resources

Managing water resources in the Russian River is already a challenging task — water quality and supply limitations impact human and ecosystem health, agricultural operations, environmental justice issues, and endangered species populations. The Russian River watershed receives its water supply through precipitation; with precipitation events predicted to become more severe and episodic, existing water supplies may be compromised — fewer, more severe weather events would result in greater flooding and runoff and less water percolating to recharge groundwater basins, which provide much of residential water supply in unincorporated areas of the watershed. Additionally, increased temperatures are expected to lead to greater evaporative water loss and contribute to drier overall conditions. These effects, coupled with increasing water demands from an increasing population will strain already stressed water supply systems. Water quality, which is currently impacted by sediment, temperature, and low dissolved oxygen (DO), will likely degrade even more during summer months when surface water is scarce, putting endangered salmonid populations at risk and requiring greater effort to ameliorate these conditions.

Electricity and Energy Demand

It is likely that increased winter temperatures will decrease winter energy demand, but increased summer temperatures are likely to increase the energy system's vulnerability to peak-period outages caused by increased use of air conditioning. Additionally, the increase in the number and severity of extreme weather events and expected increased incidence of wildfires is likely to increase risks to the energy transmission and distribution system, especially in unincorporated areas of the watershed. Existing plans to develop local renewable energy sources will buffer watershed residents from power outages within the state energy system; however, local energy systems will remain vulnerable to damages caused by wind and wildfires. Decreased summer instream flow is likely to reduce the energy generation capacity of hydropower systems during the time of year that demand is likely to peak, resulting in the need for additional energy sources to make up for this loss.

Coastal Resources

Coastal resources are at considerable risk from sea level rise, which is expected to be about 30 Ð 45 cm higher than 2000 levels by 2050 and increase to 0.6 Ð 1.4 m higher than 2000 levels by 2100 (Climate Action Team 2009). Coastal erosion is expected to occur at a much faster rate and flooding events in the lower watershed are likely to become more frequent and severe due to increased storm severity occurring in conjunction with sea level rise and existing climatic events such as El Niño. Coastal resources management faces difficult challenges due to reliance on historic data to predict future conditions and a lack of clear priorities regarding desired or anticipated future conditions. For example, federal flood insurance rates are currently utilized to guide community development, but these are based on historic runoff patterns and are thus unlikely to reflect future conditions accurately. Coastal armoring, which is the currently accepted method for protecting existing infrastructure from erosion and flooding, conflicts with ecosystem resources goals that seek to preserve wetlands by allowing for inland migration of wetland plant species as sea levels rise.

Air Quality

Increased temperatures associated with climate change are expected to increase the frequency and severity of ozone air pollution episodes and more frequent wildfires are likely to negatively affect air quality. Like coastal planners, air quality planners rely heavily on historic data to develop plans and set priorities. Such planning could easily result in lack of preparation to handle multiple extreme events such as wildfires and heat waves, which are predicted to increase dramatically.

Public Health

The increased number of extreme heat events is expected to lead to an increase in heat-related morbidity and mortality, resulting in increased use of emergency medical services and requiring the provision of supplemental outreach and resources for vulnerable populations including the elderly, economically disadvantaged, children, and Native Americans. Native American populations are among the most vulnerable because they are often closely linked to a specific piece of land due to the established reservation system. The increased incidence of wildfires and floods and increased incidence of climate-sensitive infectious disease is also expected to put additional strain on the medical system.

Ecosystem Resources

Increased air and water temperatures, increased severity of storm events, and decreased water quality will drastically alter habitat conditions in the Russian River. These factors will exacerbate and facilitate other challenges currently faced by native species such as the presence of invasive species, habitat fragmentation, pollution, incidence of disease, and habitat loss. Ecosystem resources managers face additional challenges due to reliance on historic data to guide planning and changes to migration routes and habitat as natural conditions change.

Under most climate change scenarios, ecosystem services such as carbon sequestration, forage production, and instream flow are expected to decline. Wetlands, which provide important ecosystem benefits to water quality, are an important ecosystem resource that is extremely threatened in coastal areas due to impending sea level increase. Not only do wetlands filter polluted runoff, they also sequester carbon through standing vegetative biomass and the continuous accumulation of carbon in wetland soils. These ecosystems are a natural carbon sink; research is currently underway to quantify rates of sequestration over a range of coastal tidal ecosystems for use in international carbon trading markets (Restore America's Estuaries et al. 2010). Thus, restoration of wetlands and other ecosystems is not only an adaptation strategy, it is also a mitigation strategy.

MANAGEMENT STRATEGIES 21: CLIMATE CHANGE ADAPTATION AND MITIGATION

RMS-21 Recommended Approaches

1. Avoid development in areas that cannot be adequately protected from flooding, wildfire and erosion caused by climate change.
2. Avoid development of new structures in locations that will require significant protection from sea level rise, storm surges, or coastal erosion.
3. Modify zoning and building ordinances to accommodate extreme precipitation events — ensure that any new development or redevelopment will not require emergency protection measures from anticipated flooding events.

4. Modify building standards and codes for energy efficiency, and facilitate the use of renewable energy as outlined in the Sonoma County Community Climate Action Plan (CPC 2008).
5. Support solutions identified in the Sonoma County Community Climate Action Plan — maximize energy efficiency, end-user water efficiency, switch to renewable sources of electricity, replace natural gas and propane space and water heating with electric heat pumps and solar hot water heaters, institute mandatory green building ordinances, improve water and wastewater conveyance, and treatment methods to increase efficiency.
6. Update the Local Coastal Plan to account for accelerating sea level rise and coastal erosion.
7. Modify local building codes to take sea level rise into account.
8. Ensure that local air districts incorporate changes associated with climate change into air quality plans.
9. Encourage agricultural managers to begin gradual replacement of current, longer chill requirement fruit cultivars with those requiring less winter chill
10. Develop and implement policy tools that favor retention of timberlands. These might include tax relief or other market-based incentives for small land holders, purchase programs for lands of high conservation or recreation value, or actions to draw development to other areas.
11. Develop and implement policy tools to lessen the impact of climate change on land use conversion. These might include participation in carbon markets and funding adaptation of timber management to climate change.
12. Restore and increase forest carbon stocks.

7.1.5.1 Priority RRICWMP Recommendations and Management Measures

TABLE 7.19. CLIMATE CHANGE ADAPTATION AND MITIGATION RECOMMENDATIONS				
SOURCE AGENCY. DATE PUBLISHED. SOURCE DOCUMENT	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE
ASSESSMENT				
Coyote Valley Tribal EPA Department. 2011. Expert Interview	The main focus of Coyote Valley has been on fisheries populations and native plant communities. Monitoring water quality and monitoring for climate change are important to the Coyote Valley Tribe.	Fisheries Protection	Forsythe Creek HSA	33
PLANNING				
Russian River Keeper. 2011. Expert Interview	Climate change effects. Forecasting how changes will effect land use management. For instance, using water for heat control in vineyards will be a huge demand in the summer. This practice needs to be modified.	Water Quantity	Russian River HU	35
Sonoma County Water Agency. 2011. Expert Interview	Integrated Water Resources Sciences and Services (IWRSS): NOAA program to enhance predictions for water resource situations. This will enhance operations of the dams to meet multiple goals, including climate change issues. Reference to Chris Delaney as an engineer who is involved in this project.	Water Quantity	Mainstem Russian River	32
IMPLEMENTATION				
California Department of Water Resources. 2008. California Water Plan 2009 Update Pre-Administrative Draft Volume I The Strategic Plan	State government should lead and support planning and research to help California adapt and mitigate for climate change impacts, and emphasize drought and flood contingency planning.	Socio-economic	Russian River HU	51
California Department of Water Resources. 2008. California Water Plan 2009 Update Pre-Administrative Draft Volume I The Strategic Plan	Local governments should update General Plans to address drought, water quality, and flood risks in light of existing and future climate change impacts.	Water Quantity	Russian River HU	32
Occidental Arts and Ecology Center. 2011. Expert Interview	Predictive models that link climate change to basin conditions need more press. The effects on precipitation, fire, hydrologic cycle, frost, sedimentation, sea level rise need to be better understood and provided for policy/management decisions.	Socio-economic	Guerneville HSA	28
Russian River Keeper. 2011. Expert Interview	Water rights and demands, and needs of aquatic habitats need to be balanced. Even with normal precipitation, the demand on supply from Lake Mendocino makes lack of storage a problem. Increasing storage at Lake Mendocino is an important part of addressing climate change. Options of increasing storage include sediment removal (dredging) and raising the elevation of Coyote Dam.	Water Quantity	Russian River HU	18

TABLE 7.20. CLIMATE CHANGE ADAPTATION AND MITIGATION MANAGEMENT MEASURES		
RUSSIAN RIVER ICWMP MANAGEMENT MEASURES		CLIMATE CHANGE ADAPTATION AND MITIGATION RMS
Agriculture	Erosion and Sediment control	
	Animal Waste Management	
	Nutrient Management	
	Pest and Weed Management	•
	Grazing Management	
	Irrigation Water Management	•
	Groundwater Protection	•
Urban/Rural Residential	Watershed and Groundwater Protection	•
	Flood Control	•
	Stormwater Management	•
	Low Impact Development	•
Forestry	Road Management/ Reconstruction	
	Fire Management	•
Hydromodification	Gravel Mining	
	Dam Construction and Operation	
	Streambank Erosion Control	•
	Flow and Temperature Maintenance	•

TABLE 7.20. CLIMATE CHANGE ADAPTATION AND MITIGATION MANAGEMENT MEASURES		
Natural Environment & Open Space	Fish Passage Enhancement	•
	Habitat Protection	•
	Terrestrial Habitat Restoration & Management	•
	Instream Habitat Restoration & Management	•
	Invasive non-native Vegetation Control	•
	Recreation and Public Access	
	Water Quantity Management	•
	Water Quality Management	•
	Wetland Restoration/ Management	•

7.1.6 Recreation and Public Access

The Russian River watershed has been a popular recreational destination since the late 19th century, when visitors from the San Francisco area utilized the newly constructed railroad to access the Russian River valley for summer vacations. Communities in the Lower Russian River including Guerneville, Monte Rio, Rio Nido, Summerhome Park, and Cazadero became important vacation destinations for people wishing to escape the foggy San Francisco or hot Sacramento summers. Recreation was the major industry in the Lower Russian River from the 1920s until 1935 (when the railroads were dismantled) and continues to be an important component of the economy in the watershed today. Recreational opportunities include swimming, boating, fishing, camping, hiking, biking, horseback riding and bird watching. Although many of these recreational opportunities are not directly dependent upon the presence of water, they are enhanced by the presence of high quality water in natural settings. For example, bird watching may take place in upland habitat, but the presence of a large variety of native birds is highly dependent upon the availability of a high quality water source. This RMS is linked to other RMS including ecosystem restoration, pollution prevention, and land use planning and management.

In addition to providing important economic benefits associated with the recreation industry, providing for water-dependent recreation in water projects is part of the California Public Trust Doctrine and California law. The 1961 Davis-Dowig Act stipulates that state agencies involved in water projects also provide recreation facilities and fish and wildlife enhancement and the California Public Trust Doctrine identifies recreation as a public trust use that must be considered when state agencies are managing tidelands and navigable waters and their tributaries (State Lands Commission 2001). Although local agencies are not required by law to provide recreational opportunities, it is in the best interests of local residents and all Californians for them to collaborate with state agencies in this endeavor for both economic and social reasons. Tourism is a major industry in Sonoma County and ecotourism has recently been identified as an opportunity market (Sonoma County Tourism Bureau and Sonoma County Economic Development Board 2010). The successful development of this niche will depend on continued provision of high quality outdoor recreational activities. In Mendocino County, the travel and tourism industry has grown rapidly over the past decade, currently accounting for 10% of the county's employment and 38.8% of local tax generation (County of Mendocino 2010). Additionally, the availability of recreational opportunities enhances quality of life for watershed residents. The California Water Plan (DWR 2009) identifies multiple societal benefits to water dependent recreation, including cultural understanding and the strengthening of social bonds through shared recreational experiences, potential increases in volunteerism and stewardship of natural resources through meaningful outdoor experiences, and the development of life-long positive values regarding natural environments through school-based environmental experiences. Recreational activities also provide exercise and relaxation activities, which benefit watershed residents on an individual basis.

The provision of recreational access is an important issue for water and land managers (see Apendix 16, Management Measures: Recreation and Public Access). It can have environmental, social, and economic components. Provision of access for recreation can impact the very qualities that attract people to an area. For example, trail use — whether by hikers, bicyclists, or equestrians — can lead to sedimentation of streams and rivers. Thus, proper trail development and maintenance is necessary to protect existing beneficial uses of a water body while simultaneously

providing recreational opportunities. Lack of access to recreational opportunities can be a justice issue — in low-income areas, these opportunities are generally limited, or, where they exist, the water quality may be impacted, putting recreationalists' health at risk. In the Lower Russian River, water quality can be degraded due to pathogens — the communities in this section of the watershed are largely disadvantaged. While other watershed residents may have the resources to travel to other parts of the watershed or outside the watershed for recreation, residents of the Lower Russian River may not. Thus, if they choose to engage in contact-recreation in these contaminated waters, their health is at risk. Native American Tribes are often economically disadvantaged and in addition to recreational access issues, they can experience loss of cultural resources associated with water management activities or recreational use. In some waterways, recreational activities make it difficult or impossible to access cultural materials located along water bodies (DWR 2009). The current economic downturn can also impact recreation — in down economies, people have less disposable income and tend to recreate closer to home, putting increased demand on existing facilities. Since recreation providers are also operating with reduced budgets, either services will be reduced and facilities maintenance curtailed, or fees will be increased to maintain and expand them. In either scenario, a burden would be placed on already struggling individuals — they would have to pay increased costs of recreation or find alternative recreational activities.

Lake Sonoma and Lake Mendocino, which were built as a flood control and water supply projects in 1983 and 1958 respectively, serve as important recreational destinations in both counties. Water-dependent uses such as boating and swimming are provided along with non-contact recreation such as picnicking and hiking. The protection and maintenance of these reservoirs is important not only for their original intended purpose, but also to provide residents and visitors with high-quality recreational activities. Throughout the watershed where public lands intersect with waterways, the story is much the same — excellent recreational activities exist alongside the original land use. It is the challenge of land and water managers to maintain the existing use of a property or waterway while also providing opportunities for recreational experiences.

Impacts of recreation and access on natural lands include sedimentation, spread of invasive non-native plants, disturbance of native wildlife, potential looting or disturbance of cultural and historical resources, degraded water quality due to fecal contamination where restrooms are not provided, spread of trash and animals associated with trash such as ravens, and impacts to native wildlife from unleashed dogs. When natural resources are not well managed, not only are recreational activities diminished, but water quality and other environmental amenities can be degraded (California State Parks 2009). For example, if trails are not properly maintained or visitor volume is too high for existing facilities, sediment, trash, and/or fecal matter can be deposited in waterways, potentially impacting wildlife and the aesthetic quality of an area.

When visitors travel long distances and/or use a variety of recreational areas, they may inadvertently spread invasive non-native species into recreational areas. The use of trails and other activities can disturb soil and visitors or their pets can unknowingly transfer invasive non-native seeds on clothing, fur, or vehicles. In areas where aesthetic properties are highly valued, invasive plants can have a negative impact on tourism when they outcompete with the native flora that visitors come to experience and photograph (Federal Interagency Committee for the Management of Noxious and Exotic Weeds and Westbrooks 1998). In addition to terrestrial invasive non-native species, visitors can spread aquatic species, such as *Ludwigia hexapetala*, an invasive plant that is severely infesting the Laguna de Santa Rosa, or quagga (*Dressenia bugensis*) and zebra (*D. polymorpha*) mussels, which can survive transport on boats or gear from infected areas. If these animals become established in Russian River water bodies, economic and environmental costs would be substantial (Lake County Fish and Wildlife Committee 2009). These organisms can reduce fish populations, limit or eliminate recreational boating opportunities, damage boat engines or steering equipment, and colonize structures such as pumps, dams, and boat ramps. Aggressive inspection and control measures are necessary to prevent invasion in Lakes Sonoma and Mendocino and other water bodies.

Climate change (see Sections 6.4 Climate Change, and 7.1.5 Climate Change Adaptation and Mitigation) is expected to have a significant effect on recreation resources — changes in air temperature, rainfall, and sea level will all affect the way visitors recreate and their recreational opportunities. As recreation demands shift with climatic conditions, additional strain will be put on other management strategies such as ecosystem restoration and pollution prevention. Facilities that currently serve as a resource for recreational

activities, such as developed campgrounds, may become unusable due to changing conditions such as rising sea levels, necessitating redevelopment if the recreational activity is to be preserved. Alternatively, recreation could move inland, where rising sea levels are not as much an issue, creating increased demand on inland facilities. In a time of rising costs and a shrinking state budget, these conditions are likely to result in diminished quality and quantity recreational opportunities for recreationalists in the Russian River. Table 7.21, Potential Effects of Predicted Climate Change Impacts on Recreation in the Russian River Watershed shows additional possible effects of climate change on water-dependent recreation.

TABLE 7.21 POTENTIAL EFFECTS OF PREDICTED CLIMATE CHANGE IMPACTS ON RECREATION IN THE RUSSIAN RIVER WATERSHED (AFTER DWR 2010)

PREDICTED CLIMATE CHANGE IMPACT	POTENTIAL EFFECT ON WATER-DEPENDENT RECREATION OPPORTUNITIES	POTENTIAL EFFECT ON RECREATIONISTS
Sea level rise	Erosion and damage to coastal beaches and wetlands	Coastal areas unavailable for recreation activities; coastal recreationists forced inland for water-dependent recreation
Irregular seasonal precipitation	Less water in groundwater and surface water systems	Fewer opportunities to swim, boat, fish, or take part in other water-dependent recreation
Increased temperatures	Increased surface water temperatures	Decreased coldwater fish populations; decreased fishing opportunities
Increased ozone	Degraded air quality on recreational properties	Reduced recreation due to health risks
Increased seasonal flooding due to increased severity of weather events	Increase in seasonal flooding of amenities; increased damages to sites and facilities	Decreased opportunities for recreation due to closure of and/or damages to facilities
Decreased instream flow due to increased variability of weather events	Increased surface water temperatures; reduced instream flow	Fewer opportunities to swim, boat, fish, or take part in other water-dependent recreation
Increased catastrophic fire events	Closures of recreational facilities; destruction of recreational facilities	Decreased opportunities due to closure of and/or damage to facilities

Adequate coordination between federal, state, and local agencies and sufficient funding are vital to effectively managing recreation and public access in the Russian River watershed. The NCIRWMP planning process provides a framework for watershed planning at the local scale to synchronize overlapping jurisdictions in meeting state and federal goals. For example, the Russian River Recreation and Park District, which encompasses the communities of Guerneville, Rio Nido, Guernewood Park, and Vacation Beach, can tap into resources available through the NCIRWMP to identify entities both up- and down-stream that share common goals and may be interested in collaborating on implementation projects or resource sharing that would benefit all. Similarly, the NCIRWMP has provided a proven, successful mechanism for obtaining funding for implementation projects to improve water quality in the Russian River watershed and throughout the North Coast. These successful funding efforts could be expanded upon and proposed to other funding agencies, such as the California Coastal Commission, which has a strong commitment to public access, or the North Coast Regional Water Quality Control Board or the Department of Fish and Game which have each prioritized agency-specific issues in the watershed. Because many recreation and access projects will also benefit water quality or improve environmental justice, they would contribute toward the NCIRWMP strategy of utilizing implementation projects to meet multiple state and regional goals including improved water quality for drinking water supply, conservation of salmonid populations, and environmental justice.

MANAGEMENT STRATEGIES 22: RECREATION AND PUBLIC ACCESS

RMS-22 Recommended Approaches

1. When developing recreation and access opportunities, the needs of the public and low-income communities should be accommodated.
2. Recreational needs — as determined by existing data and new surveys — should be incorporated into water project and flood control planning.
3. Collect and utilize data on visitation rates to help optimize timing of water released for environmental and flood control needs if possible.
4. Develop partnerships with research institutions to coordinate monitoring of public recreation and access patterns.
5. Create partnerships to educate youth about outdoor ethics and the preservation and protection of natural resources such as the work accomplished by the Biodiversity and Stewardship Councils.
6. Identify and mitigate impact of low water levels and stream flows that prevent Native American cultural activities.

7. Inventory cultural facilities associated with water facilities, access points, and recreational areas and mitigate those in danger of exposure or damage from reduced water levels and/or recreational activities.
8. Utilize adaptive management techniques to ensure that recreational area use remains at or below carrying capacity to prevent degradation of water quality or wildlife habitat. Utilize data available from other agencies such as the US Bureau of Reclamation, US Army Corps of Engineers, and the Federal Energy Regulatory Commission, such as FERC relicensing studies.
9. Assess, prioritize, and protect waterways and recreational areas at risk from invasive species; develop specific preventive measures and response strategies.
10. Develop a strategy to reduce recreation-related impacts to water quality such as stricter regulation outputs on gasoline engines or the increased provision of toilet facilities.
11. Collaborate with federal, state and local agencies and organizations to meet mutual water quality, environmental protection, and environmental justice goals.
12. Promote the inclusion of recreation and access considerations into water management projects in the Russian River watershed and throughout the North Coast in the NCIRWMP.

7.1.6.1 Priority RRICWMP Recommendations and Management Measures

TABLE 7.22. RECREATION AND PUBLIC ACCESS RECOMMENDATIONS				
SOURCE AGENCY. DATE PUBLISHED. SOURCE DOCUMENT	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE
ASSESSMENT				
California Dept of Parks & Recreation, Statewide Trails Office. 2005. California Recreational Trails Plan	Work toward developing a common database aimed at identifying trail accessibility and accommodation and, once developed, provide the information to the public.	Socio-economic	Russian River HU	10
PLANNING				
California State Coastal Conservancy. 2007. California State Coastal Conservancy Strategic Plan 2007	Develop approximately 11 plans to create or improve waterfront or watershed projects, including but not limited to parks along regional trails, multibenefit pocket parks or projects that demonstrate innovative storm water management strategies. Develop and use definition of "underserved community" to prioritize projects that create parks in underserved communities, especially along river parkways that connect to the Coastal Trail. Incorporate latest scientific understanding of sea-level rise into consideration when planning parks and infrastructure.	Socio-economic	Russian River HU	37
Laguna de Santa Rosa Foundation. 2006. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California	Develop plans for the urban creeks and nearby greenbelt properties. Develop existing SCWA rights-of-way into a multi-use trail system in the Rohnert Park/Cotati area. Install sufficient infrastructure, including bridges, tunnels and fords, to provide connectivity among the network of trails. Connect SCAPOSD greenbelt easement properties, situated between Rohnert Park and Santa Rosa, into a "string of pearls" connected by creekside trails. Provide connectivity between the existing trails of the Rohnert Park/ Cotati area with the proposed Laguna Community Corridor that will extend northwest to Sebastopol and the Santa Rosa Creek Trail.	Socio-economic	Laguna de Santa Rosa HSA	21
California State Coastal Conservancy. 2007. California State Coastal Conservancy Strategic Plan 2007	Design approximately 52 miles of regional trails and river parkways along rivers and creeks to connect inland populations to the coast and expand recreational opportunities. Provide funding to public agencies and noprofit organizations to refine plans for inland trails that connect to the coast. Identify inland trails that need wheelchair-accessible facilities. Prioritize trail routes identified in Completing the California Coastal Trail that connect inland populations ot the coast. Incorporate predicted alterations in stream flows and channels into siting and design of trails. Current projects include the Russian River, Big River, and Mad River.	Socio-economic	Russian River HU	20
Sonoma Land Trust, Laguna de Santa Rosa Foundation. 2006. Laguna de Santa Rosa: Resource Atlas and Protection Plan	Develop a program for docent-led hiking trails on public and other protected lands of the Laguna.	Socio-economic	Laguna de Santa Rosa HSA	12
Laguna de Santa Rosa Foundation. 2006. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California	Create an automobile touring route using existing roads that skirt the Laguna wetlands perimeter. Provide automobile access to the Laguna and its many discontiguous properties by mapping a safe and scenic route along nearby back country roads. Provide birding and other wildlife viewing opportunities to the general public without intruding into sensitive wildlife refuges. Promote eco-tourism that showcases the Laguna as a rich ecosystem of freshwater wetlands and nearby uplands with world-class birding opportunities.	Socio-economic	Laguna de Santa Rosa HSA	11
Sonoma Land Trust, Laguna de Santa Rosa Foundation. 2004. Laguna de Santa Rosa: Resource Atlas and Protection Plan	Work with Sonoma County Water Agency, City of Santa Rosa, CDFG, and SCAPOSD to develop trails on their properties.	Socio-economic	Laguna de Santa Rosa HSA	9
Laguna de Santa Rosa Foundation. 2006. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California	Develop plans for a multi-use north-south system of trails. Utilize public lands whenever possible and utilize bike lanes on roadways whenever necessary. Establish the corridor as both a transportation facility and an open space recreational opportunity. Connect the Santa Rosa Creek trail with the Joe Rodota Trail and connect the Joe Rodota Trail to the cities of Cotati and Rohnert Park.	Socio-economic	Laguna de Santa Rosa HSA	8
IMPLEMENTATION				

TABLE 7.22. RECREATION AND PUBLIC ACCESS RECOMMENDATIONS				
SOURCE AGENCY. DATE PUBLISHED. SOURCE DOCUMENT	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE
CDFG. 2002. 2002 Draft Russian River Basin Fisheries Restoration Plan	Counties should support and be active with multi-stakeholder groups (such as the Russian River Watershed Council) in working on watershed issues and landuse plan changes. Counties should identify, develop, fund or find funding to participate in these collaborative processes which assist community disclosure and support for county projects.	Socio-economic	Russian River HU	56
Laguna de Santa Rosa Foundation. 2006. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California	The City of Santa Rosa and SCWA jointly fund a creek steward position for creek channels in Santa Rosa. The creek steward performs education and outreach to the public, and facilitates community involvement in creek restoration projects. Support the continued funding of this position, and the development of a new creek steward position for channels outside the city of Santa Rosa, with special focus on the urbanized areas in the southern Laguna watershed.	Socio-economic	Laguna de Santa Rosa HSA	42
California State Coastal Conservancy. 2007. California State Coastal Conservancy Strategic Plan 2007	Implement approximately 15 projects to create or enhance waterfront or watershed parks, including but not limited to parks along regional trails, multibenefit pocket parks, or projects that demonstrate innovative stormwater management strategies. Prioritize projects that create parks in underserved communities, especially along river parkways that connect to the Coastal Trail.	Socio-economic	Russian River HU	36
Laguna de Santa Rosa Foundation. 2006. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California	When volunteers and students participate in creek restoration they develop a unique appreciation and sense of personal responsibility for the environment. Support community-based riparian restoration and environmental education programs, to educate about the importance of riparian processes and create connection to the land and the community.	Socio-economic	Laguna de Santa Rosa HSA	27
Sonoma County Water Agency. 2003. Russian River Action Plan	Ukiah Riverside Park	Socio-economic	Ukiah HSA	24
Laguna de Santa Rosa Foundation. 2011. Expert Interview	Continued environmental education by groups like the LF and partners.	Socio-economic	Laguna de Santa Rosa HSA	21
Sonoma County Water Agency. 2003. Russian River Action Plan	Riverfront Park	Socio-economic	Guerneville HSA	20
Sonoma County Water Agency. 2003. Russian River Action Plan	Sunset Beach River Access	Socio-economic	Guerneville HSA	19
Sonoma County Water Agency. 2003. Russian River Action Plan	Steelhead Beach Regional Park and Fishing Access	Socio-economic	Guerneville HSA	18
California Dept of Parks & Recreation, Statewide Trails Office. 2005. California Recreational Trails Plan	Design and implement or support assessment surveys and research projects that will help determine trail user information needs. Develop a methodology and implement a program to collect data on the number of trail users, the type of use, reasons for choosing the trail, and the benefits users received. The results should be publicized and used to promote individual trails and general trail benefits, and to determine public information needs.	Socio-economic	Russian River HU	18

Nature based learning

TABLE 7.23. RECREATION AND PUBLIC ACCESS MANAGEMENT MEASURES		
RUSSIAN RIVER ICWMP MANAGEMENT MEASURES		**RECREATION AND PUBLIC ACCESS RMS**
Agriculture	Erosion and Sediment control	
	Animal Waste Management	
	Nutrient Management	
	Pest and Weed Management	
	Grazing Management	
	Irrigation Water Management	
	Groundwater Protection	
Urban/Rural Residential	Watershed and Groundwater Protection	
	Flood Control	
	Stormwater Management	
	Low Impact Development	•
Forestry	Road Management/ Reconstruction	•
	Fire Management	
Hydromodification	Gravel Mining	
	Dam Construction and Operation	
	Streambank Erosion Control	
	Flow and Temperature Maintenance	
Natural Environment & Open Space	Fish Passage Enhancement	
	Habitat Protection	•
	Terrestrial Habitat Restoration & Management	•
	Instream Habitat Restoration & Management	
	Invasive non-native Vegetation Control	•
	Recreation and Public Access	•
	Water Quantity Management	
	Water Quality Management	
	Wetland Restoration/Management	•

7.2 COST-BENEFIT ANALYSIS OF PRIORITY RESOURCE MANAGEMENT STRATEGIES

The main purpose of the Russian River Integrated Coastal Watershed Management Plan (RRICWMP) is to protect and enhance watershed resources by improving (1) the supplies and quality of ground and surface water, and (2) the functions of aquatic and terrestrial ecosystems supporting native species of vegetation, fish and other wildlife. Improving the basin's ability to provide goods and services—including both those produced by the ecosystem and those produced by human enterprise—has direct implications for the basin's local economy, as improvements are expected to increase socioeconomic and cultural values. To this end, the RRICWMP proposes a number of resource management strategies that identify specific tools most appropriate to accomplishing the plan's goals. The following section presents a framework for how benefits and costs associated with each strategy should be determined.

The strategies included in the RRICWMP would yield benefits to the extent that they increase the value of water-related goods and services available to Californians. The strategies have the potential to increase the value of these goods and services in three ways: (1) by lowering the cost of providing a particular good or service, (2) by increasing the supply of that good or service, and (3) by increasing the demand for the good or service. Consistent with widely accepted professional standards, an assessment of how the strategies' effects should consider a broad suite of goods and services, including those whose value comes from indirect or non-use of resources (U.S. Environmental Protection Agency 2009, California Department of Water Resources 2008, National Research Council 2004, U.S. Environmental Protection Agency 2000).

This section provides a framework for defining and evaluating the benefits and costs of the strategies included in the proposed RRICWMP. The framework entails comparison of two scenarios: one with and the other without the plan. Benefits are increases, and costs are decreases in the value of goods and services or in the value of capital. For this assessment, capital is the general term representing things that have the potential for producing goods and services in the future and includes natural capital (ecosystems), human capital (capabilities of individuals and groups), built capital (infrastructure, etc.), and social and cultural capital (relationships among individuals, groups, and their environment).

This section also provides a preliminary assessment of the changes in values that might result from implementation of the RRICWMP. This overview is based on a survey of the existing peer-reviewed economic literature that identifies the marginal value Californians place on these types of goods and services. The central focus of this survey is on studies and data that measure directly the value of a specific good or service that a proposed strategy would affect. When such studies and data were not available, the survey expands to include studies that measure marginal values of the same good or service, or a similar one, in a similar setting. Descriptions of potential benefits include both those for which adequate information exists to support reliable quantification in monetary terms and those for which such information does not exist. The absence of a monetized value for a specific benefit does not mean it is necessarily more or less important than another that is described in monetary terms, but only that sufficient information for monetization does not exist. Monetized estimates of the value of benefits may reflect analyses of price data, for goods, services, and capital traded in markets, but those not trade in markets require non-market valuation techniques.13 Descriptions of the potential costs associated with each resource management strategy are based on cost information from projects that have been implemented previously in the region, or elsewhere in California or the U.S. These cost estimates include capital, operation, and maintenance costs, as well as opportunity costs, such as volunteer time, land, or other donations necessary to successfully realize the goals of the RRICWMP.

13 For more information on market-based and non-market valuation techniques, see, National Research Council. 2005. Valuing Ecosystem Services: Toward Better Environmental Decision-Making. National Academies Press.

This assessment recognizes the existence of uncertainty — often considerable uncertainty — in any estimate of benefits and costs that might result from implementation of the RRICWMP. The discussion of uncertainty is incomplete, however and does not fully describe the risks to the region's residents and businesses, as well as to those elsewhere in California.

All values of benefits and costs in this section are expressed in 2011 dollars, unless specified otherwise. The conversion of values originally estimated in dollars of another year uses the Chain Price Index of Personal Consumption Expenditures from the Bureau of Economic Analysis.

7.2.1 Natural Resources and Land Management

7.2.1.1 Ecosystem Restoration

Ecosystem restoration refers to efforts aimed at returning an ecosystem to pre-disturbance conditions so that it functions dynamically, as it did prior to human-induced changes. This strategy focuses on instream and riparian restoration aimed towards increasing populations of endangered coho salmon and of threatened steelhead. Ecosystem restoration improves habitat for wildlife while also providing a number of other indirect benefits. The table below summarizes the types of benefits and costs associated with this strategy.

POTENTIAL BENEFITS	POTENTIAL COSTS
Improved fish and riparian habitat	Revegetation costs
Decreased carbon dioxide emissions	Maintenance and monitoring costs
Improved water quality	
Improved flood control	

Improved fish and riparian habitat. Ecosystem restoration that includes reestablishment of native plant species, stream banks stabilization, and geomorphic and habitat alterations contributes to the recovery of coho and steelhead populations in the Russian River watershed. Individuals derive value from increases in salmonid populations in two ways: some derive benefit by through a direct or indirect use of the fish, such as watching, catching, or consuming them, while others (including some from the former group) derive value from the salmon solely based on the salmon's existence.

Several studies, in California and elsewhere, have estimated households' average willingness to pay to implement policies that would increase salmon populations. These studies generally reveal that households are willing to pay only fractions of a penny for increases in salmon populations but when summed

across a large population, such as California's, the total value of increases in salmon populations can become several thousands of dollars per fish. Four studies that have estimated willingness to pay values for increases in salmon populations suggest that the 11.5 million Californian households, in total, would be willing to pay these values per fish per year: $442 (Olsen et al. 1991), $2,587 (Layton et al. 1999), $3,716 (Loomis 1996), and $8,249 (Bell et al. 2003). In eliciting willingness to pay estimates from respondents, these studies told respondents that hypothetical policies would increase salmon populations by 2.5 million, 2.5 million, 300,000, and 165,000, respectively. The ecosystem restoration in the Russian River watershed would yield small potential increases in salmon populations, relative to the size of existing populations, and to the hypothetical increases posited in the valuation studies. Hence, the value per additional fish resulting from the proposed ecosystem restoration likely will resemble the upper end of the range of estimates rather than the lower end. Nonetheless, to address concerns about not overestimating the benefits, this report suggests using an intermediate value of $2,086 per additional fish per year as a rough estimate of the benefit of those projects that would increase salmon populations.

The ecosystem restoration strategy focuses on the recovery of structures and functions of native riparian forests. Existing research based on data compiled from 23 relevant studies found that the passive use value associated with North American riparian and other forest land in the cool coniferous biome is about $125 per acre per year (Chiabai et al. 2009).

Decreased carbon dioxide emissions. The restoration of riparian forest and native plants would result in increased capacity of the Russian River watershed to capture and sequester carbon dioxide in the atmosphere. The value of carbon dioxide reductions can be estimated using the social costs of this greenhouse gas identified in economic literature. Shaw et al. (2009) found that these social costs range between $7 and $60 but other analytical approaches provide support for using values considerably higher (e.g., Ackerman and Stanton 2011). Additionally, Nordhaus (2008) estimated that the costs associated with carbon dioxide will increase at an annual rate of 2 to 3 percent. Applying the mean rate of increase to the median value of the social costs of carbon dioxide emissions, a value of $35 per ton of carbon dioxide is obtained.

Improved water quality. By restoring instream function, ecosystem restoration would improve water quality at the project site and potentially downstream. One way to estimate the value of improvements in the water quality is to estimate the public's willingness to pay for them. Typically, water quality is divided into four categories: non-boatable, boatable, fishable, and swimmable. A 1993 study found that households would be willing to pay about $147 per year to maintain boatable water quality. Furthermore these households would be willing to pay an additional $110 per year to improve the water quality to fishable conditions, and another $123 per year to improve the fishable waters to swimmable status (Carson and Mitchell 1993). Another study looked at a number of variables describing water quality found that households would be willing to pay about $30, annually, to improve the water quality in a nearby river by one percent (Magat et al. 2000).

Improved flood control. The ecosystem restoration strategy would restore floodplain complexity and capacity in a reduction and more efficient control of storm runoff. The value of flood control depends on the value of the avoided costs of damaged goods (e.g., property, timber, crops) and disrupted services (e.g., measured in lost wages and opportunity costs of volunteers responding to a flood emergency). Other benefits would materialize to the extent that flood-control investments reduce injury and death to humans, livestock, and wildlife. These benefits are expected to be lower in the areas of the watershed that are less densely populated (i.e., the upper and lower reaches of the watershed) and higher in areas with high population density (i.e., the middle section of the Russian River basin). The risk of a major flood event is, however, higher in the less densely populated areas and lower in the high-density areas. Thus, the expected value of benefits from flood risk manage-

ment, which accounts for both variables, is probably more evenly distributed throughout the basin.

Strategy costs. The ecosystem restoration costs include efforts of revegetation and maintenance, including monitoring, of replanted riparian buffers and floodplains, plus any mechanical changes to the landscape necessary to ensure the successful restoration of structures and functions. Examples from other sites in California suggest that active restoration of land to riparian forest can cost between about $4,200 and $10,500 per acre, depending on the challenges and degree of changes the riparian buffers would undergo during restoration. State funding in California has been used to pay for habitat protection and restoration of riparian and floodplain habitat at an average cost of about $10,500 per acre. In the past, passive restoration of meadows on forest land cost the public about $100-$210 per acre-foot of stored water (DWR 2009).

7.2.1.2 Environmental and Habitat Protection and Improvement

Environmental and Habitat Protection

Environmental and habitat protection refers to instances where future development that otherwise would occur is forestalled by purchasing undeveloped land or purchasing development rights or easements on undeveloped land. This strategy provides a number of potential future benefits insofar as it reduces the negative effects of potential future development on the habitat and viability of native species in the Russian River Basin. The table below summarizes the types of benefits and costs associated with this strategy.

POTENTIAL BENEFITS	POTENTIAL COSTS
Improved habitat for native species	Acquisition and management costs
	Opportunity costs of forgone development

Improved habitat for native species. Relative to species that might accompany development, the native species that would have priority through protection would have a higher likelihood of survival and of withstanding other stressors from the environment or influences from human activities. The benefits of environmental and habitat protection would be especially reinforced if the land protected under the RRICWMP is contiguous with other protected areas. Studies show that habitat protection is most effective when fragmentation of habitat can be avoided and species have access to large areas that accommodate their biological needs (Girvetz et al. 2008). The value of these benefits are similar to values of specific benefits discussed elsewhere, but will vary on a project-by-project basis, depending on the species that benefit from this strategy and on the abundance or scarcity of each species.

Strategy costs. Environmental and habitat protection can occur in one of three ways: (1) acquisition of fee simple title, (2) purchase of development rights, or (3) conservation easements. All three options prevent future development. In nearly all cases, the fair market price for the land in question will dictate the price of each option. Oftentimes, there are incentives for existing owners or for the purchasers of land/ rights/ easement that may increase or decrease the price. The three options differ in terms of the future land-management responsibilities. Fee simple title or the purchase of development rights, for example, assumes the landowner takes all responsibility for managing the land and bears all associated costs. When an entity acquires a conservation easement, it typically shares some resource-management responsibilities with the landowner. The values associated with these different costs vary across the region depending on a number of factors including access to transportation, proximity to existing development, topography, and existing land use.

Landowners of protected land will also bear costs associated with forgoing the potential benefits of future development of the land. These opportunity costs can be represented by the decreased resale value of their property resulting from the habitat-protection measures. These opportunity costs, too, depend on characteristics of the land and the degree to which the land is actually developable. For instance, a property that is mountainous or located in a restricted floodplain is less likely to be purchased for development than a property that is close to existing development, with well drained soils.

Environmental and Habitat Improvement

Environmental and habitat improvement refers to instances where private and commercial landowners implement best management practices (BMPs) on their land that result in improvements in ecosystem function. Examples of BMPs implemented in the area include road sediment reduction, riparian fencing, and other actions that reduce water consumption among various groups of users. The table below summarizes the types of benefits and costs associated with this strategy.

POTENTIAL BENEFITS	POTENTIAL COSTS
Improved habitat for native species	Implementation costs
Improved water quality	
Improved water supplies	
Decreased carbon dioxide emissions	

Improved habitat for native species. Relative to species that might accompany development, the native species that would have priority through habitat improvement have a higher likelihood of survival and of withstanding other stressors from the environment or influences from human activities. The benefits of environmental and habitat improvement would be especially reinforced if the habitat improved under the RRICWMP is contiguous with other protected areas. Studies show that habitat protection is most effective when fragmentation of habitat can be avoided and species have access to large areas that accommodate their biological needs (Girvetz et al. 2008). The value of these benefits are similar to values of specific benefits discussed elsewhere, but will vary on a project-by-project basis, depending on the species that benefit from this strategy and on the abundance or scarcity of each species.

Improved water quality. This strategy would improve water quality to the extent that environmental and habitat improvements would reduce the pollutant concentration in streams, reduce soil erosion rates, and reduce stream temperatures. One way to estimate the value of improvements in the water quality is to estimate the public's willingness to pay for them. Typically, water quality is divided into four categories: non-boatable, boatable, fishable, and swimmable. A 1993 study found that households would be willing to pay about $147 per year to maintain boatable water quality. Furthermore these households would be willing to pay an additional $110 per year to improve the water quality to fishable conditions, and another $123 per year to improve the fishable waters to swimmable status (Carson and Mitchell 1993). Another study looked at a number of variables describing water quality found that households would be willing to pay about $30, annually, to improve the water quality in a nearby river by one percent (Magat et al. 2000).

Improved water supplies. The environmental and habitat improvement strategy is expected to improve the ability of recharge areas to infiltrate runoff into aquifers, storing water for later use. Literature suggests that people in the western U.S. value additional water supplies at about $54 per acre-foot for agricultural water use and at about $115 per acre-foot for urban water use (Brown 2007).

Decreases carbon dioxide emissions. By increasing the surface area covered with native vegetation, this strategy will increase the capacity of the Russian River watershed to sequester and store carbon dioxide emissions in the atmosphere. The value of carbon dioxide reductions can be estimated using the social costs of this greenhouse gas identified in economic literature. Shaw et al. (2009) found that these social costs range between $7 and $60 but other analytical approaches provide support for using values considerably higher (e.g., Ackerman and Stanton 2011). Additionally, Nordhaus (2008) estimated that the costs associated with carbon dioxide will increase at an annual rate of 2 to 3 percent. Applying the mean rate of increase to the median value of the social costs of carbon dioxide emissions, a value of $35 per ton of carbon dioxide is obtained.

Strategy costs. Given the wide range of potential BMPs associated with this strategy, implementation costs will vary widely. Costs likely will be influenced by the size of the overall project as well as a wide variety of other factors, such as cooperation from residents, accessibility of sites, or survival rates of planted vegetation .

7.2.1.3 Watershed Planning

Watershed planning is a term used to describe the overall process of designing, funding, prioritizing, implementing, and maintaining efforts to restore, sustain, and enhance ecological functions, at the watershed level. The ecological benefits associated with specific project/program types as well as their costs are described elsewhere. This section describes the benefits and costs of the planning process itself. The table below summarizes the types of benefits and costs associated with this strategy.

POTENTIAL BENEFITS	POTENTIAL COSTS
Improved watershed's ecosystem goods and services	Administrative costs
Enhanced human and social capital	Opportunity costs of citizens and stakeholders
Prioritization-related benefits	

Improved ecosystems goods and services of the watershed. The benefits of planning and management at the watershed level materialize to the extent that they enhance the benefits of other strategies discussed above by increasing the quantity and/or quality of these benefits, by decreasing the costs of different individual strategies, by increasing the likeli-

hood that the benefits would actually occur, and by decreasing the uncertainty around factors that would put the emergence of these benefits into question. By taking a watershed approach to the planning and implementation of the proposed strategies, benefits, such as increased water supplies and water quality, ecosystem health, or flood management, are more likely to be maximized and reach a large portion of the population in the Russian River basin.

Enhanced human and social capital. In many instances, watershed planning requires engaging with community members, water managers, and other stakeholders in collaborative problem solving, enhancing existing and building new relationships. These experiences would increase the human and social capital in the region insofar as they educate the local population and/or build social ties within the community. Human and social capital are valuable in that they enhance the capacity of community members to engage in and complete future projects and are more effectively able to respond to critical issues the region is likely to face as climate change and population growth continue to put pressure on its water-related resources.

Prioritization-related benefits. The planning process allows relevant agencies and stakeholders to consider all potential projects and programs at the watershed level alongside the specific needs in that watershed. By identifying and implementing the projects and programs with the highest net benefits first, watershed planning allows for more effective and efficient use of existing funding sources, labor, and other resources.

Strategy costs. Watershed planning and management involves the coordination of multiple decision-makers and stakeholders. Such coordination imposes administration and opportunity costs for all parties that participate, directly or indirectly, in the planning and management of the Russian River watershed. Based on other program expenditures, DWR estimates that statewide the assessment planning portion of this strategy may cost between $10 million and $39 million annually, while the public process may cost $8 million to $17 million annually (DWR 2009).

In the past, funding for watershed management has been sourced through property and sales taxes. In the last two decades, citizens in the City of Napa approved property tax levies totaling $24.70 per parcel per year, to pay for watershed management and stormwater management. Additionally, the citizens of Napa County passed a half-cent sales tax to raise funds for the watershed management program called Living River. The citizens' property taxes provide funding at a rate of $14,000 per square mile of the watershed and the sales taxes provide funding at a rate of $1,572 per square mile (DWR 2009).

Other costs associated with watershed planning include the opportunity costs of the citizens and stakeholders who participate in the decision process that determines the distribution and management of resources in the basin.

7.2.1.4 Wetlands Enhancement and Creation

The Russian River Basin contains many types of wetlands including vernal pools, freshwater marshes, and tidal marshes. Enhancing functions at existing wetlands and creating new wetlands provide several types of benefits. For example, properly-functioning wetlands can improve water quality, reduce erosion, reduce flood damage, and provide habitat for many types of wildlife.

POTENTIAL BENEFITS	POTENTIAL COSTS
Multiple wetland ecosystem services	Costs of construction of new wetlands
Decreased carbon dioxide emissions	Maintenance costs of new and existing wetlands
	Increased methane emissions

Multiple wetland ecosystem services. Many of the benefits wetlands provide are dependent on the type of wetland and their location. Table 7.24 shows several values associated with ecosystem services provided by a range of different single-service wetlands. The values are not necessarily additive but they provide a useful range of values that can be applied to wetland enhancement and wetland improvement projects. Alternative estimates of the value of the benefits wetlands provide come from the prices charged for wetland credits through market-based programs. A recent compilation of historical price data describing prices for wetlands purchased through in-lieu fee programs found that prices in the Pacific Ocean District ranged from $500 to $30,000 per acre (U.S. Army Corps of Engineers 2006). One additional issue to consider in estimating these benefits is that wetland enhancement and creation projects are not always successful, and it may be most appropriate to assume only a portion of the intended acreage reaches full functionality.

Decreased carbon dioxide emissions. This strategy would help sequester carbon from the atmosphere to the extent that it promotes the protection, creation, and maintenance of estuarine wetlands, which can absorb carbon dioxide at a rate that is about 10 times higher than that of freshwater wetlands (Brigham et

al. 2006). The value of carbon dioxide reductions can be estimated using the social costs of this greenhouse gas identified in economic literature. Shaw et al. (2009) found that these social costs range between $7 and $60 but other analytical approaches provide support for using values considerably higher (e.g., Ackerman and Stanton 2011). Additionally, Nordhaus (2008) estimated that the costs associated with carbon dioxide will increase at an annual rate of 2 to 3 percent. Applying the mean rate of increase to the median value of the social costs of carbon dioxide emissions, a value of $35 per ton of carbon dioxide is obtained.

TABLE 7.24 ECOSYSTEM SERVICE VALUES ASSOCIATED WITH SINGLE-SERVICE WETLANDS ($/ACRE/YEAR)

ECOSYSTEM SERVICE	MEAN	RANGE
Flood	$674	$153—$2,997
Water quality	$715	$216—$2,364
Water quantity	$218	$10—$4,410
Recreational fishing	$613	$163—$2,302
Commercial fishing	$1,334	$185—$9,637
Bird hunting	$120	$43—$358
Bird watching	$2,079	$906—$4,772
Amenity	$5	$2—$24
Habitat	$525	$163—$1,682
Storm	$407	$18—$8,820

Source: ECONW, with data from Woodward and Wui (2001).

Strategy costs. Construction and maintenance costs associated with wetland enhancement and creation efforts vary depending on project-specific characteristics. To the extent that the potential projects fall within the range of wetland credits offered through commercial mitigation banks across the country, and to the extent that prices for mitigation credits represent the relevant costs, wetland enhancement and creation efforts could cost about $1,500—$400,000 per acre (U.S. Army Corps of Engineers 2006).

While freshwater wetlands provide multiple ecosystem goods and services for water supply and quality and have high habitat values, they are sources of methane, a greenhouse gas that has 21 times the global warming potential over 100 years compared to that of carbon dioxide (IPCC 2007).

7.2.2 Water Supply Reliability

Water reliability measures a system's ability to sustain the social, environmental, and economic systems that it serves in both dry and wet years (DWR 2009). During wet years, water reliability in the Russian River basin has not been an issue. During years with precipitation and runoff below average, however, water reliability becomes a concern for all users in the watershed. The resource management strategies defined below address improvements in water reliability during dry years by (1) reducing demand, (2) improving operational efficiency and transport, and (3) increasing supplies. The following sections describe the benefits and costs associated with each strategy.

7.2.2.1 Water Demand Reduction

7.2.2.1.1 Agricultural Water Use Efficiency

Increased agricultural water-use efficiency reduces the amount of water consumed for agricultural operations and makes more water available for other uses while maintaining or improving crop yield. The table below summarizes the types of benefits and costs associated with this strategy.

POTENTIAL BENEFITS	POTENTIAL COSTS
Improved water reliability	Initial investment and maintenance costs for
Improved fish habitat	technology supporting efficient irrigation
Improved crop yields & energy savings	
Improved water quality	
Decreased soil salinity	
Avoided procedural costs associated with water storage projects	

Improved water reliability. The main benefit of this strategy is increased water reliability during years with below-average runoff, especially during drought years. During a normal water year, agricultural water use efficiency is expected to reduce the demand for irrigation water by 0.5 acre-feet per irrigated acre of land (Cooley et al., 2010). The strategy would help communities in the basin avoid the costs of building additional water supply storage that would provide equal supply reliability during periods of drought. The Bureau of Reclamation found that the average cost of building additional storage at two other locations in California ranged from $520 to $720 (both in the dollars of 2007) per acre foot (Cooley et al., 2010). Analogous costs in the Russian River basin could be lower or higher, depending on differences between the conditions in the Russian River basin and at the sites for which the Bureau of Reclamation provided its estimates.

Improved fish habitat. Increasing the efficiency of agricultural water use reduces the volume of water diverted from streams, which can have positive effects on fish habitat by augmenting instream flows and improving water quality and timing for the natural cycles of fish and other aquatic or riparian species. Estimates from the literature suggest that water left instream for environmental purposes, including

salmon habitat, has a value of about $77 per acre-foot (Brown 2007). This value also accounts for improvements in water quality (e.g., lower stream temperature, higher dissolved oxygen concentrations, decreased fine sediment in the stream, etc.) that benefit fish habitat.

Improved crop production and energy savings. Agricultural growers likely would capture some benefits resulting from investments in increasing agricultural water-use efficiency. Studies show that more efficient irrigation techniques, such as regulated deficit irrigation, can increase the quality and yield of some high-value agricultural crops, such as wine grapes, tomatoes, stone fruit, and nuts. More efficient use of agricultural water also can result in energy savings to the farmers who pump less water for irrigation. These energy savings range between 175 kWh and 970 kWh per acre-foot, depending on the current irrigation technology used and depth of groundwater well (Cohen et al., 2004; Cooley et al., 2010).

Improved water quality. Improved efficiency of agricultural-water use would improve water quality by decreasing the amount of runoff returning to streams and the agricultural pollution the runoff may contain. One way to estimate the value of improved water quality is to estimate the public's willingness to pay for improvements in quality, which typically is divided into four categories: non-boatable, boatable, fishable, and swimmable. A 1993 study found that households would be willing to pay about $147 per year to maintain boatable water quality. Furthermore, these households would be willing to pay an additional $110 per year to improve the water quality to fishable conditions, and another $123 per year to improve the fishable waters to swimmable status (Carson and Mitchell 1993). Another study that looked at a number of variables describing water quality found that households would be willing to pay about $30 annually to improve the water quality in a nearby river by one percent (Magat et al. 2000).

Unquantifiable benefits. Other benefits that cannot be quantified with currently available information are environmental, such as reductions in the soil salinity due to decreased water applied to crops. Additional benefits can be realized when improved irrigation efficiency reduces the demand for building additional supply storages and thus the amount of time public officials and private citizens spend on processes related to these building projects.

Strategy costs. The costs of improving agricultural water-use efficiency have been estimated at about $190 per acre-foot and stem from changes, such as improved irrigation scheduling, regulated deficit irrigation, and the adoption of more efficient technologies, such as drip or sprinkler irrigation (Cooley et al., 2010). This cost is a blended estimate of the costs for all three proposed changes and assumes that farmers would introduce improved drip and sprinkler irrigation on 30 percent of the agricultural land. Actual benefits can be higher or lower, depending on how much of the land on which farmers currently use flood irrigation will be converted to drip or sprinkler irrigation.

7.2.2.1.1 Urban Water Use Efficiency

Increasing urban water use efficiency improves water supply and water quality through technological improvements and users' behavioral changes, which decrease indoor and outdoor residential, commercial, industrial, and institutional water use. These reductions in urban water use are especially important during the summer months when little precipitation falls, instream flows are low, and water not diverted for urban use can remain in the stream. The table below summarizes the types of benefits and costs associated with this strategy.

POTENTIAL BENEFITS	POTENTIAL COSTS
Decreased withdrawal rates of water supplies	Initial investment and maintenance costs for technology supporting efficient use of urban water supplies
Improved water supply reliability	
Avoided energy costs	
Improved fish habitat	
Improved water quality	
Avoided procedural costs associated with water storage projects	

Decreased withdrawal rates of water supplies. Improved efficiency of urban water use decreases the rate at which urban users withdraw stored water supplies, making them available for use over a longer period of time. Research shows that water supplies for urban use are worth about $115 per acre-foot (Brown 2007). This benefit translates directly into better drought preparedness for the users in the basin. A lower withdrawal rate of water supplies reduces the need for building new water storage facilities. The U.S. Bureau of Reclamation estimated the costs of building surface storages of water supplies elsewhere in California to range between $520 and $720 (both in the dollars of 2007) per acre-foot (Cooley et al., 2010). These costs could be lower or higher for the Russian River watershed, depending on differences between the conditions in the Russian River basin and at the sites for which the Bureau of Reclamation provided its estimates.

Increased water supply reliability. Research conducted by the California Urban Water Agencies (Barakat and Chamberlin, Inc. 1994) indicate that Californians are willing to pay substantial amounts to avoid water shortages and improve their water-supply reliability. The willingness to pay estimates ranged from $201 per household per year to avoid a water-shortage reduction of 20 percent once every 30 years, to $294 per household per year to avoid a water-shortage reduction of 50 percent once every 20 years.

Avoided energy costs. Increased efficiency of urban water use decreases the water volume municipal water suppliers divert, process, and convey to the urban users, thus saving energy. Other energy savings occur when end users heat smaller amounts of water or when treatment facilities use less energy to process a decreased volume of wastewater. For California, the combination of energy consumption of the end users and wastewater treatment that would be saved due to increased efficiency of urban water use is estimated at 7,190 kWh per acre-foot for electricity and at 271 therms per acre-foot for natural gas (Cooley et al., 2010). The actual energy savings that users in the Russian River basin will realize are probably lower than this rate for the entire state of California, since the cost of water conveyance in the southern part of the state is higher than in Northern California.

Improved fish habitat. Increasing the urban water use efficiency leaves more water instream for aquatic and riparian species during the dry season in this Mediterranean climate, when high demand from urban water users comes in conflict with the need for instream flows for endangered species. Literature suggests that water left instream for environmental purposes, including salmon habitat, has a value of about $77 per acre-foot (Brown 2007). This value also accounts for improvements in water quality (e.g., lower stream temperature, higher dissolved oxygen concentrations, decreased fine sediment in the stream, etc.) that benefit fish habitat.

Improved water quality. Increasing urban water use efficiency could potentially improve water quality in nearby waterways by increasing instream flow, decreasing pollutant concentrations, and improve other water characteristics (e.g., water temperature or dissolved oxygen). One way to estimate the value of improved water quality is to estimate the public's willingness to pay for improvements in quality, which typically is divided into four categories: non-boatable, boatable, fishable, and swimmable. A 1993 study found that households would be willing to pay about $147 per year to maintain boatable water quality. Furthermore these households would be willing to pay an additional $110 per year to improve the water quality to fishable conditions, and another $123 per year to improve the fishable waters to swimmable status (Carson and Mitchell 1993). Another study that looked at a number of variables describing water quality found that households would be willing to pay about $30 annually to improve the water quality in a nearby river by one percent (Magat et al. 2000).

Unquantifiable benefits. Increased urban water use efficiency can produce benefits that can be significant but difficult to quantify. For instance, increased efficiency avoids opportunity costs of time that public officials and private citizens dedicate to procedures and possible conflicts related to building new water-storage facilities.

Strategy costs. One study in California estimated that each acre-foot gained through increased urban water use efficiency per year requires an initial investment of $4,160. When annual savings in water use, wastewater, and energy over the use-life of the capital were taken into account, however, the cost of urban water use efficiency became a negative cost, or savings, of $101 per acre-foot (Cooley et al., 2010). The actual costs in the Russian River watershed may be higher or lower, depending on differences in current rates of urban water use efficiency at the regional compared to the state level.

7.2.2.2 Operational Efficiency and Transfers Improvement

7.2.2.2.1 Regional and Local Conveyance

The existing infrastructure conveying water in the Russian River basin is becoming rapidly outdated. Upgrades to the system are needed to address environmental regulations that require improvements to fish habitat and to accommodate increased water use associated with predicted future population growth and potential changes in precipitation patterns due to climate change. The table below summarizes the types of benefits and costs associated with this strategy.

POTENTIAL BENEFITS	POTENTIAL COSTS
Improved flood control	Initial investment in capital to upgrade the current regional and local conveyance systems
Improved fish habitat	Operation and maintenance costs of upgraded systems
Increased water supply for urban users	

Improved flood control. By improving the local and regional infrastructure responsible for conveying water, this strategy could potential reduce the likelihood of future flood events and reduce the severity of flooding when it occurs. The value of the benefits derived from improved flood control depends on the value of the goods and services that would be damaged or forgone during flood events (e.g., property damage, lost wages, opportunity cost of volunteers responding to a flood emergency). Other benefits would materialize to the extent that flood-control investments reduce injury and death to humans, livestock, and wildlife. These benefits are expected to be lower in the areas of the watershed that are less densely populated (i.e., the upper and lower reaches of the watershed) and higher in areas with high population density (i.e., the middle section of the Russian River basin). The value of the benefits from the flood control also depends on the expected probability of occurrence for future flood events of different magnitudes.

Improved fish habitat. To the extent that this resource management strategy improves the fish habitat in the Russian River watershed by increasing instream flows during the dry months and water quality throughout the year, the value of these benefits can be estimated at about $77 per acre-foot of additional water available for environmental purposes (Brown 2007).

Increased water supply for urban users. The value of improvements to the conveyance system that would handle a larger capacity of transported water has a value of $115 per acre foot for each additional unit of urban water transported through the upgraded system (Brown 2007). Conversely, each additional acre-foot of water that this strategy makes available for urban and agricultural users through improved groundwater recharge can be valued at $115 for urban water use and $54 for agricultural water use (Brown 2007).

Strategy costs. The costs associated with upgrading the regional and local conveyance systems consist primarily of capital investments and increases in costs for ongoing operation, maintenance, and replacement. No current cost estimates exist for the implementation of this strategy in the Russian River watershed. Elsewhere in California, the U.S. Bureau of Reclamation estimated that the cost of water transport over a 14-mile conveyance pipeline over the Tehachapi Mountains would be about $140-$150 (dollars of 2007) per acre-foot (DWR 2007). This represents an upper bound for the cost estimates of this strategy, as it is unlikely that the system in the Russian River watershed would require the transport of water over a 2000-foot gradient, such as the one in the Tehachapi Mountains.

7.2.2.2.1 System Reoperation

System reoperation refers to a change in operation and management procedures for existing reservoirs and conveyance infrastructure to increase the water-related benefits they provide, decrease the costs, or both. This strategy is regarded as an alternative to construction of new water facilities but some physical modifications may be necessary for reoperation. The table below summarizes the types of benefits and costs associated with this strategy.

POTENTIAL BENEFITS	POTENTIAL COSTS
Avoided costs of additional supply storage	Initial investment in capital to upgrade the current reservoir and conveyance systems
Improved flood control	Operation and maintenance costs of upgraded systems
Increased water supply reliability	
Improved water quality	
Improved fish and riparian habitat	
Improved water recreation	

Avoided costs of additional supply storage. System reoperation reduces the need for building new supply storages. The U.S. Bureau of Reclamation estimated the costs of building surface storages of water supplies elsewhere in California to range between $520 and $720 (dollars of 2007) per acre-foot (Cooley et al., 2010). These costs could be lower or higher for the Russian River watershed, depending on differences between the conditions in the Russian River basin and at the sites for which the Bureau of Reclamation provided its estimates.

Improved flood control. To the extent that system reoperation results in improved regulation of stream flows, the strategy could improve flood control by reducing the likelihood of future flood events and/or decrease the severity of future flooding. The value of flood control depends on the value of the avoided costs of damaged goods (e.g., property, timber, crops) and disrupted services (e.g., measured in lost wages and opportunity costs of volunteers responding to a flood emergency). Other benefits would materialize to the extent that flood-control investments reduce injury and death to humans, livestock, and wildlife. These benefits are expected to be lower in the areas of the watershed that are less densely populated (i.e., the upper and lower reaches of the watershed) and higher in areas with high population density (i.e., the middle section of the Russian River basin). The risk

of a major flood event is, however, higher in the less densely populated areas and lower in the high-density areas. Thus, the expected value of benefits from flood risk management, which accounts for both variables, is probably more evenly distributed throughout the basin.

Improved water supply reliability. System reoperation can improve the reliability of municipal water supplies during dry summer months. Research conducted by the California Urban Water Agencies (Barakat and Chamberlin, Inc. 1994) indicates that Californians are willing to pay substantial amounts to avoid water shortages and improve their water-supply reliability. The willingness to pay estimates ranged from $201 per household per year to avoid a water-shortage reduction of 20 percent once every 30 years, to $294 per household per year to avoid a water-shortage reduction of 50 percent once every 20 years.

Improved water quality. Insofar as system reoperation improves the quality of water for urban use, this strategy would reduce costs related to water treatment for downstream users. One recent study has shown that drinking water treatment costs in the Bay Delta range between $46 and $91 per acre-foot (2007 dollars). These costs include annual operation and maintenance and annualized costs of some advanced technologies (Chen et al., 2008). One way to estimate the value improvements in the quality of water left in the basin is to estimate the public's willingness to pay for improvements in quality, which typically is divided into four categories: non-boatable, boatable, fishable, and swimmable. A 1993 study found that households would be willing to pay about $147 per year to maintain boatable water quality. Furthermore these households would be willing to pay an additional $110 per year to improve the water quality to fishable conditions, and another $123 per year to improve the fishable waters to swimmable status (Carson and Mitchell 1993). Another study looked at a number of variables describing water quality found that households would be willing to pay about $30, annually, to improve the water quality in a nearby river by one percent (Magat et al. 2000).

Improved fish and riparian habitat. System reoperation is expected to improve instream flows for aquatic species and the riparian ecosystem. Improvements to instream flows and water quality that benefit fish habitat have been estimated at about $77 per acre-foot (Brown 2007). Value estimates of riparian ecosystem services on which the strategy will have a positive effect can be expressed using an annual passive use value of $125 per acre of riparian habitat (Chiabai et al. 2009). This passive use value estimates how much society would be willing to pay for riparian habitat for its current existence or to make it available to future generations, aside from any benefits received directly or indirectly from the habitat's function. By only considering passive use, this estimate likely underestimates the total value of the benefits derived from the restoration of ecosystem services.

Improved water recreation. System reoperation would provide additional benefits to the extent that it improves opportunities for water recreation. Research suggests that the consumer surplus associated with various water-based recreation activities in the Pacific Coast region ranges from $32 for swimming and $33 for boating to $52 for fishing, per person per day (Loomis 2005).

Strategy costs. The costs associated with system reoperation are related to the capital that will be invested and the operation and maintenance costs for system upkeep. The actual coasts of this strategy in the Russian River basin will depend on the system needs for upgrade still to be identified.

7.2.2.2.1 Water Transfers

Water transfers involve a voluntary change in the way water is distributed among water users in response to water scarcity. In general, water transfers in the Russian River basin occur to prevent agricultural losses from crops that otherwise would be deprived of water during drought years. Water transfers take place by temporarily transferring water rights from users who irrigate low-value crops (e.g., alfalfa) to users who need to irrigate high-value crops (e.g., wine grapes, stone fruit, nuts). They can also occur by using water reserved for use in future years if, for example, the expectation is that precipitation in subsequent years will restore the lost reserve. The table below summarizes the types of benefits and costs associated with this strategy.

POTENTIAL BENEFITS	POTENTIAL COSTS
Avoided damage to high-value crops	Costs of building and maintaining additional surface storage
Improved fish habitat	Costs of water-transfer programs

Avoided damage to high-value crops. The actual value of the water transfers depends on the overall net increase in the production value calculated as the difference between the loss from the low-value crops and the gain from the high-value crops, both

compared to production levels that would have been obtained in the absence of the water transfers.

Improved fish habitat. Water transfers can increase the instream flows during the low-flow summer months, which has positive effects on fish habitat. One study estimates the value of additional flows available for environmental purposes at about $77 per acre-foot (Brown 2007).

Strategy costs. The costs associated with water transfers consist mainly of construction and maintenance of additional storage facilities and conveyance for water transport. The U.S. Bureau of Reclamation estimated the costs of building surface water storage facilities elsewhere in California range between $520 and $720 (dollars at 2007) per acre-foot (Cooley et al., 2010). The U.S. Bureau of Reclamation also estimated that the cost of a 14-mile conveyance pipeline over the Tehachapi Mountains would be about $140-$150 (dollars of 2007) per acre-foot (DWR 2007). This represents an upper bound for the cost estimates of this strategy, as it is unlikely that the system in the Russian River watershed would require the transport of water over a 2000-foot gradient, such as the one in the Tehachapi Mountains.

Other costs related to this strategy stem from bureaucratic procedures that facilitate the water transfer between the two parties. Currently, these costs cannot be quantified.

7.2.2.3 Water Supply Increases

7.2.2.3.1 Conjunctive Management and Groundwater Storage

Conjunctive management and groundwater storage recognizes that ground and surface water are interconnected. The strategy involves the coordinated management of surface water and groundwater resources to maximize water supply reliability, water quality, and other management objectives. This strategy has three components: (1) groundwater management, (2) project construction, and (3) capacity building. The table below summarizes the types of benefits and costs associated with this strategy.

POTENTIAL BENEFITS	POTENTIAL COSTS
Increased water reliability	Costs of groundwater storage and management
Avoided costs of surface storage building	
Improved fish habitat	
Improved flood control	

Increased water reliability. The reliability benefits of this strategy will accrue to all users in the Russian River watershed, including urban, agricultural, and owners of domestic wells. Research conducted by the California Urban Water Agencies (Barakat and Chamberlin, Inc. 1994) indicates that Californians are willing to pay substantial amounts to avoid water shortages and improve their water-supply reliability. The willingness to pay estimates ranged from about $201 per household per year to avoid a water-shortage reduction of 20 percent once every 30 years, to about $294 per household per year to avoid a water-shortage reduction of 50 percent once every 20 years.

Avoided costs of surface storage building. Conjunctive management and groundwater storage can create additional benefits to the extent that communities in the Russian River basin will avoid costs of building surface storage. The U.S Bureau of Reclamation found that the costs of building surface storages of water supplies elsewhere in California range between $520 and $720 (dollars of 2007) per acre-foot (Cooley et al., 2010). Storing water below ground may be cheaper, and the difference in costs would be an economic benefit for the approach.

Improved fish habitat. Fish habitat in the Russian River basin likely would improve to the extent this strategy results in increased stream flows during summer months. Evidence from literature suggests that people in the western U.S. value additional flows available for environmental purposes at about $77 per acre-foot (Brown 2007).

Improved flood control. By redirecting some of the surface flows to ground storage during the peak-flow season, water managers can improve the flood control in the basin and reduce the likelihood of sever flood events. The value of flood control depends on the value of the avoided costs of damaged goods (e.g., property, timber, crops) and disrupted services (e.g., measured in lost wages and opportunity costs of volunteers responding to a flood emergency). Other benefits would materialize to the extent that flood-control investments reduce injury and death to humans, livestock, and wildlife. These benefits are expected to be lower in the areas of the watershed that are less densely populated (i.e., the upper and lower reaches of the watershed) and higher in areas with high population density (i.e., the middle section of the Russian River basin). The risk of a major flood event is, however, higher in the less densely populated areas and lower in the high-density areas. Thus, the expected value of benefits from flood

risk management, which accounts for both variables, is probably more evenly distributed throughout the basin.

Strategy costs. The costs associated with conjunctive management and groundwater storage have been estimated in the past to range between $10 and $600 per acre-foot, depending on the complexity of the project, with an average cost of about $110 per acre-foot (dollars of 2001) (DWR 2005).

7.2.2.3.1 Recycled Municipal Water

Recycled or reclaimed water is wastewater from urban and agricultural uses, which has been treated to a specified quality for reuse. So far, recycled municipal water has been used to irrigate urban landscapes, agricultural crops, and to recharge the Geysers steamfields, which are a local source of renewable energy. The recharge of local groundwater basins using recycled water has been considered as a possible option in the Russian River basin. The table below summarizes the types of benefits and costs associated with this strategy.

POTENTIAL BENEFITS	POTENTIAL COSTS
Increased water reliability	Costs of groundwater storage and management
Avoided costs of building storage	
Increased water supplies	
Improved fish habitat	

Increased water reliability. Recycling municipal water can improve water reliability for urban and agricultural users during the months of low flows. Research conducted by the California Urban Water Agencies (Barakat and Chamberlin, Inc. 1994) indicates that Californians are willing to pay substantial amounts to avoid water shortages and improve their water-supply reliability. The willingness to pay estimates ranged from about $201 per household per year to avoid a water-shortage reduction of 20 percent once every 30 years, to about $294 per household per year to avoid a water-shortage reduction of 50 percent once every 20 years.

Avoided costs of building storage. By implementing this strategy, communities in the basin will avoid the cost of building additional water storage. The U.S. Bureau of Reclamation estimated the costs of building surface water storage facilities elsewhere in California range between $520 and $720 (dollars of 2007) per acre-foot (Cooley et al., 2010). While the costs of treating wastewater at tertiary levels, at which treated water is considered acceptable for consumption, are high, they likely would fall below the costs of building additional surface storage.

Increased water supplies. Currently, recycled water is not a substitute for potable water but, where recycled water displaces potable water for uses that do not require water treated to potable standards, the displaced potable water is available for other uses. Literature suggests that urban water use is valued at about $115 per acre-foot (Brown 2007). Conversely, recycled water can find beneficial uses in agriculture, where growers can use it to irrigate their crops. At the moment, recycled water can be used only in frost prevention for wine grapes. Water used for agricultural purposes has been estimated to have a value of about $54 per acre-foot (Brown 2007).

Improved fish habitat. Recycled water can also increase instream flows and increase the overall water quality resulting in improved habitat for fish and other aquatic and riparian species. Literature suggests that people in the western U.S. value water for environmental use at about $77 per acre-foot (Brown 2007).

Strategy costs. The costs of recycled water include construction and maintenance of facilities and infrastructure to convey the water to its potential users. In California, these cost estimates have varied between about $300 and $1,300 (dollars of 2009) per acre-foot, depending on the local conditions (DWR 2009). The initial investment is high because current regulations require that recycled water be transported through its own system of pipelines, separate from the potable water system. These costs can be reduced, however, if water managers match the treatment level of the recycled water to its intended use.

7.2.2.3.1 Surface Storage

Additional storage may be necessary to build in the Russian River basin to meet the demand of urban and agricultural users and to adapt to possible changes in precipitation patterns due to climate change. The table below summarizes the types of benefits and costs associated with this strategy.

POTENTIAL BENEFITS	POTENTIAL COSTS
Increased water reliability	Costs of building surface supply storages
Increased water supplies	
Improved flood control	
Improved fish habitat	

Improved water reliability. The resource management strategy associated with surface storage yields benefits related to water supply reliability by increasing the number of reservoirs or expanding the existing ones

to collect water for later release and use and making water available during periods of drought. Research conducted by the California Urban Water Agencies (Barakat and Chamberlin, Inc. 1994) indicates that Californians are willing to pay substantial amounts to avoid water shortages and improve their water-supply reliability. The willingness to pay estimates ranged from about $201 per household per year to avoid a water-shortage reduction of 20 percent once every 30 years, to about $294 per household per year to avoid a water-shortage reduction of 50 percent once every 20 years.

Increased water supplies. The increased water supplies through this strategy would benefit both urban and agricultural users. Literature suggests that the value of water for urban use is about $115 per acre-foot and that of water for agricultural use is about $54 per acre-foot (Brown 2007). The values associated with this benefit would probably be higher in the event of drought emergency, when water shortages would increase the marginal value of water available for agricultural and urban uses.

Improved flood control. This strategy would improve flood management in the basin to the extent that additional surface storage will help managers regulate flows during high precipitation event more effectively. The value of flood control depends on the value of the avoided costs of damaged goods (e.g., property, timber, crops) and disrupted services (e.g., measured in lost wages and opportunity costs of volunteers responding to a flood emergency). Other benefits would materialize to the extent that flood-control investments reduce injury and death to humans, livestock, and wildlife. These benefits are expected to be lower in the areas of the watershed that are less densely populated (i.e., the upper and lower reaches of the watershed) and higher in areas with high population density (i.e., the middle section of the Russian River basin). The risk of a major flood event is, however, higher in the less densely populated areas and lower in the high-density areas. Thus, the expected value of benefits from flood risk management, which accounts for both variables, is probably more evenly distributed throughout the basin.

Improved fish habitat. Surface storage can help regulate the instream flows in the Russian River watershed to better simulate natural flows, reducing them in the winter and spring and increasing them in the summer. The improvements to the instream flows are expected to have beneficial consequences for the endangered fish habitat. Literature suggests that the value of water for environmental use in the western U.S. is about $77 per acre-foot (Brown 2007).

Strategy costs. The costs of surface storage include capital and operation and maintenance of the reservoirs. The Bureau of Reclamation estimated the costs of building surface storage facilities elsewhere in California range between $520 and $720 (dollars of 2007) per acre-foot (Cooley et al., 2010). The Bureau of Reclamation also estimated that the cost of a 14-mile conveyance pipeline over the Tehachapi Mountains would be about $140-$150 (dollars of 2007) per acre-foot (DWR 2007). This represents an upper bound for the cost estimates of this strategy, as it is unlikely that the system in the Russian River watershed would require the transport of water over a 2000-foot gradient, such as the one in the Tehachapi Mountains.

7.2.2.3.1 Climate Change Considerations

Considerations about climate change motivate all resource management strategies for improved water reliability through increased efficiency and storage, as described above. The strategies improve the adaptability of the communities in the Russian River basin in the face of predicted changes to precipitation patterns by increasing the storage capacity of winter runoff for use during extended dry seasons.

At the same time, the strategies associated with increased water-use efficiency lower greenhouse gases, such as carbon dioxide, by decreasing the amount of energy used to transport, treat, and deliver water to users. A report submitted to the California Climate Change Center suggested that the social cost of carbon dioxide emissions is about $7 to $60 per ton of carbon dioxide (Shaw et al. 2009), although other analytical approaches provide support for using values considerably higher (e.g., Ackerman and Stanton 2011). The low estimate in the range is similar to, and in some cases lower than, prices for carbon dioxide emissions in regulatory and voluntary markets across the world. Because markets, in general, fail to incorporate all external costs and benefits associated with the goods and services they trade, the low end of this range is likely an underestimate of the full social cost of carbon dioxide emissions. The analysis is started with a median value of $33.50 per ton of carbon dioxide to estimate the social cost of carbon dioxide emissions. To estimate the benefits of reductions in carbon dioxide emissions for 2012, the median value is increased by 2.5 percent per year. The adjustment accounts for expectations that the value of the social costs would increase at an annual rate

of 2 to 3 percent as climate-change related damages mount (Nordhaus 2008). Applying this constant rate of increase, a value of $35 per ton of carbon dioxide is obtained. The total value of the reduction in carbon dioxide emissions depends on the source (e.g., fossil fuels versus renewables) and amount of energy required to convey and treat the water for urban and agricultural users in the Russian River basin.

7.2.3 Flood Risk Management

Decision-makers have to balance the benefits of floods, which perform important ecological functions for streams, groundwater, and floodplains, against the costs they can impose on human communities. An integrated approach to managing risk at acceptable levels involves the combination of structural and nonstructural methods, including management of existing reservoirs, restrictions on floodplain and low-lying coastal development, flood insurance, and disaster preparedness, response, and recovery. Communities identified as vulnerable to flood risk are Guerneville, the Laguna of Santa Rosa, Potter Valley, Ukiah, and Sanel Valley. Some of these communities have been identified as disadvantaged, with little resilience in the face of emergencies and economic losses. The table below summarizes the types of benefits and costs associated with this strategy.

POTENTIAL BENEFITS	POTENTIAL COSTS
Avoided loss of human life or injury	Costs of capital and ongoing operation and maintenance for structures
Avoided damage and disruption to goods and services	Costs of foregone development
Avoided costs of expanding emergency response programs	Costs of public programs of disaster preparedness, response, and recovery
Increased water supplies	
Improved fish and riparian habitat	
Improved water recreation	

Avoided loss of human life or injury. The main benefits of flood risk management include reduced risk of loss of human life or injury due to flood events. Currently the EPA recommends that the value of a statistical life to be used in benefit-cost analyses for any project that impacts the mortality risk of humans, regardless of age, income, or other demographic characteristics, is $8.2 million (EPA 2012). Improved flood control also decreases the risk of injury requiring medical treatment and hospitalization for adverse health consequences some citizens may sustain during a flood emergency.

Avoided damage and disruption to goods and services. The stock of goods in the Russian River basin, including but not limited to roads, forest, wildlife, agricultural crops, livestock, and structures, will benefit from the protection of improved flood control. Additionally, private and public services would avoid disruption in case of a flood event. These costs are expected to be lower in the areas of the watershed that are less densely populated (i.e., the upper and lower reaches of the watershed) and higher in areas with high population density (i.e., the middle section of the Russian River basin). The risk of a major flood event is, however, higher in the less densely populated areas, some of which are economically disadvantaged, and lower in the high-density areas. Thus, the expected value of benefits from flood risk management, which accounts for both variables, is probably more evenly distributed throughout the basin.

Avoided costs of expanding emergency response programs. Other avoided costs of flood control are the costs of hiring additional safety personnel to respond to emergency calls during flood events, as well as the costs of purchasing and maintaining equipment the personnel uses to effectively respond in emergency cases.

Increased water supplies. Nonstructural changes that manage flood risk in the Russian River watershed can restore ecological functions of floodplains and affect positively stream flows and water quality, as well as groundwater recharge. Literature suggests that people in the western U.S. value additional water supplies at about $54 per acre-foot for agricultural water use and at about $115 per acre-foot for urban water use (Brown 2007).

Improved fish and riparian habitat. To the extent that nonstructural changes of this strategy improves instream flows and water quality for fish habitat, evidence suggests these benefits have a value of about $77 per acre-foot (Brown 2007). Literature also shows that improvements in the health of riparian buffers has an annual passive use value of about $125 per acre of riparian habitat (Chiabai et al. 2009).

Improved water recreation. Recreation can also benefit from components of the flood risk management if they increase the opportunities for water-related activities by increasing the instream flows. Research suggests that the consumer surplus associated with various water-based recreation activities in the Pacific Coast region ranges from $32 for swimming and $33 for boating to $52 for fishing, per person per day (Loomis 2005).

Strategy costs. The costs of flood risk management include capital and ongoing operation and maintenance for the strategy component related to structural changes. The U.S. Bureau of Reclamation estimated the costs of building surface storage facilities elsewhere in California range between $520 and $720 (dollars of 2007) per acre-foot (Cooley et al., 2010). The supply storage expected to be built as part of this strategy are small and thus the unit costs may be smaller or larger than the range the U.S. Bureau of Reclamation provides, depending on inputs costs, such as land and labor.

Other components of the strategy, nonstructural changes and disaster preparedness, response, and recovery, would have much lower costs of implementation compared to structural changes (DWR 2009). Additionally, the costs of foregone development include the possible reduction in the value of a home that could have been built on the floodplain but is built in a high-density area due to floodplain restrictions.

7.2.4 Water Quality

Water quality supports a wide spectrum of activities for all users in the Russian River basin, including agricultural irrigation, indoor and outdoor domestic uses, recreation, as well as industrial and commercial processes. At the same time, however, these activities impact the water quality by introducing pollutants, raising stream temperatures, and increasing sediment loads. Water quantity, too, plays a role in water quality, as declining water supplies lead to increased pollutant concentrations in streams and reservoirs.

The strategies discussed in this section aim to address challenges of water quality in the Russian River watershed. For each strategy, the expected benefits and costs associated with it are presented.

7.2.4.1 Drinking Water Treatment and Distribution

A reliable supply of safe drinking water has been a priority for water managers in the Russian River basin but its provision is expected to be impaired in the future unless several issues, such as deteriorating infrastructure and the protection of source water, are addressed without delay. The implementation of this strategy also addresses environmental justice issues, as several disadvantaged communities in the basin lack the financial resources to address problems related to water treatment and infrastructure. The remoteness of some disadvantaged communities compounds their financial burden, since they are not able to connect their infrastructure to that of larger communities to benefit from economies of scale. Improving the quality and reliability of water for disadvantaged communities is an important goal of the RRICWMP but, consistent with analytical standards, progress toward this goal falls outside the framework for benefit-cost analysis and decision-makers must consider it separately. The table below summarizes the types of benefits and costs associated with this strategy.

POTENTIAL BENEFITS	POTENTIAL COSTS
Avoided costs of water-borne illnesses (e.g., medical treatment and hospitalization, lost wages)	Costs of capital and ongoing operation and maintenance of treatment facilities and conveyance

Avoided costs of water-borne illnesses. The benefits of this strategy are mainly related to the avoided costs of water-borne illnesses that could be prevented by using treatment processes and infrastructure that meet current standards. Implementation of this strategy could enable communities to avoid costs, such as medical treatment and hospitalization costs and loss of wages due to missed work.

Strategy costs. The costs of providing safe drinking water include capital and ongoing operation and maintenance for the treatment facilities and the conveyance infrastructure. The annualized capital and maintenance costs for the Metropolitan Water District in Southern California provide a reference point: $714 per acre-foot for Tier 1 treatment and $832 per acre-foot for Tier 2 treatment, both costs in the dollars of 2009. Costs per acre-foot for a small water district similar to those serving the disadvantaged communities in the Russian River basin, however, can exceed four times the costs of the large water systems (DWR 2009). Compliance with new safety regulations of maximum arsenic concentrations is expected to increase current water treatment costs by $140 to $1,870 per acre-foot (dollars of 2009) depending on the size of the water system (DWR 2009).

7.2.4.2 Groundwater and Aquifer Remediation

Groundwater remediation involves the removal of contaminants that occur naturally or have anthropogenic causes through active or passive cleanup. Natural sources of groundwater contamination include heavy metals, radioactive constituents, and salts from geologic formations or conditions in the basin. Anthropogenic contaminants originate from sources, such as industrial processes, mining operations, agricultural activities, leaking fuel tanks, and urban runoff. The table below summarizes the types of benefits and costs associated with this strategy.

POTENTIAL BENEFITS	POTENTIAL COSTS
Increased water supplies	Costs of contamination assessments
Avoided costs of acquiring water supplies through water transfers or additional storage	Costs of contamination cleanup
Avoided costs of domestic well-water treatment	

Increased water supplies. Some of the benefits of groundwater and aquifer remediation consist of increased water supplies available for use, whether used on their own or blended with other water supplies. Literature suggests that water available for urban use has a value of about $115 per acre-foot and for agricultural use of about $54 per acre-foot (Brown 2007).

Avoided costs of acquiring water supplies. Groundwater and aquifer remediation may yield supplies that are safe to use in enough quantities that water managers can avoid acquiring supplies from other sources or building additional storage to cover demand from users. Recent water transfers indicate the potential avoided costs of acquiring water from other sources. In the five years between 2004 and 2009, avoided costs of acquiring additional water supplies through water transfers in California have ranged between about $7 and $1,550 for transactions between agricultural holders of water rights, between about $120 and $5,900 for transactions between agricultural users and urban users, and between about $32 and $4,700 for transactions from agricultural users to environmental uses (Donohue and Libecap 2010). If water transfers are not a viable option to supply a volume of water equal to that provided through groundwater remediation, investments in building surface storage would have to be considered. The U.S. Bureau of Reclamation estimated the costs of building surface storages of water supplies elsewhere in California to range between $520 and $720 (dollars of 2007) per acre-foot (Cooley et al., 2010).

Avoided costs of well-water treatment. Groundwater and aquifer remediation also benefits individual well owners, who would experience a decrease in the treatment costs for their water supplies (DWR 2009). Currently there is not enough information to quantify this benefit.

Strategy costs. Costs associated with groundwater and aquifer remediation include the assessment costs of contaminant types and hydrogeologic profile of the aquifer, the costs of the remediation system, and operation and maintenance of running the system when remediation occurs over long periods of time. These costs are difficult to estimate since they depend on a series of variables, such as the type of contaminant, the extent of contamination, or the geology containing the aquifer. In the case of petroleum underground storage tanks, site cleanup cost between $100,000 and $200,000 during the 1990s (DWR 2009). Actual cleanup projects initiated under this strategy can be higher or lower than these costs, depending on changes in input costs in the last 20 years and on site characteristics.

7.2.4.3 Matching Water Quality to Use

Economic losses can occur when water quality does not match the level required by individual uses. Some uses require water treated at potable safety levels, while others require water purity less than or higher than the standards for drinking water. For instance, landscape irrigation uses water that may not be adequate for human consumption, but some industrial processes need water that is highly treated, without any impurities. The table below summarizes the types of benefits and costs associated with this strategy.

POTENTIAL BENEFITS	POTENTIAL COSTS
Avoided treatment costs	Increased energy consumption and carbon dioxide emissions due to more treatment
Avoided costs of equipment and plumbing for users	
Decreased carbon dioxide emissions	

Avoided treatment costs. By matching the water quality to use, municipal water suppliers can decrease the amount of disinfectant byproducts in potable water and provide recycled water at purity levels that are appropriate for its end use. This strategy can produce health benefits for domestic consumers in areas where potable water has had a history of safety issues and can produce savings in unnecessary treatment costs when water entering treatment facility already has high quality (DWR 2009).

Avoided costs of equipment and plumbing for users. The strategy also can save industrial manufacturers money they would have otherwise spent on equipment and plumbing damaged by water with a high level of impurities.

Decreased carbon dioxide emissions. Other avoided costs associated with this strategy stem from possible energy consumption declining for some water treatment processes. The value of carbon dioxide reductions can be estimated using the social costs of this greenhouse gas identified in economic literature. Shaw et al. (2009) found that these social costs range between $7 and $60 but other analytical approaches provide

support for using values considerably higher (e.g., Ackerman and Stanton 2011). Additionally, Nordhaus (2008) estimated that the costs associated with carbon dioxide will increase at an annual rate of 2 to 3 percent. Applying the mean rate of increase to the median value of the social costs of carbon dioxide emissions, a value of $35 per ton of carbon dioxide is obtained.

Strategy costs. Water quality requirements for other users may increase energy consumption, resulting in increased carbon dioxide emissions, as well as increased water transportation costs. The current costs of water treatment, including energy, for the Metropolitan Water District in Southern California provide a reference point: $714 per acre-foot for Tier 1 treatment and $832 per acre-foot for Tier 2 treatment for 2012, both in the dollars of 2009. Costs per acre-foot for smaller water districts similar to those serving the users in the Russian River basin, however, are probably higher and can exceed four times the costs of the large water systems (DWR 2009). These costs do not include the social costs of carbon dioxide emissions from energy production for water treatment processes.

7.2.4.4 Pollution Prevention

Reduction in the pollutant loads from nonpoint sources associated with agricultural practices, forestry, urban runoff, hydromodifications, and wetland management is a priority in the RRICWMP. The table below summarizes the types of benefits and costs associated with this strategy.

POTENTIAL BENEFITS	POTENTIAL COSTS
Avoided treatment costs	Costs of pollution prevention programs for agricultural and urban users
Improved fish habitat	
Improved water recreation	

Avoided treatment costs. Some of the benefits of preventing pollutants from entering streams materialize as avoided costs of water treatment. Pollution prevention helps maintain the water at higher quality levels before they enter the treatment cycles, thus requiring lower inputs of energy and treatment, such as filtration and cleaning, to meet a predetermined standard. The current costs of water treatment, including energy, for the Metropolitan Water District in Southern California provide a reference point: $714 per acre-foot for Tier 1 treatment and $832 per acre-foot for Tier 2 treatment for 2012, both in the dollars of 2009. Costs per acre-foot for smaller water districts similar to those serving the users in the Russian River basin, however, are probably higher and can exceed four times the costs of the large water systems (DWR 2009).

Improved fish habitat. By reducing the pollution concentration in return flows from agricultural or urban land uses, water quality in the streams remains higher than in the absence of this strategy and is more likely to sustain healthy fish habitats. Literature suggests that water available for environmental purposes has a value of about $77 per acre-foot (Brown 2007).

Improved water recreation. Higher water quality can also support recreational activities. Research shows that people are willing to pay for water quality that allows them to swim, boat, or fish. A 1993 study found that households would be willing to pay about $147 per year to maintain boatable water quality. Furthermore these households would be willing to pay an additional $110 per year to improve the water quality to fishable conditions, and another $123 per year to improve the fishable waters to swimmable status (Carson and Mitchell 1993). Another study looked at a number of variables describing water quality found that households would be willing to pay about $30, annually, to improve the water quality in a nearby river by one percent (Magat et al. 2000).

Strategy costs. The costs of pollution prevention depend on the type of pollution that can be averted. For instance, the Los Angeles Regional Water Board estimated that the cost of pollution prevention programs for agricultural runoff ranged between $177 and $425 per farmer per year (DWR 2009). The costs of pollution prevention from urban runoff is discussed in Section 2.5 *Urban Runoff Management*.

7.2.4.5 Urban Runoff Management

Activities that help manage urban runoff involve the control of stormwater, outdoor irrigation, and other runoff from urban surfaces. Low impact development (LID) is an alternative to conventional stormwater management and comprises the implementation of several techniques to infiltrate, filter, store, evaporate, and detain runoff close to the source of rainfall.

The use of urban runoff management strategies can have a positive impact on surface water by better regulating peak flows during high precipitation events and preventing urban pollutants from entering the stream via storm runoff. This strategy, however, can have positive effects on groundwater, as well, since it helps runoff infiltrate into aquifers and retain in the system for longer periods of time, instead of being flushed downstream during storm

events. The table below summarizes the types of benefits and costs associated with this strategy.

POTENTIAL BENEFITS	POTENTIAL COSTS
Avoided costs of water treatment, including carbon dioxide emissions	Costs of runoff treatment
Improved flood control	Costs of educational programs
Increased water supplies	Costs of urban pollution prevention
Avoided costs of storage building	
Improved fish and riparian habitat	
Improved water recreation	

Avoided costs of water treatment. Improved water quality translates into lower costs of water treatment and lower carbon dioxide emissions from reduced energy consumption. The current costs of water treatment, including energy, for the Metropolitan Water District in Southern California provide a reference point: $714 per acre-foot for Tier 1 treatment and $832 per acre-foot for Tier 2 treatment for 2012, both in the dollars of 2009. Costs per acre-foot for smaller water districts similar to those serving the users in the Russian River basin, however, are probably higher and can exceed four times the costs of the large water systems (DWR 2009). The value of carbon dioxide reductions can be estimated using the social costs of this greenhouse gas identified in economic literature. Shaw et al. (2009) found that these social costs range between $7 and $60 but other analytical approaches provide support for using values considerably higher (e.g., Ackerman and Stanton 2011). Additionally, Nordhaus (2008) estimated that the costs associated with carbon dioxide will increase at an annual rate of 2 to 3 percent. Applying the mean rate of increase to the median value of the social costs of carbon dioxide emissions, a value of $35 per ton of carbon dioxide is obtained.

Improved flood control. By delaying storm runoff from entering the stream during high-precipitation events, this strategy becomes an important component of coordinated flood control in the basin. The value of flood control depends on the value of the avoided costs of damaged goods (e.g., property, timber, crops) and disrupted services (e.g., measured in lost wages and opportunity costs of volunteers responding to a flood emergency). Other benefits would materialize to the extent that flood-control investments reduce injury and death to humans, livestock, and wildlife. These benefits are expected to be lower in the areas of the watershed that are less densely populated (i.e., the upper and lower reaches of the watershed) and higher in areas with high population density (i.e., the middle section of the Russian River basin). The risk of a major flood event is, however, higher in the less densely populated areas and lower in the high-density areas. Thus, the expected value of benefits from flood risk management, which accounts for both variables, is probably more evenly distributed throughout the basin.

Increased water supplies. This strategy creates pathways for urban runoff resulting from storm events to infiltrate into aquifers, where it is stored until it supplies streams with flows during dry periods or is pumped out of the ground for agricultural or domestic uses. Literature suggests that water available for urban use has a value of about $115 per acre-foot and for agricultural use of about $54 per acre-foot (Brown 2007).

Avoided costs of new storage. Increased water supplies through groundwater recharge avoids the costs of building additional surface storage. The U.S. Bureau of Reclamation estimated the costs of building surface storage facilities elsewhere in California range between $520 and $720 (dollars of 2007) per acre-foot (Cooley et al., 2010).

Improved fish habitat. By reducing flows during storm event and making them available during the dry summer months, this strategy can have positive effects on fish habitat. Improved instream flows and water quality for environmental purposes can be estimated using a value of about $77 per acre-foot, as suggested in existing literature of attitudes of people in the western U.S. towards environment restoration (Brown 2007).

Improved water recreation. Urban runoff management can increase the overall welfare of those recreating in the streams and lakes of the Russian River watershed. This increase in welfare is evident in people's willingness to pay for access to water in which they can boat, swim, or fish. A 1993 study found that households would be willing to pay about $147 per year to maintain boatable water quality. Furthermore these households would be willing to pay an additional $110 per year to improve the water quality to fishable conditions, and another $123 per year to improve the fishable waters to swimmable status (Carson and Mitchell 1993). Another study looked at a number of variables describing water quality found that households would be willing to pay about $30, annually, to improve the water quality in a nearby river by one percent (Magat et al. 2000).

Strategy costs. The costs of urban runoff management include costs of runoff treatment, of programs

that prevent the pollution of urban runoff, such as street sweeping, trash collection, sidewalk cleaning (DWR 2009). The highest costs are associated with runoff treatment. The cities of Los Angeles and Santa Monica, for example, paid $12 million for a state-of-the-art facility that treats up to 500,000 gallons of urban runoff per day (DWR 2009). Other costs include opportunity costs of public employees and volunteers, who support public education programs.

7.2.4.6 Salt and Salinity Management

Salt or salinity has not been classified as a concern for the Russian River watershed but salinity can become of concern when water is recycled multiple times and more water molecules evaporate creating a higher concentration of salt.

Avoided costs to users. Low salinity water benefits users who require high-purity water, such as industrial manufacturers. One study by the U.S. Department of the Interior found that in 1998 an incremental decrease in salinity of 100 milligrams-per-liter created an economic benefit of $95 million dollars for the municipal and industrial customers of the Metropolitan Water District in Southern California (DWR 2009).

Strategy costs. Since salinity and salt are not considered a priority in the Russian River basin, the cost of management is likely to remain low for the foreseeable future.

7.2.5 Climate Change Adaptation and Mitigation

Both Sonoma and Mendocino counties have been active in their design of plans and strategies to mitigate and adapt to climate changes that the Russian River watershed is expected to undergo. Sonoma County committed to much more aggressive reductions in greenhouse gases (GHG), 25 percent below 1990 levels by 2015, than the State of California did through AB 32, which obligated the state to 20 percent reductions below 1990 by 2020. In its General Plan, Mendocino County identified goals to mitigate GHG and is expected to identify strategies to adapt to climate change.

Many of the strategies discussed in the RRICWMP address mitigation of climate change effects, while others address the basin's adaptation to future climatic changes. Mitigation refers to strategies that reduce atmospheric emissions of GHG by sequestering carbon in the soil or by inducing reductions in the consumption of energy produced with fossil fuels. Such strategies are related to increased water use efficiency, matching water quality to use, pollution prevention, urban runoff management, ecosystem restoration, and wetland enhancement and creation. Adaptation involves strategies that diminish the vulnerability of communities and ecosystems to climate change by reducing associated adverse effects expected to occur. All strategies discussed in the RRICWMP have a component of climate change adaptability.

U.S. EPA and DWR propose a method for prioritizing different components of a plan that help a region adapt to climate change. This can be done using a composite index, which involves applying a Multi-Attribute Rating Technique. Essentially, each attribute of a plan is assigned a performance metric, similar to our discussion of individual benefits. Consequently, the value of the metric is determined by weighting it using a priority measure of the objective that the attribute is intended to address. The technique can be used to prioritize different plans or projects within plans (U.S. EPA and DWR 2011). Strategies described above already address how each yields benefits of mitigation or adaptation to climate change. Once they are identified at a project level, performance metrics and weights can be assigned to each to rank the strategies and projects based on their ability to meet climate-change objectives.

7.2.6 Public Access for Recreation

Specific efforts to increase public access to recreational opportunities in the Russian River Basin can take many forms. The 2008 California Outdoor Recreation Plan states that low-income and minority communities should have the same access to high-quality and well-maintained recreation opportunities as individuals elsewhere in the state (California State Parks 2009). To the extent that this strategy increases the quality and/or quantity of recreational opportunities in the Russian River Basin, it will increase the value of the benefits derived from recreation; it will also increase the value of some recreation-related costs.

POTENTIAL BENEFITS	POTENTIAL COSTS
Increased access to recreation	Capital, operation, and maintenance costs
	Increased sedimentation
	Increased potential for invasive species

Increased access to recreation opportunities. When individuals participate in recreation activities, the total amount they would be willing to pay to participate has two components: (1) the amount they actually pay (e.g., travel, lodging, equipment, food) which is circulated throughout the local economy, and (2) the consumer surplus they derive (i.e., the

difference between the total amount they are willing to pay and the amount they actually pay). Increasing access to recreation opportunities likely would increase recreation levels among low-income communities that rely more heavily on public recreation facilities than average Californians (California State Parks 2009). Research suggests that increasing the quality of existing recreational opportunities likely increases visitation as well as total willingness to pay per visit, which increases both expenditures and consumer surplus (Loomis 2006). Similarly, increasing the quantity of recreational opportunities likely increases recreation-related expenditures and consumer surplus by increasing visitation and willingness to pay (by decreasing congestion). Table 7.25 identifies consumer surplus values associated with several different types of recreation. Estimating site-specific, recreation-related expenditures requires complex modeling. Existing literature describes recreation-related spending, at the county level, which can be applied, on a percentage basis, to anticipated changes in recreation behavior (Dean Runyan Associates 2011).

Strategy costs. The costs associated with constructing, operating, and maintaining improvements in recreational access vary considerably depending on the type of project and its location. A wood chip trail, for example, costs about $2.10 per square foot and requires maintenance every year, while a concrete path costs about $4.75 per square foot and requires little maintenance each year (Alta Planning and Design, no date).

Increased recreation in the Russian River Basin could increase sedimentation rates, potentially decreasing the value of benefits derived from fisheries and soil productivity while increasing costs associated with managing irrigation ditches and water treatment facilities. According to a USDA analysis, the costs associated with sedimentation in and around the Russian River Basin could be up to $10 per ton (Hansen and Ribaudo 2008).

With more recreation, the ecosystems in the Russian River Basin likely will be more vulnerable to terrestrial and aquatic invasive species. Research suggests that private and public programs across the State of California spend about $82 million per year on invasive species-related control, monitoring, and outreach (California Invasive Plant Control, no date). In many cases, the costs associated with controlling and monitoring invasive species are much lower than the costs associated with the various effects invasive species have on local and regional ecosystems. Costs associated with specific control measures vary. Pesticide treatment for the invasive California red scale, for example, can cost farmers $100—$300 per acre per year (California Invasive Plant Control 2010).

TABLE 7.25 CONSUMER SURPLUS VALUES ($/PERSON/RECREATION DAY)

RECREATION TYPE	NATIONAL RANGE	PACIFIC COAST MEAN
Backpacking	$33-$100	$65
Birdwatching	$7-$97	N/A
Camping	$3-$279	$130
Fishing	$3-$691	$55
Bloatboating/rafting/canoeing	$3-$490	$35
General recreation	$2-$320	$40
Going to the beach	$5-$146	N/A
Hiking	$1-$325	$29
Horseback riding	$23	N/A
Hunting	$3-$312	$56
Motorboating	$5-$253	$33
Mountain biking	$26-$367	$62
Picnicking	$11-$177	$80
Swimming	$3-$167	$34
Wildlife viewing	$3-$432	$90

Source: ECONW with data from Loomis (2005).

8 DATA MANAGEMENT AND RRICWMP PERFORMANCE EVALUATION

Monitoring

Need for a Data Management Plan

Section 1 describes California's Integrated Regional Water Management program; a Data Management Plan for the North Coast Region (DMP) is being developed as part of this program. It is intended to result in efficient, effective, and standardized data acquisition, input, analysis, and dissemination throughout the Region.

A large number of local, regional, state, and federal agencies are required to monitor and assess the condition of waters and related ecosystems, producing a wealth of potentially useful data. Unfortunately, stakeholders interested in finding, accessing, and using these data are often hampered by poor data management (particularly the lack of user-friendly means for obtaining and sharing data) and inconsistencies in data formats and protocols (CWQMC 2008). The regional DMP, when it is fully realized, will satisfy the need for a robust data management system that is fully compatible with ongoing and newly-emerging state systems; that integrates and generates watershed-based datasets; and that is easy to use. The DMP will also fulfill the need for a region-specific framework to objectively and adaptively assess and improve indicators of watershed improvement project performance in the watershed and North Coast region.

The RRICWMP does not include a separate "Russian River" plan for data management and indicator evaluation; by design, the Russian River watershed is subsumed under the umbrella of the regional DMP outlined herein. The DMP can provide a framework for Russian River planners and managers to integrate locally-appropriate condition indicators (e.g. of habitat condition, water quality, and water quantity; see Section 5) into a single data management system that is fully compatible with ongoing and newly-emerging state systems and that can be used by everyone. Thus, rather than reinventing the wheel, the RRICWMP will complement and enhance existing programs and plans, while focusing data collection and reporting in the Russian River watershed.

Near-term goals for data management include:[14]

14 Abbreviated list of data management goals — See the complete document at http://www.northcoastirwmp.net/Content/10377/North_Coast_Assessment_Monitoring_and_Data_Management.html. It proposes a framework for developing performance and condition and details specific data management and performance assessment needs within the North Coast region. Appendices describe current monitoring/ assessment programs in the North Coast, list major data gaps, and provide background to support the developing indicator framework (Appendices A and B).

1) Develop baseline assessments of water quality, supply, and water management issues at the local (i.e. Russian River watershed) and regional scales;
2) Identify appropriate assessment/performance indicators to accurately track changes at the local and regional scales;
3) Provide a system for on-going monitoring and indicator evaluation to inform the adaptive management of North Coast ecosystems such as in the Russian River watershed;
4) Develop and standardize data development and dissemination (e.g. stakeholder data input/output using interactive web portals);
5) Provide a formal and ongoing process for user-friendly data management in the region.

8.1 DATA AVAILABILITY AND MANAGEMENT

"Data Collection, Research and Evaluation" is identified as a supporting strategy area in RRWC 2002 ("Draft Plan of Action"). Many local, regional, state, and federal entities are required to monitor and assess the condition of waters and, increasingly, bioindicators in the Russian River watershed, producing a wealth of potentially useful (though often unstandardized, inaccessible, or insufficient) data. Along with the recent and rapidly-growing body of high-quality data has come a need to maximize the efficiency and effectiveness of data collection and dissemination and to ensure that the data are available for use by decision-makers and the public (CWQMC 2008). Despite the relative flood of data being generated in and for the Russian River watershed, significant gaps in understanding persist and even the frequently-referenced datasets may be in need of update (e.g. the ubiquitous CalVeg vegetation database is mostly from 1998; partially refined in 2003).

Data Gaps

There is a wealth of data available for statewide and regional conditions, particularly for broad landscape features and cover, and (increasingly) for focal habitats like wetlands, riparian areas, and coastal/estuarine environments. New programs and indicators are being developed to identify where data for monitoring and assessment are missing, and to address data gaps with sampling programs. However, most available indicator data currently address water quality; fewer address habitat and fewer still address water quantity (particularly for groundwater). The RRICWMP should consult with experts in the watershed to identify priority and long-term data needs at the local scale, including regular data updates. For example, while current datasets may provide certain benchmarks ("before" conditions, for example), older data should be interpreted with caution. Data gaps identification, prioritization, and revision/update should be fully developed in development with this document.

Data Sources

The SWRCB has a program for monitoring and reporting water and biotic condition throughout the state that has for years collected (and continues to collect) samples in the Russian River mainstem and its tributaries. The State Water Ambient Monitoring Program (SWAMP[15]; also its partner representing groundwater, GAMA[16]) has, or soon will have, data on both traditional physiochemical quality indicators (e.g. temperature, toxicity) and bioindicators (e.g. Benthic Macroinvertebrates, BMIs). SWAMP data allow for qualitative and objective characterization of watersheds and waters throughout the state based on numeric thresholds/benchmarks. Their current program has focused spatially on perennial wadeable streams and taxonomically on BMIs. However, as resources and techniques develop, the SWAMP program aims to determine and report on aquatic conditions (water, sediment, biota) in all state waterbodies and, by extension, the watersheds to which they belong.

The DWR's Integrated Water Resource Information System (IWRIS) is a new and valuable data management tool for accessing water resources data in the Russian River watershed. It is a web based GIS application that allows you to access, integrate, query, and visualize multiple sets of data. Some of the databases include DWR Water Data Library, California Data Exchange Center (CDEC), USGS streamflow, Local Groundwater Assistance Grants (AB303), and data from local agencies. There are numerous other water datasets (e.g. quality, mainly; also quantity, hydrology, demand, availability, forecast) and habitat datasets (e.g. landscape, biotic, hydro/geomorphological) compiled and maintained by various agencies in California, the North Coast Region, and the Russian River watershed[17]. Some of the major publically-

15 E.g. see References in Section 5.6: Ode 2007, Ode and Schiff 2009, SWAMP 2006, 2008, 2010. The latest SWAMP data are available from the SWRCB http://www.waterboards.ca.gov/water_issues/programs/swamp/

16 SWRCB's Groundwater Ambient Monitoring and Assessment Program http://www.swrcb.ca.gov/gama/

17 The Sonoma County Water Agency has produced a 12-page listing of reports for the county (in the Russian River watershed) that have been generated by SCWA, DWR, US Army Corps of Engineers, and many others. See http://www.scwa.ca.gov/files/docs/outreach/reports.list-INTERNET.pdf

accessible databases and reports are provided below, along with weblinks to access their resources. The list was compiled, in part, from the SWRCB "Data and Databases" site,[18] the California Department of Fish and Game (CDFG 2011), and the Russian River Integrated Information System (RRIIS[19]) for the North Coast Integrated Regional Water Management Plan.

8.1.1 Biodiversity and Habitat Data

- California Department of Fish and Game (CDFG) (Regions 1 and 3 for the North Coast) http://www.dfg.ca.gov/about/data.html
- CDFG Biogeographic Information and Observation System (BIOS; http://bios.dfg.ca.gov/)
- CDFG California Native Diversity Database (CNDDB; http://www.dfg.ca.gov/biogeodata/cnddb/)
- CDFG Comprehensive Wetland Habitat Program http://www.dfg.ca.gov/lands/wetland/
- CDFG Watershed Assessment Program does fisheries-based assessments of coastal streams http://coastalwatersheds.ca.gov/
- California EPA and others: Environmental Protection Indicators for California (EPIC) project is responsible for developing and maintaining a set of "environmental indicators" for California. http://oehha.ca.gov/multimedia/epic/aboutepic.html
- CalFlora (for specific plant species) http://www.calflora.org/
- California Native Plant Society (for specific plant species) http://www.cnps.org/
- California Resource Agency State of the State's Wetlands Report http://resources.ca.gov/ocean/SOSW_report.pdf
- EPAs Western Environmental Monitoring and Assessment Program (WEMAP) http://www.epa.gov/region09/water/wemap/surface.html
- National Marine Fisheries Service (NMFS) Draft Recovery Plan for CCC Coho (subsumes CDFG stream habitat sampling and other major datasets) http://swr.nmfs.noaa.gov/recovery/Coho_Recovery_Plan_031810.htm
- Riparian Habitat Joint Venture (RHJV): data on riparian habitat restoration in California, especially for birds http://www.rhjv.org/
- Riparian Bird Conservation Plan (California Partners in Flight and Riparian Habitat Joint Venture) monitoring data for some focal species http://www.prbo.org/calpif/htmldocs/riparian.html
- SWAMP BMI, stream assessment, and other reports including Ode 2007, SWAMP 2005, and Ode and Rehn 2005 http://www.swrcb.ca.gov/water_issues/programs/swamp/
- State Water Resources Control Board (SWRCB) Wetland definition (2009) http://www.swrcb.ca.gov/water_issues/programs/cwa401/docs/tatmemo2_062509.pdf
- SWRCB CRAM development http://www.cramwetlands.org/
- SWRCB Riparian area assessment and data collection http://www.swrcb.ca.gov/water_issues/programs/cwa401/docs/wrapp/tatmemo3_061610.pdf
- USEPA STORET/ WQX water quality, biological, and physical data monitoring data http://www.epa.gov/storet/

8.1.2 Landuse Data

- CalFire: CalVeg http://www.fs.fed.us/r5/rsl/projects/mapping/accuracy.shtml
- CalFire: Composite Dataset of California Landcover http://frap.cdf.ca.gov/data/frapgisdata/select.asp
- CalFire: FRAP Watershed Data http://frap.fire.ca.gov/watersheds/data.asp?HRID=1
- CalFire and USDA Forest Service: California Land Cover Mapping and Monitoring Program (LCMMP) http://frap.cdf.ca.gov/projects/land_cover/index.html
- Groundwater Ambient Monitoring Program (GAMA) information http://www.swrcb.ca.gov/gama/
- USDA: National Agriculture Inventory Program (NAIP) found at CalAtlas http://www.atlas.ca.gov/download.html
- USEPA: ATtILA extension for GIS Landscape Analysis (land use quantification) http://www.epa.gov/esd/land-sci/attila/intro.htm
- USGS: National Wetlands Inventory (NWI) http://www.atlas.ca.gov/download.html
- USGS: National Hydrography Dataset http://nhd.usgs.gov/
- USGS Land Cover Institute http://landcover.usgs.gov/natllandcover.php
- USGS: Seamless Server http://seamless.usgs.gov/
- DWR Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/

18 SWRCB and many others' data at Data and Datasets http://www.waterboards.ca.gov/resources/data_databases/

19 http://www.northcoastirwmp.net/Content/10378/Monitoring_and_Assessment_Protocols_and_Data_Sources

- USEPA Watershed Assessment of River Stability and Sediment Supply (WARSSS) http://www.epa.gov/warsss/sedsource/streamflo.htm
- USEPA STORET/ WQX water quality, biological, and physical data monitoring data http://www.epa.gov/storet/
- USGS National Hydrography Dataset http://nhd.usgs.gov/
- USGS National Water Information System (NWIS) http://waterdata.usgs.gov/nwis/rt

8.1.3 Water Quantity and Hydro/ Geomorphological Data

- Department of Water Resources (DWR) California Data Exchange Center (CDEC) Hydrometerological data, forecasts, flood warnings for North Coast. Collaboration that includes US Army Corps of Engineers and Pacific Gas & Electric, among others http://www.water.ca.gov/floodmgmt/hafoo/hb/cdecs/
- DWR Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/
- DWR California Statewide Groundwater Elevation Monitoring (CASGEM) http://www.water.ca.gov/groundwater/casgem/
- SWRCB Critical Reach of Stream Systems declared Fully Appropriated (Mendocino County, Sonoma County) http://www.swrcb.ca.gov/waterrights/water_issues/programs/fully_appropriated_streams/
- USEPA Watershed Assessment of River Stability and Sediment Supply (WARSSS) http://www.epa.gov/warsss/sedsource/streamflo.htm
- USEPA STORET/ WQX water quality, biological, and physical data monitoring data http://www.epa.gov/storet/
- USGS National Hydrography Dataset http://nhd.usgs.gov/
- USGS National Water Information System (NWIS) http://waterdata.usgs.gov/nwis/rt

8.1.4 Water Quality (Physiochemical) Data

- California Water Board (SWRCB, Regional WQCBs) water quality portal http://www.waterboards.ca.gov/mywaterquality/
- Department of Water Resources (DWR) Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/
- DWR Water Plan Information Exchange: hub with links to various databases http://www.waterplan.water.ca.gov/waterpie/index.cfm
- DWR Water Plan and Updates: water quality improvement strategies and data on water use http://www.waterplan.water.ca.gov/waterquality/water_quality.cfm
- EPA TMDL program http://www.epa.gov/OWOW/tmdl/
- EPA WEMAP (Western Environmental Monitoring and Assessment Program; http://www.epa.gov/region09/water/wemap/surface.html) for physical habitat structure, sediment metabolism, sediment chemistry, water quality parameters, and riparian vegetation.
- SWAMP http://www.swrcb.ca.gov/water_issues/programs/swamp/, including water quality and toxicity data at http://swamp.mpsl.mlml.calstate.edu/online-data
- SWRCB North Coast Water Quality Control Plan (Basin Plan) http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/basin_plan.shtml
- USEPA and SWRCB and California Monitoring and Assessment Program (CMAP) http://www.epa.gov/emap2/html/pubs/docs/groupdocs/symposia/symp2007/abstracts/poster/emanuel.html
- USEPA STORET/ WQX water quality, biological, and physical data monitoring data http://www.epa.gov/storet/
- USGS groundwater quality data http://ca.water.usgs.gov/gama/publications.htm

8.1.5 Watershed Monitoring Data

Table 8.1 presents a brief sample of Russian River watershed monitoring programs. The Russian River Integrated Information System (RRIIS[20]) provides a more comprehensive listing of current programs with links to their data. The RRICWMP is intended to integrate with these and other monitoring programs to provide for consistent, accessible datasets that accurately depict the current and changing condition of watershed attributes. Appendix 11, Descriptions of Plans, Policies, and Programs provides more information about these and other watershed-specific monitoring programs. In addition to these, watershed groups and others working on the ground in the Russian River watershed may perform monitoring; their datasets are meant to be easily accessible to the public (see Section 4.7).

20 http://www.northcoastirwmp.net/Content/10380/Existing_Monitoring_Programs.html

TABLE 8.1. SELECT MONITORING PROGRAMS FOR RUSSIAN RIVER WATERSHED ATTRIBUTES			
TITLE	**AGENT**	**DATE**	**WATERSHED ATTRIBUTE**
Five Year Coordinated Work Plan for Wetlands Conservation Program Development	CDFG and SWRCB	2011	Habitat Condition Water Quality
California Wetland Monitoring Workgroup Tenets of a State Wetland and Riparian Monitoring Program (WRAMP)	California Wetland Monitoring Group (CWMG)	Proposed in 2010	Habitat Condition Water Quality
Stream Pollution Trends (SPoT) Monitoring at Integrator Sites	SWRCB, SWAMP	2008	Water Quality (sediment)
State Water Ambient Monitoring Program (SWAMP)	SWRCB	2000	Habitat Condition Water Quality
Groundwater Ambient Monitoring & Assessment Program (GAMA)	SWRCB	2000	Water Quality
Inland Surface Waters Toxicity Testing Program	NCRWQCB, UC Davis	1993	Habitat Condition Water Quality
The Bay Protection and Toxic Cleanup Program (BPTCP)	SWRCB	1989	Water Quality
State Mussel Watch Program (SMW) [now part of SWAMP]	SWRCB, CDFG	1977	Habitat Condition Water Quality
Toxic Substances Monitoring Program (TSMP) [now part of SWAMP]	SWRCB, CDFG	1976	Habitat Condition Water Quality
Many others. See listing of Monitoring Programs, referenced in text above.	Various		Habitat Condition Water Quality Water Quantity

8.2 PERFORMANCE INDICATOR FRAMEWORK

An integral component of the DMP is an indicator framework to objectively (and when possible, quantitatively) evaluate the performance of water and watershed improvement projects identified and implemented by the RRICWMP, as well as performance of the RRICWMP itself. The indicator framework facilitates development and application of a set of appropriate, standardized performance measures for assessing and evaluating the efficacy of water and watershed management regionally and locally. This need for a standardized environmental performance evaluation system — using water quantity, quality, and ecosystem indicators to objectively assess management project performance and to facilitate adaptive management - has been recognized for quite some time (Shilling and Washburn 2005). Traditionally, the state's water regulatory agencies have focused water monitoring and assessment efforts on chemical and physical criteria. While these criteria are essential, they are not sufficient. In recognition of the value of also monitoring and assessing biological criteria, a number of state programs do now conduct biological assessment monitoring; some are required to do so. However, most plans and policies do not yet contain numeric objectives or thresholds for using these biological data in regulatory decision-making. In response, there is now a concerted effort underway by state regulatory agencies (e.g. DWR, SWRCB) and others to develop indicator-based ecological objectives[21] and indicators to supplement the numerous existing state-wide assessments of water quality and supply.

The DMP proposes indicators and specific data (metrics) that describe the following watershed attributes: biotic condition (at the ecosystem, species, population, community, and individual-level), landscape condition (habitat and land use measures), chemical/physical water characteristics (organic and inorganic chemicals, nutrients, and other constituents), and hydrology/ geomorphology (ground and surface flows, channel morphology, and materials transport/deposition). To integrate across the national, state, regional, and watershed levels, the DMP augments and compliments (rather than re-invents) the data sets and protocols from existing and developing environmental monitoring programs (e.g. US EPA's Science Advisory Board, Young and Sanzone 2002; SWRCB's State Water Ambient Monitoring Program, SWAMP; CalFire, CDFG, NMFS, USGS, USDA and others). This proposed indicator framework can be applied to a variety of environmental program goals, geographic scales, and taxonomic levels and is expected to actively facilitate effective, long-term, adaptive management and conservation in the Russian River watershed.

21 For more information about the proposed SWRCB process to develop Biological Objectives for California, see http://www.waterboards.ca.gov/plans_policies/biological_objective.shtml

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9.2.1 Weblinks to Federal, State, and Regional Policies

2011 Russian River Frost Protection Regulation Policy http://www.swrcb.ca.gov/waterrights/water_issues/programs/hearings/russian_river_frost/

2011 Wetland and Riparian Area Protection Policy (WRAPP), Phase I: Wetland Area Protection Policy and Dredge and Fill Regulations. http://www.swrcb.ca.gov/water_issues/programs/cwa401/wrapp.shtml

2011 Draft Regulation Groundwater Replenishment Reuse http://www.cdph.ca.gov/healthinfo/environhealth/water/pages/waterrecycling.aspx

2011 Water Quality Control Policy for Siting, Design, Operation, and Maintenance of Onsite Wastewater Treatment Systems http://www.swrcb.ca.gov/water_issues/programs/owts/docs/draft_publiccommentd093011.pdf

2010 Policy for Maintaining Instream Flows in Northern California Coastal Streams (North Coast Instream Flow Policy) http://www.swrcb.ca.gov/waterrights/water_issues/programs/instream_flows/

2010 Policy on the Use of Coastal and Estuarine Waters for Power Plant Cooling http://www.swrcb.ca.gov/water_issues/programs/ocean/cwa316/

2008 Policy for Compliance Schedules in National Pollution Discharge Elimination System (NPDES) Permits http://www.swrcb.ca.gov/water_issues/programs/npdes/

2005 Water Quality Control Policy for Addressing Impaired Waters: Regulatory Structure and Options (TMDL Policy) http://www.swrcb.ca.gov/water_issues/programs/tmdl/

2005 Policy for Regulation of Discharges of Municipal Solid Waste http://www.swrcb.ca.gov/board_decisions/adopted_orders/resolutions/2005/rs2005-0058_rs93-62.pdf

2004 Water Quality Control Policy for developing California's Clean Water Act Section 303(d) list http://www.swrcb.ca.gov/water_issues/programs/tmdl/docs/ffed_303d_listingpolicy093004.pdf

1998 Policy on Sources of Drinking Water http://www.swrcb.ca.gov/board_decisions/adopted_orders/resolutions/2006/rs2006_0008_rev_rs88_63.pdf

1987 Timber Policy http://www.swrcb.ca.gov/northcoast/water_issues/programs/timber_operations.shtml

1986 Russian River project Decision 1610 http://www.swrcb.ca.gov/waterrights/board_decisions/adopted_orders/decisions/d1600_d1649/wrd1610.pdf

1977 Policy with Respect to Water Reclamation in California http://water.epa.gov/scitech/swguidance/standards/wqslibrary/ca_9_77_1.cfm

1968 Statement of Policy with Respect to Maintaining High Quality Waters in California http://www.swrcb.ca.gov/board_decisions/adopted_orders/resolutions/1968/rs68_016.pdf

RUSSIAN RIVER
INTEGRATED COASTAL WATERSHED
MANAGEMENT PLAN

APPENDIX 1.
SUMMARIZED EXPERT INTERVIEWS

SUMMARIZED INTERVIEWS — 2011

SUMMARY INFORMATION ON PARTICIPANTS AND RESPONSES

Interview subjects included a wide variety of people who have specific knowledge and interest in the Russian River watershed. They identified themselves as having knowledge and expertise in several categories. In addition, they often represented more than one category of stakeholder group.

Note: The tallies of responses will total more than 23 due to the range of interests these respondents have in this watershed.

Interview Participants - 24

Sonoma County - 11

Mendocino County - 13

Societal Category

Educator: 5

Farmer: 4

Federal Government: 3

Fisheries Biologist: 5

Landowner/Government Liaison: 6

Local Government: 7

Rancher: 3

Scientist: 2

State Government: 0

Tribal: 2

Water Purveyor: 3

Water Quantity Expert: 6

Watershed Group: 3

Water Quality Expert: 3

1. Geographic area of expertise/jurisdiction.

Entire mainstem and tributaries: 5

Lake Mendocino: 5

Mendocino County — mainstem: 9

Mendocino County — tributaries: 8

Sonoma County - mainstem: 4

Sonoma County - tributaries: 6

Upland habitats and forests in watershed: 4

Santa Rosa Plain: 3

Potter Valley Project: 3

2. Functional area(s) of expertise (i.e. hydrology, fisheries, plant ecology, water supply, climate change, land conservation, policy, agriculture, forestry, land use planning, etc.) Include some background if appropriate.

1	Agriculture	10
2	Agriculture Issues With Water Use	8
3	Applied Research	4
4	Climate Change	4
5	Economic Development	1
6	Fisheries	11
7	Forestry	3
8	Flood Control	1
9	Gravel Mining	2
10	Habitat: Aquatic and/or Terrestrial	4
11	Hydrology/Fluvial Geomorphology	9
12	Land Conservation	10
13	Land Use Planning	11
14	Land/Water Use Policy	10
15	Low Impact Development	6
16	Native American Culture/Heritage	2
17	Plant Ecology: native/invasive	9
18	Stormwater Management	3
19	Watershed Ecology	4
20	Watershed Education	5
21	Watershed/Habitat Restoration	9
22	Water Supply	14
23	Water Quality	9

3. What are the biggest problems that impact the sustainable functioning of the Russian River, its hydrology, ecology, habitats, plant and wildlife populations?

Prioritization based upon number of responses by interviewees

The most common response to this question is the presence of un-regulated and often illegal stream diversions from tributaries and the mainstem that negatively affect aquatic health. The illegal references were mostly in regards to marijuana cultivation, but also included illegal diversions associated with agriculture and rural residential properties. Instream flow management in tributaries has altered the hydrographs and doesn't support natural processes. **15**

The loss of upland and aquatic habitats associated with human uses of agriculture, urban expansion, road systems in general, and gravel mining were identified as key factors reducing the sustainable watershed functions. **11**

Reduction in the riparian community through agricultural and urban encroachment, as well as expansion of invasive exotic plant species, has affected stream and riverine systems. **11**

Hydrologic alterations from impervious surfaces, development, dams, pumps, diversions, and wells have affected the sustainable functions of the entire watershed. **10**

The Russian River's fluvial geomorphology has been altered by changed flow regime, disconnection from the flood plain, encroachment that limits meander, and continued gravel harvest yet no gravel input from Coyote or Warm Springs Dams. The results of no deep pools and channel incision of the mainstem are just two of the impacts observed. **8**

High turbidity in the mainstem from the poorly designed Lake Mendocino outlet, and in the tributaries from increased vineyard management/construction and poor road designs have affected the watershed's ability to function naturally. **8**

Human uses of water, especially from spring through fall, were identified separately from diversions as a factor in reduced riverine functions. **7**

Lake Mendocino storage management needs to improve to benefit river sustainability, with a focus on biodiversity, agriculture, and human needs. **6**

Increasing human population in the watershed will affect the sustainability of the river and watershed: **6**

Due to the Mediterranean climate, the watershed is "storage scarce" not "water scarce," and the problems we face will best be solved by de-centralizing water management. We need to support efforts to create small scale storage throughout the watershed. Examples of Coho Partnership, Bodega Fire Hall Project, AWEP, and Mattole watershed using community collaboration to improve their storage portfolios: **6**

Water pollution (chemicals, turbidity, car bodies, temperature, faulty septic systems, homeless encampments along the river) has negatively affected the river's ability to function sustainably: **6**

Rural roads delivering sediment to streams and the lack of a grading ordinance in Mendocino County continue to be big detriments to aquatic habitats throughout the watershed: **5**

Increasing storage in Lake Mendocino is a big problem that needs to be solved: **4**

Decreased passage for salmonids (juveniles and adults) due to separation of tributaries from the mainstem is a significant problem throughout the watershed. **3**

The legacy of forest practices has overloaded the forests with fuels. The current situation in several landscapes is that the potential for catastrophic wildfires is very high, which will negatively affect all the functions in those subwatershed. **3**

There is no water budget and no monitoring requirement to provide management protections for the streams. **2**

Frost protection efforts by vineyards has been un-regulated and detrimental to the river. The upcoming changes to water for frost protection are long overdue: **2**

The Potter Valley Project needs to continue in order to sustain the current functioning of communities, agriculture and biological resources: **1**

AB 2121 and proposed bypass flows could negatively affect sustainability of agriculture in the watershed: **1**

AB 2121 will lead to improved water management: **1**

The NOAA Biological Opinion and Decision 1610 focus on the mainstem but neglect the smaller streams, especially the smaller coho bearing tributaries low in the system: 1

Groundwater monitoring is not accomplished on a large enough scale to determine impacts on smaller fish bearing streams. This effort needs to expand throughout the watershed: **1**

Attacking instead of supporting agricultural properties has negatively affected the river's ability to function naturally: **1**

The lack of widespread water conservation efforts has reduced the amount of water left in the river and streams, thus reducing the ability of those systems to function sustainably. **1**

A concerted and cohesive watershed-wide education program on the entire water management dynamic will improve management of the water resource. **2**

The Biodiversity Action Plan addresses sustainable functioning of the watershed in detail (www.lagunafoundation.org/knowledgebase/?=node/272) : **1**

The annual installation of illegal fish weirs in tributaries to harvest adult salmonids affects the recovery of those species: **1**

4. What economic challenges, locally or regionally, most impact the sustainable functioning of the Russian River?

Decreases in Federal, State, and County budgets have delayed processing time for permits, reduced conservation and restoration programs, and minimized maintenance efforts on infrastructure. The existing backlog of projects is a good measure of how detrimental our inaction will be on the watershed's functions. One example is funding for county maintenance programs such as road repair and culvert maintenance needs to increase. **11**

Funding and community support for agricultural operations (i.e. AWEP and pond construction) and open space preservation needs to increase. If agricultural lands fail, they will be sold and converted to urban/commercial uses, thus degrading the natural functions in the basin: **4**

Funding for conservation programs available to farmers/ranchers has dwindled due to the economy, thus reducing opportunities for watershed improving actions on agricultural lands: **3**

Water supply availability is a big challenge, especially during drought. Increasing small scale storage for agriculture and rural residential will improve the economic viability in those communities and improve natural watershed functions in those areas: **3**

Storm water runoff is the biggest source of water pollution in the basin. Storm water management to reduce flood damage, pollution, and improve groundwater recharge has met with resistance from the business and agriculture interests. The short term costs are perceived to be too high to result in a positive return from their view: **3**

We need to improve the sustainability of the watershed's largest land users: **3**

We need to continue educating landowners that water is not a private property right, but a public trust resource. The effects of landowner management on water quality/quantity to downstream users need to be reinforced as their responsibility. Education for streamside management needs to improve basin wide. The long time practice of "bank protection" via LWD removal and concrete rip rap placement is inappropriate and BMPs need to be implemented. **3**

Funds for watershed restoration project need to continue to address the damage caused by decades of damaging management activities. Riparian restoration projects need additional funding for implementation on private lands. **3**

Encroachment on the river by agriculture and urban use has removed the flood plain from the river. There is an inherent conflict between sustainable functioning of the river and human uses. Applying the "Streamway Concept" on a broad scale could give the river and streams access to a scaled down version of a flood plain. **3**

Water supply improvement by improving distribution and expanding the use of recycled water is a costly venture, but well worth the effort. The economic hurdle of implementing recycled water use is difficult to implement on a basin wide scale: **2**

Jeopardizing the use of frost water to protect wine grapes will have a negative effect on the agriculture community, and the economic viability within the watershed. This could be a catalyst for farmers to sell their lands which would be converted to urban or commercial properties: **2**

There is no water budget in the watershed, yet we are managing as if we have one. The economic sustainability of this path will not lead to long term success. We need to develop water budgets for the subwatersheds and the mainstem: **2**

Balancing economic growth (agriculture, urban, commercial) with the natural resource requirements in the watershed is a complex challenge. **2**

Resource conservation programs (Fish Friendly Farming, FRGP, EQIP, WHIP, and the Code of Sustainable Farming) need continued funding support, but should be updated to include rigorous follow-up for farm and ranch practices and evaluation of successes and failures. Without improvements, these programs may just be "Green Washing" to claim environmental progress without making any substantial contributions to ecosystem improvement. **2**

Funding to approach or achieve sustainability will be the first challenge. Once achieved, maintenance of sustainable actions will be the next issue. Long term funding for monitoring and updating policies are keys to improving and supporting the river's sustainable functions: **1**

The "true cost" of water has been ignored or neglected in Mendocino County. SCWA has built into their rate structure the ability for mitigating, monitoring, and habitat management. The water districts in the Russian River portion of Mendocino County are disjointed and not fiscally able to address the "true cost" of diverting, treating, and delivering water, as well as taking care of any environmental issues that may arise during those processes: **1**

Improving/maintaining water security during the dry season without ruining the basin's hydrologic functions is extremely important. Understanding flow regimes in subwatersheds needs to improve so water users can operate without harming channel function: **1**

Water diversions from the channels for human uses (urban, agriculture, etc.) are detrimental to the natural functioning of the river and its tributaries: **1**

Widespread support for installing and monitoring stream gages in tributaries is an economic challenge, but is necessary to identify and follow individual water budgets that need to be established: **1**

Funds need to be invested in research on natural flow regimes in all subwatersheds to improve our understanding and management of water: **1**

Water quality effects and reductions in flow in small streams due to illegal marijuana growing has negatively affected the basin. The marijuana grow sites are disaster zones, with pesticides and fertilizer making an impact on all life around the site. The economic support to clean up the vast number of abandoned grow sites is just not there. **1**

The economic instability of the county government has led to decreased attention to homeless encampments along the river. The sites have become extremely hazardous, and are polluting the water downstream. **1**

We need to increase incentives to improve water conservation on agriculture, urban, and commercial lands: **1**

Invasive exotic plants in the riparian corridor have huge negative impacts in the watershed and need increased funding to control their expansion. **1**

Redwood Valley is specifically challenged, financially, in treating water for their customers. **1**

Maintaining the current amount of open space and agricultural land in the face of an expanding population is important to maintain the existing functions within the basin. **1**

The proposed asphalt batch plant at the headwaters of Forsythe Creek will have a negative impact on water and air quality in Redwood Valley and on downstream beneficial uses. **1**

Aggressive agricultural expansion will continue to degrade the natural functioning of the streams and mainstem. This will have a cascading effect on human and natural communities downstream. **1**

The presence of Coyote Dam has negatively affected the sustainability of the salmonid fisheries in the watershed. **1**

The US Army Corps of Engineers' ability to engage in projects will be critical to the future progress in the watershed. **1**

Redwood Valley has no water rights, and is subject to management decisions beyond their control. This negatively affects that community's economic viability. **1**

The funds to finish the feasibility study for raising Coyote Dam have been limiting, thus delaying the long overdue project of raising the dam. **1**

AB 2121 is not applicable to all tributaries, and will likely be a financial hardship on ranchers and farmers, thus preventing them from implementing conservation projects on their lands. **1**

Regulatory requirements of the State and Federal Endangered Species Acts are economic challenges to farmers and ranchers economic sustainability.

Government agencies need to accept responsibility in their role of declining fish populations too. **1**

Until the vacant Masonite site is cleaned up, water quality in the mainstem will continue to be negatively affected due to seepage. **1**

5. What priority programs and projects do you recommend for the Russian River watershed to address the issues listed above, both site specific and basin-wide?

Expanding riparian corridors through conservation easements, Riparian Area Program, and programs with NRCS needs to increase. Even outright purchase of lands would have long lasting effects on watershed function. **9**

Small scale agricultural and residential water storage projects and irrigation improvements on vineyards needs added financial support. Rooftop rainwater catchment needs to be supported throughout the basin to improve small scale storage at residential and agricultural properties. **7**

Expanding water conservation strategies in urban and agricultural sectors will require additional funding. Water conservation efforts need to be standardized between counties. Water conservation measures from all human uses need to increase basin wide. **4**

Eradication or control of exotic invasive plant species needs increased funding and effort. **4**

Improving fish passage to and through the tributaries is the highest priority. **3**

Implementing the Biological Opinion with regard to the two dams/reservoirs needs to occur. **3**

Focusing on smaller watersheds holds a better promise of recovery and a better return on our investments. The Russian River Coho Water Resources Partnership and the Mattole watershed water cooperative serve as good examples. **3**

Flow monitoring needs to occur in all tributaries to assist in the assessment of the hydrologic regimes in the subwatersheds. **3**

A basin wide education program to inform everyone about the water management dynamic is needed. This would improve water management throughout the watershed. **3**

Improving the operations of Lake Mendocino as a storage facility is the core issue for the mainstem Russian River. **3**

Implementing sediment reduction from hillsides and unpaved roads is the second highest priority. **2**

Clean up efforts of illegal marijuana grow sites and homeless encampments needs to continue and expand throughout both counties: **2**

Educating streamside landowners about their management practices of removing LWD and diverting water needs to take place on a basin wide scale. **2**

Protecting riparian corridors through local regulations needs to increase. **2**

Increasing storage at Lake Mendocino is a high priority project. **2**

Expanding general watershed education programs, such as those presented by RVOEP and SCWA, will involve a broader base of students, who will become the future managers of the watershed. **1**

Continued protection of the Potter Valley Project needs to occur. **1**

We need comprehensive basin plans to support resource management on a large scale. For instance, points of diversion need to be coordinated when water is planned for withdrawal. **1**

Subwatersheds need individual basin plans for water management. Reference to 2008 California Agriculture issue. **1**

AB 2121 is too broad in scope. Water budgets and flow plans need to be established for subwatersheds. **1**

Priorities identified by the Laguna Foundation in their Biodiversity Action Plan are a good place to start in mapping the road to basin wide recovery. **1**

Support and increased awareness about the Integrated Water Resources Sciences and Services Program (NOAA) will enhance dam operations to meet multiple goals within the watershed. **1**

Water recycling in the upper Russian River needs to get more widespread support. **1**

The SWQCB needs to upgrade its pond permitting process to support installation of more small scale ponds for agricultural needs. **1**

Increased support for storm water management to recharge groundwater, reduce pollution, and reduce erosion needs to occur basin wide. **1**

Providing for salmonid passage above Coyote Dam would be helpful in improving salmonid populations. **1**

Continuing the Russian River Coho Broodstock Program with a long term funding commitment from the Army Corps of Engineers is important. **1**

The Army Corps of Engineers needs to allocate funds to manage projects and comply with the Biological Opinion. **1**

Continued financial support for agricultural groups such as URRSA is important to maintain collaborative relationships and identifying acceptable solutions to the issues that arise. **1**

SCWA needs to prioritize their funding of habitat restoration projects to remove redundancies. **1**

The Upper Green Valley Creek Watershed Management Plan (2010) has a list of implementation actions to guide restoration in that subwatershed, as well as serve as a model for use in other similar subwatersheds. **1**

Dutch Bill Creek needs increased habitat restoration efforts and failing septic systems need to be upgraded. **1**

The Laguna de Santa Rosa needs to minimize its dairy runoff via improved pasture management. In addition, the Laguna needs to address its water supply issues. **1**

Preventing further channel incision of the upper Russian with checkdams will help stream reconnect to the river. Norgard rubble dam is a good example of preventing channel incision: **1**

Redundancies and lack of communication between jurisdictions has made effective watershed management and recovery unsuccessful. All entities need to commit to coordination and improved communication for any long term recovery to be accomplished: **1**

Maximizing financial resources within the watershed to focus on what the majority believes are the high priority issues is a good first step. A regional approach to financial resource management will make a difference in improving the watershed's functions: **1**

Increased monitoring of salmonid populations throughout the watershed needs to occur: **1**

Mendocino County needs to establish greater stewardship and protections for its natural resources by supporting the MCRCD. **1**

6. Please list three to five relevant Russian River programs and projects that you or your organization are engaged in, have completed within the past five years (2006 — 2010), or expect to complete in the next two years (2011-2013). Identify which of these are priority/successful projects.

Hopland Research and Extension Center:

- Water modeling in subwatersheds to evaluate adjustments and stream flow affects.
- Identifying sites where more storage is needed to meet the demand and minimize impacts on flow in tributaries.
- The watershed management tool that focuses on flows will need to be used throughout the basin. This tool has the ability to significantly improve water management in subwatersheds.

Redwood Valley Water District

- Contributed to the river flow gage at Talmage Road.
- Conservation education efforts to the public and customers is ongoing.
- Watershed Sanitary Survey to be done by Brown and Caldwell in 2011 for Redwood Valley, Ukiah, and Millview Water District

Occidental Arts and Ecology Center

- Russian River Coho Partnership
- Austin Creek instream flow and off channel storage.

NOAA Fisheries

- Russian River Biological Opinion
- Russian River Coho Captive Broodstock Program
- Draft Coho Recovery Plan
- Habitat restoration on 6 miles of Dry Creek
- Changes to management of estuary
- NFWF Water Conservation Measures
- Multi-species Recovery Plan
- Russian River Coho Partnership with CEMAR

NRCS — Sonoma and Mendocino Counties

- AWEP — Agriculture Water Enhancement Program
- EQIP — Environmental Quality Improvement Program
- WHIP — Wildlife Habitat Improvement Program

- Ukiah Valley Water Recycling Project — In process
- CCPI: Similar to AWEP but includes all resources
- CSP — Conservation Stewardship Program

Coyote Valley Indian Tribe

- Forsythe Creek Restoration Project: 2002 — 2009
- Salmonid monitoring surveys: 2005 — present
- West Fork Russian River bluff erosion control project — 2012 to 2015
- Exotic invasive plant eradication on Forsythe Creek and West Fork Russian River
- Native Plant Propagation Project: 2012

Sonoma County Water Agency

- Executive summary of the Biological Opinion provides concise statement of activities.
- Fish barrier modifications on West Fork Russian River and Crocker Creek
- Dry Creek Habitat Enhancement of 6 miles
- Modifying estuary management
- Modifying instream flows in Russian River and Dry Creek based on D1610.
- Design modifications to the Mirabel facility to improve fish passage.
- Grape Creek habitat enhancement and fish passage improvement.
- Willow Creek fish passage improvement.
- Wallace and Crane Creeks (Dry Creek tributaries) fish passage improvement projects.
- Hydrometeorological Testbed with NOAA to improve weather forecasting in Russian River watershed.

Mendocino County Farm Bureau

- Russian River Frost Protection Program: 2009 to present
- AWEP: 2009 to present
- Ukiah Valley Recycled Water Project: Ongoing

Mendocino County Water Agency

- The 5-Counties Program assessed all county roads in the watershed for sediment sources and prescribed remedies.
- Bridge cross sections were surveyed in 2009 (listed on question 14).
- Annual stream temperature monitoring in the mainstem and tributaries from 2000 to 2010.
- Monthly well monitoring in Redwood Valley and Hopland: 2000 to present.
- Participation in NCIRWMP
- 2009 Agriculture Inventory Report for Russian River in Mendocino County
- Water supply studies for Mendocino College and Calpella.
- Aggregate resource management baseline data compilation for RRIS.

Russian River Keeper

- Climate change and adaptation associated with water management planning needs.
- Russian River First Flush Project: Ongoing
- Liquor Store Beach (Guerneville) Restoration: 2005 and ongoing
- Urban Pesticide Study: 2005/2006

UC Cooperative Extension — Ukiah

- Organic Wine Growing Manual: expected publication in 2011
- Irrigated Agriculture and Water Needs in the Mendocino County Portion of the Russian River: 2008
- Vineyard Water Quality Short Course for Mendocino County: 2003
- McGourty Ranch — Private property

Riparian restoration, streambank layback, and watercourse improvements via EQIP. Excellent results.

Laguna de Santa Rosa Foundation

- Invasive Ludwigia Control Project: 2005-2007
- Ludwigia Taskforce Meetings: Ongoing
- Middle Reach Restoration Project: Ongoing

- Historical Hydrology Study of the Laguna Headwaters: Completed
- Historical Ecology Study of the Laguna Watershed: In process

Inland Water and Power Commission/ Potter Valley Irrigation District/ Upper Russian River Stewardship Alliance

- The Potter Valley Irrigation District has been converting from open ditches to pipes to improve efficiency of water delivery. 2000 to present and ongoing
- The IWPC continues its work with PG&E and FERC for continued operations of the Potter Valley Project and the upcoming re-licensing efforts.
- Lake Mendocino Feasibility Study is ongoing.
- URSA continues to work with farmers on the "water for frost protection" issue.

Redwood Valley Outdoor Education Project (RVOEP)

- West Fork Russian River habitat restoration in 2003. High flows washed away 90% of the plantings.
- Ongoing watershed education program with students of ages 6-12.

Sotoyome RCD

- Arundo donax control: ongoing
- Rural Roads Improvement Program: ongoing
- Ranch and Farm Conservation Planning: ongoing
- Austin Creek Assessment — 2008
- Maacama Creek Assessment — 2000
- Mill Creek Management Plan — in process
- Upper Mark West/Maacama Integrated Watershed Management Plan
- Copeland Creek Assessment — 2006

Gold Ridge RCD

- Russian River Coho Water Resources Partnership: 2009 to present
- Dutch Bill Creek Dam Removal and Creek Restoration Project: 2009-2010
- Rooftop catchment: 2009 to present
- Green Valley Creek water quality monitoring: ongoing
- Green Valley Watershed Management Plan: ongoing
- Willow Creek Large Wood Input Project: 2012
- Dutch Bill Creek Large Wood Input Project: 2012
- Green Valley irrigation efficiency and water conservation on agricultural and residential properties: ongoing
- Road assessment and upgrades throughout service area: ongoing

Hildreth Farms

- Ukiah Valley Recycled Water Project: in process
- Research with Pear Growers Association: ongoing
- Fish Friendly Farming courses on stream monitoring in McNab, Feliz, Dooley, and York Creeks, and the mainstem Russian River: ongoing
- Sustainable Pear Growing Manual: publication expected in 2013.

North Coast Resource Conservation and Development Council

- Rainwater catchment at River Community High School in Talmage
- Developing community farming initiative in Santa Rosa.

Russian River Flood Control District

- Very active in the Russian River Frost Water Program.

Sonoma County Farm Bureau

- Russian River Frost Protection Program
- Dry Creek fish habitat improvement projects
- Sonoma County Vineyard and Sediment Control Ordinance and BMP Handbook.

Hopland Band of Pomo Indians

- Annual creek clean up on three streams on the Reservation.
- Culvert replacement projects on NissaKah Creek and two on Highway 175 due in 2012.

- Temperature and water quality monitoring of streams on Reservation.
- Pursuing water connection with Hopland Public Utilities District.

Mendocino County Agriculture Department

- Agriculture Water Enhancement Program (AWEP) for off channel water storage.
- Fish Friendly Farming certification.

Mendocino County Resource Conservation District

- The Forsythe Creek Watershed Assessment (Bioengineering Associates, 2006) represents a significant effort in prioritizing restoration tasks for one of the upper Russian River's largest subwatersheds.
- Arundo donax eradication got back on track in 2011.
- Snorkel surveys and spawner surveys in tributaries on Tribal lands to varying degrees.
- Russian River Invasive Species Management Program: Phase I mapping complete.
- Restoration and Revegetation of Destabilized and/or Denuded Stream banks: working with willing landowners to identify sites for funding.
- Removal of loose Army Corps of Engineers erosion control jacks which pose significant health threats on the Russian River.
- Assessment of tributaries as invited by landowners for invasive species, erosion control and fish passage issues.

7. What are your highest priorities for data gathering and assessment in the Russian River watershed?

Population and trend monitoring of salmonid populations needs to expand. We need a population model for Russian River salmonids to be based upon varying mortality rates: **7**

Continued flow monitoring associated with the Russian River Frost Water Program. The quantity of water used for frost protection needs to be measured and reported. All diversion pumps need to have meters installed, and that information needs to be reported. Addressing frost related issues on the wine grape industry in subwatersheds is part of this need. **4**

Flow data in subwatersheds needs an expanded range and improved accuracy of monitoring. **3**

Juvenile salmonid survivorship in tributaries: **2**

Water quality monitoring throughout the basin: **2**

Macro-invertebrate baseline data for density and composition needs to occur: **2**

Groundwater monitoring needs to expand: **2**

Predictive models linking climate change to basin conditions needs more press coverage: **2**

Estuary physical and chemical monitoring: **2**

Data to support the development of water budgets in the mainstem and tributaries is needed: **2**

Monitoring to assess geomorphic and fluvial effects on river by Coyote Dam (channel incision, gravel supply, separation from flood plain, no access at tributaries: **2**

Assessing sediment loads in streams, identifying sources, and prescribing treatment. This includes assessing sediment sources in upper Russian tributaries as well as crossings and sources in Potter Valley: **2**

Current status and annual monitoring of exotic invasive plants in the watershed: **1**

Invasive animal species monitoring (bullfrogs, crawfish, centrarchids): **1**

Exotic invasive plant species control/eradication: **1**

Updating the Sanitary Survey for Redwood Valley Water District: **1**

Groundwater models and surface water models need to be used to improve land use management: **1**

Input data and run the RRWAMP Logic Train from Army Corps of Engineers: **1**

RRIS needs to be used to make policy and land management decisions: **1**

The Biological Opinion does not pick up needs of coho salmon in tributaries. We need more tributary information on all stream attributes: 1

Information linking terrestrial actions to aquatic systems needs more attention: **1**

Defining current fluvial geomorphic processes and identifying where or if regaining a form of natural processes is possible: **1**

We need more data on the watershed to help us define our goals more clearly. Shifting baselines affect our perception of "success," as with 2,000 returning Chinook salmon is a "good year." **1**

More data and assessment on fuel loading in forest lands: **1**

Coyote Valley Tribe's main focus has been on monitoring salmonid populations and restoring native plant communities on Forsythe Creek and the West Fork Russian River: **1**

Sonoma County Water Agency identified their data and assessment priorities on their SCWA website: **1**

Data collection at the Mirabel site needs to continue: **1**

The effects of water management on aquatic habitats and how salmonids respond to existing flow management: **1**

Stream temperature monitoring: **1**

Storm water quality monitoring from urban areas: **1**

Assessing water quality and how it is affected by flow levels: **1**

Continued data collection on vernal pools in the Santa Rosa Plain: **1**

Youth involved monitoring of water quality and riparian communities throughout the watershed. **1**

Determine baseline flow in tributaries to manage for frost protection associated with AB 2121: **1**

Rural road sediment assessments throughout the basin need to continue: **1**

Mapping points of diversion from the mainstem and tributaries: **1**

Project effectiveness and evaluation is a missing link for all the restoration work that has occurred in the watershed: **1**

Ongoing research with the Pear Growers Association: **1**

Continued efforts with Fish Friendly Farming: **1**

Who, what, where, why, and when water is used is information that is lacking and not centralized: **1**

Data needed to improve the management of dam releases based on real time demands needs to be gathered: **1**

Assessing ways to improve communications between water users and dam managers to increase the amount available to humans and salmonids year around: **1**

Assessing supply and needs for instream flow: **1**

Assessing how the "Dispatch Model" used by the Solano County Irrigation District could be applied to the Russian River basin: **1**

Information about the amounts of pesticides found by County Sheriffs' during drug enforcement actions needs to be reported to the County Agriculture Commissioners: **1**

Assessing new and previously assessed barriers to salmonid migrations (adults & juveniles) in tributaries and the mainstem river. This includes crossings identified by Ross Taylor and Associates and all stream crossings by the North Coast Railroad Authority. **1**

Assess habitat conditions and temperature regime in West Fork Russian River at the Mumford Dam restoration site for potential expansion of coho salmon planting: **1**

8. What goals and objectives do these projects address?

The goal of the Russian River Frost Water Program is to sustain agriculture and salmonid populations simultaneously. Minimizing mainstem flow fluctuations caused by direct diversion is another objective of the Frost Water Program: **3**

Tracking the long term abundance and trends of salmonids (juveniles and adults) over time is important. We need to get information to determine if our restoration efforts are paying off or not, and this information will serve to guide management, restoration and protection efforts: **3**

Evaluating the effects of Coyote Dam will help quantify how much fisheries habitat has been lost: **2**

Assessing sediment loads and sources to keep soil on roads and farms and will help move the basin towards sediment related water quality standards: **2**

Juvenile salmonid survivorship in tributaries: Determining survival/mortality with early and late season counts of juvenile salmonids will highlight where efforts can be effective in population recovery: **2**

Flow data in subwatersheds: We need to monitor the flow regimes to describe the natural condition, and then show how human management affects those systems. Gathering baseline flow data in tributaries will assist agricultural operations in responding to AB 2121 guidelines and frost water regulations. **2**

Invasive animal species monitoring: Documenting the effects of these species interactions with

salmonids is necessary to answer the ecological unknowns related to salmonid recovery: **1**

The Redwood Valley Sanitary Survey specifies parameters for drinking water requirements: **1**

Estuary monitoring: Objective is to provide information to guide management decisions and dam releases, as well as addressing water quality, water supply, and salmonid management: **1**

Water recycling for agriculture use with the objective of decreasing instantaneous drawdown of flow during drought years, and reducing water withdrawal from the river for agricultural purposes is the goal. Decreased diversion from the river benefits all species downstream: **1**

Streamlined permitting by the SWQCB for pond construction so landowners can change their water rights to help them improve aquatic habitats: **1**

Determining fuel loading and fire prevention option in forests will protect people, property, wildlife, and aquatic habitat. Areas of focus should be on the western portion of the Russian River basin plus Mark West and Knights Valleys: **1**

Restoration projects, salmonid monitoring, and riparian community monitoring have the objective of enhancing habitat and recording responses of native fish species: **1**

Mitigating impacts of water management on salmonid populations and habitats should be the goal of all projects: **1**

Biodiversity: macro-invertebrate populations, riparian communities and water temperature: **1**

Groundwater monitoring throughout the basin will help determine the impacts of water management as well as identifying possibilities for recharge. **1**

Water quality monitoring: temperature, sediment, urban pollutants: **1**

Storm water monitoring in urban areas will identify the pollutants of concern and help us devise a plan to reduce those loads. **1**

Determining salmonid forage opportunities/availability will help identify limiting factors in the ESA species recovery plans. **1**

Watershed education activities with youth in the basin will lead to increased environmental stewardship of our future land managers. **1**

The Lake Mendocino Feasibility Study will identify ways to increase storage to the point of creating a two year water supply instead of just one year: **1**

Ground truthing points of diversion will be critical to the management of water throughout the basin. 1

Implementing the Dispatch Model will provide a basis to increase the water availability and reliability for everyone along the mainstem: **1**

Reporting pesticide amounts at drug production sites will help the counties prioritize and plan for removal and control of certain pesticides. Protecting water quality is the objective: **1**

Assessing the feasibility of coho expansion to the West Fork could help in the recovery efforts of this species. Desperate times call for desperate measures. This concept should not be dismissed until after the data has been assessed: **1**

9. What are your expected outcomes?

Subwatershed Flow Monitoring

Goals & Objectives — Determine natural flow regimes. To create a basis to adequately

implement AB 2121, and to establish frost protection rules.

Expected Outcomes — Identify changes to improve water management

Location - All subwatersheds in the Russian River watershed

Engaged in/Completed? — Not engaged in

Talmage River Gage

Goals & Objectives — Improve flow management

Expected Outcomes — Increased water supply in Lake Mendocino

Location — Russian River downstream of Talmage Road Bridge

Engaged in/Completed? — Installed in 2010

Salmonid population trend monitoring: Not answered

Goals & Objectives —

Expected Outcomes —

Location —

Engaged in/Completed? —

Estuary monitoring of chemical and physical attributes: Not answered

Goals & Objectives —

Expected Outcomes —

Location —

Engaged in/Completed? —

Ukiah Valley Water Recycling Project

Goals & Objectives — Decrease agricultural diversion from river and decrease

instantaneous drawdowns

Expected Outcomes — 1,300 acres of agricultural cropland irrigated in phase I to not

require river diversions

Location — Agricultural land in Ukiah Valley and along Robinson Creek

Engaged in/Completed? — Start of Phase I in 2012

Streamline permitting by SWQCB

Goals & Objectives — Change water rights to help landowners do what is asked of them

to improve aquatic habitats

Expected Outcomes —

Location — Basin wide

Engaged in/Completed? — Not being initiated by NRCS

EQIP: Environmental Quality Improvement Program

Goals & Objectives — Conserve soil and water

Expected Outcomes — Improved natural resource conservation

Location — Site and ranch specific in both counties

Engaged in/Completed? — Varies according to ranch plans.

AWEP: Agriculture Water Enhancement Plan

Goals & Objectives — Reduce water withdrawal from creeks/river yet protect wine grape

crops from frost damage

Expected Outcomes —

Location — Site and ranch specific in both counties

Engaged in/Completed? — Some complete and some in progress, depending on property.

Russian River Tribal Working Group

Goals & Objectives — Vehicle chassis removal in upper mainstem and tributaries

Expected Outcomes — Improved safety and habitat quality for wildlife and people

Location — Upper Russian River mainstem and tributaries

Engaged in/Completed? — In the planning stage

Russian River Tribal Working Group

Goals & Objectives — Trash removal and exotic plant eradication

Expected Outcomes — Improved safety and habitat quality for wildlife and people

Location — Upper Russian River mainstem and tributaries

Engaged in/Completed? — In the planning stage

Cross-section measurements at bridge locations

Goals & Objectives — Trend monitoring of channel quality and morphology

Expected Outcomes —

Location — Talmage Road, Highway 175, Mt. House Road

Engaged in/Completed? — Ongoing (note that Mendocino County Water Agency projects

have been severely limited due to cuts in personnel)

Evaluate channel incision of river due to Coyote Dam

Goals & Objectives — Identify where active incision and erosion is taking place. Expected Outcomes — Identify how to mitigate that damage

Location — Not site specific

Engaged in/Completed? — Not engaged in

Rural Roads Inventory Project (RRIP): Assessment of culvert placement and road improvement

Goals & Objectives — Map and assess all rural roads in every subwatershed. Decrease sedimentation to river and tributaries

Expected Outcomes — Implement prescriptions to reduce sediment input and improve health of aquatic systems

Location — Basin-wide

Engaged in/Completed? — Sotoyome, Mendocino, and Gold Ridge RCDs need funding to complete mapping efforts. This is a long-term and ongoing project.

Laguna Historical Ecology

Goals & Objectives — Many

Expected Outcomes — Many

Location — Laguna watershed

Engaged in/Completed? — In development

Pennyroyal mint control

Goals & Objectives — Identify the most effective technique for controlling this species

Expected Outcomes — Identify the best technique, mapping data on site occurrence, and response to control efforts

Location — Site specific

Engaged in/Completed? — Expected completion in summer 2012

Ludwigia Task Force

Goals & Objectives — Create a long-term management strategy for Ludwigia

Expected Outcomes —

Location — Laguna watershed but possibly throughout the entire basin

Engaged in/Completed? — Currently engaged in

Summer Water Quality Monitoring in the Laguna

Goals & Objectives — Evaluate Nitrogen and Phosphorous in surface waters of several Laguna and tributary locations

Expected Outcomes — Same as Goals/Objectives, as well as establish course at Sonoma State University

Location — Southern Laguna watershed

Engaged in/Completed? — Expected completion in summer 2012

Adopt a Vernal Pool

Goals & Objectives — Annual assessment of endangered plant populations

Expected Outcomes —

Location — Laguna watershed

Engaged in/Completed? — Engaged in and ongoing

Redwood Valley Outdoor Education Project (RVOEP) Habitat Improvement Project — Phase II

Goals & Objectives — Improve bank stability, wildlife habitat, community education about native plant species.

Expected Outcomes — Establish a sedge bed for Native basket weavers. Decrease or eradicate exotic invasive plant species.

Location — RVOEP property on West Fork Russian River.

Engaged in/Completed? — In planning stage

Lake Mendocino Feasibility Study

Goals & Objectives — Identify options to increase storage

Expected Outcomes —

Location — Lake Mendocino

Engaged in/Completed? — Ongoing. Funding challenges currently

Russian River Coho Partnership

Goals & Objectives — Improve water supply and instream flow

Expected Outcomes —

Location —

Engaged in/Completed? —

Dam Removal in Tributaries (Gold Ridge RCD)

Goals & Objectives — Improve anadromy

Expected Outcomes —

Location —

Engaged in/Completed? —

Rooftop Catchment

Goals & Objectives — Improve water security and instream flows

Expected Outcomes —

Location —

Engaged in/Completed? —

Green Valley Water Quality

Goals & Objectives — Baseline trend tracking for management recommendations

Expected Outcomes —

Location —

Engaged in/Completed? —

Improved reservoir management with the "Dispatch Model"

Goals & Objectives — Increase water use efficiency

Expected Outcomes — Reduce waste and improve environmental conditions

Location — Mainstem Russian River with Lake Mendocino and Lake Sonoma

Engaged in/Completed? — Unknown

Illegal Pesticide Use Tracking

Goals & Objectives — Highlight issue to get state/federal assistance to address the problem

Expected Outcomes — Improve pesticide control and improve water quality in both counties

Location — Basin-wide

Engaged in/Completed? — Concept stage and not into planning. Reluctance by law enforcement to assist with data collection has stalled the planning component.

Metered Pumps for Frost Protection

Goals & Objectives — Quantify volumes needed for frost protection of wine grapes

Expected Outcomes — Coordinated pumping to reduce impact on the river

Location — Upper Russian River mainstem

Engaged in/Completed? — Mendocino County Agriculture Department is on the fringe of this effort, which is being led by the Upper Russian Stewardship Alliance (URSA).

Agriculture Water Enhancement Program (AWEP)

Goals & Objectives — Increase off-channel storage for use during frost protection season

Expected Outcomes — Higher volume of water available for frost protection, and reduced impact on Russian River flows.

Location — Upper Russian River mainstem

Engaged in/Completed? — Engaged in and ongoing

10. Do/did you have adequate conceptual plans, designs, and/or budgets for these projects?

Cumulative Impacts Flow Model (Hopland Research Station)

- The conceptual plan and general designs are done. They could use funds to put the model on the ground for assessments. The next step is applying the model to specific subwatersheds.
- The North Coast Watershed Assessment Program (NCWAP) was a good program. A similar program could put assessments together for SWRCB for water management and flow regime recovery. This should begin on the Russian on a subwatershed basis.

Creating basin plans for flow management would be worthwhile. The RCDs could organize input and secure contracts for getting funds to do the assessments, but the landowners will need incentives (regulatory relief etc.) to participate.

Water Recycling in Ukiah Valley

The City of Ukiah recently contracted out to perform a feasibility study to analyze the bigger scope of water recycling in Ukiah Valley.

The NRCS can contribute some funds to landowners for infrastructure projects such as

lateral lines and irrigation connections for the recycling project.

AWEP: Conceptual and site specific plans are adequate. Budgets vary according to property.

Forest fuel load assessment and management: This project is in the discussion phase. No plans, designs, or budget on paper yet.

NRCS projects on farms and ranches have plans, designs, and budgets. EQIP and WHIP funds vary yearly. Plans and designs are specific to each property.

Storm water capture projects could be applied on a case-by-case basis related to Farm Bill projects.

The Coyote Valley Indian Tribe's bluff erosion control project on the West Fork Russian River will be designed by late 2011.

Dry Creek Habitat Enhancement Project is based on comprehensive planning including a current conditions assessment, conceptual designs, and an adaptive management plan. The SCWA's component of this budget has been secured.

Estuary research and improved management is based upon an adaptive management strategy. The SCWA has incorporated a charge into its water rates to pay for a portion of the cost of projects in the estuary and mainstem identified in the Biological Opinion.

Mirabel Site: Conceptual design is complete. A DFG FRGP grant was awarded to assist with design. Complete engineering design is underway.

Russian River Coho Partnership: Five coho salmon tributaries have adequate plans, but the budgets may need additional support.

MCWA projects: Plans and designs of bridge cross sections, temperature monitoring, and groundwater monitoring are adequate. Funding is unknown due to county budget crisis.

The Russian River Frost Program has been evolving over the past three years and will continue to do so depending on actions taken by the State Water Board to adopt regulations.

Laguna Historical Ecology: Project in development. No conceptual plans, designs, or budgets to date.

Pennyroyal mint control: Plan and design in place. Project is funded but delayed.

Ludwigia Task Force: Project is new and in development. Funding is not available for partners to attend meetings, which makes progress difficult.

Summer Water Quality in the Laguna: Yes. Conceptual plan, design, and budget are adequate.

Adopt a Vernal Pool: Project is minimally funded.

RVOEP: In the process of planning and designing Phase II. Current budget of $15,000 is likely to be inadequate for complete implementation. No monitoring plan has been created yet.

Lake Mendocino Feasibility Study is ongoing, but is incomplete due to an inadequate budget.

Baseline flow data collection in tributaries for AB 2121 has no budget for implementation.

Rural Roads Inventory Project: Plans, designs, and budgets are adequate in the Sotoyome RCD. Unsure of the status in Mendocino and Gold Ridge RCDs.

Arundo control: Plan and design are adequate. Estimated funding of $16+ million needed to control Arundo in the entire watershed.

Hopland Band of Pomo Indians Projects: Two fish passage projects at culverts on the Reservation have been grant funded and the designs have been approved.

Quantifying pesticide use associated with marijuana farming is just in brainstorming stage, so no plan, design, or budget.

Gold Ridge RCD Projects

- Green Valley Assessment: page 109. Project list for funding and needs.
- Dutch Bill Creek: not well defined
- Laguna: Need a dairy program to implement. Comprehensive Nutrient Management Plan. 319(h) or NPS. June 2010

Dispatch Models exist with large irrigation districts up and down California. Big and small irrigation districts use this model for water management. River flow monitoring model would be a simple concept to apply to the Russian River. The hardware exists and the concept is in use in several watersheds throughout the state. The advances in technology make it an accurate and efficient method to manage water. Instead of spending $200 million on raising Coyote Dam, we should spend $1 million on hardware and infrastructure to enact the Dispatch Model.

11. Do you have monitoring plans for these projects? Please indicate the terms and types of monitoring and number/duration of site visits.

The subwatershed flow monitoring concept is linked to AB 2121, and using the "watershed approach" to collectively agree upon a unified flow management plan needs to gather more support in the basin. The Russian River Coho Partnership is leading the way in on-the-ground solutions to flow recovery. They need additional funds to put their plans on the ground.

There is a lot of money for restoration projects, but not enough for the comprehensive watershed flow analysis and water use/rights planning and water monitoring needs to determine appropriate flow management strategies in the tributaries.

Securing funds for a long range solution based upon monitoring and planning is more difficult to do than getting funds for immediate gratification of restoration projects.

The Russian River Flood Control District has a monitoring plan for the River Gage at Talmage.

Ukiah Valley Water Recycling: No formal monitoring plan identified to date.

Upper Russian River Stewardship Alliance (URRSA) developed a monitoring protocol for landowners to follow.

NRCS projects get reviewed after completion to ensure installation according to design. Landowners typically define their monitoring frequencies and are responsible for those efforts. Follow up of projects does not occur by NRCS once the project is complete. Since relationships with landowners is long-term, subsequent site visits by staff often involve evaluation of past projects.

Water quality monitoring at Coyote Valley Reservation follows the Tribal EPA's QAPP in accordance with the US EPA guidelines.

Dry Creek: Adaptive Management Plan and Monitoring Plan

SCWA monitoring plans are extensive and include the mainstem, tributaries, and the estuary.

MCWA

- Bridge cross sections monitored annually when fiscally supported.
- Water temperature probes installed at seven sites in the mainstem and tributaries from June through October each year.
- Groundwater monitoring: Redwood Valley sites twice per year Hopland sites get hourly data downloaded monthly.

Monitoring will be a component of the Russian River Frost Program.

Some monitoring is planned for the Rural Roads Inventory Project for "effectiveness monitoring," but securing funds to do that is difficult for long term efforts.

Arundo monitoring is in place.

The recent Water Board Study has published the new frost protection regulations.

RRFC customers have meters on their diversion pumps to quantify volumes for reporting purposes.

The adaptive management approach to the "Dispatch Model" would work well. This project is not defined, but could be continually refined to improve operations.

Hopland Tribe's two fish passage projects have monitoring plans in place.

Annual salmonid monitoring in one tributary on the Hopland Reservation will begin in 2012.

12. What protocols are you using for monitoring?

DFG/NOAA coastal salmonid monitoring plan for population and trend data. NOAA and HSU authors on Coastal Salmonid Monitoring Plan for all of California addresses population and trend monitoring on all coastal streams.

DFG implementation, effectiveness, and validation monitoring is done on all FRGP habitat restoration projects.

NRCS partners do the monitoring for their properties.

URRSA has a monitoring protocol for frost water, but the details were not available.

Coyote Valley Reservation (Forsythe Creek and West Fork Russian River)

Water quality monitoring is continuous and ongoing, following their QAPP

Climate change monitoring: details unavailable

Salmonid population monitoring: adult and juvenile surveys

The Biological Opinion website presents the monitoring protocols that are followed by SCWA.

MCWA

Temperature monitoring: North Coast Regional Water Quality Control Board

Groundwater monitoring: Dept. of Water Resources

Bridge cross sections: California Dept. of Transportation Guidelines

Adopt a Vernal Pool: This will be a long-term ongoing monitoring effort. The protocol was developed by a team of experts who collected data on the Santa Rosa Plain.

Bird Surveys — Trail: The budget and project design/plan are adequate. PRBO Point Count Protocol

Bird Surveys — Volunteer: No budget. Plan/design is adequate. Ongoing and long-term commitment once funding is secured.

Lake Mendocino Feasibility Study: The Army Corps of Engineers has protocols for the feasibility study.

Rural Roads Inventory Project: The monitoring protocols include V Star and turbidity measurements at treated crossings.

Arundo Removal: The monitoring plan includes annual site visits of treated areas where plant condition is recorded and mapping gets updated.

Dispatch Model: No monitoring protocol set up. Simply a concept worth applying to the Russian River.

The Hopland Band of Pomo Indians have a non-specific 100 year monitoring plan. Budgeting for immediate projects covers 2011- 2013 monitoring. Protocols followed include: DFG, USFWS, NMFS.

Gold Ridge RCD

Water Quality: SWAMP plan with QAPP

Dutch Bill Creek: No budget yet.

Salmonid surveys: In discussion phase with Dr. Michael Faucet and UC Cooperative Extension

13. What new planning resources do you have that can be provided to the RRWAMP?

The Hopland Research Station has an extensive GIS database for the Russian River watershed.

Redwood Valley Water District has the 2006 Sanitary Survey — Drinking Water Assessment.

Coho Recover Plan (http://swr.nmfs.noaa.gov/recovery/Coho_Recovery_Plan_031810.htm)

Multispecies Recovery Plan (Steelhead & Chinook) due for distribution in September 2011.

NRCS can work with farmers/ranchers on site plans and conservation plans as part of their service package.

Sonoma County Soil Surveys are on line at Sonoma NRCS office.

Rangeland productivity in Sonoma County has forage production per acre data, thus livestock per acre information.

Coyote Valley Tribal Native Plant Nursery should be up and running in 2012 to serve as source for restoration projects.

SCWA Stream Maintenance Program provides an annual report.

Newest data from SCWA is available through status and update reports.

MCWA has library of hard copies and archives of Russian River reports and references.

The Mendocino County Farm Bureau can assist agriculture businesses with water-related issues in the watershed.

The UC Cooperative Extension has GIS capability for mapping needs. UC Coop staff are available to provide guidance on BMPs for improving water quality in farming operations.

Potter Valley Irrigation District has water use data.

Sotoyome RCD has:

mapping for Arundo colonies throughout the watershed.

GIS data of sediment source assessments.

UC Cooperative Extension publications:

2011 — Organic Wine Growing Manual

2008 — Irrigated Agriculture and Water Needs in the Mendocino County Portion of the

Russian River Watershed.

2003 — Vineyard Water Quality Short Course for Mendocino County

1998 — Cover Cropping in Vineyards Manual

The Code of Sustainable Winegrowing — Self Assessment Workbook. Published by The

Wine Institute and the California Association of Wine Growers.

Russian River Coho Water Resources Partnership data and flow gages on Mark West, Grape,

Dutch Bill, Green Valley, and Mill Creeks.

Gold Ridge RCD's Green Valley Habitat Enhancement Plan includes geomorphic assessment and water quality monitoring data.

Roland Sanford has experience in applying the "Dispatch Model" in Lake Berryessa.

The Hopland Band of Pomo Indians has plans/designs for LID projects at various locations on the Reservation.

Mendocino County Agriculture Department has data on legal pesticide use and crop acreage.

Although preliminary, the results from our (MCRCD) Arundo and Tamarisk eradication efforts in 2011 appear promising. If the success rate from year 1 is suitable, we will consider this approach to be worth sharing.

14. What new data do you have on a watershed scale that could be provided to the RRWAMP, including but not limited to: GIS, flow data, invasive species mapping, etc.?

Hopland Research Station

GIS land coverage

Manuscript on salmonid survivorship and flow data

New tool on subwatershed assessments

Several publications on http://ucanr.org/sites/merenlender

NOAA Fisheries

Consolidation of Regional Salmonid Habitat data

GIS layers of Intrinsic Potential, salmonid occurrence, recovery strategies & actions.

The Nature Conservancy will soon release the "CAP Workbook" for California.

The Coastal Conservancy has the Passage Assessment Database.

Stemple Creek Watershed Plan provides an excellent template for subwatershed assessment.

Coyote Valley Band of Pomo Indians can provide water quality data for Forsythe Creek and

West Fork Russian River.

SCWA has data in their annual reports and on RRIS.

Mendocino County:

GIS Specialist

Mendocino County Water Agency interviewed some elderly farmers in 1991.

The Mendocino County Water Agency library is a great source for research.

Cross section data at bridges (1995-2001, 2006, 2009)

Feliz Creek at Mt. House Road

Russian River at Highway 175

West Fork Russian River at Lake Mendocino Drive

Forsythe Creek at Reeves Canyon Road

West Fork Russian River at Moore Street in Calpella

Russian River at Perkins Street in Ukiah

West Fork Russian River at School Way in Redwood Valley

Morrison Creek on Old River Road

Pieta Creek on Highway 101

Dooley Creek on Highway 101

Russian River Keeper has limited storm water data from 2002 — 2008 and some peak flow studies from the middle reach of the Russian below Healdsburg.

The Laguna de Santa Rosa Foundation has endangered and invasive species mapping data on GIS.

Janet Pauli authored and economic analysis based on data from the Mendocino County Agriculture Department to describe crop values and associated employment related to vineyard and pear production with potential impacts identified based upon proposed frost water regulations.

URRSA has flow data on the Russian River.

Russian River Coho Water Resources Partnership has flow data on their website.

Gold Ridge RCD has GIS and flow data for their jurisdiction, water quality reports, geomorphic assessments, and groundwater monitoring data in Purrington Creek.

Mike Hildreth has historical information about Ukiah Valley dating back to the 1850's.

The Russian River Flood Control District is in the process of mapping their boundaries and related points of diversion.

Hopland Band of Pomo Indians has flow data and botanical surveys for streams on their Reservation.

Mendocino County Agriculture Department has some data on invasive and noxious plant species, as well as aerial GIS data of all vineyards and orchards in the Mendocino County portion of the Russian River watershed.

Mendocino County Resource Conservation District has new mapping data on invasive species (Arundo, Ludwigia, Tamarisk) mapped from Redwood Valley to Hopland in 2011.

RUSSIAN RIVER
INTEGRATED COASTAL WATERSHED
MANAGEMENT PLAN

APPENDIX 2.
AN ORAL HISTORY OF THE RUSSIAN RIVER WATERSHED

In 1992, the Mendocino County Water Agency initiated an oral history of the Russian River. Twenty-five watershed residents who had lived closely with the river were interviewed by Carlyn Rohrig at the agency. Many of these individuals were from pioneer families and had spent their lives on or close to the river while others had moved to the Russian River as adults. Some of the interviewees remembered events and conditions in the early 20th century, while others' input focused on the second half of the century. Interviewees' affiliations included government, the Pomo Tribe, ranching, agriculture, fishing, and property management. Interview content was highly anecdotal and very personal; however, some themes, events, and practices were mentioned by multiple interviewees; these are categorized and presented below. Numbers in parentheses indicate number of interviewees.

Russian River Hydrogeomorphology in 20s, 30s, 40s, and 50s

- The Russian River used to have little islands, which slowed the water, reducing bank erosion. These islands were removed (2).
- It was easy to cross the river prior to the continuous flow addition from the Eel River (3). In the 30s, you could drive a caterpillar across the river below Hopland, near the mouth of Feliz Creek and Hopland Cemetery (1). You used to be able to drive across it almost any place you wanted (1). You could take a horse and buggy across it anywhere in the summertime (1).
- There was a flood every year; residents took it for granted (4). It used to flood fairly regularly (1).
- There were many big trees along the river — alders, lots of black walnut (1).
- The river was wide, with a lot more holes, some of which were up to 20 feet deep in some places (9). The largest were used as swimming holes.
- The river used to just about dry up in the summer (6).
- Cold Creek would go underground and come out further down (1).

Changes in Russian River Hydrogeomorphology

- Forsythe Creek in the early 90s: neighbors notice wells going dry, significant riparian vegetation along the channels dying (2). Potential causes include the Coyote Dam project and gravel extraction (1). Water releases from Lake Mendocino during winter and spring are also cited as causes of changes to the river channel (5).
- The loss of gravel has been extreme and there has been a drop in the stream channel (6). In 1956 or '57 and in '59, in one location, railroad steel piling was driven through gravel and into clay for erosion protection. By '92, the gravel was all gone, the steel piling was exposed, and the river was at clay level, having dropped about 9 feet at that location (1).
- After the dam was built, the channel of the Russian River dropped as much as 8 — 12 feet (8).
- Operations of Coyote Dam caused changes to tributary and river flow interaction during storm events. For example, when it rained Robinson Creek would fill, but on the mainstem Russian, flows would stay low because the water was held back by Coyote dam. Robinson Creek, which had not incised as deeply as the Russian and would be full with a strong current and the water stream would shoot straight across the Russian River towards the bank on the opposite side. Before the dam, the river and the creek would rise together and the flows would intermingle at the confluence and lead to sediment and gravel deposition. With dam management, the Russian was low during a storm, but afterwards, the water was let out and actually back up into Robinson Creek for about 500 — 600 yards for days at a time (1).

- Coyote Valley Dam causes weeks on end of high, muddy water during winter without the ups and downs that the system naturally experienced. It has flattened the river (8).
- After the dam was put in at Lake Mendocino, the river was held back to benefit Guerneville and some of the other low-lying areas (1). This caused a change in storm hydrology — instead of up and down with storm events, the river would go up and remain up for a week or more at a time (3).
- The dam's effect at Guerneville is almost immeasurable and there doesn't seem to be much difference in Hopland, which always floods anyway. But upstream, from Perkins Street north, there is much more effect — flooding was virtually eliminated (1).

Agricultural Practices

- General trend in agriculture has been from hops, to pears, to grapes (2). Over the years, Horst and Burke Hill Ranches changed from hops to pears, to grapes (1). Largo area family farm has gone from clearing the land, through hop production to prunes and pears and grapes (1).
- River and wells used for irrigation (10).
- Between the 80s and early 90s, the was a large decrease in riparian vegetation, in part due to expanding vineyards, in part due to expert advice (2).
- Property rights and access issues were a major concern among landowners in the early 90s (7).

Erosion Control

- Extensive use of cars for erosion control (8). Cars were hauled in from Lake County and the Sacramento valley for erosion control — "so many people were doing it that you couldn't get the cars here. The whole car — transmission, engine, differential, everything went into the river (1)."(2)
- River jacks picked up debris and silt and willows would grow in the retained soil. ACE would install the "jacks" of heavy metal; they had legs that stuck into the bank and looked like spiders (8).
- Steel railway piling was driven into the ground, connected with 1-inch cable and wired to 2-inch grid cyclone fencing or filled with old cars or other large objects to control erosion at washouts (4).
- Non-native species, including tamarisk, reed cane, Himalayan blackberry, yellow (Italian) willow, have been used in an effort to stabilize the bank and hold the original channeling (2).

Fisheries

- Everyone caught limit of steelhead in winter, but has dwindled to almost nothing compared to what it was (8).

Floods

- **1937** — A part of Highway 20 washed out and the Cold Creek Station fish hatchery was washed away (2).
- **1955** - flood wiped out an entire hops field in Valley Oaks Farms and washed out Native American graves on the "north end (1)." ACE "took the gravel bars from one side of the river and they pushed the gravel up that had washed out on the opposite side. It was useless because the first high water we had took the gravel out and we had the same problem (1)." Debris in an orchard 4 feet deep — bull dozers used to clear it out — took months to remove (1).
- **1964** — A major flood occurred. ACE engineers and workers came from all over the US to "help with repair along the river because the rivers and streams were flooded with downed trees and debris (1)." Flood was in the canopy of pear trees; interviewee had to go clean trash out of the trees after flood (1). There was damage to Largo bridge and it was removed (2) large washout at the mouth of Robinson Creek; lost 10 — 12 feet per day of orchard (1). To remediate after flood damage, about 128 or 148 cars were stacked one on top of the other at the confluence of the Russian and Robinson Creek (1).

Gravel Extraction

- General trend of depletion of gravel in the river (12).
- There used to be a lot of sandbars on the river and a lot of gravel (4).
- Gravel depletion due to over-extraction (6) and dam at Lake Mendocino (2).
- Riparian forest was periodically slashed — trees weren't cut completely down, but would be cut on the upstream side and allowed to split down. "Instead of one tree, many times they pick up

dozens of trees (1)." Another method was to drive on the riparian vegetation with a caterpillar to "mash them down starting on the upstream and working them downstream (1)."(2)

Water Quality

- Water used to be crystal clear (4). The river was not crystal clear in deep water (9, 10).
- The water temperature has increased (4).

Wildlife

- Historically, there has been very little hunting on the river (1).
- There used to be many mink in the river, but not as many otter (5).
- There used to be weasels (2).
- Crawdads used to be plentiful (4).
- There used to be a lot of suckers (1).
- There used to be a lot of frogs (1).
- There used to be a lot of eels and after spawning, lots of dead eels (3).
- There were lots of woodrats' nests (1).
- There was a lot of quail (2), rabbits, and digger squirrels (1).
- There used to be freshwater clams/ oysters (interviewee not sure which) (1).
- There were not opossums (3).
- There's not as much water fowl (1).
- Wild turkey is found extensively along the river; it first came into the area in the mid-seventies (2).
- Pigs, which weren't seen years ago, are now seen (1).
- There seem to be more coyotes now than before (1).

Historic Interview Timeline

The dates below were mentioned in interviews with long-time Russian River residents conducted in 1992 by the Mendocino County Resource Conservation District.

1850 — The river was "a little meandering stream (1)." This was the beginning of concerted agricultural development (1).

1905 — The tunnel from the Eel River was built. "The Russian River was just a trickle until then (1)."

1906 — Earthquake in April (1)

1908 — Completion of the powerhouse at the head of Potter Valley (1).

1919 — River mostly disappeared in summer, except deep holes (4).

1937 — Major flood near Ukiah (1)

1938 — 19 41 — Pear and hops agriculture just south of Ukiah (Burke Hill). Piling driven along river to protect banks; but farmers still farmed around sloughs and natural contours of the river. Lots of land still left fallow between agricultural crops and river — people used to camp between at harvest time (2).

1942 — Swimming holes up and down the river, farmers worked on the river banks - cut trees and constructed barriers to stop erosion. Area of Fetzer's Ranch in Hopland was all sloughs (just south of fire station) — from north end of ranch to town of Hopland, retained water all summer (1). Burke Hill Ranch and Horst Ranch primarily hops (1).

1950s — At Masonite, during the summer you couldn't see across the valley because it was so smokey because of about 15 mills operating in the valley. DFG came in and poisoned all the fish species, eliminating certain species such as sun fish and small mouth bass; steelhead made a dramatic return after that (1). End of hops; property that had been in hops was planted to pears (2).

1952 — There was a big washout on river in Hopland on propert y bordering Fetzer and Damiano Ranch. Most of summer and fall were spent driving piling to get the river back in its channel. "They put in pilings or whatever the farmer had that was economical for him. Then they would plant willows behind them and be able to establish the willows. As the water came in it would hit those barriers and the willows and drop the soil it was carrying, and eventually it would build back up over a period of time (1)."

1955 — A flood wiped out an entire hops field in Valley Oaks Farms and washed out Native American graves on the "north end (1)." ACE "took the gravel bars from one side of the river and they pushed the gravel up that had washed out on the opposite side. It was useless because the first high water we had took the gravel out and we had the same problem (1)." After a storm event, the debris in an orchard was 4 feet deep — bull dozers were used to clear it out — it took months to remove (1).

1959 — Coyote Dam was constructed on the Russian River for flood control to protect lower reaches of Russian River (1).

1964 — A major flood occurred. ACE engineers and workers came from all over the US to "help with repair along the river because the rivers and streams were flooded with downed trees and debris." Flood was in the canopy of pear trees; interviewee had to go clean trash out of the trees after flood (1). There was damage to Largo bridge and it was removed (2) large washout at the mouth of Robinson Creek; lost 10 — 12 feet per day of orchard (1). To remediate after flood damage, about 128 or 148 cars were stacked one on top of the other at the confluence of the Russian and Robinson Creek (1).

1980s — City of Ukiah filed a lawsuit against Sonoma County for issuing gravel permits that caused the need for bridge and water line replacement due to gravel loss (1).

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APPENDIX 3.
RUSSIAN RIVER WATERSHED NON-NATIVE PLANT SPECIES

SCIENTIFIC NAME	COMMON NAME	RATING	IMPACTS	INVASIVENESS	DISTRIBUTION	DOCUMENTATION	HABITATS OF CONCERN AND COMMENTS
Acacia dealbata	silver wattle	Moderate	B	B	B	2.5	Coastal prairie, riparian woodland, riparian forest, North Coast coniferous forest, closed cone coniferous forest.
Acacia melanoxylon	black acacia, black-wood acacia	Limited	C	C	B	2.7	Coniferous forest, chaparral, woodland, riparian. Impacts are low in most areas.
Acroptilon repens	Russian knapweed	Moderate	B	B	B	3.2	Scrub, grasslands, riparian, pinyon-juniper woodland, forest. Severe impacts in other western states. Spreading in many areas of CA.
Aegilops triuncialis	barb goatgrass	High	A	A	B	3.6	Grassland, oak woodland; spreading in NW and in Central Valley.
Agrostis avenacea	Pacific bentgrass	Limited	C	C	C	2.4	Vernal pools, coastal prairie, meadows, grasslands. Impacts are low in most areas.
Agrostis stolonifera	creeping bentgrass	Limited	C	B	C	1.9	Wetlands, riparian; grown for domestic forage. Limited distribution and impacts unknown.
Ailanthus altissima	tree-of-heaven	Moderate	B	B	B	3	Riparian areas, grasslands, oak woodland. Impacts highest in riparian areas.
Aira caryophyllea	silver hairgrass	Eval No List	D	C	A	2.6	Widespread in grasslands, but impacts appear negligible.
Aira praecox	European hairgrass	Eval No List	D	C	C	2.8	Appears to be spreading locally, but impacts unknown.
Albizia lophantha	plume acacia	Eval No List	U	C	C	1.5	Present in Golden Gate National Recreation Area. Need more information.
Allium triquetrum	three-cornered leek	Eval No List	U	C	C	1.6	Impacts unknown.
Ammophila arenaria	European beachgrass	High	A	B	B	3.2	Coastal dunes
Anthemis cotula	mayweed chamomile, dog fennel	Eval No List	D	B	B	2.4	Abiotic and wildife impacts unknown
Anthoxanthum odoratum	sweet vernalgrass	Moderate	B	B	B	2.7	Coastal prairie, coniferous forest. Little information available on impacts and limited ecological range.
Arctotheca calendula (fertile)	fertile capeweed	Moderate	B	B	C	3.6	Coastal prairie; can produce seed. Important agricultural weed in Australia, but limited distribution in CA.
Arctotheca prostrata	sterile capeweed	Moderate	B	B	B	2.8	Coastal prairie; only propagates vegetatively. More competitive than fertile form, but limited distribution.
Arundo donax	giant reed	High	A	B	A	2.8	Riparian areas, commercially grown for musical instrument reeds, structural material, etc.
Atriplex semibaccata	Australian saltbush	Moderate	B	B	B	2.9	Coastal grasslands, scrub, upper salt marsh. Limited distribution, but can be very invasive regionally.
Avena barbata	slender wild oat	Moderate	B	B	A	3.5	Coastal scrub, grasslands, oak woodland, forest. Very widespread, but impacts more severe in desert regions.
Avena fatua	wild oat	Moderate	B	B	A	3.2	Coastal scrub, chaparral, grasslands, woodland, forest. Very widespread, but impacts more severe in desert regions.
Bellardia trixago	bellardia	Limited	C	C	C	1.9	Grasslands, including serpentine. Impacts and invasiveness appear to be minor.
Bellis perennis	English daisy	Eval No List	D	C	C	2.8	Present along trails, not known to spread into undisturbed areas
Berberis darwinii	Darwin barberry	Eval No List	U	B	D	2.1	Impacts unknown
Brachypodium distachyon	annual false-brome, false brome, purple false broom, stiff brome	Moderate	B	B	B	2.6	Valley and foothill grassland, cimontane woodland
Brassica nigra	black mustard	Moderate	B	B	A	2	Widespread. Primarily a weed of disturbed sites, but can be locally a more significant problem in wildlands.
Brassica rapa	birdsrape mustard, field mustard	Limited	C	B	B	1.8	Coastal scrub, grasslands meadows, riparian. Primarily in disturbed areas, Impacts appear to be minor or unknown in wildlands.
Brassica rapa var. rapa							
Briza maxima	big quackingrass, rattlesnakegrass	Limited	B	C	B	2.3	Grasslands. Widespread in coast range. Impacts generally minor, but locally can be higher.
Bromus diandrus	ripgut brome	Moderate	B	B	A	3.3	Dunes, scrub, grassland, woodland, forest. Very widespread, but monotypic stands uncommon.
Bromus hordeaceus	soft brome	Limited	B	C	A	2.8	Grasslands, sagebrush, serpentine soils, many other habitats. Very widespread, but primarily in converted annual grasslands.
Bromus japonicus	Japanese brome, Japanese chess	Limited	B	C	B	2.6	Great Basin grassland, valley and foothill grassland, pinon and juniper woodland, lower montane coniferous forest

SCIENTIFIC NAME	COMMON NAME	RATING	IMPACTS	INVASIVENESS	DISTRIBUTION	DOCUMENTATION	HABITATS OF CONCERN AND COMMENTS
Bromus madritensis ssp. rubens	red brome	High	A	B	A	3	Scrub, grassland, desert washes, woodlands
Bromus tectorum	downy brome, cheatgrass	High	A	B	A	3.1	Interior scrub, woodlands, grasslands, pinon/Joshua tree woodland, chaparral.
Buddleja davidii	butterflybush	Eval No List	D	B	D	2.5	Not known to be invasive in CA, although it is a problem in Oregon.
Cakile maritima	European sea-rocket	Limited	C	B	B	3.6	Coastal dunes. Widespread, but impacts appear to be minor.
Carduus acanthoides	plumeless thistle	Limited	B	C	C	3	Valley and foothill grasslands. Distribution limited in CA, impacts higher locally.
Carduus pycnocephalus	Italian thistle	Moderate	B	B	A	2.9	Forest, scrub, grasslands, woodland. Very widespread. Impacts may be variable regionally.
Carduus tenuifolius	slenderflower thistle	Limited	C	C	B	2.8	Valley and foothill grasslands. Limited distribution, Impacts appear to be minor.
Carpobrotus chilensis	sea-fig, iceplant	Moderate	B	B	A	1.8	Coastal dunes, scrub, prairie. Little information on species, most inferred from C. edulis.
Carpobrotus edulis	Hottentot-fig, iceplant	High	A	B	A	3.3	Coastal habitats, especially dunes
Carthamus lanatus	woolly distaff thistle	Moderate	A	B	C	2.8	Grasslands. Expanding in coast ranges, may become more severe. Current distribution limited.
Centaurea calcitrapa	purple starthistle	Moderate	B	B	B	2.7	Grasslands. Impacts regionally variable. Distribution relatively limited.
Centaurea diffusa	diffuse knapweed	Moderate	B	B	B	3.3	Severe impacts in other western states. Limited distribution in CA with impacts higher in some locations.
Centaurea melitensis	Malta starthistle, tocalote	Moderate	B	B	B	2.6	Grasslands, oak woodland; sometimes misidentified as C. solstitialis. Impacts vary regionally.
Centaurea solstitialis	yellow starthistle	High	A	B	A	3	Grasslands, woodlands, occasionally riparian
Centaurea stoebe ssp. *micranthos;* formerly: *Centaurea maculosa*	spotted knapweed	High	A	B	B	3.4	Riparian, grasslands, wet meadows, forests. More widely distributed in other western states.
Chondrilla juncea	rush skeletonweed	Moderate	B	B	B	3.1	Grasslands. Very invasive in other western states, but currently limited in distribution in CA.
Cirsium arvense	Canada thistle	Moderate	B	B	B	2.8	Grasslands, riparian areas, forests. Severe impacts in other western states. Limited distribution in CA.
Cirsium vulgare	bull thistle	Moderate	B	B	B	3.3	Riparian areas, marshes, meadows. Widespread, can be very problematic regionally.
Cistus ladanifer	gum rockrose	Eval No List	D	C	C	3.3	Negligible known impacts in wildlands
Conium maculatum	poison hemlock	Moderate	B	B	B	2.8	Riparian woodland, grassland. Widespread in disturbed areas. Abiotic impacts unknown. Impacts can vary locally.
Convolvulus arvensis	field bindweed	Eval No List	C	B	B	3.5	Only known as agricultural weed
Cordyline australis	giant dracaena, New Zealand cabbage tree	Limited	C	C	C	2	Coniferous forest. Two reports of horticultural escape into wildlands. Appears best suited to moist, cool climates.
Cortaderia jubata	jubatagrass	High	A	A	A	3.1	Many coastal and interior habitats
Cortaderia selloana	pampasgrass	High	A	A	B	3.2	Coastal dunes, coastal scrub, Monterey pine, riparian, grasslands, wetlands, serpentine soils. Still spreading both coastal and inland.
Cotoneaster franchetii	orange cotoneaster	Moderate	B	A	B	2.6	Coniferous forest. Limited distribution. Abiotic impacts largely unknown.
Cotoneaster lacteus	Parney's cotoneaster	Moderate	B	B	B	2.1	Many coastal habitats, mainly a problem from SF Bay Area north along coast but also in San Diego County. Limited distribution. Abiotic impacts largely unknown.
Cotoneaster pannosus	silverleaf cotoneaster	Moderate	B	A	B	2.5	Many coastal habitats, mainly a problem from SF Bay Area north along coast. Limited distribution. Abiotic impacts largely unknown.
Cotula coronopifolia	brassbuttons	Limited	C	C	B	2.2	Salt and freshwater marshes. Impacts largely unknown, but appear to be minor.
Crataegus monogyna	hawthorn	Limited	C	B	C	3.4	Riparian habitats, woodland. Limited distribution. Impacts appear to be minor.
Crocosmia x crocosmiiflora	montbretia	Limited	C	B	B	2.6	Coastal scrub and prairie, north coast forests. Abiotic impacts unknown. Higher invasiveness in some areas.
Crupina vulgaris	common crupina, bearded creeper	Limited	B	C	B	3.2	Forest, woodland, grassland. Distribution limited. More invasive in other western states.
Cynara cardunculus; formerly: *Cynara scolymus*	cardoon, artichoke thistle	Moderate	B	B	B		Coastal grasslands. Impacts more severe in southern CA where monotypic stands are more common.

SCIENTIFIC NAME	COMMON NAME	RATING	IMPACTS	INVASIVENESS	DISTRIBUTION	DOCUMENTATION	HABITATS OF CONCERN AND COMMENTS
Cynodon dactylon	Bermudagrass, bermuda grass	Moderate	B	B	B	3.3	Common landscape weed, but can be very invasive in desert washes.
Cynosurus echinatus	hedgehog dogtailgrass	Moderate	B	B	A	2.5	Oak woodland, grassland. Widespread, impacts vary regionally, but typically not in monotypic stands.
Cytisus scoparius	Scotch broom	High	A	B	A	3.2	Coastal scrub, oak woodland, horticultural varieties may also be invasive.
Cytisus scoparius var. andreanus	Scotch broom						
Cytisus scoparius var. scoparius	Scotch broom						
Dactylis glomerata	orchardgrass	Limited	C	B	B	2.9	Grasslands, broadleaved forest, woodlands; common forage species. Impacts appear to be minor.
Daucus carota	wild carrot, Queen Anne's lace	Eval No List	D	C	B	2.7	Very widespread, but primarily in disturbed sites, particularly roadsides
Delairea odorata; formerly: *Senecio mikanioides*	Cape-ivy, German-ivy	High	A	A	B	3.1	Coastal, occasionally other riparian areas, common discard from gardens.
Descurainia sophia	flixweed, tansy mustard	Limited	C	B	B	1.9	Scrub, grassland, woodland. Impacts appear to be minor, but locally more invasive in NE CA.
Digitalis purpurea	foxglove	Limited	C	B	B	2.4	Forest, woodland. Widely escaped ornamental. Impacts largely unknown but appear to be minor.
Dipsacus fullonum	common teasel	Moderate	B	B	B	3.8	Grasslands, seep, riparian scrub. Impacts regionally variable, forms dense stands on occasion.
Dipsacus sativus	fuller's teasel	Moderate	B	B	B	3.8	Grasslands, seep, bogs. Impacts regionally variable, forms dense stands on occasion.
Dittrichia graveolens	stinkwort	Moderate	B	A	C	3	Grasslands, riparian scrub. Spreading rapidly, impacts may become more important in future.
Egeria densa	Brazilian waterweed, Brazilian water weed	High	A	A	B		Found throughout much of California and the US, primarily in cool to warm freshwater ponds, lakes, reservoirs and slowly flowing streams and sloughs.
Ehrharta calycina	purple veldtgrass	High	A	A	B	3.4	Sandy soils, especially dunes; rapidly spreading on central coast.
Ehrharta erecta	erect veldtgrass	Moderate	B	B	B	2.2	Scrub, grasslands, woodland, forest. Spreading rapidly, impacts may become more important in future.
Eichhornia crassipes	water hyacinth	High	A	A	C	3.2	Aquatic systems in Sacramento-San Joaquin Delta
Erica lusitanica	Spanish heath, Spanish heather	Limited	C	B	C	2.4	Disturbed open, sandy areas. Humboldt, Del Norte, Mendocino.
Erigeron karvinskianus	Mexican daisy	Eval No List	U	B	C	1.9	Impacts unknown, but appears to be expanding. May become more problematic in future
Erodium botrys	broadleaf filaree	Eval No List	D	C	A	2.8	Present in wildlands but known impacts are negligible. Often transient.
Erodium brachycarpum	short-fruited filaree	Eval No List	C	C	A	2.6	Present in wildlands but known impacts are negligible.Often transient.
Erodium cicutarium	redstem filaree	Limited	C	C	A	3.1	Many habitats. Widespread. Impacts minor in wildlands. High-density populations transient.
Erodium moschatum	whitestem filaree	Eval No List	D	C	A	2.7	Primarily an agricultural weed, little impact in wildlands.
Eucalyptus camaldulensis	river redgum, Red River gum, red gum	Limited	C	C	C	2.2	Mainly southern CA urban areas. Impacts, invasiveness and distribution all minor.
Eucalyptus globulus	Tasmanian bluegum, blue gum	Moderate	B	B	B	2.8	Riparian areas, coastal grasslands, scrub. Impacts can be much higher in coastal areas.
Euphorbia lathyris	caper spurge	Eval No List	D	C	B	2.2	Abiotic impacts unknown
Euphorbia oblongata	oblong spurge	Limited	C	C	B	2	Meadows, woodlands. Limited distribution. Impacts unknown. Locally in dense stands.
Euphorbia virgata; formerly: *Euphorbia esula*	Leafy spurge	High	A	A	C	3.5	Forests, woodlands, juniper forest. More widespread invasive in northern states.
Fallopia japonica; formerly: *Polygonum cuspidatum*	Japanese knotweed	Moderate	B	B	D	2.7	Riparian areas, wetlands, forest edges. More severe impacts in NW wetlands. Distribution limited in CA.
Fallopia sachalinensis; formerly: *Polygonum sachalinense*	Giant knotweed	Moderate	B	B	D	2.5	Riparian areas. More severe impacts in NW wetlands. Distribution limited in CA.
Festuca arundinacea	tall fescue	Moderate	B	B	A	2.9	Coastal scrub, grasslands; common forage grass. Widespread, abiotic impacts unknown.

SCIENTIFIC NAME	COMMON NAME	RATING	IMPACTS	INVASIVENESS	DISTRIBUTION	DOCUMENTATION	HABITATS OF CONCERN AND COMMENTS
Festuca myuros; formerly: *Vulpia myuros var. myuros*	Rattail sixweeks grass	Moderate	B	B	A	3	Coastal sage scrub, chaparral. Widespread. Rarely forms monotypic stands, but locally problematic
Ficus carica	edible fig	Moderate	B	A	B	2.6	Riparian woodland. Can spread rapidly. Abiotic impacts unknown. Can be locally very problematic.
Foeniculum vulgare	fennel	High	A	B	A	3	Grasslands, scrub.
Genista monspessulana	French broom	High	A	A	B	3.2	Coastal scrub, oak woodland, grasslands. Horticultural selections may also be invasive.
Geranium dissectum	cutleaf geranium	Moderate	C	B	A	1.7	Numerous habitats but impacts appear minor.
Geranium molle	dovefoot geranium	Eval No List	D	B	A	1.7	Present in wildlands, but known impacts are negligible
Geranium retrorsum	New Zealand geranium	Eval No List	D	B	B	1.9	Present in wildlands, but known impacts are negligible
Geranium robertianum	herb-robert, Robert geranium	Eval No List	D	B	C	2.8	Present in wildlands, but known impacts are negligible
Glyceria declinata	waxy mannagrass	Moderate	B	B	B	1.9	Vernal pools, moist grasslands. Often confused with native Glyceria. Impacts largely unknown, but may be significant in vernal pools.
Hedera canariensis	Canary ivy	High	A	A	A	2.7	Coastal forests, riparian areas. Species combined due to genetics questions.
Hedera helix	English ivy, Algerian ivy	High	A	A	A	2.7	Coastal forests, riparian areas. Species combined due to genetics questions.
Helichrysum petiolare	licoriceplant	Limited	C	B	C	2	North coastal scrub. Limited distribution. Impacts unknown, but can form dense stands.
Helminthotheca echioides; formerly: *Picris echioides*	Bristly ox-tongue	Limited	C	B	B	2.4	Coastal prairie, scrub, riparian woodland. Widespread locally. Abiotic impacts unknown.
Hirschfeldia incana	shortpod mustard, summer mustard	Moderate	B	B	A	1.9	Scrub, grasslands, riparian areas. Impacts not well understood, but appear to be greater in southern CA.
Holcus lanatus	common velvet grass	Moderate	B	B	A	2.9	Coastal grasslands, wetlands. Impacts can be more severe locally, especially in wetland areas.
Hordeum marinum	seaside barley	Moderate	B	B	A	2.8	Grasslands; H. marinum invades drier habitats. Widespread, but generally do not form dominant stands.
Hordeum murinum	mouse barley, foxtail barley, Farmer's Foxtail	Moderate	B	B	A	2.8	Grasslands; H. murinum invades wetlands. Widespread, but generally do not form dominant stands.
Hydrilla verticillata	hydrilla	High	A	B	C	3.2	Freshwater aquatic systems. The most important submerged aquatic invasive in southern states.
Hypericum canariense	Canary Island hypericum	Moderate	B	B	C	1.2	Coastal scrub, prairie. Impacts unknown, distribution limited. Spreading rapidly on central coast.
Hypericum perforatum	common St. John's wort, klamathweed	Moderate	B	B	B	3.7	Many northern CA habitats. Abiotic impacts low. Biological control agents have reduced overall impact.
Hypochaeris glabra	smooth catsear	Limited	C	B	B	3.1	Scrub and woodlands. Widespread. Impacts appear to be minor. Some local variability.
Hypochaeris radicata	rough catsear, hairy dandelion	Moderate	C	B	A	2.2	Coastal dunes, scrub, and prairie; woodland, forest. Widespread. Impacts unknown or appear to be minor.
Ilex aquifolium	English holly	Moderate	B	B	C	2.7	North coast forests. Expanding range south from OR.
Iris pseudacorus	yellowflag iris	Limited	C	B	C	2.3	Riparian, wetland areas, esp. southern CA. Limited distribution. Abiotic impacts unknown.
Isatis tinctoria	dyer's woad	Moderate	B	B	A	3	Great Basin scrub and grasslands, coniferous forest. More severe impacts in other western states, but can be locally very invasive in northern CA.
Kochia scoparia	kochia	Moderate	B	C	B	3.2	Scrub, chaparral, grasslands
Lactuca serriola	prickly lettuce	Eval No List	D	B	B	3.1	Primarily an agricultural and roadside weed
Lepidium draba; formerly: *Cardaria draba*	Whitetop, hoary cress	Moderate	B	B	B	2.6	Riparian areas, marshes of central coast. More severe invasive in northern CA.
Lepidium latifolium	perennial pepperweed, tall whitetop	High	A	A	A	3.1	Coastal and inland marshes, riparian areas, wetlands, grasslands; potential to invade montane wetlands.
Leucanthemum vulgare	ox-eye daisy	Moderate	B	B	B	2.5	Montane meadows, coastal grasslands, coastal scrub. Expanding range, invasiveness varies locally.
Ligustrum lucidum	glossy privet	Eval No List	D	B	C		Glossy Privet is used as an ornamental plant and easily established in disturbed areas.

SCIENTIFIC NAME	COMMON NAME	RATING	IMPACTS	INVASIVENESS	DISTRIBUTION	DOCUMENTATION	HABITATS OF CONCERN AND COMMENTS
Linaria dalmatica ssp. *dalmatica;* formerly: *Linaria genistifolia* ssp. *dalmatica*	Dalmation toadflax	Moderate	B	B	B	2.8	Grasslands, forest clearings. Limited distribution. More severe impacts in other western states.
Linaria vulgaris	yellow toadflax, butter and eggs	Moderate	B	B	B	2.3	valley and foothill grassland, Great Basin grassland, riparian woodland, lower montane coniferous forest, upper montane coniferous forest
Lobularia maritima	sweet alyssum	Limited	C	B	B	2.4	Coastal dune, coastal scrub, coastal prairie, riparian.
Lotus corniculatus	birdsfoot trefoil	Eval No List	D	B	B	2.8	Primarily a turf or agricultural weed in CA
Ludwigia hexapetala	Uruguay water-primrose	High	A	B	C	2.6	Freshwater aquatic systems. Clarification needed on taxonomic identification.
Ludwigia peploides ssp. montevidensis	creeping water-primrose	High	A	B	B	2.5	Freshwater aquatic systems. Clarification needed on taxonomic identification.
Lythrum hyssopifolium	hyssop loosestrife	Limited	C	B	B	3	Grasslands, wetlands, vernal pools. Widespread. Impacts unknown, but appear to be minor.
Lythrum salicaria	purple loosestrife	High	A	A	B	3.8	Wetlands, marshes, riparian areas
Medicago polymorpha	California burclover	Limited	C	C	A	2.8	Grasslands. Widespread weed of agriculture and disturbed areas. Impacts in wildlands minor.
Melilotus albus; formerly: *Melilotus alba*	White sweetclover	Eval No List	C	C	C		Becoming naturalized, usually in wetlands.
Melilotus officinalis	yellow sweetclover	Eval No List	D	C	C	3.3	Present in human-disturbed habitats only
Mentha pulegium	pennyroyal	Moderate	C	A	A	2.7	Vernal pools, wetlands. Poisonous to livestock. Spreading rapidly. Impacts largely unknown.
Mesembryanthemum crystallinum	crystalline iceplant	Moderate	B	B	C	3.7	Coastal bluffs, dunes, scrubs, grasslands. Limited distribution. Locally problematic, especially in southern CA.
Myoporum laetum	myoporum	Moderate	B	B	B	2.6	Coastal habitats, riparian areas; mostly along the southern coast. Abiotic impacts unknown.
Myosotis latifolia	common forget-me-not	Limited	C	B	B	2.2	Coniferous forest, riparian. Little information on impacts.
Myosotis sylvatica	woodland forget me not	Limited	C	B	B		Found in coniferous and riparian areas along the coast, from Monterey to Humboldt County.
Myriophyllum aquaticum	parrotfeather	High	A	B	C	2.8	Freshwater aquatic systems
Myriophyllum spicatum	Eurasian watermilfoil	High	A	A	B	2.8	Freshwater aquatic systems
Nerium oleander	oleander	Eval No List	D	B	D	2.6	Not known to be invasive, although reported from riparian areas in Central Valley and San Bernardino Mtns
Nicotiana glauca	tree tobacco	Moderate	B	B	B	2.5	Coastal scrub, grasslands, riparian woodland. Abiotic impacts unknown. Impacts vary locally. Rarely in dense stands.
Nymphaea odorata	fragrant waterlily	Eval No List	D	B	C	2.3	Present only at one site.
Olea europaea	olive	Limited	C	B	B	2.5	A problem in Australia. Currently a rare escape in CA but is of concern due to the possibility of spread from planted groves.
Onopordum acanthium	Scotch thistle	High	B	B	B	2.9	Wet meadows, sage brush, riparian areas
Oxalis corniculata	creeping woodsorrel	Eval No List	D	C	C	2.2	Primarily a turf weed in CA
Oxalis pes-caprae	Bermuda buttercup, buttercup oxalis, yellow oxalis	Moderate	B	B	B	2.9	Coastal dunes, scrub, oak woodland. Impacts in coastal areas may prove more severe in time.
Parentucellia viscosa	yellow glandweed, sticky parentucellia	Limited	C	B	B	2.5	Coastal prairie, grassland, and dunes. Impacts unknown, but can be locally significant.
Pennisetum clandestinum	kikuyugrass	Limited	C	C	B	2.3	Present at low levels in numerous wildland habitats. Impacts unknown. Common turf weed.
Phalaris aquatica	hardinggrass	Moderate	B	B	B	2.6	Coastal sites, especially moist soils. Limited distribution. Can be highly invasive locally.

SCIENTIFIC NAME	COMMON NAME	RATING	IMPACTS	INVASIVENESS	DISTRIBUTION	DOCUMENTATION	HABITATS OF CONCERN AND COMMENTS
Phoenix canariensis	Canary Island date palm	Limited	C	B	D	2.3	Desert washes; agricultural crop plant. Limited distribution in southern CA. Impacts can be higher locally.
Phytolacca americana	common pokeweed	Limited	C	B	C	2.8	riparian forest, riparian woodland
Piptatherum miliaceum	smilograss	Limited	C	B	B	2.4	Coastal dunes, scrub, riparian, grassland. Expanding range. Impacts largely unknown.
Pittosporum undulatum	Victorian box	Eval No List	D	C	D	2.7	Infestations in California are small. More problematic on north coast
Plantago coronopus	cutleaf plantain	Eval No List	U	C	B	1.7	Impacts unknown. Common on north coast
Plantago lanceolata	buckhorn plantain, English plantain	Limited	C	C	B	2.1	Many habitats. Turf weed primarily. Low density and impact in wildlands.
Poa pratensis	Kentucky bluegrass	Limited	C	B	B	2.7	Grasslands scrub, riparian areas. Widespread turf plant. Abiotic impacts unknown.
Poa pratensis ssp. *pratensis*	Kentucky bluegrass	Limited	C	B	B	2.7	Grasslands scrub, riparian areas. Widespread turf plant. Abiotic impacts unknown.
Polypogon monspeliensis and subspp.	rabbitfoot polypogon, annual beardgrass	Limited	C	C	B	2.3	Margins of ponds and streams, seasonally wet places, edge of coastal dunes. Widespread. Impacts appear to be minor.
Potamogeton crispus	curlyleaf pondweed	Moderate	B	B	B	3.2	Freshwater aquatic systems. Can be very invasive locally.
Prunus cerasifera	cherry plum	Limited	C	B	B	1.8	Riparian habitats, chaparral, woodland. Limited distribution. Abiotic impacts unknown.
Pyracantha angustifolia	pyracantha, firethorn	Limited	C	B	B	2.8	Coastal scrub and prairie, riparian areas. Horticultural escape. Impacts unknown or minor.
Pyracantha coccinea	pyracantha, firethorn	Limited	C	B	B	2.8	Coastal scrub and prairie, riparian areas. Horticultural escape. Impacts unknown or minor.
Pyracantha crenulata	pyracantha, firethorn	Limited	C	B	B	2.8	Coastal scrub and prairie, riparian areas. Horticultural escape. Impacts unknown or minor.
Ranunculus repens	creeping buttercup	Limited	C	C	B	2.9	Riparian areas, coniferous forest. Impacts appear to be minor to negligible in most areas.
Raphanus sativus	radish	Limited	C	C	B	2.5	Present at low levels in numerous habitats. Widespread in disturbed sites.
Robinia pseudoacacia	black locust	Limited	C	B	B	2.8	Riparian areas, canyons. Severe impacts in southern states. Impacts minor in CA.
Rubus armeniacus; formerly: *Rubus discolor*	Himalaya blackberry	High	A	A	A	3	Riparian areas, marshes, oak woodlands
Rumex acetosella	red sorrel, sheep sorrel	Moderate	B	B	A	2.3	Many habitats, riparian areas, forest, wetlands. Widespread. Abiotic impacts unknown. Impacts can vary locally.
Rumex crispus	curly dock	Limited	C	C	A	2.7	Grasslands, vernal pool, meadows, riparian. Widespread. Impacts appear to be minor.
Rytidosperma penicillatum; formerly: *Danthonia pilosa*	Purple awned Wallaby Grass, hairy oat grass	Limited	C	C	B	1.7	Coastal terrace prairie, coastal scrub, North Coast coniferous forest, valley and foothill grassland.
Salsola australis; formerly: *Salsola tragus*	Russianthistle, prickly Russian thistle, tumbleweed, Russian thistle	Limited	C	B	B	2.8	Desert dunes and scrub, alkali playa. Widespread. Impacts minor in wildlands.
Salsola soda	oppositeleaf Russian thistle	Moderate	B	B	B	2.8	marine systems, estuaries, vernal pool, marsh and swamp
Salvinia molesta	giant salvinia	High	A	A	C	2.9	Freshwater aquatic systems. Population in San Diego River was eradicated.
Schismus arabicus	Schimus, Mediterranean grass, Arabian Schismus	Limited	B	C	A	2.3	Scrub, thorn woodland. Widespread in deserts. Impacts can be more important locally.
Schismus barbatus	common Mediterranean grass, Old Han Shismus	Limited	B	C	A	2.3	Scrub, thorn woodland. Widespread in deserts. Impacts can be more important locally.
Senecio jacobaea	tansy ragwort	Limited	C	B	B	2.8	Grasslands, riparian. Impacts generally minor. Can be locally important in NW CA.
Senecio minimus; formerly *Erechtites minima*	Coastal burnweed	Moderate	C	B	A	3.2	Coastal woodland, scrub, forests. Widespread on coast, but impacts low overall. May vary locally.

SCIENTIFIC NAME	COMMON NAME	RATING	IMPACTS	INVASIVENESS	DISTRIBUTION	DOCUMENTATION	HABITATS OF CONCERN AND COMMENTS
Sesbania punicea	red sesbania, scarlet wisteria	High	A	B	C	3.2	Riparian areas
Silybum marianum	blessed milkthistle	Limited	C	C	A	3.5	Grasslands, riparian. Widespread, primarily in disturbed areas Impacts can be higher locally
Sinapis arvensis	wild mustard, charlock	Limited	C	C	C	2.9	Grasslands. Primarily in disturbed sites. Impacts minor or unknown in wildlands.
Solanum elaeagnifolium	silverleaf nightshade	Eval No List	D	B	C	2.8	Primarily agricultural weed, but escaping to wildlands in other countries. May prove to be more important in future.
Sonchus asper	spiny sowthistle	Eval No List	D	B	B	3.1	Primarily an agricultural weed
Sonchus asper ssp. asper	prickly sow thistle, Sow Thistle	Eval No List	D	B	B	6	Inhabitats disturbed places, can become naturalized, especially in wetland and riparian areas.
Spartium junceum	Spanish broom	High	A	B	B	3.2	Coastal scrub, grasslands, wetlands, oak woodland, forests
Stipa manicata; formerly: *Nassella formicara*	Andean tussockgrass	Limited	C	C	C	2.2	
Tamarix parviflora	smallflower tamarisk	High	A	A	B	3.1	Riparian areas, desert washes, coastal scrub
Tanacetum vulgare	common tansy	Moderate	B	B	B	2.3	Riparian areas, forest. Limited distribution. Severe problem in other western states.
Taraxacum officinale	common dandelion	Eval No List	D	B	B	2.8	Primarily a turf weed in CA
Tetragonia tetragonioides	New Zealand spinach						
Torilis arvensis	hedgeparsley	Moderate	C	B	B	2.3	Expanding range. Appear to have only moderate ecological impacts.
Torilis arvensis ssp. arvensis	field hedge parsley	Moderate	C	B	B	2.3	Expanding range. Appear to have only moderate ecological impacts.
Tragopogon dubius	yellow salsify	Eval No List	D	C	B	3.2	Generally a minor component of disturbed areas.
Trifolium hirtum	rose clover	Moderate	C	B	B	2.8	Grasslands, oak woodland. Widely planted in CA. Impacts relatively minor in most areas.
Tropaeolum majus	garden nasturtium	Eval No List	D	C	C	1.4	Impacts on abiotic processes and native plants unknown
Ulex europaeus; formerly: *Ulex europaea*	gorse	High	A	B	B	2.9	Scrub, woodland, forest, coastal grassland
Ulmus pumila	Siberian elm	Eval No List	D	B	B	2.5	Impacts unknown
Verbascum thapsus	common mullein,woolly mullein	Limited	C	B	B	3.8	Meadows, riparian, sagebrush, pinyon-juniper woodlands. Widespread. Impacts minor.
Verbena bonariensis	tall vervain, seashore vervain	Eval No List	D	B	C	2.1	Often in disturbed areas of irrigation canals
Verbena litoralis	seashore vervain, shore vervain	Eval No List	D	B	C		Disturbed areas.
Vicia villosa	hairy vetch	Eval No List	D	C	B	2.8	Primarily an agricultural weed, Widespread but impacts minor in wildlands.
Vicia villosa ssp. *villosa*	winter vetch, hairy vetch, Wooly Vetch	Eval No List	D	C	B		Disturbed areas.
Vinca major	big periwinkle	Moderate	B	B	B	2.8	Riparian, oak woodlands, coastal scrub. Distribution currently limited but spreading in riparian areas. Impacts can be higher locally.
Washingtonia robusta	Mexican fan palm	Moderate	B	B	C	2.7	Desert washes. Limited distribution but spreading in southern CA. Impacts can be higher locally.
Watsonia meriana; formerly: *Watsonia bulbillifera*	bulbil watsonia	Limited	C	B	C	2.3	Coastal prairie, coniferous forest. Abiotic impacts unknown, but may be locally dense.

SCIENTIFIC NAME	COMMON NAME	RATING	IMPACTS	INVASIVENESS	DISTRIBUTION	DOCUMENTATION	HABITATS OF CONCERN AND COMMENTS
Zantedeschia aethiopica	calla lily	Limited	C	B	C	2.1	Coastal prairie, wetlands. Impacts high in other countries and local impacts may be high in CA.

Scores:

A = Severe

B = Moderate

C = Limited

D = None

U = Unknown

Documentation:

Documentation level is averaged.

Nomenclature:

Scientific names are based on The Jepson Manual. For each species, the first common name is based on the Weed Science Society of America's "Composite List of Weeds", followed by other names used in California.

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RUSSIAN RIVER
INTEGRATED COASTAL WATERSHED
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APPENDIX 4.
LISTED ANIMAL AND PLANT SPECIES IN THE RUSSIAN RIVER WATERSHED

INVERTEBRATES	
California freshwater shrimp (FE, SE)	*Syncaris pacifica*
FISH	
Green sturgeon* (FT)	*Acipenser medirostris*
Coho salmon, Central CA Coast (FE, SE)	*Oncorhynchus kisutch*
Northern California Steelhead (FT, X)	*Oncorhynchus mykiss*
CA coastal chinook salmon (FT, X)	*Oncorhynchus tshawytscha*
Russian River tule perch (SC)	*Hysterocarpus traski pomo*
AMPHIBIANS	
Foothill yellow-legged frog (SC)	*Rana boylii*
California tiger salamander (FE, ST)	*Ambystoma californiense*
REPTILES	
Northwestern pond turtle (SC)	*Actinemys marmorata marmorata*
BIRDS	
Marbled murrelet (FT, SE, X)	*Brachyramphus marmoratus*
Western Snowy Plover (FT)	*Charadrius alexandinus nivosus*
Northern spotted owl (FT, X)	*Strix occidentalis caurina*
Burrowing owl (SC)	*Athene cuncularia*
Bald Eagle (SE)	*Haliaeetus leucocephalus*
Swainson's hawk (ST)	*Buteo swainsoni*
Black Rail (ST)	*Laterallus jamaicensis*
California Clapper Rail (FE, SE)	*Rallus longirostris obsoletus*
Northern Goshawk (SC)	*Accipiter gentilis*
Snowy Plover (FT)	*Charadrius alexandrinus*
Mountain Plover (C, SC)	*Charadrius montanus*
Marbled Murrelet (FT, SE)	*Brachyramphus marmoratus*
Northern Spotted Owl (FT)	*Strix occidentalis*
Long-Eared Owl (SC)	*Asio otus*
Short-eared Owl (SC)	*Asio flammeus*
Vaux's Swift (SC)	*Chaetura vauxi*
Olive-sided Flycatcher (SC)	*Contopus cooperi*
Purple Martin (SC)	*Progne subis*
Bank Swallow (ST)	*Riparia riparia*
Yellow warbler (SC)	*Dendroica petchia brewsteri*
Yellow-breasted chat (SC)	*Icteria virens*
Grasshopper Sparrow (SC)	*Ammodramus savannarum*
Tricolored blackbird (SC)	*Agelaius tricolor*
MAMMALS	
Pallid bat (SC)	*Antrozous pallidus*
Townsend's big-eared bat (SC)	*Corynorhinus townsendii*
Sonoma Tree Vole (SC)	*Arborimus pomo*
American badger (SC)	*Taxidea taxus*
Pacific Fisher (C)	*Martes pennanti*
ENDANGERED, THREATENED, AND RARE PLANTS IN MENDOCINO AND SONOMA COUNTIES	
Sonoma alopercurus (FE)	*Alopecurus aequalis var. sonomensis*
McDonald's rock cress (FE, SE)	*Arabis macdonaldiana*
Baker's manzanita (R)	*Arctostaphylos bakeri ssp. bakeri*
Vine Hill manzanita (SE)	*Arctostaphylos densiflora*
The Cedars manzanita (R)	*Arctostaphylos bakeri ssp. sublaevis*
Marsh sandwort (FE, SE)	*Arenaria paludicola*
Humboldt milk-vetch (SE)	*Astragalus agnicidus*
Clara Hunt's milk-vetch (FE, ST)	*Astragalus claranus*
Sonoma sunshine (FE, SE)	*Blennosperma bakeri*
Point Reyes blennosperma (R)	*Blennosperma nanum var. robustum*
Thread leaved brodiaea (FT, SE)	*Brodiaea filifolia*

Leafy reed grass (R)	*Calamagrostis foliosa*
White sedge (FE, SE)	*Carex albida*
Pitkin Marsh Indian paintbrush (SE)	*Castilleja uliginosa*
Howell's spineflower (FE, ST)	*Chorizanthe howellii*
Sonoma Spineflower (FE, SE)	*Chorizanthe valida*
Vine Hill clarkia (FE, SE)	*Clarkia imbricata*
Pennell's bird's-beak (FE, R)	*Cordylanthus tenuis ssp. capillaris*
Gowen cypress (FE, SE)	*Cupressus govenana ssp. goveniana*
Baker's larkspur (FE, SE)	*Delphinium bakeri*
Yello larkspur (FE, R)	*Delphinium luteum*
Geysers dichanthelium (SE)	*Dichanthelium lanuginosum var. thermale*
Cuyamaca Lake downingia (SE)	*Downingia concolor var. brevior*
Conejo dudleya (FT)	*Dudleya abramsii ssp. parva*
Kellogg's buckwheat (SE)	*Eriogonum kelloggii*
Loch Lomond button-celery (FE, SE)	*Eryngium constancei*
Menzies' wallflower (FE, SE)	*Erysimum franciscanum*
Roderick's fritillary (SE)	*Fritillaria roderickii*
Water howellia (FT)	*Howellia aquatilis*
Burke's goldfields (FE, SE)	*Lasthenia burkei*
Contra Coasta goldfields (FE)	*Lasthenia conjugens*
Beach layia (FE, SE)	*Layia carnosa*
Western lily (FE, SE)	*Lilium occidentale*
Pitkin Marsh lily (FE, SE)	*Lilium pardalinum ssp. pitkinense*
Sebastopol meadowfoam (FE, SE)	*Limnanthes vinculans*
Baker's meadowfoam (R)	*Limnanthes bakeri*
Sebastopol meadowfoam (FE, SE)	*Limnanthes vinculans*
Milo Baker's lupine (ST)	*Lupinus milo-bakeri*
Tidestrom's lupine (FE, SE)	*Lupinus tidestromii*
Many-flowered navarretia (FE, SE)	*Navarretia leucocephala ssp. plieantha*
Calistoga popcorn flower (FE, ST)	*Plagiobothrys diffuses*
North Coast semaphore grass (ST)	*Pleuropogon hooverianus*
Hickman's cinquefoil (FE, SE)	*Potentilla hickmanii*
Kenwood Marsh checkermallow (FE, SE)	*Sidalcea oregana ssp. valida*
Red Mountain catchfly (SE)	*Silene campanulata ssp. campanulata*
California seablite (FE)	*Suaeda californica*
Santa Ynez false lupine ®	*Thermopsis macrophylla*
Two-fork clover/showy Indian clover) (FE)	*Trifolium amoenum*
Pacific Grove clover (R)	*Trifolium polyodon*

KEY

(FE) — Federal Endangered

(SE) — State Endangered

(FT) — Federal Threatened

(ST) — State Threatened

(R) — State Rare

(C) — Candidate for federal listing

(X) — Critical Habitat designated for this species by federal government

* - No spawning population

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RUSSIAN RIVER
INTEGRATED COASTAL WATERSHED
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APPENDIX 5.
AQUATIC WILDLIFE DOCUMENTED IN THE RUSSIAN RIVER WATERSHED

FISH SPECIES OF THE RUSSIAN RIVER

COMMON NAME	BINOMIAL
Green sturgeon	Acipenser medirostris
White sturgeon	Acipenser transmontanus
American shad (I)	Alosa sapidissima
White catfish (I)	Ameiurus catus
Black Bullhead (I)	Ameiurus melas
Brown bullhead (I)	Ameiurus nebulosus
Sacramento perch (I)	Archoplites interruptus
Goldfish (I)	Carassius auratus
Sacramento sucker	Catostomus ocddentalis
Pacific sanddab	Citharichthys sordidus
Pacific herring	Clupea pallasi
Lake whitefish (I)	Coregonus clupeaformis
Coastrange sculpin	Cottus aleuticus
Prickly sculpin	Cottus asper
Riffle sculpin	Cottus gulosus
Shiner surfperch	Cymatogaster aggregata
Carp (I)	Cyprinus carpio
Northern anchovy	Engraulis mordax
Mosquitofish (I)	Gambusia affinis
Three-spine stickleback	Gasterosteus aculeatus
White croaker	Genyonemus lineatus.
Northern clingfish	Gobiesox maeandricus
California roach	Hesperoleucus symmetricus
Surfsmelt	Hypomesus pretiosus
Russian River tule perch	Hysterocarpus traski pomo
Channel catfish (I)	Ictalurus punctatus
Hybrid sole	Inopsetta ischyra
River lamprey	Lampetra ayresi
Western brook lamprey	Lampetra richardsoni
Pacific Lamprey	Lampetra tridentata
Hitch	Lavinia exilicauda
Staghorn sculpin	Leptocottus armatus
Green sunfish (I)	Lepomis cyanellus
Bluegill (I)	Lepomis macrochirus
Redear sunfish (I)	Lepomis microlophus
Inland silversides (I)	Menidia beryllina
Smallmouth bass (I)	Micropterus salmoides
Largemouth Bass (I)	Micropterus salmoides
Striped bass (I)	Morone saxatilis
Hardhead	Mylopharodon conocephalus
Golden shiner (I)	Notemigonus crysoleucus
Pink salmon	Oncorhynchus gorbuscha
Coho salmon	Onchrhynchus kisutch
Steelhead	Oncorhynchus mykiss
Chinook salmon	Oncorhynchus tshawytscha
Cutthroat trout (I)	Oncorhynchus clarki
Sacramento blackfish (I)	Orthodon microlepidotus
English sole	Parophrys vetulus
Yellow perch (I)	Perca flavescens
Fathead minnow (I)	Pimephales promelas
Starry flounder	Platichthys stellatus
Splittail (I)	Pogonichthys macrolepidotus
White crappie (I)	Pomoxis annularis
Black Crappie (I)	Pomoxis nigromaculatus
Sand sole	Psettichthys melanostictus
Sacramento squawfish	Ptychocheilus grandis
Atlantic salmon (I)	Salmo salar
Brown trout (I)	Salmo trutta
Eastern brook trout (I)	Salvelinus fontinalis
Lake trout (I)	Salvelinus namaycush
Rockfish	Sebastes spp.
Bay pipefish	Syngnathus leptorhynchus

AQUATIC INVERTEBRATES DOCUMENTED IN THE RUSSIAN RIVER

COMMON NAME	BINOMIAL
Slender crab	Cancer gracilis
Yellow crab	Cancer anthonyi
Hairy cancer crab	Cancer jordani
Dungeness crab	Cancer magister
Red crab	Cancer productus
Rock crab	Cancer attenuaris
Kelp crab	Pugettia producta
Shore crab	Hemigrapsus sp.
Bay shrimp	Crangon sp.
Franciscan bay shrimp	Crangon franciscorum
Spotted bay shrimp	Crangon nigromaculata
Laguna lebbeid	Lebbeus lagunae
Oriental shrimp (I)	Palaemon macrodactylus
California black sea hare	Aplysia vaccaria
Signal crayfish	Pacifastacus leniusculus
Red swamp crayfish (I)	Procambarus clarkii
California freshwater shrimp	Syncaris pacifica

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RUSSIAN RIVER
INTEGRATED COASTAL WATERSHED
MANAGEMENT PLAN

APPENDIX 6.
HERPETOFAUNA PREDICTED TO OCCUR IN THE RUSSIAN RIVER WATERSHED

COMMON NAME	SCIENTIFIC NAME
Eastern Tiger Salamander (I)	Ambystoma tigrinum
California Tiger Salamander (FT)	Ambystoma californiense
Northwestern Salamander	Ambystoma gracile
California Giant Salamander	Dicamptodom ensatus
Southern Torrent Salamander	Rhyacotriton vareigatus
Pacific Giant Salamander	Dicamptodon tenebrosus
Rough-skin Newt	Taricha granulosa
California Newt	Taricha torosa
Red-bellied Newt	Taricha rivularis
Common Ensatina	Ensatina eschscholtzi
California Slender Salamander	Batrachoseps attenuatus
Speckled Black Salamander	Aneides flavipunctatus
Arboreal Salamander	Aneides lugubris
Western Tailed Frog	Ascaphus truei
Western Toad	Buto boreas
Pacific Chorus Frog	Pseudacris egilla
Northern Red-Legged Frog	Rana aurora
Foothill Yellow-legged Frog	Rana boylii
Bullfrog (I)	Rana catesbeiana
Western Pond Turtle	Clemmys marmorata
Western Fence Lizard	Sceloporus occidentalis
Sagebrush Lizard	Sceloporus graciosus
Western Skink	Eumeces skiltonianus
Western Whiptail	Aspidoscelis tigris
Southern Alligator Lizard	Elgaria multicarinata
Northern Alligator Lizard	Elgaria coerulea
Rubber Boa (ST)	Charina bottae
Ringneck Snake	Diadophis punctatus
Sharptail Snake	Contia tenuis
Racer	Coluber constrictor
Striped Racer (FT, ST)	Masticophis lateralis
Gopher Snake	Pituophis melanoleucus
Common Kingsnake	Lampropeltis getula
California Mountain Kingsnake	Lampropeltis zonata
Long-nosed Snake	Rhinocheilus lecontei
Common Garter Snake (FE, SE)	Thamnophis sirtalis
Aquatic Garter Snake	Thamnophis atratus
Western Terrestrial Gartner Snake	Thamnophis elegans
Night Snake	Hypsiglena torquata
Western Rattlesnake	Crotalus atrox
Aquatic Garter Snake	Thamnophis atratus

California Department of Fish and Game (CDFG). California Interagency Wildlife Task Group. 2008. CWHR version 8.2 personal computer program. Sacramento, CA.

I — Introduced

FE — Federal Endangered

FT — Federal Threatened

SE — State Endangered

ST — State Threatened

RUSSIAN RIVER
INTEGRATED COASTAL WATERSHED
MANAGEMENT PLAN

APPENDIX 7.
BIRDS PREDICTED TO OCCUR IN THE RUSSIAN RIVER WATERSHED

ORDER	
FAMILY	
COMMON NAME	SCIENTIFIC NAME
ANSERIFORMES	**ANATIDAE**
Greater White-fronted Goose	Anser albifrons
Snow Goose	Chen caerulescens
Ross's Goose	Chen rossii
Brant	Branta bernicla
Canada Goose	*Branta canadensis*
Tundra Swan	*Cygnus columbianus*
Wood Duck	Aix sponsa
Gadwall	Anas strepera
Eurasian Wigeon	Anas penelope
American Wigeon	Anas americana
Mallard	Anas platyrhynchos
Blue-winged Teal	Anas discors
Cinnamon Teal	Anas cyanoptera
Northern Shoveler	Anas clypeata
Northern Pintail	Anas acuta
Green-winged Teal	Anas crecca
Canvasback	Aythya valisineria
Redhead	Aythya americana
Ring-necked Duck	Aythya collaris
Greater Scaup	Aythya marila
Lesser Scaup	Aythya affinis
Harlequin Duck	Histrionicus histrionicus
Surf Scoter	Melanitta perspicillata
White-winged Scoter	Melanitta fusca
Black Scoter	Melanitta nigra
Oldsquaw	*Clangula hyemalis*
Bufflehead	Bucephala albeola
Common Goldeneye	Bucephala clangula
Barrow's Goldeneye	Bucephala islandica
Hooded Merganser	Lophodytes cucullatus
Common Merganser	Mergus merganser
Red-breasted Merganser	Mergus serrator
Ruddy Duck	Oxyura jamaicensis
GALLIFORMES	**PHASIANIDAE**
Ring-necked Pheasant	Phasianus colchicus
Ruffed Grouse	Bonasa umbellus
Sooty Grouse	Dendragapus fuliginosus
Wild Turkey (I)	Meleagris gallopavo
ODONTOPHORIDAE	
Mountain Quail	Oreortyx pictus
California Quail	Callipepla californica
GAVIIFORMES	
GAVIIDAE	
Red-throated Loon	Gavia stellata
Pacific Loon	Gavia pacifica
Common Loon	Gavia immer
PODICIPEDIFORMES	
PODICIPEDIDAE	
Pied-billed Grebe	Podilymbus podiceps
Horned Grebe	Podiceps auritus
Red-necked Grebe	Podiceps grisegena

ORDER	
FAMILY	
COMMON NAME	SCIENTIFIC NAME
Eared Grebe	Podiceps nigricollis
Western Grebe	Aechmophorus occidentalis
Clark's Grebe	Aechmophorus clarkii
PELECANIFORMES	
PELECANIDAE	
American White Pelican	Pelecanus erythrorhynchos
PHALACROCORACIDAE	
Brandt's Cormorant	Phalacrocorax penicillatus
Double-crested Cormorant	Phalacrocorax auritus
Pelagic Cormorant	Phalacrocorax pelagicus
CICONIIFORMES	
ARDEIDAE	
American Bittern	Botaurus lentiginosus
Great Blue Heron	Ardea herodias
Great Egret	Ardea alba
Snowy Egret	Egretta thula
Cattle Egret	Bubulcus ibis
Green Heron	Butorides virescens
Black-crowned Night-Heron	Nycticorax nycticorax
CATHARTIDAE	
Turkey Vulture	Cathartes aura
FALCONIFORMES	
ACCIPITRIDAE	
Osprey	Pandion haliaetus
White-tailed Kite	Elanus leucurus
Bald Eagle (SE)	Haliaeetus leucocephalus
Northern Harrier	Circus cyaneus
Sharp-shinned Hawk	Accipiter striatus
Cooper's Hawk	Accipiter cooperii
Northern Goshawk (SC)	Accipiter gentilis
Red-shouldered Hawk	Buteo lineatus
Swainson's Hawk (ST)	Buteo swainsoni
Red-tailed Hawk	Buteo jamaicensis
Ferruginous Hawk	Buteo regalis
Rough-legged Hawk	Buteo lagopus
Golden Eagle	Aquila chrysaetos
FALCONIDAE	
American Kestrel	Falco sparverius
Merlin	Falco columbarius
Peregrine Falcon	Falco peregrinus
Prairie Falcon	Falco mexicanus
GRUIFORMES	
RALLIDAE	
Black Rail (ST)	Laterallus jamaicensis
California Clapper Rail (FE, SE)	Rallus longirostris obsoletus
Virginia Rail	Rallus limicola
Sora	Porzana carolina
Common Moorhen	Gallinula chloropus
American Coot	Fulica americana
CHARADRIIFORMES	
CHARADRIIDAE	
Black-bellied Plover	Pluvialis squatarola

ORDER	
FAMILY	
COMMON NAME	SCIENTIFIC NAME
Pacific Golden Plover	Pluvialis fulva
Snowy Plover (FT)	Charadrius alexandrinus
Semipalmated Plover	Charadrius semipalmatus
Killdeer	Charadrius vociferous
Mountain Plover (FPT, SE)	Charadrius montanus
RECURVIROSTRIDAE	
Black-Necked Stilt	Himantopus mexicanus
American Avocet	Recurvirostra americana
Scolopacidae	
Greater Yellowlegs	Tringa melanoleuca
Lesser Yellowlegs	Tringa flavipes
Willet	Tringa semipalmata
Wandering Tattler	Tringa incana
Spotted Sandpiper	Actitis macularius
Whimbrel	Numenius phaeopus
Long-billed Curlew	Numenius americanus
Marbled Godwit	Limosa fedoa
Ruddy Turnstone	Arenaria interpres
Black Turnstone	Arenaria melanocephala
Surfbird	Aphriza virgata
Red Knot	Calidris canutus
Sanderling	Calidris alba
Western Sandpiper	Calidris mauri
Least Sandpiper	Calidris minutilla
Baird's Sandpiper	Calidris bairdii
Pectoral Sandpiper	Calidris melanotos
Dunlin	Calidris alpine
Short-billed Dowitcher	Limnodromus griseus
Long-billed Dowitcher	Limnodromus scolopaceus
Wilson's Snipe	Gallinago delicata
Red-necked Phalarope	Phalaropus lobatus
Red Phalarope	Phalaropus fulicaria
LARIDAE	
Bonaparte's Gull	Larus philadelphia
Heerman's Gull	Larus heermanni
Mew Gull	Larus canus
Ring-billed Gull	Larus delawarensis
California Gull	Larus californicus
Herring Gull	Larus argentatus
Thayer's Gull	Larus thayeri
Western Gull	Larus occidentalis
Glaucous-winged Gull	Larus glaucescens
Caspian Tern	Sterna caspia
Common Tern	Sterna hirundo
Forster's Tern	Sterna forsteri
ALCIDAE	
Marbled Murrelet (FT, SE)	Brachyramphus marmoratus
Rhinoceros Auklet	Cerorhinca monocerata
COLUMBIFORMES	
COLUMBIDAE	
Rock Dove (Rock Pigeon) (I)	Columba livia
Band-tailed Pigeon	Patagioenas fasciata
Mourning Dove	Zenaida macroura

ORDER	
FAMILY	
COMMON NAME	SCIENTIFIC NAME
CUCULIFORMES	
Greater Roadrunner	Geococcyx californiaus
STRIGIFORMES	
TYTONIDAE	
Barn Owl	Tyto alba
Flammulated Owl	Otus flammeolus
Western Screech-owl	Megascops kennicottii
Great Horned Owl	*Bubo virginianus*
Northern Pygmy-owl	Glaucidium gnoma
Burrowing Owl	Athene cunicularia
Northern Spotted Owl (FT)	Strix occidentalis
Barred Owl	Strix varia
Long-Eared Owl (SC)	Asio otus
Short-eared Owl (SC)	Asio flammeus
Northern Saw-whet Owl	Aegolius acadicus
CAPRIMULGIFORMES	
CAPRIMULGIDAE	
Common Nighthawk	Chordeiles minor
Common Poorwill	Phalaenoptilus nuttallii
APODIFORMES	
APODIDAE	
Chimney Swift	Chaetura pelagica
Vaux's Swift (SC)	Chaetura vauxi
White-throated Swift	Aeronautes saxatalis
Trochilidae	
Anna's Hummingbird	Calypte anna
Calliope Hummingbird	Stellula calliope
Rufous Hummingbird	Selasphorus rufus
Allen's Hummingbird	Selasphorus sasin
CORACIIFORMES	
Alcedinidae	
Belted Kingfisher	*Ceryle alcyon*
PICIFORMES	
PICIDAE	
Lewis' Woodpecker	Melanerpes lewis
Acorn Woodpecker	Melanerpes formicivorus
Red-breasted Sapsucker	Sphyrapicus ruber
Nuttall's Woodpecker	Picoides nuttallii
Downy Woodpecker	Picoides pubescens
Hairy Woodpecker	Picoides villosus
White-headed woodpecker	Picoides albolarvatus
Northern Flicker	Colaptes auratus
Pileated Woodpecker	Dryocopus pileatus
PASSERIFORMES	
TYRANNIDAE	
Olive-sided Flycatcher (SC)	Contopus cooperi
Western Wood-pewee	Contopus sordidulus
Hammond's Flycatcher	Empidonax hammondii
Dusky Flycatcher	*Empidonax oberholseri*
Pacific-slope Flycatcher	Empidonax difficilis
Black Phoebe	Sayoronis nigricans
Say's Phoebe	Sayornis saya

ORDER	
FAMILY	
COMMON NAME	SCIENTIFIC NAME
Ash-throated Flycatcher	*Myiarchus cinerascens*
Western Kingbird	Tyrannus verticalis
LANIIDAE	
Loggerhead Shrike	Lanius ludovicianus
VIREONIDAE	
Plumbeous Vireo	Vireo plumbeus
Cassin's Vireo	Vireo cassinii
Hutton's Vireo	Vireo huttoni
Warbling Vireo	Vireo gilvus
CORVIDAE	
Gray Jay	Perisoreus canadensis
Steller's Jay	Cyanocitta stelleri
Western Scrub-Jay	Aphelocoma coerulescens
Clark's Nutcracker	Nucifraga columbiana
American Crow	Corvus brachyrhynchos
Common Raven	Corvus corax
Alaudidae	
Horned Lark	Eremophila alpestris
Hirundinidae	
Purple Martin (SC)	Progne subis
Tree Swallow	Tachycineta bicolor
Violet-green Swallow	Tachycineta thalassina
Northern Roughed-winged Swallow	Stelgidoptryx serripennis
Bank Swallow	Riparia riparia
Cliff Swallow	Petrochelidon pyrrhonota
Barn Swallow	Hirundo rustica
Paridae	
Mountain Chickadee	Poecile gambeli
Chestnut-backed Chickadee	Poecile rufescens
Oak Titmouse	Baeolophus inornatus
Aegithalidae	
Bushtit	Psaltriparus minimus
Sittidae	
Red-breasted Nuthatch	Sitta canadensis
White-breasted Nuthatch	Sitta carolinensis
Pygmy Nuthatch	Sitta pygmaea
Certhiidae	
Brown Creeper	Certhia americana
Troglodytidae	
Rock Wren	Salpinctes obsoletus
Canyon Wren	Catherpes mexicanus
Bewick's Wren	Thryomanes bewickii
House Wren	Troglodytes aedon
Winter Wren	Troglodytes troglodytes
Marsh Wren	Cistothorus palustris
Cinclidae	
American Dipper	Cinclus mexicanus
Regulidae	
Golden-crowned Kinglet	Regulus satrapa
Ruby-crowned Kinglet	Regulus calendula
Sylviidae	
Blue-gray Gnatcatcher	Polioptila caerulea
Turdidae	

ORDER	
FAMILY	
COMMON NAME	SCIENTIFIC NAME
Western Bluebird	Sialia mexicana
Mountain Bluebird	Sialia currucoides
Townsend's Solitaire	Myadestes townsendi
Swainson's Thrush	Catharus ustulatus
Hermit Thrush	Catharus guttatus
American Robin	Turdus migratorious
Varied Thrush	Ixoreus naevius
Timaliidae	
Wrentit	Chamaea fasciata
Mimidae	
Northern Mockingbird	Mimus polyglottos
California Thrasher	Toxostoma redivivum
Sturnidae	
European Starling (I)	Sturnus vulgaris
Motacillidae	
American Pipit	Anthus rubescens
Bombycillidae	
Cedar Waxwing	Bombycilla cedrorum
Parulidae	
Oranged-crowned Warbler	Vermivora celata
Nashville Warbler	Vermivora ruficapilla
Yellow Warbler (SC)	Dendroica petechia
Yellow-rumped Warbler	Dendroica coronata
Black-throated Gray Warbler	Dendroica nigrescens
Townsend's Warbler	Dendroica townsendi
Hermit Warbler	Dendroica occidentalis
American Redstart	Setophaga ruticilla
MacGillivray's Warbler	Oporornis tolmiei
Common Yellowthroat	Geothlypis trichas
Wilson's Warbler	Wilsonia pusilla
Yellow-breasted Chat	Icteria virens
Thraupidae	
Western Tanager	Piranga ludoviciana
Emberizidae	
Green-tailed Towhee	Pipilo chlorurus
Spotted Towhee	Pipilo maculatus
California Towhee	Pipilo crissalis
Rufous-crowned Sparrrow	Aimophila ruficeps
Chipping Sparrow	Spizella passerina
Black-chinned Sparrow	Spizella atrogularis
Lark Sparrow	Chondestes grammacus
Sage Sparrow	Amphispiza belli
Savannah Sparrow	Passerculus sandwichensis
Grasshopper Sparrow	Ammodramus savannarum
Fox Sparrow	Passerella iliaca
Song Sparrow	Melospiza melodia
Lincoln's Sparrow	Melospiza lincolnii
White-throated Sparrow	*Zonotrichia albicollis*
Harris' Sparrow	*Zonotrichia querula*
White-crowned Sparrow	*Zonotrichia leucophrys*
Golden-crowned Sparrow	*Zonotrichia atricapilla*
Dark-eyed Junco	*Junco hyemalis*
CARDINALIDAE	

ORDER	
FAMILY	
COMMON NAME	SCIENTIFIC NAME
Black-headed Grosbeak	*Pheucticus melanocephalus*
Lazuli Bunting	*Passerina amoena*
Indigo Bunting	*Passerina cyanea*
ICTERIDAE	
Red-winged Blackbird	*Agelaius phoeniceus*
Tricolored Blackbird (SC)	*Agelaius tricolor*
Western Meadowlark	*Sturnella neglecta*
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
Brewer's Blackbird	*Euphagus cyanocephalus*
Brown-headed Cowbird	*Molothrus ater*
Hooded Oriole	*Icterus cucullatus*
Bullock's Oriole	*Icterus bullockii*
FRINGILLIDAE	
Purple Finch	*Carpodacus purpureus*
Cassin's Finch	*Carpodacus cassinii*
House Finch	*Carpodacus mexicanus*
Red Crossbill	*Loxia curvirostra*
Pine Siskin	*Carduelis pinus*
Lesser Goldfinch	*Carduelis psaltria*
Lawrence's Goldfinch	*Carduelis lawrencei*
American Goldfinch	*Carduelis tristis*
Evening Grosbeak	*Coccothraustes vespertinus*
PASSERIDAE	
House Sparrow(I)	*Passer domesticus*

I - Introduced

FE — Federal Endangered

SE — State Endangered

FT — Federal Threatened

ST — State Threatened

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RUSSIAN RIVER
INTEGRATED COASTAL WATERSHED
MANAGEMENT PLAN

APPENDIX 8.
MAMMALS PREDICTED TO OCCUR IN THE RUSSIAN RIVER WATERSHED

COMMON NAME	SCIENTIFIC NAME
Virginia Opossum (I)	Didelphis virginiana
Vagrant Shrew	Sorex vagrans
Fog Shrew	Sorex sonomae
Ornate Shrew	Sorex ornatus
Water Shrew	Sorex palustris
Marsh Shrew	Sorex bendirii
Trowbridge's Shrew	Sorex trowbridgii
Shrew-mole	Neurotrichus gibbsii
Coast mole	Sacpanus orarius
Broad-footed Mole	Scapanus latimanus
Little Brown Bat (Little Brown Myotis)	Myotis lucifugus
Yuma Myotis	Myotis yumanensis
Long-eared Myotis	Myotis evotis
Fringed Myotis	Myotis thysanodes
Long-legged Myotis	Myotis volans
California Myotis	Myotis californicus
Western Small-footed Myotis	Myotis ciliolabrum
Silver-haired Bat	Lasionycteris noctivagan
Western Pipistrelle	Pipistrellus hesperus
Big Brown Bat	Eptesicus fuscus
Western Red Bat	Lasiurus blossevillii
Hoary Bat	Lasiurus cinereus
Townsend's big-eared bat (SC)	Corynorhinus townsendii
Pallid Bat (SC)	Antrozous pallidus
Brazilian Free-tailed Bat	Tadarida brasiliensis
Brush rabbit	Sylvilagus bachmani
Black-tailed Jackrabbit	Lepus californicus
Mountain Beaver	Aplodontia ruta
Yellow-pine Chipmunk	Neotamias amoenus
Yellow-cheeked Chipmunk	Tamias ochrogenys
Allen's chipmunk	Tamias senex
Sonoma Chipmunk	Tamias sonomae
California Ground Squirrel	Spermophilus beecheyi
Golden-mantled Ground Squirrel	Spermophilus lateralis
Western Gray Squirrel	Sciurus griseus
Douglas' squirrel	Tamiasciurus douglasii
Northern Flying Squirrel	Glaucomys sabrinus
Botta's Pocket Gopher	Thomomys bottae
Western Pocket Gopher	Thomomys mazama
California Kangaroo Rat	Dipodomys californicus
American Beaver	Castor canadensis
Western Harvest Mouse	Reithrodontomys Megalotis
Deer Mouse	Peromyscus maniculatas
Brush Mouse	Peromyscus boylii
Pinyon Mouse	Peromyscus truei
Dusky-footed Woodrat	Neotoma fuscipes
Bushy-tailed Woodrat	Neotoma cinerea
Western Red-backed Vole	Clethrionomys californicus
Sonoma Tree Vole (SC)	Arborimus pomo
California Vole	*Microtis californicus*
Long-tailed Vole	Microtus longicaudus
Creeping Vole	Microtus oregoni
Common Muskrat	Ondatra zibethicus
Black Rat (I)	*Rattus rattus*
Norway Rat (I)	Rattus norvegicus

COMMON NAME	SCIENTIFIC NAME
House Mouse (I)	Mus musculus
Western Jumping Mouse	Zapus princeps
Pacific Jumping Mouse	Zapus trinotatus
Common Porcupine	Erethizon dorsatum
Coyote	Canis latrans
Red Fox (I)	Vulpes vulpes
Gray Fox	Urocyon cinereoargenteus
Black Bear	Ursus americanus
Ringtail	Bassariscus astutus
Raccoon	Procyon lotor
American Marten	Martes americana
Pacific Fisher (SC)	Martes pennanti
Ermine	Mustela frenata
Long-tailed Weasel	Mustela frenata
American Mink	Mustela vison
American Badger (SC)	Taxidea taxus
Western Spotted Skunk	Spilogale gracillis
Striped Skunk	Mephitis mephitis
Northern River Otter	Lontra canadensis
Mountain Lion	Felis concolor
Bobcat	Felis rufus
California Sea Lion	Zalophus californianus
Harbor Seal	Phoca vitulina
Wild Pig	Sus scrofa
Elk	Cervus elaphus
Fallow Deer (I)	Dama dama
Mule Deer	Odocoileus hemionus
Domestic cat (I)	Felis cattus
Domestic dog (I)	Canis familiaris

KEY

Non-native (I)

California Species of Special Concern (SC)

SOURCES

California Department of Fish and Game (CDFG). California Interagency Wildlife Task Group. 2008. CWHR version 8.2 personal computer program. Sacramento, CA.

California Department of Fish and Game. 2011a. Biogeographic Data Branch, California Natural Diversity Database: State & Federally Listed Endangered & Threatened Animals of California.

California Department of Fish and Game. 2011b. Biogeographic Data Branch, California Natural Diversity Database: Special Animals.

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APPENDIX 9.
RUSSIAN RIVER WATERSHED DESIGNATED CULTURAL RESOURCES

NAME	DESIGNATION	COUNTY	LOCATION
Charles M. Schulz, Sonoma County Airport	California Point of Historical Interest	Sonoma	2200 Airport Boulevard, Santa Rosa
Sonoma County Library: Wine Library	California Point of Historical Interest	Sonoma	139 Piper Street, Healdsburg
Frog Woman Rock (formerly Squaw Rock)	California Historical Landmark	Mendocino	6 mi S of Hopland on Hwy 101 (P.M. 5.1)
Sun House	California Historical Landmark	Mendocino	431 S Main St, Ukiah
Ukiah Vichy Springs Resort	California Historical Landmark	Mendocino	2701 Vichy Springs Rd, Ukiah
Cooper's Sawmill	California Historical Landmark	Sonoma	SW corner at Mirabel and River Rds (P.M. 174) near Mirabel Park, 8 mi W of Santa Rosa
Cotati Downtown Plaza	California Historical Landmark	Sonoma	SE corner of Old Redwood Hwy and E Cotati Ave, Cotati
Fort Ross	California Historical Landmark	Sonoma	19005 Coast Hwy, State Hwy 1 (P.M. 33.0), 12 mi N of Jenner
Hood House	California Historical Landmark	Sonoma	Hood Mansion, Santa Rosa Jr College, 7501 Sonoma Hwy (Hwy 12), Santa Rosa
Icaria-Speranza Commune	California Historical Landmark	Sonoma	W side of Asti Rd, 1.68 mi N of Asti Post Office Rd, S of Cloverdale
Italian Swiss Colony	California Historical Landmark	Sonoma	10 mi S on Asti Post Office Rd from Asti Rs, thru Winery Gates, Asti
Luther Burbank Home and Garden	California Historical Landmark	Sonoma	200 block of Santa Rosa Ave, Santa Rosa
Walters Ranch Hop Kiln	California Historical Landmark	Sonoma	6050 Westside Rd, Healdsburg
20th Century Fox Folk Art Environments — John Medica Gardens	California Historical Landmark	Sonoma	5000 Medica Rd, off Stonespring Rd in a gated community, Santa Rosa
Charles Hoffman House	National Register of Historical Places	Mendocino	308 S. School St., Ukiah
Cloverdale Railroad Station	National Register of Historical Places	Sonoma	Railroad Ave., Cloverdale
Held-Poage House	National Register of Historical Places	Mendocino	603 W. Perkins St., Ukiah
Luther Burbank House and Garden	National Register of Historical Places	Mendocino	200 Santa Rosa Ave., Santa Rosa
Palace Hotel	National Register of Historical Places	Mendocino	272 N. State St., Ukiah
Cnopius House	National Register of Historical Places	Sonoma	726 College Ave., Santa Rosa
De Turk Round Barn	National Register of Historical Places	Sonoma	819 Donahue St., Santa Rosa
Dry Creek — Warm Springs Valley's Archaeological District	National Register of Historical Places	Sonoma	Address restricted, Healdsburg vicinity
Duncan's Landing	National Register of Historical Places	Sonoma	Address restricted, Jenner vicinity
Fort Ross Commander's House	National Register of Historical Places	Sonoma	N of Fort Ross on CA 1, Fort Ross State Historical Monument near Jenner
The Gables	National Register of Historical Places	Sonoma	4257 Petaluma Hill Rd., Santa Rosa
Geyserville Union School	National Register of Historical Places	Sonoma	Main St., Geyserville
Gold Ridge Farm	National Register of Historical Places	Sonoma	W of Sebastopol
Gould-Shaw House	National Register of Historical Places	Sonoma	215 N. Cloverdale Blvd., Cloverdale
Guerneville Bridge	National Register of Historical Places	Sonoma	Rt. 116 over Russian River, Guerneville
Healdsburg Carnegie Library	National Register of Historical Places	Sonoma	221 Matheson St., Healdsburg
Hicks House	National Register of Historical Places	Sonoma	3160 Hicks Rd., Graton
Hotel La Rose	National Register of Historical Places	Sonoma	5th and Wilson Sts., Santa Rosa
Isaac E. Shaw Building	National Register of Historical Places	Sonoma	219 N. Cloverdale Blvd., Cloverdale
Laughlin House	National Register of Historical Places	Sonoma	SE of Windsor on Lone Redwood Rd., Windsor
Llano Road Roadhouse	National Register of Historical Places	Sonoma	4353 Gravenstein Hwy., S., Sebastopol
Lumsden House	National Register of Historical Places	Sonoma	727 Mendocino St., Santa Rosa
Madrona Knoll Rancho District	National Register of Historical Places	Sonoma	1001 Westside Rd., Healdsburg
MacDonald Mansion	National Register of Historical Places	Sonoma	1015 McDonald Ave., Santa Rosa
Old Post Office	National Register of Historical Places	Sonoma	425 7th St., Santa Rosa
Park Apartments	National Register of Historical Places	Sonoma	300 Santa Rosa Ave., Santa Rosa
Pinschower House	National Register of Historical Places	Sonoma	302 N. Main St., Cloverdale
Railroad Square District	National Register of Historical Places	Sonoma	Roughly bounded by 3rd, Davis, Wilson, and 6th Sts. and Santa Rosa Creek, Santa Rosa
Rosenburg's Department Store	National Register of Historical Places	Sonoma	700 Fourth St., Santa Rosa
Sebastopol Depot of the Petaluma and Santa Rosa Railway	National Register of Historical Places	Sonoma	261 S. Main St., Sebastopol
SS POMONA (Shipwreck)	National Register of Historical Places	Sonoma	Fort Ross Cove, off Fort Ross Historic State Park, Jenner vicinity
William Hood House	National Register of Historical Places	Sonoma	7501 Sonoma Hwy., Santa Rosa

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APPENDIX 10.
SUMMARY OF POTENTIAL INDICATORS

The following summary of potential indicators for the Russian River watershed was compiled from federal (USEPA 2003, NMFS 2010), state (SWAMP 2006, SWAMP 2010, CDFG 2007), and regional (NCRWQCB 2010) sources. These sources use different terms to describe the "category" of indicators (e.g. NMFS = "Habitat Attributes," SWRCB = "Beneficial Use Category," CDFG = "Inventory Parameter," and NCRWQCB = "Monitoring Parameter") but all include a specific class of indicators, each complementing one or more Russian River watershed attributes: "Habitat Condition," "Water Quality," or "Water Quantity."

SUMMARY OF POTENTIAL ASSESSMENT/ MONITORING INDICATORS

		WATERSHED ATTRIBUTE		
CATEGORY*	INDICATOR	HABITAT CONDITION	WATER QUALITY	WATER QUANTITY
*NOAA/NMFS Habitat Attribute Indicators for Russian River Watershed CCC Coho (NMFS 2010)				
Estuary Function	Score/ Hybrid Indicator	X		
Hydrology	Flow Conditions	X		X
Hydrology	Redd Scour	X		X
Hydrology	Passage Flows (adults to spawning grounds)	X		X
Hydrology	Instantaneous Flow	X		X
Hydrology	Baseflow	X		X
Hydrology	Impervious Surfaces	X		
Hydrology	Stand Age	X		
Land disturbance	Agriculture	X		
Land disturbance	Timber Harvest	X		
Passage (Instream)	Physical Barriers	X		X
Passage (Stream Mouth)	Entry Period	X		X
Pool Habitat	Frequency of Primary Pools	X		
Pool Habitat	LWD Freq. (BFW 0-10)	X		
Pool Habitat	LWD Freq. (BFW 10-100)	X		
Pool Habitat	Shelter Rating	X		
Riparian Vegetation	Stream Shading/ Canopy Cover	X		
Riparian Vegetation	DBH (North)	X		
Riparian Vegetation	DBH (South)	X		
Riparian Vegetation	Species Composition	X		
Sediment	Gravel Quality (Bulk)	X		
Sediment	Embeddedness	X		
Sediment	Spawning gravel quantity & distribution	X		
Sediment Transport	Road Density	X		
Sediment Transport	Road density (Riparian)	X		
Velocity Refuge	Complex Habitat Types	X		
Velocity Refuge	Off-channel Habitats	X		
Velocity Refuge	Floodplain Connectivity	X		
Viability, Population Density	Density (adult, juvenile)	X		
Water Quality, Temperature	Water temperature (MWAT or MWMT)	X	X	
Water Quality, Toxins	Toxicity (Acute)	X	X	
*SWRCB/ SWAMP Core Indicators for Beneficial Uses in California (SWAMP 2010/ SWAMP 2006)				
Aquatic Life/ Wildlife Beneficial Uses	Conventionals: Temperature	X	X	
Aquatic Life/ Wildlife Beneficial Uses	Conventionals: Conductivity	X	X	
Aquatic Life/ Wildlife Beneficial Uses	Conventionals: pH	X	X	
Aquatic Life/ Wildlife Beneficial Uses	Conventionals: Dissolved Oxygen (DO)	X	X	
Aquatic Life/ Wildlife Beneficial Uses	Conventionals: Nutrients	X	X	
Aquatic Life/ Wildlife Beneficial Uses	Conventionals: Metals	X	X	
Aquatic Life/ Wildlife Beneficial Uses	Conventionals: Pesticides	X	X	
Aquatic Life/ Wildlife Beneficial Uses	Conventionals: Bioaccumulative	X	X	
Aquatic Life/ Wildlife Beneficial Uses	Conventionals: Water and/or sediment toxicity	X	X	
Aquatic Life/ Wildlife Beneficial Uses	Biological Conditions: Benthic Macro-invertebrates (BMI, streams)	X	X	
Aquatic Life/ Wildlife Beneficial Uses	Biological Conditions: Chlorophyll (lakes, streams, estuaries)	X	X	
Aquatic Life/ Wildlife Beneficial Uses	Biological Conditions: Algae (periphyton)	X	X	
Aquatic Life/ Wildlife Beneficial Uses	Physical Habitat: PHab (streams)	X	X	
Aquatic Life/ Wildlife Beneficial Uses	Physical Habitat: CRAM (wetlands)	X	X	

		WATERSHED ATTRIBUTE		
CATEGORY*	INDICATOR	HABITAT CONDITION	WATER QUALITY	WATER QUANTITY
Drinking Water Beneficial Uses	Trace metals		X	
Drinking Water Beneficial Uses	Pathogens (Drinking Water Rule, Basin Plan language)		X	
Drinking Water Beneficial Uses	Algae (Microcystis/ Microcystin)		X	
Drinking Water Beneficial Uses	Nitrates		X	
Drinking Water Beneficial Uses	Salinity		X	
Drinking Water Beneficial Uses	Sediments/TDS		X	
Fish/Shellfish Consumption Beneficial Uses	Chemical Indicators: Mercury		X	
Fish/Shellfish Consumption Beneficial Uses	Chemical Indicators: Chlordane		X	
Fish/Shellfish Consumption Beneficial Uses	Chemical Indicators: DDTs		X	
Fish/Shellfish Consumption Beneficial Uses	Chemical Indicators: PCBs		X	
Fish/Shellfish Consumption Beneficial Uses	Enterococci, total and fecal coliform (seawater)		X	
Recreation Beneficial Uses	*E. coli*, enterococci (freshwater)		X	
Recreation Beneficial Uses	Secchi depth for water clarity (lakes)		X	
Recreation Beneficial Uses	Nuisance plant Growth		X	
Recreation Beneficial Uses	Chlorophyll a		X	
Recreation Beneficial Uses	Algae (Microcystis/ Microcystin)		X	
*CDFG Habitat and Biological Inventory Parameters for Russian River Basin Fisheries (CDFG 2007)				
Stream Channel Habitat	Flow	X		X
Stream Channel Habitat	Stream Habitat Type	X		
Stream Channel Habitat	Air and Water Temperature	X	X	
Stream Channel Habitat	Embeddedness	X		
Stream Channel Habitat	Shelter Rating	X		
Stream Channel Habitat	Substrate Composition	X		
Stream Channel Habitat	Canopy	X		
Stream Channel Habitat	Bank Composition	X		

		WATERSHED ATTRIBUTE		
CATEGORY*	INDICATOR	HABITAT CONDITION	WATER QUALITY	WATER QUANTITY
Biological Inventory	Species Diversity	X		
Biological Inventory	Species Distribution	X		
**NCRWQCB Monitoring Parameters, sample for Garcia River Sediment TMDL (NCRWQCB 2011)*				
Instream Condition	Sediment-related barriers	X		
Instream Condition	Embeddedness	X	X	
Instream Condition	Percent fines, gravel composition	X		
Instream Condition	Pool characteristics	X		
Instream Condition	Frequency of Primary Pools	X		
Instream Condition	V* (pools)	X		
Instream Condition	D50 (particle size distribution)	X		
Instream Condition	Volume of large woody debris	X		
Instream Condition	Cross-section	X		
Instream Condition	Thalweg profile	X		
Instream Condition	Miles of open stream channel	X		
Instream Condition	Flow and/or stage height	X		X
Instream Condition	Rainfall			X
Hillslope Condition	Landslides, fluvial, and surface erosion (roads, landings, skid trails)	X	X	
Hillslope Condition	Landslides, fluvial, and surface erosion (agricultural activities)	X	X	
Hillslope Condition	Landslides associated with timber harvest units	X	X	
Hillslope Condition	Stream crossing failures	X	X	
Hillslope Condition	Density of unpaved roads	X	X	

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APPENDIX 11.
DESCRIPTIONS OF PLANS, POLICIES, AND PROGRAMS

The following table provides descriptions of the various Acts, Policies, Plans and Programs that apply to habitats and waters of the Russian River watershed.

DESCRIPTIONS OF FEDERAL, STATE, AND REGIONAL WATERSHED PLANS, POLICIES AND PROGRAMS

TITLE	AGENT	DATE	DESCRIPTION	WATERSHED ATTRIBUTE
OVERARCHING LEGISLATION				
California Environmental Quality Act (CEQA)	CDFG	1970	CEQA is California's broadest environmental law. Guides CDFG during issuance of permits and approval of projects. CEQA applies to all discretionary projects proposed to be conducted or approved by a California public agency.	Habitat Condition Water Quality Water Quantity
California Endangered Species Act (CESA)	CDFG	1984 (Federal 1973)	CESA states that all native species of fishes, amphibians, reptiles, birds, mammals, invertebrates, and plants, and their habitats, threatened with extinction and those experiencing a significant decline which, if not halted, would lead to a threatened or endangered designation, will be protected or preserved.	Habitat Condition Water Quality Water Quantity
Porter-Cologne Water Quality Control Act	SWRCB	1969 2011 Amended	California's comprehensive water quality control law and program to protect beneficial uses. Requires adoption of Basin Plans by RWQCBs and that Basin Plans become part of the CWP.	Water Quality
PLANS AND POLICIES				
Draft Regulations for Groundwater Replenishment with Recycled Water	California Dept. Public Health (CDPH)	2011 Draft	Tbd	Water Quality Water Quantity
Recycled Water Policy	SWRCB	2011	Tbd	Water Quality Water Quantity
Policy for Water Quality Control for Recycled Water	CDPH	2009	Tbd	Water Quality Water Quantity
California Water Plan (CWP) Update 2013	Dept. of Water Resources (DWR)	2011 in Develop-ment	Presents status and trends for water-dependent resources, supplies, and demands. Evaluates regional and statewide management strategies to identify effective actions and policies. Includes Regional Basin Plans.	Habitat Condition Water Quality
Russian River Frost Protection Regulation Policy	SWRCB	2011 2012 EFFECTIVE	Regulations designed to prevent salmon stranding mortality from cumulative effects of diversion of water for frost protection of crops. Database of real-time provisional data available from four Russian River stream gages (water level sensors).	Water Availability Data Availability
Wetland and Riparian Area Protection Policy (WRAPP) Phase I: Wetland Area Protection Policy and Dredge and Fill Regulations	SWRCB	2011 Phase I	Phase I is intended to protect all State waters from dredge and fill discharges. Defines "wetlands;" "riparian" tbd. Assessment framework for collecting and reporting aquatic resource information. Phase 2 (expands scope to other potential threats) and Phase 3 (expands scope to include "Riparian" definition, objectives, and restoration) are in development.	Habitat Condition Water Quality
Policy for Maintaining Instream Flows in Northern California Coastal Streams (North Coast Instream Flow Policy)	SWRCB	2010	Applies to applications to appropriate water, small domestic use and stockpond registrations; and water right petitions. Focuses on protective measures for anadramous fish. Seasonally limits diversions to high-flow periods. Prohibits diversions until streamflows are higher than minimum instream flow needed by fishes. Limits diversion rate to maintain habitat. Considers cumulative effects of diversions on flow. Restricts permitting of new onstream dams. Monitoring and reporting requirements.	Habitat Condition Water Quality Water Availability Data Availability

TITLE	AGENT	DATE	DESCRIPTION	WATERSHED ATTRIBUTE
Workplan for Developing Biological Objectives for Perennial Wadeable Streams in the State of California	SWRCB	2010 DRAFT	Defines a path toward creating biological objectives to protect aquatic resources of the state.	Habitat Condition Water Quality
Water Quality Control Policy for Addressing Impaired Waters: Regulatory Structure and Options (TMDL Policy)	SWRCB	2005	Establishes the State's Total Maximum Daily Load (TMDL) program. TMDL sets limits on the amount of pollutants water can be exposed to before adversely impacting Beneficial Uses of water. Required by Section 303(d) of the Federal CWA, established in 1972.	Water Quality
Water Quality Control Policy for developing California's Clean Water Act Section 303(d) list	SWRCB	2004	Describes the process by which the SWRCB and Regional Boards will comply with the listing requirements of Section 303(d) of the federal Clean Water Act (CWA).	Water Quality
Water Quality Plan for Ocean Waters of California (Ocean Plan)	SWRCB	1972 1990 UPDATE	For Pacific Ocean waters adjacent to the California coast outside enclosed bays, estuaries, and coastal lagoons. Beneficial Uses establishment. Water quality objectives. Effluent quality requirements. Waste discharge prohibitions. Waste management principles. Provides for designation of Areas of Special Biological Significance with special water quality requirements.	Water Quality
Policy on Sources of Drinking Water	SWRCB	1988	Provides full protection to current and potential sources of drinking water standards. Provides conditions for exceptions.	
Nonpoint Source Management Plan	SWRCB	1988	Identifies nonpoint source control programs and milestones. Effluent limitations.	Water Quality
Policy with Respect to Water Reclamation in California	SWRCB	1977	Requires Regional Water Quality Control Boards (i.e. NCRWQCB) to conduct reclamation surveys and actions.	Water Quality
Water Quality Control Policy for the Enclosed Bays and Estuaries of California (Antidegradation Policy)	SWRCB	1974 1995 UPDATE	Water quality principles and guidelines. Prevent degradation of water quality. Protect Beneficial Uses. Does not apply to vessel waste or land runoff except for siltation and sewer flows.	Water Quality
Water Quality Plan for the Control of Temperature in the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California (Thermal Plan)	SWRCB	1972	For thermal characteristics of water and waste discharges. Water quality objectives. Effluent quality limits. Discharge prohibitions.	Water Quality
Statement of Policy with Respect to Maintaining High Quality Waters in California (Antidegradation Policy)	SWRCB	1968	Requires continued maintenance of existing high quality waters. Provides conditions for exceptions.	Water Quality
Water Quality Control Policy for Siting, Design, Operation, and Maintenance of Onsite Wastewater Treatment Systems	NCRWQCB	2011 DRAFT	Requires State to develop statewide regulations for septic systems to ensure surface and ground waters are not contaminated by domestic septic system waste and are safe for Beneficial Uses.	Water Quality
Pathogens in the Russian River Policy	NCRWQCB and Sonoma County Dept. of Health Services	1996	Russian River and tributary monitoring at several sites to determine bacteria abundance and variability (1996-2010). 2011-2012 efforts aimed at development of Russian River Pathogen TMDL. Land use, beach use impacts on bacteria levels. Quality assurance project plans (QUAPP). Establishes bacteria thresholds for human health.	Water Quality Data Availability
Timber Policy	NCRWQCB, CAL FIRE, State Board of Forestry	1972	Regulates discharges from logging and associated timber harvest activities. Timber Harvest Plans (THPs), Habitat Conservation Plans, Sustained Yield Plans reviewed. Participates in TMDL development.	Water Quality
ASSESSMENT/ MONITORING PROGRAMS				
Five Year Coordinated Work Plan for Wetlands Conservation Program Development	CDFG and SWRCB	2011	To assist and support the State's WRAPP. Describes each agency's wetland program activities and how they will coordinate to achieve common goals. Focus is on Regulation; Monitoring and Assessment; Water Quality Standards for Wetlands; and Voluntary Restoration and Protection.	Habitat Condition Water Quality

TITLE	AGENT	DATE	DESCRIPTION	WATERSHED ATTRIBUTE
California Wetland Monitoring Workgroup Tenets of a State Wetland and Riparian Monitoring Program (WRAMP)	California Wetland Monitoring Group	Proposed in 2010	To develop standardized practices and methods to assist and support the State's WRAPP.	Habitat Condition Water Quality
State Water Ambient Monitoring Program (SWAMP)	SWRCB	2000	Assessment of conditions of all surface waters; initial focus on wadeable perennial streams. Included TSMP, SMW, Coastal Fish Contamination Program, Reference Condition Management Program. Will capture data from TMDS, NPS, and Watershed Project Support Programs. Does not monitor effluent or discharge, which is under NPDES permits and Waste Discharge Requirements. Uses the CEDEN database. All data eventually goes to EPA's STORET database.	Habitat Condition Water Quality
Groundwater Ambient Monitoring & Assessment Program	SWRCB	2000	GAMA Collects data on chemicals in groundwater wells. Compiles and reports data on Geo Tracker GAMA.	Water Quality
TITLE	AGENT	DATE	DESCRIPTION	WATERSHED ATTRIBUTE
Inland Surface Waters Toxicity Testing Program	NCRWQCB, UC Davis	1993	Monitoring of acute and chronic toxicity of surface waters. Tests on organismal growth, reproduction, survival. Describes extent, magnitude, type, source of surface toxicity. Focus is on agricultural, mining, and urban areas. Database available.	Habitat Condition Water Quality
The Bay Protection and Toxic Cleanup Program (BPTCP)	SWRCB	1989	Monitoring directed at areas of known or potential contamination of bays and estuarian waters. Identifies and characterizes toxic hotspots. Database available.	Water Quality
State Mussel Watch Program (SMW)	SWRCB, CDFG	1977	Longterm monitoring of geographic and temporal (interannual) trends in toxic pollution on the California coast. Database available 1977 to 2000.	Habitat Condition Water Quality
Toxic Substances Monitoring Program (TSMP)	SWRCB, CDFG	1976	Detection and evaluation of toxic substances in organisms in fresh, estuarine, and marine water from sample stations Some stations monitor long-term trends, others are temporarily established for priority projects as needed. Database available 1978 to 2000.	Habitat Condition Water Quality
North Coast Region Water Quality Monitoring Programs (Various)	NCRWQCB	Various	Discharger Self-Monitoring and Compliance Monitoring as part of National Pollutant Discharge Elimination System (NPDES) permits for ground and surface water Complaint investigation and enforcement as appropriate. Special studies/ intensive surveys/ nonpoint source investigations. Aerial surveys to monitor facilities. Development of water quality models (e.g. for Russian River by DWR).	Water Quality

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APPENDIX 12.
KEY REGULATORY POLICIES AND DECISIONS: MANAGEMENT IMPLICATIONS

NMFS BIOLOGICAL OPINION FOR THE RUSSIAN RIVER

The Biological Opinion prepared by NMFS concluded that the flood control and water supply management activities (notably the operation of Lake Mendocino, Lake Sonoma, the management of the Russian River estuary at Jenner), and the ongoing maintenance of flood control facilities in tributary streams (as proposed by the USACE and the Sonoma County Water Agency) could jeopardize the continued existence of Central California Coast (CCC) steelhead, CCC Coho salmon, and California Coastal Chinook salmon, and therefore prescribes an RPA (Russian River RPA) that the USACE and Sonoma County Water Agency have begun to implement. The operation of Lake Mendocino has been the subject of a Biological Opinion, which was released by NMFS on September 24, 2008 (NMFS, 2008) and as in the case of the Biological Opinion for the PVP, analyzes the impact of project operations on salmon and steelhead.

The Sonoma County Water Agency is obligated to implement the measures specified in the Russian River RPA. Implementation of the Russian River RPA will improve salmonid habitats in the Russian River drainage, but the reduced stream flows will also reduce the dilution capacity of the lower Russian River, an area that currently experiences poor water quality due in part to failing privately-owned domestic septic systems. Implementation of the Russian River RPA will indirectly push regulators to address the sources of water quality impairments in the lower Russian River region, which could necessitate expensive improvements to existing sewage treatment facilities, and additional measures to control non-point pollution.

More information at:
http://www.swr.noaa.gov/pdf/Signed-Russian_River_Final_BO_9-24-08.pdf

POTTER VALLEY HYDROELECTRIC PROJECT

The operation of the Potter Valley Hydroelectric Project (PVP) has been a source of controversy on the North Coast for many years and the subject of extensive and continuing litigation (Langridge, 2002; FERC, 2002; FERC, 2009). Historically, the PVP diverted approximately 160,000 acre-feet from the Eel River to the East Fork. However, in 2004 the Federal Energy Regulatory Commission (FERC) amended the hydroelectric license for the PVP pursuant to a Biological Opinion issued by the National Marine Fisheries Service (NMFA) on November 26, 2002 (NMFS, 2002). Implementation of the Biological Opinion has significantly reduced diversions to the Russian River.

The Biological Opinion, which addressed the effects of the PVP on salmon and steelhead in the Eel River, concluded that operation of the PVP, as proposed by PG&E, would likely "...jeopardize the continued existence of southern Oregon/Northern California Coho Salmon, California Coastal Chinook Salmon, and Northern California Steelhead", and therefore in accordance with federal law, included a "reasonable and prudent alternative" (RPA) designed to modify project operations, so as to avoid jeopardizing the above listed fish species. The findings of the Biological Opinion and implementation of the RPA has been the subject of considerable debate and controversy. Key points of contention include the adequacy of the RPA with respect to the protection of salmon and steelhead fish species in the Eel River, and the degree to which agricultural and urban water supplies in the Russian River drainage have been and will continue to be reduced as a result of RPA implementation.

The Final Environmental Impact Statement (FEIS) prepared in support of the PVP license amendment concluded that implementation of the RPA would reduce diversions to the Russian River by an average of 15 percent (FERC, 2000). Implementation of the RPA and more specifically, operation of Lake Pillsbury and the application of the criteria dictating PVP water diversions has not occurred as anticipated in the FEIS. Water diversions to the Russian River have been reduced by as much as 60 percent, and it is now apparent that implementation of the RPA and the criteria that dictates PVP water diver-

sions, as currently crafted and interpreted, reduces annual diversions to the Russian River by an average of 40 to 50 percent. The reduced PVP diversions have had a significant impact on storage levels at Lake Mendocino and in turn the availability and reliability of the Lake Mendocino water supply.

The PVP diversions provide much of the available inflow to Lake Mendocino during the summer and fall of all years, and nearly all inflow during critically dry years (MCWA, 2010). Without the PVP water diversions, Lake Mendocino water levels during the late summer and fall of most years would be substantially lower and the ability for Lake Mendocino to provide a reliable water supply severely curtailed. The reduced storage will limit Lake Mendocino's ability to augment summer and fall stream flows in the Russian River main stem, upstream of the Dry Creek confluence and as a result, emergency measures, such as further reductions in stream flow, or the development of additional water supplies, may be needed to replace the diminished water supply of Lake Mendocino. Although limited, the available data suggest that the impact of the Potter Valley Project's RPA on Lake Mendocino storage will be largely, but not completely, offset through implementation of the revised minimum instream flow regime specified by the Russian River RPA (see discussion of NMFS Biological Opinion for the Russian River).

More information at:
http://eelriver.org/about/potter-valley-project-dams/

ASSESSMENT OF WATER RIGHTS DECISION 1610

Water Rights Decision 1610 (D1610), which was adopted by the State Water Resources Control Board in 1986 (SWRCB, 1986), amended the Sonoma County Water Agency's water rights to the Russian River and lakes Mendocino and Sonoma, and prescribed minimum instream flow requirements downstream of Coyote and Warm Springs dams. Since the adoption of D1610 steelhead, Coho and Chinook salmon populations in the Russian River drainage have been listed as either threatened or endangered, pursuant to the Federal Endangered Species Act. On September 24, 2008 the National Marine Fisheries Service issued a Biological Opinion that among other things concludes that the instream flow requirements prescribed by D1610 are at times excessive and deleterious to federally listed steelhead, Coho and Chinook salmon populations in the Russian River. The Biological Opinion requires the Sonoma County Water Agency to undertake a number of actions, most notably to petition the State Water Resources Control Board to modify the minimum instream flow requirements specified by D1610 so as to reflect the minimum instream flow recommendations prescribed by the Biological Opinion.

On September 23, 2009 the Sonoma County Water Agency complied with the Biological Opinion directive and filed a petition with the State Water Resources Control Board to modify the instream flow requirement set forth in D1610. The scope of the Sonoma County Water Agency's petition is limited to the modification of minimum instream flow requirements. However, other parties have suggested that the reopening of Water Rights Decision 1610 is an opportune time to address other issues, such as the water rights associated with Lake Mendocino and more specifically, the degree to which additional water may or may not be available for appropriation, the degree to which the Potter Valley FERC decision may or may not have reduced the sustainable yield of Lake Mendocino, and the degree to which implementation of the Russian River RPA may or may not offset the water supply impacts of the Potter Valley FERC Decision. The State Water Resources Control Board has circulated the Sonoma County Water Agency's petition for public comment and will at some point schedule one or more hearings to review the substantive issues associated with the petition. For planning purposes it is assumed that the administrative process for modifying D1610 will be completed in 2016.

The forthcoming assessment of D1610, which in addition to prescribing minimum instream flows downstream of Coyote and Warm Springs dams allocates the Russian River water supply , possibly provides the best opportunity to develop and implement a comprehensive solution to long standing water supply issues in the Mendocino County portion of the Russian River drainage, and to adjust water supply allocations to reflect the impact of the Potter Valley FERC Decision and the Biological Opinion for the Russian River on the sustainable yields of the Lake Mendocino water supply. Alternatives include the courts, which hold concurrent jurisdiction over water rights, and state and federal legislation.

At the very least, it is anticipated that the forthcoming Decision 1610 Water Right hearings will result in the implementation of the minimum instream flow criteria specified in the Russian River RPA. Whether or not the issues surrounding the current allocation of Lake Mendocino's water supply are addressed at that time, they will continue to exist, and if not

addressed during the forthcoming hearings, will need to be addressed at some time in the future.

More information at: http://www.swrcb.ca.gov/waterrights/board_decisions/adopted_orders/decisions/d1600_d1649/wrd1610.pdf

MINIMUM INSTREAM FLOW: NORTH COAST INSTREAM FLOW POLICY

The North Coast Instream Flow Policy was adopted by the SWRCB on May 4, 2010 in response to the precipitous decline of salmonid populations in coastal streams, from the Mattole River in Humboldt County to San Francisco Bay, and coastal streams entering San Pablo Bay (SWRCB, 2010). The North Coast Instream Flow Policy has been adopted as a stop-gap measure to halt if not reverse the ongoing diminuation of endangered salmonid fish populations in the policy area. If populations continue to decline it is likely that increasingly stringent regulations will be enacted. Accordingly, stabilizing and restoring salmonid fish populations is essential in order to preclude additional regulation, and for any hope of repealing or relaxing existing regulations, as they pertain to the Russian River drainage.

The policy establishes operational parameters for water diversions (minimum by pass flow requirements, maximum annual diversion amounts and season of diversion limitations) to ensure that sufficient stream flows are reserved for the protection of fishery resources. In general, the water diversion guidelines set forth by the North Coast Instream Flow Policy are more restrictive than historically prescribed for North Coast streams, and because of their restrictiveness, a source of controversy, particularly within the agricultural community. In addition to increasing the cost of lawfully initiating and maintaining a water diversion facility, implementation of the North Coast Instream Flow Policy will further restrict and in some instances preclude the development of surface water resources, particularly in small tributary drainages where the opportunities to divert and store water are limited to brief periods during major storm events.

The North Coast Instream Flow Policy includes provisions for groups of individuals and entities within a common geographic area to coordinate the development and operation of their respective water diversions. This approach, identified and described as the "watershed-based approach," offers several advantages, most notably, potentially reducing the expense and amount of time required to secure regulatory approvals while enhancing the effectiveness of the Policy, vis-à-vis the protection of fishery resources. However, the watershed-based approach does require participants to coordinate technical studies and the submission of information to the State Water Resources Control Board. In many instances potential participants lack the expertise, time and/or financial resources to develop such an agreement. Existing organizations, watershed groups and most notably Resource Conservation Districts could potentially fulfill the coordinating role.

Compliance with the North Coast Instream Flow Policy will typically require professional engineering, hydrologic and/or biologic expertise to plan, design and construct even relatively modest water diversion facilities. In many cases information required to design a water diversion facility in compliance with the North Coast Instream Flow Policy, such as the upstream limit of anadromy, are not readily available to private individuals, or else there is conflicting information.

Implementation of the North Coast Instream Flow Policy will restrict the availability of surface water supplies, which will encourage the development of alternative water supplies such as groundwater (if available) and/or change water use practices to reflect the diminished availability of affordable water supplies. In some instances the diminished availability of affordable water supplies may preclude certain land uses, such as irrigated agriculture.

More information at:
http://www.swrcb.ca.gov/waterrights/water_issues/programs/instream_flows/

FROST PROTECTION FOR AGRICULTURAL PURPOSES

During cold nights in the spring water is used to protect the emerging buds from grapevines and pear trees from being damaged by frost and freezing conditions. According to the SWRCB, frost protection of crops is a beneficial use of water (i.e. Agrucultural). However, simultaneous demand for water by the watershed's growers may lower stream levels to the point where fishes become stranded and die. This can be avoided by better coordinating and regulating frost diversion rates in accordance with an approved Water Demand Management Program (WDMP; the first of these are due Feb 1, 2012). After March 14, 2012, any diversions from waters of the Russian River stream system (including hydraulically-connected groundwater) without preapproval of a WDMP will constitute an "unreasonable use of water" and water diverters will be in violation of the state's Water Code. Stream monitoring efforts will be required. The cost of monitoring for individuals is likely to encourage

local growers' joint participation in WDMP governing bodies (although governing bodies may be individuals). The governing bodies, in consultation with NMFS and CDFG may conduct stream surveys to evaluate the potential for stranding mortality of salmonids.

More information at: http://www.swrcb.ca.gov/waterrights/water_issues/programs/hearings/russian_river_frost/docs/factsheet.pdf

PERCOLATING GROUNDWATER VERSUS UNDERFLOW

Within recent years the State Water Resources Control Board has asserted that essentially all of the groundwater in the Ukiah Valley and at least some of the valleys traversed by the Russian River is "underflow" as opposed to "percolating groundwater", and therefore a water source that is subject to the State Water Resources Control Board's regulatory jurisdiction. Underflow is defined as groundwater that is flowing through a well-defined subterranean channel, while percolating groundwater is defined as water that is widely dispersed and is not part of a subterranean stream. The State Water Resources Control Board's assertions are supported in part by recent court cases, in which groundwater flowing through relatively narrow valleys was deemed underflow by the courts (SWRCB, 1999; 2003).

Pursuant to existing law, subterranean streams flowing through known and definite channels are governed by the same rules that apply to surface streams. Consequently, for regulatory purposes, the right to divert and use underflow is typically made under a riparian or appropriative water right: riparian if the underflow source is taken from and used on the same legal parcel, appropriative if the water is taken from a subterranean stream beneath one legal parcel and used on another parcel and/or impounded and stored for more than 30 consecutive days.

There are currently hundreds of groundwater wells in the various valleys traversed by the Russian River. In the event that it is concluded, perhaps by the courts, that these wells are drawing underflow as opposed to percolating groundwater, many if not all of the affected landowners could be forced to apply for appropriative water rights in order to lawfully pump water from their wells. Because the Russian River is fully appropriated between the months of July through October (SWRCB 1998), it remains unclear whether or not some if not all of the appropriative water right applications for existing groundwater wells would be denied, or granted but with season-of-use restrictions that would prohibit or at least curtail groundwater extractions during the summer and fall. Applications to extract underflow from new groundwater wells would most likely be subject to the same season-of-use restrictions imposed on new applications for surface water diversions and would be junior to any preexisting underflow or surface water diversions.

A determination that much of the available groundwater in the Russian River drainage is underflow as opposed to percolating groundwater will most likely limit the availability of groundwater supplies, particularly during the summer and fall, which would in turn restrict the continuation and expansion of some land uses and would create additional demand for surface water sources to meet future and existing water demands.

More information at:
http://www.russianriverkeeper.org/issues/laws/laws.php

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APPENDIX 13.
DESCRIPTIONS OF BENEFICIAL USES

Full text descriptions of the beneficial uses of water as defined in Section 5.4.2 are included bleow, along with the abbreviation/ code referenced by the SWRCB and NCRWQCB.

Descriptions of Beneficial Uses in the Russian River Hydrologic Unit

BENEFICIAL USE	CODE	DESCRIPTOR
Agricultural Supply	AGR	Uses of water for farming, horticulture, or ranching including, but not limited to, irrigation, stock watering, or support of vegetation for range grazing.
Aquaculture	AQUA	Uses of water for aquaculture or mariculture operations including, but not limited to, propagation, cultivation, maintenance, or harvesting of aquatic plants and animals for human consumption or bait purposes.
Cold Freshwater Habitat	COLD	Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic habits, vegetation, fish, or wildlife, including invertebrates.
Commercial and Sport Fishing	COMM	Uses of water for commercial, recreational (sport) collection of fish, shellfish, or other aquatic organisms including, but not limited to, uses involving organisms intended for human consumption or bait purposes.
Estuarine Habitats	EST	Uses of water that support estuarine ecosystems including, but not limited to, preservation or enhancement of estuarine habitats, vegetation, fish, shellfish, or wildlife (e.g., estuarine mammals, waterfowl, shorebirds).
Flood Peak Attenuation/ Flood Water Storage	FLD	Uses of riparian wetlands in flood plain areas and other wetlands that receive natural surface drainage and buffer its passage and receiving waters.
Freshwater Replenishment	FRSH	Uses of water for natural or artificial maintenance of surface water quantity or quality (e.g. salinity).
Groundwater Recharge	GWR	Uses of water for natural or artificial recharge of groundwater for purposes of future extraction, maintenance of water quality, or halting of saltwater intrusion into freshwater aquifers.
Hydropower Generation	POW	Uses of water for hydropower/ hydroelectric generation.
Industrial Process Supply	PRO	Uses of water for industrial activities that depend primarily on water quality.
Industrial Service Supply	IND	Uses of water for industrial activities that do not depend primarily on water quality including, but not limited to, mining, cooling water supply, hydraulic conveyance, gravel washing, fire protection, or oil well repressurization.
Inland Saline Water Habitat	SAL	Uses of water that support cold water ecosystems including, but not limited to, preservation or enhancement of aquatic saline habitats, vegetation, fish, or wildlife, including invertebrates.
Marine Habitat	MAR	Uses of water that support marine ecosystems including, but not limited to, preservation or enhancement of marine habitats, vegetation such as kelp, fish, shellfish, or wildlife (e.g., marine mammals, shorebirds).
Migration of Aquatic Organisms	MIGR	Uses of water that support habitats necessary for migration or other activities by aquatic organisms, such as anadramous fish.
Municipal and Domestic Supply	MUN	Uses of water for community, military, or individual water supply systems including, but not limited to, drinking water supply.
Native American Culture	CUL	Uses of water that support the cultural and/or traditional rights of indigenous people such as subsistence fishing and shellfish gathering, basket weaving and jewelry material collection, navigation to traditional ceremonial locations, and ceremonial uses.
Navigation	NAV	Uses of water for shipping, travel, or other transportation by private, military or commercial vehicles.
Non-Contact Water Recreation	REC-2	Uses of water for recreational activities involving proximity to water, but not normally involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.
Preservation of Areas of Special Biological Significance	ASBS	Includes marine life refuges, ecological reserves and designated areas of special biological significance, such as areas where kelp propagation and maintenance are features of the marine environment requiring special protection.
Rare, Threatened, or Endangered Species	RARE	Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under state or federal law as rare, threatened, or endangered.
Shellfish Harvesting	SHELL	Uses of water that support habitats suitable for the collection of filter-feeding shellfish (e.g., clams, oysters, and mussels) for human consumption, commercial, or sports purposes
Spawning, Reproduction, and/or Early Development	SPWN	Uses of water that support high quality aquatic habitats suitable for reproduction and early development of fish.
Subsistence Fishing	FISH	Uses of water that support subsistence fishing.

BENEFICIAL USE	CODE	DESCRIPTOR
Warm Freshwater Habitat	WARM	Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.
Water Contact Recreation	REC-1	Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white-water activities, fishing, or use of natural hot springs.
Water Quality Enhancement	WQE	Uses of waters, including wetlands and other Waterbodies, that support natural enhancement or improvement of water quality in or downstream of a waterbody including, but not limited to, erosion control, filtration and purification of naturally occurring water pollutants, streambank stabilization, maintenance of channel integrity, and siltation control.
Wetland Habitat	WET	Uses of water that support natural and man-made wetland ecosystems, including, but not limited to, preservation or enhancement of unique wetland functions, vegetation, fish, shellfish, invertebrates, insects, and wildlife habitat.
Wildlife Habitat	WILD	Uses of water that support terrestrial ecosystems including, but not limited to, preservation or enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.

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APPENDIX 14.
BENEFICIAL USES IDENTIFIED FOR HYDROLOGIC SUB-AREAS AND WATERBODIES OF THE RUSSIAN RIVER WATERSHED

TABLE 1. BENEFICIAL USES IDENTIFIED FOR HYDROLOGIC SUB-AREAS OF THE RUSSIAN RIVER HYDROLOGIC UNIT																								
	AGRICULTURAL SUPPLY	AQUACULTURE	COLD FRESHWATER HABITAT	COMMERCIAL & SPORT FISHING	ESTUARINE HABITAT	FLOOD ATTENUATION/STORAGE	FRESH WATER REPL ENISHMENT	GROUND WATER RECHARGE	INDUSTRIAL SERVICE SUPPLY	MIGRATION OF AQUATIC ORGANISMS	MUNICIPAL & DOMESTIC SUPPLY	NAVIGATION	NATIVE AMERICAN CULTURAL	POWER GENERATION (HYDROELECT.)	INDUSTRIAL PROCESS SUPPLY	RARE, THREATENED, END. SPECIES	RECREATION, NON-WATER-CONTACT	RECREATION, WATER CONTACT	SHELLFISH HARVESTING	SPAWN, REPRO, EARLY DEV. FISHES	WARM FRESHWATER HABITAT	WATER QUALITY ENHANCEMENT	WETLAND HABITAT	WILDLIFE HABITAT
HYDROLOGIC SUB-AREAS	**BENEFICIAL USES[1]**																							
Lower Russian River Hydrologic Area																								
Guerneville	E	P	E	E	E		E	E	E	E	E	E		P	P	E	E	E	P	E	E			E
Austin Creek	E	P	E	E			E	E	E	E	E	E		P	P	E	E	E	E	E	E			E
MIDDLE RUSSIAN RIVER HYDROLOGIC AREA																								
Laguna	E	P	E	E			E	E	E	E	P	E		E	P	E	E	E	P	E	E			E
Santa Rosa	E	P	E	E			E	E	E	E	E	E		P	P	E	E	E	P	E	E			E
Mark West	E	P	E	E			E	E	E	E	E	E		P	P	E	E	E	P	E	E			E
Warm Springs	E	E	E	E			E	E	E	E	E	E		E	P	E	E	E		E	E			E
Geyserville	E	P	E	E			E	E	E	E	E	E		P	P	E	E	E	P	E	E			E
Sulphur Creek	E	P	E	E			E	E	E	E	E	E		P	P	E	E	E		E	E			E
UPPER RUSSIAN RIVER HYDROLOGIC AREA																								
Ukiah	E	P	E	E			E	E	E	E	E	E		E	P	E	E	E	P	E	E			E
Coyote Valley	E	P	E	E			E	E	E	E	E	E		E	P	E	E	E		E	E			E
Forsythe Creek	E	P	E	E				E	E	E	E	E		P	P	E	E	E		E	E			E
Specific Waterbodies: See Table 5.15(b)																								

Source: NCRWQCB 2011

TABLE 2. BENEFICIAL USES IDENTIFIED FOR SPECIFIC WATERBODIES OF THE RUSSIAN RIVER HYDROLOGIC UNIT																										
	AGRICULTURAL SUPPLY	AQUACULTURE	AREAS OF SPECIAL BIOLOGICAL SIGNIFICANCE	COLD FRESHWATER HABITAT	COMMERCIAL & SPORT FISHING	ESTUARINE HABITAT	FLOOD ATTENUATION/STORAGE	FRESH WATER REPLENISHMENT	GROUND WATER RECHARGE	INDUSTRIAL SERVICE SUPPLY	MARINE HABITAT	MIGRATION OF AQUATIC ORGANISMS	MUNICIPAL & DOMESTIC SUPPLY	NAVIGATION	NATIVE AMERICAN CULTURAL	POWER GENERATION (HYDROELECT.)	INDUSTRIAL PROCESS SUPPLY	RARE, THREATENED, END. SPECIES	RECREATION2 NON-WATER-CONTACT	RECREATION1 WATER CONTACT	SHELLFISH HARVESTING	SALINE, INLAND WATER HABITAT	SPAWN, REPRO, EARLY DEV. FISHES	WARM FRESHWATER HABITAT	WATER QUALITY ENHANCEMENT	WETLAND HABITAT	WILDLIFE HABITAT
TYPE	**BENEFICIAL USES[2]**																									
Minor Coastal Streams[3]	P	P		P	E	E		P	P	P	P	P	E	P	P		P	E	P	P			P	P			E
Ocean Waters		E	P		E					P	E	E		E			P	E	E	E	E		E				E
Bay		P		E	E	P				P	E	E		E	P		P	P	E	P	E		E	P			E
Saline Wetlands		P		P	P	P		P	P	P	P	P		P	P			P	P	P	P	P	P	P			P
Freshwater Wetlands	P	P		P	P	P	P	P	P	P		P	P	P	P			P	P	P	P		P	P	P	E	P
Estuary	P	P		E	P	E	P	P		P	E	E	P	E	P	P	P	P	E	E	E		E	P	P	E	E
Ground-water	E	P								E			E		E		P										

Source: NCRWQCB

Beneficial Uses Designated for the Russian River Watershed (NCRWQCB 2011)

(FOOTNOTES)

1 P=Potential Use, E=Existing Use, as defined in NCRWQCB 2011.

2 P=Potential Use, E=Existing Use, as defined in NCRWQCB 2011.

3 Those not listed in Table1, Beneficial Uses Identified for Hydrologic Sub-Areas of the Russian River Hydrologic Unit

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APPENDIX 15.
RECOMMENDATIONS FOR THE RUSSIAN RIVER WATERSHED FROM AGENCY AND PEER-REVIEWED DOCUMENTS AND EXPERT INTERVIEWS

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
California Department of Water Resources. California Water Plan 2005 Update. December, 2005	Regional efforts should incorporate integrated resource planning to meet multiple water management objectives consistent with the principles advanced in this water plan.	Socioeconomic	Russian River HU	59
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Implement high-priority coho salmon habitat restoration programs and projects.	Coho Population Recovery	Mainstem Russian River	57
Sonoma County Water Agency. Russian River Action Plan. May, 2003	Russian River Tributary Restoration and Landowner Outreach	Socioeconomic	Russian River HU	55
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Restore or minimize impacts to watershed processes (e.g., riparian, sediment transport, hydrology and estuary function).	Coho Population Recovery	Russian River HU	55
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Expand abilities to provide financial assistance and technical advice to private landowners and grassroots groups conducting conservation or restoration activities.	Socioeconomic	Laguna de Santa Rosa HSA	54
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Implement measures to improve instream coho salmon habitat conditions.	Habitat Availability	Mark West HSA	53
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Improve survival at all life stages by improving the spatial and temporal pattern of surface flows throughout spawning, rearing, and migration areas.	Coho Population Recovery	Russian River HU	53
California Department of Water Resources. California Water Plan 2005 Update. September, 2008	DWR will adapt its expertise, resources, and existing programs and develop new ones to give incentives and technical assistance to regional and local agencies and governments to prepare comprehensive, integrated water management plans that include actions to protect public trust resources and promote efficient, beneficial water use. DWR will develop the necessary tools to assist local and regional agencies be successful with the integrated regional water management and planning and will monitor the development and implementation of these plans to ensure an equitable distribution of technical and financial assistance in planning efforts. Data from these plans can be integrated into future California water plan updates.	Socioeconomic	Russian River HU	52
Sotoyome Resource Conservation District. Austin Creek Watershed Assessment. October, 2005	Watershed restoration and management is needed to address aquatic habitat issues	Habitat Protection	Austin Creek HSA	51
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Develop county strategies for "prioritizing fishery protection and restoration actions within individual watersheds throughout the counties (Harris et al. 2001)."	Fisheries Protection	Russian River HU	50
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Implement appropriate recommendations to offset impacts from county policies and operations, as developed by the FishNet program.	Habitat Protection	Russian River HU	50
Mendocino County Water Agency. Interviewee Roland Sanford. 3/15/2011	The future of water agencies is to become resource management agencies. They don't just treat and deliver water. They pull the water from a natural system, so have a direct link that needs to become part of the management strategy. Several water districts throughout the state are heading in this direction; SCWA is one.	Resource Management	Russian River HU	49
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Upgrade the Russian River Basin Plan to benefit coho salmon	Coho Population Recovery	Russian River HU	48
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Develop a campaign and clear guidelines to "balance habitat protection and land development."	Habitat Protection	Russian River HU	48
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Expand and coordinate multiagency research and planning efforts evaluating Laguna hydrology and hydraulics at the scale of the entire watershed as well as in targeted planning areas, to provide sound information on which to base water management decisions involving restoration, flood protection, water quality and quantity, water conservation measures, groundwater withdrawals, and recycled water discharges.	Science	Laguna de Santa Rosa HSA	47

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Sonoma County Water Agency. Russian River Action Plan. March, 2003	Fisheries Enhancement Program (FEP)	Fisheries Protection	Russian River HU	47
Sonoma County Water Agency. Russian River Action Plan. May, 2003	North Bay KRIS Program	Fisheries Protection	Russian River HU	47
California Department of Water Resources. California Water Plan 2005 Update. December, 2005	Local and regional planners diversify and increase the resource management strategies in their integrated regional water management plans.	Socioeconomic	Russian River HU	46
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. March, 2007	Market a "save the river" message that encourages community members to "think outside the box" for the protection of watershed resources and support elected officials and entities that provide incentives for the implementation of "outside the box" strategies and better management practices.	Socioeconomic	Russian River HU	46
Sonoma County Water Agency. Russian River Action Plan. March, 2003	Forsythe Creek Watershed Implementation	Habitat Availability	Forsythe Creek HSA	46
Sonoma County Water Agency. Interviewee David Manning. 3/28/2011	The ACE needs to allocate federal funds to manage projects and comply with BO related requirements to improve management of flows and to maintain fish habitat. Federal funds and authority to make the improvements need to be secured. Mike Dillabough, from ACE, has an excellent understanding of federal roles/responsibilities in the Russian River.	Fisheries Protection	Mainstem Russian River	46
City Council of Healdsburg. Healdsburg 2030 General Plan Policy Document. 2009, amended 2011	Conservation and restoration of Healdsburg's native plants and wildlife, ecosystems and waterways.	Habitat Protection	Guerneville HSA	45
Mendocino County Farm Bureau. Interviewee Devon Jones, Executive Director. 3/18/2011	Support for agricultural based groups such as URSA (the Upper Russian Stewardship Alliance) to work on collaborative approaches to maintain agricultural operations while encouraging environmental stewardship.	Socioeconomic	Ukiah HSA	45
California Coastal Sediment Management Workgroup. California Coastal Sediment Master Plan Status Report. September, 2008	Help facilitate long term solutions to Sediment Management such as bypassing around dams, removal of developments/setback policies for floodplains, and restoration of natural creek environment.	Resource Management	Russian River HU	43
Sotoyome Resource Conservation District. Maacama Creek Watershed Assessment. March, 2005	Watershed - based restoration and land management approach is necessary	Resource Management	Geyserville HSA	43
Russian River Keeper. Interviewee Don McEnhill. 3/28/2011	Win win projects that help farmers/ranchers that also help the streams and river need to be embraced and expanded.	Resource Management	Russian River HU	43
California Coastal Sediment Management Workgroup. California Coastal Sediment Master Plan Status Report. September, 2008	Assist local/regional entities establish priorities, and coordinate regional strategies for each of the state's coastal regions and littoral cells.	Resource Management	Russian River HU	42
California Coastal Sediment Management Workgroup. California Coastal Sediment Master Plan Status Report. September, 2008	Develop Regional Sediment Management Plans that emphasize and reflect regional differences across CA.	Resource Management	Russian River HU	42
California Department of Water Resources. California Water Plan 2009 Update Pre-Administrative Draft Volume I The Strategic Plan. October, 2008	Regional partnerships should develop and update Integrated Regional Water Management plans in close coordination with local General Plans, State, federal and Tribal land management plans, transportation Regional Blueprint Plans, and energy, ecosystem, and resource plans.	Socioeconomic	Russian River HU	42
California Department of Water Resources. California Water Plan 2009 Update Pre-Administrative Draft Volume I The Strategic Plan. October, 2008	State government should manage California's water resources with ecosystem health and water supply reliability as co-equal goals, and should protect public trust resources.	Socioeconomic	Russian River HU	42
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Adapt and/or develop informational and outreach materials about existing regulations, permitting processes, land use development decisions, and appropriate contacts at all levels of government for distribution to agencies and the public.	Socioeconomic	Russian River HU	42
Mendocino County Farm Bureau. Interviewee Devon Jones, Executive Director. 3/18/2011	The goal is to be able to sustain agriculture and the fishery simultaneously in the Russian River Watershed	Fisheries Protection	Ukiah HSA	42
Russian River Keeper. Interviewee Don McEnhill. 3/28/2011	Continuing programs like Fish Friendly Farming, the Code of Sustainable Farming is important, but those programs need to be updated and include an improved/rigorous follow-up of the ranch and farm practices.	Resource Management	Russian River HU	42

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Adopt remaining recommendations of the Fishnet 4C Program Report, work with community, stakeholder groups, and state and federal agencies to ensure timeliness of implementation and technical support for permitting and funding.	Fisheries Protection	Russian River HU	41
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Instream habitat improvements as well as upslope mapping and restoration are needed in virtually every stream.	Habitat Availability	Ukiah HSA	41
UC Berkeley & Hopland Research & Extension Center, Environmental Science Policy and Management. Interviewee Adina Merenlender, PhD. March 23, 2011	Smaller watersheds hold a better promise for recovery, so that is where our focus should be; not so much focus needed on the mainstem. We have more potential to get big returns on our investments in smaller watersheds. (In some cases for these small watersheds 2% of the users are causing 90% of the damage so the problems can be solved.)	Resource Management	Russian River HU	41
Sonoma County Farm Bureau. Interviewee Tito Sasaki, Board Member. 4/1/2011	If salmonid survivability is the hottest topic of the day, we should do Research and Development on improving the species' survival chance against catastrophic natural or man-made changes in the water quantity and quality and the River morphology.	Fisheries Protection	Russian River HU	41
California Department of Water Resources. California Water Plan 2005 Update. December, 2005	DWR will work with California research and academic institutions to identify and prioritize applied research projects. State government should also encourage pilot projects and focused research incorporating knowledge and experience specific to each region. DWR will work with other State agencies and in coordination with the Interagency Ecological Program and CALFED Science Program to invest in a broad and diverse scientific agenda that will fill the gaps of knowledge about California's water resources.	Science	Russian River HU	40
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. March, 2007	Promote the implementation of more watershed stewardship programs such as RCD programs.	Socioeconomic	Russian River HU	40
Sonoma County Agricultural Preservation and Open Space District. Connecting Communities and the Land: A Long-Range Acquisition Plan. March, 2003	Partner with local agencies to implement recovery plans for threatened and endangered species.	Resource Management	Russian River HU	40
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Protect and enhance riparian and instream habitat.	Riparian Stability	Guerneville HSA	40
California Department of Water Resources. California Water Plan 2005 Update. September, 2008	DWR and State agencies should advance water planning and management that restore and protect watersheds and assess instream flow demands needed to protect and restore aquatic ecosystems.	Resource Management	Russian River HU	39
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Fund "Urban stream coordinator" positions to work with the communities and cities to complete and implement Urban Creek Restoration Plans-model work after City of Santa Rosa and City of Ukiah Efforts	Habitat Restoration	Russian River HU	39
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Examine the historical record to support our ability to restore and manage the Laguna's natural resources. Examine historic maps, photographs and sketches to understand the history behind landscape changes and to help develop sustainable restoration projects. Determine the extent to which freshwater wetlands and adjacent floodplains have been lost. Use site-specific research to determine the feasibility and advisability of recreating historic wetlands. Examine the written record of the early explorers, settlers, and naturalists to develop an understanding of what has been extirpated. Use this understanding to establish realistic objectives for native habitat restoration. Examine the pre-contact evidentiary record, including anthropological and archeological artifacts to understand the role of indigenous people in the active management of their landscape. Use this understanding to further refine our own management practices. Develop a deeper appreciation for humans in nature as being integral and codependent. Honor those who lived here before us and respect the cultural artifacts they left behine.	Resource Management	Laguna de Santa Rosa HSA	39

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Increase watershed related press coverage in local, regional and national newspapers and explore opportunities to use the web or create a watershed program on a television network.	Socioeconomic	Russian River HU	39
Mendocino County Water Agency. Interviewee Dennis Slota. 3/9/2011	Exotic plant removal and enhancement of natural riparian systems needs to continue and expand if possible.	Riparian Stability	Ukiah HSA	39
Russian River Keeper. Interviewee Don McEnhill. 3/28/2011	Invasive plant species in the riparian corridor have huge negative effects in the watershed and need continued control efforts.	Habitat Protection	Russian River HU	39
Gold Ridge RCD. Interviewee Lisa Hulette. 3/18/2011	Management measures to protect and restore the hydrologic and biological integrity of the watershed should include: Water quantity & quality, Integrated Pest Management, Erosion and Sediment Control, Storm Water Retention, Riparian and Vegetation Buffers, Ground Water Recharge and Retention, Conservation Easements, Road Assessments and Maintenance, Alternative Treatment Systems.	Habitat Protection	Guerneville HSA	39
California State Coastal Conservancy. California State Coastal Conservancy Strategic Plan 2007. 2007	Implement approximately 60 projects that foster the long-term viablility of coastal working lands, including projects to assist farmers, ranchers, and timber producers to reduce impacts of their operations on wildlife habitat and water quality. 50 projects in the North Coast.	Resource Management	Russian River HU	38
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. March, 2007	Promote awareness of watersheds, basins, and aquifers and their relationship to water flow, supply and quality.	Socioeconomic	Russian River HU	38
Sonoma County Water Agency. Russian River Action Plan. March, 2003	Environmental Quality Incentives Program (EQIP)	Habitat Availability	Russian River HU	38
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Implement the NRCS/RCD coordinated program for fishery restoration practices.	Coho Population Recovery	Russian River HU	38
Mendocino County Water Agency. Interviewee Dennis Slota. 3/9/2011	Long term riparian corridor enhancement would be a way to improve the rivers functions. Helping the river reach its flood plain and attain more meanders probably takes 300-500 feet on each side of the river. This extent of conversion to the natural system is not likely in the current management scenario. However, encouraging land use setbacks from the river will help the riparian corridor expand, and eventually reach its flood plain. We need to let the river find its equilibrium and get away from the "rip rap mentality" of hard structures to prevent channel movement.	Riparian Stability	Ukiah HSA	38
Mendocino County Water Agency. Interviewee Dennis Slota. 3/9/2011	Current status of invasive plant communities in watershed. Mapping of colonies and plans for removal and assessment need to be updated and/or communicated to the community.	Habitat Availability	Ukiah HSA	38
California State Coastal Conservancy. California State Coastal Conservancy Strategic Plan 2007. 2007	Implement 49 projects to preserve and restore coastal watersheds and create river parkways. Fund the implementation of projects to preserve and restore coastal watersheds and create river parkways. Promote public outreach and community involvement.	Resource Management	Russian River HU	37
California State Coastal Conservancy. California State Coastal Conservancy Strategic Plan 2007. 2007	Provide funding for 38 plans for projects that foster the long-term viability of coastal working lands, including projects to assist farmers, ranchers, and timber producers to reduce impacts of their operations on wildlife habitat and water quality. 30 plans for North Coast.	Resource Management	Russian River HU	37
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Jenner Creek has an active and interested community group. Work should focus on implementing DFG habitat improvement recommendations.	Habitat Availability	Guerneville HSA	37
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Large-scale river projects such as removal of onstream levees and construction of offset levees to increase floodplain and reduce floodcontrol maintenance, moving or raising structures in frequently flooded areas, adding floodplain level culverts to increase floodplain draining at culvert crossings, and purchase of riparian easements to allow floodplain flooding and stream meandering are recommended to achieve riparian stability.	Riparian Stability	Mainstem Russian River	37

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Sonoma County Water Agency. Russian River Action Plan. May, 2003	Lower Forsythe Creek Implementation	Habitat Availability	Forsythe Creek HSA	37
Mendocino RCD. Mendocino County RCD Interviewees Jan Olave, Shelley Janek, Joe Scriven. February 27,2012	Mendocino County needs to establish greater stewardship and protections for its natural resources by supporting the MCRCD. Financial support through tax roll contributions and program support through ordinances will assist the MCRCD in project implementation on private properties. Landowner outreach and education through workshops, publications, and project implementation is key to a healthy functioning riverine system.	Resource Management	Forsythe Creek HSA	37
California Department of Water Resources. California Water Plan 2005 Update. December, 2005	State government should give preference to applicants of Proposition 50, Chapter 81 grants who have plans that apply DWR and State Water Resource Control Board (SWRCB) grant program guidelines.	Socioeconomic	Russian River HU	36
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Advocate for agency sharing of case studies and models based on their extensive resources and contacts.	Socioeconomic	Russian River HU	36
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. March, 2007	Restore the stream corridor through a variety of stream corridor protection and watershed management methods (e.g., meander corridor setbacks, floodplain and wetland protection, and riparian revegetation).	Habitat Protection	Russian River HU	36
Sonoma County Water Agency. Russian River Action Plan. March, 2003	Central Sonoma Watershed	Habitat Availability	Russian River HU	36
Sotoyome Resource Conservation District. Maacama Creek Watershed Assessment. March, 2005	Reduce fine sediment sources, remove migration barriers, continue to monitor water temperatures, evaluate riparian habitat and channel form and processes in the Knights Valley passage reach.	Fisheries Protection	Geyserville HSA	36
NRCS - Sonoma and Marin Counties. Interviewee Charlette Epifanio. 3/16/2011	We have no water budget in the watershed, yet we are making decisions as if we have enough information. The known issues of salmonid population decrease and demand on available water is too high. If stormwater capture, infiltration, storage, and management is a good thing, then we should have a program to do it on a larger basin-wide scale.	Resource Management	Mainstem Russian River	36
NRCS - Sonoma and Marin Counties. Interviewee Charlette Epifanio. 3/16/2011	Riparian restoration efforts need continued support. The Riparian Area Program includes education, protection, and incentives for private landowners.	Riparian Stability	Mainstem Russian River	36
Sonoma County Water Agency. Interviewee David Manning. 3/28/2011	Implementation of the Russian River Biological Opinion is the most likely route to improve conditions in the watershed.	Coho Population Recovery	Mainstem Russian River	36
Sotoyome RCD. Upper Mark West Watershed Management Plan Phase 1: Watershed Characterization and Needs Assessment.. 2008	Assess, protect & enhance riparian and wetland habitat.	Habitat Protection	Mark West HSA	35
Sonoma County Water Agency. Interviewee David Manning. 3/28/2011	Water quality and habitat conditions in the estuary.	Habitat Availability	Mainstem Russian River	35
Sonoma County Water Agency. Interviewee David Manning. 3/28/2011	The effects of water demands on aquatic habitats and how salmonids respond to existing water management needs to be understood.	Habitat Protection	Mainstem Russian River	35
Russian River Keeper. Interviewee Don McEnhill. 3/28/2011	We need to improve the sustainability of the watershed's largest land users.	Resource Management	Russian River HU	35
California Department of Water Resources. California Water Plan 2005 Update. December, 2005	The Resources Agency should continue to support development and use of statewide natural resource databases, analytical tools, and evaluation criteria to identify priorities for ecosystem restoration and provide information to planners and decision-makers.	Habitat Protection	Russian River HU	34
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. March, 2007	Provide a watershed information center that serves as a central dispatch location providing press kits and public information materials for resource and community organizations to increase overall understanding and share information.	Socioeconomic	Russian River HU	34
Sotoyome Resource Conservation District. Maacama Creek Watershed Assessment. March, 2005	Reduce fine sediment sources, repair/replace migration barriers, increase riparian cover, monitor water temperatures and siltation, address conditions in passage reach.	Fisheries Protection	Geyserville HSA	34
Mendocino RCD. Mendocino County RCD Interviewees Jan Olave, Shelley Janek, Joe Scriven. February 27,2012	Exotic invasive plant control/eradication - map Arundo sites within Ukiah city limites; review and update Arundo map from Sotoyome RCD.	Resource Management	Forsythe Creek HSA	34

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
NRCS - Sonoma and Marin Counties. Interviewee Charlette Epifanio. 3/16/2011	Fuel loading in the forest lands needs more information and assessment. The fuel loading assessment and prevention in forest lands will: protect life, homes, livelihood, prevent sediment loading and protect wildlife habitat. Areas of focus should be western portion of the Russian plus Mark West and Knights Valley.	Resource Management	Russian River HU	34
Russian River Keeper. Interviewee Don McEnhill. 3/28/2011	Macroinvertebrate index for RR, answer questions about Salmon/ Steelhead forage opportunities/ availability	Habitat Availability	Russian River HU	34
UC Cooperative Extension. Interviewee Glenn McGourty. 3/8/2011	Riparian restoration projects on the mainstem and tributaries need to continue.	Riparian Stability	Mainstem Russian River	34
Gold Ridge RCD. Interviewee Lisa Hulette. 3/18/2011	Need increased instream habitat improvement efforts. Need septic systems to be improved. Need a conservation easement program for riparian owners.	Habitat Protection	Guerneville HSA	34
Hildreth Farms, Inc.. Interviewee Mike Hildreth. 5/27/2011	Continuing the efforts of the Fish Friendly Farming (FFF) classes on stream monitoring with the goal to improve fish habitat and continue farming in a "fish friendly" manner.	Resource Management	Ukiah HSA	34
California State Coastal Conservancy. California State Coastal Conservancy Strategic Plan 2007. 2007	Implement fish barrier removal projects to open or improve 99 miles of habitat. Remove or modify culverts and stream crossings; construct fishways that restore access; modify diversions to ensure adequate instream flow.	Migration	Russian River HU	33
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Stream setbacks are quite narrow in many urban areas—as little as 30 feet in some cases. Narrow setbacks provide little room for restoring natural meanders or riparian vegetation, and give little protection from flooding or bank failure. Because encroachment and loss of native habitat in urban areas is so severe, the need for wide riparian corridors through cities is greater than it is for ex-urban areas. New residential and commercial developments should work with SCAPOSD to acquire land along creeks. Cities should also adopt plans that expand the width of setbacks in new developments in order to increase habitat connectivity and allow for future restoration and ongoing maintenance.	Riparian Stability	Laguna de Santa Rosa HSA	33
Sotoyome Resource Conservation District. Maacama Creek Watershed Assessment. June, 2002	Evaluate for inclusion as a priority creek area	Fisheries Protection	Geyserville HSA	33
Sotoyome Resource Conservation District. Maacama Creek Watershed Assessment. June, 2002	Evaluate for inclusion as a priority creek area	Fisheries Protection	Geyserville HSA	33
Sotoyome Resource Conservation District. Maacama Creek Watershed Assessment. March, 2005	Reduce fine sediment sources especially from roads, increase riparian cover, monitor water temperatures and siltation, address passage reaches.	Fisheries Protection	Geyserville HSA	33
NRCS - Sonoma and Marin Counties. Interviewee Charlette Epifanio. 3/16/2011	Creating a synopsis of past findings and identifying steps for the future is needed. The synopsis should include the whole water management dynamic.	Resource Management	Mainstem Russian River	33
Sonoma County Water Agency. Interviewee David Manning. 3/28/2011	The process of addressing planning and environmental compliance issues needed to do projects should be improved so beneficial projects are not seen as burdens. For instance, mutually beneficial projects associating agriculture and water storage could get more support and implementation. Landowners need incentives to gain their long term support. Agencies need a more holistic approach with landowners to attain improvements in long term management of private lands.	Resource Management	Mainstem Russian River	33
Sonoma County Water Agency. Interviewee David Manning. 3/28/2011	Collection of data set at the Mirabel site needs to continue.	Fisheries Protection	Mainstem Russian River	33
Russian River Keeper. Interviewee Don McEnhill. 3/28/2011	One of the more recent limiting factors facing ESA listed fish is lack of forage habitat due to channel simplification, incision, loss of riparian areas, need to determine how big a factor for fish recovery issue really is.	Habitat Availability	Russian River HU	33
Laguna de Santa Rosa Foundation. Interviewee Hattie Brown. 4/20/2011	Removal of invasive species, particularly Ludwigia in the Laguna and the Russian.	Habitat Protection	Laguna de Santa Rosa HSA	33

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Mendocino County Water Agency. Interviewee Roland Sanford. 3/15/2011	First on the list should be to maximize the use of the financial resources we have. We will have to identify the direction and follow it as a team, even if we do lose part of the flock in the process. We need a regional approach. For instance, the Rohnert Park groundwater plan to reduce river diversions may keep more water in the river, but could over draft the aquifer if relied upon too heavily. Managing outflow at Coyote Dam to dilute the leaky septic systems in Cazadero seems un-necessary. Why not fix the septic systems and save the water? A regional approach to financial resources management will make a difference in improving the watershed's functions.	Resource Management	Russian River HU	33
California Department of Water Resources. California Water Plan 2005 Update. December, 2005	DWR will work with other State agencies and in coordination with the Interagency Ecological Program and CALFED Science Program to invest in a broad and diverse scientific agenda that will fill the gaps of knowledge about California's water resources.	Science	Russian River HU	32
California Department of Water Resources. California Water Plan 2005 Update. December, 2005	DWR with regional input will develop a general checklist of issues, resources, data, and analytical tools as well as guidelines to aid regional integrated resource planning.	Resource Management	Russian River HU	32
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	BMPs to prevent the need for later restorative actions should always be encouraged and adopted into management strategies.	Habitat Protection	Russian River HU	32
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Conduct outreach with the community and landowners of Potter Valley to develop a "safe harbor agreement" from the ESA to enable constric-tion of the bypass and cooperation of landowners in restoration of native steelhead and chinook habitat.	Habitat Availability	Coyote Valley HSA	32
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	The City of Ukiah's redevelopment and corridor recommendations should be supported and implemented.	Habitat Availability	Ukiah HSA	32
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	In upper mainstem, prioritize and plan coho salmon habitat restoration programs and projects	Habitat Protection	Mainstem Russian River	32
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Promote streamside conservation measures, including conservation easements, setbacks, and riparian buffers	Riparian Stability	Russian River HU	32
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Sustainable urban creek restoration depends on careful planning to balance human and environmental needs. Support existing urban creek restoration projects, including full implementation of the Santa Rosa Creek Master Plan, and the Santa Rosa Citywide Creek Master Plan. Expedite a Creek Master Plan process for the southern Laguna (Rohnert Park and Cotati).	Habitat Availability	Laguna de Santa Rosa HSA	32
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Develop a citizen recognition program that awards the "Top 10" private citizens, property owners and local businesses for exemplary behavior and practices that positively impact the health of the watershed.	Socioeconomic	Russian River HU	32
Sonoma County Water Agency. Russian River Action Plan. May, 2003	Russian River Ecosystem Restoration	Fisheries Protection	Russian River HU	32
Sotoyome RCD, Gold Ridge RCD, Mendocino County RCD, Sonoma County ater Agency, and Prunuske Chatham, Inc.. Stewardship Guide for the Russian River. undated	Enhance instream habitat.	Habitat Protection	Russian River HU	32
NRCS - Sonoma and Marin Counties. Interviewee Charlette Epifanio. 3/16/2011	CREP: Conservation Reserve Enhancement Program focuses on riparian resources, and is similar to the AWEP program. We could create a Russian River CREP. Example of the CREP in Tomales Bay. The goal of this program is to raise the value of riparian acreage.	Riparian Stability	Mainstem Russian River	32
Mendocino County Water Agency. Interviewee Dennis Slota. 3/9/2011	Temperature monitoring	Habitat Availability	Ukiah HSA	32
Russian River Keeper. Interviewee Don McEnhill. 3/28/2011	The geomorphic state of the Russian River is a big problem. The channel is deeply incised, especially in the Ukiah Valley due to gravel mining. Clay substrates are getting exposed because the gravels have washed downstream. The river cannot expand or meander because of encroachment and development. We need to consider increasing the buffer width for the river, and back off from encroachment by new development.	Riparian Stability	Russian River HU	32

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Mendocino County Water Agency. Interviewee Roland Sanford. 3/15/2011	How do we get going in the same direction? This is hopefully what the RRWAMP can do. So many plans sit on the shelf and do no good. In this watershed the long term commitment has been lacking. We need to increase the commitment and communication to get projects accomplished, as with the NCIRWMP.	Socioeconomic	Russian River HU	32
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Consider riparian buffer restoration a top priority in reducing erosion, providing filtering of chemicals and pesticides, providing shade for reduction in water temperatures and increasing dissolved oxygen.	Riparian Stability	Mainstem Russian River	31
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Identify on-stream structures and encourage change-willing owners to switch to off-stream through cost shares for relocation, wells, crop buy-out, or easements.	Migration	Russian River HU	31
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Participate in regional water management planning through the general plan process and in other venues as appropriate.	Socioeconomic	Russian River HU	31
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Support implementation of measures to modify flows in Dry Creek to provide summer rearing habitat for coho salmon.	Coho Population Recovery	Warm Springs HSA	31
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Determine the feasibility and need for a basin-wide and reach specific gravel budget that is based on stream hydrology and identifies the gravel recruitment needs for healthy fisheries.	Gravel Quantity	Russian River HU	31
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. March, 2007	Provide stewardship training opportunities where needed at the sub-watershed level.	Socioeconomic	Russian River HU	31
Sotoyome Resource Conservation District. Maacama Creek Watershed Assessment. June, 2002	Evaluate summertime stream flows	Fisheries Protection	Geyserville HSA	31
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Monitor and enhance habitat for salmonids.	Coho Population Recovery	Guerneville HSA	31
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Monitor and enhance habitat for wildlife.	Habitat Protection	Guerneville HSA	31
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Reduce road densities by 10 percent over the next 10 years, prioritizing high risk areas in historical habitats or Core CCC coho salmon watersheds. Russian River - core areas - Sheephouse Creek area of the Willow Creek planning watershed; Freezeout Creek area of the Freezeout Creek Planning watershed; Dutch Bill, Felta, Wallace, Palmer, and Upper East Gray Creek planning watersheds; Purrington Creek area of the Purrington Creek planning watershed.	Fisheries Protection	Guerneville HSA	31
Russian River Keeper. Interviewee Don McEnhill. 3/28/2011	Channel incision has stranded some older riparian communities. The Russian River watershed has lost over 90% of its riparian community in the last 100 years. We need an improved program to conserve and protect riparian areas, possibly with incentive programs for landowners to support riparian set-aside acreage. The issue would be creating the program that is valuable and fair to the farmers/ranchers. The mechanism would simply compensate the landowner for the loss of income that the riparian acreage would have otherwise provided.	Riparian Stability	Russian River HU	31
Gold Ridge RCD. Interviewee Lisa Hulette. 3/18/2011	Increase cooperative relationships with private owners for riparian restoration efforts.	Riparian Stability	Guerneville HSA	31
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	"Develop a program or policies for identifying especially unsuitable existing development, infrastructure and road segments affecting anadromous fish streams (Harris et al. 2001)". The cities of Santa Rosa, Ukiah, Berkeley and Richmond could serve as models for developing solutions, alternatives and re-development plans and funding.	Fisheries Protection	Russian River HU	30

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	The Wilfred/Bellevue flood control channel is one of the most degraded in the Laguna watershed, with a wide, flat trapezoidal cross-section and scant riparian vegetation. The channel bottom is vulnerable to aquatic weed infestation, specifically Ludwigia. Feasibility studies should be conducted to install a meandering low flow channel to hold summer water in order to reduce weed growth and allow shade trees to be planted at the toe of the bank. Ideally, there should be public purchase of wider setbacks along either bank, to increase opportunities for riparian restoration.	Socioeconomic	Laguna de Santa Rosa HSA	30
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Identify partnerships and community relationships that leverage resources, funding, and media opportunities about restoration activities such as Adopt-a-Watershed.	Socioeconomic	Russian River HU	30
Sonoma Land Trust, Laguna de Santa Rosa Foundation. Laguna de Santa Rosa: Resource Atlas and Protection Plan. March, 2006	Enhance wildlife corridors between the Laguna Channel and preserve areas; plant riparian vegetation and enhance existing habitat along the creeks; add linear fencing to protect known rookeries and other sensitive resource areas, to reduce grazing from adjacent agricultural lands, and to minimize human trespass off of public trails; and remove lateral fencing to allow wildlife to move freely along the corridor.	Habitat Protection	Laguna de Santa Rosa HSA	30
Sonoma Land Trust, Laguna de Santa Rosa Foundation. Laguna de Santa Rosa: Resource Atlas and Protection Plan. October, 2004	Work with private landowners to implement restoration projects and/ or best management practices that protect and enhance the ecological function of high composite natural resource areas.	Habitat Protection	Laguna de Santa Rosa HSA	30
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Develop Estuary Protection and Enhancement Guidelines to maintain estuary function and provide information for estuary restoration	Habitat Availability	Guerneville HSA	30
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Maintain and restore hydrologic function, protect riparian and floodplain areas, and minimize adverse effects to water quality and instream rearing habitats resulting from commercial and urban development.	Riparian Stability	Russian River HU	30
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Restoration projects that upgrade or decommission high risk roads in Core areas should be considered an extremely high priority for funding (e.g., PCSRF). Where no Core areas are designated, apply this action to Phase I areas. Russian River - core areas - Sheephouse Creek area of the Willow Creek planning watershed; Freezeout Creek area of the Freezeout Creek Planning watershed; Dutch Bill, Felta, Wallace, Palmer, and Upper East Gray Creek planning watersheds; Purrington Creek area of the Purrington Creek planning watershed.	Fisheries Protection	Guerneville HSA	30
UC Berkeley & Hopland Research & Extension Center, Environmental Science Policy and Management. Interviewee Adina Merenlender, PhD. March 23, 2011	Education on stream side management needs to expand: LWD removal, checkdams and diversions, cumulative effects of land management, water as a public trust resource.	Riparian Stability	Russian River HU	30
NOAA Fisheries, Protected Resources Division. Interviewee Bob Coey, Fisheries Biologist. 3/16/2011	Conservation easements to preserve existing corridors	Habitat Protection	Russian River HU	30
NRCS - Sonoma and Marin Counties. Interviewee Charlette Epifanio. 3/16/2011	The whole water management dynamic is not well known to most people. An education effort to inform landowners, resource agencies, the environmental community and the general public would be good. Lack of information leads to lack of communication, thus lack of collaboration. A good education program would open the door to improved management throughout the watershed.	Resource Management	Mainstem Russian River	30
Mendocino County Water Agency. Interviewee Dennis Slota. 3/9/2011	Macro-Invertebrate density and composition	Science	Ukiah HSA	30
Laguna de Santa Rosa Foundation. Interviewee Hattie Brown. 4/20/2011	Revegetation of creeks and streams toward the goal of 100% riparian cover proposed by Grant Davis (SCWA).	Riparian Stability	Laguna de Santa Rosa HSA	30
Laguna de Santa Rosa Foundation. Interviewee Hattie Brown. 4/20/2011	Long-term data collection related to vernal pools in the Santa Rosa Plain.	Habitat Protection	Laguna de Santa Rosa HSA	30

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
California State Coastal Conservancy. California State Coastal Conservancy Strategic Plan 2007. 2007	Develop 28 plans for the restoration and enhancement of coastal habitats, including coastal wetlands and intertidal areas, stream corridors, dunes, coastal terraces, coastal sage scrub, redwood forest, oak woodlands, Douglas fir forests, and coastal prairie, and for prevention, eradication, or control of invasive species. Participate in local and regional strategic planning processes to target most important resources and assess local and regional strategic resource plans.	Resource Management	Russian River HU	29
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	"Extend coastal zone protection policies to non-coastal areas of the counties to include wetland and riparian protection, sensitive habitat protection and grading and erosion control (Harris et al. 2001)".	Habitat Protection	Russian River HU	29
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Alternatives to breaching such as acquiring property and relocating or raising adjacent facilities and residences, and above ground septic systems should be explored through FEMA funding.	Migration	Russian River HU	29
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Develop and implement programs to protect and increase instream flows for coho salmon.	Fisheries Protection	Russian River HU	29
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Ecological processes and conditions occurring in the upper parts of the watershed strongly affect processes and conditions downstream. For this reason it is essential to undertake research and management planning for water and other environmental resources at the scale of the entire Laguna watershed.	Socioeconomic	Laguna de Santa Rosa HSA	29
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Robust restoration planning and formal adaptive management require accurate evaluations of initial conditions. For restoration at individual project sites, baseline assessments are used to evaluate features needing restoration and features needing protection. These assessments, along with ongoing monitoring, form a basis for adaptive management analyses. For the most rigorous watershed restoration planning, baseline assessments may be needed at several geographic scales, for example: the scale of the individual site, the scale of the property or preserve area, and the scale of the entire watershed.	Resource Management	Laguna de Santa Rosa HSA	29
Sonoma County Water Agency. Russian River Action Plan. March, 2003	Feliz Creek Implementation	Migration	Ukiah HSA	29
Sonoma County Water Agency. Russian River Action Plan. May, 2003	Santa Rosa Creek - Pierson Reach Restoration	Habitat Availability	Santa Rosa Creek HSA	29
Sonoma County Water Agency. Russian River Action Plan. May, 2003	Santa Rosa Creek Prince Memorial Greenway - Phase IV	Habitat Availability	Santa Rosa Creek HSA	29
Sotoyome Resource Conservation District. Maacama Creek Watershed Assessment. June, 2002	Manage Maacama Creek as a passage reach to allow anadromous fish to reach other tributaries, repair roads near the creek and continue to monitor the reach.	Fisheries Protection	Geyserville HSA	29
Sotoyome Resource Conservation District. Maacama Creek Watershed Assessment. June, 2002	Monitoring of creek conditions is needed to assure that priorities are adjusted to produce the greatest level of improvement in aquatic habitats	Science	Geyserville HSA	29
The Conservation Fund. Conservation Prospects for the North Coast. August, 2005	Develop plans to improve riparian vegetation in Dry Creek and its tributaries.	Riparian Stability	Warm Springs HSA	29
The Conservation Fund. Conservation Prospects for the North Coast. August, 2005	Encourage Sonoma County and the City of Santa Rosa to reduce habitat fragmentation and implement riparian improvements through land-use planning and use of conservation easements from willing landowners.	Habitat Protection	Russian River HU	29
The Conservation Fund. Conservation Prospects for the North Coast. 2005	Support implementation of measures to modify flows in Dry Creek to provide summer rearing habitat for coho salmon.	Habitat Availability	Warm Springs HSA	29
The Conservation Fund. Conservation Prospects for the North Coast. 2005	Work to encourage private landowners to enhance seasonal and permanent wetlands, and promote the restoration of riparian zones.	Habitat Protection	Russian River HU	29
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Manage riparian areas for their site potential composition and structure.	Riparian Stability	Russian River HU	29

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Conduct outreach and education regarding the adverse effects of roads, and the types of best management practices protective of salmonids.	Fisheries Protection	Russian River HU	29
NRCS - Sonoma and Marin Counties. Interviewee Charlette Epifanio. 3/16/2011	One program to fund prioritized projects based on a watershed management plan would be a more efficient use of finite resources. Coordinated permitting in Marin County would be a good template to follow.	Resource Management	Mainstem Russian River	29
Mendocino County Water Agency. Interviewee Dennis Slota. 3/9/2011	Improving fish passage to and through the tributaries is the highest priority.	Migration	Ukiah HSA	29
Gold Ridge RCD. Interviewee Lisa Hulette. 3/18/2011	Large wood removal from streams is a problem in all tributaries. The wood is removed for firewood or under the guise of erosion prevention. Also, the perception that LWD causes flooding or bank instability needs to be addressed and landowners should be educated.	Habitat Protection	Guerneville HSA	29
Mendocino County Water Agency. Interviewee Roland Sanford. 3/15/2011	We first need to identify the target condition of sustainability. With that in mind, we then identify the new baseline levels of chosen attributes to accept as the "sustainable condition." If the RRWAMP can define sustainable conditions for the watershed, then that may be its claim to success.	Resource Management	Russian River HU	29
Hopland Band of Pomo Indians. Interviewee Shawn Pady, Chair and Tribal Historic Preservation Officer. 3/23/2011	Improving and expanding efforts on exotic plant eradication.	Habitat Protection	Ukiah HSA	29
California State Coastal Conservancy. California State Coastal Conservancy Strategic Plan 2007. 2007	Implement 16 projects that target prevention, control or eradication of non-native invasive species that threaten important coastal habitats. Many projects involve removal of Arundo donax on various river corridors and removal of terrestrial species, such as pampas grass.	Resource Management	Russian River HU	28
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Fund solutions identified in the Coastal Conservancies Draft Russian River Enhancement Plan to solve flooding, river capture of gravel pits, fish stranding, and erosion control issues on mainstem Russian River (Middle and Ukiah Reaches).	Habitat Protection	Mainstem Russian River	28
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Develop plans to improve instream coho salmon habitat conditions	Habitat Protection	Mark West HSA	28
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	There are well-established laws allowing mitigation for wetland loss by creating or restoring wetland areas, but the science and techniques to ensure these practices accomplish their objectives are still evolving. Policy changes are needed to promote experimental efforts to improve techniques for wetland creation and restoration, such as awarding extra mitigation credits for projects designed as experiments, and allowing longer evaluation times. Increase emphasis on wetland function and habitat connectivity. Require adequate endowments for perpetual stewardship.	Socioeconomic	Laguna de Santa Rosa HSA	28
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Participate in the Regional Committee for Critical Coastal Areas to protect Critical Coastal Areas and promote Critical Coastal Area Action Plans and implementation of CCA projects	Habitat Protection	Russian River HU	28
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Promote development and adoption of a county grading ordinance.	Socioeconomic	Russian River HU	28
Sonoma County Water Agency. Russian River Action Plan. March, 2003	Giant Reed (Arundo donax) eradication	Riparian Stability	Russian River HU	28
Sotoyome Resource Conservation District. Austin Creek Watershed Assessment. October, 2004	Watershed restoration and management is needed to address aquatic habitat issues	Habitat Protection	Austin Creek HSA	28
Sotoyome Resource Conservation District. Copeland Creek Watershed Assessment. June, 2002	Revegetation/restoration of natural channel functions	Riparian Stability	Laguna de Santa Rosa HSA	28
Sotoyome Resource Conservation District. Maacama Creek Watershed Assessment. June, 2002	Evaluate Redwood Creek in Knights Valley	Fisheries Protection	Geyserville HSA	28

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Work with SWRCB and landowners to improve flow regimes for adult migration to spawning habitats and smolt outmigration.	Coho Population Recovery	Russian River HU	28
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Work with water managers on regulated streams to assure adequate and proper consideration is given to fish needs. Develop agreements that will minimize water-use conflicts and impacts on fish and wildlife resources during drought conditions.	Coho Population Recovery	Russian River HU	28
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	All proposed development projects should include habitat protection, and/or alternatives that minimize impacts to salmon habitat.	Habitat Protection	Russian River HU	28
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Develop a Salmon Certification Program for road maintenance staff.	Fisheries Protection	Russian River HU	28
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Establish a moratorium on new road construction within floodplains, riparian areas, unstable soils or other sensitive areas until a watershed specific and/or agency/company specific road management plan is created and implemented.	Flood Plain Management	Russian River HU	28
Occidental Arts and Ecology Center. Interviewee Brock Dolman. 3/18/2011	Land use management needs to be protective of soil, water, fire, and biology. "Slow it, spread it, sink in" needs to get in front of more people. Land and water use authorities need to understand that terrestrial actions affect aquatic systems and watershed carrying capacity. We need to design land use performance standards that behave more friendly to watershed processes.	Resource Management	Guerneville HSA	28
Hildreth Farms, Inc.. Interviewee Mike Hildreth. 5/27/2011	Down-cutting in mainstem would be a lot worse if Norgard Dam was not there. We should consider installing grade control checkdams at key locations on the river to re-connect the creeks, re-supply some shallow aquifers, and retain some spawning gravel. There are some check dams in the channel in the upper basin that serve as good examples. Janet Pauli would be a good contact to follow up on this topic.	Resource Management	Ukiah HSA	28
California Coastal Sediment Management Workgroup. California Coastal Sediment Master Plan Status Report. September, 2008	Develop studies to determine how large wood debris affects sand retention in streams, coastlines and estuaries.	Resource Management	Russian River HU	27
California State Coastal Conservancy. California State Coastal Conservancy Strategic Plan 2007. 2007	Restore and enhance 6,820 acres of coastal habitats including coastal wetlands and intertidal areas, stream corridors, dunes, coastal sage scrub, coastal terraces, redwood forest, oak woodlands, Douglas fir forests and coastal prairie.	Resource Management	Russian River HU	27
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	"Develop and adopt written standards for county road maintenance practices, under routine and emergency conditions. These standards should include guidelines for road maintenance and new construction that minimize sedimentation and runoff impacts and address storage and disposal of spoils, stream crossings, culvert diversion potential, fish passage and landslide and slope repair (Harris et al. 2001)". The Five County Road Manual, ODOT Manual, California Stream Habitat Restoration Manual, and NFMS/DFG criteria for stream crossings should serve as reference documents for standard development and training.	Fisheries Protection	Russian River HU	27
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Reduce native riparian vegetation clearing and sediment removal adjacent to and in anadromous coho streams.	Riparian Stability	Russian River HU	27
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Use land-use planning and conservation easements with willing landowners, to protect riparian vegetation.	Riparian Stability	Warm Springs HSA	27

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Urban streams must often be managed like linear parks rather than natural areas, but healthy urban riparian corridors are essential for providing habitat connectivity between the floodplain and the hills surrounding the plain. Develop restoration projects to increase the amount of tree canopy where the Laguna channel and its tributaries pass through urban and suburban area	Habitat Availability	Laguna de Santa Rosa HSA	27
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Create a science review and advisory panel that includes local watershed and resource management experts and agency staff to address existing data gaps, assist in developing and evaluating project proposals, interpret current or new policies, and evaluate land application impacts such as pesticide use in sensitive aquatic areas (e.g., the use of Rodeo versus Roundup).	Science	Russian River HU	27
Sonoma County Water Agency. Russian River Action Plan. March, 2003	Alexander and Dry Creek Valleys Flood Protection and Ecosystem Restoration	Habitat Availability	Geyserville HSA	27
Sonoma County Water Agency. Russian River Action Plan. October, 2005	Wildlife Habitat Incentives Program (WHIP)	Habitat Availability	Russian River HU	27
Sonoma Land Trust, Laguna de Santa Rosa Foundation. Laguna de Santa Rosa: Resource Atlas and Protection Plan. October, 2004	Work with private landowners to implement best management practices that protect and enhance seasonla wetland habitats.	Habitat Protection	Laguna de Santa Rosa HSA	27
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Work with SWRCB and landowners to improve over summer survival of juveniles by re-establishing summer baseflows (from July 1 to October 1) in rearing reaches that are currently impacted by water use.	Coho Population Recovery	Russian River HU	27
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Continue education of Caltrans, County road engineers, and County maintenance staff regarding watershed processes and the adverse effects of improper road construction and maintenance on salmonids and their habitats.	Fisheries Protection	Russian River HU	27
NOAA Fisheries, Protected Resources Division. Interviewee Bob Coey, Fisheries Biologist. 3/16/2011	Protection of riparian corridors through local regulations and expansion of riparian corridors through NRCS CREP or KREP	Riparian Stability	Russian River HU	27
NRCS - Sonoma and Marin Counties. Interviewee Charlette Epifanio. 3/16/2011	The use of recycled water is getting more attention for use on park landscapes and agricultural crops. While this effort may free up water for other uses, there are some things to consider. Is recycled effluent water OK to use on agriculture crops? What might be the environmental issues? Will we monitor for salt and nutrient changes in the aquifer or soils if recycled water is used?	Resource Management	Mainstem Russian River	27
Mendocino County Water Agency. Interviewee Roland Sanford. 3/15/2011	Funding for the river and watershed health needs to be long term and solid in order to maintain sustainability (i.e. monitoring, policy updates, etc.). We cannot manage a resource without long periods of reliable funding and effort.	Socioeconomic	Russian River HU	27
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Identify and fund solutions to floodplain development of Fife and Hulbert Creeks. Ie. Move or raise houses instead of leveeing and rip-rapping.	Habitat Availability	Russian River HU	26
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Lower Pena Creek would benefit from reduced bankfull width-to-depth ratio and increased riparian to improve vegetation. Mapping non-point source erosion is a priority in this sub-basin.	Habitat Availability	Warm Springs HSA	26
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Promote "alternatives to conventional bank stabilization for public and private projects" (such as bio-engineering techniques, conservation easements for riparain buffers, and setback levees) and require evaluation of alternatives, and cumulative effects of new and existing bank hardening projects through the County permit process.	Riparian Stability	Russian River HU	26
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Riparian restoration, riparian setbacks, conservation easements to improve protect riparian and restore floodplain processes are the priority needs to improve migration in many sub-basin tributaries.	Migration	Ukiah HSA	26

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	The comprehensive Arundo donax removal strategy provided in the documents: Assessment of Giant Reed and Restoration Planning: Russian River Tributaries (Circuit Rider Productions (CRP) 2002) and Giant Reed (Arundo donax) in the Russian River Watershed: A Plan for Removal and Restoration (CRP 2000) should be funded and implemented.	Riparian Stability	Russian River HU	26
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Review development set-backs for adequacy in protecting key streams inhabited by coho salmon.	Riparian Stability	Russian River HU	26
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Use land-use planning and conservation easements, from willing landowners, to maintain and improve riparian vegetation condition and water temperature.	Riparian Stability	Geyserville HSA	26
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Use land-use planning and conservation easements, from willing landowners, to reduce habitat fragmentation and improve riparian vegetation.	Riparian Stability	Mark West HSA	26
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Use land-use planning and conservation easements, from willing landowners, to reduce habitat fragmentation and improve riparian vegetation.	Riparian Stability	Santa Rosa Creek HSA	26
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Develop management techniques and policies that enhance the survival of acorns, oak seedlings and saplings in ways that are compatible with other land uses such as hay production, grazing and irrigation with treated wastewater. Support research to develop new management techniques and policies to reduce the vulnerability of mature oaks to sudden oak death and other diseases.	Habitat Protection	Laguna de Santa Rosa HSA	26
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Partner with willing landowners to implement riparian-fencing projects throughout the greater Laguna watershed to control the access of livestock to streams and waterways. Streamside fencing should be installed with livestock bridges and gates as appropriate; damaged stream banks should be laid back and vegetative armor should be used to restore impaired waterways to healthy conditions. Top priority areas are in the southern Laguna: due to the nature of the soil conditions, land use, and lack of perennial plant cover around upper Gossage Creek, substantial erosion occurs on nearly every tributary and swale in the area.	Resource Management	Laguna de Santa Rosa HSA	26
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Sediment retention and water infiltration basins are an engineering-based solution to addressing sedimentation and flooding concerns. While it is best to control erosion and reduce runoff in the upper watershed, it is also necessary to evaluate the feasibility of establishing flood water infiltration and sediment capture basins in ground water recharge areas east of Rohnert Park—to reduce the height of peak discharge, reduce the volume of sediment entering the southern Laguna water system, and provide a public recreational resource.	Resource Management	Laguna de Santa Rosa HSA	26
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	The Laguna de Santa Rosa historically had several large lakes, including Lake Jonive, north of Sebastopol. In addition to the benefits of replicating historical conditions and increasing flood-storage capacity, restoration of a Laguna lake would greatly benefit fish and wildlife, and would be a tremendous public resource for recreational boating and nature viewing.	Habitat Availability	Laguna de Santa Rosa HSA	26
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Tule marshes are an essential habitat element in the Laguna watershed. One of the suggestions for Ludwigia management is to flood or drain areas vulnerable to Ludwigia infestation, but this potentially eliminates tule habitat. It is critically important to develop management strategies that sustain emergent marshland in the watershed.	Habitat Availability	Laguna de Santa Rosa HSA	26
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Improve forest management practices to protect stream conditions and promote soil retention.	Socioeconomic	Russian River HU	26
Sonoma County Water Agency. Russian River Action Plan. May, 2003	Source Water Protection	Resource Management	Russian River HU	26

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Sotoyome Resource Conservation District. Copeland Creek Watershed Assessment. June, 2002	Quantitative monitoring of channel conditions	Resource Management	Laguna de Santa Rosa HSA	26
UC Cooperative Extension, Sonoma County & Sonoma County Department of Emergency Services. Sonoma County Sudden Oak Death Strategic Response Plan. 2008	Slow the spread of SOD. Hazardous tree removal and practices that may slow the spread of the disease are used minimally in Sonoma County currently, mainly because of lack of awareness and lack of funds.	Habitat Protection	Russian River HU	26
Community Foundation Sonoma County and Sonoma County Water Agency. Biodiversity Action Plan: Priority Actions to Preserve Biodiversity in Sonoma County. October 2010	Enhance the Ecological Value of Private Land	Resource Management	Guerneville HSA	26
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Work with Sonoma County to develop more protective regulations in regard to exurban development (vineyard and rural residential).	Fisheries Protection	Guerneville HSA	26
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Use available best management practices for road construction, maintenance, management and decommissioning (e.g. Hagans & Weaver, 1994; Sommarstrom, 2002; Oregon Department of Transportation, 1999).	Fisheries Protection	Russian River HU	26
Occidental Arts and Ecology Center. Interviewee Brock Dolman. 3/18/2011	Scope of Biological Opinion does not pick up the needs of the main coho salmon tributaries. We need more information on the coho streams to help guide management.	Coho Population Recovery	Guerneville HSA	26
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Channel and Riparian Corridor Clearing: Reduce native vegetation clearing, large woody debris and sediment removal adjacent to and in anadromous fish streams.	Riparian Stability	Russian River HU	25
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Establish priorities for culverts, work with each county to develop and secure funding. Remediation should follow the NMFS Guidelines for Salmonid Passage at Stream Crossings (NMFS 2000), with recommendations in text.	Migration	Mainstem Russian River	25
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Implement streamside conservation measures, including conservation easements, setbacks, and riparian buffers.	Riparian Stability	Russian River HU	25
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Coordinate and expand modeling and monitoring efforts of Army Corps, SCWA, USGS and other agencies to provide baseline characterization of Laguna watershed and ability to project future scenarios that incorporate changes to channel/floodplain geometry and weather patterns. Use these models to plan and prioritize restoration, flood protection, and pollution control projects.	Resource Management	Laguna de Santa Rosa HSA	25
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	The USGS is now developing a pilot 3-D model for a portion of the Laguna floodplain. Expansion of this model, combined with LIDAR data, is essential for long-term flood protection and pollution control planning, evaluating which areas will be vulnerable to Ludwigia, and for designing successful restoration projects.	Resource Management	Laguna de Santa Rosa HSA	25
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Expand the hillside vineyard outreach program to educate vineyard landowners of best management practices and conduct enforcement activities to address erosion from hillside vineyards. Expand outreach on best management practices for hillside vineyards, including further development of interagency coordination and cooperation on addressing erosion problems.	Socioeconomic	Russian River HU	25
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. March, 2007	Present the Phase II Plan of Action (POA) as a tool to educate elected officials and decisionmakers throughout all levels of government about the potential actions required to address the critical issues existing in the Russian River watershed.	Socioeconomic	Russian River HU	25
Sonoma County Water Agency. Russian River Action Plan. March, 2003	Cloverdale River Park	Habitat Availability	Geyserville HSA	25
Stewards of the Coast and Redwoods. Willow Creek Watershed Management Plan. August, 2005	Expand existing monitoring efforts in the Willow Creek Watershed.	Science	Guerneville HSA	25
The Conservation Fund. Conservation Prospects for the North Coast. 2005	Improve migration and summer/overwintering habitat through riparian restoration and erosion control in Forsythe Creek HSA.	Migration	Forsythe Creek HSA	25

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
City Council of Cloverdale. City of Cloverdale General Plan. 2009, amended 2010	Develop a hillside ordinance for any areas above 400 foot elevation and for properties over 20% slope that are within the Urban Growth Boundary. All development applications submitted prior to the adoption of a Hillside Ordinance shall be required to submit a Grading and Erosion Control Plan which addresses prompt revegetation of disturbed areas, avoidance of grading activities during wet weather, avoidance of drainage corridors and riverbanks, and other erosion control measures to the satisfaction of the City of Cloverdale.	Habitat Protection	Guerneville HSA	25
City of Santa Rosa. Santa Rosa General Plan 2035. November, 2009	Ensure local creeks and riparian corridors are preserved, enhanced, and restored as habitat for fish, birds, mammals and other wildlife.	Habitat Protection	Russian River HU	25
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Design new developments to avoid unstable slopes, wetlands, areas of high habitat value, and similarly constrained sites that occur adjacent to a CCC coho salmon watercourse.	Fisheries Protection	Russian River HU	25
Mendocino RCD. Mendocino County RCD Interviewees Jan Olave, Shelley Janek, Joe Scriven. February 27,2012	Create a riparian conservation/preservation program to provide financial incentives for all stream side and river front property owners to enhance riparian communities on their properties, starting with the creation of a minimum 50 ft. "No Touch" riparian zone.	Riparian Stability	Forsythe Creek HSA	25
Mendocino RCD. Mendocino County RCD Interviewees Jan Olave, Shelley Janek, Joe Scriven. February 27,2012	A contiguous riparian corridor should be established along the length of the Russian River and its tributaries. Whether through easements of landowner participation, financial incentives and ordinances should be developed to ensure restoration and maintenance of the ripairan flood plain.	Riparian Stability	Forsythe Creek HSA	25
UC Cooperative Extension. Interviewee Glenn McGourty. 3/8/2011	We need to get a sense of how much damage has been done by Coyote Dam and how it has changed the hydrologic system. Look from the dam to the Mendocino County line. Example: Talmage Bridge replacement because footing were getting exposed. Down cutting has lowered the water table. Shallow wells are now dry. Streams are disconnected from the mainstem, for instance Morrison Creek dries at the mouth earlier than normal.	Science	Mainstem Russian River	25
UC Cooperative Extension. Interviewee Glenn McGourty. 3/8/2011	How much fisheries habitat has been lost due to disconnecting tributaries from the river? We need to quantify that amount.	Coho Population Recovery	Mainstem Russian River	25
Redwood Valley Outdoor Education Project (RVOEP). Interviewee Helen Menasian. 2/23/2011	Land management by river-front property owners is a problem for riparian community diversity. A lot of folks will cut down a leaning tree before it falls into the creek/river to prevent the bank from eroding. This eliminates the input of large wood to the channel, which takes away from potential diversity in aquatic habitats. Education may be the key to reducing these practices. Is it possible to monitor river-front activities?	Habitat Protection	Forsythe Creek HSA	25
Gold Ridge RCD. Interviewee Lisa Hulette. 3/18/2011	Project effectiveness evaluation is a missing link in a lot of work in our watershed.	Science	Guerneville HSA	25
NRCS, North Coast Resrouce Conservation & Development Council. Interviewee Phile Giles. 3/16/2011	Conservation easements and outright purchase of lands would have long lasting effects on watershed function. These lands would provide multiple benefits and have no full-time residents to impact the resource when the systems are fragile.	Resource Management	Russian River HU	25
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	"Establish riparian protection areas to protect stream function, wherein new development is prohibited (Harris et al. 2001)". These areas should be defined based on geomorphic conditions, not vegetation or arbitrary distances, and should preclude roads, urban landscaping and any other type of development conditions from the zone. The meander belt width setback approach proposed by the "Fish Friendly Farming Program" would be the preferred method.	Riparian Stability; Habitat Availability	Russian River HU	24
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Assist with DFG funded culvert assessment of remaining Sonoma and Mendocino County culverts-Russian River.	Migration	Russian River HU	24
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Restore the riparian corridor and floodplain on tributaries to the Laguna through riparian setbacks, conservation easements, and streambank stabilization techniques such as bioengineering.	Riparian stability	Laguna de Santa Rosa HSA	24

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Use elements of the Basin Planning Program to restore tributaries with unsuitable coho habitat and to identify tributaries with suitable coho habitat.	Coho Population Recovery	Russian River HU	24
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Develop a watershed-scale erosion control plan to address the need for better adherence to best management practices among land owners and land managers; coordinate this planning effort with the Standard Urban Stormwater Mitigation Plans of the watershed's cities.	Resource Management	Laguna de Santa Rosa HSA	24
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Restore natural hydrology and hydraulics wherever possible and retain a diversity of such conditions within the Laguna system—waterways, ponds, high marsh, low marsh, seasonal wetlands and floodplains—to provide diverse habitat types and support healthy and diverse native plant and animal communities, thus managing not only for high floods, but also for annual floods, bankful and base-flows conditions.	Habitat Availability	Laguna de Santa Rosa HSA	24
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	The science of restoration and adaptive management is continually evolving, and the greatest progress is made when knowledge is shared between different members of the community. Consult with landowners, restoration scientists, local jurisdictions and public agency staff to continuously improve best management practices and restoration techniques. Develop communication channels to share this information between practitioners.	Science	Laguna de Santa Rosa HSA	24
Sonoma Land Trust, Laguna de Santa Rosa Foundation. Laguna de Santa Rosa: Resource Atlas and Protection Plan. October, 2004	Work with private property owners within the Laguna Study Area to plant riparian vegetation along creeks and drainage-ways leading to the main Laguna channel.	Habitat Availability	Laguna de Santa Rosa HSA	24
Stewards of the Coast and Redwoods. Willow Creek Watershed Management Plan. August, 2005	Forest stand naturalization in the Willow Creek Watershed.	Resource Management	Guerneville HSA	24
Stewards of the Coast and Redwoods. Willow Creek Watershed Management Plan. August, 2005	Maintain coastal prairies and native grasslands.	Resource Management	Guerneville HSA	24
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Improve compliance with existing water resource regulations via monitoring and enforcement.	Resource Management	Russian River HU	24
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Improve coho salmon survival by minimizing the introduction into the stream environment of sediment or toxic compounds originating from commercial or residential development.	Coho Population Recovery	Russian River HU	24
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Develop legislation that will fund county planning for environmentally sound growth and water supply and work in coordination with California Dept. of Housing, Association of Bay Area Governments and other government associations (DFG 2004).	Fisheries Protection	Russian River HU	24
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Bridges associated with new roads or replacement bridges (including railroad bridges) should be free span or constructed with the minimum number of bents feasible in order to minimize drift accumulation and facilitate fish passage.	Migration	Russian River HU	24
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Investigate and monitor the relationship between instream flow levels and adverse effects to coho salmon habitat.	Habitat Availability	Russian River HU	24
Mendocino RCD. Mendocino County RCD Interviewees Jan Olave, Shelley Janek, Joe Scriven. February 27,2012	Assessment of tributaries for sediment delivery sources and reduction prescriptions.	Resource Management	Forsythe Creek HSA	24
NOAA Fisheries, Protected Resources Division. Interviewee Bob Coey, Fisheries Biologist. 3/16/2011	Implementation of the Russian River Biological Opinion on SCWA's/ USCOE's Operations of the two dams and reservoirs. (see http://www.swr.noaa.gov/pdf/Signed-Russian_River_Final_BO_9-24-08.pdf specifically Section X.A for a summary of the projects underway as required by the BO)	Coho Population Recovery	Russian River HU	24
NOAA Fisheries, Protected Resources Division. Interviewee Bob Coey, Fisheries Biologist. 3/16/2011	Estuary physical and chemical monitoring	Coho Population Recovery	Russian River HU	24

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Mendocino County Water Agency. Interviewee Dennis Slota. 3/9/2011	With agriculture and urban encroachment on the river, it is not economically feasible to allow the river access to the flood plain. It is a land use conflict: agriculture versus flood plain function. Applying the "Streamway Concept" could alleviate the conflict by providing a scaled down version of access to the flood plain.	Flood Plain Management	Ukiah HSA	24
Laguna de Santa Rosa Foundation. Interviewee Hattie Brown. 4/20/2011	Comprehensive historical ecology study to understand what this region used to look like to help guide restoration activities.	Habitat Protection	Laguna de Santa Rosa HSA	24
Sotoyome Resource Conservation District. Interviewee Kara Heckert. 3/17/2011	SCWA needs to prioritize what they fund for habitat restoration and water conservation programs. They need to get rid of the redundancies and get a more comprehensive approach; especially when it comes to how they fund RCDs and NGOs for similar work . Example of SCWA providing $ for Laguna Foundation support for efforts that Sotoyome Watershed Coordinator is already doing and has separate grant funding for. The Russian has a coordination problem, and the redundancies need to be fixed.	Resource Management	Russian River HU	24
California Coastal Sediment Management Workgroup. California Coastal Sediment Master Plan Status Report. September, 2008	Continue studies to determine coastal processes in coastal California.	Resource Management	Russian River HU	23
California Department of Water Resources. California Water Plan 2005 Update. December, 2005	State government should lead an effort to examine where the mandates and jurisdictions of State, federal, and local governments and agencies conflict with or complement each other to streamline and coordinate the roles and jurisdictions governing California water management.	Socioeconomic	Russian River HU	23
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Restoration projects by SCWA, SSU, and the USACE Laguna Restoration should be supported and maintained.	Riparian stability	Laguna de Santa Rosa HSA	23
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Sudden Oak Death Syndrome (SODS) prevention protocols should be endorsed and followed.	Riparian Stability	Russian River HU	23
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Develop a grading ordinance and grading and erosion control standards to minimize sediment impacts to coho salmon habitat.	Habitat Protection	Russian River HU	23
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Manage summer flows in the mainstem Russian River to benefit rearing coho salmon and the estuary, while ensuring that all existing legal water uses and rights are accounted for.	Habitat Protection	Mainstem Russian River	23
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Identify sites of active erosion and implement erosion control projects throughout the watershed, to address both large-scale sediment sources and non-point source contributions. Place special emphasis on erosion control in the upper watershed, promoting restoration-based methods where possible.	Resource Management	Laguna de Santa Rosa HSA	23
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Increase knowledge of the Laguna's ecology and species biology through scientific research and monitoring. Support and develop scientific research programs on the physical and biological processes that contribute to the ecology of the Laguna; fostering partnerships between local restoration practitioners, researchers from universities and government agencies in both basic and applied sciences. Develop science-based measures to quantify the success of restoration projects.	Science	Laguna de Santa Rosa HSA	23

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	The confluence of the Laguna and Mark West Creek has been shifted in historic times, and Mark West is reported to deposit large quantities of gravel onto the floodplain. Research the feasibility and potential benefits—to salmonids, sediment transport and flood protection—of hydrological restoration on the lower portions of Mark West Creek, by improving conditions in the current channel alignment, and potentially by providing alternate fish passage in the original Mark West channel. Hydrologic studies would provide information on potential solutions that could support the interests of local landowners as well as regulators and upstream communities.	Resource Management	Laguna de Santa Rosa HSA	23
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	The most healthy and sustainable riparian corridors have their width determined by natural hydrological conditions, but this is not possible in many developed areas. Work with public and private landowners to determine the optimal feasible width and composition of riparian forest buffers in different geographic areas and land use conditions. Encourage the planting of riparian vegetation in rural areas with these suggested widths: 100 feet on each side for major creeks, 70 feet on each side for all other creeks with year-round flow, 40 feet on each side for intermittent waterways.	Riparian Stability	Laguna de Santa Rosa HSA	23
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Promote awareness of the effects of increased erosion on channel morphology.	Resource Management	Russian River HU	23
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Develop standardized criteria to evaluate the impacts of specific restoration efforts. Review evaluation criteria developed and used by the USACE to determine potential application for activities, projects and programs implemented by a variety of agencies, resource management organizations and steward groups.	Science	Russian River HU	23
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Preservation is recommended for this reach, due to habitat value for wildlife. Habitat enhancement including invasive species removal and replacement with native vegetation is also recommended. Some bank stabilization may also be needed to prevent excess sediment from entering the stream.	Habitat Protection	Santa Rosa Creek HSA	23
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Preservation of Arroyo Sierra Creek upstream of Hoen Avenue is recommended due to habitat value for wildlife. Habitat enhancement involving invasive species removal and replacement with native vegetation is recommended throughout the reach. Fish passage barriers should be addressed, but only after passage is secured through the concrete diversion structure just east of Hoen Avenue.	Habitat Protection	Santa Rosa Creek HSA	23
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2003	This reach is recommended for preservation, due to habitat value for fish and wildlife. Habitat enhancement involving invasive species removal and replacement with native vegetation is also recommended. Restoration of natural stream meanders and native vegetation may be possible along the frontage with Montgomery High School, between Franquette Avenue and Hahman Drive.	Habitat Protection	Santa Rosa Creek HSA	23
Sonoma County Water Agency. Russian River Action Plan. March, 2003	Dutch Bill Creek Fish Habitat Improvements	Habitat Availability	Guerneville HSA	23
The Conservation Fund. Conservation Prospects for the North Coast. January, 2008	Explore use of riparian conservation easements at Potter Valley.	Resource Management	Russian River HU	23
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Develop a program to arrest channel incision through grade control in lower Purrington Creek.	Riparian Stability	Guerneville HSA	23
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Protect and enhance upland habitats.	Coho Population Recovery	Guerneville HSA	23
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Work with Sonoma County Agricultural Preservation and Open Space District to promote easements and habitat enhancement projects on land trusted properties.	Habitat Protection	Guerneville HSA	23

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Sotoyome RCD, Gold Ridge RCD, Mendocino County RCD, Sonoma County ater Agency, and Prunuske Chatham, Inc.. Stewardship Guide for the Russian River. undated	Restore native riparian vegetation and remove invasive plant species.	Riparian Stability	Russian River HU	23
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Where appropriate, remove structures and/or modify practices which impair or reduce the historical tidal prism and/or estuarine function where feasible and where benefits to coho salmon and/or the estuarine environment are predicted.	Coho Population Recovery	Guerneville HSA	23
Community Foundation Sonoma County and Sonoma County Water Agency. Biodiversity Action Plan: Priority Actions to Preserve Biodiversity in Sonoma County. October 2010	Develop and implement ecosystem-specific management plans.	Resource Management	Guerneville HSA	23
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	New development in all historic CCC coho salmon watersheds should meet a zero net increase in storm-water runoff, changes in duration, or magnitude of peak flow.	Coho Population Recovery	Russian River HU	23
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Use NMFS Guidelines for Salmonid Passage at Stream Crossings (NMFS 2001a) and appropriate barrier databases when developing new or retrofitting existing road crossings.	Migration	Russian River HU	23
Mendocino RCD. Mendocino County RCD Interviewees Jan Olave, Shelley Janek, Joe Scriven. February 27,2012	A long-term invasive plant species eradication and maintenance program is needed to restore biodiversity, and increase habitat on the mainstem and tributaries.	Habitat Protection	Forsythe Creek HSA	23
Mendocino RCD. Mendocino County RCD Interviewees Jan Olave, Shelley Janek, Joe Scriven. February 27,2012	Petition County Agriculture Commissioners to declare certain plant species as "nuisance" and prohibit sales in landscape shops (i.e. Tamarisk, Arundo, Vinca, broom).	Socioeconomic	Forsythe Creek HSA	23
NRCS. Interviewee Carol Mandel. 2/22/2011	Landowners are challenged in participating in restoration programs because of the economy and their inability to make the matching fund requirements. For instance, AWEP has a 50% match requirement that many landowners cannot make. More farmers, ranchers, and forest land owners would participate in conservation programs if they could afford it. The economy and State/Federal budgets have decreased the availability of grants and programs for conservation efforts. For instance, the local wine grape market has not done well, thus affecting local landowners' opportunities to implement restoration/enhancement projects.	Resource Management	Mainstem Russian River	23
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Establish a tree-planting and irrigation program to reduce need for stream clearing along county maintained floodways.	Habitat Availability	Russian River HU	22
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Identify and fund solutions to modify or eliminate summer breaching of the Russian River Estuary, with the goal of providing for longer estuary rearing of salmon and steelhead, and eliminating early adult chinook migration to appropriate migration period when river conditions are optimal. This two-fold goal could be accomplished through a series of management changes - see page 238 of source document.	Migration	Guerneville HSA	22
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Identify and remediate upslope problems to reduce need for stream-dredging along county maintained floodways (creeks). Ie., identify and remediate sources of sediment and eliminate delivery mechanisms (ditches and gullies).	Habitat Availability	Russian River HU	22
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Reduce flows in the main river to improve habitat along the mainstem and reduce the frequency of breaching in the estuary.	Habitat Availability	Russian River HU	22
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Reduce flows out of Lake Mendocino to improve stratification in the Mendocino reach deeper pools for juvenile fish.	Habitat availability	Russian River HU	22
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	To reduce bank erosion and improve conditions for migrating and spawning adult salmonids, flow release schedules should be established which closely mimic natural flow regimes.	Habitat Availability	Mainstem Russian River	22
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Control erosion to improve migration and summer/over-wintering habitat for coho salmon.	Migration	Forsythe Creek HSA	22
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Restore and enhance priority riparian habitat	Riparian Stability	Russian River HU	22

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Restore riparian vegetation to improve migration and summer/overwintering habitat for coho salmon.	Migration	Forsythe Creek HSA	22
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Oak woodlands and perennial grasses stabilize hillsides. Historic clearing of oak woodlands and conversion to annual grasslands have contributed to significant increases in erosion, especially in geologically unstable areas. Work with public and private landowners to initiate large-scale restoration projects planting oaks and deep-rooted native perennial grasses on slopes around the Santa Rosa Plain, especially in the southern portions of the watershed.	Habitat Protection	Laguna de Santa Rosa HSA	22
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Riparian forests are essential for ecosystem health, but more than half of the stream channels in the Laguna watershed have no stream canopy. Restoration at this scale will require public and private collaborations for planning, funding, implementation and management, as well as outreach and education programs. Many existing efforts can contribute to the overall goal. Top priority areas include the Middle Reach of the Laguna channel between Highway 12 in Sebastopol and Guerneville Road, the Sunland reach of the Laguna channel, Colgan Creek, Gossage and Washoe Creeks near Cotati, the Laguna channel from its headwaters to the confluence with Copeland Creek; and the Wilfred and Hinebaugh flood control channels.	Riparian Stability	Laguna de Santa Rosa HSA	22
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	The Laguna floodplain has an extremely low gradient, and several inches difference in elevation makes huge differences for determining flood-risk areas and habitat conditions for aquatic plants like Ludwigia. High-resolution digital elevation data, along with 3-D floodplain models, is essential for long-term flood protection and pollution control planning, evaluating which areas will be vulnerable to Ludwigia, and for designing successful restoration projects.	Resource Management	Laguna de Santa Rosa HSA	22
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Reduce fine sediment input to Foote Creek. Reshape and plant with native vegetation over-steep banks in the lower portion of Reach 1. Repair human-related point sources of sediment. Manage livestock access and wet crossings.	Riparian Stability	Geyserville HSA	22
North Coast Regional Water Quality Control Board. Regional Water Board Staff Work Plan to Control Excess Sediment in Sediment-Impaired Watersheds. November, 2002	Develop dairy-focused outreach and education program. Work with the Animal Resource Management Committee, Sonoma County Farm Bureau, Western United Dairymen, dairy operators, and stakeholders to develop and implement a collaborative outreach and education program for dairy water quality.	Resource Management	Russian River HU	22
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. March, 2007	Support and encourage fish-friendly programs and maintenance plans to ensure that roads and culverts do not contribute to significant soil erosion and sedimentation in the watershed nor restrict fish and wildlife passage.	Socioeconomic	Russian River HU	22
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Preservation is recommended for Peterson Creek through Youth Park, due to habitat value for fish and wildlife. Habitat restoration is recommended where possible. The most likely location would be between Guerneville Road and Santa Rosa Creek, with channel enlargement possible through removal of one of the service roads. Instream habitat structures and native vegetation could be placed in the creek channel. Habitat enhancement involving removal of invasive species and replacement with native vegetation is recommended throughout the reach. Fish passage at the confluence of Peterson Creek and Santa Rosa Creek should be addressed.	Habitat Availability	Santa Rosa Creek HSA	22
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Preservation is recommended for this reach, due to habitat value for wildlife. The barriers to fish migration should be addressed. In particular, passage through the Piner Reservoir would allow access to upstream habitat for steelhead. Habitat enhancement including invasive species removal and replacement with native vegetation is also recommended.	Habitat Protection	Santa Rosa Creek HSA	22

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Some stream meanders and native vegetation could be restored to Lornadell Creek along the frontage with Yulupa School and Mesquite Park. A detailed hydrology analysis of the watershed for this creek will be necessary before development of a habitat restoration plan. Habitat enhancement involving invasive species removal and replacement with native vegetation is recommended throughout the reach.	Habitat Availability	Santa Rosa Creek HSA	22
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . June, 2006	The majority of this reach is recommended for preservation, due to habitat value for fish and wildlife. Habitat enhancement involving invasive species removal and replacement with native vegetation is also recommended. Consideration should be given to the daylighting and restoration of Matanzas Creek near the confluence of Santa Rosa Creek. If daylighting is not feasible, a fish ladder should be constructed to open up access to several miles of healthy habitat upstream for migrating steelhead trout.	Habitat Protection	Santa Rosa Creek HSA	22
Sonoma Land Trust, Laguna de Santa Rosa Foundation. Laguna de Santa Rosa: Resource Atlas and Protection Plan. March, 2006	Purchase in-fee land for valley oak/vernal pool complex preserves from willing sellers. Develop preserves that are approximately 500 acres in size in order to preserve the hydrologic regime that results in vernal these vernal pools.	Habitat Protection	Laguna de Santa Rosa HSA	22
Sonoma Land Trust, Laguna de Santa Rosa Foundation. Laguna de Santa Rosa: Resource Atlas and Protection Plan. October, 2004	Use conservation easements to preclude development of structures or creation of impervious surfaces in the floodplain.	Habitat Protection	Laguna de Santa Rosa HSA	22
Sotoyome Resource Conservation District. Maacama Creek Watershed Assessment. June, 2002	Implement recommended monitoring program: establish at least one study reach on McDonnell, Briggs, Redwood, Bidwell, and Franz Creeks to evaluate changes, use the V* protocol over a broad area of each subbasin, collect water temperature data from multiple sites in each subbasin, objectively monitor all restoration projects.	Fisheries Protection	Geyserville HSA	22
The Conservation Fund. Conservation Prospects for the North Coast. January, 2008	Encourage stream enhancement in the upperwatershed of the east fork of Austin Creek.	Resource Management	Austin Creek HSA	22
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Assess watershed and reach- scale geomorphic processes. Conduct an in- depth hydrologic and geomorphic assessment of the Upper Green Valley watershed.	Habitat Protection	Guerneville HSA	22
Sotoyome RCD. Upper Mark West Watershed Management Plan Phase 1: Watershed Characterization and Needs Assessment.. 2008	Restore and protect forest health.	Habitat Protection	Mark West HSA	22
Gold Ridge RCD. Willow Creek Watershed Management Plan. March 2005	To the extent possible, management of the watershed should work toward restoration of of habitats and landscape functions	Habitat Availability	Guerneville HSA	22
Gold Ridge RCD. Willow Creek Watershed Management Plan. March 2005	Reducing the volume and rate of sediment production in the upper watershed is essential for long-term ecosystem health.	Habitat Protection	Guerneville HSA	22
Community Foundation Sonoma County and Sonoma County Water Agency. Biodiversity Action Plan: Priority Actions to Preserve Biodiversity in Sonoma County. October 2010	Conduct Priority Conservation Research Projects	Science	Guerneville HSA	22
Laguna de Santa Rosa Foundation. Laguna Watershed Research Plan 2008 - 2012. 2008	Creation/expansion of a scientific knowledgebase to inform the implementation of effective restoration and appropriate long-term management of conservation areas.	Science	Laguna de Santa Rosa HSA	22
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Completion of Farm Conservation Plans that address sediment source reduction, riparian habitat, forest health, and restoration.	Habitat Availability	Russian River HU	22
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	The priorities in this recovery plan should serve as a guide for independent Forest Certification.	Fisheries Protection	Russian River HU	22
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Assess efficacy and necessity of ongoing stream maintenance practices and evaluate, avoid, minimize and/or mitigate their impacts to rearing and migrating CCC coho salmon.	Fisheries Protection	Russian River HU	22

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Occidental Arts and Ecology Center. Interviewee Brock Dolman. 3/18/2011	We need to define our goals more clearly. Our shifting baselines are based on recent generational knowledge, where a "good" year in the Russian is 2,000 adults. How do we define a biologically defensible target for salmonid populations? What was the population of salmonid species in the watershed pre-contact? What was a good year back then compared to a bad year? We have no historic baseline. What about presence, distribution, and abundance of beavers and their influences on coho salmon habitat?	Coho Population Recovery	Guerneville HSA	22
NRCS - Sonoma and Marin Counties. Interviewee Charlette Epifanio. 3/16/2011	Forests have Sudden Oak Death (SOD) infestations and other diseases are often not managed because they are now rural residential, and the potential for extreme fire events is very real. The value of the forests for wildlife and fisheries habitat cannot be under-estimated. We need additional resources to better manage the forests for disease/pest management, fire protection, and timber production.	Resource Management	Mainstem Russian River	22
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Alternatives such as excluding livestock from the riparian corridor except at controlled access points and the use of "riparian pastures," off-site watering devices, and other effective stock management techniques should be explored with livestock grazers and developed whenever possible.	Riparian Stability	Russian River HU	21
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Eliminate channel maintenance activities at Mirabel and Wohler to provide for habitat complexity in the vicinity.	Migration	Russian River HU	21
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Explore other alternatives to breaching including pumping flood waters over the sand berm or installing a bypass structure (buried pipe or culvert) through the berm during summer months.	Migration	Russian River HU	21
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Modification of log debris accumulations (LDA) is desirable, but must be done carefully, over time, to avoid excessive sediment loading in downstream reaches, and to preserve the larger beneficial scouring elements.	Migration	Russian River HU	21
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Operate dams to more closely mimic rainfall hydrograph to improve migration, and provide sediment flushing flows, but eliminate the extended "limb" of the hydrograph which increases bank erosion and impedes upstream fish migration.	Migration	Russian River HU	21
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Projects to offset channel incision, diminished gravel recruitment, gravel bed scour, bank erosion and riparian loss need to be developed on the mainstem and many tributary sections. Projects to increase spawning gravel are desirable where suitable spawning gravel is found on relatively few reaches, or crowding and/or superimposition of redds has been observed during winter surveys. Flosi et al. 1998 has specific structure recommendations for each channel type.	Gravel Quantity	Russian River HU	21
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Reduce flows in Dry Creek during the summer through shifting dependency to offstream storage or piping needed water supply to Mirabel.	Habitat Availability	Russian River HU	21
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Reduce flows in the main river.	Migration	Russian River HU	21
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Review and modify policy on how "storm-damage related road, culvert, and bank" work are treated under emergency conditions relative to effects on anadromous streams, and work with FEMA to alter existing conditions. Reduce dependency of maintenance or capitol improvement budgets on FEMA funding and instead create reserve budgets annually to treat emergencies correctly.	Fisheries Protection	Russian River HU	21

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	The impacts of opening the bar need to be studied, and monitoring for fish species composition and distribution conducted before, during and after breaching. Sampling further upstream from existing sampling stations needs to be conducted as recent data indicate conditions may be more favorable for salmonids there (SCWA 2000). . The county will have to conduct environmental studies on the impact on biotic resources as well as the flood control benefits, and alternatives through the Section 7 consultation with NMFS and the USACE.. A no-beach alternative needs to be evaluated, and sampling conducted to show whether chinook salmon utilize the estuary through the summer in a lagoon type environment.	Migration	Guerneville HSA	21
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	To reduce bank erosion and improve conditions for migrating and spawning adult salmonids, flow schedules should be established which closely mimic natural flow regimes.	Habitat Availability	Mainstem Russian River	21
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Encourage Sonoma County and the City of Santa Rosa to reduce habitat fragmentation and implement riparian improvements through land-use planning and use of conservation easements.	Habitat Protection	Santa Rosa Creek HSA	21
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Promote alternatives to conventional bank stabilization for public and private projects, including bioengineering techniques.	Habitat Availability	Russian River HU	21
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	It will be difficult to entirely restore the environmental integrity of the Santa Rosa Creek system until Santa Rosa and Matanzas Creeks are day-lighted from their culverts where they flow through downtown Santa Rosa. Restoring this downtown stretch of the two creeks would allow the Prince Memorial Greenway to be extended further into the heart of the city.	Habitat Availability	Laguna de Santa Rosa HSA	21
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Like birds in the forest, fish prefer structured habitats. In mature riparian forests, this structure is provided in part by fallen trunks and tree limbs that create pools and eddies— hiding places for fish, and resting and feeding sites for their invertebrate prey. In developed areas, fish needs for habitat structure must be balanced with flooding concerns. Preserve large woody debris within stream channels wherever possible, but restorationists should work closely with regulators, local jurisdictions, SCWA and local landowners to reduce flood risks.	Habitat Availability	Laguna de Santa Rosa HSA	21
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Standardize preserve management practices among private and publicly owned preserve properties. Ensure effectiveness and efficiency of preserve management by assigning responsibility for coordination, consolidated management, monitoring, and data synthesis to a single local conservation organization.	Resource Management	Laguna de Santa Rosa HSA	21
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	The Cities of Rohnert Park and Cotati have plans to embark on an urban creek master planning process to coordinate creek restoration and public access. To accelerate the implementation of restoration efforts, hydrology studies should be initiated in parallel to the planning process, to evaluate the baseline conditions and feasibility of potential restoration projects such as establishing low flow channels.	Resource Management	Laguna de Santa Rosa HSA	21
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	The elevation of the Laguna main channel between Stony Point and Llano roads determines the summertime water depths of the Bellevue-Wilfred channel upstream. Under current conditions, the Bellevue-Wilfred channel is ponded and stagnant, infested by Ludwigia, and a substantial source of mosquito production. It is a high priority to evaluate the feasibility of establishing low-flow channel in this reach.	Resource Management	Laguna de Santa Rosa HSA	21
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	The Laguna de Santa Rosa is a complex watershed, whether measured by social or ecological standards. Given this complexity, rigorous environmental planning will require broad consultation between different stakeholders. Establishing a formal stakeholder council may be the most effective and efficient way to share knowledge and gather input on specific projects and policies.	Socioeconomic	Laguna de Santa Rosa HSA	21

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	The Laguna wetlands are the most biologically diverse, productive and complex habitat in the ecosystem, yet little is known about the details of their ecological functions, and how biological and physical processes interact. Much more research is needed to inform restoration and management programs for seasonal wetlands, floodplains, and emergent perennial wetlands and waterways.	Science	Laguna de Santa Rosa HSA	21
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Coordinate and develop protocols for identifying standard habitat and wetland protections to be used during land use planning and development decisions. The same protocols may apply across counties, municipalities, and special districts.	Habitat Protection	Russian River HU	21
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. March, 2007	Seek an appropriate balance for riparian vegetative cover throughout the watershed.	Riparian Stability	Russian River HU	21
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . June, 2006	The valley oaks along the Northwestern Pacific right of way should be preserved. Habitat enhancement involving removal of invasive species and replacement with native vegetation is recommended throughout the reach. The fish migration barriers should be addressed, most importantly the barrier at the confluence of Steele Creek and Piner Creek.	Habitat Availability	Santa Rosa Creek HSA	21
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2003	This reach is recommended for preservation, due to habitat value for fish and wildlife. Habitat enhancement involving invasive species removal and replacement with native vegetation is also recommended. Restoration of natural stream meanders and native vegetation may be possible through the Caltrans right of way between Hoen Avenue and Mayette Avenue.	Habitat Protection	Santa Rosa Creek HSA	21
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2003	This reach is recommended for preservation, due to habitat value for fish and wildlife. Habitat restoration recommended for this reach is focused on providing migratory fish passage upstream. Existing culverted crossings should be replaced with span bridges. In addition, habitat enhancement involving invasive species removal and replacement with native vegetation is recommended.	Habitat Availability	Santa Rosa Creek HSA	21
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2003	This reach is recommended for preservation. Compliance with the City's 50 foot setback requirement is proposed for this reach, due to habitat value for wildlife. Habitat enhancement including invasive species removal and replacement with native vegetation is also recommended.	Habitat Protection	Santa Rosa Creek HSA	21
The Conservation Fund. Conservation Prospects for the North Coast. 2005	Work to further land use planning and land acquisition programs in the Green Valley Creek watershed and Pitkin Marsh.	Habitat Protection	Russian River HU	21
The Conservation Fund. Conservation Prospects for the North Coast. 2005	Work to realize DFG land protection targets for 7,000 acres of the Laguna de Santa Rosa.	Habitat Protection	Laguna de Santa Rosa HSA	21
Sotoyome RCD. Upper Mark West Watershed Management Plan Phase 1: Watershed Characterization and Needs Assessment.. 2008	Restore aquatic habitat.	Fisheries Protection	Mark West HSA	21
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Improve over-winter survival by increasing the frequencyand functionality of off-channel habitats	Habitat Availability	Russian River HU	21
Gold Ridge RCD. Willow Creek Watershed Management Plan. March 2005	Apply BMPs to prevent further introduction or spread of invasive species.	Habitat Availability	Guerneville HSA	21
City Council of Cloverdale. City of Cloverdale General Plan. 2009, amended 2010	Adopt a hillside ordinance or a hillside provisions within the Zoning Ordinance to implement hillside development provisions.	Habitat Protection	Guerneville HSA	21
City of Santa Rosa. Santa Rosa General Plan 2035. November, 2009	Conserve wetlands, vernal pools, wildlife ecosystems, rare plant habitats, and waterways.	Habitat Protection	Russian River HU	21
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Develop a Large Wood Recruitment Plan that assesses instream wood needs, and sites potentially responsive to wood recruitment or placement, and develop a riparian strategy to ensure long term natural recruitment of wood via large tree retention.	Riparian Stability	Russian River HU	21

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Promote alternatives to conventional bank stabilization for public and private projects, including bioengineering techniques (DFG 2004).	Resource Management	Russian River HU	21
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Improve riparian and instream conditions in rearing habitats by establishing riparian protection zones that extends from the outer edge of the channel out to the site potential of tree height to allow LWD recruitment.	Riparian Stability	Russian River HU	21
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Solicit cooperation from NRCS, RCDs, Farm Bureau, and others to devise incentive programs and incentive-based approaches to encourage increased involvement and support existing landowners who conduct operations in a manner compatible with CCC coho salmon recovery priorities.	Habitat Protection	Russian River HU	21
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Develop a California Forest Practice monitoring protocol to determine whether specific practices are effectively meeting intended objectives and are providing for the protection of CCC coho salmon.	Fisheries Protection	Russian River HU	21
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Maintain intact and properly functioning riparian buffers to filter and prevent fine sediment input from entering streams.	Riparian Stability	Russian River HU	21
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Minimize potential impacts to coho salmon habitat when planning and developing residential and commercial property.	Fisheries Protection	Russian River HU	21
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Encourage development and implementation of a program similar to the County of Santa Cruz's Integrated Vegetation Management Plan for Roads Near Perennial Waters (URS Corporation, 2008) regarding roadside maintenance activities to discourage or eliminate unwanted vegetation and promote desirable (native) vegetation.	Fisheries Protection	Russian River HU	21
Mendocino RCD. Mendocino County RCD Interviewees Jan Olave, Shelley Janek, Joe Scriven. February 27,2012	Livestock exclusionary fencing	Riparian Stability	Forsythe Creek HSA	21
Mendocino RCD. Mendocino County RCD Interviewees Jan Olave, Shelley Janek, Joe Scriven. February 27,2012	Livestock exclusionary fencing	Riparian Stability	Ukiah HSA	21
Mendocino RCD. Mendocino County RCD Interviewees Jan Olave, Shelley Janek, Joe Scriven. February 27,2012	Barriers to Fish Passage	Coho Population Recovery	Ukiah HSA	21
Mendocino RCD. Mendocino County RCD Interviewees Jan Olave, Shelley Janek, Joe Scriven. February 27,2012	Barriers to Fish Passage	Coho Population Recovery	Ukiah HSA	21
Mendocino RCD. Mendocino County RCD Interviewees Jan Olave, Shelley Janek, Joe Scriven. February 27,2012	Assess barriers to fish passage at all railroad crossings at Class I streams	Coho Population Recovery	Forsythe Creek HSA	21
Mendocino RCD. Mendocino County RCD Interviewees Jan Olave, Shelley Janek, Joe Scriven. February 27,2012	Re-assess barriers to fish passage identified by Ross Taylor and Associates in 2002	Coho Population Recovery	Forsythe Creek HSA	21
Occidental Arts and Ecology Center. Interviewee Brock Dolman. 3/18/2011	Land managers/authorities need an improved understanding of fire in the region, and need to begin planning for managing for action or planning for devastation. Fire and fuel loads have not been managed since the subwatersheds became rural communities. Past logging has created abnormally high fuel loads in the forests, which could create stand-replacing forest fires. We have inherited these fuel loads and may have to pay the price in the form of disaster and decades of forest recovery. The Fire Safe Council needs funds for planning and implementation.	Resource Management	Guerneville HSA	21
Hildreth Farms, Inc.. Interviewee Mike Hildreth. 5/27/2011	Addressing the disconnection of the stream from the river is important. The river down-cutting at the creek mouths makes fish access from the river to the creek more difficult on some creeks.	Riparian Stability	Ukiah HSA	21

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
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Sonoma County Farm Bureau. Interviewee Tito Sasaki, Board Member. 4/1/2011	Environmental fines collected should be used first for rectifying the infrastructure, equipment, or organizational defects that caused the violations. The balance should be used for improving the physical protection of the harmed beneficial uses in the same watershed. The above proposed project falls in the latter category. No part of the fines should go to the general fund, environmental studies that are not the solution to the violation-caused problems, or projects outside the watershed.	Socioeconomic	Russian River HU	21
California State Coastal Conservancy. California State Coastal Conservancy Strategic Plan 2007. 2007	Develop 112 plans to remove barriers to fish passage and ensure sufficient instream flow to support fish habitat	Migration	Russian River HU	20
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Development of local bond measures should be pursued to cost-share large-scale river restoration projects for riparian stability.	Riparian Stability	Mainstem Russian River	20
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Existing culverts on fish bearing tributaries should be assessed for barrier potential following Fish Passage Evaluation at Road Crossings (Taylor 2000). DFG supports remediation of all passage issues at all County culvert identified in the Taylor assessment.	Migration	Russian River HU	20
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Flows in Dry Creek have been estimated to be too high for adequate juvenile rearing and rearing habitat is lacking due to lack of LWD through channel clearing and riparian loss. Addition of LWD to pool locations would improve rearing habitat.	Habitat Availability	Warm Springs HSA	20
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Habitat enhancement projects often initiate landowner interest, and projects should be encouraged when the need is justified through habitat assessment, and the activity is well defined and designed whenever possible. Habitat Inventory reports summarize the need for habitat addition, and enhancement by geomorphic reach but do not detail specific locations.	Habitat availability	Russian River HU	20
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Implement solutions to problems for coho salmon caused by channelization	Migration	Santa Rosa Creek HSA	20
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Implement environmentally appropriate sediment removal projects in areas where excess sediment accumulation has degraded environmental conditions. For example, such projects may include restoring low-flow channels, or restoring one or more historic deep-water features in the Laguna.	Resource Management	Laguna de Santa Rosa HSA	20
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Riparian and floodplain areas have far-reaching environmental functions that are essential to the overall health of the Laguna ecosystem. Support development of a strong NCRWQCB stream and wetland protection policy that recognizes the importance of maintaining healthy hydrology and vegetation in riparian areas and floodplains, and the connectivity between riparian, floodplain and wetland areas. Policies should be developed through consultation with the public, and reflect the constraints of existing development.	Riparian Stability	Laguna de Santa Rosa HSA	20
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	This and other remnant upland wetlands in the western portions of the watershed are the most endangered habitat type in the watershed, supporting some of the rarest plant species. Although a conservation easement protects a portion of Cunningham Marsh, species recovery efforts would be greatly aided if more of the marsh and surrounding uplands were to be purchased from willing landowners.	Habitat Protection	Laguna de Santa Rosa HSA	20
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Change data collection/analysis practices to include assessments of cumulative effects and future obligations (e.g., number of building permits versus population growth figures or extent and rate of top soil loss or enhancement).	Science	Russian River HU	20
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Develop equipment and tool sharing/loaning program that enables community groups and individuals to monitor resource quality and quantities.	Socioeconomic	Russian River HU	20
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Implement a model K-12 watershed curriculum in local schools that has been tailored to the conditions and issues within the Russian River watershed.	Socioeconomic	Russian River HU	20

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat restoration is recommended for this reach. However, the presence of a trunk sewer line underneath the left bank service road between Austin Creek and Highway 12 prevents the restoration of this portion of the reach. With improved detention in the upper watershed, it may be possible to restore this reach within the current channel cross-section. Without such a change in reach hydrology, restoration is recommended only between Montecito Boulevard and Austin Creek. Restoration would include the removal of grouted riprap and concrete. The service road along the left bank would be removed to enlarge the creek channel area, creating room for a meandering low-flow channel, instream habitat structures such as boulders and rootwads to encourage pool formation, and planting of native vegetation.	Habitat Availability	Santa Rosa Creek HSA	20
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat restoration is recommended for this reach. Removal of one service road where present would allow for channel enlargement to accommodate a meandering low-flow channel, instream habitat structures, and replanting of native vegetation.	Habitat Availability	Santa Rosa Creek HSA	20
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat restoration is recommended for this reach. Removal of the service road along the left bank between Maitland Avenue and Ludwig Avenue would allow for channel enlargement to accommodate a meandering low-flow channel, instream habitat structures, and replanting of native vegetation. Crossings may be needed to accommodate trail users.	Habitat Availability	Santa Rosa Creek HSA	20
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat restoration is recommended for this reach. The channel could be recontoured to include a meandering low-flow channel, instream habitat structures, and replanting of native vegetation.	Habitat Availability	Santa Rosa Creek HSA	20
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat restoration is recommended through Rincon Valley Park. The concrete basins and channel bottom would be removed and replaced with a meandering creek, incorporating a low flow channel and boulders for aquatic habitat, and native vegetation to filter runoff from turf areas. Additional trees would be planted to increase shading of the channel. The basin currently used for the dog park could be reconstructed away from the creek. In addition, habitat enhancement is recommended throughout this reach, including invasive species removal and replacement with native vegetation.	Habitat Availability	Santa Rosa Creek HSA	20
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Preservation is recommended for the more natural portions of this reach, upstream of Old Redwood Highway. Habitat enhancement is recommended throughout the reach, involving removal of invasive species and replacement with native vegetation.	Habitat Protection	Santa Rosa Creek HSA	20
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Preservation is recommended for the portions of this reach upstream of Bicentennial Drive. Habitat enhancement involving removal of invasive species and replacement with native vegetation is recommended throughout the reach.	Habitat Protection	Santa Rosa Creek HSA	20
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Preservation is recommended for this reach. Habitat enhancement including invasive species removal and replacement with native vegetation is also recommended.	Habitat Availability	Santa Rosa Creek HSA	20
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Preservation is recommended for this reach. Habitat enhancement including invasive species removal and replacement with native vegetation is also recommended.	Habitat Availability	Santa Rosa Creek HSA	20

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
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City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . June, 2006	The portion of this reach downstream of Middle Rincon Road is recommended for restoration. There are two channels at this location, the natural channel (now abandoned) and a modified channel that carries the waters of Austin Creek. Uniting the channels would enlarge the cross-sectional area and allow for the introduction of a meandering low-flow channel, along with instream habitat structures like rootwads and boulders to create pools, and plantings of native trees and shrubs. Fish passage barriers should be addressed at the road crossings mentioned above. Habitat enhancement is recommended throughout the reach, including removal of invasive species and replanting with native vegetation.	Habitat Availability	Santa Rosa Creek HSA	20
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2003	This reach is recommended for preservation, due to the habitat value for fish and wildlife. Habitat enhancement is also recommended, including removal of invasive species and replanting with native vegetation. The fish passage barriers at Deer Trail Road, Amber Lane, Riebli Road, and at Wallace Road need to be addressed.	Habitat Protection	Santa Rosa Creek HSA	20
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2003	This reach is recommended for restoration, as described in the Lower Colgan Creek Restoration Concept Plan, adopted by City Council in 2002 . A meandering low-flow channel would be restored to the creek, with instream habitat structures and native revegetation. The existing service road along the left bank between Victoria Drive and Bellevue Avenue would be removed to allow for more room in the channel for improvements. From this point downstream to Burgess Drive the right bank service road would be removed. .	Habitat Availability	Santa Rosa Creek HSA	20
Sonoma Land Trust, Laguna de Santa Rosa Foundation. Laguna de Santa Rosa: Resource Atlas and Protection Plan. October, 2004	Purchase in-fee or establish easements from willing sellers on property within the Laguna floodplain (below the 76-foot topographic contour).	Habitat Protection	Laguna de Santa Rosa HSA	20
Sonoma Land Trust, Laguna de Santa Rosa Foundation. Laguna de Santa Rosa: Resource Atlas and Protection Plan. October, 2004	Purchase property in-fee from willing sellers for seasonal wetland preserves. Work to develop preserves that are approximately 500 acres in size in order to preserve the hydrologic regime that results in these seasonal wetlands.	Habitat Protection	Laguna de Santa Rosa HSA	20
Sotoyome Resource Conservation District. Maacama Creek Watershed Assessment. March, 2005	Reforest lower Redwood Creek	Fisheries Protection	Geyserville HSA	20
California Dept of Parks & Recreation, Statewide Trails Office. California Recreational Trails Plan. March, 2005	Develop multi-jurisdictional plans for habitat linkages. Since most wildlife corridors cover multi-jurisdictional areas, it is essential that planning discussions and activities include the land managers for the corridor region, as well as stakeholders and affected regulators.	Habitat Protection	Russian River HU	20
The Conservation Fund. Conservation Prospects for the North Coast. January, 2008	Explore adjusting the operation of Mirabel Dam within confines of existing water rights and legal uses, to improve passage of downstream migrants.	Migration	Russian River HU	20
The Conservation Fund. Conservation Prospects for the North Coast. 2005	Implement the Coho Salmon Captive Broodstock Program: continue genetic analysis of source stocks for coho salmon broodstock; stock first-priority barren streams, and identify additional streams that may be suitable for stocking as restoration occurs; develop and implement a monitoring and evaluation program to adaptively manage the Program; develop, implement, and evaluate experimental release protocols for the Program; review and revise long-term hatchery Program goals based on results of the monitoring and evaluation program; and develop and implement a long-term monitoring program for coho salmon abundance trends in suitable index streams that have recent (within eight years) coho salmon presence or that will be supplemented with the Program.	Coho Population Recovery	Russian River HU	20
UC Cooperative Extension, Sonoma County & Sonoma County Department of Emergency Services. Sonoma County Sudden Oak Death Strategic Response Plan. 2008	Educate agencies and residents to keep them current with research about SOD, forest health, fire dangers, and management techniques.	Habitat Protection	Russian River HU	20

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Restore and enhance estuary habitat in the watershed	Habitat Availability	Guerneville HSA	20
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Restore estuarine habitat and the associated wetlands and sloughs by providing fully functioning habitat	Habitat Availability	Guerneville HSA	20
Gold Ridge RCD. Willow Creek Watershed Management Plan. March 2005	For restoration of channel continuity and dynamic equilibrium in the lower watershed, the obstacles to natural channel forming processes must also be addressed.	Flood Plain Management	Guerneville HSA	20
Community Foundation Sonoma County and Sonoma County Water Agency. Biodiversity Action Plan: Priority Actions to Preserve Biodiversity in Sonoma County. October 2010	Set Conservation Targets to Define Success	Science	Guerneville HSA	20
Community Foundation Sonoma County and Sonoma County Water Agency. Biodiversity Action Plan: Priority Actions to Preserve Biodiversity in Sonoma County. October 2010	Steward our Protected Lands Network	Resource Management	Guerneville HSA	20
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Barriers to upstream and downstream migration in Willow Creek should be corrected by removing or altering the design of the second bridge to allow channel forming processes to occur. The primary factors contributing to obstruction of upstream adult and downstream juvenile migration are the rapid sediment aggradation, widespread flow distribution, and channel disconnection at lower flows. These problems will continue without substantial changes to the bermed roadway at the second bridge.	Migration	Guerneville HSA	20
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Encourage landowners to implement restoration projects as part of their ongoing operations in stream reaches where large woody debris is lacking.	Habitat Availability	Russian River HU	20
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	In the Ward Creek sub-basin reforestation to a conifer forest should be a long term strategy to return the area to fully functioning condition. Implementing this type of strategy will need to employ incentives and assistance to landowners. In conjunction with Sudden Oak death programs.	Resource Management	Austin Creek HSA	20
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Provide for properly functioning watershed processes (e.g., cycles of wood, water and sediment) by promoting long term sustainable forestry practices that support coho salmon habitats.	Resource Management	Russian River HU	20
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Improve stream maintenance practices to protect instream complexity, hydrologic processes and riparian functions.	Fisheries Protection	Russian River HU	20
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Disperse discharge from new or upgraded commercial and residential areas into a spatially distributed network rather than a few point discharges, which can result in locally severe erosion and disruption of riparian vegetation and instream habitat.	Resource Management	Russian River HU	20
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Identify areas at high risk of conversion, and develop incentives and alternatives for landowners that discourage conversion.	Fisheries Protection	Russian River HU	20
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Ensure all existing and new road crossings allow upstream and downstream passage for coho salmon.	Migration	Russian River HU	20
Mendocino RCD. Mendocino County RCD Interviewees Jan Olave, Shelley Janek, Joe Scriven. February 27,2012	Assess stream crossings and sediment sources in Potter Valley and prioritize for treatment.	Resource Management	Forsythe Creek HSA	20

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Mendocino RCD. Mendocino County RCD Interviewees Jan Olave, Shelley Janek, Joe Scriven. February 27,2012	Barriers to Fish Passage	Coho Population Recovery	Ukiah HSA	20
Mendocino RCD. Mendocino County RCD Interviewees Jan Olave, Shelley Janek, Joe Scriven. February 27,2012	Barriers to Fish Passage	Coho Population Recovery	Ukiah HSA	20
Mendocino RCD. Mendocino County RCD Interviewees Jan Olave, Shelley Janek, Joe Scriven. February 27,2012	Barriers to Fish Passage	Coho Population Recovery	Ukiah HSA	20
Mendocino RCD. Mendocino County RCD Interviewees Jan Olave, Shelley Janek, Joe Scriven. February 27,2012	Barriers to Fish Passage	Coho Population Recovery	Forsythe Creek HSA	20
Mendocino RCD. Mendocino County RCD Interviewees Jan Olave, Shelley Janek, Joe Scriven. February 27,2012	Barriers to Fish Passage: Assess Norgard Rubble Dam for juvenile salmonid passage	Coho Population Recovery	Ukiah HSA	20
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Avoid high flow dam inspections during the incubation period; coordinate them with timing of flushing flows to promote channel and habitat formation.	Migration	Russian River HU	19
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Implement Taylor recommendations for county road culvert passage issues.	Migration	Mark West HSA	19
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Implement Taylor Report recommendations when completed (see Draft Taylor Report (January 2002).	Migration	Russian River HU	19
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Other flood control measures need to be evaluated (other than breaching) in the Section 7 process. A reduction in flows from the Potter Valley project, which would improve conditions both in some reaches of the Russian and Eel River systems, may alleviate the need for frequent breaching of the estuary.	Migration	Guerneville HSA	19
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Projects involving solely rip-rap as a treatment for bank erosion should be discouraged, except where structures are threatened. Bio-engineering techniques utilizing vegetative materials and limited rock should be encouraged whenever possible. The California Department of Fish & Game Salmonid Stream Habitat Restoration Manual (Flosi et al. 1998) and Water Bioengineering Techniques for Watercourse Bank and Shoreline Protection (H.M.Schiechtl and R.Stern), are good references for bio-engineering type projects.	Gravel Quantity	Russian River HU	19
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Riparian restoration is also needed, but is challenging in most of the watersheds where harsh summertime temperatures prevail. Riparian restoration would be most successful and should target the steep south and west facing tributaries, such as the squaw sub-watershed and the Little Sulphur and North Branch Creeks in the upper watershed areas.	Riparian Stability	Sulphur Creek HSA	19
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Implement riparian vegetation improvement plans.	Riparian Stability	Warm Springs HSA	19
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Birds are probably the most visible form of wildlife in the Laguna watershed, and the Laguna has become a popular destination area for birdwatchers. Birds play very important ecological roles as predators and seed dispersers, and as they have complex habitat requirements, certain species can be excellent indicators for environmental quality—allowing comparisons between sites for adaptive management. For all these reasons, land managers should work with avian ecologists and volunteers to develop bird-monitoring programs for all large restoration projects. Compile these data in the Laguna ecosystem database.	Resource Management	Laguna de Santa Rosa HSA	19
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Conduct on-the-ground surveys of all potential salmonid-bearing streams to identify barriers to migration, sites of active erosion, and other conditions that would benefit from restoration or remediation. Highest priority reaches are the entire extent of Mark West, Porter, Windsor, and Pool creeks. Next in priority are the upper reaches of Santa Rosa, Matanzas, and Spring creeks, followed by Copeland and Blucher.	Habitat Availability	Laguna de Santa Rosa HSA	19

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Opening up the narrow half mile reach of the Laguna, situated between the broad and deep channel located within Sebastopol and the similarly broad and deep channel south of Occidental Road, would create an opportunity for greater public access by allowing summer kayaking between Highway 12 and Guerneville Road. In this reach the channel passes through a large ongoing riparian restoration project, and parallels a new trail being established by the SCAPOSD. This project would require substantial sediment removal and channel clearing, and would require feasibility studies to evaluate its effects on local hydrology, but might be effective in providing flood protection within Sebastopol.	Habitat Availability	Laguna de Santa Rosa HSA	19
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	The health of vernal pools and swales is inseparable from the health of their upland matrix. To be successful, vernal pool restoration must be accompanied by grassland management to control invasive species and restoration to improve habitat values. Without restoring the matrix, vernal pool communities will experience wave after wave of invasion by non-native grasses and problem species like perennial pepperweed.	Habitat Protection	Laguna de Santa Rosa HSA	19
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Address fish passage conditions in the lower portion of Gill Creek; remove the remnants of the old River Road crossing (just downstream of the current crossing; structures should be designed and placed in the channel so that adults are afforded ample low velocity sites to use as rest stops during migration; consider designing a low water channel in the downstream-most portion of the stream that would facilitate a longer temporal window for adult upstream migration.	Migration	Geyserville HSA	19
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Address fish passage conditions in the lower portion of Gird Creek; structures should be designed and placed in the channel so that adults are afforded ample low velocity sites to use as rest stops during migration; consider designing a low water channel in the downstream-most portion of the stream that would facilitate a longer temporal window for adult upstream migration.	Migration	Geyserville HSA	19
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Continue the restoration of portions of Santa Rosa Creek.	Habitat Protection	Santa Rosa Creek HSA	19
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Create a tool-box of non-toxic removal and replacement methods for exotic species that can be easily disseminated for application by private property owners, stewardship groups, resource agencies, and local municipalities.	Habitat Protection	Russian River HU	19
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. March, 2007	Use vegetation management techniques to preserve natural vegetation, reduce invasive species, and benefit the watershed.	Riparian Stability	Russian River HU	19
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Preservation of the remnant portion of Cooper Creek upstream of Cooper Drive is recommended, due to habitat value for wildlife. Habitat enhancement involving invasive species removal and replacement with native vegetation is also recommended.	Habitat Protection	Santa Rosa Creek HSA	19
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Removal of one service road along the right bank would allow for channel enlargement to accommodate a low flow meandering channel and revegetation with native species. Crossings may be needed to accommodate trail users.	Habitat Availability	Santa Rosa Creek HSA	19
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Removal of the right bank service road would allow for channel enlargement to accommodate a low flow meandering channel and revegetation with native species.	Habitat Availability	Santa Rosa Creek HSA	19
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . June, 2006	The scour at Badger Road should be addressed to ensure adequate fish passage to the uppermost portion of this reach. Additional pools could be created if instream structures such as boulders or large woody debris were placed within the channel. Habitat enhancement involving removal of invasive species and replanting with native vegetation is recommended throughout the reach.	Habitat Availability	Santa Rosa Creek HSA	19

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
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City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2003	This reach is recommended for preservation, due to the habitat value for fish and wildlife. Habitat enhancement is also recommended, including removal of invasive species and replanting with native vegetation. Fish passage barriers at St. Francis Road and San Ramon Way should be addressed.	Habitat Protection	Santa Rosa Creek HSA	19
Sonoma County Water Agency. Russian River Action Plan. March, 2003	Green Valley Creek Habitat Improvement	Habitat Availability	Guerneville HSA	19
Sotoyome Resource Conservation District. Coastal Tributary Improvement Program Final Monitoring Summary Report Agreement No. 03-214-551-0. October, 2004	Continue riparian canopy enhancement projects in areas with less than adequate cover and adjacent to stream channels showing temperatures that exceed water quality objectives	Riparian Stability	Austin Creek HSA	19
California Dept of Parks & Recreation, Statewide Trails Office. California Recreational Trails Plan. August, 2005	Provide open space corridors with adequate space to accommodate trails and allow areas for wildlife habitat and sensitive ecosystems.	Habitat Protection	Russian River HU	19
Stewards of the Coast and Redwoods. Willow Creek Watershed Management Plan. August, 2005	Place large woody debris in deficient stream reaches of the Willow Creek Watershed	Habitat Availability	Guerneville HSA	19
City Council of Cloverdale. City of Cloverdale General Plan. 2009, amended 2010	Land outside the Urban Growth Boundary shall be retained as Conservation Features, except for the Industrial and Asti Exception Areas.	Habitat Protection	Guerneville HSA	19
City Council of Cloverdale. City of Cloverdale General Plan. 2009, amended 2010	Maintain and expand the tree canopy within and outside the developed areas of the City, including old growth and newly planted trees. Prepare tree protection standards that can be implemented with or without a tree preservation ordinance.	Resource Management	Guerneville HSA	19
City Council of Cloverdale. City of Cloverdale General Plan. 2009, amended 2010	Protect distinctive natural vegetation such as oak woodlands, riparian corridors and mixed evergreen forests by maintaining the natural features as a whole. Preservation of individual trees or features rather than the larger habitat does not satisfy this policy.	Habitat Protection	Guerneville HSA	19
City Council of Cloverdale. City of Cloverdale General Plan. 2009, amended 2010	Conserve natural vegetation and wildlife resources.	Habitat Protection	Guerneville HSA	19
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Manage reservoirs and dam releases to maintain suitable rearing temperatures and migratory flows in downstream habitats (e.g., pulse flow programs for adult upstream migration and smolt outmigration).	Migration	Russian River HU	19
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Restore passage in high priority areas of the Russian River Watershed as identified by the DFG, NMFS, RCD, the County of Sonoma, Caltrans, and existing fish passage databases. High priority sites identified through DFG watershed surveys (DFG 2009) include: Dry Creek sub-basin: Mill Creek - private dam, Wallace Creek - county culvert, Crane Creek - bedrock sill, Grape Creek - County culvert. Lower River Tributaries: Purrington Creek - county culvert and possible private barriers, Dutch Bill, Duvoul and Grub Creek tributaries - County culverts, Willig Gulch - private culvert. Mark West sub-basin: Porter Creek - crossing at Calistoga Road. Maacama sub-basin: Redwood Creek - private crossing.	Migration	Russian River HU	19
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Encourage retention and recruitment of large woody debris for all historic CCC coho salmon streams to maintain and enhance current stream complexity, pool frequency, and depth. Consult a hydrologist and qualified fisheries biologist before removing wood from streams.	Habitat Availability	Russian River HU	19
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Promote streamside conservation measures, including conservation easements, setbacks, and riparian buffers (DFG 2004).	Habitat Protection	Russian River HU	19
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Promote agricultural practices that protect and restore CCC coho salmon habitat by working with the agricultural community.	Habitat Protection	Russian River HU	19

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Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Evaluate and prepare contingency plans to breach estuary sandbars to facilitate adult upmigration when instream flows are adequate for passage and spawning if sandbar remains closed by mid-January.	Migration	Russian River HU	19
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Expand the NRCS/RCD coordinated permit program to a statewide programmatic ESA consultation that allows funding and technical expertise to small land owners and rural residential property owners.	Fisheries Protection	Russian River HU	19
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Develop a road upgrade fund to supplement FEMA emergency repair funding so problem roads could be upgraded to reduce sediment loading and improve road reliability. The Counties should seek amendment of FEMA policies to allow improvements that prevent erosion and failure, particularly in watersheds with endangered salmonid habitat.	Fisheries Protection	Russian River HU	19
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Promote conjunctive use of water with water projects whenever possible to maintain or restore coho salmon habitat.	Fisheries Protection	Russian River HU	19
NRCS. Interviewee Carol Mandel. 2/22/2011	Preserving open space as part of protecting agriculture land is also important.	Habitat Protection	Mainstem Russian River	19
NRCS. Interviewee Carol Mandel. 2/22/2011	Fish populations do not get monitored in the tributaries, and that effort needs to improve to create a better understanding of population status. Need a comprehensive understanding, not just based on counts at the SCWA weir or COY facility.	Coho Population Recovery	Mainstem Russian River	19
Coyote Valley Tribal EPA Department. Interviewees Richard Campbell and Dan Rodriquez. 2/24/2011	Restoration projects like those on Forsythe Creek and West Fork Russian River need to continue so progress in habitat improvement can expand.	Habitat Availability	Forsythe Creek HSA	19
Mendocino County Water Agency. Interviewee Dennis Slota. 3/9/2011	Geomorphology monitoring	Science	Ukiah HSA	19
Hopland Band of Pomo Indians. Interviewee Shawn Pady, Chair and Tribal Historic Preservation Officer. 3/23/2011	Increased monitoring of salmonid populations throughout the watershed needs to occur.	Fisheries Protection	Russian River HU	19
Agriculture Department, County of Mendocino. Interviewee Tony Linegar. 2/24/2011	Cleanup efforts of illegal pot growing sites needs to continue and expand throughout the county.	Habitat Protection	Russian River HU	19
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Barriers on Big Sulphur, Little Sulphur, Wildhorse and Hummingbird Creeks should be assessed by a fish passage specialist, and modified if necessary. Several of these partial barriers have been impacted by nearby road activities.	Migration	Sulphur Creek HSA	18
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Continue habitat restoration projects that include pool development, use of large woody debris and other cover for salmonid rearing.	Habitat Availability	Mainstem Russian River	18
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	County maintained/owned culverts with low flow passage impaired identified so far: Wine Creek and Dutcher Creek (2 culverts).	Migration	Warm Springs HSA	18
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Decreasing or eliminating wastewater discharge would improve upstream migration conditions in Laguna Creek and sport fishing on the lower river.	Migration	Laguna de Santa Rosa HSA	18
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	DFG recommends designing and engineering pool enhancement structures to increase the number of pools or deepen existing pools, where the banks are stable or in conjunction with stream bank armor to prevent erosion, when pool habitat is lacking (as described earlier). Flosi et al. (1998) includes specific structure recommendations for each channel type. Instream habitat improvement is only appropriate in stream reaches suitable for habitat improvement structures.	Habitat availability	Russian River HU	18
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Except for Ward Creek, coho streams require further habitat restoration to re-establish natural coho populations or before supplementation with the Captive Broodstock Program would be considered.	Coho Population Recovery	Austin Creek HSA	18
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Implement Taylor recommendations for county road culvert passage issues.	Migration	Laguna de Santa Rosa HSA	18

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
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CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	It is recommended that new vineyards be installed at a distance greater than 300 feet from any riparian corridor. Opportunity also exists to expand the riparian corridor when vineyard or orchard replanting occurs in response to disease outbreaks and/or variety changes.	Riparian Stability	Russian River HU	18
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Outreach with private landowners to complete habitat assessment to establish priorities in this sub-basin is a high priority.	Habitat Availability	Ukiah HSA	18
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Projects to offset channel incision, diminished gravel recruitment, gravel bed scour, bank erosion and riparian loss need to be developed on Dry Creek below Lake Sonoma and in the Ukiah reach of the mainstem below Lake Mendocino. Projects involving solely rip-rap as a treatment for bank erosion on steep banks should be discouraged, except where structures are threatened. Bio-engineering techniques utilizing vegetative materials and limited rock should be encouraged whenever possible.	Gravel Quantity	Mainstem Russian River	18
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Riparian vegetation management plans are recommended after the presence of blue-green sharpshooter has been detected. See the Pierc's Disease/Riparian Habitat Workgroup's Information Manual: Riparian Vegetation Management for Pierce's Disease in North Coast California Vineyards, 9/1/2000.	Riparian Stability	Russian River HU	18
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Assess riparian canopy and impacts of exotic vegetation (e.g., Arundo donax), prioritized, and develop riparian habitat reclamation and enhancement programs.	Riparian Stability	Russian River HU	18
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Assess, prioritize, and develop plans to treat barriers to coho salmon passage in all HSAs	Migration	Russian River HU	18
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Develop and implement protocols for controlling Pierce's Disease to maintain a native riparian corridor	Riparian Stability	Russian River HU	18
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Develop plans to improve riparian vegetation in Dry Creek and its tributaries.	Riparian Stability	Warm Springs HSA	18
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Evaluate operating the estuary as a natural system to benefit coho salmon rearing and migration	Habitat Protection	Mainstem Russian River	18
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Evaluate the feasibility of bypassing large dams	Migration	Mainstem Russian River	18
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	If appropriate, control exotic vegetation (especially Arundo donax).	Riparian Stability	Russian River HU	18
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	If appropriate, operate the estuary as a natural system to benefit coho salmon rearing and migration.	Habitat Protection	Mainstem Russian River	18
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	All public properties in the Laguna should have site-specific plans for invasive species management. Plans should define explicit management objectives—for example, managing preserves for California tiger salamander (CTS) or managing farms for wastewater disposal—and reflect differences in environmental conditions and species of concern, as well as constraints on available control measures.	Resource Management	Laguna de Santa Rosa HSA	18
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Certain species, like the yellow-billed cuckoo, need large blocks of forest. Use historical ecology and hydrological analyses of the floodplain to identify which parcels are likely to support extensive riparian tree plantings without impeding flood protection.	Habitat Availability	Laguna de Santa Rosa HSA	18
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	It is very difficult to determine the most effective ways to promote species recovery without an understanding of their population dynamics, ecological interactions, and vulnerable life stages. Increase understanding of species and habitats by promoting research, mapping and monitoring of species and physical conditions on the Santa Rosa Plain.	Science	Laguna de Santa Rosa HSA	18

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
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Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Support regional collaborations between agencies and environmental organizations through the Marin/Sonoma Weed Management Area. Support local collaborations between public and private landowners as well as watershed and volunteer groups. Respect philosophical differences in views and values. Provide technical assistance and support to private landowners seeking to control invasive species. Initiate collaborative control efforts for the most aggressive high-priority invasive species. Use an integrated pest management approach that considers the geographic and ecological context of the invasion, minimizes the control effort and minimizes non-target impacts.	Resource Management	Laguna de Santa Rosa HSA	18
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Address fish passage conditions in the lower portion of Miller Creek. Structures should be designed and placed in the channel so that adults are afforded ample low velocity sites to use as rest stops during migration. Consider designing a low water channel in the downstream-most portion of the stream that would facilitate a longer temporal window for adult upstreammigration	Migration	Geyserville HSA	18
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Riparian enhancement in Foote Creek. Native vegetation should be planted in the upstream portion of Reach 1 to replace the current vegetation which provides very little canopy closure or large woody debris for instream cover.	Riparian Stability	Geyserville HSA	18
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Establish watershed priorities and promote policy recommendations to protect sensitive land areas.	Science	Russian River HU	18
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. March, 2007	Review and recommend improvements to city and county building requirements including sediment and erosion controls.	Socioeconomic	Russian River HU	18
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. March, 2007	Work with Section 7 lead entities to integrate projects in upland and stream corridor areas using completed stream assessments that meet NMFS Biological Opinion criterion.	Habitat Protection	Russian River HU	18
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat restoration is recommended at Franklin Park, where there is room to enlarge the channel and reintroduce stream meanders and native vegetation. Native trees should be planted along this portion of the reach. Habitat enhancement including invasive species removal and replacement with native vegetation is also recommended.	Habitat Availability	Santa Rosa Creek HSA	18
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . June, 2006	This reach is recommended for preservation, due to habitat value for fish and wildlife. Habitat enhancement involving invasive species removal and replacement with native vegetation is also recommended.	Habitat Protection	Santa Rosa Creek HSA	18
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2003	This reach is recommended for preservation, due to habitat value for fish and wildlife. Habitat enhancement involving invasive species removal and replacement with native vegetation is also recommended.	Habitat Protection	Santa Rosa Creek HSA	18
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2003	This reach is recommended for preservation, due to its habitat value for fish and wildlife. Habitat enhancement is also recommended, including removal of invasive species and replanting with native vegetation.	Habitat Protection	Santa Rosa Creek HSA	18
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2003	This reach is recommended for preservation, due to the habitat value for fish and wildlife, especially upstream of Highway 12. Habitat enhancement is also recommended, including removal of invasive species and replanting with native vegetation.	Habitat Protection	Santa Rosa Creek HSA	18
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2003	This reach should be restored. The channel could be enlarged to make room for a low-flow channel, instream habitat structures like boulders or rootwads to promote pool formation, and planting of native vegetation. One service road could be removed along the left bank from Marlow Road to Paulin Creek, the right bank from Paulin Creek to Steele Creek, and the left bank from Steele Creek to Santa Rosa Creek. In addition, habitat enhancement involving removal of invasive species and replacement with native vegetation is recommended throughout the reach.	Habitat Availability	Santa Rosa Creek HSA	18

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SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Sonoma County Agricultural Preservation and Open Space District. Connecting Communities and the Land: A Long-Range Acquisition Plan. March, 2003	Develop a program to protect riparian corridors, including broad zones of habitat and adequate meander belts along sensitive reaches.	Habitat Protection	Russian River HU	18
Sonoma County Water Agency. Russian River Action Plan. May, 2003	Supplemental Geographic Information System Development	Fisheries Protection	Russian River HU	18
Sonoma Land Trust, Laguna de Santa Rosa Foundation. Laguna de Santa Rosa: Resource Atlas and Protection Plan. October, 2004	Purchase in-fee parcels from willing sellers within the Laguna that support substantial stands of riparian forests.	Habitat Protection	Laguna de Santa Rosa HSA	18
Sonoma Land Trust, Laguna de Santa Rosa Foundation. Laguna de Santa Rosa: Resource Atlas and Protection Plan. October, 2004	Purchase or acquire conservation easements over riparian forest from willing sellers.	Habitat Protection	Laguna de Santa Rosa HSA	18
Sonoma Land Trust, Laguna de Santa Rosa Foundation. Laguna de Santa Rosa: Resource Atlas and Protection Plan. October, 2004	Purchase or acquire conservation easements to protect smaller areas of high composite resource value within larger properties, such as riparian areas.	Habitat Protection	Laguna de Santa Rosa HSA	18
Sotoyome Resource Conservation District. Maacama Creek Watershed Assessment. June, 2002	Expand riparian corridors along Franz Creek and Bidwell Creek	Fisheries Protection	Geyserville HSA	18
California Dept of Parks & Recreation, Statewide Trails Office. California Recreational Trails Plan. March, 2005	Encourage and support scientific studies that address trail impacts on the environment.	Resource Management	Russian River HU	18
Stewards of the Coast and Redwoods. Willow Creek Watershed Management Plan. August, 2005	Enhance lower Willow Creek Channel	Habitat Availability	Guerneville HSA	18
Stewards of the Coast and Redwoods. Willow Creek Watershed Management Plan. August, 2005	Recruit large woody debris in deficient stream reaches in the Willow Creek Watershed.	Habitat Availability	Guerneville HSA	18
The Conservation Fund. Conservation Prospects for the North Coast. 2005	Increase habitat structure and complexity in Dry Creek to enhance habitat diversity, and provide depositional areas for spawning gravels for coho salmon (i.e., place LWD or large boulder structures).	Habitat Availability	Warm Springs HSA	18
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Expand assessment of erosion and sediment delivery.	Habitat Protection	Guerneville HSA	18
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Develop an invasive species eradication program.	Habitat Protection	Guerneville HSA	18
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Target habitat restoration and enhancement that will function between winter base flow and flood stage.	Coho Population Recovery	Russian River HU	18
Gold Ridge RCD. Willow Creek Watershed Management Plan. March 2005	Anthropogenic features that are detrimental to the environment should be improved or removed.	Habitat Availability	Guerneville HSA	18
Community Foundation Sonoma County and Sonoma County Water Agency. Biodiversity Action Plan: Priority Actions to Preserve Biodiversity in Sonoma County. October 2010	Develop conservation focused economic incentives	Resource Management	Guerneville HSA	18
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Improve summer rearing, winter rearing, and smolt survival by increasing instream channel complexity in potential rearing and migration reaches. Additionally, improve egg survival by reducing redd scour in streams characterized by high bedload mobility.	Habitat Availability	Russian River HU	18
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Restore and protect riparian vegetation to improve migration and summer/overwintering habitat for coho salmon (DFG 2004). Watersheds identified by DFG as having poor shelter habitat and riparian condition include Turtle Creek, Fife Creek, Porter Creek, Bluejay Creek, Fisher Creek, Grub Creek, and Corral Creek (DFG 2009).	Migration	Guerneville HSA	18
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Establish greater oversight and post-harvest monitoring by the permitting agency for operations within Core, Phase I and Phase II CCC coho salmon areas. Russian River - core areas - Sheephouse Creek area of the Willow Creek planning watershed; Freezeout Creek area of the Freezeout Creek Planning watershed; Dutch Bill, Felta, Wallace, Palmer, and Upper East Gray Creek planning watersheds; Purrington Creek area of the Purrington Creek planning watershed.	Fisheries Protection	Guerneville HSA	18

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Where existing infrastructure exists within historical floodplains or offchannel habitats in any historical coho watersheds, and restoration is found feasible, encourage willing landowners to restore these areas through conservation easements, etc.	Flood Plain Management	Russian River HU	18
NRCS - Sonoma and Marin Counties. Interviewee Charlette Epifanio. 3/16/2011	Farm Bill funding is not enough to satisfy interest in the various programs. The costs for engineering, permitting, design, and installation for AWEP ponds puts a lot of landowners out of contention because they cannot come up with the required match.	Socioeconomic	Mainstem Russian River	18
Gold Ridge RCD. Interviewee Lisa Hulette. 3/18/2011	Support partnerships with landowners through grant programs	Resource Management	Guerneville HSA	18
Hopland Band of Pomo Indians. Interviewee Shawn Pady, Chair and Tribal Historic Preservation Officer. 3/23/2011	Fish counts and spawning surveys for monitoring salmonid populations. Native/natural and hatchery fish counts.	Fisheries Protection	Ukiah HSA	18
California State Coastal Conservancy. California State Coastal Conservancy Strategic Plan 2007. 2007	Acquire approximately 74,070 acres of working-lands conservation easements or fee interests over strategic properties in key coastal watersheds. 70,000 acres in the North Coast.	Resource Management	Russian River HU	17
California State Coastal Conservancy. California State Coastal Conservancy Strategic Plan 2007. 2007	Implement approximately 25 projects to preserve and restore wildlife corridors both between core habitat areas along the coast and from coastal to inland habitat areas.	Resource Management	Russian River HU	17
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Barriers by culverts exist on the smaller tributaries to Dry Creek. The recent culvert survey by Taylor should prioritize their remediation. Several large barriers exist on Dutcher Creek, which may make remediation problematic and prohibitively expensive.	Migration	Warm Springs HSA	17
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Conduct studies to elucidate the effect on early returning chinook, outmigrating steelhead, and the proliferation or loafing presence of warmwater predators including timing of operations.	Migration	Mainstem Russian River	17
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	DFG and other agencies with jurisdiction should evaluate stream reaches located below permanent dams or other gravel supply restriction areas for potential to import spawning gravel.	Gravel Quantity	Russian River HU	17
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Evaluate carrying capacity of system for each salmonid species; evaluate historic and present genetic structure of wild and hatchery populations of fish; radio telemetry study of smolt migration covering entire course of the Russian River and to evaluate length of estuarine residency and survival of hatchery smolts; radio telemetry study of down stream migrant adult steelhead; broodstock evaluation and research to establish selection criteria; genetic sampling	Coho Population Recovery	Russian River HU	17
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Implement recommendations of sediment source surveys on Grey Creek and monitor crossings	Migration	Austin Creek HSA	17
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Redwood and Foote Creeks need riparian buffers.	Riparian Stability	Geyserville HSA	17
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Manage winter dam releases to achieve channel forming flows every 1.5 years to establish creation of diversity in channel morphology and habitat makeup.	Habitat Availability	Russian River HU	17
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Monitor passage and improvements at the barrier.	Migration	Forsythe Creek HSA	17
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Project Implementation recommendations must be thoroughly reviewed before proceeding with instream structures to enhance spawning substrate.	Gravel Quantity	Russian River HU	17
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Remove Arundo donax using the following guidelines: removing upstream stands first and moving downstream; prioritizing the removal of stands that are in or near the active channel and most likely to be transported by high flows; removing new stands before they become established, and; monitoring sites for at least three years after removal to eradicate any re-growth.	Riparian Stability	Mainstem Russian River	17
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Survey Redslide Creek.	Habitat Availability	Austin Creek HSA	17

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SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	When considering the removal of invasive plant species, control methods should: 1) address the way the plant spreads, either by seed or vegetatively; 2) include an evaluation of the extent of the invasion and plan for eradication; 3) Start at the upstream end of the watershed to avoid reinfestation; 4) include removal of single individual plants and small patches first, then the larger ones; 5) include proper disposal to avoid infesting another area; 6) Include control strategies for future years; 6) Incorporate erosion control measures and revegetation with native species, endemic to the watershed and planted in appropriate place to enhance survival rates.	Riparian Stability	Russian River HU	17
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Implement any practices pertinent to coho salmon recovery in the Five County Roads manual.	Habitat Protection	Russian River HU	17
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Increase habitat structure and complexity in Dry Creek to enhance habitat diversity, including depositional areas for spawning gravels for coho salmon (e.g., place LWD or large boulders)	Habitat Availability	Warm Springs HSA	17
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Agricultural areas provide essential buffers between preserve lands and developed areas. The ecological value of natural areas will be greatly increased by protecting the agricultural open space around them. Species conservation areas will need to share space with ranch or dairy operations, in part because much of the land is in private ownership, but also because without management the health of grasslands and seasonal wetlands will further decline.	Habitat Availability	Laguna de Santa Rosa HSA	17
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Constructed wetlands and stormwater retention basins can produce high numbers of mosquitoes if improperly managed. Design and manage constructed wetlands, storm water retention basins and flood storage areas in consultation with the Marin/Sonoma Mosquito and Vector Control District such that basins do not promote mosquito production.	Resource Management	Laguna de Santa Rosa HSA	17
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Develop and implement plans to eradicate perennial pepperweed from the greater Laguna watershed. Institute collaborative control agreements for work on neighboring properties.	Resource Management	Laguna de Santa Rosa HSA	17
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Implement the Ludwigia Task Force's recommendations for interim and long-term Ludwigia control, as described in the Ludwigia Management Plan.	Resource Management	Laguna de Santa Rosa HSA	17
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Many classes of data are being gathered for different purposes throughout the greater Laguna watershed. To expedite research and enhance the collective understanding of the Laguna's biological and physical systems, these data must be consolidated into a central, web-accessible GIS database. This database is the appropriate repository of monitoring data from preserves, and will allow researchers to evaluate species data within the context of other environmental variables. Integrate with the Russian River Interactive Information System, The Nature Conservancy's Weed Information Management System, and other regional and national databases.	Science	Laguna de Santa Rosa HSA	17
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Prioritize land protection and design restoration projects that form links between existing areas of habitat, thus increasing the size of large, contiguous habitat areas, or forming corridors between habitat patches. Favor projects and parcels with adjoining land uses that are compatible with restoration goals.	Habitat Availability	Laguna de Santa Rosa HSA	17
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Evaluate key species indicators developed by NMFS and habitat inventory data compiled by DFG to identify appropriate locations for the implementation of recovery actions.	Habitat Protection	Russian River HU	17

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	The Citywide Creek Master Plan is recommending enhancement rather than restoration of this reach, including removal of invasive species and replanting with natives.	Resource Management	Santa Rosa Creek HSA	17
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	The Citywide Creek Master Plan is recommending enhancement rather than restoration of this reach, including removal of invasive species and replanting with natives.	Resource Management	Santa Rosa Creek HSA	17
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . June, 2006	This reach is recommended for preservation, due to habitat value for fish and wildlife. Habitat enhancement involving invasive species removal and replacement with native vegetation is also recommended.	Habitat Protection	Santa Rosa Creek HSA	17
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2003	This reach is recommended for preservation. Habitat enhancement including invasive species removal and replacement with native vegetation is also recommended.	Habitat Availability	Santa Rosa Creek HSA	17
Sonoma County Agricultural Preservation and Open Space District. Connecting Communities and the Land: A Long-Range Acquisition Plan. March, 2003	Coordinate with local agencies and organizations to develop a conservation strategy to identify and prioritize lands for protection based on research, planning studies, threat analysis and available funding.	Habitat Protection	Russian River HU	17
Sonoma County Agricultural Preservation and Open Space District. Connecting Communities and the Land: A Long-Range Acquisition Plan. March, 2003	Develop a strategy to identify partners to leverage resources for the protection and management of natural areas	Resource Management	Russian River HU	17
Sonoma County Water Agency. Russian River Action Plan. March, 2003	Green Valley Creek Fish Passage Improvement	Migration	Guerneville HSA	17
Sonoma County Water Agency. Russian River Action Plan. May, 2003	Matanzas Creek Fishway	Migration	Santa Rosa Creek HSA	17
Sotoyome Resource Conservation District. Austin Creek Watershed Assessment. October, 2004	Restoration actions should be evaluated and informed by quantitative monitoring.	Science	Austin Creek HSA	17
Stewards of the Coast and Redwoods. Willow Creek Watershed Management Plan. August, 2005	Modify the second bridge to provide for channel-forming processes at the current Willow Creek Road.	Migration	Guerneville HSA	17
Stewards of the Coast and Redwoods. Willow Creek Watershed Management Plan. August, 2005	Modify the third bridge along the Willow Creek Road to provide for channel forming processes.	Habitat Availability	Guerneville HSA	17
The Conservation Fund. Conservation Prospects for the North Coast. 2005	Work to protect forestland on Willow Creek between land trust and state park property.	Habitat Protection	Guerneville HSA	17
Sotoyome RCD. Copeland Creek Watershed Assessment. 2004	Revegetate and restore natural channel functions.	Riparian Stability	Laguna de Santa Rosa HSA	17
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Investigate the potential role of the Laguna de Santa Rosa in supporting floodplain and off-channel habitat	Flood Plain Management	Laguna de Santa Rosa HSA	17
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Reduce water that effects the natural hydrograph, develop alternative water sources, and implementation of diversion regimes protective of the natural hydrograph.	Coho Population Recovery	Russian River HU	17
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Fence riparian areas from grazing (using fencing standards that allow other wildlife to access the stream). Watersheds identified by DFG include Porter, Foote, Grub, Franz, and Franchi.	Resource Management	Geyserville HSA	17
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Implement performance standards in Stormwater Management Plans.	Fisheries Protection	Russian River HU	17
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	As mitigation for hydrograph consequences, municipalities and counties should investigate funding of larger detention devices in key watersheds with ongoing channel degradation or in sub-watersheds where impervious surface area > 10 percent.	Resource Management	Russian River HU	17

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Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Minimize rate, and subsequent adverse affects, of land conversion to residential and commercial development.	Fisheries Protection	Russian River HU	17
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Conduct collaborative evaluations of priorities for treatment of CCC coho salmon passage barriers, such as the Fish Passage Forum (DFG 2004).	Migration	Russian River HU	17
Mendocino RCD. Mendocino County RCD Interviewees Jan Olave, Shelley Janek, Joe Scriven. February 27,2012	Assess habitat conditions and temperature regime in West Fork Russian River at the Mumford Dam restoration site for potential expansion of coho salmon planting	Coho Population Recovery	Forsythe Creek HSA	17
Occidental Arts and Ecology Center. Interviewee Brock Dolman. 3/18/2011	We need an improved understanding of pre-contact beavers in the watershed. Using beavers in suitable sites to improve water quantity and fisheries restoration is worth considering. There is significant correlation of beaver presence to coho salmon concentrations in scientific literature.	Coho Population Recovery	Guerneville HSA	17
Sonoma County Water Agency. Interviewee David Manning. 3/28/2011	Getting a more complete understanding of salmonid residence time, growth, and survival in various parts of the watershed would be worthwhile.	Coho Population Recovery	Mainstem Russian River	17
California Department of Water Resources. California Water Plan 2005 Update. December, 2005	Where DWR is the owner of a dam, it will make releases in compliance with Fish and Game Code section 5937. The State will assist all dam owners in meeting this code.	Migration	Russian River HU	16
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Bring fish screens at Mirabel and Wohler into compliance with NMFS criteria; reduce approach velocities at the screens to avoid impingement of juveniles; construct bypass to allow passive escape from infiltration ponds.	Migration	Russian River HU	16
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Coho streams in this sub-basin require further habitat restoration to re-establish natural coho populations before supplementation with the Captive Broodstock Program would be considered.	Riparian Stability	Forsythe Creek HSA	16
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Conduct habitat enhancement work on Jenner, Dutchbill, and Mission Creeks.	Habitat Availability	Guerneville HSA	16
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Develop alternatives for restoration at Camp Meeker Dam.	Migration	Guerneville HSA	16
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	DFG recommends pool enhancement projects to be considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined as having a maximum depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width. In third and fourth order streams, a primary pool must be at least three feet deep.	Habitat availability	Russian River HU	16
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Fund feasibility engineering study of Park Steiner's Lake Mendocino Bypass Proposal	Migration	Coyote Valley HSA	16
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Identify locations and solutions for alternatives to in-stream and terrace mining.	Gravel Quantity	Russian River HU	16
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	In streams or stream reaches where the shelter is lacking it is desirable to increase woody cover in the pool and flatwater habitat units, with complex, woody cover, especially where the material is locally available. In general, DFG recommends in streams or stream reaches where the mean pool shelter ratings are calculated to be less than 80 it is desirable to increase woody cover for shelter.	Habitat availability	Russian River HU	16
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Numerous direct tributaries north of Geyserville require habitat assessment for priorities to be established. These surveys are expected to be conducted in 2002 or 2003.	Habitat Availability	Geyserville HSA	16
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Upgrading culverts on Little Briggs and Coon Creeks are the highest priority in this sub-watershed.	Migration	Geyserville HSA	16

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CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Mill and Felta Creeks have been identified for re-introduction of native coho utilizing a Captive broodstock Program discussed in Appendix G. Remaining coho streams in this sub-basin require further habitat restoration to re-establish natural coho populations or before supplementation with the Captive Broodstock Program would be considered.	Coho Population Recovery	Warm Springs HSA	16
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Pursue easements for riparian acquisition or setbacks along Mark West Creek.	Riparian Stability	Mark West HSA	16
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Surveys in the West Fork sub-watershed are needed before priorities are developed. Complete by 2003.	Habitat Availability	Forsythe Creek HSA	16
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Develop an outreach program for controlling Pierce's Disease	Socioeconomic	Russian River HU	16
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Evaluate adjusting the operation of Mirabel Dam, within existing water rights and legal uses, to improve passage of downstream migrants.	Migration	Mainstem Russian River	16
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Update temperature analyses below Coyote Dam and Warm Springs Dam and review dam management.	Migration	Mainstem Russian River	16
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Agricultural hedgerows increase habitat quality and connectivity at the wildland/agricultural interface. Implement hedgerow projects in upland areas to increase linkages between natural areas, reduce runoff and erosion, and provide habitat for insects, birds and wildlife on farms and along roadsides. Hedgerows should incorporate a diversity of native trees, shrubs and herbaceous plants.	Resource Management	Laguna de Santa Rosa HSA	16
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Develop standard operating procedures (SOPs) for monitoring, experiments, and field surveys wherever feasible to support the collection and analysis of data in the Laguna ecosystem database. Place special emphasis on standardized water monitoring and biological surveys. Data collection methods must be simple enough to be accurately executed by individuals with a range of abilities.	Science	Laguna de Santa Rosa HSA	16
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Initiate one or more grassland restoration demonstration projects on public land. Design projects as experiments to: (1) compare the productivity and forage levels of restored and unrestored grasslands, (2) evaluate the ability of native perennial grasses to stabilize soil on eroding hillsides, (3) evaluate wildlife use of restored native grassland as compared to remnant native patches and fields dominated by non-natives, (4) test alternative restoration techniques, and (5) where appropriate, test the success of different grazing regimes in achieving management goals. The Laguna Uplands Preserve is an excellent candidate site for a grassland restoration pilot project.	Habitat Protection	Laguna de Santa Rosa HSA	16
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Address artificial passage barrier near the mouth of Crane Creek. The head-cut near the mouth of the stream should be addressed by evaluating the channel for placement of grade control structures and/or modifications to the head-cut itself.	Habitat Availability	Warm Springs HSA	16
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Address artificial passage barriers in Reach 2 of Redwood Creek. Seek an alternative to the two wet crossings and address/repair the head-cuts they created.	Migration	Geyserville HSA	16
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Address fish passage issues caused by grade control structures in Grape Creek. Boulder weirs to address fish passage at the West Dry Creek Road crossing should be adjusted to facilitate movement of all salmonid life stages over a broader range of flows. These structures should then be periodically inspected and readjusted to maximize fish passage. Ideally a properly designed and implemented solution to the West Dry Creek Road crossing would obviate the need for these grade control structures altogether.	Migration	Warm Springs HSA	16

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Address the accumulation of sediment in Reach 1 of Crocker Creek through removal of sediment from the stream channel in the immediate vicinity of the River Road crossing and consideration of replacing the River Road crossing with a larger culvert or free span bridge that would not limit the passing of sediment.	Habitat Availability	Geyserville HSA	16
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. March, 2007	Work with organizations that can hold conservation easements to develop standard easement definitions and evaluation protocols for establishing riparian habitat and corridors in sensitive areas.	Riparian Stability	Russian River HU	16
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat restoration is recommended between West Steele Lane and Piner Creek. The channel could be enlarged by removing a service road along the right bank, allowing for placement of instream habitat structures such as rootwads and boulders to promote pool formation, and revegetation with native plant species. Crossings may be necessary to accommodate trail users. Habitat enhancement including invasive species removal and replacement with native vegetation is also recommended.	Habitat Availability	Santa Rosa Creek HSA	16
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	The Citywide Creek Master Plan is recommending enhancement rather than restoration of this reach, including removal of invasive species and replanting with natives.	Resource Management	Santa Rosa Creek HSA	16
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	The Citywide Creek Master Plan is recommending enhancement rather than restoration of this reach, including removal of invasive species and replanting with natives.	Resource Management	Santa Rosa Creek HSA	16
Sonoma Land Trust, Laguna de Santa Rosa Foundation. Laguna de Santa Rosa: Resource Atlas and Protection Plan. March, 2006	Establish guidelines for working with property owners to preserve valley oaks. These woulde include but not be limited to preserving relict valley oak specimens; avoiding summer irrigation; fencing around the tree canopy to protect seedlings from grazing and mowing. Identify incentives that would encourage property owners to adopt these practices.	Habitat Protection	Laguna de Santa Rosa HSA	16
Stewards of the Coast and Redwoods. Willow Creek Watershed Management Plan. August, 2005	Control invasive plant species in the Willow Creek Watershed	Resource Management	Guerneville HSA	16
Stewards of the Coast and Redwoods. Willow Creek Watershed Management Plan. August, 2005	Reconnect springs bisected by roads in the Willow Creek Watershed	Habitat Availability	Guerneville HSA	16
Sotoyome RCD, Gold Ridge RCD, Mendocino County RCD, Sonoma County ater Agency, and Prunuske Chatham, Inc.. Stewardship Guide for the Russian River. undated	Attract wildlife	Habitat Protection	Russian River HU	16
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Address artificial passage barrier located in downstream stream segments	Migration	Warm Springs HSA	16
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Fund an investigation of the feasibility of laguna restoration.	Habitat Availability	Laguna de Santa Rosa HSA	16
Gold Ridge RCD. Willow Creek Watershed Management Plan. March 2005	Fish passage barriers should be addressed including the bermed roadway across the valley at the second bridge.	Migration	Guerneville HSA	16
City of Santa Rosa. Santa Rosa General Plan 2035. November, 2009	Conserve significant vegetation and trees.	Habitat Protection	Russian River HU	16
Community Foundation Sonoma County and Sonoma County Water Agency. Biodiversity Action Plan: Priority Actions to Preserve Biodiversity in Sonoma County. October 2010	Promote wildlife friendly fencing	Resource Management	Guerneville HSA	16
Community Foundation Sonoma County and Sonoma County Water Agency. Biodiversity Action Plan: Priority Actions to Preserve Biodiversity in Sonoma County. October 2010	Support BMPs	Resource Management	Guerneville HSA	16
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Improve the structure and composition of riparian areas to provide shade, large woody debris input, nutrient input, bank stabilization, and other CCC coho salmon needs.	Riparian Stability	Russian River HU	16

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Assess impacts of exotic vegetation (e.g., Arundo donax, etc.), prioritize and develop riparian habitat reclamation and enhancement programs (DFG 2004).	Riparian Stability	Russian River HU	16
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Conduct a comprehensive assessment of watershed processes (e.g., hydrology, geology, fluvial-geomorphology, water quality, and vegetation), instream habitat, and factors limiting coho salmon production (DFG 2004).	Habitat Availability	Russian River HU	16
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Improve regulatory oversight of channel modifying projects to ensure potential effects to coho salmon habitat are fully minimized or mitigated.	Habitat Protection	Russian River HU	16
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Encourage counties to develop a Sensitive Habitat Ordinance similar to that in place for the County of Santa Cruz.	Habitat Protection	Russian River HU	16
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Encourage infill and high density developments over dispersal of low density rural residential in undeveloped areas.	Fisheries Protection	Russian River HU	16
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Continue to refine, update, and maintain the Coastal Conservancy database of barriers to fish passage (DFG 2004).	Migration	Russian River HU	16
Mendocino RCD. Mendocino County RCD Interviewees Jan Olave, Shelley Janek, Joe Scriven. February 27,2012	Assess stream mouths at confluence of tributaries with mainstem and West Fork Russian River for fish passage status.	Coho Population Recovery	Forsythe Creek HSA	16
UC Berkeley & Hopland Research & Extension Center, Environmental Science Policy and Management. Interviewee Adina Merenlender, PhD. March 23, 2011	Invasive animal species monitoring: bullfrogs, crawfish, centrarchids.	Habitat Protection	Russian River HU	16
NRCS. Interviewee Carol Mandel. 2/22/2011	Increased level of funding for conservation programs for agriculture in Mendocino County.	Socioeconomic	Mainstem Russian River	16
Hopland Band of Pomo Indians. Interviewee Shawn Pady, Chair and Tribal Historic Preservation Officer. 3/23/2011	Fish passage at culverts. Specifically at Nissakah Creek on HWY 175 and on Nokomis Road. Watershed restoration projects listed on the NCIRWMP.	Migration	Ukiah HSA	16
California Coastal Sediment Management Workgroup. California Coastal Sediment Master Plan Status Report. September, 2008	Research the impact of sand and gravel operations on the availability of beach sand.	Resource Management	Russian River HU	15
California Department of Water Resources. California Water Plan 2005 Update. December, 2005	DWR, in coordination with the appropriate State and federal agencies, will review its current monitoring and regulatory programs to identify and address gaps in available data and monitoring programs that impact disadvantaged communities and vulnerable populations.	Science	Russian River HU	15
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Address numerous County Crossing barriers on Dutchbill and Porter Creeks.	Migration	Guerneville HSA	15
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Coho streams in this sub-basin require further habitat restoration before supplementation with the Captive Broodstock Program would be considered	Riparian Stability	Mark West HSA	15
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Conduct habitat enhancement (address LWD structures) along corridors adjacent to county roads.	Habitat Availability	Laguna de Santa Rosa HSA	15
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Conduct habitat enhancement (address of LWD structures) along corridors adjacent to county roads.	Habitat Availability	Mark West HSA	15
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Fish passage should be monitored and improved where possible.	Migration	Russian River HU	15
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Funding entities should scrutinize proposals for habitat enhancement to make sure that causes of habitat degradation are being treated and not just symptoms. Otherwise habitat work may come undone through the disrupted hydrologic processes.	Habitat availability	Russian River HU	15

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Habitat improvement with natural structures is needed on Fife Creek to complete the project adding large wood for complexity and constrictors for pool scour and gravel sorting.	Habitat Availability	Guerneville HSA	15
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Improve passage at Willow Water District and Mumford Dams.	Migration	Ukiah HSA	15
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	In some cases fishladders and resting cover is needed (City of Ukiah tributaries).	Migration	Ukiah HSA	15
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Limit installation of rubber dam to non-migration periods of smolts and adults June through Octover-November.	Migration	Russian River HU	15
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Project Implementation plans must be thoroughly reviewed before proceeding with a pool enhancement project. Cover structures should only be considered in stream reaches suitable for habitat improvement structures.	Habitat availability	Russian River HU	15
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Slow dam ramping rates to avoid stranding juveniles during inspections; avoid critical timing of earlhy emrgence and summer high temperatures for inspection periods; explore and fund other alternatives to slower the ramping rates.	Migration	Russian River HU	15
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	The Department should strongly oppose the construction of any onstream dams on the Russian River or its tributaries.	Migration	Russian River HU	15
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	If appropriate, adjust the operation of Mirabel Dam, within existing water rights and legal uses, to improve passage of downstream coho salmon migrants.	Migration	Mainstem Russian River	15
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	If appropriate, revise management of Coyote and Warm Springs dams to benefit coho salmon recovery.	Migration	Mainstem Russian River	15
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Integrate coho salmon passage projects at county facilities with coho salmon passage improvements involving other Landowners, throughout targeted coho salmon watersheds.	Migration	Russian River HU	15
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Given competing land uses and lack of natural hydrologic disturbances that sustain habitat diversity, not all areas that could potentially support riparian forest should be restored to riparian forest. Some riparian areas are emergent wetlands, grading to wet meadows and floodplain seasonal wetlands, and these should be protected for their distinct habitat values.	Habitat Availability	Laguna de Santa Rosa HSA	15
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Include nested, consistent, and complementary management and monitoring plans as a central feature of implementing the Conservation Strategy—such plans reflect the geographic hierarchy of individual pre-serves nested in conservation areas, and conservation areas supporting species recovery at the scale of the entire plain.	Resource Management	Laguna de Santa Rosa HSA	15
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Address artifical passage barriers located in downstream stream segments of Grape Creek; West Dry Creek Road crossing, and further evaluate the impacts and effects of operation schedule of lower reach, onstream storage dams on fish movement.	Migration	Warm Springs HSA	15
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Address artificial passage barrier located in upstream stream segment of Wine Creek. The culvert associated with the road crossing at the top of Reach 5 presents a partial barrier to fish passage. However, given the presence of the natural barrier (bedrock cascades) immediately downstream of the road crossing, measures to address this artificial barrier should be given low priority within the watershed.	Migration	Warm Springs HSA	15
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Adress fish passage conditions in the lower portion of Crocker Creek; structures should be designed and placed in the channel so that adults are afforded ample low velocity sites to use as rest stops during migration and consider designing a low water channel in the downstream-most portion of the stream that would facilitate a longer temporal window for adult upstream migration.	Migration	Geyserville HSA	15
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Continue working with the Sonoma Land Trust on mitigation projects for restoration in the lower Russian River and Bodega Bay areas.	Habitat Availability	Russian River HU	15

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Implement a system for modeling and monitoring existing refugia to identify appropriate locations for protection.	Habitat Protection	Russian River HU	15
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Enhancements including removal of invasive species and replanting with natives is also recommended.	Riparian Stability	Santa Rosa Creek HSA	15
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat enhancement including invasive species removal and replacement with native vegetation is recommended. Habitat restoration may be possible with removal of some of the landscaped area. Ground water contamination may be an issue for restoration activities within this reach.	Habitat Availability	Santa Rosa Creek HSA	15
Sonoma Land Trust, Laguna de Santa Rosa Foundation. Laguna de Santa Rosa: Resource Atlas and Protection Plan. March, 2006	Develop "neighborhood easements' to protect seasonal wetlands under multiple small lot ownership.	Habitat Protection	Laguna de Santa Rosa HSA	15
Sonoma Land Trust, Laguna de Santa Rosa Foundation. Laguna de Santa Rosa: Resource Atlas and Protection Plan. March, 2006	Establish agricultural conservation easements which seek to protect the use of land in agriculture to protect oak woodlands. Under the terms of an agricultural easement, valley oaks may be protected through modification of irrigation and fencing to encourage regeneration.	Habitat Protection	Laguna de Santa Rosa HSA	15
Sotoyome Resource Conservation District. Austin Creek Watershed Assessment. October, 2004	Need to work with and address needs of private landowners	Socioeconomic	Austin Creek HSA	15
The Conservation Fund. Conservation Prospects for the North Coast. 2005	Work with private landowners to design a public trail from Fort Ross State Historic Park to Jenner	Resource Management	Russian River HU	15
UC Cooperative Extension, Sonoma County & Sonoma County Department of Emergency Services. Sonoma County Sudden Oak Death Strategic Response Plan. 2008	Reduce fire fuels in the wildland urban intermix	Habitat Protection	Russian River HU	15
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Address fish passage conditions in the middle portionof Reach 2	Migration	Geyserville HSA	15
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Address artificial passage barriers in Reach 1	Migration	Geyserville HSA	15
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Enhance cover in existing pools	Habitat Availability	Geyserville HSA	15
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Address fish passage conditions in the lower portion of the stream	Migration	Geyserville HSA	15
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Design and build pools for juvenile rearing	Habitat Availability	Geyserville HSA	15
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Create flood refuge habitat, such as hydrologically connected floodplains with riparian forest, or remove or setback levees, and use streamway concept where appropriate	Habitat Availability	Russian River HU	15
Gold Ridge RCD. Willow Creek Watershed Management Plan. March 2005	Identify the appropriate landscape matrix based upon physical constraints within the Willow Creek watershed with consideration of effects of fire, flooding, landsliding, windthrow, and recurrence rates for these disturbance factors.	Habitat Availability	Guerneville HSA	15
Gold Ridge RCD. Willow Creek Watershed Management Plan. March 2005	Large woody debris is needed in the system for development and maintenance of rearing habitat (pools) and spawning gravels (riffles).	Habitat Availability	Guerneville HSA	15
City Council of Cloverdale. City of Cloverdale General Plan. 2009, amended 2010	For areas that are not constrained by levees within the City, riparian areas shall be provided adjacent to the Russian River when development projects are proposed to restore native grassland habitat for raptors.	Habitat Availability	Guerneville HSA	15
Community Foundation Sonoma County and Sonoma County Water Agency. Biodiversity Action Plan: Priority Actions to Preserve Biodiversity in Sonoma County. October 2010	Protect and Connect Priority Habitats	Habitat Protection	Guerneville HSA	15

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Community Foundation Sonoma County and Sonoma County Water Agency. Biodiversity Action Plan: Priority Actions to Preserve Biodiversity in Sonoma County. October 2010	Carefully target acquisitions to maximize ecological value give limited financial resources	Habitat Protection	Guerneville HSA	15
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Identify high priority barriers and restore passage per NMFS' Guidelines for Salmonid Passage at Stream Crossings (NMFS 2001a).	Migration	Russian River HU	15
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Identify historic CCC coho salmon habitats lacking in channel complexity, and promote restoration projects designed to create or restore complex habitat features that provide for localized pool scour, velocity refuge, and cover. Prioritize Core areas first followed by Phase I areas. Russian River - core areas - Sheephouse Creek area of the Willow Creek planning watershed; Freezeout Creek area of the Freezeout Creek Planning watershed; Dutch Bill, Felta, Wallace, Palmer, and Upper East Gray Creek planning watersheds; Purrington Creek area of the Purrington Creek planning watershed.	Habitat Availability	Guerneville HSA	15
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Install or enhance existing LWD, boulders, and other instream features to increase habitat complexity and improve pool frequency and depth (DFG 2004). Focus on the following areas: tributaries of Austin Creek, Crane Creek, Green Valley Creek, Dry Creek, Forsythe Creek, Grape Creek, Willow Creek, Sheephouse Creek, Porter Creek, Dutch Bill Creek, Redwood Creek, Foote Creek, Kellog Creek, Wine Creek and Yellowjacket Creek.	Habitat Availability	Russian River HU	15
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Plant native vegetation to promote streamside shade: increase the canopy by planting native species where shade canopy is not at acceptable levels.	Riparian Stability	Russian River HU	15
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Maintain and enhance riparian vegetation near agricultural activities and allow trees in riparian areas to age, die and recruit into the stream naturally.	Riparian Stability	Russian River HU	15
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Promote bio-engineering solutions as appropriate (e.g. except where critical infrastructure is located) for bank hardening projects.	Riparian Stability	Russian River HU	15
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Modify Federal, State, city and county regulatory and planning processes to eliminate provisions allowing new construction of permanent infrastructure that will adversely affect watershed processes, particularly within the 100-year flood prone zones in all historic CCC coho salmon watersheds.	Coho Population Recovery	Russian River HU	15
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Develop a framework similar to Washington State that establishes a scientific framework for monitoring the effectiveness of practices in meeting watershed process goals and a decision-making process that is adaptive to the new information.	Fisheries Protection	Russian River HU	15
NOAA Fisheries, Protected Resources Division. Interviewee Bob Coey, Fisheries Biologist. 3/16/2011	Population and trend monitoring of salmonid populations	Coho Population Recovery	Russian River HU	15
Sonoma County Water Agency. Interviewee David Manning. 3/28/2011	The data already collected needs to be gathered and disseminated with an improved data management plan.	Socioeconomic	Mainstem Russian River	15
Hopland Band of Pomo Indians. Interviewee Shawn Pady, Chair and Tribal Historic Preservation Officer. 3/23/2011	Beginning a juvenile steelhead fish rescue program will be critical, especially in the creeks that have lost instream flow due to diversions for agricultural purposes.	Fisheries Protection	Ukiah HSA	15
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Conservation easements along riparian zones connecting the Russian River to high quality protected habitat in the Briggs and McDonnel Creek watersheds should be considered.	Riparian Stability	Geyserville HSA	14
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Implement barrier modifications on south fork of Santa Rosa Creek	Migration	Laguna de Santa Rosa HSA	14

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Provide attraction flows at Mirabel fish ladder to improve outmigration of smolts; systematically lower the dam at Mirabel during the fall to improve the passability of salmonids or flush them over the dam structure	Migration	Russian River HU	14
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	If feasible, bypass large dams.	Migration	Mainstem Russian River	14
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Restore coho salmon passage at county structures on all streams inhabited by coho salmon, as identified in the Russian River Fish Passage Assessment report.	Migration	Russian River HU	14
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Retain LWD within streams to the extent possible	Habitat availability	Russian River HU	14
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Treat barriers to coho salmon passage	Migration	Russian River HU	14
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Backyards in both rural and urban residential areas can provide stepping-stone connectivity for many species when planted with native landscaping. Educating the community about how to "restore" their own backyards can help to enhance and support wildlife on nearby public preserves.	Habitat Availability	Laguna de Santa Rosa HSA	14
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Certain agricultural land uses are compatible with CTS and vernal pool plant conservation efforts on the Santa Rosa Plain. In particular, it may be essential to allow grazing in upland areas to suppress the growth of non-native grasses. Support compatible agricultural use of preserve uplands and buffer areas, and develop locally customized conservation instruments that help maintain the economic viability of these land uses.	Resource Management	Laguna de Santa Rosa HSA	14
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Expand current research efforts on Ludwigia taxonomy, ecophysiology, population biology and community ecology—including research on biological control organisms— to support long-term restoration-based Ludwigia control.	Science	Laguna de Santa Rosa HSA	14
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Expand research on ecology and control methods for the worst invasive species. Include funding for invasive species research and monitoring into grant applications for invasive species control projects. It is essential to track invasive species to improve control and adaptive management. Map and monitor the highest-priority invasive species on public properties in the Laguna, including both weeds and animals. Collect data in the Laguna ecosystem database and integrate it with the Nature Conservancy's Weed Information Management System. Provide assistance for private landowners interested in participating with monitoring on their properties. Use research and mapping information to develop numeric targets for control of highest-priority invasive species.	Science	Laguna de Santa Rosa HSA	14
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Pursue restoration efforts throughout the watershed that promote healthy native plant communities and control invasive species. All restoration plans must have a weed prevention and control component.	Habitat Availability	Laguna de Santa Rosa HSA	14
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Research historical ecology of streams in the Laguna watershed to determine which streams had large coho or trout populations, using historical documents and descriptions of Laguna tributaries. Use these descriptions as part of the basis for determining which streams should be targeted for restoration.	Habitat Availability	Laguna de Santa Rosa HSA	14
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Address artifical passage barriers located in downstream stream segments of Dutcher Creek; Dry Creek Road crossing, Dutcher Creek Road crossing, and private driveway crossing.	Migration	Warm Springs HSA	14

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Address artifical passage barriers located in upstream segments of Dutcher Creek	Migration	Warm Springs HSA	14
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Address artificial passage barriers located in upstream stream segments of Crane Creek. The upstream-most crossing, and one flashboard dam.	Migration	Warm Springs HSA	14
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Address fish passage issues caused by grade control structures in Wine Creek. Boulder and log weirs in downstream reaches should be adjusted to facilitate movement of all salmonid life stages over a broader range of flows. These structures should then be periodically inspected and readjusted to maximize fish passage.	Migration	Warm Springs HSA	14
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Design and build pools for juvenile rearing in Franz Creek. Construct pools for juvenile rearing; construct pools in Reaches 3 - 5. Enhance cover in newly constructed pools by adding large wood structures.	Habitat Availability	Geyserville HSA	14
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Design and build pools for juvenile rearing in Miller Creek; pools should be constructed in middle and upstream portions of Reach 1 and enhance cover in newly constructed pools by adding large wood structures.	Habitat Availability	Geyserville HSA	14
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Design and build pools for juvenile rearing; construct pools in low gradient stream segments and enhance cover innewly constructed pools by adding large wood structures in Crocker Creek	Habitat Availability	Geyserville HSA	14
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Enhance cover in existing pools by adding large wood structures to pools in lower gradient portions of the stream in Crocker Creek	Habitat Availability	Geyserville HSA	14
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Enhance cover in existing pools in Crane Creek aby adding large wood structures to pools in lower gradient portions of the stream	Habitat Availability	Warm Springs HSA	14
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Enhance cover in existing pools in Dutcher Creek; add large wood structures to pools in lower gradient portions o fthe stream.	Habitat Availability	Warm Springs HSA	14
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Enhance cover in existing pools in Franz Creek. Add large wood structures to pools in lower gradient portions of the stream.	Habitat Availability	Geyserville HSA	14
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Enhance cover in existing pools in Gill Creek by adding large wood structures to pools in lower gradient portions of the stream	Habitat Availability	Geyserville HSA	14
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Enhance cover in existing pools in Gird Creek by adding large wood structures to pools in lower gradient portions of the stream	Habitat Availability	Geyserville HSA	14
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Enhance cover in existing pools in Grape Creek; Add large wood structures to pools in lower gradient portions of Reach 1	Habitat Availability	Warm Springs HSA	14
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Enhance cover in existing pools in Maacama Creek. Add large wood structures to pools in lower gradient portions of the stream.	Habitat Availability	Geyserville HSA	14

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Enhance cover in existing pools in Redwood Creek. Add large wood structures to pools in lower gradient portions of the stream.	Habitat Availability	Geyserville HSA	14
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Enhance cover in existing pools in Wine Creek. Add large wood structures to pools in lower gradient poritons of Reaches 1 - 4.	Habitat Availability	Warm Springs HSA	14
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Evaluate the need and remove artificial structures that are acting as barriers in Maacama Creek.	Migration	Geyserville HSA	14
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Enhancement including removal of invasive species and replanting with natives is also recommended.	Riparian Stability	Santa Rosa Creek HSA	14
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Enhancements including removal of invasive species and replanting with natives is also recommended.	Riparian Stability	Santa Rosa Creek HSA	14
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat enhancement including invasive species removal and replacement with native vegetation is recommended for this reach.	Habitat Availability	Santa Rosa Creek HSA	14
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat enhancement including invasive species removal and replacement with native vegetation is recommended for this reach.	Habitat Availability	Santa Rosa Creek HSA	14
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat enhancement including invasive species removal and replacement with native vegetation is recommended for this reach.	Habitat Availability	Santa Rosa Creek HSA	14
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat enhancement including invasive species removal and replacement with native vegetation is recommended for this reach.	Habitat Availability	Santa Rosa Creek HSA	14
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat enhancement including invasive species removal and replacement with native vegetation is recommended for this reach.	Habitat Availability	Santa Rosa Creek HSA	14
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat enhancement including invasive species removal and replacement with native vegetation is recommended.	Habitat Availability	Santa Rosa Creek HSA	14
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat enhancement including invasive species removal and replacement with native vegetation is recommended.	Habitat Availability	Santa Rosa Creek HSA	14
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat enhancement involving removal of invasive species and replacement with native vegetation is recommended throughout the reach.	Habitat Availability	Santa Rosa Creek HSA	14
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat enhancement involving removal of invasive species and replacement with native vegetation is recommended throughout the reach. The fish passage barrier at the check dam should be addressed.	Habitat Availability	Santa Rosa Creek HSA	14
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat enhancement involving removal of invasive species and replanting with native vegetation is recommended throughout the reach. The restoration project area monitoring should continue, and adaptive management actions taken if the vegetation or other aspects of the project are not performing as intended.	Habitat Availability	Santa Rosa Creek HSA	14
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat enhancement is recommended for this reach, including removal of invasive species and replanting with native vegetation. Additional trees should be planted at the top of bank to encourage more canopy cover. The fish passage barrier should be addressed, but at this time is deemed a low priority, since limited upstream habitat exists.	Riparian Stability	Santa Rosa Creek HSA	14
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat enhancement is recommended throughout this reach. Additional trees should be planted to shade the channel, and invasive species removed and replaced with native understory vegetation.	Habitat Availability	Santa Rosa Creek HSA	14
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . June, 2006	The restored portions of this reach should be monitored for colonization by invasive species. Invasives should be removed as soon as possible and replaced with native plantings. Adaptive management should be used if the planted vegetation or other aspects of the project are not performing as expected.	Riparian Stability	Santa Rosa Creek HSA	14

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
The Conservation Fund. Conservation Prospects for the North Coast. 2005	Supplement first-priority barren streams as part of the coho salmon broodstock program. These streams include Willow, Sheephouse, Freezeout, Dutchbill and Green Valley creeks within the Guerneville HSA; Ward Creek in the Austin Creek HSA; and Mill and Felta creeks.	Coho Population Recovery	Austin Creek HSA	14
The Conservation Fund. Conservation Prospects for the North Coast. 2005	Support retention of current zoning along Potter Valley and the upper mainstem Russian River to protect existing habitat values.	Socioeconomic	Russian River HU	14
The Conservation Fund. Conservation Prospects for the North Coast. 2005	Work with volunteer groups to place wood duck nest boxes in suitable habitat along the Russian River at Potter Valley, and along the upper mainstem Russian River to Hopland.	Resource Management	Mainstem Russian River	14
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Address artificial passage barriers in Reach 2	Migration	Geyserville HSA	14
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Address artificial passage barriers near the mouth of the stream	Migration	Laguna de Santa Rosa HSA	14
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Address artificial passage barriers located in downstream segments	Migration	Warm Springs HSA	14
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Design and build pools for juvenile rearing	Habitat Availability	Geyserville HSA	14
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Enhance cover in existing pools	Habitat Availability	Warm Springs HSA	14
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Design and build pools for juvenile rearing	Habitat Availability	Warm Springs HSA	14
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Address fish passage issues caused by grade control structures	Migration	Warm Springs HSA	14
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Enhance cover in existing pools	Habitat Availability	Geyserville HSA	14
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Design and build pools for juvenile rearing	Habitat Availability	Geyserville HSA	14
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Design and build pools for juvenile rearing	Habitat Availability	Geyserville HSA	14
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Delineate reaches possessing both potential winter rearing habitat and floodplain areas	Habitat Availability	Russian River HU	14
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Promote restoration projects designed to create or restore alcove, backchannel, ephemeral tributary, or seasonal pond habitats.	Habitat Availability	Russian River HU	14
Gold Ridge RCD. Willow Creek Watershed Management Plan. March 2005	Detailed mapping and analysis of forest and grassland gullies is still needed.	Habitat Protection	Guerneville HSA	14
City Council of Cloverdale. City of Cloverdale General Plan. 2009, amended 2010	Encourage the County to retain surrounding lands in very low density residential, agricultural, open space, and natural resource uses that provide contrast to urbanized Cloverdale. Promote the creation of a community separator or open space buffer between Cloverdale and any urban development around the City.	Habitat Protection	Guerneville HSA	14

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SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Community Foundation Sonoma County and Sonoma County Water Agency. Biodiversity Action Plan: Priority Actions to Preserve Biodiversity in Sonoma County. October 2010	Maintain and protect corridors	Habitat Protection	Guerneville HSA	14
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Monitor, identify problems, and prioritize need for changes to water diversion on current or potential coho streams (DFG 2004).	Migration	Russian River HU	14
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Identify and remove existing passage barriers.	Migration	Russian River HU	14
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Spawning gravels on Green Valley Creek are limited due to channel incision. Structures to decrease channel incision and recruit spawning gravel (using gravel retention structures), should be installed to trap, sort and expand redd distribution in the stream where appropriate.	Gravel Quantity	Guerneville HSA	14
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Continue the operation of the Captive Broodstock Program in the Russian River.	Coho Population Recovery	Russian River HU	14
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Work with state and local agencies reviewing and authorizing timber operations to ensure take of coho salmon is fully minimized.	Fisheries Protection	Russian River HU	14
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Consider use of the Monitoring Study Group to create a platform for more large-scale assessments of Rule implementation and effectiveness.	Fisheries Protection	Russian River HU	14
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Purchase conservation easements from landowners that currently have grazing or agricultural operations along the estuary.	Flood Plain Management	Russian River HU	14
NRCS. Interviewee Carol Mandel. 2/22/2011	Protecting agriculture land from development in the long run will determine the sustainable functioning of the watershed. Once the land is paved, it typically does not revert back to natural habitat.	Resource Management	Mainstem Russian River	14
NRCS - Sonoma and Marin Counties. Interviewee Charlette Epifanio. 3/16/2011	State and Federal budget shortfalls are going to make the permitting process even slower. This affects restoration projects and water storage projects, as well as development.	Resource Management	Mainstem Russian River	14
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	In Willow Creek, alternatives to channel adjustment between bridges 2 and 3 are being developed. This should include raising and widening bridge w or re-aligning the road to the east sided of the creek and removing bridge 2.	Migration	Guerneville HSA	13
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Kellogg, Yellowjacket, and Sausal Creeks have not been surveyed due to un-cooperative ownerships.	Habitat Availability	Geyserville HSA	13
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Log-jams in the Chapman Branch of Pena Creek need to be monitored for passage. Other passage issues in the Pena Creek watershed stem from log jams associated with natural constrictions.	Migration	Warm Springs HSA	13
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Oppose construction of any new summer dams on the Russian River or it's tributaries.	Migration	Mainstem Russian River	13
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Passage improvements are being considered on Mariposa Creek. Alternate passage should be explored and supported.	Migration	Forsythe Creek HSA	13
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Expand coho salmon passage barrier inventories as needed to use a comprehensive watershed approach improving coho salmon passage.	Migration	Russian River HU	13
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	From willing Landowners, acquire conservation easements or fee-title of habitat essential for coho salmon	Habitat Protection	Guerneville HSA	13

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Develop monitoring protocols and initiate monitoring program for wild turkeys on public lands in the Laguna, collecting this information in the Laguna ecosystem database. Provide outreach and assistance for private landowners interested in participating with monitoring on their properties.	Resource Management	Laguna de Santa Rosa HSA	13
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Grazing is probably the most sustainable method for grassland management, and recent studies have shown that it has great benefits for some seasonal wetlands. However, depending on conditions, grazing can also degrade grasslands and seasonal wetlands. Research is needed on the optimal grazing regimes for CTS and vernal pool preserves on the Santa Rosa Plain. Studies should evaluate how site-specific conditions and different grazing management strategies interact with the ecology of wetland plants and animals.	Science	Laguna de Santa Rosa HSA	13
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Grazing is the most sustainable tool now available for managing and restoring grassland, oak savannah and seasonal wetland ecosystems in the Laguna watershed. Grazing can also exacerbate environmental degradation, and to avoid these problems, it is critical to develop site-specific plans. To develop grazing plans for preserve areas and restoration sites, restorationists must work closely with local producers and UC Extension range management advisors who are familiar with local conditions and issues. Grazing regimes must be flexible to support financially viable livestock production, as well as conservation goals.	Resource Management	Laguna de Santa Rosa HSA	13
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Lasthenia burkei is the most at-risk of all the vernal pool species on the Santa Rosa Plain, and although little is known about its habitat requirements and how best to design vernal pool creation or restoration projects, habitat mitigation projects continue to be approved. Targeted research is urgently needed to support L. burkei recovery efforts.	Science	Laguna de Santa Rosa HSA	13
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Many birds and bats prefer to nest in the cavities and crevasses of old trees, which are frequently missing from our human-altered landscapes. Although restoration practitioners should attempt to keep natural cavities whenever possible, building bird and bat houses and establishing them in natural areas can have a beneficial effect on cavity-dependent species. It is important to monitor these structures annually to ensure they are not colonized by starlings or other non-native species. Raptor perches and telephone poles take the place of old snags in the grasslands, where hawks can perch and watch for rodents and other prey.	Habitat Availability	Laguna de Santa Rosa HSA	13
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Riparian restoration on both public and private lands is often slowed or limited by the complexities of the permitting process. Other watersheds have greatly increased the number and rate of restoration projects by working with regulatory agencies to bundle or streamline permits. This effort can result in substantial cost savings over the long term, as it increases the efficiency of the process for both regulators and project proponents.	Socioeconomic	Laguna de Santa Rosa HSA	13
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	The Santa Rosa Plain Conservation Strategy Team developed a detailed list of quantitative goals and objectives for the recovery of CTS and listed vernal pool plant species on the Santa Rosa Plain. Actions to achieve these objectives should be implemented as soon as possible; with emphasis on protecting large, contiguous preserve lands ahead of mitigation needs. Further expand these objectives to include greater emphasis on genetic research for plant populations, and to develop a program to collect and bank seeds for future restoration of declining populations.	Science	Laguna de Santa Rosa HSA	13

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SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Working on the scale of the entire watershed must be an interdisciplinary endeavor, and many research, restoration and management programs cross jurisdictional boundaries. Without pooled intellectual and financial resources, it is difficult to leverage watershed-scale projects. Coordinate efforts of all agencies and organizations working within the watershed, continually working to develop synergistic partnerships.	Socioeconomic	Laguna de Santa Rosa HSA	13
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Floodplain cross sections: field surveys of cross-sections using a total station or survey floodplain topography using ground-based LIDAR. Once every 10 years or after 1:100 year flood events.	Science	Laguna de Santa Rosa HSA	13
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Address artifical passage barriers in Reach 2 of Foote Creek. Review opration of the reservoir dam to minimize impacts to the downstream channel.	Migration	Geyserville HSA	13
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Address fish passage conditions in the middle portion of Reach 2 of Redwood Creek. Consider designing a low flow channel in the middle two-thirds of the reach that would facilitate a longer temporal window for adult upstream migration.	Migration	Geyserville HSA	13
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Design and build pools for juvenile rearing in Foote Creek. Construct pools in low gradient stream segments; enhance cover in newly constructed pools by adding large wood structures.	Habitat Availability	Geyserville HSA	13
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Design and build pools for juvenile rearing in Wine Creek. Construct pools in Reaches 1 - 4. Enhance cover in newly constructed pools by adding large wood structures.	Habitat Availability	Warm Springs HSA	13
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Enhance cover in existing pools in Foote Creek. Add large wood structures to pools in lower gradient portions of the stream.	Habitat Availability	Geyserville HSA	13
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Evaluate the need and remove artificial sructures that are acting as barriers.	Migration	Geyserville HSA	13
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Ensure appropriate training is made available for data users and collectors. Provide training sessions to potential users of RRIIS to ensure RRWC members, resource managers and the public are able to access and add information.	Socioeconomic	Russian River HU	13
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Establish continuous habitat corridors, where appropriate, to enhance migration corridors and minimize fragmentation.	Habitat Protection	Russian River HU	13
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Identify highly erosive soils and fault lines in sensitive land areas that need further land use protection.	Resource Management	Russian River HU	13
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. March, 2007	Use available data to map weak links in habitat and migration routes in the watershed to enhance fish passage and connections.	Migration	Russian River HU	13
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat enhancement involving removal of invasive species and replacement with native vegetation is recommended throughout the reach.	Habitat Availability	Santa Rosa Creek HSA	13
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat enhancement involving removal of invasive species and replacement with native vegetation is recommended throughout the reach.	Habitat Availability	Santa Rosa Creek HSA	13
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat enhancement is recommended throughout the reach, involving removal of invasive species and replacement with native vegetation.	Habitat Availability	Santa Rosa Creek HSA	13
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2007	Habitat enhancement is recommended throughout this reach, including invasive species removal and replacement with native vegetation.	Habitat Availability	Santa Rosa Creek HSA	13

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Sonoma County Agricultural Preservation and Open Space District. Connecting Communities and the Land: A Long-Range Acquisition Plan. March, 2003	Add watershed and groundwater basin information to the project evaluation process for potential District projects.	Resource Management	Russian River HU	13
Sonoma County Water Agency. Russian River Action Plan. May, 2003	Salmon Fisheries Ocean Monitoring	Fisheries Protection	Russian River HU	13
The Conservation Fund. Conservation Prospects for the North Coast. 2005	Supplement first-priority barren streams as part of the coho salmon broodstock program. These streams include Willow, Sheephouse, Freezeout, Dutchbill and Green Valley creeks within the Guerneville HSA; Ward Creek in the Austin Creek HSA; and Mill and Felta creeks.	Coho Population Recovery	Guerneville HSA	13
The Conservation Fund. Conservation Prospects for the North Coast. 2005	Supplement first-priority barren streams as part of the coho salmon broodstock program. These streams include Willow, Sheephouse, Freezeout, Dutchbill and Green Valley creeks within the Guerneville HSA; Ward Creek in the Austin Creek HSA; and Mill and Felta creeks.	Coho Population Recovery	Russian River HU	13
Sotoyome RCD. Copeland Creek Watershed Assessment. 2004	Complete outreach to vineyard owners in Copeland Creek watershed to enroll in the Fish Friendly Farming program.	Resource Management	Laguna de Santa Rosa HSA	13
Sotoyome RCD. Copeland Creek Watershed Assessment. 2004	The Sotoyome RCD should seek funds and work with the NRCS to prepare detailed grazing management plans for willing owners	Resource Management	Laguna de Santa Rosa HSA	13
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Enhance cover in existing pools	Habitat Availability	Geyserville HSA	13
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Enhance cover in existing pools	Habitat Availability	Warm Springs HSA	13
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Enhance cover in existing pools	Habitat Availability	Geyserville HSA	13
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Address artificial passage barriers located in upstream stream segments	Migration	Warm Springs HSA	13
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Enhance cover in existing pools	Habitat Availability	Warm Springs HSA	13
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Address fish passage conditions in the lower portion of the stream	Migration	Geyserville HSA	13
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Enhance cover in existing pools	Habitat Availability	Geyserville HSA	13
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Address fish passage conditions in the lower portion of the stream	Migration	Geyserville HSA	13
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Enhance cover in existing pools	Habitat Availability	Geyserville HSA	13
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Address fish passage conditions in the lower portion of the stream	Migration	Geyserville HSA	13
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Address fish passage issues caused by grade control structures	Migration	Warm Springs HSA	13
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Address artificial passage barrier located in upstream stream segment	Migration	Warm Springs HSA	13

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SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Address artificial passage barriers located in upstream stream segments	Migration	Warm Springs HSA	13
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Evaluate the need and remove artificial structures that are acting as passage barriers	Migration	Geyserville HSA	13
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Evaluate the need and remove artificial structures that are acting as passage barriers	Migration	Geyserville HSA	13
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Address artificial passage barriers in Reach 1	Migration	Geyserville HSA	13
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Enhance cover in existing pools	Habitat Availability	Geyserville HSA	13
Sotoyome Resource Conservation District. Austin Creek Watershed Assessment. October, 2005	Need to work with and address needs of private landowners	Socioeconomic	Austin Creek HSA	13
Sotoyome Resource Conservation District. Austin Creek Watershed Assessment. October, 2005	Restoration actions should be evaluated and informed by quantitative monitoring.	Science	Austin Creek HSA	13
City Council of Cloverdale. City of Cloverdale General Plan. 2009, amended 2010	"Conservation Features" areas outside the Urban Growth Boundary, as shown on the General Plan Land Use Map, shall be reserved for agricultural uses. "Conservation Features" areas in hillsides to the west of the City shall be reserved for protection of forested hillsides.	Habitat Protection	Guerneville HSA	13
City Council of Cloverdale. City of Cloverdale General Plan. 2009, amended 2010	Investigate historic, archaeological, and paleontological resources and preserve or conserve resources that help residents and visitors understand the history of Cloverdale.	Archaeological Resources	Guerneville HSA	13
Community Foundation Sonoma County and Sonoma County Water Agency. Biodiversity Action Plan: Priority Actions to Preserve Biodiversity in Sonoma County. October 2010	Coordinate Monitoring and Evaluate Success	Resource Management	Guerneville HSA	13
Community Foundation Sonoma County and Sonoma County Water Agency. Biodiversity Action Plan: Priority Actions to Preserve Biodiversity in Sonoma County. October 2010	Continue to protect land via acquisitions and easements	Habitat Protection	Guerneville HSA	13
Community Foundation Sonoma County and Sonoma County Water Agency. Biodiversity Action Plan: Priority Actions to Preserve Biodiversity in Sonoma County. October 2010	Track integration of biodiversity protection with general plan and other land use policies.	Habitat Protection	Guerneville HSA	13
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Provide incentives to restore high priority sites as determined by watershed analysis, DFG, or CalFire.	Habitat Availability	Russian River HU	13
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Continue efforts to find long term funding for monitoring of the Russian River Coho Salmon Captive Broodstock Program.	Coho Population Recovery	Russian River HU	13
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Use the emergency drought operations center (EDOC) or other similar group to help discourage poaching of coho salmon by measures to: Cooperate with and provide incentives to landowners to maintain road and trail closures to be effective against trespass; Encourage monitoring of road closures and timely repair of defective or damaged road closure systems; Promote CalTIP, especially how it might apply to spawning coho salmon; and report un-permitted road use to local, State, and federal enforcement personnel during periods when coho salmon are migrating (DFG 2004).	Fisheries Protection	Russian River HU	13
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Work with DFG, Counties, other agencies, and knowledgeable biologists to develop emergency rules and adopt implementation agreements.	Fisheries Protection	Russian River HU	13

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Work with landowners and other agencies to conduct actions (e.g., maintain road and trail closures, increase enforcement patrols) that prevent trespassing and poaching activities.	Fisheries Protection	Russian River HU	13
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Assign NMFS staff to conduct THP reviews of the highest priority areas using revised "Guidelines for NMFS Staff when Reviewing Timber Operations: Avoiding Take and Harm of Salmon and Steelhead" (NMFS 2004).	Fisheries Protection	Russian River HU	13
Mendocino RCD. Mendocino County RCD Interviewees Jan Olave, Shelley Janek, Joe Scriven. February 27,2012	Expand spawner and snorkel survey efforts to more streams in the upper Russian	Coho Population Recovery	Forsythe Creek HSA	13
UC Berkeley & Hopland Research & Extension Center, Environmental Science Policy and Management. Interviewee Adina Merenlender, PhD. March 23, 2011	Juvenile salmonid survivorship in tributaries.	Coho Population Recovery	Russian River HU	13
Occidental Arts and Ecology Center. Interviewee Brock Dolman. 3/18/2011	RRWAMP logic train from Army Corps of Engineers: Wayne Hayden (USGS) has a good handle on how to run the watershed model. There has been a lot of input to the model. Rich Walker, at CalFire, is able to drive/operate the model. Rich.Walker@fire.ca.gov.	Resource Management	Guerneville HSA	13
Occidental Arts and Ecology Center. Interviewee Brock Dolman. 3/18/2011	RRIIS needs to be used. There is a lot of science based content that is not getting brought to land use policy and management decisions.	Resource Management	Guerneville HSA	13
Sonoma County Water Agency. Interviewee David Manning. 3/28/2011	Russian River Coho Broodstock Program is very important. ACE needs to ensure that they are budgeting for this program.	Coho Population Recovery	Mainstem Russian River	13
Redwood Valley Outdoor Education Project (RVOEP). Interviewee Helen Menasian. 2/23/2011	Improve watershed education at all levels of schools. This would impact residential attitudes on land and water use.	Resource Management	Forsythe Creek HSA	13
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Address barriers on Humbug, Van Buren, Mill, Porter, and Osborne Creeks.	Migration	Mark West HSA	12
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Reduce ramping rates when removing the Mirabel rubber dam by lowering it slowly	Migration	Russian River HU	12
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Studies to elucidate the effect and the proliferation or loafing presence of warm-water predators need to be conducted. Timing of outmigration needs to be evaluated at a minimum.	Migration	Russian River HU	12
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	The falls on lower Mill Creek and on lower Felta Creek need to be evaluated for passage periodically. Adjustment may be needed presently on Mill Creek.	Migration	Warm Springs HSA	12
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	The recommended approach to decreasing the severity of Pierce's disease is removal of specific riparian plants and replacement with native plant species that do not host the disease, thereby reducing the number of infected sharpshooters (PDRHW 2000). The replacement plants should mimic as closely as possible the ecological role of the removed plants. A transition zone at the edge of the riparian is recommended and long-term management is required. See The Pierce's Disease/Riparian Habitat Workgroup's Information Manual: Riparian Vegetation Management for Pierce's Disease in North Coast California Vineyards, 9/1/2000.	Riparian Stability	Russian River HU	12
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	To offset losses of mainstem fisheries habitat for the backwatered distance upstream of Mirabel, mitigate through habitat restoration elsewhere (Mendocino reach) or through the purchase and creation of conservation easements in the riparian zone elsewhere (Dry Creek).	Habitat Availability	Russian River HU	12
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Review and develop preferred protocols for Pierce's Disease Control that would maintain a native riparian corridor and develop an outreach program.	Riparian Stability	Warm Springs HSA	12
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Long-term breeding pool studies are needed to assess regional population dynamics, and benefits and problems associated with habitat restoration and enhancement. Annual larval sampling to determine the proportion of occupied pools is believed to be the most effective and accurate way to track CTS status on the Santa Rosa Plain, expanding current monitoring efforts.	Science	Laguna de Santa Rosa HSA	12

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Other urgent research needs include determining the pattern and timing of "colonization" of constructed pools, optimal depth of pools for CTS persistence, effects of non-native crayfish on CTS, timing of larval metamorphosis and the implications for pool depth, and effects of pool size on CTS reproduction.	Science	Laguna de Santa Rosa HSA	12
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Western pond turtles are a recognized species of concern in California, but they have received little conservation attention in the Laguna watershed. Habitat enhancement for pond turtles includes creating basking structures where they can pull out of the water and lie in the sun. However, serious population recovery will require much more research on the conservation biology of western pond turtles in the Laguna: their distribution, population growth rates, and mortality factors.	Science	Laguna de Santa Rosa HSA	12
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Benthic Macroivertebrate Diversity Index; rapid bioassessment in both upper reaches of watershed and reaches of cities. Initial five years every spring, then every other year.	Science	Laguna de Santa Rosa HSA	12
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Rates of bed and bank erosion and aggradation: baseline channel reconnaissance survey to locate and record bed and bank erosion and aggradation locations. Once every ten years or after 1:100 year flood events.	Science	Laguna de Santa Rosa HSA	12
National Marine Fisheries Service, Southwest Region. Biological Opinion for Water Supply, Flood Control Operations and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed. February, 2005	Undertake measures to assist NMFS in determining the amount of take resulting from turbidity releases at Coyote Valley Dam.	Fisheries Protection	Coyote Valley HSA	12
National Marine Fisheries Service, Southwest Region. Biological Opinion for Water Supply, Flood Control Operations and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed. February, 2005	Undertake measures to ensure that harm and mortality to listed salmonids from adaptive management of the bar at the mouth of the Russian River are low.	Fisheries Protection	Guerneville HSA	12
National Marine Fisheries Service, Southwest Region. Biological Opinion for Water Supply, Flood Control Operations and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed. February, 2005	Undertake measures to ensure that harm and mortality to listed salmonids resulting from Dry Creek and tributary habitat enhancements and channel maintenance activities in the mainstem Russian River, Dry Creek, and Zone 1A, are low.	Fisheries Protection	Warm Springs HSA	12
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Foster partnerships between federal and state agencies, the RRWC and local community organizations to optimize available resources.	Socioeconomic	Russian River HU	12
Sonoma Land Trust, Laguna de Santa Rosa Foundation. Laguna de Santa Rosa: Resource Atlas and Protection Plan. March, 2006	Purchase high composite land in-fee from willing sellers. In-fee purchase is appropriate where sufficient land may be acquired to create, or add to, and ecological preserve.	Habitat Protection	Laguna de Santa Rosa HSA	12
California Dept of Parks & Recreation, Statewide Trails Office. California Recreational Trails Plan. August, 2005	Provide training and educational information about state-of-the-art trail design and construction techniques to the trail builders by supporting trail maintenance and management courses and workshops and enabling trail managers and volunteers to attend education opportunities.	Resource Management	Russian River HU	12
Stewards of the Coast and Redwoods. Willow Creek Watershed Management Plan. August, 2005	Remove portions of existing cross-fencing in the Willow Creek Watershed.	Habitat Availability	Guerneville HSA	12

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Sotoyome RCD. Copeland Creek Watershed Assessment. 2004	Maintain native vegetation.	Habitat Protection	Laguna de Santa Rosa HSA	12
Community Foundation Sonoma County and Sonoma County Water Agency. Biodiversity Action Plan: Priority Actions to Preserve Biodiversity in Sonoma County. October 2010	Map Habitat Types and Species Distributions	Habitat Availability	Guerneville HSA	12
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Encourage the use of native vegetation in new landscaping to reduce the need for watering and application of herbicides, pesticides, and fertilizers.	Resource Management	Russian River HU	12
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Evaluate the feasibility of providing adult passage over Coyote Valley Dam, and Warm Springs Dam (DFG 2004) .	Migration	Coyote Valley HSA	12
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	In Willow Creek there is a limited supply of large diameter, riparian redwood and Douglas-fir in the watershed. Promote growth of conifers in the riparian zone for later in-channel recruitment.	Riparian Stability	Guerneville HSA	12
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Eliminate the use of gabion baskets and undersized rock within the bankfull channel.	Habitat Availability	Russian River HU	12
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	All proposed levees should be designed to account for minimal maintenance associated with an intact and functioning riparian zone.	Riparian Stability	Russian River HU	12
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Thoroughly investigate the ultimate cause of channel instability prior to engaging in site specific channel modifications and maintenance. Identify and target remediation of watershed process disruption as an overall priority.	Resource Management	Russian River HU	12
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	NMFS will work with DFG to modify low flow restrictions under Article 4. Supplemental Regulations, Section 8.00 (a).	Fisheries Protection	Russian River HU	12
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Allow trees in riparian areas to age, die, and recruit into the stream naturally.	Habitat Availability	Russian River HU	12
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Investigate opportunities to programmatically permit the forest certification program to authorize incidental take for landowners through Section 10(a)(1)(B).	Fisheries Protection	Russian River HU	12
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Standards and recommendations regarding development should apply to all jurisdictions, including school districts and other special districts not subject to county and/or state related ordinances or policies.	Fisheries Protection	Russian River HU	12
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Find funding to establish an ongoing monitoring program to evaluate existing chinook distribution.	Coho Population Recovery	Russian River HU	11
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Fish ladders and bypass structures need to be maintained to ensure that they are operating at peak efficiency when outmigration is occurring.	Migration	Russian River HU	11
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Maintain fish ladders at Vacation Beach, Johnson's Beach, and Wohler dams to ensure they are operating at peak efficieny. Maintenance to include proper positioning of ladders.	Migration	Mainstem Russian River	11
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Warm Springs Hatchery and The Coyote Valley Steelhead Facility should be utilized to enhance the size of the salmonid run in the Russian River and replenish lost runs to rehabilitated tributaries.	Coho Population Recovery	Russian River HU	11

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SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Evaluate recommendations to offset impacts from county policies and operations as developed by the Five County effort.	Habitat Protection	Russian River HU	11
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Evaluate, and develop solutions, to problems for coho salmon caused by channelization.	Coho Population Recovery	Santa Rosa Creek HSA	11
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Currently, the CDFG is funding a study of the genetic variation in Sebastopol meadowfoam, Burke's goldfields, and Sonoma sunshine. These genetic assessments should be expanded to include other declining vernal plant species such as Many-flowered navarretia, Baker's navarretia, Dwarf downingia; Gairdner's yampah; Douglas's pogogyne; and Lobb's aquatic buttercup; and vernal pool animal species such as CTS and California linderiella. Genetic assessments should be continued over several years and correlated with climatic fluctuations to deduce possible genetic variation of populations among years.	Science	Laguna de Santa Rosa HSA	11
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Historical records describe large herds of elk and pronghorn antelope in the Laguna, which were wiped out by hunters more than a century ago. Tule elk have been successfully reintroduced to Point Reyes National Seashore, and a small reintroduction of elk or pronghorn antelope would be an excellent focal point for environmental education and boost tourism, as well as provide alternative grazing animals for vernal pool and grassland restoration. Such reintroductions would require careful management and feasibility studies to evaluate the effects of these native grazers on CTS and vernal pool plants, and to address potential concerns about disease transmission between elk and domestic livestock.	Resource Management	Laguna de Santa Rosa HSA	11
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Oak recruitment is the factor most limiting for oak population recovery in the Laguna watershed. Plant replacements for oaks nearing the end of their natural life spans, and promote oak re-colonization of grasslands where feasible, increasing oak density. As oaks take many years to reach maturity, it is important to undertake restoration efforts as soon as possible.	Habitat Protection	Laguna de Santa Rosa HSA	11
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Oaks take many decades to mature before they reach their most productive stage and host the greatest number of different animal and insect species. Whenever possible, oaks should be retained throughout the watershed.	Habitat Protection	Laguna de Santa Rosa HSA	11
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	The likelihood of success is much greater and the costs and control impacts are much less if invasive species control efforts can be implemented when populations are very small. Prioritize invasive species surveys and mapping to increase early detection, and prioritize funding and implementation of control programs for small satellite populations of invasive species.	Resource Management	Laguna de Santa Rosa HSA	11
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Where possible, restoration and management should focus on habitats and ecosystems rather than single-species conservation. When managing for the recovery of rare species, include monitoring for additional species and environmental factors.	Resource Management	Laguna de Santa Rosa HSA	11
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Wild turkey population growth is likely to create conflicting management objectives on public preserve lands in the Laguna. To strengthen the legal basis for instituting wild turkey reduction strategies, explicitly develop turkey policy statements for site-specific management plans in the Laguna.	Resource Management	Laguna de Santa Rosa HSA	11
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Assess habitat upstream of Reach 3 in Gill Creek	Habitat Availability	Geyserville HSA	11

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SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
National Marine Fisheries Service, Southwest Region. Biological Opinion for Water Supply, Flood Control Operations and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed. February, 2005	Undertake measures to ensure that harm and mortality to listed salmonids from diversion operations, maintenance, and fish screen replacement at Wohler and Mirabel are low.	Fisheries Protection	Guerneville HSA	11
National Marine Fisheries Service, Southwest Region. Biological Opinion for Water Supply, Flood Control Operations and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed. February, 2005	Undertake measures to ensure that harm and mortality to listed salmonids from pre-flood/periodic maintenance at Coyote Valley Dam are low.	Fisheries Protection	Coyote Valley HSA	11
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Consider watershed conservancies and land trusts to increase the amount of protected land in the Russian River watershed.	Habitat Protection	Russian River HU	11
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Develop a project review protocol to ensure all agencies coordinate their input into project planning processes prior to project approval and/or implementation.	Socioeconomic	Russian River HU	11
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. March, 2007	Promote policies that create incentives for low impact developments and design.	Socioeconomic	Russian River HU	11
Sonoma County Water Agency. Russian River Action Plan. March, 2003	Coho Broodstock Program	Coho Population Recovery	Russian River HU	11
The Conservation Fund. Conservation Prospects for the North Coast. January, 2008	Enhance wildlife values on Lake Mendocino through cooperative efforts with the Army Corps of Engineers.	Resource Management	Coyote Valley HSA	11
Laguna de Santa Rosa Foundation. Laguna Watershed Research Plan 2008 - 2012. 2008	Evaluation of existing habitats and land use to identify important conservation areas and to implement their conservation.	Science	Laguna de Santa Rosa HSA	11
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Evaluate, develop solutions and implement immediate needs to address problems resulting from channelization.	Flood Plain Management	Russian River HU	11
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Discourage stabilization projects which will lead to additional instability either up- or downstream.	Riparian Stability	Russian River HU	11
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Minimize interception of CCC coho salmon during the trout and steelhead freshwater sport fishing season.	Fisheries Protection	Russian River HU	11
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	NMFS will work with DFG to modify the California Freshwater Sport Fishing Regulations to minimize interception of adult salmonids.	Fisheries Protection	Russian River HU	11
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Maintain and expand California's working forestlands and forestlands held by the State, and prevent future conversion of forestlands to agriculture or other land uses.	Fisheries Protection	Russian River HU	11
Sotoyome Resource Conservation District. Interviewee Kara Heckert. 3/17/2011	There is a new program under development in Sonoma County where open ag land is being identified for agriculture leasing to support or preserve farming in the county.	Socioeconomic	Russian River HU	11

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SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	If genetic analysis determines that the present stock of steelhead at Warm Springs Hatchery and Coyote Valley Steelhead Facility differs greatly from that of wild stocks or fish found above unsurpassable barriers, several suggestions for hatchery management modifications are provided on pages 241 and 242.	Coho Population Recovery	Russian River HU	10
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Develop and implement a monitoring and evaluation program to adaptively manage the coho salmon broodstock program and meet high and medicum priority monitoring objectives as outlined in the coho salmon HGMP	Coho Population Recovery	Russian River HU	10
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Evaluate recommendations to offset impacts from county policies and operations, as developed by the FishNet 4C program in their report, Effects of County Land Use Policies and Management Practices on Anadromous Salmonids and Their Habitat.	Habitat Protection	Russian River HU	10
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	If appropriate, revise development set-backs to adequately protect key streams inhabited by coho salmon.	Riparian Stability	Russian River HU	10
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Stock high-priority barren streams, including Ward Creek, with the coho salmon broodstock rogram.	Coho Population Recovery	Austin Creek HSA	10
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Store and make available woody material removed from streams for stream enhancement projects benefiting coho salmon.	Habitat Availability	Russian River HU	10
County of Sonoma Board of Supervisors. Draft Sonoma County Outdoor Recreation Plan. March, 2003	Acquisition of additional land for the expansion of Annadel State Park. 2008 Update - this recommendation is ongoing, with some land having been acquired and more recommended as it becomes available.	Resource Management	Santa Rosa Creek HSA	10
County of Sonoma Board of Supervisors. Draft Sonoma County Outdoor Recreation Plan. March, 2003	Acquisition of additional land for the expansion of Austin Creek SRA. 2008 Update - this recommendation is still being proposed, no expansion has occurred since the publication of this Plan.	Resource Management	Guerneville HSA	10
County of Sonoma Board of Supervisors. Draft Sonoma County Outdoor Recreation Plan. March, 2003	Acquisition of land for the expansion of Willow Creek State Park. 2008 Update - this recommendation has been implemented with the acquisition of large parcels of land that have been transferred to State Parks, but will remain within the Plan as a recommendation to continue to acquire additional land as it becomes available.	Habitat Protection	Guerneville HSA	10
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Increase the effectiveness of preserve management with broad-based, long-term monitoring programs that track diverse environmental factors, catalogue and map biodiversity information for other animals and plants on preserves, and gather all data into the Laguna ecosystem database.	Resource Management	Laguna de Santa Rosa HSA	10
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Management is complicated when CTS and vernal pool mitigation sites are in private ownership. It is difficult to monitor management requirements and to enforce easement restrictions. Promote ownership and management of preserve lands by public agencies and local conservation organizations.	Resource Management	Laguna de Santa Rosa HSA	10
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Many of the most important restoration and conservation activities in the Laguna watershed depend on the reauthorization of SCAPOSD to bring key properties into public ownership, to provide compensation for landowners for setting aside land for conservation purposes, and to help maintain the financial viability of farming in the watershed. Long-term restoration and stewardship endowments should be factored into the cost of all acquisitions to support the environmental quality of these lands.	Socioeconomic	Laguna de Santa Rosa HSA	10
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	One of the few remaining stands of Sebastopol Meadowfoam occurs on wetlands adjoining the City of Sebastopol's Meadowlark Field on the Laguna Wetland Preserve. Although this is a floodplain wetland, rather than a vernal pool, it represents an excellent opportunity for public viewing and appreciation of vernal pool wildflower communities. The property is scheduled to be transferred to the SCAPOSD, and the wetland is adjacent to planned trail alignments. Restoration planning should include consideration of future seasonal public access to wetland areas, via ADA-compliant boardwalks.	Socioeconomic	Laguna de Santa Rosa HSA	10

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Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Support watershed research and modeling efforts by increasing the amount of data collected within the Laguna watershed: (1) expand the network of rainfall gauges to better capture variation between the Santa Rosa Plain and the upper montane regions; (2) add new gauges along Copeland, Colgan, Gossage, and Blucher Creeks to measure discharge and stage; (3) locate or develop GIS layers on land use and physical attributes of land surfaces.	Resource Management	Laguna de Santa Rosa HSA	10
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Chlorophyll-a: several locations using standard methods 10200-l or equivalent. At least once at the peak of the growing season and once during winter months when growth is minimal.	Science	Laguna de Santa Rosa HSA	10
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Address artifical passage barriers in Reach 1 of Foote Creek. The artificial passage barrier caused by the flashboard dam should be addressed by modifying or removing it if it is no longer used. Seek and alternative to the wet crossing and address the head-cut it created.	Migration	Geyserville HSA	10
National Marine Fisheries Service, Southwest Region. Biological Opinion for Water Supply, Flood Control Operations and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed. February, 2005	The Corps could expand the DCFH to enable it to support a captive coho salmon broodstock program that would help recover coho salmon in watersheds near and adjacent to the Russian River (e.g., Salmon Creek, Gualala River, Walker Creek, and the Garcia River).	Coho Population Recovery	Russian River HU	10
National Marine Fisheries Service, Southwest Region. Biological Opinion for Water Supply, Flood Control Operations and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed. February, 2005	Undertake measures to ensure that harm and mortality to listed salmonids from ramping procedures at Coyote Valley Dam are low	Fisheries Protection	Coyote Valley HSA	10
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Assess the scope of data currently available. Develop an informational warehouse or database of existing data and identify methods used to collect specific data and the question answered by the collection of specific data (see descriptions of RRIIS in Chapters 2 and 5 of source document).	Science	Russian River HU	10
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2003	This reach of Santa Rosa Creek is recommended for preservation, due to its value as fish and wildlife habitat.	Habitat Protection	Santa Rosa Creek HSA	10
Sonoma County Water Agency. Russian River Action Plan. March, 2003	Conservation/Supplementation Hatchery Program	Coho Population Recovery	Russian River HU	10
California Dept of Parks & Recreation, Statewide Trails Office. California Recreational Trails Plan. March, 2005	Encourage local government agencies to develop trail system plans by making it a requirement for submitting a grant application or give preference to those grant applicants with a local or regionally adopted trail system plan.	Resource Management	Russian River HU	10
Stewards of the Coast and Redwoods. Willow Creek Watershed Management Plan. August, 2005	Assess potential participation in captive brood stock fisheries program.	Coho Population Recovery	Guerneville HSA	10
UC Cooperative Extension, Sonoma County & Sonoma County Department of Emergency Services. Sonoma County Sudden Oak Death Strategic Response Plan. 2008	Manage the hazardous trees (those affected by SOD) in order to avoid injury and loss of life and damage to property	Habitat Protection	Russian River HU	10
City Council of Healdsburg. Healdsburg 2030 General Plan Policy Document. 2009, amended 2011	Protection and preservation of Healdsburg's Native American cultural places.	Archaeological Resources	Guerneville HSA	10
City of Santa Rosa. Santa Rosa General Plan 2035. November, 2009	Preserve, as permanent open space, areas which contain state or federally listed rare and endangered species.	Habitat Protection	Russian River HU	10
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Increase coho salmon smolt production at the Russian River Coho Salmon Broodstock facility to a level where consistent returns can be incorporated reliably into the spawning matrix	Coho Population Recovery	Russian River HU	10

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Continue to utilize surplus fish in additional recovery opportunities (adult releases, releases to extirpated watersheds) and evaluate such actions in the context of recovering coho in the Russian River, extirpated watersheds, and the contribution to the diversity stratum	Coho Population Recovery	Russian River HU	10
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Minimize departure from the genetic profile that historically existed in the population.	Coho Population Recovery	Russian River HU	10
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Use surplus broodstock to repopulate nearby watersheds (within diversity strata) where populations have extirpated.	Coho Population Recovery	Russian River HU	10
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Agencies should develop large woody debris retention programs and move away from the practice of removing instream large woody debris under high flow "emergencies".	Habitat Protection	Russian River HU	10
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	NMFS will work with DFG to modify marking strategy of captive broodstock recovery program coho to decrease confusion with allowable harvested hatchery steelhead	Fisheries Protection	Russian River HU	10
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Areas adjacent to currently owned State parks or forestlands supporting Core, Phase I and Phase II priority areas should be considered for purchase (if feasible within the next 5 years). Russian River - core areas - Sheephouse Creek area of the Willow Creek planning watershed; Freezeout Creek area of the Freezeout Creek Planning watershed; Dutch Bill, Felta, Wallace, Palmer, and Upper East Gray Creek planning watersheds; Purrington Creek area of the Purrington Creek planning watershed.	Habitat Protection	Guerneville HSA	10
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Conserve and manage forestlands for older forest stages.	Habitat Availability	Russian River HU	10
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Provide information to BOF regarding CCC coho salmon priorities and recommend upgrading relevant forest practices.	Fisheries Protection	Russian River HU	10
Redwood Valley Outdoor Education Project (RVOEP). Interviewee Helen Menasian. 2/23/2011	RVOEP should be used by high school students. I.e. senior projects, Environmental Club, Research. Need science teachers to get involved in watershed education.	Resource Management	Forsythe Creek HSA	10
Redwood Valley Outdoor Education Project (RVOEP). Interviewee Helen Menasian. 2/23/2011	Watershed education activities to increase environmental and watershed awareness by the community. Increased awareness leads to improved actions at home and work to reduce negative impacts on the watershed.	Resource Management	Forsythe Creek HSA	10
Hopland Band of Pomo Indians. Interviewee Shawn Pady, Chair and Tribal Historic Preservation Officer. 3/23/2011	Increasing salmonid populations and other fish species in local creeks is important. Maybe helping jump start the population with hatchery plantings needs to be explored.	Fisheries Protection	Ukiah HSA	10
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Replace/Remove remaining weirs on Fife Creek.	Migration	Guerneville HSA	9
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Screen disharges at Mirabel and Wohler for warm water fishes.	Habitat Availability	Russian River HU	9
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Where steelhead runs are completely absent but habitat remains, an enhancement program should be installed to recover lost runs.	Coho Population Recovery	Russian River HU	9
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Willow, Sheephouse, Freezeout and Green Valley Creeks have been identified for re-introduction of native coho utilizing a Captive Broodstock Program.	Coho Population Recovery	Guerneville HSA	9
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Develop, implement, and evaluate experimental release protocols for the captive broodstock program	Coho Population Recovery	Russian River HU	9

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Identify additional streams that may be suitable for stocking coho salmon.	Coho Population Recovery	Russian River HU	9
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Review and revise long-term hatchery program goals based on results of the monitoring and evaluation program implemented in the experimental captive broodstock program.	Coho Population Recovery	Russian River HU	9
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Stock first priority streams missing coho salmon, including Felta and Mill creeks (tributary to Dry Creek west of Healdsburg), Freezeout, Willow and Sheephouse creeks (near Duncans Mills), and Ward Creek (tributary to Austin Creek). Identify additional streams that may be suitable for stocking as restoration occurs.	Coho Population Recovery	Russian River HU	9
County of Sonoma Board of Supervisors. Draft Sonoma County Outdoor Recreation Plan. March, 2003	Acquisition of "The Cedars" for a wilderness park to preserve an area identified in the Sonoma County General Plan as a critical habitat area. 2008 Update - this recommendation will remain in the plan, but other agencies are in the lead.	Habitat Protection	Guerneville HSA	9
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Adult CTS spend greater than 95% of their lives underground, yet very little is known about this life-stage. There is almost nothing known about the ecological relationship between CTS and burrowing mammals, such as gophers, except that CTS are dependent on burrows for survival.	Science	Laguna de Santa Rosa HSA	9
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Although steelhead trout and coho salmon have had substantial attention in the Laguna watershed, relatively little is known about the ecology and distribution of the other fish species found here. Survey the fish community in both the main Laguna channel and major tributaries in summer and winter to characterize the ecology of the system, develop indicators for water quality and stream condition, and identify potential problems, such as non-native predators. Compile these data in the Laguna ecosystem database.	Science	Laguna de Santa Rosa HSA	9
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Develop a scientific research program to better understand the ecological interactions of mosquitoes and wetland systems, in order to develop methods of wetland management that reduce mosquito production without impairing wetland function or requiring excessive mosquito-control products. Work collaboratively with staff from the Marin/ Sonoma Mosquito and Vector Control District.	Science	Laguna de Santa Rosa HSA	9
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Given the substantial changes that have occurred over time in the watershed, there are now a number of animals like bats and barn swallows that rely on the human-altered components of the landscape. These include agricultural areas, water channels, buildings, roadways, bridges, ponds, telephone poles, and urban back yards. Large non-native trees or old orchards may provide essential nesting habitat for birds and other animals while native restoration plantings mature. Restorationists and land managers should consider the ecological value of these features while planning restoration projects.	Resource Management	Laguna de Santa Rosa HSA	9
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Large-scale grassland restoration will not be possible until there is a large-scale source of local native grass seed. Work with agricultural producers to propagate native grass seed on the Santa Rosa Plain using locally collected stock.	Resource Management	Laguna de Santa Rosa HSA	9
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Natural plant communities have complex vegetation structure, with different species of different sizes and age classes often growing in clumps and patches. Restoration projects should be designed to reproduce this structural complexity to enhance the ecological value of restoration sites. Reference habitats indicate which species are locally adapted and appropriate, and can potentially be a source of parent material for plant propagation. Wherever possible, restoration practitioners should find and use reference sites within the Laguna watershed.	Riparian Stability	Laguna de Santa Rosa HSA	9

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Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Restoration projects frequently involve some form of environmental disturbance—for example digging or invasive plant removal. Whenever possible, projects should be timed to minimize disturbance to the greatest number of species, using special care to reduce disturbance to particularly sensitive or rare species. Disturbance that affects listed species is considered a form of "take" and is regulated by natural resource agencies.	Resource Management	Laguna de Santa Rosa HSA	9
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	The Laguna main channel is 303(d) listed as impaired for low dissolved oxygen (DO). Dissolved oxygen levels are a function of biophysical processes—DO is elevated by air mixing at the water surface and by photosynthesis of aquatic plants, and decreased by microbial decomposition of organic matter. Research is needed to study the driving forces for low DO in the Laguna: whether organic material is derived from aquatic or terrestrial origins, the effect of bioturbation (the stirring or mixing of sediment by organisms) on the breakdown of organic matter in sediments, and the influence of nutrient availability.	Science	Laguna de Santa Rosa HSA	9
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Channel cross sections: identify and monument cross sections that would best reflect geomorphic change without being affected by hydraulic conditions. Once every 5 years or before and after dredging if applicable.	Science	Laguna de Santa Rosa HSA	9
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Longitudinal profiles: detailed field surveys using a total station. Once every five years if no dredging activity; otherwise before each dredging activity.	Science	Laguna de Santa Rosa HSA	9
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Macrophytes: determine the area covered by macrophytic growth using walking GPS surveys, grids and photographic documentation - calculate percent of the area covered by aquatic plants. Samples from representative locations to quantify biomass. At least once at the peak of the growing season and once during winter months when growth is minimal.	Science	Laguna de Santa Rosa HSA	9
National Marine Fisheries Service, Southwest Region. Biological Opinion for Water Supply, Flood Control Operations and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed. February, 2005	The Corps (and CDFG) shall operate the DCFH and CVFF steelhead programs in a manner that minimizes adverse genetic effects to steelhead within the Russian River and within the CCC steelhead DPS.	Fisheries Protection	Russian River HU	9
National Marine Fisheries Service, Southwest Region. Biological Opinion for Water Supply, Flood Control Operations and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed. February, 2005	The Corps could fund the annual collection of adult steelhead trout in tributaries of the Russian River within Mendocino County and in tributaries of Dry Creek in Sonoma County for purposes of including wild adult steelhead in the pool of steelhead spawned at CVFF and the DCFH. Inclusion of wild adult steelhead into the hatchery program would promote an integrated hatchery program which would help avoid adverse genetic affects of the mating of wild steelhead with stray hatchery fish.	Fisheries Protection	Russian River HU	9
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2003	This reach of Santa Rosa Creek is recommended for preservation, due to its value as fish and wildlife habitat.	Habitat Protection	Santa Rosa Creek HSA	9
City of Santa Rosa, County of Sonoma, Sonoma County Water Agency. Santa Rosa Citywide Creek Master Plan . March, 2003	This reach of Santa Rosa Creek is recommended for preservation, due to its value as fish and wildlife habitat.	Habitat Protection	Santa Rosa Creek HSA	9
California Dept of Parks & Recreation, Statewide Trails Office. California Recreational Trails Plan. March, 2005	Encourage increased data gathering regarding trail use, including numbers of trail users, types of trail use (equestrian, hiking, mountain bike, etc.), miles traveled, most popular trails, visitor surveys and other information that may be useful or required for adequate planning, development, operation and maintenance activities.	Resource Management	Russian River HU	9
California Dept of Parks & Recreation, Statewide Trails Office. California Recreational Trails Plan. August, 2005	Recommend amending the California Subdivision Map Act to require a trail element in all future local government plans. Until such a legal requirement exists, continue encouraging local agencies to incorporate the current option to include a recreation element in their general plans.	Resource Management	Russian River HU	9

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Take steps to ensure the preservation of all archaeological resources in the watershed.	Archaeological Resources	Guerneville HSA	9
Sotoyome RCD. Upper Mark West Watershed Management Plan Phase 1: Watershed Characterization and Needs Assessment.. 2008	Support designated uses for aquatic life.	Fisheries Protection	Mark West HSA	9
Sotoyome RCD. Upper Mark West Watershed Management Plan Phase 1: Watershed Characterization and Needs Assessment.. 2008	Promote native biodiversity in upland habitats.	Habitat Protection	Mark West HSA	9
Sotoyome RCD. Copeland Creek Watershed Assessment. 2004	Complete outreach to rangeland owners and cattle grazing operations.	Resource Management	Laguna de Santa Rosa HSA	9
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Assess habitat upstream of Reach 3	Habitat Availability	Geyserville HSA	9
City of Santa Rosa. Santa Rosa General Plan 2035. November, 2009	Design hillside development to be sensitive to existing terrain, views, and significant natural landforms or features.	Habitat Protection	Russian River HU	9
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Re-establish a naturally reproducing run of coho salmon in appropriate subwatersheds.	Coho Population Recovery	Russian River HU	9
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Ward Creek has been identified for re-introduction of native coho utilizing a Captive broodstock Program discussed in Appendix G of the source document.	Coho Population Recovery	Austin Creek HSA	8
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Continue genetic analysis of source stocks for coho salmon broodstock.	Coho Population Recovery	Russian River HU	8
County of Sonoma Board of Supervisors. Draft Sonoma County Outdoor Recreation Plan. March, 2003	Acquisition of additional land for the expansion of Sugarloaf Ridge State Park. 2008 Update - this recommendation has been implemented with multiple acquisitions, but is still ongoing as more land becomes available. An interim plan is under development.	Resource Management	Santa Rosa Creek HSA	8
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Reduce horticultural introductions and other accidental introductions of invasive species through environmental education to gardeners and collaborations with nurseries, and by raising the awareness of the public about other invasion pathways.	Riparian Stability	Laguna de Santa Rosa HSA	8
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	To determine optimal location, size and management of protected habitats, there is a critical need for more information on salamander movement, migration, and dispersal—using radio telemetry of migrating adults and juveniles and upland pitfall traps to determine migration patterns and occupied uplands.	Science	Laguna de Santa Rosa HSA	8
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Vegetation mapping establishes a baseline for restoration efforts, and provides information about the relative diversity and distribution of different species and habitat types in the watershed. Species lists are much more detailed surveys, often compiled over many years and seasons, of which plants are found on individual parcels or preserves. Both are invaluable for long-term biodiversity research and monitoring. Support vegetation mapping efforts by CNPS and other groups. Develop plant species lists for all preserve lands in the watershed. Integrate these with monitoring and GIS data in the Laguna ecosystem database.	Resource Management	Laguna de Santa Rosa HSA	8
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Birds; area search, point count and nesting surveys in riparian zones and along waterways. Spring and summer.	Science	Laguna de Santa Rosa HSA	8
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Riparian buffer habitat condition: GIS mapping and regular geographic survey to identify alterations to buffer width and habitat connectivity; shade cover/density; on the ground assessments of vegetation and fauna condition throughout watershed including determination of non-native and invasive components. Monitoring of uptake and trapping efficiency of various buffer types and widths. Once every five years.	Science	Laguna de Santa Rosa HSA	8

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Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Warm and Cold Water Fish; electro-shock and release, initial detailed community surveys in main stem and reaches not yet surveyed, then monitor communities at set locations within watershed at regular intervals. Low and high flow conditions as conditions allow.	Science	Laguna de Santa Rosa HSA	8
National Marine Fisheries Service, Southwest Region. Biological Opinion for Water Supply, Flood Control Operations and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed. February, 2005	SCWA shall undertake measures to ensure that injury and mortality to listed salmonids resulting from fish monitoring at Mirabel diversion dam, in the estuary, and in Dry Creek are low.	Fisheries Protection	Guerneville HSA	8
California Department of Parks and Recreation Planning Division, Statewide Trails Office. California Recreational Trails Plan. March, 2005	Design and compete a survey of all State Park trails and establish an easily accessible master trail database, along with procedures and protocols for maintaining accurate data. Encourage cities, counties, regional parks and federal land managers to survey all trails within their jurisdictions. Make data available on the internet.	Resource Management	Russian River HU	8
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Biological Resources Montiroing.	Habitat Protection	Guerneville HSA	8
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Per the Russian River Biological Opinion, utilize adaptive management to guide future management and development of above guidelines	Coho Population Recovery	Guerneville HSA	8
City Council of Cloverdale. City of Cloverdale General Plan. 2009, amended 2010	Develop a tree-protection ordinance that will identify heritage trees (trees over 23 inches diameter and/or historically significant) and significant trees and tree species (trees over 8 inches diameter).	Habitat Protection	Guerneville HSA	8
City of Santa Rosa. Santa Rosa General Plan 2035. November, 2009	Protect Native American heritage.	Archaeological Resources	Russian River HU	8
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Improve and expand rearing capacity of the Coho Salmon Captive Broodstock facility.	Coho Population Recovery	Russian River HU	8
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Continue and expand the existing coho salmon life-cycle monitoring efforts.	Coho Population Recovery	Russian River HU	8
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Streamline permit processing where agricultural landowners are conducting actions aligned with recovery priorities.	Coho Population Recovery	Russian River HU	8
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Discourage Mendocino and Sonoma Counties from rezoning forestlands to rural residential or other land uses.	Resource Management	Russian River HU	8
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Coordinate with the agencies that authorize conversions to minimize conversions in key watersheds and discourage forestland conversions.	Resource Management	Russian River HU	8
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Promote CalTip to discourage poaching (DFG 2004).	Fisheries Protection	Russian River HU	8
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Promote public outreach to the fishing community to ensure that coho salmon are properly identified and immediately released if incidentally caught during steelhead fishing.	Fisheries Protection	Russian River HU	8

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Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Encourage DFG to modify the Fishing Regulation manual to clearly identify differences in body morphology of all potentially present adult salmonids with color photos (e.g., caudal fin spotting, caudal fin shape, coloration of lower jaw, peduncle width, etc.).	Fisheries Protection	Russian River HU	8
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Install/construct permanent signs at all major public access points along the Russian River (below Dry Creek) that clearly identify differences in body morphology of all potentially present adult salmonids with color photos (e.g., caudal fin spotting, caudal fork shape, coloration of lower jaw, peduncle width, etc.).	Fisheries Protection	Russian River HU	8
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Monitor passage on Pole Mountain and Gillian Creek.	Migration	Austin Creek HSA	7
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Natural barriers exist on Alder, Anna Belcher, Frasier, Lovers Gulch and Squaw and should not be modified as most contain resident populations of steelhead trout.	Habitat Availability	Sulphur Creek HSA	7
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Stock high-priority barren streams, such as Mill and Felta creeks, as part of the coho salmon broodstock program.	Coho Population Recovery	Warm Springs HSA	7
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	For long-term sustainability, it is important to retain locally-adapted genetic strains and within-population genetic diversity when implementing restoration projects. Ideally, seed should be collected from a large numberof parent individuals growing at a nearby reference site. If this is not possible, native seed or plants should be purchased from local native seed companies or nurseries. Records should be kept on the origin of all plant material used in restoration projects.	Resource Management	Laguna de Santa Rosa HSA	7
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Rare species are at great risk of losing genetic variation within and among populations. Seed collections should be made of listed vernal pool plants in order to preserve the current population variation, and stored at appropriate seed storage facilities (e.g. Rancho Santa Ana Botanic Gardens), to allow use of these seeds in future restoration efforts of declining populations. Collections should be made over several years to capture genetic variation within species for different preferred germination conditions.	Resource Management	Laguna de Santa Rosa HSA	7
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	The most diverse plant communities, supporting the greatest variety of wildlife, are mosaics of different successional stages. To mimic these natural processes, restoration projects should ideally be phased: first planting trees and shrubs that tolerate harsher conditions, then following up with more shade-tolerant understory plants after the first plantings have begun to fill in.	Riparian Stability	Laguna de Santa Rosa HSA	7
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Two species of non-native crayfish have been introduced to the Laguna: the Louisiana swamp crayfish and the Signal crayfish. There were no crayfish native to this area, but they are now found in huge numbers. Crayfish appear to be an important part of the diets of raccoons, otter, and large wading birds in the Laguna, and are themselves omnivorous, preying on fish, turtles, amphibians, and other aquatic invertebrates as well as live and decaying plant material. Given their central food web position and great abundance, it is likely that crayfish are having a profound effect on the ecology of Laguna wetlands, but these effects have never been evaluated. Much more research is needed to inform management recommendations.	Resource Management	Laguna de Santa Rosa HSA	7
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Very little is known about the current and potential ecological impacts of wild turkeys on the Laguna ecosystem. Initiate research to evaluate turkey impacts to oak restoration, endangered species, and invasive plant establishment.	Resource Management	Laguna de Santa Rosa HSA	7
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Amphibians; calling and crossing surveys. Yearly during spring.	Science	Laguna de Santa Rosa HSA	7

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. March, 2007	Review current stream classifications that consider more than hydrologic attributes, for example, species genetic, behavioral, and population attributes.	Science	Russian River HU	7
Sonoma County Agricultural Preservation and Open Space District. Connecting Communities and the Land: A Long-Range Acquisition Plan. March, 2003	Partner with local agencies and organizations to compile existing information and data about resources in the county into a central repository.	Resource Management	Russian River HU	7
California Dept of Parks & Recreation, Statewide Trails Office. California Recreational Trails Plan. March, 2005	Develop and maintain trail maps on a GIS (Geographic Information System). Create GIS maps of public trails in California. The GIS maps would also serve as an overlay for planners in developing and updating land use plans in California.	Resource Management	Russian River HU	7
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Fund a hydrological and ecological study to determine the historic role of seasonal lakes and wetland areas of the laguna as over-winter and summer rearing habitat.	Flood Plain Management	Laguna de Santa Rosa HSA	7
Laguna de Santa Rosa Foundation. Laguna Watershed Research Plan 2008 - 2012. 2008	Evaluation of the historical versus current status of Laguna human and natural systems, including trends in land use, resource economics and related perils to Laguna ecosystems.	Science	Laguna de Santa Rosa HSA	7
Laguna de Santa Rosa Foundation. Laguna Watershed Research Plan 2008 - 2012. 2008	Investigation into the status of declining species in order to inform recovery decisions.	Science	Laguna de Santa Rosa HSA	7
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Increase size at release to attain 160 mm at emigration, to enhance marine survival and increasing adult returns	Coho Population Recovery	Russian River HU	7
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Adopt hatchery guidelines defined in Spence et al. 2007.	Coho Population Recovery	Russian River HU	7
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Increase enforcement patrols by DFG, State Parks, and NMFS OLE in sensitive spawning and rearing areas.	Fisheries Protection	Russian River HU	7
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Should large tracts of forestlands within any watershed identified as a priority in this recovery plan become available for purchase, Federal, State, local government, and non-governmental organizations should consider purchasing the area as a Demonstration Forest or State Park.	Habitat Protection	Russian River HU	7
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Discourage home building or other incompatible land use in areas identified as timber production zones (TPZ).	Fisheries Protection	Russian River HU	7
Coyote Valley Tribal EPA Department. Interviewees Richard Campbell and Dan Rodriquez. 2/24/2011	Helping salmonids use aquatic habitats above Lake Mendocino would be good.	Coho Population Recovery	Forsythe Creek HSA	7
Redwood Valley Outdoor Education Project (RVOEP). Interviewee Helen Menasian. 2/23/2011	RVOEP should be used by Eagle Peak Middle School. The challenge is that class periods are only 50 minutes.	Resource Management	Forsythe Creek HSA	7
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Stock Willow, Sheephouse, Freezeout, Dutchbill and Green Valley creeks as part of the coho salmon broodstock program	Coho Population Recovery	Guerneville HSA	6
County of Sonoma Board of Supervisors. Draft Sonoma County Outdoor Recreation Plan. March, 2003	Acquire and develop Regional Park in West County of about 740 acres to meet both preservation and compatible recreation needs. 2008 Update - this recommendation is still being proposed with an increase in recommended acreage.	Habitat Protection	Guerneville HSA	6
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Whenever possible, restoration plans and grant applications should include at least three years of follow-up into their budgets. Public landowners should include funding for long-term maintenance into their operations or public works budgets	Socioeconomic	Laguna de Santa Rosa HSA	6
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Baseline faunal surveys.	Science	Laguna de Santa Rosa HSA	6

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: NATURAL RESOURCES AND LAND MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Encourage learning opportunities such as informational workshops involving agencies, landowners, community and steward groups and sub-watershed councils.	Socioeconomic	Russian River HU	6
Gold Ridge RCD. Willow Creek Watershed Management Plan. March 2005	Determine extent and cause of invasive species presence.	Habitat Availability	Guerneville HSA	6
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Consider the development of a Watershed Database (similar to the DFG Northern Spotted Owl database) for salmonids that provides watershed data and information in a consistent fashion to all foresters for consideration in their harvest plans.	Fisheries Protection	Russian River HU	6
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Obtain better fish utilization information on Windsor and Pool Creeks.	Fisheries Protection	Mark West HSA	5
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Dead and dying oaks and other trees provide invaluable habitat for many animals. Wherever possible, these should be retained, and allowed to naturally decay. When dead or dying trees must be taken down for safety reasons, the logs and branches should be left in the landscape.	Habitat Protection	Laguna de Santa Rosa HSA	5
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Riparian restoration requires careful reach-by-reach site-specific surveys to evaluate the health, density and diversity of existing vegetation, and potential site-specific challenges. Use field reconnaissance and GIS data to assess the state of riparian vegetation on perennial and ephemeral stream channels in the Laguna watershed.	Riparian Stability	Laguna de Santa Rosa HSA	5
Laguna de Santa Rosa Foundation. Laguna Watershed Research Plan 2008 - 2012. 2008	Establish historic, contemporary and long-term ecological and biodiversity status baselines of Laguna natural systems and their connectivity and related threats	Science	Laguna de Santa Rosa HSA	5
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Integrated pest management is a strategy that incorporates a range of different control techniques to minimize pesticides use for weed management, and control programs should always seek to follow an integrated pest management approach.	Resource Management	Laguna de Santa Rosa HSA	4
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Restoration projects should incorporate diverse plant species, including trees, shrubs, grasses and herbaceous perennials.	Riparian Stability	Laguna de Santa Rosa HSA	4
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Educate the public about environmental health and safety issues through RRIIS and consider adding to current curriculum development efforts.	Socioeconomic	Russian River HU	4
Community Foundation Sonoma County and Sonoma County Water Agency. Biodiversity Action Plan: Priority Actions to Preserve Biodiversity in Sonoma County. October 2010	Promote effective economic incentives for land owners	Habitat Protection	Guerneville HSA	4
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	"Establish adequate spoils storage sites throughout the counties (Harris et al. 2001) " so that these do not become chronic sources of surface or fluvial erosion.	Fisheries Protection	Russian River HU	3

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: WATER SUPPLY RELIABILITY				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
California Department of Water Resources. California Water Plan 2005 Update. December, 2005	DWR will use its technical and financial assistance programs (including Proposition 50 funded programs) to effectively and equitably support planning and implementation of local and regional water use efficiency, water recycling, groundwater storage and management, ecosystem restoration, urban streams, flood management, and related planning efforts.	Socioeconomic	Russian River HU	51
California Department of Water Resources. California Water Plan 2009 Update Pre-Administrative Draft Volume I The Strategic Plan. October, 2008	State, federal, Tribal, regional, and local governments and agencies, pubic and private organizations, and water users should implement the actions of California Water Plan Update 2009 to achieve its goals and objectives. They should in partnership adopt an integrated, collaborative, multi-benefit, and transparent approach toward resource planning and management. Californians, acting as individuals, make daily choices that can impact water quality and prevent water waste. State government should create incentives for citizens to aggressively participate in water protection and conservation efforts. These efforts may be modeled after energy conservation efforts conducted by the State.	Water Quantity	Russian River HU	50
UC Berkeley & Hopland Research & Extension Center, Environmental Science Policy and Management. Expert Interview. March 23, 2011	We need collective basin plans, like in Napa or in the Salinas basins. A collective arrangement to allow for management on a larger scale. Points of diversion need to be coordinated when water is planned for withdrawal.	Water Quantity	Russian River HU	49
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Develop new policies, regulations and programs to provide suitable flow conditions for CCC coho salmon.	Water Quantity	Russian River HU	46
California Department of Water Resources. California Water Plan 2005 Update. December, 2005	DWR will develop the necessary tools to assist local and regional agencies be successful with the integrated regional water management and planning and will monitor the development and implementation of these plans to ensure an equitable distribution of technical and financial assistance in planning efforts. Data from these plans can be integrated into future California water plan updates	Water Quantity	Russian River HU	44
California Department of Water Resources. California Water Plan 2005 Update. December, 2005	Local governments and agencies should improve coordination between land use planning and water planning and management to ensure that new infrastructure has adequate water supply and that land uses are protective of water quality.	Water Quantity	Russian River HU	43
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Avoid and/or minimize the adverse effects of water diversion on CCC coho salmon by establishing a more natural hydrograph, by-pass flows, season of diversion, and off-stream storage (DFG 2004).	Water Quantity	Russian River HU	42
Mendocino County Water Agency. Expert Interview. 3/15/2011	Data Needs: Who, what, where, and when water is used. No one seems to have a good idea of who uses water from the Russian River, how much they use, where it is used, and when. Lake Mendocino and Lake Sonoma are the two systems that are used for flow management. Operations need to improve to be based on real time to meet obligations, and not release excess amounts based on so many unknown "fudge factors." A lot of water is being released from the two reservoirs, in excess of actual needs. There is a lot of slop in the process. Without knowing what diverters are doing downstream, we cushion our management to prevent damage to the river. A better use of funds would be to track water instead of raising Coyote Dam. This would address the quantity issue for human uses and environmental needs.	Water Quantity	Russian River HU	42
California Department of Water Resources. California Water Plan 2005 Update. December, 2005	DWR will develop guidelines for technical and financial assistance and templates for integrated regional water management plans, urban and agricultural water management plans, and drought contingency plans.	Socioeconomic	Russian River HU	41

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: WATER SUPPLY RELIABILITY				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 2002	Develop county programs to protect and increase instream flows for anadromous fish, working with water districts on conservation issues and conduct regional water management planning. Counties should also condition development which would divert or store surface water on the applicants having received appropriative rights from the SWRCB.	Water Supply	Russian River HU	41
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 2002	Significant impacts can be avoided if the season of diversion is limited to December 15 through March 31, reservoirs are built offstream, specific bypass flow are provided during the diversion season, and the natural hydrograph is protected to avoid cumulative impacts due to flow reduction in the watershed. See Guidelines for Maintaining Instream Flows to Protect Fisheries Resources Downstream of Water Diversions in mid-California Coastal Streams (CDFG & NMFS 2000), Staff Report, Assessing Site Specific and Cumulative Impacts on Anadromous Fisheries Resources in Coastal WAtersheds in Northern California (SWRCB 2001).	Water Quantity	Mainstem Russian River	41
The Conservation Fund. Conservation Prospects for the North Coast.	Manage summer flows in the mainstem of the Russian River to the benefit of rearing coho salmon and of the estuary, while ensuring that all existing legal water uses and rights are accounted for.	Water Quantity	Russian River HU	41
Sonoma County Water Agency. Expert Interview. 3/28/2011	Russian River Coho Water Resources Partnership: Coordinated water use will be very effective in improving watershed conditions. Reference to the Mattole watershed model for remediation in very rural environments.	Water Quantity	Mainstem Russian River	41
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Salmon and steelhead need year-round water in creeks where they spawn. Although some ephemeral streams have deep pools where juveniles can survive the summer, creeks need to be deep enough that the water stays sufficiently cool, and so that fish can travel up them in the fall and down in the spring. In the Laguna tributaries, channel down-cutting and groundwater pumping threaten the sustainability of summertime flows. Water budgets should be developed for salmonid-bearing streams to evaluate their current status and future needs. This is an issue on which it pays to be proactive with land use decisions and water conservation planning.	Water Quantity	Laguna de Santa Rosa HSA	40
CDFG. Recovery Strategy for California Coho Salmon. 38018	Request that the SWRCB review and/or modify water use based on the needs of coho salmon and authorized diverters.	Water Quantity	Guerneville HSA	38
Potter Valley Irrigation District and Upper Russian Stewardship Alliance. Expert Interview. 3/15/2011	We need to determine what baseline flow data is for tributaries to manage for frost protection and to address AB 2121.	Water Quantity	Forsythe Creek HSA	37
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 2002	Attend SCWA's "Water Supply" workshops for discussion on watershed management, water supply, and groundwater/gravel mining.	Water Quantity	Mainstem Russian River	36
Sonoma County Water Agency. Expert Interview. 3/28/2011	Research by the UC Coop Extension and National Fish and Wildlife Foundation Russian River Coho Water Resources Partnership: fisheries research and hydrologic modeling in subwatersheds.	Water Quantity	Mainstem Russian River	36
Agriculture Department, County of Mendocino. Expert Interview. 2/24/2011	More off-channel storage ponds will improve the Russian River, especially during frost protection season. The ponds also serve to increase wildlife habitat and often times as sediment storage basins.	Water Quantity	Russian River HU	36
Mendocino County Water Agency. Expert Interview. 3/15/2011	The frost protection effort is a great example of improved management and communication in this area. Expanding this type of communication to the rest of the calendar year and to the rest of the river will increase knowledge about water needs. This could free up 10,000 to 30,000 AF each year just by improving efficiency of communications and outflow management. This approach is probably the most cost effective way to increase water quantity available to human users and the environment. The details of how the frost protection program with URSA operates could be applied to the Russian River as a whole.	Water Quantity	Russian River HU	35
CDFG. Recovery Strategy for California Coho Salmon. 38018	Monitor, identify problems, and prioritize needs for changes to water diversion on current or potential coho streams that go dry in some years, in particular Green Valley and Dutch Bill creeks.	Water Quantity	Guerneville HSA	34

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: WATER SUPPLY RELIABILITY				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
North Coast Regional Water Quality Control Board. Regional Water Board Staff Work Plan to Control Excess Sediment in Sediment-Impaired Watersheds. November, 2002	Conduct outreach and education and work with local stakeholders/ watershed groups		Russian River HU	34
Sotoyome RCD. Upper Mark West Watershed Management Plan Phase 1: Watershed Characterization and Needs Assessment.. 2008	Improve water conservation.	Water Quantity	Mark West HSA	34
Russian River Keeper. Expert Interview. 3/28/2011	Projects that decrease agricultural water consumption/diversion from streams and the river during critical periods. Storage projects.	Water Quantity	Russian River HU	34
Mendocino County Russian River Flood Control & WCID. Expert Interview. 3/9/2011	The Russian River Frost Program is attempting to facilitate the development of small scale reservoirs for agriculture.	Water Quantity	Russian River HU	34
Agriculture Department, County of Mendocino. Expert Interview. 2/24/2011	The amount of water used for frost protection needs to be monitored and known. Meters need to be installed on all pumps to know the effect on the Russian River. Minimizing the impact of frost protection on the river is the main goal of documenting water use during frost protection periods.	Water Quantity	Russian River HU	34
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 2002	Support the addition of a water resources component to the Sonoma County General Plan.	Water Quantity	Mainstem Russian River	33
CDFG. Recovery Strategy for California Coho Salmon. 38018	Support efforts and develop county, city, and other local programs to protect and increase instream flows for coho salmon	Water Quantity	Russian River HU	33
UC Berkeley & Hopland Research & Extension Center, Environmental Science Policy and Management. Expert Interview. March 23, 2011	Creating basin plans for flow management would be worthwhile. The RCDs could organize input and secure contracts for getting funds to do the assessments but the landowners will need incentives (regulatory relief etc.) to participate.	Water Quantity	Russian River HU	33
Potter Valley Irrigation District and Upper Russian Stewardship Alliance. Expert Interview. 3/15/2011	Addressing frost issues on grape crops in tributary subwatersheds still needs to be accomplished. We need to build storage ponds in the tributary subwatersheds.	Water Quantity	Forsythe Creek HSA	33
Potter Valley Irrigation District and Upper Russian Stewardship Alliance. Expert Interview. 3/15/2011	Off stream storage needs to increase throughout the watershed to reduce impacts on the creeks and river and answer the needs from human uses. Increasing off channel storage through the AWEP program provides a good option, and can even use recycled water like they are proposing with the Sanitation District.	Water Quantity	Forsythe Creek HSA	32
California Department of Water Resources. California Water Plan 2005 Update. September, 2008	DWR will continue to promote implementation of recommendations from California's Groundwater Update 2003 (DWR Bulletin 118-03) to improve groundwater management and work with local agencies to develop guidelines to reduce overdraft.	Socioeconomic	Russian River HU	31
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 2002	The NCRWQCB and SWRCB along with DFG and other agencies should obtain data and locations watershed-wide on water diversions, riparian water rights, water right permits, groundwater and well-water usage, and aquifer conditions in order to make safe and protective decisions on continued water quantity impacts on salmonids.	Water Quantity	Russian River HU	31
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Collaborate with landowners to minimize impacts on summer base flow from riparian water diversion activities.	Water Quantity	Russian River HU	31
UC Berkeley & Hopland Research & Extension Center, Environmental Science Policy and Management. Expert Interview. March 23, 2011	Subwatersheds need to have their own basin plans for water management. Reference to Adina's paper in the 2008 California Agriculture issue. This is parallel to the concept of a water master, but on a subwatershed basis.	Water Quantity	Russian River HU	31
California Department of Water Resources. California Water Plan 2005 Update. September, 2008	DWR will continue to provide technical, administrative, and financial assistance to implement actions under the California Urban Water Conservation Council, "Memorandum of Understanding Regarding Urban Water Conservation in California" and the Agricultural Water Management Council, "Memorandum of Understanding" to improve water use efficiency in California.	Socioeconomic	Russian River HU	30

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: WATER SUPPLY RELIABILITY				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
The Conservation Fund. Conservation Prospects for the North Coast.	Identify water diverters, and request that SWRCB review or modify water use based on the needs of coho salmon and authorized diverters. Monitor and identify problems, and prioritize needs in terms of changes to water diversion, in particular Green Valley and Dutch Bill creeks, which have been identified as current or potential coho streams s that often go dry.	Water Quantity	Russian River HU	30
NOAA Fisheries, Protected Resources Division. Expert Interview. 3/16/2011	Water conservation measures	Water Quantity	Russian River HU	30
NRCS. Expert Interview. 2/22/2011	Water storage and irrigation improvements in wine grape operations.	Water Quantity	Mainstem Russian River	30
Gold Ridge RCD. Expert Interview. 3/18/2011	Need to increase incentives to address water supply, including rural residential too.	Socioeconomic	Guerneville HSA	30
California Floodplain Management Task Force. California Floodplain Management Report. December, 2002	Permitting agencies should consider the impacts of land-use decisions on the capacity of the floodplain to recharge groundwater.	Flood Plain Management	Russian River HU	29
North Coast Regional Water Quality Control Board. Regional Water Board Staff Work Plan to Control Excess Sediment in Sediment-Impaired Watersheds. November, 2002	Work with the Dept. of Parks and Rec to ensure compliance with the Regional Excess Sediment Prohibition		Russian River HU	29
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Identify and recommend practices that manage flow for economic and ecological benefits and establish a flow regime that is appropriate for listed species and the sustainability of natural habitat in both the mainstem and tributaries.	Water Quantity	Russian River HU	29
Sotoyome RCD, Gold Ridge RCD, Mendocino County RCD, Sonoma County ater Agency, and Prunuske Chatham, Inc.. Stewardship Guide for the Russian River. undated	Conserve water.	Water Quantity	Russian River HU	29
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Improve coordination between agencies and others to address season of diversion, off-stream reservoirs, bypass flows protective of coho salmon and their habitats, and avoidance of adverse impacts caused by water diversion (DFG 2004).	Water Quantity	Russian River HU	29
UC Berkeley & Hopland Research & Extension Center, Environmental Science Policy and Management. Expert Interview. March 23, 2011	Mainstem water management is not too complex. Large reservoir management is much easier than tributary management. However, we need a plan that addresses all diversions, with a focus on subwatersheds.	Water Quantity	Russian River HU	29
Sotoyome Resource Conservation District. Expert Interview. 3/17/2011	Water conservation needs more widespread efforts by all water users and more funding support for ag/rural residential water conservation programs.	Water Quantity	Russian River HU	29
CDFG. Recovery Strategy for California Coho Salmon. 38018	Review, and modify if necessary, water use based on the needs of coho salmon and authorized diverters.	Water Quantity	Russian River HU	28
Laguna de Santa Rosa Foundation. Expert Interview. 4/20/2011	Understanding the water use, demand, and recharge.	Water Quantity	Laguna de Santa Rosa HSA	28
Sotoyome Resource Conservation District. Expert Interview. 3/17/2011	Water conservation programs needs to continue, even if we're not in a drought situation.	Water Quantity	Russian River HU	28
Sotoyome Resource Conservation District. Expert Interview. 3/17/2011	Water conservation includes all users, not just agriculture but to include urban and rural residential too. Most cities have innovative and effective water conservation programs for urban users but there is always room for improvement.	Water Quantity	Russian River HU	28
California Department of Water Resources. California Water Plan 2005 Update. December, 2005	DWR will work with local agencies and private utilities to overcome constraints to implement recycling and desalination projects.	Water Quantity	Russian River HU	27
California Department of Water Resources. California Water Plan 2005 Update. December, 2005	State works with regional water planning efforts to identify physical and operational constraints in statewide water management systems, and to find ways to improve operational efficiencies and supply reliability.	Water Quantity	Russian River HU	27
California Department of Water Resources. California Water Plan 2005 Update. December, 2005	The degree and nature of the need for more groundwater and surface water storage varies from region to region; therefore, DWR will work with regional entities to evaluate the best ways to meet their groundwater and surface storage needs and the possible means of sharing storage capacity among regions.	Water Quantity	Russian River HU	27

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: WATER SUPPLY RELIABILITY				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Analyze impact of river and stream modifications and water withdrawals on subterranean water flows to enhance groundwater and underground systems that maintain functional if not ideal flows for listed species.	Water Quality	Russian River HU	27
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Establish water budgets for the Russian River watershed and its sub-basins.	Water Quantity	Russian River HU	27
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Patterns of water runoff, including surface and subsurface drainage, should match, to the greatest extent possible, the natural hydrologic pattern for the watershed in timing, quantity, and quality.	Water Quantity	Russian River HU	27
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Promote alternative frost protection strategies.	Water Quantity	Russian River HU	27
Occidental Arts and Ecology Center. Expert Interview. 3/18/2011	We need to let uplands infiltrate and recharge the aquifers. Although storage is scarce, it will not be solved by another dam. Solution is to get water management de-centralized. Store it in the winter for use in the summer, thus keeping the diversions out of streams in summer.	Water Quantity	Guerneville HSA	27
Occidental Arts and Ecology Center. Expert Interview. 3/18/2011	We need a water budget in the mainstem and in the subwatersheds.	Water Quantity	Guerneville HSA	27
Sotoyome Resource Conservation District. Expert Interview. 3/17/2011	Groundwater monitoring	Water Quality	Russian River HU	27
CDFG. Recovery Strategy for California Coho Salmon. 38018	Modify flows in Dry Creek to provide summer rearing habitat for coho salmon.	Water Quantity	Warm Springs HSA	26
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Establish a comprehensive stream flow evaluation program to determine instream flow needs for coho salmon.	Water Quantity	Russian River HU	26
UC Berkeley & Hopland Research & Extension Center, Environmental Science Policy and Management. Expert Interview. March 23, 2011	Flow monitoring in tributaries: how, when, where, why. We need the data to assess the status of subwatershed hydrologic regimes.	Water Quantity	Russian River HU	26
Potter Valley Irrigation District and Upper Russian Stewardship Alliance. Expert Interview. 3/15/2011	We need to find out what the impacts of illegal agriculture operations are on the tributaries; quantity and quality.	Water Quantity	Forsythe Creek HSA	26
Hildreth Farms, Inc. Expert Interview. 5/27/2011	Addressing water supply for all users is going to be a big issue in the near future. Much bigger of an issue than it currently is. Before the tunnel in Potter Valley, the river bed was used as a wagon road in some locations because the gravel bars and riffles went dry. The diversion from the Eel created a year around flow in the Russian. This year around flow is artificial, but over time has allowed agriculture and residential growth in Mendocino and Sonoma Counties. It would be hard to go back to pre-diversion conditions now.	Water Quantity	Ukiah HSA	26
Community Foundation Sonoma County and Sonoma County Water Agency. Biodiversity Action Plan: Priority Actions to Preserve Biodiversity in Sonoma County. October 2010	Increase water efficiency and increase the re-use of water at all scales.	Water Quantity	Guerneville HSA	25
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	All local and state planning and development should consider, and provide contingencies for, droughts in a manner compatible with CCC coho salmon recovery needs.	Water Quantity	Russian River HU	25
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Establish an emergency drought operations center (EDOC), (e.g., Washington Department of Fish and Wildlife, 2001), comprised of the SWRCB, DFG, NMFS, and others to develop emergency rules for augmenting water supplies and mitigating the effects of drought on fish.	Water Quantity	Russian River HU	25
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Promote water conservation best practices such as drip irrigation for vineyards.	Water Quantity	Russian River HU	25

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: WATER SUPPLY RELIABILITY				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Promote passive diversion devices designed to allow diversion of water only when minimum streamflow requirements are met or exceeded (DFG 2004).	Water Quantity	Russian River HU	25
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Institutionalize programs to purchase easements on water rights to encourage the maintenance of surface flows.	Water Quantity	Russian River HU	25
Redwood Valley County Water District. Expert Interview. 2/24/2011	Integrating agricultural storage needs with Redwood Valley's ability to supply water to them, especially if SWQCB forces a lot of the ranch ponds to be removed.	Water Quantity	Ukiah HSA	25
Gold Ridge RCD. Expert Interview. 3/18/2011	Rooftop catchment for irrigation needs is a good solution towards addressing supply and some NPS runoff.	Water Quantity	Guerneville HSA	25
CDFG. Recovery Strategy for California Coho Salmon. 38018	Identify water diverters	Water Quantity	Guerneville HSA	24
City of Santa Rosa. Santa Rosa General Plan 2035. November, 2009	Conserve water and maintain water quality.	Water Quantity	Russian River HU	24
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Implement water conservation strategies that provide for drought contingencies without relying on interception of surface flows or groundwater depletion.	Water Quantity	Russian River HU	24
Sotoyome Resource Conservation District. Expert Interview. 3/17/2011	Ground truthing points of direct diversions.	Water Quantity	Russian River HU	24
Mendocino County Water Agency. Expert Interview. 3/15/2011	Improved reservoir operations based on real time data will require updates in hardware (gages) and policy. We need to look at other alternatives to address growth demands for the next 20 years or so. One way is to operate what we have in a more efficient manner. Addresses supply and needs for instream flow. Need to do more with what we have. It is cheaper to maximize existing systems than creating new supply. "Dispatch Model" at the Solano County Irrigation District and Lake Berryessa 1. Call the dispatcher a day in advance to "place an order" for the volume you need. 2. Dispatcher calculates all water orders and determines release rates and durations. 3. Special situations such as drought get more scrutiny for releases. River flow monitoring model would be a simple concept to apply to the Russian. The hardware exists and the concept is in use in several watersheds throughout California. The advances in technology make it an accurate and efficient method to manage water. Instead of spending $200 million on raising Coyote Dam, spend $1 million on hardware and infrastructure to enact the dispatch method.	Water Quantity	Russian River HU	24
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 2002	DFG should encourage the North Coast Regional Water Quality Control Board (NCRWQCB) and the State Water Resources Control Board (SWRCB) to integrate life history requirements for salmonids and other aquatic life into the water rights permitting process. Water right permits should consider natural flow and water quantity/water quality requirements of the listed species.	Water Quantity	Russian River HU	23
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 2002	DFG wardens, should work directly with the SWRCB, NMFS, USFWS, and in investigating complaints of illegal water diversions and water right permit violations	Water Quantity	Russian River HU	23
CDFG. Recovery Strategy for California Coho Salmon. 38018	Identify water diverters.	Water Quantity	Russian River HU	23
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Develop alternative water storage systems to reduce the dependency on diversions.	Water Supply	Guerneville HSA	23

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: WATER SUPPLY RELIABILITY				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Identify and eliminate depletion of summer base flows from unauthorized water uses.	Water Quantity	Russian River HU	23
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Support the development of new regulations to minimize impacts on spring and summer baseflow from frost protection and other water diversions.	Water Quantity	Russian River HU	23
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Work within existing federal, state and local regulations to minimize coho salmon take from water diversion activities.	Water Quantity	Russian River HU	23
NRCS. Expert Interview. 2/22/2011	Increasing quantity of water available for agriculture and domestic needs is important. Raise COY dam and/or increase number of ponds.	Water Quantity	Mainstem Russian River	23
Mendocino County Water Agency. Expert Interview. 3/15/2011	The adaptive management approach to the Dispatch Model would work well. This project is not defined, but could be continually refined to improve operations.	Water Quantity	Russian River HU	23
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	To improve connectivity of surface flows with groundwater reduce aggradation and overall sediment load at the watershed scale by treating roads and sources of mass wasting.	Flood Plain Management	Russian River HU	22
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Promote off-channel storage to reduce impacts of water diversion (e.g., storage tanks for rural residential users).	Water Quantity	Russian River HU	22
Occidental Arts and Ecology Center. Expert Interview. 3/18/2011	Groundwater and surface water models need to be used to improve evolution of land use management.	Resource Management	Guerneville HSA	22
NRCS. Expert Interview. 2/22/2011	Water recycling in the upper Russian River.	Water Quantity	Mainstem Russian River	22
Potter Valley Irrigation District and Upper Russian Stewardship Alliance. Expert Interview. 3/15/2011	Use of water conservation strategies and activities needs to increase, which includes urban as well as agricultural operations.	Water Quantity	Forsythe Creek HSA	22
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Develop an Upper Green Valley Watershed water conservation program and task force.	Water Supply	Guerneville HSA	21
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Pursue opportunities to acquire or lease water, or acquire water rights from willing sellers, for coho salmon recovery purposes. Develop incentives for water right holders to dedicate instream flows for the protection of coho salmon (DFG 2004)(Water Code § 1707).	Water Quantity	Russian River HU	21
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Work with the SWRCB to place a moratorium on summer water diversions in all priority CCC coho salmon watersheds. Focus first on Core Areas, then on Phase I and Phase II areas. Russian River - core areas - Sheephouse Creek area of the Willow Creek planning watershed; Freezeout Creek area of the Freezeout Creek Planning watershed; Dutch Bill, Felta, Wallace, Palmer, and Upper East Gray Creek planning watersheds; Purrington Creek area of the Purrington Creek planning watershed.	Water Quantity	Guerneville HSA	21
NRCS. Expert Interview. 2/22/2011	Accurate streamflow monitoring, especially in the tributaries needs to occur. Right now a lot is based upon assumptions, which could be damaging to the mainstem and tributaries.	Water Quantity	Mainstem Russian River	21
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Support SWRCB in regulating the use of streamside wells and groundwater.	Water Quantity	Russian River HU	20
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Minimize water use and seek alternatives during droughts.	Water Quantity	Russian River HU	20

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: WATER SUPPLY RELIABILITY				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Identify and work with water users to minimize depletion of summer base flows from unauthorized water uses.	Water Quantity	Russian River HU	20
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Provide incentives to improve instream flows for coho salmon.	Water Quantity	Russian River HU	20
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Encourage the SWRCB to adjudicate watersheds with CCC coho salmon populations to resolve over-allocation of water resources and provide adequate funding to water masters to enforce allocations.	Water Quantity	Russian River HU	20
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Evaluate requests for on-stream dams above coho migratory reaches for effects on the natural hydrograph and the supply of spawning gravel for recruitment downstream (DFG 2004).	Water Quantity	Russian River HU	20
Potter Valley Irrigation District and Upper Russian Stewardship Alliance. Expert Interview. 3/15/2011	Educating the public about how water is used by agriculture and urban areas needs to be increased. The public needs to understand the value of water to the community and the environmental complexities that water supports. How water is used and where it comes from is poorly understood by the majority of the people.	Water Quantity	Forsythe Creek HSA	20
California Department of Water Resources. California Water Plan 2005 Update. December, 2005	DWR will work with State agencies to help in the collection of data and analysis of instream flows.	Science	Russian River HU	19
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 2002	Follow and give support to the U.S. Geological Survey (USGS) and Sonoma County Water Agency (SCWA) "Joint Groundwater Study".	Water Quantity	Russian River HU	19
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Evaluate reports and studies regarding dam operations and maintenance projects to determine the watershed-wide impacts of agency activities and potential alternatives (e.g., low and pulse flow mechanisms, new pipelines, inflatable dams and infiltration ponds).	Water Quantity	Russian River HU	19
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Promote the use of reclaimed water for agricultural or other uses.	Water Quantity	Russian River HU	19
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. March, 2007	Investigate upland groundwater recharge and infiltration opportunities to reduce excessive run-off, improve soil infiltration and increase water-holding capacity in the watershed.	Resource Management	Russian River HU	18
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Winter water storage is likely the most significant improvement that can be made to provide for agricultural and residential water needs while providing sufficient resources for aquatic biota.	Water Supply	Guerneville HSA	18
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Work with land owners or public agencies to acquire water that would be utilized to minimize effects of droughts.	Water Quantity	Russian River HU	18
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Provide incentives to water rights holders willing to convert some or all of their water right to instream use via petition change of use and §1707 (DFG 2004).	Water Quantity	Russian River HU	18
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Petition SWRCB to declare the Russian River watershed fully appropriated.	Water Quantity	Russian River HU	18
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Upgrade the existing water rights information system so that water allocations can be readily quantified by watershed.	Water Quantity	Russian River HU	18

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: WATER SUPPLY RELIABILITY				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Support the Development and implementation of groundwater use regulations.	Water Quantity	Russian River HU	18
Redwood Valley County Water District. Expert Interview. 2/24/2011	Improve operations of Lake Mendocino as a water storage facility is the core issue for the Russian River.	Water Quantity	Ukiah HSA	18
Redwood Valley County Water District. Expert Interview. 2/24/2011	Raising funds to improve the water treatment and distribution system.	Water Quantity	Ukiah HSA	18
Occidental Arts and Ecology Center. Expert Interview. 3/18/2011	Groundwater monitoring needs to expand. The model on the Laguna de Santa Rosa links surface to groundwater. This type of understanding should be spread throughout the basin.	Water Quantity	Guerneville HSA	18
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. March, 2007	Review wastewater uses, policies and best practices that enable the delivery of more usable wastewater for commercial and agricultural uses and habitat restoration.	Water Quantity	Russian River HU	17
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. March, 2007	Support and promote consumer and business incentives that promote water conservation.	Water Quantity	Russian River HU	17
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Develop appropriate indicators that are specific to environmental concerns in the Laguna watershed, using research, field surveys, monitoring and mapping information.		Laguna de Santa Rosa HSA	16
Community Foundation Sonoma County and Sonoma County Water Agency. Biodiversity Action Plan: Priority Actions to Preserve Biodiversity in Sonoma County. October 2010	Require water supply and treatment projects to provide multiple benefits.	Water Quantity	Guerneville HSA	16
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Request that SWRCB review and/or modify water use based on the needs of coho salmon and authorized diverters (DFG 2004).	Water Quantity	Russian River HU	16
Mendocino RCD. Mendocino County RCD Interviewees Jan Olave, Shelley Janek, Joe Scriven. February 27,2012	B. The Agricultural Water Enhancement Program is a great start in getting large scale water users to minimize mainstem diversions. The next step down in size would be to develop a financial incentive program to install water tanks (5-50,000 gal) for produce and marijuana farmers so their impact on tributaries in summer is nullified.	Water Quantity	Forsythe Creek HSA	16
Potter Valley Irrigation District and Upper Russian Stewardship Alliance. Expert Interview. 3/15/2011	Increasing storage at Lake Mendocino.	Water Quantity	Forsythe Creek HSA	16
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 2002	Public assistance is encouraged in reporting of suspected violations and continued vigilance by CDFG and NCRWQCB is necessary.	Water Quantity	Russian River HU	15
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Require the SWRCB to conduct interagency consultation with the California Department of Fish and Game, and seek technical assistance from NMFS on the issuance of water rights permits.	Water Quantity	Russian River HU	15
NRCS. Expert Interview. 2/22/2011	The SWQCB needs to upgrade its pond permitting process. Ponds that store recycled water don't require state permits, only county permits. All other ponds need to be permitted, but get blocked. The process needs to improve so landowners can follow the guidelines put before them to fulfill ESA requirements.	Water Quantity	Mainstem Russian River	15
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 2002	Fund GIS mapping of surface water diversions and ground water usage on coho tribs. Fund GIS mapping of hotspot, low flow conditions/water quantity conditions on coho tribs.	Water Quantity	Mainstem Russian River	14
Sonoma County Water Agency. Russian River Action Plan. March, 2003	Coyote Valley Dam Reconnaissance Study	Water Quantity	Coyote Valley HSA	14
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Establish a comprehensive stream flow evaluation program to determine instream flow needs for coho salmon.	Water Quantity	Russian River HU	14

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: WATER SUPPLY RELIABILITY				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Identify and evaluate potential recharge and retention sites for opportunities to store excess flows.	Water Quantity	Russian River HU	13
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	DFG, SWRCB, RWQCB, CalFire, Caltrans, and other agencies and landowners, in cooperation with NMFS, should evaluate the rate and volume of water drafting for dust control in streams or tributaries and where appropriate, minimize water withdrawals that could impact coho salmon. These agencies should consider existing regulations or other mechanisms when evaluating alternatives to water as a dust palliative (including EPA-certified compounds) that are consistent with maintaining or improving water quality (DFG 2004).	Water Quantity	Russian River HU	13
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Determine and monitor 1600 program compliance related to water diversions (DFG 2004).	Water Quantity	Russian River HU	13
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Bankfull flow: identify bankfull conditions in the field and estimate the associated discharge based on flow calculations. Once every ten years or after 1:100 year flood events	Science	Laguna de Santa Rosa HSA	11
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Support the development and implementation of regulations for activities that intercept groundwater recharge (e.g., use of subsurface tiles in vineyards, impervious surfaces, etc.).	Water Quantity	Russian River HU	11
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Work with counties to develop and implement ordinances (e.g. Santa Cruz County Code 2008) to restrict subdivisions by requiring a minimum acreage limit for parcelization in concert with limits on water supply and groundwater recharge areas.	Water Quantity	Russian River HU	10
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Require streamflow gauging devices to determine the current streamflow condition.	Water Quantity	Russian River HU	9
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Assess and map water diversions (DFG 2004).	Water Quantity	Russian River HU	9
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Installation of an acoustic Doppler sensor at the River Road Bridge to record flow direction and velocity so that inflows from the Russian River can be quantified.	Science	Laguna de Santa Rosa HSA	8
Potter Valley Irrigation District and Upper Russian Stewardship Alliance. Expert Interview. 3/15/2011	Continuing protection of the Potter Valley Project (PVP) operations though legal and environmental defense actions. We need to protect that water source.	Water Quantity	Forsythe Creek HSA	8
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Atmospheric deposition; USGS method described in Water Resources Investigations Report 03-4241. During the wet season.	Science	Laguna de Santa Rosa HSA	7
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Groundwater Study	Water Supply	Guerneville HSA	7
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Monitor effectiveness of water supply enhancement projects.	Water Supply	Guerneville HSA	5
Sotoyome Resource Conservation District. Expert Interview. 3/17/2011	Water conservation needs to be standardized in both counties. The Russian River Watershed Association (RRWA) may be the appropriate entity to coordinate conservation programs in Mendocino County.	Water Quantity	Russian River HU	4

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: FLOOD RISK MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
California Floodplain Management Task Force. California Floodplain Management Report. December, 2002	While providing for public safety and flood damage reduction, flood management programs and projects should maximize opportunities for agricultural conservation and ecosystem protection and restoration, where feasible. When land is being considered for use in a flood management project or program, the following should be addressed equitably: Conserve productive agricultural land and natural habitat; Promote the recovery and stability of agriculture; Promote the recovery and stability of native species populations, and overall biotic community diversity; Provide for natural, dynamic hydrologic, and geomorphic processes; Increase and improve the quantity, diversity, and connectivity of native habitat; Eliminate or mitigate negative redirected impacts to neighboring landowners; and Evaluate and address economic impacts to local communities and regions.	Flood Plain Management	Russian River HU	48
California Department of Water Resources. California Water Plan 2009 Update Pre-Administrative Draft Volume I The Strategic Plan. October, 2008	State agencies should ensure Environmental Justice in all communities and equal access to State funding for water and flood projects.	Socioeconomic	Russian River HU	45
California Department of Water Resources. California Water Plan 2009 Update Pre-Administrative Draft Volume I The Strategic Plan. October, 2008	State government should provide effective leadership, assistance, and oversight for California's water and flood planning and management activities.	Socioeconomic	Russian River HU	42
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 2002	In the remaining "natural" waterways/channels where the county has jurisdiction, flood control practices should be kept to a minimum, and only utilized when necessary as documented with monitored cross sections which show an unacceptable rise in the elevation in the 100 year flood height or as shown to significantly reduce flood capacity. In these channels, additional alternatives should be developed, such as: offset levees to increase floodplain and reduce floodcontrol maintenance, adding floodplain level culverts to increase floodplain draining at culvert crossings, active tree planting and irrigation to increase shading which will reduce growth of brushy and exotic species to increase capacity and add stability, and purchase of riparian easements to allow floodplain flooding and stream meandering. The county should contract with a hydrological consultant to develop and prioritize these alternatives in the channels they maintain. Bank stabilization projects at erosion sites should only utilize bio-engineering practices except where structures are threatened. The county should contract with a reputable bioengineering consultant (there are several locally) to provide training for SCWA labor forces and public works Dept. These recommendations are intended to improve sediment transport, encourage development of complex habitat, and reduce maintenance costs in the long term.	Floodplain Management	Russian River HU	42
California Floodplain Management Task Force. California Floodplain Management Report. December, 2002	State and local agencies should approach flood management as part of multi-objective watershed management. Where feasible, these projects should provide adequate protection for natural, recreational, residential, business, economic, agricultural, and cultural resources and protect water quality and supply.	Flood Plain Management	Russian River HU	36
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Encroaching development reduces the area of open land on the floodplain, and interferes with natural hydrological processes. Support the public purchase of lands or conservation easements in the floodplain to retain open space for seasonal flood storage areas, while still allowing compatible uses such as agriculture, parks and wildlife habitat. Use floodplain models to evaluate where setting back levees or other actions can reclaim historical floodplain areas.	Flood Plain Management	Laguna de Santa Rosa HSA	36

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: FLOOD RISK MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
California Floodplain Management Task Force. California Floodplain Management Report. December, 2002	In planning new or upgraded floodwater management programs and projects, including structural projects, local and State agencies should, where appropriate, encourage nonstructural approaches and the conservation of the beneficial uses and functions of floodplains. It is recognized that some structural approaches provide needed flood protection and opportunities for agricultural conservation and ecosystem protection and restoration.	Flood Plain Management	Russian River HU	35
California Department of Water Resources. California Water Plan 2009 Update Pre-Administrative Draft Volume I The Strategic Plan. October, 2008	California should maintain, rehabilitate, and improve its aging water and flood infrastructure.	Socioeconomic	Russian River HU	32
California Floodplain Management Task Force. California Floodplain Management Report. December, 2002	State and local agencies should manage floodplains proactively and adaptively by periodically adjusting to current environmental, economic, hydraulic, and biological conditions and in response to new scientific information and knowledge. If new or additional flood management projects alter the size of a floodplain, cities and counties should evaluate all of their objectives for the area removed from or added to that floodplain.	Flood Plain Management	Russian River HU	31
NRCS - Sonoma and Marin Counties. Interviewee Charlette Epifanio. 3/16/2011	We need to focus more energy on stormwater management to address flood damage as well as improving summer supply. Reducing excess stormwater runoff through capture, infiltration, and management will reduce sediment deposition to the stream channels.	Flood Plain Management	Mainstem Russian River	31
California Floodplain Management Task Force. California Floodplain Management Report. December, 2002	As with other types of floodplains, local agencies should assess the risks of the reasonably foreseeable flood instead of relying solely on the 100-year flood.	Flood Plain Management	Russian River HU	30
California Floodplain Management Task Force. California Floodplain Management Report. December, 2002	State and local governments should increase and leverage federal programs, as appropriate, and encourage local, State, federal, public, nongovernmental, and other private cost sharing to achieve equitable and fair financing of multi-objective floodplain management actions and planning.	Flood Plain Management	Russian River HU	30
Sonoma County Water Agency. Russian River Action Plan. March, 2003	Laguna De Santa Rosa Feasibility Study	Flood Plain Management	Laguna de Santa Rosa HSA	29
California Floodplain Management Task Force. California Floodplain Management Report. December, 2002	Flood-prone communities should (1) develop and publish potential evacuation routes for the whole community, specifically including those areas developed with flood protection levees, (2) provide real-time multi-lingual information on flood risk to its population to minimize loss of life and property, (3) conduct periodic flood simulation exercises, and (4) include community input and involvement.	Flood Plain Management	Russian River HU	28
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 2002	The "constructed flood control channels" should be managed or restored to improve hydrologic function where possible. This could include: removal of onstream levees and construction of offset levees to increase floodplain and reduce floodcontrol maintenance, moving or raising structures in frequently flooded areas, adding floodplain level culverts to increase floodplain draining at culvert crossings, and purchase of riparian easements to allow floodplain flooding and stream meandering. Local bond measures could be developed to cost-share these activities with county and other funds.	Floodplain Management	Russian River HU	28
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Under natural conditions, many developed areas on the Santa Rosa Plain would flood, especially if the riparian corridor were allowed to grow unrestrained. As riparian corridors are essential for ecosystem health, they must be regularly maintained to allow continued flood capacity in developed areas—through vegetation management, invasive species control, and sediment or debris removal if necessary. Develop site-specific management plans for all the Laguna tributaries and flood control channels, including maintenance policies, schedules and practices.	Flood Plain Management	Laguna de Santa Rosa HSA	28

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: FLOOD RISK MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Set-back existing levees in strategic areas to increase flood-flow detention and promote flood-tolerant land uses.	Flood Plain Management	Russian River HU	28
California Floodplain Management Task Force. California Floodplain Management Report. December, 2002	Planning and development of ecosystem restoration projects should consider costs and impacts with respect to vector control and monitoring related to mosquito-transmitted diseases.	Flood Plain Management	Russian River HU	27
California Department of Water Resources. California Water Plan 2009 Update Pre-Administrative Draft Volume I The Strategic Plan. October, 2008	California should provide sustainable funding for statewide and regional water and flood management recognizing the critical role of public-private partnerships, the principle of beneficiary pays, incentive-based water pricing and user fees, and investment decisions based on sustainability.	Socioeconomic	Russian River HU	26
California Floodplain Management Task Force. California Floodplain Management Report. December, 2002	Entities involved in land-use planning for alluvial fans, distinct from FEMA mapping, should address the following: Alluvial fan flood flows are generally unpredictable, and a site analysis should be performed to determine all reasonably foreseeable flood apex flow paths. Flood flow depths and velocities should be determined for these flow paths. Any debris and scour associated with reasonably foreseeable apex flood flow should be determined. Land-use agencies should be encouraged to ensure that new development will not be damaged by the special risks associated with alluvial floods. These risks include velocities, debris, and scour associated with reasonably foreseeable floods.	Flood Plain Management	Russian River HU	26
California Floodplain Management Task Force. California Floodplain Management Report. December, 2002	In making land-use decisions, local governments should have knowledge of the characteristics of alluvial fan floodplains.	Flood Plain Management	Russian River HU	26
Sonoma County Water Agency. Russian River Action Plan. May, 2003	Santa Rosa Creek Watershed Feasibility Study	Flood Plain Management	Santa Rosa Creek HSA	26
California Floodplain Management Task Force. California Floodplain Management Report. December, 2002	Priority for alluvial floodplain mapping should be given to those alluvial fan floodplains being considered for development	Flood Plain Management	Russian River HU	24
Sotoyome Resource Conservation District. Copeland Creek Watershed Assessment. June, 2002	Flood control channel management	Flood Plain Management	Laguna de Santa Rosa HSA	24
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	All new crossings and upgrades to existing crossings (bridges, culverts, fills, and other crossings) must accommodate 100-year flood flows and associated bedload and debris.	Flood Plain Management	Russian River HU	24
California Floodplain Management Task Force. California Floodplain Management Report. December, 2002	Local, State, and federal agencies should create, develop, produce, and disseminate compatible GIS-based flood maps.	Flood Plain Management	Russian River HU	23
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	The final mile of each of these two creeks, prior to joining the Laguna, is at the frontier of the Cotati urban boundary. The area is very low-lying and will become the recipient of increased floodwaters as construction and development picks up pace to the south. Existing county zoning should be safeguarded in this area.	Socioeconomic	Laguna de Santa Rosa HSA	23
California Floodplain Management Task Force. California Floodplain Management Report. December, 2002	Decision makers should use FIRMs conservatively, as a decision tool starting point, if they provide the best information available. However, decision makers should gather information and data beyond FIRMs, including historical flood damage records, to better predict and plan for reasonably foreseeable floods.	Flood Plain Management	Russian River HU	22
California Floodplain Management Task Force. California Floodplain Management Report. December, 2002	Local and State agencies preparing floodplain maps should incorporate consideration of current and future planned development, pursuant to the local General Plan. If new or additional floodwater management measures are implemented in the future, their impacts also should be reflected in updated floodplain maps.	Flood Plain Management	Russian River HU	22

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: FLOOD RISK MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
California Floodplain Management Task Force. California Floodplain Management Report. December, 2002	Local agencies should request that FIRM maps from FEMA include build-out as well as current development. If new or additional floodwater management measures are implemented in the future, their impacts should be reflected in updated floodplain maps. If new or additional floodwater management projects alter the size of a floodplain, cities and counties should evaluate their objectives for areas removed from or added to that floodplain.	Flood Plain Management	Russian River HU	21
California Department of Water Resources. California Water Plan 2009 Update Pre-Administrative Draft Volume I The Strategic Plan. October, 2008	California should clarify the roles, authorities, rights and responsibilities of federal, Tribal, State, regional, and local governments and agencies responsible for water and flood management.	Socioeconomic	Russian River HU	20
California Floodplain Management Task Force. California Floodplain Management Report. December, 2002	Residents in alluvial fan floodplains should be informed of any increased risks that might result from changed conditions, including fire, seismic activity, or other physical changes, that could affect the risk of alluvial fan flooding.	Flood Plain Management	Russian River HU	20
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Very little is known about how salmonids and other fish species use inundated floodplains and small drainages. Flooded areas are likely an important source of nutrients, especially during warmer, late-season events when animals have increased metabolic rates. However, when waters recede, floodplains may be a source of fish mortality, and a rich hunting ground for fishing animals and birds. We need studies evaluating the role of floodplains in the ecosystem, and comparing the role of grassland floodplains to flooded riparian forests.	Flood Plain Management	Laguna de Santa Rosa HSA	19
California Floodplain Management Task Force. California Floodplain Management Report. December, 2002	Structural and/or non-structural measures should be explored to provide sufficient flow-through areas on alluvial fans.	Flood Plain Management	Russian River HU	18
California Floodplain Management Task Force. California Floodplain Management Report. December, 2002	Wherever practical and appropriate, floodplain maps should be prepared on a watershed basis.	Flood Plain Management	Russian River HU	17
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Implement managed retreat of current development and infrastructure from stream channels and floodplains.	Flood Plain Management	Russian River HU	17
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Conduct restoration activities that restore channels, floodplains and meadows to extend the duration of the summer flow and provide refuge from high winter flows.	Flood Plain Management	Russian River HU	17
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Reduce risk of flooding in developed areas of the Santa Rosa Plain, as well as for Russian River communities, by retaining as much water as possible inthe upper watershed, reducing the height of peak discharges and flashiness of flows.	Flood Plain Management	Laguna de Santa Rosa HSA	16
Community Foundation Sonoma County and Sonoma County Water Agency. Biodiversity Action Plan: Priority Actions to Preserve Biodiversity in Sonoma County. October 2010	Integrate groundwater management (drought preparedness) with stormwater management (flood preparedness).	Flood Plain Management	Guerneville HSA	16
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Where new levees or similar flood control projects are planned develop setbacks to allow the river to respond to natural hydrologic process and remain in equilibrium. At a minimum, setbacks should accommodate a 100 year event.	Flood Plain Management	Russian River HU	16
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Counties and municipalities should adopt a policy of "managed retreat" (removal of problematic infrastructure and replacement with native vegetation or flood tolerant land uses) for areas highly susceptible to, or previously damaged from, flooding.	Flood Plain Management	Russian River HU	16
California Floodplain Management Task Force. California Floodplain Management Report. December, 2002	Local agencies should work with the OES and/or DWR to identify whether they have any residential properties or businesses that flood repeatedly. If so, they should work with OES and/or DWR and other agencies to make voluntary programs available for residences, businesses, and public infrastructure and to encourage owners to take advantage of these programs to reduce repetitive losses.	Flood Plain Management	Russian River HU	15

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: FLOOD RISK MANAGEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	The floodplain of both Turner and Blucher Creeks, just above where they join the Laguna, represents an important riparian floodplain of exceptionally high value. Further acquisitions into the public realm, from willing sellers, should be sought in order to protect both the high quality habitat and the beneficial flood dampening effect of this area.	Socioeconomic	Laguna de Santa Rosa HSA	15
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Flood control projects or other channel modifications facilitating new development (as opposed to protecting existing infrastructure) should be avoided.	Flood Plain Management	Russian River HU	15
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Develop Bank Stabilization and Floodplain Guidelines for use by private and public entities.	Flood Plain Management	Russian River HU	14
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Modify Federal, State, local processes, and County General Plans, to eliminate provisions allowing new construction in undeveloped areas within the 100-year flood prone zones in all historic CCC coho salmon watersheds.	Flood Plain Management	Russian River HU	14
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Land use zoning should be appropriate to the site and consider the floodplain and riparian functions of stream channels.	Flood Plain Management	Russian River HU	13
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Provide assistance/coordination to Sonoma County Water Agency for the development of an early warning system for the mainstem Russian River.	Socioeconomic	Russian River HU	10

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: WATER QUALITY PROTECTION AND IMPROVEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Community Foundation Sonoma County and Sonoma County Water Agency. Biodiversity Action Plan: Priority Actions to Preserve Biodiversity in Sonoma County. October 2010	Protect streams, wetlands, and riparian areas in order to safeguard future water quality and quantity (simultaneously protecting habitat connectivity, enhancing areas with disproportionately high concentrations of sensitive species, and moderating local temperatures).	Water Quality	Guerneville HSA	53
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Collaborate with property owners, agencies and educational institutions to establish appropriate watershed-wide control of unnatural erosion through run-off protocols, better management practices and activities that promote water resource sustainability (e.g., groundwater recharge).	Water Quality	Russian River HU	51
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Identify, map and support efforts at the sub-basin level to reduce impacts including, but not limited to, sedimentation, run-off, dissolved oxygen, and high water temperature.	Water Quality	Russian River HU	46
California Department of Water Resources. California Water Plan 2005 Update. December, 2005	DWR will help resolve long-standing water quality issues in the state, such as Delta salinity, dissolved oxygen in San Joaquin River (SJR) near Stockton, salinity at Vernalis, and ecosystem restoration flow needs, extending from the Klamath River in the north to Salton Sea in the south.	Water Quality	Russian River HU	45
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Remedy priority water diversion problems for current or potential coho streams that go dry in some years.	Water Quality	Guerneville HSA	45
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Implement appropriate recommendations to offset impacts from county policies and operations, as developed by the Five County effort.	Water Quality	Russian River HU	44
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Initiate a Laguna TMDL process as a comprehensive and inclusive basin-scale study of factors influencing water quality in the Laguna, involving diverse stakeholders in both identifying problems and developing solutions to water quality impairments. Process should include a stratified and standardized water quality monitoring program, a study of beneficial uses, land-use factors, and the development of policies and management practices to expedite improvements, increase public awareness, responsibility and participation.	Water Quality	Laguna de Santa Rosa HSA	43
Mendocino County Water Agency. Interviewee Dennis Slota. 3/9/2011	Implementing sediment reduction projects is the 2nd highest priority.	Gravel Quality	Ukiah HSA	42
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Assist organizations and agencies in obtaining grant funding for water quality improvement activities and implementation projects in the watershed.	Water Quality	Mainstem Russian River	39
Russian River Keeper. Interviewee Don McEnhill. 3/28/2011	Municipal awareness has improved, but can improve significantly more throughout the basin with more public education as we are all part of the problem and need to be part of the solution, cities can't do it alone without huge costs. We need to improve our focus on urban storm water runoff so we don't ruin our future like other Central Valley watersheds.	Water Quality	Russian River HU	39
Russian River Keeper. Interviewee Don McEnhill. 3/28/2011	Stormwater quality data from urban areas	Water Quality	Russian River HU	39
Sotoyome Resource Conservation District. Copeland Creek Watershed Assessment. June, 2002	Reduction in sources of fine sediment in the watershed	Water Quality	Laguna de Santa Rosa HSA	38
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Implement Sotoyome RCD's Fish Friendly Farming Program	Water Quality	Warm Springs HSA	37
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Stormwater can be a valuable resource if it can recharge groundwater aquifers rather than run off during storm events. Encourage distributed retention and infiltration of stormwater, especially in groundwater recharge areas, through engineered retention basins and the use of permeable surfaces, such as those described in the Standard Urban Stormwater Mitigation Plan; and educate the public about ways that they can reduce stormwater and sediment discharge on private properties. Where catchment areas are specifically designed to trap sediment, annual maintenance for sediment removal must be built into the design and permitting. Develop programs and partnerships to provide technical assistance and incentives to individual landowners for design, permitting and implementation of small-scale projects.	Water Quality	Laguna de Santa Rosa HSA	37

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: WATER QUALITY PROTECTION AND IMPROVEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Sonoma Land Trust, Laguna de Santa Rosa Foundation. Laguna de Santa Rosa: Resource Atlas and Protection Plan. October, 2004	Work with private landowners to institute best management practices to reduce erosion and sedimentation of waterways to preserve flood control capability of the Laguna.	Water Quality	Laguna de Santa Rosa HSA	37
Sotoyome Resource Conservation District. Copeland Creek Watershed Assessment. June, 2002	Reduction of urban runoff pollutants	Water Quality	Laguna de Santa Rosa HSA	37
City Council of Healdsburg. Healdsburg 2030 General Plan Policy Document. 2009, amended 2011	Improve water quality and flows in the Russian River, Dry Creek and Foss Creek to protect the city's water supply, recreation, fish and wildlife.	Water Quality	Guerneville HSA	37
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Improve habitat conditions at multiple life stages by reducing sediment inputs to the stream at the watershed scale.	Gravel Quality	Russian River HU	37
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Continue outreach and interagency coordination and cooperation to the grape growing industry to reduce impacts of vineyards on water resources, especially the anadromous fishery.	Water Quality	Russian River HU	36
Agriculture Department, County of Mendocino. Interviewee Tony Linegar. 2/24/2011	NRCS and DFG programs to address un-paved roads to decrease sediment input to the river needs to expand. So many dirt roads in the Russian system continue to dump unnecessary volumes of soil into the channels.	Water Quality	Russian River HU	36
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Develop and implement restoration and public works projects that enhance water quality through riparian and grassland restoration, urban and agricultural reuse of wastewater, constructed and restored wetlands, reduced run-off, and increased infiltration. Reduce dry-weather urban run-off by encouraging water conservation and sprinkler maintenance.	Water Quality	Laguna de Santa Rosa HSA	35
Sonoma County Agricultural Preservation and Open Space District. Connecting Communities and the Land: A Long-Range Acquisition Plan. March, 2003	Develop an informational landowner handbook that includes recommendations and standards for best management practices developed by local organizations and experts.	Water Quality	Russian River HU	35
Coyote Valley Tribal EPA Department. Interviewees Richard Campbell and Dan Rodriquez. 2/24/2011	Monitoring water quality and quantity in Forsythe Creek and the West Fork Russian River needs to continue and should be expanded.	Water Quality	Forsythe Creek HSA	35
Russian River Keeper. Interviewee Don McEnhill. 3/28/2011	We need to improve the designs and functions of the un-paved roads in both counties.	Water Quality	Russian River HU	35
Russian River Keeper. Interviewee Don McEnhill. 3/28/2011	Assess sediment loads and sources	Water Quality	Russian River HU	35
North Coast Regional Water Quality Control Board. Regional Water Board Staff Work Plan to Control Excess Sediment in Sediment-Impaired Watersheds. November, 2002	Continue to regulate instream gravel mining operations	Water Quality	Russian River HU	33
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Minimize sediment input from existing road networks into the aquatic environment.	Gravel Quality	Russian River HU	33
Gold Ridge RCD. Interviewee Lisa Hulette. 3/18/2011	Need a dairy program to minimize or reduce runoff. Pasture management and water supply programs need to be set up.	Water Quality	Laguna de Santa Rosa HSA	33
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Implement the Sotoyome Recource Conservation District's Fish Friendly Farming Program within Sonoma and Mendocino Counties.	Water Quality	Russian River HU	32
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Develop and support environmental education programs that inform the public how individual actions and daily choices affect water-quality in the Laguna. Increase public awareness of the value of healthy creeks and wetlands; promote a sense of individual responsibility toward water quality and water conservation in the citizens of the Laguna watershed; and develop incentives and mechanisms that increase participation in pollution reduction programs.	Water Quality	Laguna de Santa Rosa HSA	32

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: WATER QUALITY PROTECTION AND IMPROVEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
North Coast Regional Water Quality Control Board. Regional Water Board Staff Work Plan to Control Excess Sediment in Sediment-Impaired Watersheds. November, 2002	Work with road associations. Meet with road associations to determine what sediment control work has already been done and what more needs to be accomplished. Give workshops and presentations to road associations as part of the outreach effort (Regional Task 5). If reconnaissance efforts determine that roads with road associations are discharging significant amounts of excess sediment, work with the road association to encourage self-determined sediment control prior to using progressive enforcement.	Water Quality	Russian River HU	32
Sotoyome Resource Conservation District. Austin Creek Watershed Assessment. October, 2004	Reduction of fine sediment loads	Water Quality	Austin Creek HSA	32
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Implement actions that reduce sediment and runoff impacts from road networks to stream channel.	Gravel Quality	Russian River HU	32
UC Cooperative Extension. Interviewee Glenn McGourty. 3/8/2011	Addressing rural roads and culverts in the basin is the most cost effective way to improve water quality. Using forestry road standards to upgrade rural dirt roads is a good start. The UC Coop Extension has held road workshops in the past. The Handbook for Rural and Ranch Roads is a good reference for road construction and management.	Water Quality	Mainstem Russian River	32
Sotoyome Resource Conservation District. Interviewee Kara Heckert. 3/17/2011	Rural road sediment source assessments - RRIP	Water Quality	Russian River HU	32
Mendocino County Russian River Flood Control & WCID. Interviewee Sean White. 3/9/2011	Address roads and road crossings.	Water Quality	Russian River HU	32
California Department of Water Resources. California Water Plan 2005 Update. December, 2005	DWR will work with the Department of Health Services, State Water Resources Control Board, Regional Water Quality Control Boards, and other State, federal, and local agencies to develop a coordinated process to monitor, evaluate, prevent, mitigate, and treat the effects of contaminants on surface water and groundwater quality. DWR could participate by sharing data, coordinating data collection efforts, identifying problem watersheds and aquifers, and conducting analysis of surface water and groundwater flow and transport of contaminants.	Water Quality	Russian River HU	31
North Coast Regional Water Quality Control Board. Regional Water Board Staff Work Plan to Control Excess Sediment in Sediment-Impaired Watersheds. November, 2002	Implement General Waste Discharge Requirements (WDRs) and a General Waiver for Dairies. Approximately 100 dairies are located in the Santa Rosa Plain, which drains to the Laguna de Santa Rosa. Following their development and adoption, implment the general WDRs and the general conditional waiver for dairies for excess sediment and other water quality concerns.	Water Quality	Russian River HU	31
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Reduce fine sediment input to the stream	Water Quality	Geyserville HSA	31
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Created wetlands are increasingly recognized as a valuable BMP for improving water quality. Although Kelly Marsh is very effective at polishing treated wastewater, there are a number of environmental concerns with creating wastewater treatment wetlands in upland areas. Instead, wetland restoration and creation efforts should be targeted at lower elevation areas in the floodplain for habitat, stormwater treatment and flood storage.	Water Quality	Laguna de Santa Rosa HSA	30
North Coast Regional Water Quality Control Board. Regional Water Board Staff Work Plan to Control Excess Sediment in Sediment-Impaired Watersheds. November, 2002	Implement WDRs or a conditional waiver for BLM for non-timber harvest activities. Following their development and adoption (as described in Regional Task 18), implement the WDRs or the conditional waiver for BLM to control excess sediment on BLM land in the Russian River watershed.	Water Quality	Russian River HU	30

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: WATER QUALITY PROTECTION AND IMPROVEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
North Coast Regional Water Quality Control Board. Regional Water Board Staff Work Plan to Control Excess Sediment in Sediment-Impaired Watersheds. November, 2002	Use progressive enforcement or develop WDRs or conditional waivers. For excess sediment sites identified through reconnaissance, complaints, or from other information, do one or more of the following: • Deploy the storm and sediment response team to investigate and take appropriate corrective actions. • Use progressive enforcement for violations of the Measures to Control Excess Sediment Prohibition (Regional Task 6). • Use progressive enforcement for violations of the Stream and Wetlands System Protection Policy (Regional Task 6). • Require ROWDs and develop individual WDRs or conditional waivers (Regional Task 11).	Water Quality	Russian River HU	30
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Identify and reduce fine sediment input to the stream	Water Quality	Geyserville HSA	30
NRCS - Sonoma and Marin Counties. Interviewee Charlette Epifanio. 3/16/2011	Stormwater recharge basins for aquifer improvement.	Water Quality	Mainstem Russian River	30
Russian River Keeper. Interviewee Don McEnhill. 3/28/2011	Storm water runoff is the biggest source of water pollution. This effects the aquatic ecosystem in the entire watershed. Solutions of LID strategies need widespread application. We need to get away from old design strategies in new developments. The example of herbicide applicator spraying in the city gutter with a wet street and rain in the forecast shows that education efforts need to improve, and that enforcement at some level needs to accompany education efforts to provide a deterrent effect and improve water quality.	Water Quality	Russian River HU	30
UC Cooperative Extension. Interviewee Glenn McGourty. 3/8/2011	Improved water monitoring needs to occur, with more gaging stations on the river and metered diversion pumps where appropriate. More information about rural, urban, and agriculture water users needs to be gathered.	Water Quality	Mainstem Russian River	30
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	CDFG and other state, local and federal agencies should support voluntary programs suchas the NRCS Dairy Waste Program, Environmental Quality Incentive Program (EQIP), and Sotoyome Resource Conservation Districts' Fish Friendly Farming Program which recommends BMP's for reducing sediment runoff from agricultural lands and practices through the use of BMP's for cover crops, drainage, road construction, riparian buffers, avoidance measures.	Water Quality	Russian River HU	29
North Coast Regional Water Quality Control Board. Regional Water Board Staff Work Plan to Control Excess Sediment in Sediment-Impaired Watersheds. November, 2002	Identify most egregious excess sediment sources using aerial and road-based reconnaissance, complaints, staff observations, general knowledge, and other information. Focus initial reconnaissance efforts on watersheds that currently support coho salmon. Austin Creek, Dry Creek, Dutch Bill Creek, Fife Creek, Forsythe Creek, Freezeout Creek, Green Valley Creek, Jenner Gulch, Maacama Creek, Mark West Creek, Mill Creek, Mission Creek, Sheephouse Creek, Turtle Creek, Willow Creek, and York Creek.	Water Quality	Russian River HU	29
North Coast Regional Water Quality Control Board. Regional Water Board Staff Work Plan to Control Excess Sediment in Sediment-Impaired Watersheds. November, 2002	Implement General Waste Discharge Requirements (WDRs) and a General Conditional Waiver for Vineyards. Following their development and adoption, implement the general WDRs and the general conditional waiver for excess sediment from vineyards. Encourage enrollment in Fish Friendly Farming and the conditional waiver once it is developed.	Water Quality	Russian River HU	29
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Collaborate with agency staff and County representatives (e.g., County personnel, citizen, economic environmental and other groups) to identify model erosion control and bank stabilization ordinances, programs and practices that lead to improved water quality.	Water Quality	Russian River HU	29
Sotoyome Resource Conservation District. Coastal Tributary Improvement Program Final Monitoring Summary Report Agreement No. 03-214-551-0. October, 2004	Conduct sediment source assessment and reduction projects throughout the Austin and Fife Creek watersheds with an emphasis on unpaved rural road improvements. Work with private landowners to conduct inventories and improvement projects.	Science	Austin Creek HSA	29

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: WATER QUALITY PROTECTION AND IMPROVEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
The Conservation Fund. Conservation Prospects for the North Coast. 2005	Implement the Sotoyome Resource Conservation District's Fish Friendly Farming Program within Sonoma and Mendocino counties.	Water Quality	Russian River HU	29
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Implementation of Management Measures to Decrease Sediment Loads.	Water Quality	Guerneville HSA	29
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Implementation of BMPs to decrease summer water temperatures, increase flow, and improve DO.	Water Quality	Guerneville HSA	29
Russian River Keeper. Interviewee Don McEnhill. 3/28/2011	Retrofitting existing developments for stormwater management is hugely expensive. Therefore we need to focus on new developments to ensure they are built with LID designs that slow down and spread out polluted runoff in landscaped areas allowing more water to sink in and recharge groundwater as well as clean it up. A good example of source controls is a parking lot maintenance program in Santa Rosa where it gets nightly lot sweeping and oil spots get actively cleaned.	Water Quality	Russian River HU	29
Gold Ridge RCD. Interviewee Lisa Hulette. 3/18/2011	Water quality monitoring throughout the basin.	Water Quality	Guerneville HSA	29
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Complete sediment source survey on Sweetwater springs Rd (Sonoma County) and Walker Rd (Mendocino County) as a demonstration and training scenario for county staff to identify and quantify sediment sources and estimate sediment savings using DFG approved protocols. Implement recommendations of these assessments when completed with oversight of an experienced contractor in fish friendly road techniques.	Gravel Quality	Russian River HU	28
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Promote additional outreach and enforcement where appropriate for road maintenance and sediment control, agricultural operations, implementation of best management practices and pollution prevention at commercial and industrial facilities, and new development of hillside vineyards.	Water Quality	Russian River HU	28
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Continue to coordinate with local agencies/groups in the support of local non-regulatory, cooperative efforts for erosion/sedimentation controls.	Water Quality	Russian River HU	28
Sotoyome Resource Conservation District. Coastal Tributary Improvement Program Restoration Project Summary Report Agreement No. 03-214-551-0. June, 2002	Address legacy logging road and rural residential road complexes.	Water Quality	Austin Creek HSA	28
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Identify and reduce fine sediment input to the stream	Water Quality	Geyserville HSA	28
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Assess and implement actions that hydrologically disconnect roads or reduce sediment sources in Core CCC coho salmon areas within five years, Phase I within 10 years, and Phase II areas within 15 years (from 2010). Russian River - core areas - Sheephouse Creek area of the Willow Creek planning watershed; Freezeout Creek area of the Freezeout Creek Planning watershed; Dutch Bill, Felta, Wallace, Palmer, and Upper East Gray Creek planning watersheds; Purrington Creek area of the Purrington Creek planning watershed.	Gravel Quality	Guerneville HSA	28
Russian River Keeper. Interviewee Don McEnhill. 3/28/2011	Turbidity in streams and the river due to unpaved roads and agricultural operations is a big problem. Vineyard management needs to focus on keeping soil on the hill slopes and out of the channels. For example, a vineyard that was plowed in March for weed control has created a muddy source with excessive sediment input to its nearby stream.	Water Quality	Russian River HU	28
Sotoyome Resource Conservation District. Coastal Tributary Improvement Program Restoration Project Summary Report Agreement No. 03-214-551-0. June, 2002	Erosion control for localized bank erosion and road related erosion projects.	Water Quality	Austin Creek HSA	27
Sotoyome RCD. Copeland Creek Watershed Assessment. 2004	The County of Sonoma's Department of Public Works should review the condition of its roads in the watershed and determine maintenance and repair needs to reduce fine sediment generation.	Water Quality	Laguna de Santa Rosa HSA	27

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: WATER QUALITY PROTECTION AND IMPROVEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Continue to educate and encourage the County of Mendocino to adopt a grading ordinance that meets NMFS, RWQCB, and DFG approval.	Gravel Quality	Ukiah HSA	27
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Develop a Road Sediment Reduction Plan that prioritizes sites and outlines implementation and a timeline of necessary actions. Begin with a road survey focused on inner gorge roads followed by roads in other settings.	Gravel Quality	Russian River HU	27
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Alternatives to minimize livestock in the riparian corridor including exclusion fencing and off-stream water development should be explores in the Big Sulphur Creek watershed.	Water Quality	Sulphur Creek HSA	26
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Conduct outreach to landowners and on-the-ground surveys of roads, hillsides and stream channels to identify sites of active erosion and opportunities for erosion control projects throughout the watershed, to address both large-scale sediment sources and non-point source contributions.	Socioeconomic	Laguna de Santa Rosa HSA	26
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Assist City of Sebastopol in a source water protection program and continue efforts at source control for the ground water contaminated with solvents and petroleum products.	Water Quality	Russian River HU	26
North Coast Regional Water Quality Control Board. Regional Water Board Staff Work Plan to Control Excess Sediment in Sediment-Impaired Watersheds. November, 2002	Develop and implement WDRs for Mendocino County and Sonoma County to control excess sediment from county roads.	Water Quality	Russian River HU	26
Sonoma County Water Agency. Russian River Action Plan. May, 2003	Santa Rosa Urban Recycled Water Distribution System	Water Quality	Russian River HU	26
Sotoyome RCD. Copeland Creek Watershed Assessment. 2004	Reduce urban runoff	Water Quality	Laguna de Santa Rosa HSA	26
Sotoyome RCD, Gold Ridge RCD, Mendocino County RCD, Sonoma County ater Agency, and Prunuske Chatham, Inc.. Stewardship Guide for the Russian River. undated	Prevent and control soil erosion.	Water Quality	Russian River HU	26
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Reduce fine sediment input	Water Quality	Warm Springs HSA	26
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Repair human-related point sources of sediment throughout the stream	Water Quality	Warm Springs HSA	26
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Repair human-related point sources of sediment throughout the stream	Water Quality	Warm Springs HSA	26
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Reduce fine sediment input to the stream	Water Quality	Geyserville HSA	26
Hopland Band of Pomo Indians. Interviewee Shawn Pady, Chair and Tribal Historic Preservation Officer. 3/23/2011	Water quality monitoring on Reservation creeks.	Water Quality	Ukiah HSA	26
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Collaborate with the State Water Resources Control Board, Division of Water Rights to evaluate the water rights permitting process and its effects on salmonids and macro invertebrates.	Water Quality	Mainstem Russian River	25
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Continue bio-engineering projects in the Forsythe Creek with adjacent landowners. Monitor cattle exclusion fencing.	Gravel Quality	Forsythe Creek HSA	25
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Assess, prioritize, and develop plans to treat sources of excess sediment.	Water Quality	Forsythe Creek HSA	25
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Assess, prioritize, and develop plans to treat sources of excess sediment.	Water Quality	Geyserville HSA	25

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: WATER QUALITY PROTECTION AND IMPROVEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Livestock management in Foote Creek watershed. Develop and implement a water quality monitoring plan focused on assessing the impacts of livestock access to the stream. The riparian zone needs to be better protected and allowed to widen and diversify by restricting or managing cattle access to the stream.	Water Quality	Geyserville HSA	25
North Coast Regional Water Quality Control Board. Regional Water Board Staff Work Plan to Control Excess Sediment in Sediment-Impaired Watersheds. November, 2002	Address Downcutting from Warm Springs & Coyote Dams; Identify, research, and analyze more recent data on downcutting in the mainstem Russian River. If more recent data does not exist, ensure data is gathered and analyzed. If the analysis of data shows that downcutting in the mainstem RR has continued, restore the balance between coarse sediment supply and coarse sediment transport.	Gravel Quantity	Russian River HU	25
North Coast Regional Water Quality Control Board. Regional Water Board Staff Work Plan to Control Excess Sediment in Sediment-Impaired Watersheds. November, 2002	Work with Caltrans on state highways. Work with Caltrans to identify, prioritize, control, and monitor existing excess sediment discharges from Highways 1, 12 and Bodega Highway, 20, 101, 128, 175, and other State Highways in the Russian River watershed. Work with Caltrans to ensure their management practices prevent future sediment discharges.	Water Quality	Russian River HU	25
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Assess the effectiveness of the Sonoma County Vineyard Erosion and Sediment Control Ordinance (also known as the "hillside ordinance") to determine if the ordinance promotes or reduces hillside erosion and run-off and meets the RRWC mission and goals.	Water Quality	Russian River HU	25
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Assess and manage pollutant delivery.	Water Quality	Guerneville HSA	25
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Reduce non-point sediment sources	Water Quality	Geyserville HSA	25
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Assess the number of septic systems or other wastewater producers that deliver toxics to the lower mainstem Russian River and tributaries (such as Dutchbill Creek and others). Work with cities and Sonoma County to eliminate these sources of toxic input.	Water Quality	Russian River HU	25
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	A sediment budget needs to be developed for the river and a sustainable mining plan needs to be developed. County Aggregate Resource Mining Plans would then need to be modified to reflect source and replenishment issues and local jurisdiction.	Gravel Quantity	Mainstem Russian River	24
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Evaluate alternatives to Willow Creek bridging needs: Remove Willow Creek Bridge #2 and realign road on east side of creek.	Gravel Quality	Russian River HU	24
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Follow and provide comment to the NCRWQB's Russian River sediment objective amendment to the NCRWQCB's Basin Plan.	Water Quality	Mainstem Russian River	24
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Repair human-related point sources of sediment throughout the stream; two road/driveway crossings and other human-related point sources of sediment throughout Crane Creek.	Gravel Quality	Warm Springs HSA	24
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Coordinate with local agencies to protect ground water, assess effects of gravel mining and other land use activities on local water tables, and assess impacts of industrial and agricultural chemicals in the ground water.	Water Quality	Russian River HU	24
North Coast Regional Water Quality Control Board. Regional Water Board Staff Work Plan to Control Excess Sediment in Sediment-Impaired Watersheds. November, 2002	Continue to use the municipal storm water program and improve requirements. Continue to use the municipal storm water program to control excess sediment from municipalities in the Russian River watershed (Regional Task 19). Ensure excess sediment is adequately and effectively controlled. Work with Mendocino and Sonoma counties on improving storm water requirements for rural residential developments.	Water Quality	Russian River HU	24
North Coast Regional Water Quality Control Board. Regional Water Board Staff Work Plan to Control Excess Sediment in Sediment-Impaired Watersheds. November, 2002	Work with the North Coast Railroad Authority	Water Quality	Russian River HU	24
Sonoma County Water Agency. Russian River Action Plan. March, 2003	Leddy Park Area Infrastructure Improvements	Water Quality	Laguna de Santa Rosa HSA	24

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: WATER QUALITY PROTECTION AND IMPROVEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Sotoyome Resource Conservation District. Coastal Tributary Improvement Program Final Monitoring Summary Report Agreement No. 03-214-551-0. October, 2004	If indicator bacteria results continue to exceed water quality objectives at the downstream F¨IF-20 sampling site, it may be improtant to assess and address non-septic inputs, such as effluent from the Russian River County Sanitation District or direct input such as pet and homeless encampment waste. Potential tools for reducing direct inputs include installing temporary toilets at established homeless encampments and awareness raising signage and sanitary bags for picking up after pets.	Water Quality	Austin Creek HSA	24
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Reduce or prevent streambank and gully erosion.	Water Quality	Guerneville HSA	24
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Reduce fine sediment input to the stream	Water Quality	Geyserville HSA	24
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Address sediment sources from road networks and other actions that deliver sediment and runoff to stream channels, in each sub-basin.	Gravel Quality	Russian River HU	24
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	In the East Austin Creek watershed, implement results of existing sediment source surveys, and assess remaining watershed road networks to eliminate high priority and high sediment yield sources. Upgrade and decommission sites and road networks where appropriate. These actions include outsloping roads, ditch relief culverts, and installing rolling dips.	Gravel Quality	Austin Creek HSA	24
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Minimize sediment delivery from roads during the winter period.	Gravel Quality	Russian River HU	24
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Benthic macro-invertebrate samping should be conducted. CDFG encourages the use of the Russian River Index of Biological Integrity (RRIBI, available in: An Index of Biological Integrity for First to Third Order Russian River Tributary Streams (CDFG 1998)) and supports Citizen Monitoring within the basin. Funding for citizen and agency training and sample collection to establish reference conditions on which to refine the RRIBI should continue.	Water Quality	Russian River HU	23
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Landslide mapping and a sediment source survey of roads are priority concerns throughout. New roads should avoid steep slopes of this unstable region.	Water Quality	Sulphur Creek HSA	23
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Livestock fencing would reduce sediment concerns in the Maacama Creek watershed on several tributary systems. Riparian improvements are also needed.	Gravel Quality	Geyserville HSA	23
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Support Sotoyome Resource Conservation District's Fish Friendly Farming Program which recommends BMP's for reducing sediment, pesticide and herbicide pollution	Water Quality	Mainstem Russian River	23
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Inventory, evaluate, and prioritize problem roads which contribute sediment to streams inhabited by coho salmon.	Water Quality	Russian River HU	23
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Continued changes in channel capacity or global weather patterns will increase the Subregional Wastewater Treatment Facility's vulnerability to extreme flood events, and the consequent risk of major sewage spills. Such a spill would have negative and long-lasting environmental effects on the Laguna waterways. Initiate engineering and feasibility studies for a system to protect water treatment infrastructure from flooding and prevent future catastrophic spills of untreated effluent, anticipating increases in extreme weather events. Design system to minimize flood risk to downstream neighbors.	Water Quality	Laguna de Santa Rosa HSA	23

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Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	The portion of the Laguna Wildlife Area located between Occidental and Guerneville Roads has been undergoing rapid hydrologic and hydraulic changes that appear to be associated with sedimentation patterns. Historically, this area was extensively modified, including drainage and filling of wetlands and seasonal lakes, and channelization to open land for agriculture. It is now highly invaded by Ludwigia, and is a candidate for extensive restoration. However, restoration cannot proceed without further studies and feasibility analyses, to predict the future direction of hydrologic changes and to develop engineered solutions that will be in dynamic equilibrium and sustainable over time, rather than rapidly filling in with sediment.	Science	Laguna de Santa Rosa HSA	23
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Reduce fine sediment input to Miller Creek; much of the sediment input is the result of over-steepened stream banks because of channelization and hydrogeomorphic processes related to activities in the Russian River. Conduct an assessment of roads in the watershed.	Gravel Quality	Geyserville HSA	23
North Coast Regional Water Quality Control Board. Regional Water Board Staff Work Plan to Control Excess Sediment in Sediment-Impaired Watersheds. November, 2002	Develop and implement ownership-wide WDRs for Mendocino Redwood Company	Water Quality	Russian River HU	23
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Examine grading and erosion control ordinances to ensure that they reduce sedimentation and other hydrological impacts.	Gravel Quality	Russian River HU	23
Sonoma County Water Agency. Russian River Action Plan. March, 2003	Dooley Creek Watershed Implementation	Water Quality	Ukiah HSA	23
Sonoma County Water Agency. Russian River Action Plan. May, 2003	North Sonoma County Agricultural Reuse Feasibility Study	Water Quality	Russian River HU	23
Sonoma County Water Agency. Russian River Action Plan. May, 2003	Russian River County Sanitation District Third Unit Processes	Water Quality	Guerneville HSA	23
Sonoma County Water Agency. Russian River Action Plan. May, 2003	Sonoma County Area Recycled Water Irrigation	Water Quality	Russian River HU	23
Sotoyome RCD. Upper Mark West Watershed Management Plan Phase 1: Watershed Characterization and Needs Assessment.. 2008	Complete high and medium priority improvements on all rural roads in the watershed, as specified in assessment reports.	Water Quality	Mark West HSA	23
Sotoyome RCD, Gold Ridge RCD, Mendocino County RCD, Sonoma County ater Agency, and Prunuske Chatham, Inc.. Stewardship Guide for the Russian River. undated	Control runoff.	Water Quality	Russian River HU	23
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Develop site-specific recommendations, including incentives, to remedy high temperatures and implement (DFG 2004) initially in core areas, following with phase 1 and 2 areas. Russian River - core areas - Sheephouse Creek area of the Willow Creek planning watershed; Freezeout Creek area of the Freezeout Creek Planning watershed; Dutch Bill, Felta, Wallace, Palmer, and Upper East Gray Creek planning watersheds; Purrington Creek area of the Purrington Creek planning watershed.	Water Quality	Guerneville HSA	23
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	A sediment source survey has been conducted in the State Park portion of Fife Creek. Road surveys on remaining private land are needed.	Gravel Quantity	Guerneville HSA	22
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Complete road assessment surveys to include private property and implement recommendations.	Gravel Quality	Mark West HSA	22
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Complete sediment source surveys on all County maintained roads to identify and quantify sediment sources and estimate sediment savings using DFG approved protocols.	Gravel Quality	Russian River HU	22
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Conduct sediment source surveys in Kidd Creek	Gravel Quantity	Austin Creek HSA	22
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Continue discussion within the Russian River Watershed Temperature Committee to develop the most protective temperature objective for the NCRWQCB Basin Plan amendment.	Water Quality	Mainstem Russian River	22
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Encourage citizen water quality monitoring through the Sotoyome Resource Conservation District.	Water Quality	Mainstem Russian River	22

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CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Support the California Dairy Quality Assurance Program in cooperation with the UCCE and continue in the development of the Environmental Stewardship Certification Program for dairy facilities.	Water Quality	Mainstem Russian River	22
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Assess, prioritize, and develop plans to treat sources of excess sediment.	Water Quality	Mark West HSA	22
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Assess, prioritize, and develop plans to treat sources of excess sediment.	Water Quality	Santa Rosa Creek HSA	22
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Treat high-priority sources of excess sediment.	Gravel Quality	Geyserville HSA	22
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Treat high-priority sources of excess sediment.	Gravel Quality	Mark West HSA	22
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Treat high-priority sources of excess sediment.	Gravel Quality	Santa Rosa Creek HSA	22
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Treat high-priority sources of excess sediment.	Water Quality	Warm Springs HSA	22
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Treat priority sources of excess sediment.	Gravel Quality	Guerneville HSA	22
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Livestock management in Grape Creek watershed. Livestock access to the stream should be carefully managed. Develop and implement a water quality monitoring plan focused on assessing the impacts of livestock access to the creek. Livestock fence across the stream should be evaluated for need and removed and/or replaced with alternative types of fencing (e.g., floating fence) as needed.	Water Quality	Warm Springs HSA	22
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Reduce fine sediment input in Grape Creek. Reshape and plant with native vegetation over-steepened stream banks that are the result of aritifical confinement and channel incisement. This is an important step towards reconnecting the stream to its flood plain while simultaneously filtering fine sediment from stream runoff. Repair human-related point sources of sediment throughout the stream.	Gravel Quality	Warm Springs HSA	22
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Repair human-related point sources of sediment throughout the Dutcher Creek.	Gravel Quality	Warm Springs HSA	22
North Coast Regional Water Quality Control Board. Proposed Regional Excess Sediment Basin Plan. November, 2002	Minimize - If the discharge or threatened discharge of excess sediment cannot be fully prevented, then plan, design, and implement the project in such a way that discharges to waters of the state are minimized to the maximum extent possible. Steps to be taken to address discharge of excess sediment from existing sources include: inventory, prioritize, implement, monitor and adapt.	Water Quality	Russian River HU	22
Sonoma County Water Agency. Russian River Action Plan. May, 2003	McNab Creek Road Implementation	Water Quality	Ukiah HSA	22
Stewards of the Coast and Redwoods. Willow Creek Watershed Management Plan. August, 2005	Upgrade roads in the Willow Creek Watershed	Water Quality	Guerneville HSA	22
Sotoyome RCD. Copeland Creek Watershed Assessment. 2004	The Sotoyome RCD should complete outreach to private landowners in the headwaters reach and provide assistance for road assessments and repairs.	Water Quality	Laguna de Santa Rosa HSA	22
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Reduce fine sediment	Gravel Quality	Warm Springs HSA	22
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Encourage the NRCS and RCDs to increase the number of landowners participating in sediment reduction planning and implementation.	Gravel Quality	Russian River HU	22

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Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Establish adequate spoils storage sites throughout the watershed so that material from landslides and road maintenance can be stored safely away from coho streams. Coordinate these efforts with all landowners in the watershed, CalTrans, and county road maintenance staff as appropriate.	Gravel Quality	Russian River HU	22
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	"Develop grading and erosion control standards supported by ordinances to minimize sediment impacts to streams (Harris et al. 2001)", which also minimizes winter grading. Compliance and enforcement programs would need to be increased or developed.	Gravel Quality; Water Quality	Russian River HU	21
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Alternatives for mitigation to unavoidable site specific impacts could also be discussed such as : the length of the streams modified through these activities could be mitigated for on streams where channel capacity is not an issue, through native re-vegetation efforts and floodplain easements in other coho drainages of the Russian River.	Floodplain Management	Russian River HU	21
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Gather and share data on pesticide use and effects on salmonids and aquatic life. Continue to fill data gaps by collecting trend data on the mainstem and tributaries, utilizing the NCRWQCB, DFG, Sonoma County Water Agency, Sotoyome Resource Conservation District, and other data.	Water Quality	Mainstem Russian River	21
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Integrate the California Coastal Commission's "Model Urban Runoff Program" in Russian River watershed communities.	Water Quality	Mainstem Russian River	21
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Assess, prioritize, and develop plans to treat sources of excess sediment.	Water Quality	Warm Springs HSA	21
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Review and, if appropriate, approve Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Maintenance (FishNet 4C 2004).	Water Quality	Russian River HU	21
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Treat high-priority sources of excess sediment.	Gravel Quality	Forsythe Creek HSA	21
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Livestock management in Franz Creek. Manage livestock access to the stream in Reach 4.	Water Quality	Geyserville HSA	21
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Livestock management in Redwood Creek. Restrict/manage cattle access to the stream and consider alternatives to fencing across the stream. Reshape and plant with native vegetation over-steep banks in portions of both reaches that have been impacted by cattle accessing the stream.	Water Quality	Geyserville HSA	21
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Reduce fine sediment input to Wine Creek. Immediate steps should be taken to reduce the likelihood of a second large sedimentation event associated with the failed roads project upstream of Reach 8. Identify non-point sources of fine sediment inputs including a general roads assessment in the watershed that pays careful attention to the sediment contribution of Koch Roac. For road segments that cannot be realigned, ways to diver sediment (e.g., water bars, diversion ditches) before it enters the stream channel should be identified and implemented. Implement projects to reshape and plant with native vegetation over-steep stream banks that result from the unnaturally confined and entrenched stream channel in Reach 1. Repair human-related erosion sites throughout the stream.	Gravel Quality	Warm Springs HSA	21
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Evaluate and pursue methods for evaluating sediment sources (e.g., satellite imagery, aerial photography).	Water Quality	Russian River HU	21
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Explore a wide range of methods and feasibility for treating and reusing wastewater in the watershed.	Water Quality	Russian River HU	21

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Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. March, 2007	Monitor and encourage the implementation of land use and development programs to address stormwater discharges.	Water Quality	Russian River HU	21
Sotoyome RCD, Gold Ridge RCD, Mendocino County RCD, Sonoma County ater Agency, and Prunuske Chatham, Inc.. Stewardship Guide for the Russian River. undated	Manage landscape and household water use.	Water Quality	Russian River HU	21
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Livestock management	Water Quality	Geyserville HSA	21
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Identify and reduce impacts from cattle (as appropriate) upstream of Reach 3	Water Quality	Geyserville HSA	21
Sotoyome Resource Conservation District. Austin Creek Watershed Assessment. October, 2005	Reduction of fine sediment loads	Water Quality	Austin Creek HSA	21
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Decommission riparian road systems and/or upgrade roads (and skid trails on forestlands) that deliver sediment into adjacent watercourses (DFG 2004). High priority streams identified by DFG habitat reports include Sheephouse Creek, Austin and East Austin Creeks, Pena Creek, Porter Creek, Kidd Creek, Sexton Creek, Gilliam Creek, Hobson Creek, Conshea Creek, Crane Creek, and Schoolhouse Creek (DFG 2009).	Gravel Quality	Austin Creek HSA	21
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Assess and remove sources of toxics from watershed areas or streams.	Water Quality	Russian River HU	21
Agriculture Department, County of Mendocino. Interviewee Tony Linegar. 2/24/2011	The County Agriculture Department is mandated to collect data on all commercial pesticides applied in county watersheds. The use of pesticides by pot growers is not reported to the Ag Dept. The amounts found by the County Sheriff's Department during busts is significant, but law enforcement does not supply that information to the Ag Department. We want that information. Documenting the pounds/tons of pesticide illegally spread throughout the county needs to begin. These poisons could have detrimental effects on humans and wildlife if left un-controlled.	Water Quality	Russian River HU	21
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Address sediment releases and catastrophic failure of private dam in the headwaters of the south fork	Gravel Quality	Laguna de Santa Rosa HSA	20
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Conduct road assessments on larger ranches in watershed and implement recommendations.	Gravel Quality	Mark West HSA	20
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Expand road sediment source surveys in Big Austin Creek	Gravel Quality	Austin Creek HSA	20
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Habitat Inventory reports contain point-source descriptions of stream bank erosion. Implementation plans should prioritize them according to present and potential sediment yield.	Gravel Quality	Russian River HU	20
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Increase canopy in Markwest and all tributaries to reduce water temperatures.	Water Quality	Mark West HSA	20
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Maintenance and new construction on unimproved private and county roads should follow techniques outlined in "Handbook for Forest and Ranch Roads" by Weaver and Hagans, 1994. Culvert installation should follow NMFS fish passage guidelines (NMFS 2000), and USACE stream crossing guidelines.	Gravel Quality	Russian River HU	20

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Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Phase-out direct discharges of treated wastewater into the Laguna channel. Expand the capacity of current disposal alternatives, including agricultural and urban re-use, water conservation, and repair of the current piping system to reduce infiltration and infill. Identify and develop new environmentally favorable disposal options. Until the phase-out can occur, Laguna discharges should be limited to November—February, when Ludwigia and other aquatic weeds are not actively growing.	Water Quality	Laguna de Santa Rosa HSA	20
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Identify and reduce fine sediment input to Franz Creek. Assess sediment delivery to Reach 5 from road crossings and upslope road network. Repair human-related erosion sites.	Gravel Quality	Geyserville HSA	20
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Reduce fine sediment input to Gird Creek; much of the sediment input is the result of over-steepened stream banks because of channelization and hydrogeomorphic processes related to activities in the Russian River	Gravel Quality	Geyserville HSA	20
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Continue with pollution prevention activities to promote the continuing development and application of best management practices for storage, treatment, and disposal of hazardous substances, storm water pollution prevention controls, solid waste, dairy waste, municipal waste water, agricultural and domestic and industrial wastes.	Water Quality	Russian River HU	20
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Support the Sonoma County's hillside vineyard ordinance that addresses the issue of erosion and sediment discharges from hillside vineyard development.	Water Quality	Russian River HU	20
North Coast Regional Water Quality Control Board. Proposed Regional Excess Sediment Basin Plan. November, 2002	Prevent - Plan, design and implement the project or activity in such a way that no excess sediment discharge occurs or could occur to waters of the state	Water Quality	Russian River HU	20
Sotoyome Resource Conservation District. Coastal Tributary Improvement Program Final Monitoring Summary Report Agreement No. 03-214-551-0. October, 2004	Continue OWTS informational workshop series targeting lower River homeowners and residents. Emphasis should be on assessing and improving the functionality and adequacy of existing OWTS	Socioeconomic	Austin Creek HSA	20
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Manage stormwater.	Water Quality	Guerneville HSA	20
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Implement private roads erosion reduction program.	Water Quality	Guerneville HSA	20
Sotoyome RCD. Copeland Creek Watershed Assessment. 2004	Control runoff from horse corrals, stables and pastures.	Water Quality	Laguna de Santa Rosa HSA	20
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Livestock management	Water Quality	Geyserville HSA	20
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Livestock management	Water Quality	Geyserville HSA	20
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Sediment from existing and future commercial and urban development should be reduced to magnitudes appropriate to the geological setting of the watershed, resulting in no net increase in sedimentation over natural limits.	Gravel Quality	Russian River HU	20
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	DFG generally recommends riparian restoration planting where average canopy is below 80% and water temperature is over target by species (Flosi et al. 1998). See Circuit Rider Productions' A Guide to Restoring Native Riparian Habitat in the Russian River Watershed.	Water Quality	Russian River HU	19
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Identified point-sources should be treated to reduce the amount of fine sediments entering the stream.	Gravel Quality	Russian River HU	19
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Implement sediment source treatments in Pole Mountain/Ward Creek	Gravel Quality	Austin Creek HSA	19

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: WATER QUALITY PROTECTION AND IMPROVEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Participate with the University of California Cooperative Extension staff in their education and outreach efforts. Continue landowner workshops in partnership with various agencies and organizations and the Russian River Watershed Council.	Water Quality	Mainstem Russian River	19
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Road assessments should be conducted to: 1) catalog road construction history (relative to storm history) and identify potential sources of erosion and sediment production from aerial photos; 2) perform field road assessment and mapping utilizing DFG approved protocols for sediment inventory including: roads and landings, sources of erosion and sediment production on watershed roads, and erosion history and potential landslide evidence; 3) evaluate results of watershed assessment ranking treatment sites on a fishery priority basis (yd3 delivered to stream channels) basis and a cost/benefit ($spent/yd3 saved from stream channels) basis.	Gravel Quality	Russian River HU	19
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Implement any best management practices pertinent to coho salmon recovery in Guidelines for Protecting Aquatic Habitat and Salmon Fisheries for County Road Maintenance (FishNet 4C 2004).	Water Quality	Russian River HU	19
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Refine and then attain water quality targets for salmonid-bearing headwater streams that protect spawning and rearing requirements of steelhead and coho. Refine and attain water quality targets for the Laguna main channel that support salmonid migration. Support education campaigns that reduce the household and commercial use of chemical fertilizers and pesticides that interfere with salmonid development.	Water Quality	Laguna de Santa Rosa HSA	19
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Identify and reduce fine sediment input to Gill Creek; conduct an assessment of roads in the watershed, address the sediment coming from the road crossing at the upstream end of Reach 3.	Gravel Quality	Geyserville HSA	19
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Identify and reduce impacts from cattle as appropriate in the stream segment upstream of Reach 3 in Gill Creek	Gravel Quality	Geyserville HSA	19
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Reduce non-point sediment sources in Maacama Creek. Assess and treat road systems in the watershed.	Water Quality	Geyserville HSA	19
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Pursue post construction storm water management to improve water quality and flood control.	Water Quality	Russian River HU	19
North Coast Regional Water Quality Control Board. Regional Water Board Staff Work Plan to Control Excess Sediment in Sediment-Impaired Watersheds. November, 2002	Continue to fund sediment waste discharge control projects; Continue to fund excess sediment control projects in the Russian River watershed through available nonpoint source and watershed protection grants and loans as appropriate	Water Quality	Russian River HU	19
Sonoma County Water Agency. Russian River Action Plan. March, 2003	Camp Meeker Wastewater Reclamation	Water Quality	Guerneville HSA	19
Sotoyome Resource Conservation District. Coastal Tributary Improvement Program Final Monitoring Summary Report Agreement No. 03-214-551-0. June, 2002	Increase continuous temperature monitoring stations throughout target tributary watersheds, add more tributary watershed to the temperature monitoring program, increase the number of sediment sampling stations, add permeability monitoring to the parameters measured and continue to work cooperatively and share data with other agencies to maximize resources.	Science	Austin Creek HSA	19
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Implement agricultural BMPs	Water Quality	Guerneville HSA	19
Sotoyome RCD. Upper Mark West Watershed Management Plan Phase 1: Watershed Characterization and Needs Assessment.. 2008	Complete rural roads assessments for remaining roads in watershed.	Water Quality	Mark West HSA	19

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SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Sotoyome RCD. Copeland Creek Watershed Assessment. 2004	The semi-arid climate of Sonoma County does not provide forage for year-round grazing and plans need to address rotation of cattle and resting of pasture to provide a defined minimum level of plant cover to protect soil from erosion.	Water Quality	Laguna de Santa Rosa HSA	19
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Implement actions to maintain and restore water temperatures to meet habitat requirements for CCC coho salmon in assessed streams (DFG 2004).	Water Quality	Russian River HU	19
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Address culverts on un-named tributaries to lower Big Austin Creek.	Gravel Quality	Austin Creek HSA	18
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Assist Sonoma County Planning Dept. with GIS mapping of land ownership, roads, and culverts. GIS coverage of private roads and culverts	Water Quality	Russian River HU	18
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Conduct road assessment on Sheephouse, Hulbert, Mission, Fife, and Porter Creeks.	Gravel Quality	Guerneville HSA	18
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Implement results of Willow Creek Channel reconstruction and address sedimentation at Bridge 2.	Gravel Quality	Guerneville HSA	18
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Livestock fencing is also needed in the headwater areas of Gill, Crocker, Foote and possibly Gird Creeks.	Gravel Quality	Geyserville HSA	18
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Treat high-priority sources of excess sediment.	Gravel Quality	Austin Creek HSA	18
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Develop and implement a water quality monitoring plan in Redwood Creek. Plan should focus on the impacts of livestock access to the creek.	Water Quality	Geyserville HSA	18
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Livestock management in Maacama Creek; manage livestock access to the stream in Reach 2.	Water Quality	Geyserville HSA	18
The Conservation Fund. Conservation Prospects for the North Coast. 2005	Update temperature analyses below Coyote Dam and Warm Springs Dam, and review dam management.	Science	Russian River HU	18
Sotoyome RCD. Upper Mark West Watershed Management Plan Phase 1: Watershed Characterization and Needs Assessment.. 2008	Identify and address other large-scale sediment sources in the watershed.	Water Quality	Mark West HSA	18
Sotoyome RCD. Copeland Creek Watershed Assessment. 2004	Operations along Copeland Creek should implement either exclusionary fencing to keep cattle out of the creek or create riparian pastures.	Water Quality	Laguna de Santa Rosa HSA	18
City Council of Healdsburg. Healdsburg 2030 General Plan Policy Document. 2009, amended 2011	The City will provide through its regulatory powers for the continued use of properties along the Russian River for sand and gravel mining operations. Such operations shall be allowed to continue for the productive and economic life of the operations so long as it can be demonstrated that no significant adverse environmental impacts to water quality, geomorphology, flooding and biological resources will occur.	Water Quality	Guerneville HSA	18
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	In Purrington Creek several stream crossings exist in Reach 1. These crossings should be improved to eliminate active soil erosion and runoff.	Gravel Quality	Guerneville HSA	18
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Improve summer rearing survival by reducing instream temperatures in potential rearing reaches. See strategies for restoring and enhancing riparian vegetation.	Water Quality	Russian River HU	18
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Work with landowners to assess the effectiveness of erosion control measures throughout the winter period.	Gravel Quality	Russian River HU	18
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Adequate monitoring to determine thermal potential - the estimated thermal regime achievable after all reversible anthropocentric heat sources are removed - should be implemented.	Water Quality	Russian River HU	17

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CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Assess natural and current flow regimes.	Water Quality	Mainstem Russian River	17
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Identify and obtain easements or purchase spoil site locations for end-hauling ditch and slide spoils during winter preparation and maintenance (identified as a need by county road crews).	Gravel Quality	Russian River HU	17
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Implement sediment source treatments on upper east Austin Creek road.	Gravel Quality	Austin Creek HSA	17
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Participate in the Sonoma Marin Animal Waste forum and support its recommendations and guidelines for manure management	Water Quality	Mainstem Russian River	17
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Sonoma and Mendocino Counties should adopt standards for unimproved road construction following techniques outlined in Weaver and Hagans, (1994). Training is needed for County Public Works to implement these fish friendly techniques.	Gravel Quality	Russian River HU	17
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Fix problem roads which contribute sediment to streams inhabited by coho salmon.	Gravel Quality	Russian River HU	17
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Review the Five County Roads manual.	Gravel Quality	Russian River HU	17
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Establish a monitoring network in high risk/high ground water use areas.	Water Quality	Russian River HU	17
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Develop a database of mitigation and enhancement activities that could influence the changes in water quality objectives for listed and unlisted species, and enhance the quality of surface water for the benefit of listed and unlisted species.	Water Quality	Russian River HU	17
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Identify natural resources that provide erosion control and (e.g., large rock, filter strips, oak trees and woodlands to help stabilize soil and slopes, reduce erosion and support many plant and wildlife species) and evaluate related ordinances or guidelines developed by other entities to protect these resources.	Gravel Quality	Russian River HU	17
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Increase citizen and property owner involvement in the long-term monitoring of water quality.	Water Quality	Russian River HU	17
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Install remote water quality monitoring stations at road crossings to measure water quality as it flows downstream and compile data about changes between specific points of the stream or its tributaries. Implement continuous water quantity monitoring to ensure data collected represents a range of environmental conditions (e.g., wet versus dry years)	Water Quality	Russian River HU	17
Sonoma County Water Agency. Russian River Action Plan. May, 2003	Monte Rio Wastewater Pollution Control	Water Quality	Guerneville HSA	17
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Develop water quality goals and monitoring/analysis framework.	Water Quality	Guerneville HSA	17
Sotoyome RCD. Copeland Creek Watershed Assessment. 2004	Filter strips may be needed along ephemeral creeks and the main creek corridor as well as next to any animal holding facilities.	Water Quality	Laguna de Santa Rosa HSA	17
Sotoyome RCD. Copeland Creek Watershed Assessment. 2004	The Sotoyome RCD should complete outreach to landowners and offer assistance in erosion control.	Water Quality	Laguna de Santa Rosa HSA	17
Sotoyome RCD. Copeland Creek Watershed Assessment. 2004	Stormwater management.	Water Quality	Laguna de Santa Rosa HSA	17
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Implement BMP's for road improvements on numerous smaller tracts of land throughout the watershed.	Gravel Quality; Water Quality	Mark West HSA	16
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Implement recommendations of DFG funded Willow Creek Road Assessment on county road see Appleton Report (January 2002)	Gravel Quality	Russian River HU	16

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CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Implement results of sediment source assessment on Freezeout and Willow Creeks.	Gravel Quality	Guerneville HSA	16
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Initiate road assessment and landslide mapping in the Forsythe watershed.	Gravel Quality	Forsythe Creek HSA	16
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Obtain data from the North Coast Regional Water Quality Control Board's (NCRWQCB) Surface Water Ambient Monitoring Program (SWAMP).	Water Quality	Mainstem Russian River	16
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Studies to determine the presence and potential effects of environmental estrogens are needed.	Water Quality	Russian River HU	16
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Conduct research and modeling to increase understanding of the biological and physical processes affecting water quality in the watershed, patterns of spatial and temporal variation in water quality, and the needs of different animal and plant communities; and use the results of these studies to ensure that regulations support appropriate beneficial uses.	Water Quality	Laguna de Santa Rosa HSA	16
Sotoyome RCD. Copeland Creek Watershed Assessment. 2004	Construction on hillsides.	Water Quality	Laguna de Santa Rosa HSA	16
Sotoyome RCD, Gold Ridge RCD, Mendocino County RCD, Sonoma County ater Agency, and Prunuske Chatham, Inc.. Stewardship Guide for the Russian River. undated	Properly maintain unsurfaced roads and driveways.	Water Quality	Russian River HU	16
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Address the accumulation of sediment in Reach 1	Gravel Quality	Geyserville HSA	16
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Livestock management	Water Quality	Warm Springs HSA	16
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Road sediment source surveys for Sheephouse Creek remain a priority.	Gravel Quality	Guerneville HSA	15
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Where non-point problems persist, active and potential sediment sources related to the road system need to be identified, mapped, and treated according to their potential for sediment yield to the stream and its tributaries.	Gravel Quality	Russian River HU	15
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Assess and prioritize sources of excess sediment	Gravel Quality	Austin Creek HSA	15
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Encourage local agencies to implement recommendations of completed non-point source sediment assessments.	Water Quality	Austin Creek HSA	15
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Encourage local agencies to implement recommendations of completed non-point source sediment assessments.	Gravel Quality	Guerneville HSA	15
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Continue to track compliance with time schedules in NPDES Permits and enforcement orders	Water Quality	Russian River HU	15
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Propose modified Basin Plan water quality objectives for Regional Board consideration to address protection of FESA listed salmonid fish.	Water Quality	Russian River HU	15
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. March, 2007	Review and evaluate information regarding surface and subsurface water quality, for example, oil and grease discharge into stormwater run-off.	Water Quality	Russian River HU	15
Sotoyome RCD, Gold Ridge RCD, Mendocino County RCD, Sonoma County ater Agency, and Prunuske Chatham, Inc.. Stewardship Guide for the Russian River. undated	Dispose of household waste responsibly.	Water Quality	Russian River HU	15
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Implement recommendations of the Eldridge Creek Road Survey completed in 2000.	Gravel Quality	Forsythe Creek HSA	14
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Implement record of Hulbert Creek sediment source survey.	Gravel Quality	Guerneville HSA	14

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SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Assess and prioritize sources of excess sediment	Gravel Quality	Guerneville HSA	14
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Stream conditions and surrounding vegetation strongly affect water quality and aquatic communities. Initiate field surveys to characterize in-stream conditions throughout the watershed—including spatial and temporal patterns of water quality impairments, stratification, animal and plant communities, and the condition of riparian areas.	Water Quality	Laguna de Santa Rosa HSA	14
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Water quality in the Laguna watershed is highly variable, depending on channel conditions, natural processes, season, and anthropogenic pollution inputs. Without further research and monitoring it will not be possible to determine the relative impacts of different sources of impairments. Implement a permanent and geographically stratified water-quality research and monitoring program with standard water quality monitoring protocols to track impairments and improvements in the Laguna and its tributaries.	Water Quality	Laguna de Santa Rosa HSA	14
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Identify any point source discharges of hazardous or toxic substances to Santa Rosa Creek and mitigate.	Water Quality	Santa Rosa Creek HSA	14
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. November, 2002	Investigate the susceptibility of salmonids to wastewater exposure by examining the effects of pharmaceuticals, compounds not completely removed during water treatment, and nutrients on water quality and fish metabolism.	Water Quality	Russian River HU	14
Stewards of the Coast and Redwoods. Willow Creek Watershed Management Plan. August, 2005	Decommission legacy logging roads in the Willow Creek Watershed	Water Quality	Guerneville HSA	14
Sotoyome RCD. Copeland Creek Watershed Assessment. 2004	The effect of grazing on the many springs in the headwaters should be analyzed in the grazing plans.	Water Quality	Laguna de Santa Rosa HSA	14
Sotoyome RCD. Copeland Creek Watershed Assessment. 2004	Reduce small erosion problems with emergency erosion control measures.	Water Quality	Laguna de Santa Rosa HSA	14
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Conduct road assessments on the larger ranches in watershed and implement recommendations	Gravel Quality	Laguna de Santa Rosa HSA	13
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Methods to release cooler flows out of Walker Dam should be explored.	Water Quality	Forsythe Creek HSA	13
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Runoff from dairies, pastures, vineyards, and land application of tertiary treated wastewater; collection of runoff from drainage ditches, culverts, and storm water drains and analysis for nutrient constituents and BOD. Also include shallow wells to monitor infiltration rates from irrigated fields to the streams. Ditch and culverts shoudl include 3 samples each during both wet and dry seasons.	Science	Laguna de Santa Rosa HSA	13
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Maintain the sampling regimen at the four long-term historical water quality monitoring stations to provide long-term monitoring data for the Russian River mainstem under SWAMP. Evaluate monitoring sites in other streams in the WMA and schedule monitoring under the SWAMP rotating schedule for FY 2004-05.	Water Quality	Russian River HU	13
Sonoma County Water Agency. Russian River Action Plan. March, 2003	Canon Manor Infrastructure Improvements	Water Quality	Laguna de Santa Rosa HSA	13
Gold Ridge RCD. Upper Green Valley Creek Watershed Management Plan. 2010	Surface water quality monitoring should continue with enhanced equipment at an increased number of sites.	Water Quality	Guerneville HSA	13
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Maintenance of ditches, culverts, and inboard cutbank slides should be improved to decrease the potential of sediment delivery to Dutchbill and Grub Creeks.	Gravel Quality	Guerneville HSA	13

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Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Avoid, or at a minimum regulate, the use of commercial and industrial products (e.g. pesticides) with high potential for contamination of local waterways.	Water Quality	Russian River HU	13
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Toxic waste products from urban activities should receive the appropriate treatment before being discharged into any body of water that may enter any historic CCC coho salmon waters.	Water Quality	Russian River HU	13
Russian River Keeper. Interviewee Don McEnhill. 3/28/2011	Fine sediment input to the Russian River from Lake Mendocino is a big problem. Turbidity from Lake Mendocino is often 700-800 NTU, even when tributaries are flowing clear. The intake/outlet structure at the dam needs to be modified to reduce turbidity of the outflow at Coyote Dam. Lake Mendocino releases for flood control will keep turbidity high for a few weeks after the tributaries have been flowing clear. Outflow management needs to be modified.	Water Quality	Russian River HU	13
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Follow the NCRWQCB's regionwide sediment objective amendment to the NCRWQCB's Basin Plan (separate amendment process to the Russian River sediment amendment process).	Water Quality	Mainstem Russian River	12
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Increase budget for county road maintenance crews (identify sources of funding other than FEMA)	Gravel Quality	Russian River HU	12
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Provide training for Public Works road crews on fish-friendly road practices.	Gravel Quality	Russian River HU	12
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Implement recommendations of completed non-point source sediment assessments.	Gravel Quality	Austin Creek HSA	12
CDFG. Recovery Strategy for California Coho Salmon. 2/1/2004	Implement recommendations of completed non-point source sediment assessments.	Gravel Quality	Guerneville HSA	12
National Marine Fisheries Service. Draft Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin. November, 2007	Evaluate sediment sources in Crocker Creek; the erosion sites upstream of the old dam site that were caused by the former impoundment are still probably delivering sediment to the stream; however, an evaluation of whether or not this constitutes a significant problem should be conducted before further actions are taken.	Gravel Quality	Geyserville HSA	12
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Maintain bacterial sampling at public water- contact recreation areas.	Water Quality	Russian River HU	12
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Post, on the Regional Water Board web site, the results of summertime bacteriological sampling at swimming beaches conducted by the county health department with the Regional Board's assistance.	Water Quality	Russian River HU	12
Russian River Watershed Council. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. March, 2007	Monitor and study nutrient contributions and toxic contamination in areas where septic systems are common (AB 885 requires monitoring of septic systems).	Water Quality	Russian River HU	12
Laguna de Santa Rosa Foundation. Laguna Watershed Research Plan 2008 - 2012. 2008	Investigation of landscape level dynamics of Laguna ecosystems affecting water quality.	Water Quality	Laguna de Santa Rosa HSA	12
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Conduct studies to evaluate whether in the Laguna have bioaccumulations of heavy metals or other toxins; initial efforts should focus on higher trophic levels (predatory fish), and on non-native crayfish to evaluate impacts on fish and wildlife. Researchers should also interview members of the fishing community to determine which species are being caught for consumption, and include these species in the analysis.	Science	Laguna de Santa Rosa HSA	11
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Sediment: grain size, wet-sieve/laser diffraction; TOC, ASTM D4129-82M (or equivalent); embeddedness: survey ring/grid method; Nutrients, Total P (EPA 365.3), Total N (EPA 351.3). Grain size/TOC during high and low flow conditions; embeddedness during low flow as conditions allow	Science	Laguna de Santa Rosa HSA	11
Sotoyome Resource Conservation District. Maacama Creek Watershed Assessment. March, 2005	Restoration programs must integrate the owners' needs while addressing environmental and water quality problems	Socioeconomic	Geyserville HSA	11

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National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Develop and implement a water quality monitoring plan	Water Quality	Geyserville HSA	11
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Close unauthorized trails and conduct appropriate decommissioning practices. Hydrologically disconnect trails from associated waterways.	Gravel Quality	Russian River HU	11
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Limit winter use of unsurfaced roads and recreational trails to decrease fine sediment loads.	Gravel Quality	Russian River HU	11
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Homeowners should consult "The House and Garden Audit: Protecting Your Family's Health and Improving the Environment" by (Marcus et al 2001), which includes tips for monitoring the garden for insects or insect damage, examining insects and damage and keeping notes.	Water Quality	Russian River HU	10
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Screen for xenobiotic estrogens by using vitellogenin testing of fish under SWAMP. Monitor for toxic chemicals through coordination with the SWAMP rotation in FY 2004-05. Conduct a pathogen source analysis on the mainstem and tributaries.	Water Quality	Russian River HU	10
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Seek funding for additional assessment of semi volatile, volatile, and metal pollutants in Laguna de Santa Rosa tributaries.	Water Quality	Laguna de Santa Rosa HSA	10
Stewards of the Coast and Redwoods. Willow Creek Watershed Management Plan. August, 2005	Maintain roads, trails, and other facilities in the Willow Creek Watershed.	Water Quality	Guerneville HSA	10
Southwest Regional Office National Marine Fisheries Service. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon - Public Review Draft. March 2010	Domestic garbage along Purrington Creek should be cleaned up and existing illegal dump sites along the road should be posted to reduce the possibility of toxic substances entering the creek. These dump sites appear to be routinely visited and periodic patrols by local law enforcement should be encouraged.	Water Quality	Guerneville HSA	10
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Reports of assessments should include developed plans for specific treatments for high priority sites, and recommended treatments for secondary priority sites.	Gravel Quality	Russian River HU	9
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Dredge removal volumes: clearly identify the extent of the dredged reach. Record timing of the dredging. Estimate the magnitude of the dredged volume. Frequency based on dredging frequency.	Science	Laguna de Santa Rosa HSA	9
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Minimum DO/ % Sat/ REDOX: several locations - electronic probe at multiple depths. Continuously at 15 minute increments.	Science	Laguna de Santa Rosa HSA	9
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Nutrient concentrations (eg: PO4, TP, NO3, NO2, TN, Total ammonia); EPA 365.3/EPA 351.3.	Science	Laguna de Santa Rosa HSA	9
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Organic carbon/BOD concentrations; organic carbon: astm D4129-82M or equivalent; BOD 5 day: SM5210B.	Science	Laguna de Santa Rosa HSA	9
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Sediment nutrient flux to measure the sediment nutirent flux in the Laguna's sediments during low and high flow conditions.	Science	Laguna de Santa Rosa HSA	9
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Sediment Oxygen Demand (SOD) as a special study to measure the SOD in the Laguna's sediments during low and high flow conditions.	Science	Laguna de Santa Rosa HSA	9
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Unionized ammonia and pH: NH3 Calculated from temperature, pH and total ammonia; pH - electric probe. pH at 15 minute intervals, NH3 to be determined.	Science	Laguna de Santa Rosa HSA	9
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Under the Sonoma County Water Agency contract, monitor aluminum and temperature in the mainstem and tributaries, especially the East Fork and at gravel mining areas near Healdsburg.	Water Quality	Coyote Valley HSA	9

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: WATER QUALITY PROTECTION AND IMPROVEMENT				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
North Coast Regional Water Quality Control Board. North Coast Regional Water Quality Control Board Watershed Planning Chapter. February, 2005	Maintain bacterial sampling at public water- contact recreation areas.	Water Quality	Russian River HU	9
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	N/P limitation to measure the nitrogen and phosphorus ratios in the Laguna during low and high flow conditions.	Science	Laguna de Santa Rosa HSA	8
National Marine Fisheries Service. Habitat Restoration and Conservation Plan for Anadromous Salmonid Habitat in Selected Tributaries of the Russian River Basin DRAFT. 2007	Evaluate sediment sources	Water Quality	Geyserville HSA	8
Laguna de Santa Rosa Foundation. The Altered Laguna A Conceptual Model for Watershed Stewardship. 2007	Temperature: several locations - electronic probe at multiple depths. Continuously at 15 minute increments.	Science	Laguna de Santa Rosa HSA	7

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: CLIMATE CHANGE ADAPTATION AND MITIGATION				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
California Department of Water Resources. California Water Plan 2009 Update Pre-Administrative Draft Volume I The Strategic Plan. October, 2008	State government should lead and support planning and research to help California adapt and mitigate for climate change impacts, and emphasize drought and flood contingency planning.	Socioeconomic	Russian River HU	51
Russian River Keeper. Interviewee Don McEnhill. 3/28/2011	Climate change effects. Forecasting how changes will effect land use management. For instance, using water for heat control in vineyards will be a huge demand in the summer. This practice needs to be modified.	Water Quantity	Russian River HU	35
Coyote Valley Tribal EPA Department. Interviewees Richard Campbell and Dan Rodriquez. 2/24/2011	The main focus of Coyote Valley has been on fisheries populations and native plant communities. Monitoring water quality and monitoring for climate change are important to the Coyote Valley Tribe.	Fisheries Protection	Forsythe Creek HSA	33
California Department of Water Resources. California Water Plan 2009 Update Pre-Administrative Draft Volume I The Strategic Plan. October, 2008	Local governments should update General Plans to address drought, water quality, and flood risks in light of existing and future climate change impacts.	Water Quantity	Russian River HU	32
Sonoma County Water Agency. Interviewee David Manning. 3/28/2011	Integrated Water Resources Sciences and Services (IWRSS): NOAA program to enhance predictions for water resource situations. This will enhance operations of the dams to meet multiple goals, including climate change issues. Reference to Chris Delaney as an engineer who is involved in this project.	Water Quantity	Mainstem Russian River	32
Occidental Arts and Ecology Center. Interviewee Brock Dolman. 3/18/2011	Predictive models that link climate change to basin conditions need more press. The effects on precipitation, fire, hydrologic cycle, frost, sedimentation, sea level rise need to be better understood and provided for policy/management decisions.	Socioeconomic	Guerneville HSA	28
Russian River Keeper. Interviewee Don McEnhill. 3/28/2011	Water rights and demands, and needs of aquatic habitats need to be balanced. Even with normal precipitation, the demand on supply from Lake Mendocino makes lack of storage a problem. Increasing storage at Lake Mendocino is an important part of addressing climate change. Options of increasing storage include sediment removal (dredging) and raising the elevation of Coyote Dam.	Water Quantity	Russian River HU	18

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: CLIMATE CHANGE ADAPTATION AND MITIGATION				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
CDFG. 2002 Draft Russian River Basin Fisheries Restoration Plan. 7/1/2002	Counties should support and be active with multi-stakeholder groups (such as the Russian River Watershed Council) in working on watershed issues and landuse plan changes. Counties should identify, develop, fund or find funding to participate in these collaborative processes which assist community disclosure and support for county projects.	Socioeconomic	Russian River HU	56
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	The City of Santa Rosa and SCWA jointly fund a creek steward position for creek channels in Santa Rosa. The creek steward performs education and outreach to the public, and facilitates community involvement in creek restoration projects. Support the continued funding of this position, and the development of a new creek steward position for channels outside the city of Santa Rosa, with special focus on the urbanized areas in the southern Laguna watershed.	Socioeconomic	Laguna de Santa Rosa HSA	42
California State Coastal Conservancy. California State Coastal Conservancy Strategic Plan 2007. 2007	Develop approximately 11 plans to create or improve waterfront or watershed projects, including but not limited to parks along regional trails, multibenefit pocket parks or projects that demonstrate innovative storm water management strategies. Develop and use definition of "underserved community" to prioritize projects that create parks in underserved communities, especially along river parkways that connect to the Coastal Trail. Incorporate latest scientific understanding of sea-level rise into consideration when planning parks and infrastructure.	Socioeconomic	Russian River HU	37
California State Coastal Conservancy. California State Coastal Conservancy Strategic Plan 2007. 2007	Implement approximately 15 projects to create or enhance waterfront or watershed parks, including but not limited to parks along regional trails, multibenefit pocket parks, or projects that demonstrate innovative stormwater management strategies. Prioritize projects that create parks in underserved communities, especially along river parkways that connect to the Coastal Trail.	Socioeconomic	Russian River HU	36
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	When volunteers and students participate in creek restoration they develop a unique appreciation and sense of personal responsibility for the environment. Support community-based riparian restoration and environmental education programs, to educate about the importance of riparian processes and create connection to the land and the community.	Socioeconomic	Laguna de Santa Rosa HSA	27
Sonoma County Water Agency. Russian River Action Plan. May, 2003	Ukiah Riverside Park	Socioeconomic	Ukiah HSA	24
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Develop plans for the urban creeks and nearby greenbelt properties. Develop existing SCWA rights-of-way into a multi-use trail system in the Rohnert Park/Cotati area. Install sufficient infrastructure, including bridges, tunnels and fords, to provide connectivity among the network of trails. Connect SCAPOSD greenbelt easement properties, situated between Rohnert Park and Santa Rosa, into a "string of pearls" connected by creekside trails. Provide connectivity between the existing trails of the Rohnert Park/Cotati area with the proposed Laguna Community Corridor that will extend northwest to Sebastopol and the Santa Rosa Creek Trail.	Socioeconomic	Laguna de Santa Rosa HSA	21
Laguna de Santa Rosa Foundation. Interviewee Hattie Brown. 4/20/2011	Continued environmental education by groups like the LF and partners.	Socioeconomic	Laguna de Santa Rosa HSA	21
California State Coastal Conservancy. California State Coastal Conservancy Strategic Plan 2007. 2007	Design approximately 52 miles of regional trails and river parkways along rivers and creeks to connect inland populations to the coast and expand recreational opportunities. Provide funding to public agencies and noprofit organizations to refine plans for inland trails that connect to the coast. Identify inland trails that need wheelchair-accessible facilities. Prioritize trail routes identified in Completing the California Coastal Trail that connect inland populations ot the coast. Incorporate predicted alterations in stream flows and channels into siting and design of trails. Current projects include the Russian River, Big River, and Mad River.	Socioeconomic	Russian River HU	20

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: CLIMATE CHANGE ADAPTATION AND MITIGATION				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Sonoma County Water Agency. Russian River Action Plan. May, 2003	Riverfront Park	Socioeconomic	Guerneville HSA	20
Sonoma County Water Agency. Russian River Action Plan. May, 2003	Sunset Beach River Access	Socioeconomic	Guerneville HSA	19
Sonoma County Water Agency. Russian River Action Plan. May, 2003	Steelhead Beach Regional Park and Fishing Access	Socioeconomic	Guerneville HSA	18
California Dept of Parks & Recreation, Statewide Trails Office. California Recreational Trails Plan. March, 2005	Design and implement or support assessment surveys and research projects that will help determine trail user information needs. Develop a methodology and implement a program to collect data on the number of trail users, the type of use, reasons for choosing the trail, and the benefits users received. The results should be publicized and used to promote individual trails and general trail benefits, and to determine public information needs.	Socioeconomic	Russian River HU	18
California Dept of Parks & Recreation, Statewide Trails Office. California Recreational Trails Plan. August, 2005	Encourage public agencies to incorporate trails and trails planning into their normal organizational infrastructure, including the development of annual operation and maintenance budgets to adequately care for trails.	Socioeconomic	Russian River HU	14
City of Santa Rosa. Santa Rosa General Plan 2035. November, 2009	Provide educational opportunities along the waterways in the city.	Socioeconomic	Russian River HU	13
California State Coastal Conservancy. California State Coastal Conservancy Strategic Plan 2007. 2007	Construct approximately 56 miles of regional trails and river parkways along rivers and creeks to connect inland populations to the coast and expand recreational opportunities. Current projects include the Russian, Big, and Mad River	Socioeconomic	Russian River HU	12
County of Sonoma Board of Supervisors. Draft Sonoma County Outdoor Recreation Plan. March, 2003	Develop the Guerneville regional recreation area (river access) on surplus Caltrans property. This regional recreation facility would be located on a 6.5 acre site surrounding the south side of the former Highway 116 bridge. This need is identified by the Russian River related plans and the park acreage/population analysis method. 2008 Update - this recommendation is ongoing.	Socioeconomic	Guerneville HSA	12
Sonoma Land Trust, Laguna de Santa Rosa Foundation. Laguna de Santa Rosa: Resource Atlas and Protection Plan. March, 2006	Develop a program for docent-led hiking trails on public and other protected lands of the Laguna.	Socioeconomic	Laguna de Santa Rosa HSA	12
California Dept of Parks & Recreation, Statewide Trails Office. California Recreational Trails Plan. August, 2005	Provide grant programs or other funding to encourage development of local trail system plans. This could be accomplished, in part, by including criteria and scoring enhancements for grant applicants who relate their trail project to needs identified in an existing and approved local or regional trails plan.	Socioeconomic	Russian River HU	12
County of Sonoma Board of Supervisors. Draft Sonoma County Outdoor Recreation Plan. March, 2003	Develop land for a regional open space park in the Mark West Creek Road area. 2008 update - this recommendation has had progress made; the Cresta property was acquired by the Open Space district, which connects to about 6 miles of OSD trail easements adjacent to Pepperwood. More connections are currently in the works.	Socioeconomic	Mark West HSA	11
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Create an automobile touring route using existing roads that skirt the Laguna wetlands perimeter. Provide automobile access to the Laguna and its many discontiguous properties by mapping a safe and scenic route along nearby back country roads. Provide birding and other wildlife viewing opportunities to the general public without intruding into sensitive wildlife refuges. Promote eco-tourism that showcases the Laguna as a rich ecosystem of freshwater wetlands and nearby uplands with world-class birding opportunities.	Socioeconomic	Laguna de Santa Rosa HSA	11
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Increase opportunities for the public to view and appreciate restored seasonal wetlands and other Laguna habitat complexes in ways that respect the environmental sensitivity of these habitats.	Socioeconomic	Laguna de Santa Rosa HSA	11

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: CLIMATE CHANGE ADAPTATION AND MITIGATION				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Work with all of the public land managers in the Laguna to develop a consolidated trails and recreation plan. Use the SCAPOSD plan as a framework for further opening adjacent public properties to the general public. Include in the plans the properties owned by CDFG, Sonoma County Regional Parks Department, SCWA, SCAPOSD, Sebastopol, Cotati, Rohnert Park, Windsor and Santa Rosa. Consider passive forms of recreation including: wildlife viewing, hiking, biking, horseback riding, kayaking and canoeing.	Socioeconomic	Laguna de Santa Rosa HSA	11
California Dept of Parks & Recreation, Statewide Trails Office. California Recreational Trails Plan. August, 2005	Promote continued state funding and identify new funding sources for acquisition and development of trails or to formalize traditional trail routes.	Socioeconomic	Russian River HU	10
California Dept of Parks & Recreation, Statewide Trails Office. California Recreational Trails Plan. August, 2005	Work toward developing a common database aimed at identifying trail accessibility and accommodation and, once developed, provide the information to the public.	Socioeconomic	Russian River HU	10
Community Foundation Sonoma County and Sonoma County Water Agency. Biodiversity Action Plan: Priority Actions to Preserve Biodiversity in Sonoma County. October 2010	Support development of K-12 curricula focused on biodiversity and eco-system services, promote high school learning opportunities, facilitate partnerships between resource agencies and managers and cooleges and universities, facilitate public access to the reserve network, engage stewardship groups, highlight the impact of biodiversity on quality of life, safety, livelihood, and pocketbook for Sonoma County residents.	Socioeconomic	Guerneville HSA	10
County of Sonoma Board of Supervisors. Draft Sonoma County Outdoor Recreation Plan. March, 2003	Acquisition and development of the Laguna de Santa Rosa Preserve with trail connections. 2008 Update - this recommendation is still ongoing, with other agencies in the lead.	Socioeconomic	Laguna de Santa Rosa HSA	9
Sonoma Land Trust, Laguna de Santa Rosa Foundation. Laguna de Santa Rosa: Resource Atlas and Protection Plan. October, 2004	Work with Sonoma County Water Agency, City of Santa Rosa, CDFG, and SCAPOSD to develop trails on their properties.	Socioeconomic	Laguna de Santa Rosa HSA	9
California Dept of Parks & Recreation, Statewide Trails Office. California Recreational Trails Plan. March, 2005	Develop appropriate legislative support for trails funding, including encouraging, on the state level, the inclusion of trail categories in future bond acts and agressively pursuing the re-authorization of TEA on the federal level.	Socioeconomic	Russian River HU	9
California Dept of Parks & Recreation, Statewide Trails Office. California Recreational Trails Plan. March, 2005	Encourage and support open and continuing dialogue among private property owners, community organizations, professional land use organizations such as farm and cattlemen associations, adjacent public property government entities, and trail expansion advocates regarding trail systems and needed links.	Socioeconomic	Russian River HU	9
County of Sonoma Board of Supervisors. Draft Sonoma County Outdoor Recreation Plan. March, 2003	Matanzas Lake Regional Park. 2008 Update - action on this recom-mendation is moving forward; SCWA owns this property and a feasibility study is being prepared.	Socioeconomic	Santa Rosa Creek HSA	8
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Develop plans for a multi-use north-south system of trails. Utilize public lands whenever possible and utilize bike lanes on roadways whenever necessary. Establish the corridor as both a transportation facility and an open space recreational opportunity. Connect the Santa Rosa Creek trail with the Joe Rodota Trail and connect the Joe Rodota Trail to the cities of Cotati and Rohnert Park.	Socioeconomic	Laguna de Santa Rosa HSA	8
Sonoma Land Trust, Laguna de Santa Rosa Foundation. Laguna de Santa Rosa: Resource Atlas and Protection Plan. October, 2005	Acquire strips of land in fee or easement for public access trails.	Socioeconomic	Laguna de Santa Rosa HSA	8
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Increased public access raises environmental awareness about the importance of riparian corridors. Where there are well-used trails and bike paths there is less vandalism and illegal camping. Where appropri-ate, service roads and rights-of-way should be developed as walking or biking trails.	Socioeconomic	Laguna de Santa Rosa HSA	7
County of Sonoma Board of Supervisors. Draft Sonoma County Outdoor Recreation Plan. March, 2003	Acquire and develop Fitch Mountain as a regional open space park between 200 - 250 acres in size to provide passive recreation opportuni-ties at a prominent landmark. 2008 update - the lead on this project is being shared by the City of Healdsburg and Sonoma County OSD.	Socioeconomic	Geyserville HSA	6

RUSSIAN RIVER ICWMP RESOURCE MANAGEMENT STRATEGY: CLIMATE CHANGE ADAPTATION AND MITIGATION				
SOURCE AGENCY. SOURCE DOCUMENT/ INTERVIEW. DATE PUBLISHED	RECOMMENDATION DESCRIPTION	MAIN SUBJECT	LOCATION/ HSA	SCORE (MAX. 60)
County of Sonoma Board of Supervisors. Draft Sonoma County Outdoor Recreation Plan. March, 2003	Acquire and develop Western Hills regional open space park in the hills west of Cloverdale of about 300 acres in size. 2008 update - this recommendation is on track with OSD having purchased the Clover Springs parcel. More land may be added in the future, so this recommendation is likely to change slightly in the next iteration of the Plan.	Socioeconomic	Geyserville HSA	6
County of Sonoma Board of Supervisors. Draft Sonoma County Outdoor Recreation Plan. March, 2003	Acquire land for regional open space park in the Porter Creek area. 2008 Update - this recommendation is still ongoing and seeks to protect and provide access to the unique features of the Petrified Forest area. Some of the progress made on the Mark West Creek Road area recommendation - the Cresta acquisition - contributes to this recommendation.	Socioeconomic	Russian River HU	6
Sonoma Land Trust, Laguna de Santa Rosa Foundation. Laguna de Santa Rosa: Resource Atlas & Protection Plan. October, 2005	Acquire land for passive recreational opportunities.	Socioeconomic	Laguna de Santa Rosa HSA	6
County of Sonoma Board of Supervisors. Draft Sonoma County Outdoor Recreation Plan. March, 2003	Acquire land for expanding Hood Mountain Regional Park. 2008 update - this recommendation has been implemented several times and is likely to continue as more land becomes available for acquisition.	Socioeconomic	Santa Rosa Creek HSA	5
Laguna de Santa Rosa Foundation. Enhancing and Caring for the Laguna de Santa Rosa Volume I: A plan for restoring and managing the Laguna de Santa Rosa Watershed, Sonoma County, California. 2006	Follow the SCAPOSD plans, developed with community input, that specify public access on the City of Santa Rosa's farms. Use these plans to site trailheads, trails, picnic facilities, and interpretive signs.	Socioeconomic	Laguna de Santa Rosa HSA	5
Sonoma Land Trust, Laguna de Santa Rosa Foundation. Laguna de Santa Rosa: Resource Atlas and Protection Plan. October, 2005	Acquire land for trailhead facilities.	Socioeconomic	Laguna de Santa Rosa HSA	4

RUSSIAN RIVER
INTEGRATED COASTAL WATERSHED
MANAGEMENT PLAN

APPENDIX 16. MANAGEMENT MEASURES FOR THE RUSSIAN RIVER WATERSHED

AGRICULTURE

ANIMAL WASTE

1. Baseline Description

General Setting:

The Lower Russian River and Laguna de Santa Rosa are 303(d) listed as impaired due to pathogens, low dissolved oxygen (DO), and nutrients. Total Maximum Daily Loads (TMDLs) and TMDL Implementation Plans for pathogens, DO, and nutrients will be completed by the North Coast Regional Water Quality Control Board (NCRWQCB 2006). An increase in pathogens can be a human health risk, leading to limitations on water contact recreation and closed beaches; it can also cause an increase in biochemical oxygen demand (BOD), which is the amount of oxygen consumed by microbial decomposition of organic waste. An increase in BOD can cause a decrease in DO; increased nutrients can also cause algae blooms, leading to a decrease in DO available for biotic respiration. This lack of DO affects all aquatic organisms, including endangered salmonids.

Causal Factors:

Dairy operations and other confined animal feeding operations (CAFOs) have contributed to pathogens and nutrients above natural background levels in the Laguna de Santa Rosa and the Lower Russian River. Other sources of animal waste above background levels in the watershed include range animals and pets.

2. Management Measure Description

The Animal Waste MM limits the discharge of manure, litter, and process wastewater from confined animal facilities that are not CAFOs. Facilities defined as CAFOS are considered point source discharges and are required to obtain NPDES permits; all other confined animal facilities are considered nonpoint sources.

3. Resource Concerns

Inadequate Water Quality

Water Quality — Excessive Nutrients, Pathogens, or Organics

4. Management Practices

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
NRCS	Animal Mortality Facility (316)	No.
NRCS	Closure of Waste Impoundments (360)	No.
NRCS	Composting Facility (317)	No.
NRCS	Drainage Water Management (514)	AC
NRCS	Solid/Liquid Waste Separation Facility (632)	No.
NRCS	Waste Storage Facility (313)	No.
NRCS	Waste Storage Facility, Shotcrete Structure (313A)	No.
NRCS	Waste Storage Facility, Pond (31B)	No.
NRCS	Waste Storage Facility, Concrete Structure (313C)	No.

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Chemical and Physical Characteristic (Water Quality)	
Conventionals: Dissolved Oxygen (DO)	Dissolved Oxygen: Greater than 5 mg/L, 2 to 5 mg/L,Less than 2 mg/L
Conventionals: Nutrients	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L
Biological Conditions: Chlorophyll (lakes, streams, estuaries)	Algae (Chlorophyll a): "High" "Moderate" and "Low Quality" less than 5.0 µg/L, 5 to 20 µg/L, greater than 20 µg/L
Pathogens (Drinking Water Rule, Basin Plan language)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Algae (Microcystis/ Microcystin)	Algae (Chlorophyll a): "High" "Moderate" and "Low Quality" less than 5.0 µg/L, 5 to 20 µg/L, greater than 20 µg/L
Nitrates	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L
E. coli, enterococci (freshwater)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Biotic Condition	
Biological Conditions: Benthic Macro-invertebrates (BMI, streams)	BMIs: Threshold between "Good" and "Fair," out of 1.00 for reference condition. California Macroinvertebrate Observed/ Expected Index (O/E Index) score of 0.77; Western EMAP Macroinvertebrate Index of Biotic Integrity (IBI) score of 0.57.

Protocol & Data Sources

SWAMP protocols ("Standard Operating Procedures") http://swamp.mpsl.mlml.calstate.edu/

California Monitoring and Assessment Program (CMAP). The CAMP monitoring project was developed in collaboration with the SWRCB's Non-Point Source Pollution control Program (NPS), SWRCB's SWAMP program and the US EPA's Region IX.

Department of Water Resources (DWR) Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/

DWR Water Plan Information Exchange: hub with links to various databases http://www.waterplan.water.ca.gov/waterpie/index.cfm

DWR Water Plan and Updates: water quality improvement strategies and data on water use http://www.waterplan.water.ca.gov/waterquality/water_quality.cfm

EPA TMDL program http://www.epa.gov/OWOW/tmdl/

EPA WEMAP (Western Environmental Monitoring and Assessment Program; http://www.epa.gov/region09/water/wemap/surface.html) for physical habitat structure, sediment metabolism, sediment chemistry, water quality parameters, and riparian vegetation.

SWAMP http://www.swrcb.ca.gov/water_issues/programs/swamp/, including water quality and toxicity data at http://swamp.mpsl.mlml.calstate.edu/online-data

SWAMP BMI, stream assessment, and other reports including Ode 2007, SWAMP 2005, and Ode and Rehn 2005 http://www.swrcb.ca.gov/water_issues/programs/swamp

SWAMP protocols ("Standard Operating Procedures") http://swamp.mpsl.mlml.calstate.edu/ and selected reports under "Bioassessment" at http://www.swrcb.ca.gov/water_issues/programs/swamp/reports.shtml#bioassessment

SWRCB North Coast Basin Plan http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/basin_plan.shtml

6. Relevant Programs

Agricultural Management Assistance Program, NRCS

"Agricultural Management Assistance (AMA) provides cost share assistance to agricultural producers to voluntarily address issues such as water management, water quality, and erosion control by incorporating conservation into their farming operations. Producers may construct or improve water management structures or irrigation structures; plant trees for windbreaks or to improve water quality; and mitigate risk through production diversification or resource conservation practices, including soil erosion control, integrated pest management, or transition to organic farming."

Agricultural Water Quality Grant Program, SWRCB

"The Agricultural Water Quality Grant Program provides funding for projects that reduce or eliminate non-point source pollution discharge to surface waters from agricultural lands. Funding from Propositions 40 and 50 were administered through two solicitations, most recently the 2005-2006 Consolidated Grants Process. Additional funds will be made available in the future through Proposition 84."

Biologically Integrated Farming Systems (BIFS)

"BIFS is a program to help growers enhance environmental quality while maintaining yields and profits. BIFS projects use on-farm demonstrations and a collaborative model of outreach and extension involving public-private partnerships."

California Dairy Quality Assurance (CDQA) Program

"California Dairy Quality Assurance (CDQA) Program was created to assist dairy producers with navigating and complying with the rules and regulations governing the industry. The CDQA program is a voluntary partnership between dairy producers, government agencies, and academia to address environmental stewardship, animal welfare, and food safety issues. The environmental stewardship module has three components: education, self-assessment, and third-party evaluation, terminating in certification, and focuses on compliance with federal, state, and local water quality regulations. A comprehensive checklist is used as the assessment tool in the certification process."

California's Critical Coastal Areas Program

The purpose of California's Critical Coastal Areas (CCA) Program is "to foster collaboration among local stakeholders and government agencies and better coordinate resources and efforts in coastal-zone watershed areas critically in need of protection from polluted runoff." The North Coast is one of four regional pilot CCAs in which the CCA Program will form teams comprised of local stakeholders and state, federal, and local agencies to develop community-based action plans to reduce

polluted runoff in coastal zone watershed areas. www.coastal.ca.gov/nps/cca-nps.html

Conservation Planning Assistance, NRCS

"The Natural Resources Conservation Service (NRCS) provides conservation planning and technical assistance to clients (individuals, groups, and units of government). These clients develop and implement conservation plans to protect, conserve, and enhance natural resources (soil, water, air, plants, and animals) within their related social and economic interests."

Environmental Quality Incentives Program, NRCS

"The Environmental Quality Incentives Program (EQIP) was reauthorized in the Farm Security and Rural Investment Act of 2002 (Farm Bill) to provide a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land."

Nonpoint Source Management Program — Clean Water Act Section 319, US Environmental Protection Agency

This Program was established through an amendment to the Clean Water Act in 1987 to provide grant money to support activities including technical and financial assistance, education and training, technology transfer, demonstration projects, and project success monitoring. http://www.epa.gov/owow/nps/cwact.html

Nonpoint Source Pollution Control Programs, SWRCB

The State Water Resources Control Board administers several grant programs, which assist local entities with nonpoint source pollution control. The grants are made available through voter approval of the following Propositions: 13, 40, 50, and 84.

Watershed Protection Programs, SWRCB

The State Water Resources Control Board administers several programs for watershed protection under Propositions approved by voters. These Propositions are: 13, 40, and 50.

7. Relevant Policies & Plans

California Water Plan Update 2013, DWR

Presents status and trends for water-dependent resources, supplies, and demands. Evaluates regional and statewide management strategies to identify effective actions and policies. Includes Regional Basin Plans.

Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program, SWRCB

"The information provided in this policy is designed to assist all responsible and/or interested parties in understanding how the State's NPS water quality control requirements will be implemented and enforced. The parties involved include the SWRCB and the RWQCBs, federal, state and local agencies, individual dischargers, designated third-party representatives and any other interested public and private parties."

Porter-Cologne Water Quality Control Act, SWRCB

This act provides for regional water quality control under the supervision of the State Water Resources Control Board. Regional Water Quality Control Boards were created to prescribe and define beneficial uses of water and to define standards necessary to maintain them.

Workplan for Developing Biological Objectives for Perennial Wadeable Streams in the State of California, SWRCB

Defines a path toward creating biological objectives to protect aquatic resources of the state.

Water Quality Control Policy for Addressing Impaired Waters: Regulatory Structure and Options (TMDL Policy), SWRCB

Establishes the State's Total Maximum Daily Load (TMDL) program. TMDL sets limits on the amount of pollutants water can be exposed to before adversely impacting Beneficial Uses of water. Required by Section 303(d) of the Federal CWA, established in 1972.

Water Quality Control Policy for developing California's Clean Water Act Section 303(d) list, SWRCB

Describes the process by which the SWRCB and Regional Boards will comply with the

listing requirements of Section 303(d) of the federal Clean Water Act (CWA).

Nonpoint Source Management Plan, SWRCB

Identifies nonpoint source control programs and milestones, and effluent limitations.

Pathogens in the Russian River Policy, NCRWQCB and Sonoma County Department of Health Services

Russian River and tributary monitoring at several sites to determine bacteria abundance and variability (1996-2010). 2011-2012 efforts aimed at development of Russian River Pathogen TMDL. Land use, beach use impacts on bacteria levels. Quality assurance project plans (QUAPP). Establishes bacteria thresholds for human health.

8. Sources

SWRCB. 2009. NPS Encyclopedia. 1B — Animal Waste. http://www.waterboards.ca.gov/water_issues/programs/nps/encyclopedia/1b_animalwste.shtml

SWRCB/ SWAMP Core Indicators for Beneficial Uses in California (SWAMP 2010/ SWAMP 2006)

USDA. No date. *Electronic Field Office Technical Guide for California*. U.S. Department of Agriculture, Natural Resource Conservation Service. (http://efotg.nrcs.usda.gov/)

EROSION AND SEDIMENT CONTROL

1. Baseline Description

General Setting:

The Russian River is 303(d) listed as impaired by sediment. Excessive sedimentation can alter instream habitat by causing embeddedness of spawning gravels or changing stream morphology by reducing channel depth and decreasing the depth, frequency, and volume of pools. It can also increase turbidity, which decreases availability and visibility of food sources, and when severe may damage fish directly by clogging gills. When agricultural soil erodes, fertile soil for agricultural operations is lost and fertilizer, pesticides, and other contaminants may be carried with the soil into the river system.

Causal Factors:

Sedimentation in the Russian River watershed is caused by runoff from unpaved roads, construction, agricultural and forestry activities, and other anthropogenic activities that disturb soil. Exposed soil erodes during storm events and enters water bodies that drain to the Russian River.

2. Management Measure Description

The Erosion and Sediment Control Management Measure promotes practices that reduce erosion and to the extent practicable, retain sediment on site. The goal of this MM is to put forth practices that will contribute to the attainment of the Russian River Sediment TMDL (in development) and the eventual delisting of the Russian River as impaired due to excessive sedimentation.

3. Resource Concerns

Inadequate Food Sources for Wildlife

Inadequate Shelter

Inadequate Water Quality

Soil Erosion — Roadbank and Construction Sites

Soil Erosion - Sheet and Rill
Threatened and Endangered Fish and Wildlife Species

Water Quality — Excessive Nutrients, Pathogens, or Organics

Water Quality — Excessive Sediment

Water Quality — Harmful Temperatures of Surface Water

4. Management Practices

Recommended practices for promoting upland sediment and erosion control should include the following principles:

- Project planning is critical for success
- Erosion and sediment control should be evaluated within a watershed management context
- Choose an appropriate approach to slope stabilization and erosion control — a vegetative method for reducing erosion is preferable to a structural
- approach
- When using plant material, seeds, transplants and plant materials for propagation should be collected as close as possible to the project site (within project site watershed). Collection should be conducted to maximize genetic diversity of propagation material (from multiple plants in diverse locations and in the case of seeds, at different time intervals) and in a manner that minimizes impacts to the collection site

- Project implementation should be conducted to minimize impacts to adjacent areas and resident wildlife
- Project should be monitored for success and to provide information for adaptive management

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
CDFG	Emergent Transplant Installation	AC
CDFG	Container Plant Installation with Protective Shelters	AC
CDFG	Direct Seed Installation	AC
CDFG	Slide Stabilization	FT
CDFG	Native Material Revetment	FT
CDFG	Mulching	AC
CDFG	Brush Mattress	FT
CDFG	Waterbars	FT
SWRB	Storm Water Pollution Prevention Plan	
NRCS	Conservation Cover (327)	AC
NRCS	Residue Management (329)	AC
NRCS	Contour Farming (330)	AC
NRCS	Contour Orchard and Other Fruit Area (331)	AC
NRCS	Contour Buffer Strips (332)	AC
NRCS	Cover Crop (340)	AC
NRCS	Critical Area Planting (342)	AC
NRCS	Residue and Tillage Management Mulch Till (345)	AC
NRCS	Residue and Tillage Management Mulch Till (346)	AC
NRCS	Residue Management No Till and Strip Till (347)	AC
NRCS	Sediment Basin	NO
NRCS	Field Border (386)	FT
NRCS	Filter Strip (393)	AC
NRCS	Land Reclamation Landslide Treatment (453)	NO
NRCS	Precision Land Forming (462)	AC
NRCS	Use Exclusion (472)	AC
NRCS	Mulching (484)	AC
NRCS	Prescribed Grazing (528)	AC
NRCS	Land Reconstruction — Abandoned Mined Land (543)	AC
NRCS	Land Reconstruction — Currently Mined Land (544)	AC
NRCS	Row Arrangement (557)	AC
NRCS	Roof Runoff Structure (558)	NO
NRCS	Runoff Management System (570)	NO
NRCS	Stripcropping (585)	AC
NRCS	Pest Management (595A)	AC
NRCS	Terrace (600)	FT
NRCS	Vegetative Barrier (601)	FT
NRCS	Surface Roughening (609)	AC
NRCS	Tree/Shrub Establishment (612)	AC
NRCS	Tree/Shrub Establishment (A), Bareroot/Containerized Stock (612A)	AC
NRCS	Tree/Shrub Establishment (B), Direct Seeding (612B)	AC
NRCS	Tree/Shrub Establishment (C), Pole plantings/cuttings (612C)	AC
NRCS	Water and Sediment Control Basin (638)	NO
NRCS	Windbreak-Shelterbelt Renovation	FT
NRCS	Road/Landing Removal (722)	AC
USEPA	Infiltration Practices	
USEPA	Detention/Retention Practices	

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
LANDSCAPE CONDITION	
Impervious Surfaces	**Impervious surface:** > 12.01 % of watershed by area 7.01 to 12 % 3.01 to 7 % 0 to 3 %
Rainfall	
Landslides, fluvial, and surface erosion (agricultural activities)	
Stream crossing failures	
Density of unpaved roads	
Road Density	**Road Density**: From "Poor" to "Very Good" Road density: > 3 miles/ square mile, 3 to 2.5, 2.5 to 1.6, <1.6; Road density within 100 m. stream: >1 mile/square miles, 1 to 0.5, 0.5 to 0.1, <0.1
Hydrology and Geomorphology	
Gravel Quality (Bulk)	**Gravel quality (bulk):** >17 % (D50=0.85), 15 to 17 %, 12 to 14 %, <12 %
Embeddedness	**Gravel quality (embeddedness):** <25 % of scores are Category 1 or 2, 25 to 50 %, >50 %, Not defined
Spawning gravel quantity & distribution	**Gravel quality (bulk):** >17 % (D50=0.85), 15 to 17 %, 12 to 14 %, <12 %
Substrate Composition	**Gravel quality (embeddedness):** <25 % of scores are Category 1 or 2, 25 to 50 %, >50 %, Not defined
Sediment-related barriers	**Physical barriers:** <50 of IP-km, 50 to 70 %, 70 to 90 %, >90 %
CHEMICAL AND PHYSICAL CHARACTERISTICS	
Conventionals: Dissolved Oxygen (DO)	**Dissolved Oxygen:** Greater than 5 mg/L, 2 to 5 mg/L,Less than 2 mg/L
Conventionals: Water and/or sediment toxicity	**Sediment Quality Indicators:** Total Organic Carbon Sediment Contamination, Amphipod Toxicity, Species Richness - See Attachment B2.
Sediments/TDS	**Sediment Quality Indicators:** Total Organic Carbon Sediment Contamination, Amphipod Toxicity, Species Richness - See Attachment B2.
BIOTIC CONDITION	
Biological Conditions: Benthic Macro-invertebrates (BMI, streams)	BMIs: Threshold between "Good" and "Fair," out of 1.00 for reference condition. California Macroinvertebrate Observed/ Expected Index (O/E Index) score of 0.77; Western EMAP Macroinvertebrate Index of Biotic Integrity (IBI) score of 0.57.

Protocol & Data Sources

California Monitoring and Assessment Program (CMAP). The CAMP monitoring project was developed in collaboration with the SWRCB's Non-Point Source Pollution control Program (NPS), SWRCB's SWAMP program and the US EPA's Region IX.

Department of Water Resources (DWR) Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/

DWR Water Plan Information Exchange: hub with links to various databases http://www.waterplan.water.ca.gov/waterpie/index.cfm

DWR Water Plan and Updates: water quality improvement strategies and data on water use http://www.waterplan.water.ca.gov/waterquality/water_quality.cfm

EPA TMDL program http://www.epa.gov/OWOW/tmdl/

EPA WEMAP (Western Environmental Monitoring and Assessment Program; http://www.epa.gov/region09/water/wemap/surface.html) for physical habitat structure, sediment metabolism, sediment chemistry, water quality parameters, and riparian vegetation.

SWAMP http://www.swrcb.ca.gov/water_issues/programs/swamp/, including water quality and toxicity data at http://swamp.mpsl.mlml.calstate.edu/online-data

SWRCB North Coast Basin Plan http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/basin_plan.shtml

California Rapid Assessment Method (CRAM) method for riparian condition measures: Collins et al 2008 http://www.cramwetlands.org/documents/

California Watershed Assessment Manual II Chapter 3 (Florsheim 2005) http://cwam.ucdavis.edu/Volume_2/TOC.htm

Florsheim 2005 and references therein provide methods for measuring discharge; measuring sediment transport; calculating effective discharge; assessing substrate and grain size distributions; and assessing morphology (http://cwam.ucdavis.edu/Volume_2/TOC.htm).

SWAMP BMI, stream assessment, and other reports including Ode 2007, SWAMP 2005, and Ode and Rehn 2005 http://www.swrcb.ca.gov/water_issues/programs/swamp/

SWAMP protocols ("Standard Operating Procedures") http://swamp.mpsl.mlml.calstate.edu/ and selected reports under "Bioassessment" at http://www.swrcb.ca.gov/water_issues/programs/swamp/reports.shtml#bioassessment

SWAMP physical habitat procedures (Ode 2007 http://swamp.mpsl.mlml.calstate.edu/resources-and-downloads/standard-operating-procedures)

USDA Forest Service: Cumulative watershed effects: Reid 1993 (http://www.fs.fed.us/psw/rsl/projects/water/reid_141.pdf), UCCCWE 2001

USEPA Watershed Assessment of River Stability and Sediment Supply (WARSSS) http://www.epa.gov/warsss/sedsource/streamflo.htm

USGS National Hydrography Dataset http://nhd.usgs.gov/

USGS National Water Information System (NWIS) http://waterdata.usgs.gov/nwis/rt

6. Relevant Programs

Agricultural Management Assistance Program, NRCS

> "Agricultural Management Assistance (AMA) provides cost share assistance to agricultural producers to voluntarily address issues such as water management, water quality, and erosion control by incorporating conservation into their farming operations. Producers may construct or improve water management structures or irrigation structures; plant trees for windbreaks or to improve water quality; and mitigate risk through production diversification or resource conservation practices, including soil erosion control, integrated pest management, or transition to organic farming."

Agricultural Water Quality Grant Program, SWRCB

> "The Agricultural Water Quality Grant Program provides funding for projects that reduce or eliminate non-point source pollution discharge to surface waters from agricultural lands. Funding from Propositions 40 and 50 were administered through two solicitations, most recently the 2005-2006 Consolidated Grants Process. Additional funds will be made available in the future through Proposition 84."

California Forest Stewardship Program, California Department of Forestry and Fire Protection

> "The California Forest Stewardship Program is designed to encourage good stewardship of private forestland. The program provides technical and financial assistance to influence positive changes to forestland management, assists communities in solving common watershed problems, and helps landowners."

The Coastal Watershed Planning and Assessment Program, CDFG

> The Coastal Watershed Planning and Assessment Program (CWPAP) is a Department of Fish and Game (CDFG) program conducting fishery-based watershed assessments along the length of the California coast. Assessment basins are chosen as study areas based upon the nature of the socio-economic and natural resource problems within them. The CDFG Coho Recovery Plan and Steelhead Recovery Plan are useful in selecting basins as well. CWPAP has developed assessment methods, protocols and report outlines.

California Coastal Salmon and Watersheds Program, California Resources Agency

The goal of this program is to: recover harvestable salmon and steelhead populations, restore watersheds, and so contribute to building healthy communities."

California's Critical Coastal Areas Program

The purpose of California's Critical Coastal Areas (CCA) Program is "to foster collaboration among local stakeholders and government agencies and better coordinate resources and efforts in coastal-zone watershed areas critically in need of protection from polluted runoff (CCC undated)." The North Coast is one of four regional pilot CCAs in which the CCA Program will form teams comprised of local stakeholders and state, federal, and local agencies to develop community-based action plans to reduce polluted runoff in coastal zone watershed areas.

Clean Water Team Citizen Monitoring Program, SWRCB

The SWRCB provides support to citizens and local organizations who would like to improve water quality through pollution prevention and citizen-based monitoring programs.

Conservation Planning Assistance, NRCS

"The Natural Resources Conservation Service (NRCS) provides conservation planning and technical assistance to clients (individuals, groups, and units of government). These clients develop and implement conservation plans to protect, conserve, and enhance natural resources (soil, water, air, plants, and animals) within their related social and economic interests."

Environmental Enhancement and Mitigation Program, The California Resources Agency

"The Environmental Enhancement and Mitigation Program was established by the Legislature in 1989. It offers a total of $10 million each year for grants to local, state, and federal governmental agencies and to nonprofit organizations for projects to mitigate the environmental impacts caused by new or modified state transportation facilities." Grants are awarded in three categories: 1) Highway landscape and urban forestry; 2) Resource lands, and 3) Roadside recreational.

Environmental Quality Incentives Program, NRCS

"The Environmental Quality Incentives Program (EQIP) was reauthorized in the Farm Security and Rural Investment Act of 2002 (Farm Bill) to provide a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land."

Fish Friendly Farming, California Land Stewardship Institute

"Fish Friendly Farming provides an incentive-based method for creating and sustaining environmental quality and habitat on private land. Landowners and managers enroll in the program, learn environmentally beneficial management practices and carry out ecological restoration projects."

Fisheries Restoration Grant Program, CDFG

The California Department of Fish and Game coordinates this grant program, which works towards the conservation and restoration of anadromous fisheries and watershed health.

Forestry Improvement Program (FIP), California Department of Forestry and Fire Protection, the Natural Resources Conservation Service, and the USDA Forest Service

This program provides technical and financial assistance for timber stand improvement and site preparation in an effort to enhance productivity of private nonindustrial forestland.

Integrated Hardwood Range Management Program, University of California

The Integrated Hardwood Range Management Program "was established in 1986 to ensure the sustainability of the State's 10 million acres of hardwood rangelands."

Integrated Regional Water Management Grant Program, SWRCB

"The Integrated Regional Water Management (IRWM) Implementation Grants Program,

funded by Proposition 50, Chapter 8, will provide approximately $64 million during Round 2. IRWM Implementation Grants will fund projects that meet one or more of the program objectives of protecting communities from drought, protecting and improving water quality, and improving local water security by reducing dependence on imported water. Implementation Grant proposals must be based on a qualified IRWM Plan."

Nonpoint Source Management Program — Clean Water Act Section 319, US Environmental Protection Agency

This Program was established through an amendment to the Clean Water Act in 1987 to provide grant money to support activities including technical and financial assistance, education and training, technology transfer, demonstration projects, and project success monitoring.

Nonpoint Source Pollution Control Programs, SWRCB

The State Water Resources Control Board administers several grant programs which assist local entities with nonpoint source pollution control. The grants are made available through voter approval of the following Propositions: 13, 40, 50, and 84.

Recovery Strategy for California Coho Salmon, CDFG

"The California Department of Fish and Game, with the assistance of recovery teams representing diverse interests and perspectives, created the Recovery Strategy for California Coho Salmon, a guide for the process of recovering coho salmon on the north and central coasts of California. The Recovery Strategy emphasizes cooperation and collaboration at many levels, and recognizes the need for funding, public and private support for restorative actions, and maintaining a balance between regulatory and voluntary efforts."

Resource Management Program, California Department of Forestry and Fire Protection

The goal of this program is to maintain the sustainability of California's natural resources through administration of State and federal forestry assistance programs for landowners, operation of eight demonstration State Forests, enforcement of the California Forest Practice Act, provision of research and educational outreach, and coordination of fuel reduction to reduce fire danger and improve native ecosystems.

Surface Transportation Program, US Department of Transportation

This program is a block grant program that may be used by states and local governments for any roads that are not functionally classified as local or rural minor collectors. Ten percent of allocated STP funds must be set aside by each state for transportation enhancements, including mitigation of water pollution due to highway runoff.

Watershed Program, DWR

"The Department of Water Resources Watershed Program works with locally led stewardship efforts to integrate the needs of communities, urban and rural, with resource management that sustains watershed ecology."

Watershed Protection Programs, SWRCB

The State Water Resources Control Board administers several programs for watershed protection under Propositions approved by voters. These Propositions are: 13, 40, and 50.

Watershed Stewardship Program, Sotoyome Resource Conservation District

"The SRCD program focuses on education and collaboration within the community to restore resources, improve water quality and habitat, and monitor creeks and watersheds. Working together to find viable solutions for the restoration of the smaller tributary watersheds that will lead to improvements downstream in the main stem of the Russian River Watershed is one of the main goals of this program."

Wildlife Habitat Incentives Program, NRCS

"The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land. Through WHIP USDA's Natural Resources Conservation Service provides both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat. WHIP agreements between NRCS and the participant generally last from 5 to 10 years from the date the agreement is signed."

7. Relevant Policies

California Endangered Species Act (CESA), California Environmental Protection Agency

Compliance with the CESA may be required for environmental projects and management practices. The CDFG administers CESA and can authorize exceptions to the state's prohibition against take of a listed species.

California Environmental Quality Act (CEQA), California Resources Agency

CEQA is a statue requiring state and local agencies to identify significant environmental impacts of proposed activities and to avoid or mitigate those impacts if feasible.

California Forest Practice Rules, California Department of Forestry and Fire Protection Resource Management, Forest Practice Program

"The California Department of Forestry and Fire Protection (CDF) enforces the laws that regulate logging on privately-owned lands in California. These laws are found in the Forest Practice Act which was enacted in 1973 to ensure that logging is done in a manner that will preserve and protect our fish, wildlife, forests and streams."

City of Cloverdale Draft General Plan Update

Chapter 6 Conservation and Open Space Element, provides for protection of distinctive natural vegetation, including riparian, wetlands, and upland ecosystems. Contains policies specifically intended to protect and enhance the natural beauty, habitat and biotic productivity of the Russian River through the use of conservation buffers, stormwater runoff management, habitat improvement, and the use of natural wetland treatment for expansionof wastewater treatment facilities.

City of Cotati General Plan

Chapter 17.53 — Hillside and Ridgeline Development, sets limits to development to protect natural vegetation and prevent erosion, slope failure, and other environmental degradation.

City of Healdsburg General Plan

Chapter 7 — Natural Resources, establishes policies that improve water quality and flows in the Russian River and Dry and Foss Creeks, promote conservation and restoration of native ecosystems and waterways, preserve the city's natural setting, protect the viability of agriculture, reduce greenhouse gas emissions, and protect riparian resources.

City of Rohnert Park General Plan

Chapter 6 — Environmental Conservation, 6.2 Habitat and Biological Resources, sets policies for protection of special status species and special habitat areas, use of native plants for landscaping, and planting of low water use trees. Sets creek protection zones which prohibit development except greenway enhancement, requires evaluation and implementation of bank stabilization and erosion control measures.

City of Sebastopol General Plan

Chapter III: Conservation, Parks and Open Space, sets policies which preserve areas with important biotic resources, ensure the maintenance of wetlands adjacent to City boundaries as permanent open space, protect, maintain and restore wetlands areas, protect and preserve soil as a natural resource, conserve, protect and enhance trees and native vegetation, conserve energy, protect and improve air quality, provide for water conservation, reduce the volume of solid waste the City generates, provides an attractive and comprehensive system of parks and trials that meets all citizens' recreational needs, ensures that recreational facilities are developed in harmony with the surroundings, and incorporates the 1992 Laguna Park Master Plan. The Plan sets minimum buffers for urban land and farming operations adjacent to Laguna habitats, and sets policy to minimize the impacts of backyards adjacent to the Laguna, restore and enhance Laguna habitats, and recover declining species.

Coastal Zone Act Reauthorization Amendments, USEPA, NOAA

Amendments to the Coastal Zone Act to more specifically address effects of NPS pollution on coastal water quality. These amendments require each state with an approved Coastal Zone Management Program to develop a Coastal Nonpoint Pollution Control Program.

Coastal Zone Management Act, NOAA

Provides federal funding for wetlands programs in coastal states, including the preparation of Coastal Zone Management Plans.

Endangered Species Act (ESA), US Environmental Protection Agency

The US FWS works with landowners to provide incentives to manage land for endangered species. In some instances land use activities qualify for exemptions to ESA prohibitions.

Healthy Forests Restoration Act, Bureau of Land Management

"The Healthy Forests Restoration Act (HFRA) provides BLM and Forest Service land managers with legislative tools to expedite forest and rangeland restoration projects. HFRA aims to expedite the preparation and implementation of hazardous fuels-reduction projects on Federal land and assist rural communities, States, and private landowners in restoring healthy forest conditions on State and private lands."

Mendocino County General Plan. Land Use Element of the Mendocino County General Plan, Natural Resources.

Section 11 — Soil Resources sets policies to reduce soil loss and erosion, stabilize streambanks, and to limit development on certain soil types.

National Environmental Protection Act, US EPA

"The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet this requirement, federal agencies prepare a detailed statement known as an Environmental Impact Statement (EIS)."

Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program, SWRCB

"The information provided in this policy is designed to assist all responsible and/or interested parties in understanding how the State's NPS water quality control requirements will be implemented and enforced. The parties involved include the SWRCB and the RWQCBs, federal, state and local agencies, individual dischargers, designated third-party representatives and any other interested public and private parties."

Porter-Cologne Water Quality Control Act, SWRCB

This act provides for regional water quality control under the supervision of the State Water Resources Control Board. Regional Water Quality Control Boards were created to prescribe and define beneficial uses of water and to define standards necessary to maintain them.

Santa Rosa General Plan

Chapter 7: 7-3 Biological Resources and Waterways, sets policies which maximize the benefits of open space, conserve the City's open spaces, conserve agricultural soils, conserve wetlands, vernal pools, wildlife ecosystems, rare plant habitats, and waterways, and conserve significant vegetation and trees, conserve water and maintain water quality, and take actions to achieve and maintain ambient air quality standards.

Sonoma County General Plan

2.2 — Prevention of Soil Erosion, sets policies to promote and encourage soil conservation and management practices that maintain the productivity of soil resources.

Town of Windsor General Plan — 2015

Chapter 6 Environmental Resources, proposes strategies for the protection and enhancement of open space resources, agricultural resources, water supply and quality, biological resources, cultural resources, extractive resources, and scenic resources.

Z'Berg-Nejedly Forest Practice Act, California Board of Forestry

This act authorizes regulation of timber harvest through the adoption of rules for each forest district in California. The rules are intended to be used as standards for preparing Timber Harvest Plans and evaluating effects of harvest operations.

8. Sources

CDFG Habitat and Biological Inventory Parameters for Russian River Basin Fisheries (CDFG 2007)

Natural Resources Conservation Service (NRCS). 2003. Electronic Field Office Technical Guide. Available at: http://www.nrcs.usda.gov/Technical/efotg/.

NOAA/NMFS Habitat Attribute Indicators for Russian River Watershed CCC Coho (NMFS 2010)

NCRWQCB Monitoring Parameters, sample for Garcia River Sediment TMDL (NCRWQCB 2011)

Sotoyome Resource Conservation District (SRCD). Undated. Grazing Handbook A Guide for Resource Managers for Coastal California. 68 pages.

State of California. Undated. California's Critical Coastal Areas: California's Nonpoint Source Management Measures. Web Site available at: http://www.coastal.ca.gov/nps/Web/cca_nps_mm.htm. Accessed 5/07.

Tetra Tech, Inc., 2006. California Nonpoint Source Encyclopedia. California State Water Resources Control Board. 281 pages.

US Environmental Protection Agency. 2006. Polluted Runoff (Nonpoint Source Pollution). Web Site. Available at: http://www.epa.gov/owow/nps/categories.html. Accessed 6/07.

US Environmental Protection Agency. 2001. Albion River Total Maximum Daily Load for Sediment. Available at: http://www.epa.gov/region09/water/tmdl/albion/albionfinaltmdl.pdf. 49 pages.

NUTRIENT MANAGEMENT

1. Baseline Description

General Setting:

The Lower Russian River and Laguna de Santa Rosa are 303(d) listed as impaired due to low dissolved oxygen (DO), and nutrients. Total Maximum Daily Loads (TMDLs) and TMDL Implementation Plans for DO, and nutrients will be completed by the North Coast Regional Water Quality Control Board (NCRWQCB 2006). An increase in nutrients can cause an increase in biochemical oxygen demand (BOD), which is the amount of oxygen consumed by microbial decomposition of organic matter. An increase in BOD can cause a decrease in DO; increased nutrients can also cause algae blooms, leading to a decrease in DO available for biotic respiration. This lack of DO affects all aquatic organisms, including endangered salmonids.

Causal Factors:

Agricultural operations and residential and industrial landscaping activities have increased nutrients above natural background levels. When fertilizers are applied at rates greater than crop or landscape plants can take them up, the resulting excess can be transported to waterways during irrigation or precipitation events.

2. Management Measure Description

The Nutrient Management MM reduces nutrient loss from agricultural, residential, and urban lands, which generally occurs through edge-of-field/property runoff or leaching from the root zone. The most effective way to manage agricultural nutrients is the development of a nutrient management plan, which should be updated at least once every five years. For urban and residential properties, the most effective way to minimize nutrient runoff is public outreach and education.

3. Resource Concerns

Inadequate Water Quality

Water Quality — Excessive Nutrients, Pathogens, or Organics

4. Management Practices

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
NRCS	Contour Buffer Strips (332)	AC
NRCS	Conservation Cover (327)	AC
NRCS	Critical Area Planting (342)	AC
NRCS	Field Border (386)	AC
NRCS	Filter Strip (393)	AC
NRCS	Hedgerow Planting (422)	FT
NRCS	Nutrient Management (590)	AC
NRCS	Riparian Forest Buffer (391)	AC
NRCS	Riparian Herbaceous Cover (390)	AC
NRCS	Stormwater Runoff Control (570)	AC
NRCS	Vegetative Barrier (601)	FT

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Chemical and Physical Characteristic (Water Quality)	
Conventionals: Dissolved Oxygen (DO)	Dissolved Oxygen: Greater than 5 mg/L, 2 to 5 mg/L,Less than 2 mg/L
Conventionals: Nutrients	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L
Biological Conditions: Chlorophyll (lakes, streams, estuaries)	Algae (Chlorophyll a): "High" "Moderate" and "Low Quality" less than 5.0 µg/L, 5 to 20 µg/L, greater than 20 µg/L

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Pathogens (Drinking Water Rule, Basin Plan language)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Algae (Microcystis/ Microcystin)	Algae (Chlorophyll a): "High" "Moderate" and "Low Quality" less than 5.0 µg/L, 5 to 20 µg/L, greater than 20 µg/L
Nitrates	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L
E. coli, enterococci (freshwater)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Biotic Condition	
Biological Conditions: Benthic Macro-invertebrates (BMI, streams)	BMIs: Threshold between "Good" and "Fair," out of 1.00 for reference condition. California Macroinvertebrate Observed/ Expected Index (O/E Index) score of 0.77; Western EMAP Macroinvertebrate Index of Biotic Integrity (IBI) score of 0.57.

Protocol & Data Sources

California Monitoring and Assessment Program (CMAP). The CAMP monitoring project was developed in collaboration with the SWRCB's Non-Point Source Pollution control Program (NPS), SWRCB's SWAMP program and the US EPA's Region IX.

Department of Water Resources (DWR) Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/

DWR Water Plan Information Exchange: hub with links to various databases http://www.waterplan.water.ca.gov/waterpie/index.cfm

DWR Water Plan and Updates: water quality improvement strategies and data on water use http://www.waterplan.water.ca.gov/waterquality/water_quality.cfm

EPA TMDL program http://www.epa.gov/OWOW/tmdl/

EPA WEMAP (Western Environmental Monitoring and Assessment Program; http://www.epa.gov/region09/water/wemap/surface.html) for physical habitat structure, sediment metabolism, sediment chemistry, water quality parameters, and riparian vegetation.

SWAMP BMI, stream assessment, and other reports including Ode 2007, SWAMP 2005, and Ode and Rehn 2005 http://www.swrcb.ca.gov/water_issues/programs/swamp/

SWAMP protocols ("Standard Operating Procedures") http://swamp.mpsl.mlml.calstate.edu/ and selected reports under "Bioassessment" at http://www.swrcb.ca.gov/water_issues/programs/swamp/reports.shtml#bioassessment

SWAMP http://www.swrcb.ca.gov/water_issues/programs/swamp/, including water quality and toxicity data at http://swamp.mpsl.mlml.calstate.edu/online-data

SWRCB North Coast Basin Plan http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/basin_plan.shtml

6. Relevant Programs

Agricultural Management Assistance Program, NRCS

> "Agricultural Management Assistance (AMA) provides cost share assistance to agricultural producers to voluntarily address issues such as water management, water quality, and erosion control by incorporating conservation into their farming operations. Producers may construct or improve water management structures or irrigation structures; plant trees for windbreaks or to improve water quality; and mitigate risk through production diversification or resource conservation practices, including soil erosion control, integrated pest management, or transition to organic farming."

Agricultural Water Quality Grant Program, SWRCB

> "The Agricultural Water Quality Grant Program provides funding for projects that reduce or eliminate non-point source pollution discharge to surface waters from agricultural lands. Funding from Propositions 40 and 50 were administered through two solicitations, most recently the 2005-2006 Consolidated Grants Process. Additional funds will be made available in the future through Proposition 84."

Biologically Integrated Farming Systems (BIFS)

> "BIFS is a program to help growers enhance environmental quality while maintaining yields and profits. BIFS projects use on-farm demonstrations and a collaborative model of outreach and extension involving public-private partnerships."

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> The CCA Program "can help producers grow economically and environmentally sound crops. The California CCA program is a voluntary certification program for individu-

als who provide advice to growers on crop management and inputs. Their Web site lists certified crop advisors for California."

California Dairy Quality Assurance (CDQA) Program

"California Dairy Quality Assurance (CDQA) Program was created to assist dairy producers with navigating and complying with the rules and regulations governing the industry. The CDQA program is a voluntary partnership between dairy producers, government agencies, and academia to address environmental stewardship, animal welfare, and food safety issues. The environmental stewardship module has three components: education, self-assessment, and third-party evaluation, terminating in certification, and focuses on compliance with federal, state, and local water quality regulations. A comprehensive checklist is used as the assessment tool in the certification process."

California's Critical Coastal Areas Program

The purpose of California's Critical Coastal Areas (CCA) Program is "to foster collaboration among local stakeholders and government agencies and better coordinate resources and efforts in coastal-zone watershed areas critically in need of protection from polluted runoff." The North Coast is one of four regional pilot CCAs in which the CCA Program will form teams comprised of local stakeholders and state, federal, and local agencies to develop community-based action plans to reduce polluted runoff in coastal zone watershed areas. www.coastal.ca.gov/nps/cca-nps.html

Conservation Planning Assistance, NRCS

"The Natural Resources Conservation Service (NRCS) provides conservation planning and technical assistance to clients (individuals, groups, and units of government). These clients develop and implement conservation plans to protect, conserve, and enhance natural resources (soil, water, air, plants, and animals) within their related social and economic interests."

Environmental Quality Incentives Program, NRCS

"The Environmental Quality Incentives Program (EQIP) was reauthorized in the Farm Security and Rural Investment Act of 2002 (Farm Bill) to provide a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land."

Fish Friendly Farming, California Land Stewardship Institute

"Fish Friendly Farming provides an incentive-based method for creating and sustaining environmental quality and habitat on private land. Landowners and managers enroll in the program, learn environmentally beneficial management practices and carry out ecological restoration projects."

Nonpoint Source Management Program — Clean Water Act Section 319, US Environmental Protection Agency

This Program was established through an amendment to the Clean Water Act in 1987 to provide grant money to support activities including technical and financial assistance, education and training, technology transfer, demonstration projects, and project success monitoring. http://www.epa.gov/owow/nps/cwact.html

Nonpoint Source Pollution Control Programs, SWRCB

The State Water Resources Control Board administers several grant programs, which assist local entities with nonpoint source pollution control. The grants are made available through voter approval of the following Propositions: 13, 40, 50, and 84.

Watershed Protection Programs, SWRCB

The State Water Resources Control Board administers several programs for watershed protection under Propositions approved by voters. These Propositions are: 13, 40, and 50.

7. Relevant Policies & Plans

California Water Plan Update 2013, DWR

Presents status and trends for water-dependent resources, supplies, and demands. Evaluates regional and statewide management strategies to identify effective actions and policies. Includes Regional Basin Plans.

Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program, SWRCB

"The information provided in this policy is designed to assist all responsible and/or interested parties in understanding how the State's NPS water quality control requirements will be implemented and enforced. The parties involved include the SWRCB and the RWQCBs, federal, state and local agencies, individual dischargers, designated third-party representatives and any other interested public and private parties."

Porter-Cologne Water Quality Control Act, SWRCB

This act provides for regional water quality control under the supervision of the State Water Resources Control Board. Regional Water Quality Control Boards were created to prescribe and define beneficial uses of water and to define standards necessary to maintain them.

Workplan for Developing Biological Objectives for Perennial Wadeable Streams in the State of California, SWRCB

Defines a path toward creating biological objectives to protect aquatic resources of the state.

Water Quality Control Policy for Addressing Impaired Waters: Regulatory Structure and Options (TMDL Policy), SWRCB

Establishes the State's Total Maximum Daily Load (TMDL) program. TMDL sets limits on the amount of pollutants water can be exposed to before adversely impacting Beneficial Uses of water. Required by Section 303(d) of the Federal CWA, established in 1972.

Water Quality Control Policy for developing California's Clean Water Act Section 303(d) list, SWRCB

Describes the process by which the SWRCB and Regional Boards will comply with the listing requirements of Section 303(d) of the federal Clean Water Act (CWA).

Nonpoint Source Management Plan, SWRCB

Identifies nonpoint source control programs and milestones, and effluent limitations.

Pathogens in the Russian River Policy, NCRWQCB and Sonoma County Department of Health Services

Russian River and tributary monitoring at several sites to determine bacteria abundance and variability (1996-2010). 2011-2012 efforts aimed at development of Russian River Pathogen TMDL. Land use, beach use impacts on bacteria levels. Quality assurance project plans (QUAPP). Establishes bacteria thresholds for human health.

8. Sources

SWRCB. 2009. NPS Encyclopedia. 1C — Nutrient Management http://www.waterboards.ca.gov/water_issues/programs/nps/encyclopedia/1c_nutrnt.shtml

SWRCB/ SWAMP Core Indicators for Beneficial Uses in California (SWAMP 2010/ SWAMP 2006)

USDA. No date. *Electronic Field Office Technical Guide for California*. U.S. Department of Agriculture, Natural Resource Conservation Service. (http://efotg.nrcs.usda.gov/)

PEST AND WEED MANAGEMENT

1. Baseline Description

General Setting:

The use of pesticides to control plant and animal pests has increased; as plants and animals develop resistance to commonly used pesticides, new ones are developed. These chemicals can be harmful to desirable plants and animals if they spread from the targeted area. For example, some pesticides are extremely toxic to aquatic ecosystems; their use near waterways is regulated. In other instances, non-target species may be affected. For example, when a rat ingests poison and dies, it may be consumed by native birds and mammals, which could also be killed if they consumer enough of the pesticide present in the rat's carcass.

Causal Factors:

Over-application, application prior to irrigation or precipitation, and improper use can lead to pesticide pollution in both terrestrial and aquatic ecosystems. Improperly calibrated equipment and lack of knowledge about alternative pest management methods can also cause pesticide pollution.

2. Management Measure Description

The Pest and Weed Management MM will reduce or eliminate pesticide runoff through

the proper use of pesticides and the pursuit of alternative pest management practices when feasible. Integrated Pest Management education programs and outreach to individual property owners in urban and rural residential areas will also reduce pesticide pollution in the watershed.

3. Resource Concerns

Inadequate Water Quality

Water Quality — Excessive Nutrients, Pathogens, or Organics

4. Management Practices

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
NRCS	Herbaceous Weed Control (315)	AC
NRCS	Integrated Pest Management (595)	AC
NRCS	Mulching (484)	AC

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Chemical and Physical Characteristic (Water Quality)	
Conventionals: Dissolved Oxygen (DO)	Dissolved Oxygen: Greater than 5 mg/L, 2 to 5 mg/L,Less than 2 mg/L
Conventionals: Nutrients	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L
Pathogens (Drinking Water Rule, Basin Plan language)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Algae (Microcystis/ Microcystin)	Algae (Chlorophyll a): "High" "Moderate" and "Low Quality" less than 5.0 µg/L, 5 to 20 µg/L, greater than 20 µg/L
Nitrates	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L
E. coli, enterococci (freshwater)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Toxicity (Acute)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Metals	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Pesticides	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Bioaccumulative	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Chemical Indicators: DDTs	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Chemical Indicators: PCBs	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Biotic Condition	
Biological Conditions: Benthic Macro-invertebrates (BMI, streams)	BMIs: Threshold between "Good" and "Fair," out of 1.00 for reference condition. California Macroinvertebrate Observed/ Expected Index (O/E Index) score of 0.77; Western EMAP Macroinvertebrate Index of Biotic Integrity (IBI) score of 0.57.

Protocol & Data Sources

California Monitoring and Assessment Program (CMAP). The CAMP monitoring project was developed in collaboration with the SWRCB's Non-Point Source Pollution control Program (NPS), SWRCB's SWAMP program and the US EPA's Region IX.

Department of Water Resources (DWR) Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/

DWR Water Plan Information Exchange: hub with links to various databases http://www.waterplan.water.ca.gov/waterpie/index.cfm

DWR Water Plan and Updates: water quality improvement strategies and data on water use http://www.waterplan.water.ca.gov/waterquality/water_quality.cfm

EPA TMDL program http://www.epa.gov/OWOW/tmdl/

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SWRCB North Coast Basin Plan http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/basin_plan.shtml

USGS groundwater quality data http://ca.water.usgs.gov/gama/publications.htm

6. Relevant Programs

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Coalition for Urban/Rural Environmental Stewardship (CURES)

CURES "has two programs to promote the environmental friendly use of pesticides. The Water Steward Orchard Program is designed to promote awareness of pesticide runoff from products used in dormant orchard sprays. http://www.curesworks.org/home.asp

Conservation Planning Assistance, NRCS

"The Natural Resources Conservation Service (NRCS) provides conservation planning and technical assistance to clients (individuals, groups, and units of government). These clients develop and implement conservation plans to protect, conserve, and enhance natural resources (soil, water, air, plants, and animals) within their related social and economic interests."

Department of Pesticide Regulation Pest Management Alliance Program

"Department of Pesticide Regulation (DPR) Pest Management Alliance Program provides support for agricultural, nonagricultural, and urban groups to develop and demonstrate pest management systems that reduce risks associated with pesticide use, including risks to surface and ground waters. The Web site has Alliance project evaluations, reports, and other technical information available for pest man-

agement systems in various commodities such as almonds, stone fruit, and strawberries." http://www.cdpr.ca.gov/docs/pestmgt/ipminov/ipmmenu.htm

Department of Pesticide Regulation Ground Water Protection Program

DPRs Ground Water Protection Program "addresses both agricultural and nonagricultural sources of pesticide residues in ground waters. The DPR is proposing to revise the Ground Water Quality Program by changing the current ground water regulations." http://www.cdpr.ca.gov/docs/emon/grndwtr/

Department of Pesticide Regulation Surface Water Quality Program

"DPRs Surface Water Quality Program addresses both agricultural and nonagricultural sources of pesticide residues in surface waters. It has preventive and response components that reduce the presence of pesticides in surface waters. The preventive component includes local outreach to promote management practices that reduce pesticide runoff. Prevention also relies on DPR's registration process in which potential adverse effects on surface water quality, particularly those in high-risk situations, are evaluated. The response component includes mitigation options to meet water quality goals, recognizing the value of self-regulating efforts to reduce pesticides in surface water as well as the regulatory authorities of DPR, the SWRCB, and the RWQCBs." http://www.cdpr.ca.gov/docs/emon/surfwtr/

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University of California Statewide Integrated Pest Management Program

University of California Statewide Integrated Pest Management Program contains information for practitioners on how to identify and manage pests, including educational resources, databases, publications, projects, and other resources. http://www.ipm.ucdavis.edu/

Watershed Protection Programs, SWRCB

The State Water Resources Control Board administers several programs for watershed protection under Propositions approved by voters. These Propositions are: 13, 40, and 50.

7. Relevant Policies & Plans

California Water Plan Update 2013, DWR

Presents status and trends for water-dependent resources, supplies, and demands. Evaluates regional and statewide management strategies to identify effective actions and policies. Includes Regional Basin Plans.

California Pesticide Management Plan for Water Quality

"California Pesticide Management Plan for Water Quality is a joint effort by DPR and the SWRCB to protect water quality from the potential adverse effects of pesticides. It describes how DPR and the County Agricultural Commissioners work in cooperation with the SWRCB and the Regional Water Quality Control Boards (RWQCBs) to protect water quality from the use of pesticides." http://www.cdpr.ca.gov/docs/emon/surfwtr/maaplan.htm

Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program, SWRCB

"The information provided in this policy is designed to assist all responsible and/or interested parties in understanding how the State's NPS water quality control requirements will be implemented and enforced. The parties involved include the SWRCB and the RWQCBs, federal, state and local agencies, individual dischargers, designated third-party representatives and any other interested public and private parties."

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Nonpoint Source Management Plan, SWRCB

Identifies nonpoint source control programs and milestones, and effluent limitations.

8. Sources

EPA. 2002. Chapter 4: Management Measures. In *National Management Measures for the Control of Nonpoint Pollution from Agriculture*. U.S. Environmental Protection Agency, Washington, DC. (http://www.epa.gov/owow/nps/agmm/)

NOAA/NMFS Habitat Attribute Indicators for Russian River Watershed CCC Coho (NMFS 2010)

SWRCB/ SWAMP Core Indicators for Beneficial Uses in California (SWAMP 2010/ SWAMP 2006)

SWRCB. 2009. NPS Encyclopedia. 1D — Pest and Weed Management http://www.waterboards.ca.gov/water_issues/programs/nps/encyclopedia/1d_pstcd.shtml

USDA. No date. *Electronic Field Office Technical Guide for California*. U.S. Department of Agriculture, Natural Resource Conservation Service. (http://efotg.nrcs.usda.gov/)

GRAZING MANAGEMENT

1. Baseline Description

General Setting:

The Russian River watershed has an extensive history of grazing cows, sheep, and goats. More than half of the watershed is considered "rangeland" and may be grazed by domestic livestock. Cattle and sheep ranching are widespread in Mendocino County, especially in oak woodlands.

Causal Factors:

Grazing affects both terrestrial and aquatic ecosystems through spread of invasive plant species, livestock consumption of palatable native plants, and trampling and sedimentation due to livestock movement. During hot summer days, cattle will take refuge in the shade of riparian vegetation if possible, leading to trampling of undergrowth and sedimentation of creeks and streams.

2. Management Measure Description

The Grazing Management MM will protect sensitive areas in range, pasture, and other grazing lands by implementing USDA NRCS standards for conservation management systems. These systems include erosion control, adequate pasture stand density and proper rangeland condition.

3. Resource Concerns

Inadequate Water Quality

Inadequate Wildlife Movement/Travel Corridors

Invasive Non-native Plants

Soil Condition — Compaction

Soil Erosion — Shoreline

Soil Erosion — Streambank

Water Quality — Excessive Sediment

4. Management Practices

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
NRCS	Access Control (472)	AC
NRCS	Animal Trails and Walkways (575)	FT
NRCS	Feed Management (592)	NO
NRCS	Fence (382)	FT
NRCS	Forage and Biomass Planting (512)	AC
NRCS	Grazing Land Mechanical Treatment (548)	AC
NRCS	Heavy Use Area Protection (561)	AC
NRCS	Herbaceous Weed Control (315)	AC
NRCS	Range Planting (550)	AC
NRCS	Spring Development (574)	NO
NRCS	Watering Facility (614)	NO
NRCS	Water Harvesting Catchment (636)	NO

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Chemical and Physical Characteristic (Water Quality)	
Conventionals: Dissolved Oxygen (DO)	Dissolved Oxygen: Greater than 5 mg/L, 2 to 5 mg/L,Less than 2 mg/L
Conventionals: Nutrients	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L
Biological Conditions: Chlorophyll (lakes, streams, estuaries)	Algae (Chlorophyll a): "High" "Moderate" and "Low Quality" less than 5.0 µg/L, 5 to 20 µg/L, greater than 20 µg/L
Pathogens (Drinking Water Rule, Basin Plan language)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Algae (Microcystis/ Microcystin)	Algae (Chlorophyll a): "High" "Moderate" and "Low Quality" less than 5.0 µg/L, 5 to 20 µg/L, greater than 20 µg/L
Nitrates	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L
E. coli, enterococci (freshwater)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Sediments/TDS	**Total Suspended Solids**: "Most Disturbed" is greater than 50 mg/L, "Least Disturbed" is less than or equal to 15 mg/L
Hydrology and Geomorphology	
Gravel Quality (Bulk)	**Gravel quality (bulk):** >17 % (D50=0.85), 15 to 17 %, 12 to 14 %, <12 %
Embeddedness	**Gravel quality (embeddedness):** <25 % of scores are Category 1 or 2, 25 to 50 %, >50 %, Not defined
Spawning gravel quantity & distribution	**Gravel quality (bulk):** >17 % (D50=0.85), 15 to 17 %, 12 to 14 %, <12 %
Substrate Composition	**Gravel quality (embeddedness):** <25 % of scores are Category 1 or 2, 25 to 50 %, >50 %, Not defined
Bank Composition	
Biotic Condition	
Biological Conditions: Benthic Macro-invertebrates (BMI, streams)	BMIs: Threshold between "Good" and "Fair," out of 1.00 for reference condition. California Macroinvertebrate Observed/ Expected Index (O/E Index) score of 0.77; Western EMAP Macroinvertebrate Index of Biotic Integrity (IBI) score of 0.57.
Biological Conditions: Algae (periphyton)	Algae (Chlorophyll a): "High" "Moderate" and "Low Quality" less than 5.0 µg/L, 5 to 20 µg/L, greater than 20 µg/L
Physical Habitat: PHab (streams)	Riparian Vegetation: From "Poor to "Very Good" Canopy cover: <75 % average over IP-km, 75 to 85 %, 85 to 95 %, >95 %
Physical Habitat: CRAM (wetlands)	Riparian Vegetation: From "Poor to "Very Good" Canopy cover: <75 % average over IP-km, 75 to 85 %, 85 to 95 %, >95 %
Nuisance plant Growth	
Species Diversity	
Species Distribution	
Species Composition	

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Sotoyome RCD, Monitoring Riparian Grazing, Grazing Handbook, 2006

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"California Dairy Quality Assurance (CDQA) Program was created to assist dairy producers with navigating and complying with the rules and regulations governing the industry. The CDQA program is a voluntary partnership between dairy producers, government agencies, and academia to address environmental stewardship, animal welfare, and food safety issues. The environmental stewardship module has three components: education, self-assessment, and third-party evaluation, terminating in certification, and focuses on compliance with federal, state, and local water quality regulations. A comprehensive checklist is used as the assessment tool in the certification process."

California's Critical Coastal Areas Program

The purpose of California's Critical Coastal Areas (CCA) Program is "to foster collaboration among local stakeholders and government agencies and better coordinate resources and efforts in coastal-zone watershed areas critically in need of protection from polluted runoff." The North Coast is one of four regional pilot CCAs in which the CCA Program will form teams comprised of local stakeholders and

state, federal, and local agencies to develop community-based action plans to reduce polluted runoff in coastal zone watershed areas. www.coastal.ca.gov/nps/cca-nps.html

Conservation Planning Assistance, NRCS

"The Natural Resources Conservation Service (NRCS) provides conservation planning and technical assistance to clients (individuals, groups, and units of government). These clients develop and implement conservation plans to protect, conserve, and enhance natural resources (soil, water, air, plants, and animals) within their related social and economic interests."

Department of Pesticide Regulation Pest Management Alliance and Planning Program

'Department of Pesticide Regulation (DPR), Pest Management Alliance and Planning Program provides funding support, when funds become available, to encourage increased implementation of biologically intensive, reduced-risk pest management. This program is designed to create a collaborative, interdisciplinary team that uses a systems approach—the assumption is that team members have already solved pest problems and other specialized components through applied research. The Alliance is part of a problem-solving continuum, taking the data collected from research and preparing for the next stage—education through demonstration, and ultimately implementation. http://www.cdpr.ca.gov/docs/pestmgt/ipminov/pmap.htm

Environmental Quality Incentives Program, NRCS

"The Environmental Quality Incentives Program (EQIP) was reauthorized in the Farm Security and Rural Investment Act of 2002 (Farm Bill) to provide a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land."

NRCS Conservation of Private Grazing Land Initiative

"NRCS, Conservation of Private Grazing Land initiative will ensure that technical, educational, and related assistance is provided to those who own private grazing lands. It is not a cost share program. This technical assistance will offer opportunities for: better grazing land management; protecting soil from erosive wind and water; using more energy-efficient ways to produce food and fiber; conserving water; providing habitat for wildlife; sustaining forage and grazing plants; using plants to sequester greenhouse gases and increase soil organic matter; and using grazing lands as a source of biomass energy and raw materials for industrial products." http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/technical/?cid=nrcs143_008456

NRCS Grassland Reserve Program

"NRCS, Grassland Reserve Program (GRP) is a voluntary program which helps landowners restore and protect grassland, rangeland, pastureland, shrubland and certain other lands and provides assistance for rehabilitating grasslands. The program will conserve vulnerable grasslands from conversion to cropland or other uses and conserve valuable grasslands by helping maintain viable ranching operations." http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/grassland

Nonpoint Source Management Program — Clean Water Act Section 319, US Environmental Protection Agency

This Program was established through an amendment to the Clean Water Act in 1987 to provide grant money to support activities including technical and financial assistance, education and training, technology transfer, demonstration projects, and project success monitoring. http://www.epa.gov/owow/nps/cwact.html

Nonpoint Source Pollution Control Programs, SWRCB

The State Water Resources Control Board administers several grant programs, which assist local entities with nonpoint source pollution control. The grants are made available through voter approval of the following Propositions: 13, 40, 50, and 84.

Watershed Protection Programs, SWRCB

The State Water Resources Control Board administers several programs for watershed protection under Propositions approved by voters. These Propositions are: 13, 40, and 50.

7. Relevant Policies & Plans

California Water Plan Update 2013, DWR

Presents status and trends for water-dependent resources, supplies, and demands. Evaluates regional and statewide management strategies to identify effective actions and policies. Includes Regional Basin Plans.

California Rangeland Water Quality Management Plan

California Board of Forestry's California Rangeland Water Quality Management Plan is a voluntary plan developed by the California Cattlemen's Association, in collaboration with University of California Cooperative Extension and USDA NRCS. The plan was officially approved in 1995 and includes rangeland water quality management strategies, policy and coordination mechanisms, as well as sample plans and sources of assistance. The California Board of Forestry is responsible for administering the plan. http://www.waterboards.ca.gov/publications_forms/publications/general/docs/ca_rangeland_wqmgmt_plan_july1995.pdf

Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program, SWRCB

"The information provided in this policy is designed to assist all responsible and/or interested parties in understanding how the State's NPS water quality control requirements will be implemented and enforced. The parties involved include the SWRCB and the RWQCBs, federal, state and local agencies, individual dischargers, designated third-party representatives and any other interested public and private parties."

Porter-Cologne Water Quality Control Act, SWRCB

This act provides for regional water quality control under the supervision of the State Water Resources Control Board. Regional Water Quality Control Boards were created to prescribe and define beneficial uses of water and to define standards necessary to maintain them.

Workplan for Developing Biological Objectives for Perennial Wadeable Streams in the State of California, SWRCB

Defines a path toward creating biological objectives to protect aquatic resources of the state.

Water Quality Control Policy for Addressing Impaired Waters: Regulatory Structure and Options (TMDL Policy), SWRCB

Establishes the State's Total Maximum Daily Load (TMDL) program. TMDL sets limits on the amount of pollutants water can be exposed to before adversely impacting Beneficial Uses of water. Required by Section 303(d) of the Federal CWA, established in 1972.

Water Quality Control Policy for developing California's Clean Water Act Section 303(d) list, SWRCB

Describes the process by which the SWRCB and Regional Boards will comply with the listing requirements of Section 303(d) of the federal Clean Water Act (CWA).

Nonpoint Source Management Plan, SWRCB

Identifies nonpoint source control programs and milestones, and effluent limitations.

Pathogens in the Russian River Policy, NCRWQCB and Sonoma County Department of Health Services

Russian River and tributary monitoring at several sites to determine bacteria abundance and variability (1996-2010). 2011-2012 efforts aimed at development of Russian River Pathogen TMDL. Land use, beach use impacts on bacteria levels. Quality assurance project plans (QUAPP). Establishes bacteria thresholds for human health.

8. Sources

CDFG Habitat and Biological Inventory Parameters for Russian River Basin Fisheries (CDFG 2007)

EPA. 2002. National Management Measures to Control Nonpoint Source Pollution from Agriculture, Chapter 4E: Grazing Management. In *National Management Measures for the Control of Nonpoint Pollution from Agriculture*. U.S. Environmental Protection Agency, Washington, DC. (http://www.epa.gov/owow/nps/agmm/)

NOAA/NMFS Habitat Attribute Indicators for Russian River Watershed CCC Coho (NMFS 2010)

NCRWQCB Monitoring Parameters, sample for Garcia River Sediment TMDL (NCRWQCB 2011)

SWRCB. 1995. *California Rangeland Water Quality Management Plan*. State Water Resources Control Board, Division of Water Quality, NPS Program, Sacramento, CA.

SWRCB. 2009. NPS Encyclopedia. 1E — Grazing Management http://www.waterboards.ca.gov/water_issues/programs/nps/encyclopedia/1e_graz.shtml

USDA. No date. *Electronic Field Office Technical Guide for California*. U.S. Department of Agriculture, Natural Resource Conservation Service. http://efotg.nrcs.usda.gov/

IRRIGATION WATER MANAGEMENT

1. Baseline Description

General Setting:

Agriculture is the primary land use within the Russian River basin with a recent trend in the past two decades of conversion of historic crops, ranches, orchards, and forests to vineyards. This has increased the use of irrigation, since some historic land uses, such as ranching and forests, did not use irrigation as intensively as vineyards. Advancements in irrigation technology are constantly being developed; rate and timing of irrigation can now be matched to precise crop needs based on soil moisture content, instantaneous weather data, and crop water requirements.

Causal Factors:

Irrigated crop production has been identified as a potential source of sediment in several 303(d) listed segments of the Russian River watershed. When irrigation is not timed or applied correctly, soil erosion and pesticide, or fertilizer pollution may occur in addition to wasting water and potentially limiting crop production. The cost of improved technology may limit irrigation improvements. Additionally, there is need for outreach to agricultural, rural, and urban landowners regarding proper use of irrigation in both agricultural and landscape settings.

2. Management Measure Description

The Irrigation Water Management MM will reduce NPS pollution of surface and ground waters caused by improper irrigation. This MM contains practices to apply irrigation waters efficiently and minimize runoff and soil erosion.

3. Resource Concerns

Water Quantity — Excessive Runoff, Flooding, or Ponding

Water Quantity — Inefficient Water Use on Irrigated Land

Water Quality — Excessive Nutrients, Pathogens, or Organics

Water Quality — Excessive Sediment

Water Quality — Harmful Temperatures of Surface Water

4. Management Practices

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
NRCS	Irrigation Field Ditch (388)	FT
NRCS	Irrigation Land Leveling (464)	AC
NRCS	Irrigation Pipeline (430)	FT
NRCS	Irrigation Reservoir (436)	Ac.-Ft
NRCS	Irrigation System, Microirrigation (441)	AC
NRCS	Irrigation System, Sprinkler (442)	Ac.
NRCS	Irrigation System, Surface and Subsurface (443)	AC
NRCS	Irrigation System, Tailwater Recovery (447)	NO
NRCS	Irrigation Water Management (449)	AC
NRCS	Pumping Plant (533)	NO

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Hydrology and Geomorphology	
Flow Conditions	
Flow	
Chemical and Physical Characteristics	
Conventionals: Dissolved Oxygen (DO)	**Dissolved Oxygen:** Greater than 5 mg/L, 2 to 5 mg/L,Less than 2 mg/L
Nitrates	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L
Algae (Microcystis/ Microcystin)	Algae (Chlorophyll a): "High" "Moderate" and "Low Quality" less than 5.0 µg/L, 5 to 20 µg/L, greater than 20 µg/L
Conventionals: Nutrients	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L
Biotic Condition	

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Biological Conditions: Benthic Macro-invertebrates (BMI, streams)	BMIs: Threshold between "Good" and "Fair," out of 1.00 for reference condition. California Macroinvertebrate Observed/ Expected Index (O/E Index) score of 0.77; Western EMAP Macroinvertebrate Index of Biotic Integrity (IBI) score of 0.57.
Nuisance plant Growth	

Protocol & Data Sources

California Monitoring and Assessment Program (CMAP). The CAMP monitoring project was developed in collaboration with the SWRCB's Non-Point Source Pollution control Program (NPS), SWRCB's SWAMP program and the US EPA's Region IX.

Department of Water Resources (DWR) Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/

DWR Water Plan Information Exchange: hub with links to various databases http://www.waterplan.water.ca.gov/waterpie/index.cfm

DWR Water Plan and Updates: water quality improvement strategies and data on water use http://www.waterplan.water.ca.gov/waterquality/water_quality.cfm

EPA TMDL program http://www.epa.gov/OWOW/tmdl/

EPA WEMAP (Western Environmental Monitoring and Assessment Program; http://www.epa.gov/region09/water/wemap/surface.html) for physical habitat structure, sediment metabolism, sediment chemistry, water quality parameters, and riparian vegetation.

SWAMP http://www.swrcb.ca.gov/water_issues/programs/swamp/, including water quality and toxicity data at http://swamp.mpsl.mlml.calstate.edu/online-data

SWRCB North Coast Basin Plan http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/basin_plan.shtml

SWAMP BMI, stream assessment, and other reports including Ode 2007, SWAMP 2005, and Ode and Rehn 2005 http://www.swrcb.ca.gov/water_issues/programs/swamp/

SWAMP protocols ("Standard Operating Procedures") http://swamp.mpsl.mlml.calstate.edu/ and selected reports under "Bioassessment" at http://www.swrcb.ca.gov/water_issues/programs/swamp/reports.shtml#bioassessment

USGS National Hydrography Dataset http://nhd.usgs.gov/

USGS National Water Information System (NWIS) http://waterdata.usgs.gov/nwis/rt

6. Relevant Programs

Agricultural Management Assistance Program, NRCS

"Agricultural Management Assistance (AMA) provides cost share assistance to agricultural producers to voluntarily address issues such as water management, water quality, and erosion control by incorporating conservation into their farming operations. Producers may construct or improve water management structures or irrigation structures; plant trees for windbreaks or to improve water quality; and mitigate risk through production diversification or resource conservation practices, including soil erosion control, integrated pest management, or transition to organic farming."

Agriculture Water Management Planning Program, DWR

"Agriculture Water Management Planning Program provides technical, financial, and administrative assistance to the Agricultural Water Management Council and to the water districts throughout the State to develop water management plans and to help implement cost-effective, efficient water management practices." http://www.water.ca.gov/wateruseefficiency/agricultural/agmgmt.cfm

Agricultural Water Quality Grant Program, SWRCB

"The Agricultural Water Quality Grant Program provides funding for projects that reduce or eliminate non-point source pollution discharge to surface waters from agricultural lands. Funding from Propositions 40 and 50 were administered through two solicitations, most recently the 2005-2006 Consolidated Grants Process. Additional funds will be made available in the future through Proposition 84."

Agricultural Water Use Program, DWR

The Department of Water Resources' "Office of Water Use Efficiency works to disseminate and transfer information on improved irrigation technologies and to identify and help develop technologies and farming methods that improve water use efficiency."

Biologically Integrated Farming Systems (BIFS)

"BIFS is a program to help growers enhance environmental quality while maintaining yields and profits. BIFS projects use on-farm demonstrations and a collab-

orative model of outreach and extension involving public-private partnerships."

California Cerified Crop Advisors (CCA) Program

The CCA Program "can help producers grow economically and environmentally sound crops. The California CCA program is a voluntary certification program for individuals who provide advice to growers on crop management and inputs. Their Web site lists certified crop advisors for California."

California's Critical Coastal Areas Program

The purpose of California's Critical Coastal Areas (CCA) Program is "to foster collaboration among local stakeholders and government agencies and better coordinate resources and efforts in coastal-zone watershed areas critically in need of protection from polluted runoff." The North Coast is one of four regional pilot CCAs in which the CCA Program will form teams comprised of local stakeholders and state, federal, and local agencies to develop community-based action plans to reduce polluted runoff in coastal zone watershed areas. www.coastal.ca.gov/nps/cca-nps.html

California Irrigation Management Information System (CIMIS), DWR, Office of Water Use Efficiency

"Department of Water Resources, California Irrigation Management Information System (CIMIS) helps agricultural growers and turf managers who administer parks, golf courses, and other landscapes to develop water budgets for determining when to irrigate and how much water to apply. " http://wwwcimis.water.ca.gov/cimis/welcome.jsp

Conservation Planning Assistance, NRCS

"The Natural Resources Conservation Service (NRCS) provides conservation planning and technical assistance to clients (individuals, groups, and units of government). These clients develop and implement conservation plans to protect, conserve, and enhance natural resources (soil, water, air, plants, and animals) within their related social and economic interests."

Environmental Quality Incentives Program, NRCS

"The Environmental Quality Incentives Program (EQIP) was reauthorized in the Farm Security and Rural Investment Act of 2002 (Farm Bill) to provide a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land."

Fish Friendly Farming, California Land Stewardship Institute

"Fish Friendly Farming provides an incentive-based method for creating and sustaining environmental quality and habitat on private land. Landowners and managers enroll in the program, learn environmentally beneficial management practices and carry out ecological restoration projects."

Hydromet Network, Pacific Northwest Cooperative Agricultural Weather Network

The Pacific Northwest Cooperative Agricultural Weather Network, Hydromet network is a series of automated data collection platforms that provide information necessary for near-real-time management of Reclamation's water operations in the Pacific Northwest. As a subset of the overall Hydromet network, this agricultural network, dedicated to crop water use modeling and other agricultural applications, has been identified as AgriMet. http://www.usbr.gov/pn/hydromet/

Irrigation Management Program, UC Davis, Cooperative Extension Service

"This program is dedicated to the study of irrigation problems and techniques. The Cooperative Extension Service develops and extends research based information that promotes environmentally sound agricultural practices and that improves the efficient utilization of California's valuable water resource." http://lawr.ucdavis.edu/irrigation/index.htm

Nonpoint Source Management Program — Clean Water Act Section 319, US Environmental Protection Agency

This Program was established through an amendment to the Clean Water Act in 1987 to provide grant money to support activities including technical and financial assistance, education and training, technology transfer,

demonstration projects, and project success monitoring. http://www.epa.gov/owow/nps/cwact.html

Nonpoint Source Pollution Control Programs, SWRCB

The State Water Resources Control Board administers several grant programs, which assist local entities with nonpoint source pollution control. The grants are made available through voter approval of the following Propositions: 13, 40, 50, and 84.

WaterSense Program, USEPA

"WaterSense is a voluntary partnership program sponsored by the U.S. Environmental Protection Agency. Its mission is to protect the future of our nation's water supply by promoting and enhancing the market for water-efficient products and services."

Watershed Protection Programs, SWRCB

The State Water Resources Control Board administers several programs for watershed protection under Propositions approved by voters. These Propositions are: 13, 40, and 50.

7. Relevant Policies & Plans

California Water Plan Update 2013, DWR

Presents status and trends for water-dependent resources, supplies, and demands. Evaluates regional and statewide management strategies to identify effective actions and policies. Includes Regional Basin Plans.

North Coast Instream Flow Policy, SWRCB

The policy establishes operational parameters for water diversions (minimum by pass flow requirements, maximum annual diversion amounts and season of diversion limitations) to ensure that sufficient stream flows are reserved for the protection of fishery resources. In addition to increasing the cost of lawfully initiating and maintaining a water diversion facility, implementation of the North Coast Instream Flow Policy will further restrict and in some instances preclude the development of surface water resources, particularly in small tributary drainages where the opportunities to divert and store water are limited to brief periods during major storm events. The Policy includes provisions for groups of individuals and entities within a common geographic area to coordinate the development and operation of their respective water diversions.

Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program, SWRCB

"The information provided in this policy is designed to assist all responsible and/or interested parties in understanding how the State's NPS water quality control requirements will be implemented and enforced. The parties involved include the SWRCB and the RWQCBs, federal, state and local agencies, individual dischargers, designated third-party representatives and any other interested public and private parties."

Porter-Cologne Water Quality Control Act, SWRCB

This act provides for regional water quality control under the supervision of the State Water Resources Control Board. Regional Water Quality Control Boards were created to prescribe and define beneficial uses of water and to define standards necessary to maintain them.

Russian River Frost Protection Regulation Policy, SWRCB

Regulations designed to prevent salmon stranding mortality from cumulative effects of diversion of water for frost protection of crops. Database of real-time provisional data available from four Russian River stream gages (water level sensors).

Workplan for Developing Biological Objectives for Perennial Wadeable Streams in the State of California, SWRCB

Defines a path toward creating biological objectives to protect aquatic resources of the state.

Water Quality Control Policy for Addressing Impaired Waters: Regulatory Structure and Options (TMDL Policy), SWRCB

Establishes the State's Total Maximum Daily Load (TMDL) program. TMDL sets limits on the amount of pollutants water can be exposed to before adversely impacting Beneficial Uses of water. Required by Section 303(d) of the Federal CWA, established in 1972.

Water Quality Control Policy for developing California's Clean Water Act Section 303(d) list, SWRCB

Describes the process by which the SWRCB and Regional Boards will comply with the listing requirements of Section 303(d) of the federal Clean Water Act (CWA).

Nonpoint Source Management Plan, SWRCB

Identifies nonpoint source control programs and milestones, and effluent limitations.

8. Sources

SWRCB. 2009. NPS Encyclopedia. 1F — Irrigation Water Management http://www.waterboards.ca.gov/water_issues/programs/nps/encyclopedia/1f_irr.shtml

NCRWQCB Monitoring Parameters, sample for Garcia River Sediment TMDL (NCRWQCB 2011)

SWRCB/ SWAMP Core Indicators for Beneficial Uses in California (SWAMP 2010/ SWAMP 2006)

USDA. No date. *Electronic Field Office Technical Guide for California*. U.S. Department of Agriculture, Natural Resource Conservation Service. (http://efotg.nrcs.usda.gov/)

GROUNDWATER PROTECTION

1. Baseline Description

General Setting:

Groundwater is an important source of agricultural, industrial, and domestic water in the Russian River watershed, especially in rural areas, where it is the principal source of domestic water. In 2002, there were approximately 40,000 groundwater wells in Sonoma County, with over 40% of the county's population at least partially dependent on groundwater supplies. Eight economically significant groundwater basins and five sub-basins are located within the Russian River drainage.

Causal Factors:

The lack of regulation on groundwater extraction has led to its substitution, where possible, when surface water supplies are limited. Groundwater depletion can occur when withdrawal rates are faster than recharge rates. Groundwater quality can be impacted by runoff from fertilizer and pesticide application, urban and road runoff, and pollutant spills.

2. Management Measure Description

The Groundwater Protection MM will protect groundwater quality through the implementation of management practices to reduce or eliminate runoff and/or leaching of pollutants to groundwater. This MM will protect groundwater quantity through the implementation of management practices to use water efficiently and to recharge groundwater when depletion is occurring.

3. Resource Concerns

Water Quantity — Inefficient Water Use on Irrigated Land

Water Quantity — Inefficient Water Use on Non-Irrigated Land

Water Quality — Excessive Nutrients, Pathogens, or Organics

Water Quality — Harmful Levels of Heavy Metals

4. Management Practices

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
NRCS	Integrated Pest Management (%(%)	AC
NRCS	Irrigation Field Ditch (388)	FT
NRCS	Irrigation Land Leveling (464)	AC
NRCS	Irrigation Pipeline (430)	FT
NRCS	Irrigation Reservoir (436)	Ac.-Ft
NRCS	Irrigation System, Microirrigation (441)	AC
NRCS	Irrigation System, Sprinkler (442)	Ac.
NRCS	Irrigation System, Surface and Subsurface (443)	AC
NRCS	Irrigation System, Tailwater Recovery (447)	NO
NRCS	Irrigation Water Management (449)	AC
NRCS	Pumping Plant (533)	NO

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Hydrology and Geomorphology	
Flow Conditions	
Flow	
Instantaneous Flow	
Baseflow	
Chemical and Physical Characteristics	
Nitrates	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Pathogens (Drinking Water Rule, Basin Plan language)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Nutrients	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L
E. coli, enterococci (freshwater)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Toxicity (Acute)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Metals	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Pesticides	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Bioaccumulative	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Chemical Indicators: DDTs	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Chemical Indicators: PCBs	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Biotic Condition	
Biological Conditions: Benthic Macro-invertebrates (BMI, streams)	BMIs: Threshold between "Good" and "Fair," out of 1.00 for reference condition. California Macroinvertebrate Observed/ Expected Index (O/E Index) score of 0.77; Western EMAP Macroinvertebrate Index of Biotic Integrity (IBI) score of 0.57.

Protocol & Data Sources

California Monitoring and Assessment Program (CMAP). The CAMP monitoring project was developed in collaboration with the SWRCB's Non-Point Source Pollution control Program (NPS), SWRCB's SWAMP program and the US EPA's Region IX.

Department of Water Resources (DWR) Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/

DWR Water Plan Information Exchange: hub with links to various databases http://www.waterplan.water.ca.gov/waterpie/index.cfm

DWR Water Plan and Updates: water quality improvement strategies and data on water use http://www.waterplan.water.ca.gov/waterquality/water_quality.cfm

EPA TMDL program http://www.epa.gov/OWOW/tmdl/

EPA WEMAP (Western Environmental Monitoring and Assessment Program; http://www.epa.gov/region09/water/wemap/surface.html) for physical habitat structure, sediment metabolism, sediment chemistry, water quality parameters, and riparian vegetation.

SWAMP http://www.swrcb.ca.gov/water_issues/programs/swamp/, including water quality and toxicity data at http://swamp.mpsl.mlml.calstate.edu/online-data

SWRCB North Coast Basin Plan http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/basin_plan.shtml

SWAMP BMI, stream assessment, and other reports including Ode 2007, SWAMP 2005, and Ode and Rehn 2005 http://www.swrcb.ca.gov/water_issues/programs/swamp/

SWAMP protocols ("Standard Operating Procedures") http://swamp.mpsl.mlml.calstate.edu/ and selected reports under "Bioassessment" at http://www.swrcb.ca.gov/water_issues/programs/swamp/reports.shtml#bioassessment

USGS National Hydrography Dataset http://nhd.usgs.gov/

USGS National Water Information System (NWIS) http://waterdata.usgs.gov/nwis/rt

6. Relevant Programs

Agricultural Management Assistance Program, NRCS

> "Agricultural Management Assistance (AMA) provides cost share assistance to agricultural producers to voluntarily address issues such as water management, water quality, and erosion control by incorporating conservation into their farming operations. Producers may construct or improve water management structures or irrigation structures; plant trees for windbreaks or to improve water quality; and mitigate risk through production diversification or resource conservation practices, including soil erosion control, integrated pest management, or transition to organic farming."

Agriculture Water Management Planning Program, DWR

> "Agriculture Water Management Planning Program provides technical, financial, and administrative assistance to the Agricultural Water Management Council and to the

water districts throughout the State to develop water management plans and to help implement cost-effective, efficient water management practices." http://www.water.ca.gov/wateruseefficiency/agricultural/agmgmt.cfm

Agricultural Water Quality Grant Program, SWRCB

"The Agricultural Water Quality Grant Program provides funding for projects that reduce or eliminate non-point source pollution discharge to surface waters from agricultural lands. Funding from Propositions 40 and 50 were administered through two solicitations, most recently the 2005-2006 Consolidated Grants Process. Additional funds will be made available in the future through Proposition 84."

Agricultural Water Use Program, DWR

The Department of Water Resources' "Office of Water Use Efficiency works to disseminate and transfer information on improved irrigation technologies and to identify and help develop technologies and farming methods that improve water use efficiency."

Biologically Integrated Farming Systems (BIFS)

"BIFS is a program to help growers enhance environmental quality while maintaining yields and profits. BIFS projects use on-farm demonstrations and a collaborative model of outreach and extension involving public-private partnerships."

California Cerified Crop Advisors (CCA) Program

The CCA Program "can help producers grow economically and environmentally sound crops. The California CCA program is a voluntary certification program for individuals who provide advice to growers on crop management and inputs. Their Web site lists certified crop advisors for California."

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The purpose of California's Critical Coastal Areas (CCA) Program is "to foster collaboration among local stakeholders and government agencies and better coordinate resources and efforts in coastal-zone watershed areas critically in need of protection from polluted runoff." The North Coast is one of four regional pilot CCAs in which the CCA Program will form teams comprised of local stakeholders and state, federal, and local agencies to develop community-based action plans to reduce polluted runoff in coastal zone watershed areas. www.coastal.ca.gov/nps/cca-nps.html

California Irrigation Management Information System (CIMIS), DWR, Office of Water Use Efficiency

"Department of Water Resources, California Irrigation Management Information System (CIMIS) helps agricultural growers and turf managers who administer parks, golf courses, and other landscapes to develop water budgets for determining when to irrigate and how much water to apply. " http://wwwcimis.water.ca.gov/cimis/welcome.jsp

Coalition for Urban/Rural Environmental Stewardship (CURES)

CURES "has two programs to promote the environmental friendly use of pesticides. The Water Steward Orchard Program is designed to promote awareness of pesticide runoff from products used in dormant orchard sprays. http://www.curesworks.org/home.asp

Conservation Planning Assistance, NRCS

"The Natural Resources Conservation Service (NRCS) provides conservation planning and technical assistance to clients (individuals, groups, and units of government). These clients develop and implement conservation plans to protect, conserve, and enhance natural resources (soil, water, air, plants, and animals) within their related social and economic interests."

Department of Pesticide Regulation Pest Management Alliance Program

"Department of Pesticide Regulation (DPR) Pest Management Alliance Program provides support for agricultural, nonagricultural, and urban groups to develop and demonstrate pest management systems that reduce risks associated with pesticide use, including risks to surface and ground waters. The Web site has Alliance project evaluations, reports, and other technical information available for pest management systems in various commodities such as almonds, stone fruit, and strawberries." http://www.cdpr.ca.gov/docs/pestmgt/ipminov/ipmmenu.htm

Department of Pesticide Regulation Ground Water Protection Program

"DPRs Ground Water Protection Program addresses both agricultural and nonagricultural sources of pesticide residues in ground waters. The DPR is proposing to revise the Ground Water Quality Program by changing the current ground water regulations." http://www.cdpr.ca.gov/docs/emon/grndwtr/

Department of Pesticide Regulation Surface Water Quality Program

"DPRs Surface Water Quality Program addresses both agricultural and nonagricultural sources of pesticide residues in surface waters. It has preventive and response components that reduce the presence of pesticides in surface waters. The preventive component includes local outreach to promote management practices that reduce pesticide runoff. Prevention also relies on DPR's registration process in which potential adverse effects on surface water quality, particularly those in high-risk situations, are evaluated. The response component includes mitigation options to meet water quality goals, recognizing the value of self-regulating efforts to reduce pesticides in surface water as well as the regulatory authorities of DPR, the SWRCB, and the RWQCBs." http://www.cdpr.ca.gov/docs/emon/surfwtr/

Environmental Quality Incentives Program, NRCS

"The Environmental Quality Incentives Program (EQIP) was reauthorized in the Farm Security and Rural Investment Act of 2002 (Farm Bill) to provide a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land."

Fish Friendly Farming, California Land Stewardship Institute

"Fish Friendly Farming provides an incentive-based method for creating and sustaining environmental quality and habitat on private land. Landowners and managers enroll in the program, learn environmentally beneficial management practices and carry out ecological restoration projects."

Groundwater Ambient Monitoring Assessment (GAMA) Program, SWRCB

The "(GAMA) Program goal is to improve statewide ambient groundwater quality monitoring and assessment and to increase the availability of information about groundwater quality to the public. Stewardship of the state's groundwater resources is the shared responsibility of all levels of the government and community. Participation in the GAMA Program is voluntary." http://www.waterboards.ca.gov/water_issues/programs/gama/

Hydromet Network, Pacific Northwest Cooperative Agricultural Weather Network

The Pacific Northwest Cooperative Agricultural Weather Network, Hydromet network is a series of automated data collection platforms that provide information necessary for near-real-time management of Reclamation's water operations in the Pacific Northwest. As a subset of the overall Hydromet network, this agricultural network, dedicated to crop water use modeling and other agricultural applications, has been identified as AgriMet. http://www.usbr.gov/pn/hydromet/

Irrigation Management Program, UC Davis, Cooperative Extension Service

"This program is dedicated to the study of irrigation problems and techniques. The Cooperative Extension Service develops and extends research based information that promotes environmentally sound agricultural practices and that improves the efficient utilization of California's valuable water resource." http://lawr.ucdavis.edu/irrigation/index.htm

Nonpoint Source Management Program — Clean Water Act Section 319, US Environmental Protection Agency

This Program was established through an amendment to the Clean Water Act in 1987 to provide grant money to support activities including technical and financial assistance, education and training, technology transfer, demonstration projects, and project success monitoring. http://www.epa.gov/owow/nps/cwact.html

Nonpoint Source Pollution Control Programs, SWRCB

The State Water Resources Control Board administers several grant programs, which assist local entities with nonpoint source pollution control. The grants are made available through voter approval of the following Propositions: 13, 40, 50, and 84.

University of California Statewide Integrated Pest Management Program

University of California Statewide Integrated Pest Management Program contains information for practitioners on how to identify and manage pests, including educational resources, databases, publications, projects, and other resources. http://www.ipm.ucdavis.edu/

WaterSense Program, USEPA

"WaterSense is a voluntary partnership program sponsored by the U.S. Environmental Protection Agency. Its mission is to protect the future of our nation's water supply by promoting and enhancing the market for water-efficient products and services."

Watershed Protection Programs, SWRCB

The State Water Resources Control Board administers several programs for watershed protection under Propositions approved by voters. These Propositions are: 13, 40, and 50.

7. Relevant Policies & Plans

California Pesticide Management Plan for Water Quality

"California Pesticide Management Plan for Water Quality is a joint effort by DPR and the SWRCB to protect water quality from the potential adverse effects of pesticides. It describes how DPR and the County Agricultural Commissioners work in cooperation with the SWRCB and the Regional Water Quality Control Boards (RWQCBs) to protect water quality from the use of pesticides." http://www.cdpr.ca.gov/docs/emon/surfwtr/maaplan.htm

California Water Plan Update 2013, DWR

Presents status and trends for water-dependent resources, supplies, and demands. Evaluates regional and statewide management strategies to identify effective actions and policies. Includes Regional Basin Plans.

Safe Water Drinking Act, US EPA

This act was intended to protect public health by regulating public drinking water supply. It requires the protection of drinking water and its' sources, including rivers, lakes, reservoirs, springs, and ground water wells.

8. Sources

CDFG Habitat and Biological Inventory Parameters for Russian River Basin Fisheries (CDFG 2007)

NCRWQCB Monitoring Parameters, sample for Garcia River Sediment TMDL (NCRWQCB 2011)

NOAA/NMFS Habitat Attribute Indicators for Russian River Watershed CCC Coho (NMFS 2010)

SWRCB/ SWAMP Core Indicators for Beneficial Uses in California (SWAMP 2010/ SWAMP 2006)

SWRCB. 2009. NPS Encyclopedia. 1G — Groundwater Protection http://www.waterboards.ca.gov/water_issues/programs/nps/encyclopedia/1g_grndwtr.shtml

USDA. No date. *Electronic Field Office Technical Guide for California*. U.S. Department of Agriculture, Natural Resource Conservation Service. http://efotg.nrcs.usda.gov/

URBAN/ RURAL RESIDENTIAL

WATERSHED SURFACE WATER AND GROUNDWATER PROTECTION

1. Baseline Description

General Setting:

The Russian River has experienced habitat loss and water quality degradation, leading to loss of wildlife and impaired water quality for both environmental and human beneficial uses. Groundwater and surface water are important sources of agricultural, industrial, and domestic water in the Russian River watershed, especially in rural areas, where it is the principal source of domestic water. In 2002, there were approximately 40,000 groundwater wells in Sonoma County, with over 40% of the county's population at least partially dependent on groundwater supplies. Eight economically significant groundwater basins and five sub-basins are located within the Russian River drainage. Municipal supply wells in Sebastopol and

Santa Rosa have been closed due to contamination and many individual wells have been contaminated.

Causal Factors:

A long history of development has led to habitat loss and fragmentation, native species decline, extirpation, or extinction, and overuse of natural resources. The Russian River is over-appropriated during the summer months, leading to water shortages when drought occurs. The lack of regulation on groundwater extraction has led to its substitution, where possible, when surface water supplies are limited. Groundwater depletion can occur when withdrawal rates are faster than recharge rates. Groundwater quality can be impacted by a range of urban and rural residential activities, including runoff from fertilizer and pesticide application, urban and road runoff, and pollutant spills.

2. Management Measure Description

The Watershed Surface Water and Groundwater Protection MM encourages land use and development planning on a watershed scale that takes into consideration sensitive areas that, when protected, will maintain or improve water quality. Public outreach and education is an integral component of decreasing incidence of groundwater contamination and overdraft.

3. Resource Concerns

Habitat Fragmentation

Inadequate Food Sources for Wildlife

Inadequate Shelter

Inadequate Wildlife Movement/Travel Corridors

Inadequate Wildlife Territory

Invasive Non-native Plants

Threatened and Endangered Fish and Wildlife Species

Water Quantity — Excessive Runoff, Flooding, or Ponding

Water Quantity — Inadequate Outlets

Water Quality — Excessive Nutrients, Pathogens, or Organics

Water Quality — Excessive Sediment

Water Quality — Harmful Levels of Heavy Metals

Water Quality — Harmful Temperatures of Surface Water

4. Management Practices

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
NRCS	Drainage Water Management (554)	AC
NRCS	Integrated Pest Management (595)	AC
NRCS	Land Clearing (460)	AC
NRCS	Recreation Area Improvement (562)	AC
NRCS	Restoration and Management of Declining Habitats (643)	AC
NRCS	Shallow Water Development and Management (646)	AC
NRCS	Stormwater Runoff Control (570)	NO and AC
NRCS	Stream Habitat Improvement and Management (395)	AC
NRCS	Streambank and Shoreline Protection (580)	FT
NRCS	Trails and Walkways (568)	FT
NRCS	Tree/Shrub Establishment (612)	NO and AC
NRCS	Wetland Wildlife Habitat Management (644)	AC
NRCS	Wetland Restoration (657)	AC
NRCS	Wetland Creation (658)	AC
NRCS	Wetland Enhancement (659)	AC
EPA	Identify environmentally sensitive, critical conservation areas (3.3.1.1)	NO
EPA	Identify and protect drinking water sources (3.3.1.2)	NO
EPA	Development of a Watershed Management Plan (3.3.2)	NO
EPA	Develop ordinances or regulations requiring nonpoint source pollution controls for new/re-development (3.3.3.1)	NO
EPA	Plan infrastructure (3.3.3.2)	NO
EPA	Revise local zoning infrastructure (3.3.3.3)	NO
EPA	Establish limits on impervious surfaces, encourage open space, and promote cluster development (3.3.3.4)	NO
EPA	Revitalize existing developed areas (3.3.3.5)	NO
EPA	Establish setback (buffer zone) standards (3.3.3.6)	NO
EPA	Establish slope restrictions (3.3.3.7)	NO
EPA	Promote urban forestry (3.3.3.8)	AC
EPA	Use site plan reviews and approval (3.3.3.9)	NO
EPA	Designate an entity responsible for maintaining the infrastructure, including urban runoff management systems (3.3.3.10)	NO
EPA	Use official mapping (3.3.3.11)	NO
EPA	Require environmental impact assessment statements (3.3.3.12)	NO
EPA	Land or Development Rights Acquisition Practices (3.3.5)	NO
SWRCB	Education/Outreach Pollution Prevention/Education (3.6A)	

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Hydrology and Geomorphology	
Flow Conditions	**Salmonid Habitat:** North Coast and Central Coast ESU Salmonids freshwater habitat quality indicator benchmarks
Flow	
Instantaneous Flow	
Baseflow	
Stream Shading/ Canopy Cover	**Riparian Vegetation:** From "Poor to "Very Good" Canopy cover: <75 % average over IP-km, 75 to 85 %, 85 to 95 %, >95 %
Complex Habitat Types	**Channel Morphology and Connectivity**: From "Poor" to "Very Good"

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Floodplain Connectivity	**Floodplain connectivity:** <50 %, 50 to 80 %, >80 %, Not defined Physical barriers <50 of IP-km, 50 to 70 %, 70 to 90 %, >90 %
Stream Habitat Type	**Channel Morphology and Connectivity**: From "Poor" to "Very Good"
Chemical and Physical Characteristics	
Nitrates	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L
Pathogens (Drinking Water Rule, Basin Plan language)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Nutrients	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L
E. coli, enterococci (freshwater)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Toxicity (Acute)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Metals	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Pesticides	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Bioaccumulative	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Chemical Indicators: DDTs	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Chemical Indicators: PCBs	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Biotic Condition	
Biological Conditions: Benthic Macro-invertebrates (BMI, streams)	BMIs: Threshold between "Good" and "Fair," out of 1.00 for reference condition. California Macroinvertebrate Observed/ Expected Index (O/E Index) score of 0.77; Western EMAP Macroinvertebrate Index of Biotic Integrity (IBI) score of 0.57.

Protocol & Data Sources

California Monitoring and Assessment Program (CMAP). The CAMP monitoring project was developed in collaboration with the SWRCB's Non-Point Source Pollution control Program (NPS), SWRCB's SWAMP program and the US EPA's Region IX.

Department of Water Resources (DWR) Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/

DWR Water Plan Information Exchange: hub with links to various databases http://www.waterplan.water.ca.gov/waterpie/index.cfm

DWR Water Plan and Updates: water quality improvement strategies and data on water use http://www.waterplan.water.ca.gov/waterquality/water_quality.cfm

EPA TMDL program http://www.epa.gov/OWOW/tmdl/

EPA WEMAP (Western Environmental Monitoring and Assessment Program; http://www.epa.gov/region09/water/wemap/surface.html) for physical habitat structure, sediment metabolism, sediment chemistry, water quality parameters, and riparian vegetation.

SWAMP http://www.swrcb.ca.gov/water_issues/programs/swamp/, including water quality and toxicity data at http://swamp.mpsl.mlml.calstate.edu/online-data

SWRCB North Coast Basin Plan http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/basin_plan.shtml

SWAMP BMI, stream assessment, and other reports including Ode 2007, SWAMP 2005, and Ode and Rehn 2005 http://www.swrcb.ca.gov/water_issues/programs/swamp/

SWAMP protocols ("Standard Operating Procedures") http://swamp.mpsl.mlml.calstate.edu/ and selected reports under "Bioassessment" at http://www.swrcb.ca.gov/water_issues/programs/swamp/reports.shtml#bioassessment

USGS National Hydrography Dataset http://nhd.usgs.gov/

USGS National Water Information System (NWIS) http://waterdata.usgs.gov/nwis/rt

6. Relevant Programs

5 Star Restoration Program, USEPA

> "The Five Star Restoration Program brings together students, conservation corps, other youth groups, citizen groups, corporations, landowners and government agencies to provide environmental education and train-

ing through projects that restore wetlands and streams. The program provides challenge grants, technical support and opportunities for information exchange to enable community-based restoration projects."

***Arundo donax* Removal Program, Sotoyome Resource Conservation District**

The Sotoyome RCD is collaborating with Circuit Rider Productions, Inc. to implement a long-term effort to remove *Arundo donax* from the Russian River Watershed. *Arundo donax* removal is offered to landowners in the watershed free of charge.

California Coastal Salmon and Watersheds Program, California Resources Agency

The goal of this program is to: recover harvestable salmon and steelhead populations, restore watersheds, and so contribute to building healthy communities." http://ceres.ca.gov/cra/coastal_salmon_plan.html

California Riparian Habitat Conservation Program, California Wildlife Conservation Board

"The California Riparian Habitat Conservation Program was created within the Wildlife Conservation Board by legislation in 1991. The program has a basic mission to develop coordinated conservation efforts aimed at protecting and restoring the state's riparian ecosystems." http://www.wcb.ca.gov/Pages/california_riparian_habitat_conservation_program.htm

California River Parkways Program, California Resources Agency

"The Proposition 50 California River Parkways Program in the Resources Agency is a competitive grant program for river parkways projects. Eligible projects must provide public access or be a component of a larger parkway plan that provides public access."

California's Critical Coastal Areas Program

The purpose of California's Critical Coastal Areas (CCA) Program is "to foster collaboration among local stakeholders and government agencies and better coordinate resources and efforts in coastal-zone watershed areas critically in need of protection from polluted runoff." The North Coast is one of four regional pilot CCAs in which the CCA Program will form teams comprised of local stakeholders and state, federal, and local agencies to develop community-based action plans to reduce polluted runoff in coastal zone watershed areas. www.coastal.ca.gov/nps/cca-nps.html

Clean Water Team Citizen Monitoring Program, SWRCB

The SWRCB provides support to citizens and local organizations who would like to improve water quality through pollution prevention and citizen-based monitoring programs.

Coastal Program, USFS

"The Coastal Program provides incentives for voluntary protection of threatened, endangered and other species on private and public lands alike."

Conjunctive Water Management Program, DWR

The Department of Water Resources works with "local agencies and the public to develop surface and groundwater conjunctive-management projects for improving regional water supply reliability."

Conservation Planning Assistance, NRCS

"The Natural Resources Conservation Service (NRCS) provides conservation planning and technical assistance to clients (individuals, groups, and units of government). These clients develop and implement conservation plans to protect, conserve, and enhance natural resources (soil, water, air, plants, and animals) within their related social and economic interests."

Education and Public Outreach Programs, SWRCB

The State Water Resources Control Board provides a web site with information regarding water quality education outreach to various interest groups, including business and industry, municipalities, schools, and tribes.

Education Program, Sotoyome Resource Conservation District

"The Sotoyome Resource Conservation District (SRCD) Education Program delivers adult and K-12 education that promotes an understanding of the interplay between agriculture and natural resources, and sponsors projects that address stewardship of our natural resources."

Endangered Species Protection Program, USEPA

The Endangered Species Protection Program seeks to protect endangered species from the use of pesticides and to minimize the impact of the program on pesticide users.

Environmental Contaminants Program, USFWS

The US Fish and Wildlife Service's "Environmental Contaminants Program includes contaminants specialists stationed at more than 75 locations around the country. Service contaminants specialists are on the front lines in the fight against pollution. They specialize in detecting toxic chemicals; addressing their effects; preventing harm to fish, wildlife and their habitats; and removing toxic chemicals and restoring habitat when prevention isn't possible."

Environmental Enhancement and Mitigation Program, The California Resources Agency

"The Environmental Enhancement and Mitigation Program was established by the Legislature in 1989. It offers a total of $10 million each year for grants to local, state, and federal governmental agencies and to nonprofit organizations for projects to mitigate the environmental impacts caused by new or modified state transportation facilities." Grants are awarded in three categories: 1) Highway landscape and urban forestry; 2) Resource lands, and 3) Roadside recreational.

Environmental Justice Small Grants Program, Cal/EPA

"Cal/EPA has established the EJ Small Grants Program to assist eligible community-based, grassroots, non-profit entities, and federally recognized tribal governments to address environmental justice issues."

Fisheries Restoration Grant Program, CDFG

The California Department of Fish and Game coordinates this grant program, which works towards the conservation and restoration of anadromous fisheries and watershed health.

Flood Control Subventions Program, DWR

The Department of Water Resources implements the national flood control program for the North Coast of California. The national flood control program requires "nonfederal interests to pay the costs of rights of way and relocations for channel improvements and levee projects." Several state laws enacted subsequent to the federal program provide for varying cost-share percentages between state and local agencies.

Flood Protection Corridor Program, DWR

This DWR program funds acquisition of property rights from willing sellers and other activities that contribute to flood protection corridor projects.

The Global Invasive Species Initiative, TNC

The Global Invasive Species Initiative is The Nature Conservancy's response to abating the damage caused to native biodiversity by the human-facilitated introduction of non-native, harmful invasive species. This web site provides many resources designed to help all conservationists deal most effectively with invasive species. http://tncweeds.ucdavis.edu/

National Coastal Wetland Conservation Grant Program, USFWS

Under the National Coastal Wetland Conservation Grant Program, the US Fish and Wildlife Service "provides matching grants to States for acquisition, restoration, management, or enhancement of coastal wetlands."

National Fish Passage Program, USFS

The US Fish and Wildlife's "National Fish Passage Program uses a voluntary, non-regulatory approach to remove and bypass barriers. The Program addresses the problem of fish barriers on a national level, working with local communities and partner agencies to restore natural flows and fish migration."

Pollinator Conservation Program, The Xerces Society

"The Xerces Society's pollinator program works with farmers, land managers, golf course staff, public agencies, and gardeners to promote the conservation and recovery of native pollinator insects and their habitat."

Recovery Strategy for California Coho Salmon, CDFG

"The California Department of Fish and Game, with the assistance of recovery teams representing diverse interests and perspectives, created the Recovery Strategy for California

Coho Salmon, a guide for the process of recovering coho salmon on the north and central coasts of California. The Recovery Strategy emphasizes cooperation and collaboration at many levels, and recognizes the need for funding, public and private support for restorative actions, and maintaining a balance between regulatory and voluntary efforts."

Riparian Habitat Joint Venture

"The Riparian Bird Conservation Plan is a collaborative effort of the Riparian Habitat Joint Venture and has been developed to guide conservation policy and action on behalf of riparian habitats and California's landbirds." http://www.prbo.org/calpif/htmldocs/riparian.html

Surface Transportation Program, US Department of Transportation

This program is a block grant program that may be used by states and local governments for any roads that are not functionally classified as local or rural minor collectors. Ten percent of allocated STP funds must be set aside by each state for transportation enhancements, including mitigation of water pollution due to highway runoff.

Urban Forestry Program, California Department of Forestry and Fire Protection

"The Urban Forestry Program offers grants of over $1 million dollars a year to plant trees and over $2.5 million for related projects in urban communities throughout California. Four Urban Forestry Field Specialists provide expert urban forestry support to communities, non-profit groups and other municipal governments to create and maintain sustainable urban forest."

Urban Streams Restoration Program, DWR

"The objectives of the Urban Streams Restoration Program are to assist communities in reducing damages from stream bank and watershed instability and floods while restoring the environmental and aesthetic values of streams, and to encourage stewardship and maintenance of streams by the community. With voter approval of Proposition 84, the Urban Streams Restoration Program will have available grant funding. Proposition 84 includes $18 million for the Urban Streams Restoration Program. DWR anticipates holding the first of two application cycles in mid 2007."

Volunteer Monitoring Program, USEPA

"The U.S. Environmental Protection Agency's (EPA) Office of Water encourages all citizens to learn about their water resources and supports volunteer monitoring because of its many benefits. Volunteer monitors build awareness of pollution problems, become trained in pollution prevention, help clean up problem sites, provide data for waters that may otherwise be unassessed, and increase the amount of water quality information available to decision makers at all levels of government."

Water Quality Service Learning Program, SWRCB

The State Water Resources Control Board has developed a web site designed to introduce teachers to student-centered investigation of polluted runoff. The site offers units of study, free lesson plans, online teacher support, and materials in Spanish.

Water Recycling Programs, SWRCB

The State Water Resources Control Board administers three programs designed to assist local entities with water recycling programs. These programs are: Proposition 50 Integrated Regional Water Management Program (described above), State Revolving Fund Loans, and Water Recycling Loans and Grants.

WaterSense Program, USEPA

"WaterSense is a voluntary partnership program sponsored by the U.S. Environmental Protection Agency. Its mission is to protect the future of our nation's water supply by promoting and enhancing the market for water-efficient products and services."

Watershed Program, DWR

"The Department of Water Resources Watershed Program works with locally led stewardship efforts to integrate the needs of communities, urban and rural, with resource management that sustains watershed ecology."

Watershed Protection Programs, SWRCB

The State Water Resources Control Board administers several programs for watershed

protection under Propositions approved by voters. These Propositions are: 13, 40, and 50.

Watershed Stewardship Program, Sotoyome Resource Conservation District

"The SRCD program focuses on education and collaboration within the community to restore resources, improve water quality and habitat, and monitor creeks and watersheds. Working together to find viable solutions for the restoration of the smaller tributary watersheds that will lead to improvements downstream in the main stem of the Russian River Watershed is one of the main goals of this program."

Wildlife and Sport Fish Restoration Programs Division of Federal Assistance, USFWS

"The mission of the Federal Assistance Program is to strengthen the ability of State and Territorial fish and wildlife agencies to meet the consumptive and non-consumptive needs of the public for fish and wildlife resources. The Division of Federal Assistance is responsible for administering grant programs to help States meet these needs."

Wildlife Habitat Incentives Program, NRCS

"The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land. Through WHIP USDA's Natural Resources Conservation Service provides both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat. WHIP agreements between NRCS and the participant generally last from 5 to 10 years from the date the agreement is signed."

7. Relevant Policies & Plans

California Dual Plumbing Code, 2009

The California Dual Plumbing Code establishes statewide standards to install both potable and recycled water plumbing systems in all types of buildings as determined by the State Department of Public Health.

California Endangered Species Act (CESA), California Environmental Protection Agency

Compliance with the CESA may be required for environmental projects and management practices. The CDFG administers CESA and can authorize exceptions to the state's prohibition against take of a listed species. http://www.essexenv.com/endangered_species/cesa.html

California Environmental Quality Act (CEQA), California Resources Agency

CEQA is a statue requiring state and local agencies to identify significant environmental impacts of proposed activities and to avoid or mitigate those impacts if feasible. http://www.ceres.ca.gov/ceqa/

Clean Water Act, EPA, Army Corps of Engineers, USFWS, NOAA

Establishes a permit program for the discharge of pollutants into all waters of the US.

California Water Plan Update 2013, DWR

Presents status and trends for water-dependent resources, supplies, and demands. Evaluates regional and statewide management strategies to identify effective actions and policies. Includes Regional Basin Plans.

Endangered Species Act (ESA), US Environmental Protection Agency

The US FWS works with landowners to provide incentives to manage land for endangered species. In some instances land use activities qualify for exemptions to ESA prohibitions. http://www.fws.gov/endangered/landowner/index.html

Estuary Restoration Act of 2000, US EPA, NOAA, US ACE, USFWS, USDA

Develops a national estuary restoration strategy, promotes estuary restoration, and provides federal assistance for restoration, monitoring and research.

Food, Agriculture, Conservation, and Trade Act of 1990, NRCS

Provides for acquisition of perpetual nondevelopment easements on farmed wetlands and subsidizes restoration of wetlands from croplands.

Food Security Act of 1985 (Swampbuster), FARM SERVICE AGENCY, USFWS

Suspends subsidies to farmers who convert wetlands to farmland. Allows Farmer's Home Administration and the Farm Service Agency

to forgive farm debts in exchange for long-term easements that protect wetlands.

Healthy Forests Restoration Act, Bureau of Land Management

"The Healthy Forests Restoration Act (HFRA) provides BLM and Forest Service land managers with legislative tools to expedite forest and rangeland restoration projects. HFRA aims to expedite the preparation and implementation of hazardous fuels-reduction projects on Federal land and assist rural communities, States, and private landowners in restoring healthy forest conditions on State and private lands."

Lake and Streambed Alteration Program, CDFG

"Fish and Game Code section 1602 requires any person, state or local governmental agency, or public utility to notify the Department before beginning any activity that will do one or more of the following: 1) substantially obstruct or divert the natural flow of a river, stream, or lake; 2) substantially change or use any material from the bed, channel, or bank of a river, stream, or lake; or 3) deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it can pass into a river, stream, or lake. Fish and Game Code section 1602 applies to all perennial, intermittent, and ephemeral rivers, streams, and lakes in the state."

Local Urban Water Management Plans, Local Municipalities

These plans set policies for the conservation of water during periods of water scarcity and drought. The following entities have filed Urban Water Management Plans with the Department of Water Resources: Sonoma County Water Agency, Cotati, Healdsburg, Rohnert Park, Santa Rosa, Sebastopol, Ukiah, and Windsor.

National Environmental Protection Act, US EPA

"The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet this requirement, federal agencies prepare a detailed statement known as an Environmental Impact Statement (EIS)."

Stream and Wetland System Protection Policy, NCRWQCB

This policy is a proposed amendment to the Water Quality Control Plans for the North Coast and San Francisco Bay Regions that will "protect stream and wetlands systems, including measures to protect riparian areas and floodplains."

8. Sources

CDFG Habitat and Biological Inventory Parameters for Russian River Basin Fisheries (CDFG 2007)

EPA. 2005. National Management Measures to Control Nonpoint Source Pollution from Urban Areas. Management Measure 3: Watershed Protection. Available: http://water.epa.gov/polwaste/nps/urban/upload/2005_12_08_NPS_urbanmm_urban_ch03.pdf

NCRWQCB Monitoring Parameters, sample for Garcia River Sediment TMDL (NCRWQCB 2011)

NOAA/NMFS Habitat Attribute Indicators for Russian River Watershed CCC Coho (NMFS 2010)

SWRCB/ SWAMP Core Indicators for Beneficial Uses in California (SWAMP 2010/ SWAMP 2006)

SWRCB. 2009. NPS Encyclopedia. 3.1A — Planning and Design — Watershed and Groundwater Protection http://www.waterboards.ca.gov/water_issues/programs/nps/encyclopedia/3_1a_plandes_wtrsdgrdwtr_protect.shtml

USDA. No date. *Electronic Field Office Technical Guide for California*. U.S. Department of Agriculture, Natural Resource Conservation Service. (http://efotg.nrcs.usda.gov/)

LOW IMPACT DEVELOPMENT

1. Baseline Description

General Setting:

Low Impact Development (LID) is a paradigm shift in the way storm water is managed; it uses watershed-scale planning with the intent to protect, conserve, and enhance natural resources with an emphasis on water quality and aquatic resources. Urban areas in the Russian River watershed are promoting LID through the adoption of Smart Growth policies to require that new development use LID practices.

Causal Factors:

Traditional planning occurs on jurisdictional scales that do not consider movement of water and pollutants through a watershed. Communities in the

Russian River watershed have recently begun to plan on a watershed scale and implement LID. Since LID is relatively new, older communities and individual buildings do not incorporate these principles and continue to contribute to watershed degradation; efforts to bring all infrastructure into the LID paradigm are hampered by lack of sufficient funds and lack of widespread public knowledge and acceptance.

2. Management Measure Description

The LID MM aims to protect and conserve natural resources through maintenance and restoration of a site's pre-development hydrograph when possible. This MM includes management practices that use watershed based continuous rainfall simulation models to help with site design. It includes both regional, large-scale and small-scale management measures and can be implemented at both the municipal planning scale and on individual sites.

3. Resource Concerns

Soil Erosion — Roadbank and Construction Sites

Water Quantity — Excessive Runoff, Flooding, or Ponding

Water Quantity — Inadequate Outlets

Water Quantity — Inefficient Water Use on Irrigated Land

Water Quantity — Inefficient Water Use on Non-Irrigated Land

Water Quantity — Reduced Capacity of Conveyances by Sediment Deposition

Water Quantity — Reduced Storage of Water Bodies by Sediment Accumulation

Water Quality — Excessive Nutrients, Pathogens, or Organics

Water Quality — Excessive Sediment

Water Quality — Harmful Levels of Heavy Metals

Water Quality — Harmful Temperatures of Surface Water

4. Management Practices

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
SWRCB	Use watershed based continuous rainfall simulation models to help with site design	NO
SWRCB	Plant trees to absorb carbon and nutrients, and to retain sediment from eroding into nearby waterbodies	NO
SWRCB	Maintain forested buffers surrounding streams to help with pollutant attenuation, flood control, and shading	AC
SWRCB	Protect open space, especially riparian habitat and wetlands by developing conservation easements, parks, or conjunctive-use management plans	AC
SWRCB	Enhance or restore riparian habitat and wetland functions	NO
SWRCB	Construct and maintain: vegetated filter strips, grassed swales, and vegetated buffers or storm water wetlands	AC
SWRCB	Protect and restore natural drainage features	NO
SWRCB	Minimize (limit, reduce, or mitigate) and disconnect impervious surfaces. Smart growth and urban infill development includes limiting, mitigating, and/or reducing impervious surfaces.	AC
SWRCB	Use bioretention, i.e. phytoremediation and natural biogeochemical cycling, to transform and attenuate common pollutants from storm water runoff at its source or as close to the source as practical.	NO
LID Center	Bioretention areas to function as soil and plant based filtration devices that remove pollutants through a variety of physical, biological, and chemical treatment processes.	NO
LID Center	Vegetated roof covers are multi-beneficial structural components that help to mitigate the effects of urbanization on water quality by filtering, absorbing or detaining rainfall.	AC
LID Center	Permeable paving materials can allow for local infiltration of rainwater and reduce runoff.	AC or AC-FT
LID Center	Rain Barrels and Cisterns retain rooftop runoff for later use onsite, reducing runoff.	NO or AC-FT
LID Center	Soil amendments after construction activities can include compost, mulch, top soil, lime and gypsum, helping to offset nutritional deficiencies and control soil acidity.	CU YDS
LID Center	Tree box filters are mini bioretention areas installed beneath trees that can be very effective at controlling runoff, expecially when distributed throughout the site.	NO

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Landscape Condition	
Impervious Surfaces	**Impervious surface:** > 12.01 % of watershed by area 7.01 to 12 % 3.01 to 7 % 0 to 3 %
Road Density	**Road Density**: From "Poor" to "Very Good" Road density: > 3 miles/ square mile, 3 to 2.5, 2.5 to 1.6, <1.6; Road density within 100 m. stream: >1 mile/square miles, 1 to 0.5, 0.5 to 0.1, <0.1
Land Use	**Land Use:** Unnatural Index (Agricultural + Urban) "Most Disturbed" is Greater than 40 %, "Least Disturbed" is less than 10 %; Percent Urban Greater than 25 %, Less than 5 %; Percent Agricultural Greater than 50 %, Less than 10 %
Hydrology and Geomorphology	
Complex Habitat Types	**Channel Morphology and Connectivity**: From "Poor" to "Very Good"
Floodplain Connectivity	**Floodplain connectivity:** <50 %, 50 to 80 %, >80 %, Not defined Physical barriers <50 of IP-km, 50 to 70 %, 70 to 90 %, >90 %
Stream Habitat Type	**Channel Morphology and Connectivity**: From "Poor" to "Very Good"

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Chemical and Physical Characteristics	
Nitrates	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L
Pathogens (Drinking Water Rule, Basin Plan language)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Nutrients	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L
E. coli, enterococci (freshwater)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Toxicity (Acute)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Metals	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Pesticides	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Bioaccumulative	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Chemical Indicators: DDTs	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Chemical Indicators: PCBs	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Sediments/TDS	**Total Suspended Solids**: "Most Disturbed" is greater than 50 mg/L, "Least Disturbed" is less than or equal to 15 mg/L
Biotic Condition	
Biological Conditions: Benthic Macro-invertebrates (BMI, streams)	BMIs: Threshold between "Good" and "Fair," out of 1.00 for reference condition. California Macroinvertebrate Observed/ Expected Index (O/E Index) score of 0.77; Western EMAP Macroinvertebrate Index of Biotic Integrity (IBI) score of 0.57.

Protocol & Data Sources

California Monitoring and Assessment Program (CMAP). The CAMP monitoring project was developed in collaboration with the SWRCB's Non-Point Source Pollution control Program (NPS), SWRCB's SWAMP program and the US EPA's Region IX.

Department of Water Resources (DWR) Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/

DWR Water Plan Information Exchange: hub with links to various databases http://www.waterplan.water.ca.gov/waterpie/index.cfm

DWR Water Plan and Updates: water quality improvement strategies and data on water use http://www.waterplan.water.ca.gov/waterquality/water_quality.cfm

EPA TMDL program http://www.epa.gov/OWOW/tmdl/

EPA WEMAP (Western Environmental Monitoring and Assessment Program; http://www.epa.gov/region09/water/wemap/surface.html) for physical habitat structure, sediment metabolism, sediment chemistry, water quality parameters, and riparian vegetation.

EPA Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Control Measures — Urban, US Environmental Protection Agency. 1997. http://www.epa.gov/owow/nps/urban2.html

National Pollutant Discharge Elimination System (NPDES) Stormwater Final Rules. Available at: http://cfpub.epa.gov/npdes/regresult.cfm?program_id=6&view=all&type=1

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Methods to Observe, Estimate, or Measure Flow. SWRCB 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Measuring Suspended Solids and Water Column Turbidity. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Measuring Nitrate and Nitrite. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Measuring Orthophosphate. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: E. Coli and Total Coliform Counts Using the Enzyme Substrate Colilert Reagents with QuantiTrays. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Entercoccus Counts Using Enterolert. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html.

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: The California Streamside Biosurvey. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html.

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Methods for Particle Size Distribution Analyses. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html.

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Methods to Observe, Estimate, or Measure Flow. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Visual Observations in Streams and Shorelines. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html.

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Rapid Trash Assessment & Worksheet. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html.

SWAMP http://www.swrcb.ca.gov/water_issues/programs/swamp/, including water quality and toxicity data at http://swamp.mpsl.mlml.calstate.edu/online-data

SWRCB North Coast Basin Plan http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/basin_plan.shtml

SWAMP BMI, stream assessment, and other reports including Ode 2007, SWAMP 2005, and Ode and Rehn 2005 http://www.swrcb.ca.gov/water_issues/programs/swamp/

SWAMP protocols ("Standard Operating Procedures") http://swamp.mpsl.mlml.calstate.edu/ and selected reports under "Bioassessment" at http://www.swrcb.ca.gov/water_issues/programs/swamp/reports.shtml#bioassessment

USGS National Hydrography Dataset http://nhd.usgs.gov/

USGS National Water Information System (NWIS) http://waterdata.usgs.gov/nwis/rt

6. Relevant Programs

5 Star Restoration Program, USEPA

"The Five Star Restoration Program brings together students, conservation corps, other youth groups, citizen groups, corporations, landowners and government agencies to provide environmental education and training through projects that restore wetlands and streams. The program provides challenge grants, technical support and opportunities for information exchange to enable community-based restoration projects."

***Arundo donax* Removal Program, Sotoyome Resource Conservation District**

The Sotoyome RCD is collaborating with Circuit Rider Productions, Inc. to implement a long-term effort to remove *Arundo donax* from the Russian River Watershed. *Arundo donax* removal is offered to landowners in the watershed free of charge.

California Riparian Habitat Conservation Program, California Wildlife Conservation Board

"The California Riparian Habitat Conservation Program was created within the Wildlife Conservation Board by legislation in 1991. The program has a basic mission to develop coordinated conservation efforts aimed at protecting and restoring the state's riparian ecosystems." http://www.wcb.ca.gov/Pages/california_riparian_habitat_conservation_program.htm

California River Parkways Program, California Resources Agency

"The Proposition 50 California River Parkways Program in the Resources Agency is a competitive grant program for river parkways projects. Eligible projects must provide public access or be a component of a larger parkway plan that provides public access."

California's Critical Coastal Areas Program

The purpose of California's Critical Coastal Areas (CCA) Program is "to foster collaboration among local stakeholders and government agencies and better coordinate resources and efforts in coastal-zone watershed areas critically in need of protection from polluted runoff." The North Coast is one of four regional pilot CCAs in which the CCA Program will form

teams comprised of local stakeholders and state, federal, and local agencies to develop community-based action plans to reduce polluted runoff in coastal zone watershed areas. www.coastal.ca.gov/nps/cca-nps.html

Clean Water Team Citizen Monitoring Program, SWRCB

The SWRCB provides support to citizens and local organizations who would like to improve water quality through pollution prevention and citizen-based monitoring programs.

Coastal Program, USFS

"The Coastal Program provides incentives for voluntary protection of threatened, endangered and other species on private and public lands alike."

Conjunctive Water Management Program, DWR

The Department of Water Resources works with "local agencies and the public to develop surface and groundwater conjunctive-management projects for improving regional water supply reliability."

Conservation Planning Assistance, NRCS

"The Natural Resources Conservation Service (NRCS) provides conservation planning and technical assistance to clients (individuals, groups, and units of government). These clients develop and implement conservation plans to protect, conserve, and enhance natural resources (soil, water, air, plants, and animals) within their related social and economic interests."

Education and Public Outreach Programs, SWRCB

The State Water Resources Control Board provides a web site with information regarding water quality education outreach to various interest groups, including business and industry, municipalities, schools, and tribes.

Education Program, Sotoyome Resource Conservation District

"The Sotoyome Resource Conservation District (SRCD) Education Program delivers adult and K-12 education that promotes an understanding of the interplay between agriculture and natural resources, and sponsors projects that address stewardship of our natural resources."

Endangered Species Protection Program, USEPA

The Endangered Species Protection Program seeks to protect endangered species from the use of pesticides and to minimize the impact of the program on pesticide users.

Environmental Contaminants Program, USFWS

The US Fish and Wildlife Service's "Environmental Contaminants Program includes contaminants specialists stationed at more than 75 locations around the country. Service contaminants specialists are on the front lines in the fight against pollution. They specialize in detecting toxic chemicals; addressing their effects; preventing harm to fish, wildlife and their habitats; and removing toxic chemicals and restoring habitat when prevention isn't possible."

Environmental Enhancement and Mitigation Program, The California Resources Agency

"The Environmental Enhancement and Mitigation Program was established by the Legislature in 1989. It offers a total of $10 million each year for grants to local, state, and federal governmental agencies and to nonprofit organizations for projects to mitigate the environmental impacts caused by new or modified state transportation facilities." Grants are awarded in three categories: 1) Highway landscape and urban forestry; 2) Resource lands, and 3) Roadside recreational.

Fisheries Restoration Grant Program, CDFG

The California Department of Fish and Game coordinates this grant program, which works towards the conservation and restoration of anadromous fisheries and watershed health.

Flood Protection Corridor Program, DWR

This DWR program funds acquisition of property rights from willing sellers and other activities that contribute to flood protection corridor projects.

The Global Invasive Species Initiative, TNC

The Global Invasive Species Initiative is The Nature Conservancy's response to abating the damage caused to native biodiversity by the human-facilitated introduction of non-native, harmful invasive species. This web

site provides many resources designed to help all conservationists deal most effectively with invasive species. http://tncweeds.ucdavis.edu/

National Coastal Wetland Conservation Grant Program, USFWS

Under the National Coastal Wetland Conservation Grant Program, the US Fish and Wildlife Service "provides matching grants to States for acquisition, restoration, management, or enhancement of coastal wetlands."

National Fish Passage Program, USFS

The US Fish and Wildlife's "National Fish Passage Program uses a voluntary, non-regulatory approach to remove and bypass barriers. The Program addresses the problem of fish barriers on a national level, working with local communities and partner agencies to restore natural flows and fish migration."

Pollinator Conservation Program, The Xerces Society

"The Xerces Society's pollinator program works with farmers, land managers, golf course staff, public agencies, and gardeners to promote the conservation and recovery of native pollinator insects and their habitat."

Recovery Strategy for California Coho Salmon, CDFG

"The California Department of Fish and Game, with the assistance of recovery teams representing diverse interests and perspectives, created the Recovery Strategy for California Coho Salmon, a guide for the process of recovering coho salmon on the north and central coasts of California. The Recovery Strategy emphasizes cooperation and collaboration at many levels, and recognizes the need for funding, public and private support for restorative actions, and maintaining a balance between regulatory and voluntary efforts."

Riparian Habitat Joint Venture

"The Riparian Bird Conservation Plan is a collaborative effort of the Riparian Habitat Joint Venture and has been developed to guide conservation policy and action on behalf of riparian habitats and California's landbirds." http://www.prbo.org/calpif/htmldocs/riparian.html

Urban Forestry Program, California Department of Forestry and Fire Protection

"The Urban Forestry Program offers grants of over $1 million dollars a year to plant trees and over $2.5 million for related projects in urban communities throughout California. Four Urban Forestry Field Specialists provide expert urban forestry support to communities, non-profit groups and other municipal governments to create and maintain sustainable urban forest."

Urban Streams Restoration Program, DWR

"The objectives of the Urban Streams Restoration Program are to assist communities in reducing damages from stream bank and watershed instability and floods while restoring the environmental and aesthetic values of streams, and to encourage stewardship and maintenance of streams by the community. With voter approval of Proposition 84, the Urban Streams Restoration Program will have available grant funding. Proposition 84 includes $18 million for the Urban Streams Restoration Program. DWR anticipates holding the first of two application cycles in mid 2007."

Volunteer Monitoring Program, USEPA

"The U.S. Environmental Protection Agency's (EPA) Office of Water encourages all citizens to learn about their water resources and supports volunteer monitoring because of its many benefits. Volunteer monitors build awareness of pollution problems, become trained in pollution prevention, help clean up problem sites, provide data for waters that may otherwise be unassessed, and increase the amount of water quality information available to decision makers at all levels of government."

Water Quality Service Learning Program, SWRCB

The State Water Resources Control Board has developed a web site designed to introduce teachers to student-centered investigation of polluted runoff. The site offers units of study, free lesson plans, online teacher support, and materials in Spanish.

Water Recycling Programs, SWRCB

The State Water Resources Control Board administers three programs designed to assist

local entities with water recycling programs. These programs are: Proposition 50 Integrated Regional Water Management Program (described above), State Revolving Fund Loans, and Water Recycling Loans and Grants.

WaterSense Program, USEPA

"WaterSense is a voluntary partnership program sponsored by the U.S. Environmental Protection Agency. Its mission is to protect the future of our nation's water supply by promoting and enhancing the market for water-efficient products and services."

Watershed Program, DWR

"The Department of Water Resources Watershed Program works with locally led stewardship efforts to integrate the needs of communities, urban and rural, with resource management that sustains watershed ecology."

Watershed Protection Programs, SWRCB

The State Water Resources Control Board administers several programs for watershed protection under Propositions approved by voters. These Propositions are: 13, 40, and 50.

Watershed Stewardship Program, Sotoyome Resource Conservation District

"The SRCD program focuses on education and collaboration within the community to restore resources, improve water quality and habitat, and monitor creeks and watersheds. Working together to find viable solutions for the restoration of the smaller tributary watersheds that will lead to improvements downstream in the main stem of the Russian River Watershed is one of the main goals of this program."

Wildlife Habitat Incentives Program, NRCS

"The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land. Through WHIP USDA's Natural Resources Conservation Service provides both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat. WHIP agreements between NRCS and the participant generally last from 5 to 10 years from the date the agreement is signed."

7. Relevant Policies & Plans

California Dual Plumbing Code, 2009

The California Dual Plumbing Code establishes statewide standards to install both potable and recycled water plumbing systems in all types of buildings as determined by the State Department of Public Health.

Clean Water Act, EPA, Army Corps of Engineers, USFWS, NOAA

Establishes a permit program for the discharge of pollutants into all waters of the US.

California Water Plan Update 2013, DWR

Presents status and trends for water-dependent resources, supplies, and demands. Evaluates regional and statewide management strategies to identify effective actions and policies. Includes Regional Basin Plans.

Estuary Restoration Act of 2000, US EPA, NOAA, US ACE, USFWS, USDA

Develops a national estuary restoration strategy, promotes estuary restoration, and provides federal assistance for restoration, monitoring and research.

Healthy Forests Restoration Act, Bureau of Land Management

"The Healthy Forests Restoration Act (HFRA) provides BLM and Forest Service land managers with legislative tools to expedite forest and rangeland restoration projects. HFRA aims to expedite the preparation and implementation of hazardous fuels-reduction projects on Federal land and assist rural communities, States, and private landowners in restoring healthy forest conditions on State and private lands."

Local Urban Water Management Plans, Local Municipalities

These plans set policies for the conservation of water during periods of water scarcity and drought. The following entities have filed Urban Water Management Plans with the Department of Water Resources: Sonoma County Water Agency, Cotati, Healdsburg, Rohnert Park, Santa Rosa, Sebastopol, Ukiah, and Windsor.

8. Sources

Low Impact Development (LID) Center. 2007. Urban Design Tools: Low Impact Development. Web Site. Accessed June 2012. http://www.lid-stormwater.net/lid_techniques.htm

NCRWQCB Monitoring Parameters, sample for Garcia River Sediment TMDL (NCRWQCB 2011)

SWRCB/ SWAMP Core Indicators for Beneficial Uses in California (SWAMP 2010/ SWAMP 2006)

SWRCB. 2009. NPS Encyclopedia. Hydromodification — 5.2C Low Impact Development http://www.waterboards.ca.gov/water_issues/programs/nps/encyclopedia/5.2c_hydromod_lid.shtml

LOW IMPACT DEVELOPMENT — IMPERVIOUS SURFACES

1. Baseline Description

General Setting:

Impervious surfaces, such as parking lots, streets, buildings, and roads, prevent infiltration of storm-water or irrigation into the ground, instead leading to runoff. As water runs over these surfaces, it picks up and carries with it debris, chemicals, sediment, and other pollutants into the storm drain system, and from there into tributaries or the mainstem river. When impervious surfaces cover less than 10 percent of a watershed, streams generally remain healthy; however, above 10 percent impervious cover, common signs of degradation such as increased sedimentation, reduced groundwater recharge, and loss of riparian habitat become evident.

Causal Factors:

Lack of watershed planning to limit sprawl and use of traditional development practices can lead to excessive impervious surfaces. Budget limitations and lack of knowledge about greener development alternatives can be a constraint that prolongs the use of planning and building practices that create and maintain impervious surfaces.

2. Management Measure Description

The Impervious Surfaces MM promotes practices that support innovative site and structure designs to reduce building footprints, decrease the amount of paved infrastructure, and provide for dispersed drainage and infiltration of runoff from impervious surfaces. These MMs can be used on an individual site basis or required by municipalities through implementation of building ordinances.

3. Resource Concerns

Soil Erosion — Roadbank and Construction Sites

Soil Erosion - Sheet and Rill

Water Quantity — Excessive Runoff, Flooding, or Ponding

Water Quality — Excessive Nutrients, Pathogens, or Organics

Water Quality — Excessive Sediment

Water Quality — Harmful Levels of Heavy Metals

4. Management Practices

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
EPA	Site Planning Practices (4.3.1)	NO
EPA	On-Lot Impervious Surfaces (4.3.2)	AC
EPA	Residential Street and Right-of-Way Impervious Surfaces (4.3.3)	AC
EPA	Parking Lot Impervious Surfaces (4.3.4)	AC
EPA	Infiltration Practices (5.3.1)	NO
EPA	Vegetated Open Channel Practices (5.3.2)	NO
EPA	Filtering Practices (5.3.3)	NO
EPA	Detention and Retention Practices (5.3.4)	NO
EPA	Other Practices (5.3.5)	NO
EPA	Managing Structural Controls to Reduce Mosquito-Breeding Habitat (5.5)	NO
EPA	Nonpoint Source Pollution Education for Citizens (9.3.5)	NO
EPA	Establishing a Runoff Control Operation and Maintenance Program (11.3.1)	NO
EPA	Runoff Source Control Operation and Maintenance (11.3.2)	NO
EPA	Runoff Treatment Control Operation and Maintenance (11.3.3)	NO
NRCS	Roof Runoff Structure (558)	NO
SWRCB	Urban Areas Education/Outreach (3.3)	NO

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Landscape Condition	
Impervious Surfaces	**Impervious surface:** > 12.01 % of watershed by area 7.01 to 12 % 3.01 to 7 % 0 to 3 %
Road Density	**Road Density**: From "Poor" to "Very Good" Road density: > 3 miles/ square mile, 3 to 2.5, 2.5 to 1.6, <1.6; Road density within 100 m. stream: >1 mile/square miles, 1 to 0.5, 0.5 to 0.1, <0.1
Land Use	**Land Use:** Unnatural Index (Agricultural + Urban) "Most Disturbed" is Greater than 40 %, "Least Disturbed" is less than 10 %; Percent Urban Greater than 25 %, Less than 5 %; Percent Agricultural Greater than 50 %, Less than 10 %
Chemical and Physical Characteristics	

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
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Pathogens (Drinking Water Rule, Basin Plan language)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Nutrients	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L
E. coli, enterococci (freshwater)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Toxicity (Acute)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Metals	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Pesticides	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Bioaccumulative	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
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Protocol & Data Sources

California Monitoring and Assessment Program (CMAP). The CAMP monitoring project was developed in collaboration with the SWRCB's Non-Point Source Pollution control Program (NPS), SWRCB's SWAMP program and the US EPA's Region IX.

Department of Water Resources (DWR) Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/

DWR Water Plan Information Exchange: hub with links to various databases http://www.waterplan.water.ca.gov/waterpie/index.cfm

DWR Water Plan and Updates: water quality improvement strategies and data on water use http://www.waterplan.water.ca.gov/waterquality/water_quality.cfm

EPA TMDL program http://www.epa.gov/OWOW/tmdl/

EPA WEMAP (Western Environmental Monitoring and Assessment Program; http://www.epa.gov/region09/water/wemap/surface.html) for physical habitat structure, sediment metabolism, sediment chemistry, water quality parameters, and riparian vegetation.

EPA Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Control Measures — Urban http://water.epa.gov/polwaste/nps/urban2.cfm

SWAMP http://www.swrcb.ca.gov/water_issues/programs/swamp/, including water quality and toxicity data at http://swamp.mpsl.mlml.calstate.edu/online-data

SWRCB North Coast Basin Plan http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/basin_plan.shtml

SWAMP BMI, stream assessment, and other reports including Ode 2007, SWAMP 2005, and Ode and Rehn 2005 http://www.swrcb.ca.gov/water_issues/programs/swamp/

SWAMP protocols ("Standard Operating Procedures") http://swamp.mpsl.mlml.calstate.edu/ and selected reports under "Bioassessment" at http://www.swrcb.ca.gov/water_issues/programs/swamp/reports.shtml#bioassessment

USGS National Hydrography Dataset http://nhd.usgs.gov/

USGS National Water Information System (NWIS) http://waterdata.usgs.gov/nwis/rt

6. Relevant Programs

Clean Water Team Citizen Monitoring Program, SWRCB

The SWRCB provides support to citizens and local organizations who would like to improve

water quality through pollution prevention and citizen-based monitoring programs.

Education and Public Outreach Programs, SWRCB

The State Water Resources Control Board provides a web site with information regarding water quality education outreach to various interest groups, including business and industry, municipalities, schools, and tribes.

Environmental Enhancement and Mitigation Program, The California Resources Agency

"The Environmental Enhancement and Mitigation Program was established by the Legislature in 1989. It offers a total of $10 million each year for grants to local, state, and federal governmental agencies and to nonprofit organizations for projects to mitigate the environmental impacts caused by new or modified state transportation facilities." Grants are awarded in three categories: 1) Highway landscape and urban forestry; 2) Resource lands, and 3) Roadside recreational.

Green Highways and Green Infrastructure Program, LID Center

The Green Infrastructure approach to infrastructure planning, design, and construction is a revolutionary approach to resource protection and environmental compliance. The approach is based on providing predictable pathways to streamline the delivery of transportation projects by the use of incentives and recognition for the use of innovate stormwater and environmental designs that are done in the context, or framework, of a watershed approach. http://lowimpactdevelopment.org/green_highways.htm

Nonpoint Source Management Program — Clean Water Act Section 319, US Environmental Protection Agency

This Program was established through an amendment to the Clean Water Act in 1987 to provide grant money to support activities including technical and financial assistance, education and training, technology transfer, demonstration projects, and project success monitoring.

Nonpoint Source Pollution Control Programs, SWRCB

The State Water Resources Control Board administers several grant programs which assist local entities with nonpoint source pollution control. The grants are made available through voter approval of the following Propositions: 13, 40, 50, and 84.

Storm Water Program, SWRCB

The State Water Resources Control Board has four programs to assist with Storm Water Management: Construction, Industrial, Municipal, and Caltrans.

Surface Transportation Program, US Department of Transportation

This program is a block grant program that may be used by states and local governments for any roads that are not functionally classified as local or rural minor collectors. Ten percent of allocated STP funds must be set aside by each state for transportation enhancements, including mitigation of water pollution due to highway runoff.

Volunteer Monitoring Program, USEPA

"The U.S. Environmental Protection Agency's (EPA) Office of Water encourages all citizens to learn about their water resources and supports volunteer monitoring because of its many benefits. Volunteer monitors build awareness of pollution problems, become trained in pollution prevention, help clean up problem sites, provide data for waters that may otherwise be unassessed, and increase the amount of water quality information available to decision makers at all levels of government."

Water Quality Service Learning Program, SWRCB

The State Water Resources Control Board has developed a web site designed to introduce teachers to student-centered investigation of polluted runoff. The site offers units of study, free lesson plans, online teacher support, and materials in Spanish.

7. Relevant Policies & Plans

California Water Plan Update 2013, DWR

Presents status and trends for water-dependent resources, supplies, and demands. Evaluates regional and statewide management strategies to identify effective actions and policies. Includes Regional Basin Plans.

Nonpoint Source Management Plan, SWRCB

Identifies nonpoint source control programs and milestones, and effluent limitations.

Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program, SWRCB

"The information provided in this policy is designed to assist all responsible and/or interested parties in understanding how the State's NPS water quality control requirements will be implemented and enforced. The parties involved include the SWRCB and the RWQCBs, federal, state and local agencies, individual dischargers, designated third-party representatives and any other interested public and private parties."

Stormwater Final Rules, National Pollutant Discharge Elimination System (NPDES), USEPA

Website contains Phase I and Phase II NPDES regulations, extensions, and amendments.

8. Sources

EPA. 2005. National Management Measures to Control Nonpoint Source Pollution from Urban Areas. Chapter 4: Site Development. Available: http://water.epa.gov/polwaste/nps/urban/upload/2005_12_08_NPS_urbanmm_urban_ch04.pdf

NCRWQCB Monitoring Parameters, sample for Garcia River Sediment TMDL (NCRWQCB 2011)

NOAA/NMFS Habitat Attribute Indicators for Russian River Watershed CCC Coho (NMFS 2010)

SWRCB/ SWAMP Core Indicators for Beneficial Uses in California (SWAMP 2010/ SWAMP 2006)

SWRCB. 2009. NPS Encyclopedia. 3.1C — Planning and Design — Impervious Surfaces. http://www.waterboards.ca.gov/water_issues/programs/nps/encyclopedia/3_1c_plandes_impsurf.shtml

USDA. No date. *Electronic Field Office Technical Guide for California*. U.S. Department of Agriculture, Natural Resource Conservation Service. (http://efotg.nrcs.usda.gov/)

LOW IMPACT DEVELOPMENT - LANDSCAPING

1. Baseline Description

General Setting:

The Russian River watershed is close enough to the San Francisco Bay area for commuting and as the Bay area population has increased, land historically in agriculture has increasingly been converted to suburban and rural development, especially in the middle of the watershed along the Highway 101 corridor in Sonoma County. The conversion from agriculture to residential has resulted in an increase in managed landscapes and the spread of invasive non-native plant cultivars into wildlands. Traditionally developed and maintained landscapes use 50 to 70 percent of household water.

Causal Factors:

Traditional landscaping practices, which contain large expanses of grass and ornamental plants common to wetter regions require large amounts of irrigation water to survive California's hot, dry summers. This increased water demand occurs at the same time that juvenile salmonids require sufficient instream flow to meet habitat requirements. During periods of water scarcity, municipalities may implement water rationing to provide instream flow. The improper use of pesticides and fertilizers can contribute to water quality impairments in the watershed. Resistance to change and lack of knowledge about problems caused by traditional landscaping are factors in the continued prevalence of traditional landscapes in the watershed.

2. Management Measure Description

The Landscaping MM provides management practices for increasing groundwater infiltration, decreasing pollutants, and reducing water demand during the summer months. Providing information to the public about impacts of and alternatives to traditional landscaping will increase MM implementation.

3. Resource Concerns

Inadequate Water Quality

Inadequate Water Quantity

Invasive Non-native Plants

Water Quantity — Inefficient Water Use on Irrigated Land

Water Quantity — Inefficient Water Use on Non-Irrigated Land

Water Quality — Excessive Nutrients, Pathogens, or Organics

Water Quality — Harmful Temperatures of Surface Water

4. Management Practices

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
NRCS	Herbaceous Weed Control (315)	AC
NRCS	Integrated Pest Management (595)	AC
NRCS	Mulching (484)	AC
NRCS	Tree/Shrub Establishment (612)	AC
NRCS	Water Harvesting Catchment (636)	NO
EPA	Lawn conversion (9.3.2.1)	AC
EPA	Soil building (9.3.2.2)	CU YD
EPA	Grass selection (9.3.2.3)	NO
EPA	Mowing and thatch management (9.3.2.4)	NO
EPA	Yard waste management (9.3.2.5)	NO
EPA	Minimal fertilization (9.3.2.6)	GAL
EPA	Weed control and tolerance (9.3.2.7)	NO
EPA	Pest management (9.3.2.8)	NO and GAL
EPA	PointOof-sale education (9.3.2.9)	NO
EPA	Sensible irrigation	AC-FT
EPA	Spill prevention, control, and clean-up plans (9.3.3.4)	GAL
EPA	Nonpoint Source Pollution Education for Citizens	NO
SWRCB	Increase groundwater infiltration and recharge by exposing native soils	AC
SWRCB	Increase pollutant attenuation through bioretention	AC
SWRCB	Collect and store non-potable water on-site for use in landscaping	GAL and AC-FT
SWRCB	Use landscaping to restore or maintain predevelopment hydrographs	NO
SWRCB	Replace lawns with rain gardens	AC
SWRCB	Plant and maintain urban forests	AC

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Hydrology and Geomorphology	
Flow Conditions	
Flow	
Chemical and Physical Characteristics	
Conventionals: Dissolved Oxygen (DO)	**Dissolved Oxygen:** Greater than 5 mg/L, 2 to 5 mg/L,Less than 2 mg/L
Pathogens (Drinking Water Rule, Basin Plan language)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Nitrates	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L
Algae (Microcystis/ Microcystin)	Algae (Chlorophyll a): "High" "Moderate" and "Low Quality" less than 5.0 µg/L, 5 to 20 µg/L, greater than 20 µg/L
Conventionals: Nutrients	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L
Biotic Condition	
Biological Conditions: Benthic Macro-invertebrates (BMI, streams)	BMIs: Threshold between "Good" and "Fair," out of 1.00 for reference condition. California Macroinvertebrate Observed/ Expected Index (O/E Index) score of 0.77; Western EMAP Macroinvertebrate Index of Biotic Integrity (IBI) score of 0.57.
Nuisance plant Growth	

Protocol & Data Sources

California Monitoring and Assessment Program (CMAP). The CAMP monitoring project was developed in collaboration with the SWRCB's Non-Point Source Pollution control Program (NPS), SWRCB's SWAMP program and the US EPA's Region IX.

Department of Water Resources (DWR) Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/

DWR Water Plan Information Exchange: hub with links to various databases http://www.waterplan.water.ca.gov/waterpie/index.cfm

DWR Water Plan and Updates: water quality improvement strategies and data on water use http://www.waterplan.water.ca.gov/waterquality/water_quality.cfm

EPA TMDL program http://www.epa.gov/OWOW/tmdl/

EPA Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Control Measures — Urban http://water.epa.gov/polwaste/nps/urban2.cfm

EPA WEMAP (Western Environmental Monitoring and Assessment Program; http://www.epa.gov/region09/water/wemap/surface.html) for physical habitat structure, sediment metabolism, sediment chemistry, water quality parameters, and riparian vegetation.

SWAMP http://www.swrcb.ca.gov/water_issues/programs/swamp/, including water quality and toxicity data at http://swamp.mpsl.mlml.calstate.edu/online-data

SWRCB North Coast Basin Plan http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/basin_plan.shtml

SWAMP BMI, stream assessment, and other reports including Ode 2007, SWAMP 2005, and Ode and Rehn 2005 http://www.swrcb.ca.gov/water_issues/programs/swamp/

SWAMP protocols ("Standard Operating Procedures") http://swamp.mpsl.mlml.calstate.edu/ and selected reports under "Bioassessment" at http://www.swrcb.ca.gov/water_issues/programs/swamp/reports.shtml#bioassessment

USGS National Hydrography Dataset http://nhd.usgs.gov/

USGS National Water Information System (NWIS) http://waterdata.usgs.gov/nwis/rt

6. Relevant Programs

***Arundo donax* Removal Program, Sotoyome Resource Conservation District**

The Sotoyome RCD is collaborating with Circuit Rider Productions, Inc. to implement a long-term effort to remove *Arundo donax* from the Russian River Watershed. *Arundo donax* removal is offered to landowners in the watershed free of charge.

Clean Water Team Citizen Monitoring Program, SWRCB

The SWRCB provides support to citizens and local organizations who would like to improve water quality through pollution prevention and citizen-based monitoring programs.

Education and Public Outreach Programs, SWRCB

The State Water Resources Control Board provides a web site with information regarding water quality education outreach to various interest groups, including business and industry, municipalities, schools, and tribes.

Education Program, Sotoyome Resource Conservation District

"The Sotoyome Resource Conservation District (SRCD) Education Program delivers adult and K-12 education that promotes an understanding of the interplay between agriculture and natural resources, and sponsors projects that address stewardship of our natural resources."

Endangered Species Protection Program, USEPA

The Endangered Species Protection Program seeks to protect endangered species from the use of pesticides and to minimize the impact of the program on pesticide users.

The Global Invasive Species Initiative, TNC

The Global Invasive Species Initiative is The Nature Conservancy's response to abating the damage caused to native biodiversity by the human-facilitated introduction of non-native, harmful invasive species. This web site provides many resources designed to help all conservationists deal most effectively with invasive species. http://tncweeds.ucdavis.edu/

Nonpoint Source Management Program — Clean Water Act Section 319, US Environmental Protection Agency

This Program was established through an amendment to the Clean Water Act in 1987 to provide grant money to support activities including technical and financial assistance, education and training, technology transfer, demonstration projects, and project success monitoring. http://www.epa.gov/owow/nps/cwact.html

Nonpoint Source Pollution Control Programs, SWRCB

The State Water Resources Control Board administers several grant programs which assist local entities with nonpoint source pollution control. The grants are made available through voter approval of the following Propositions: 13, 40, 50, and 84.

Pesticide Environmental Stewardship Program, USEPA

This is "a voluntary program that forms partnerships with pesticide users to reduce health and environmental risk and implement pollution prevention strategies."

Pollinator Conservation Program, The Xerces Society

"The Xerces Society's pollinator program works with farmers, land managers, golf course staff, public agencies, and gardeners to promote the conservation and recovery of native pollinator insects and their habitat."

Urban Forestry Program, California Department of Forestry and Fire Protection

"The Urban Forestry Program offers grants of over $1 million dollars a year to plant trees and over $2.5 million for related projects in urban communities throughout California. Four Urban Forestry Field Specialists provide expert urban forestry support to communities, non-profit groups

and other municipal governments to create and maintain sustainable urban forest."

7. Relevant Policies & Plans

California Water Plan Update 2013, DWR

Presents status and trends for water-dependent resources, supplies, and demands. Evaluates regional and statewide management strategies to identify effective actions and policies. Includes Regional Basin Plans.

Nonpoint Source Management Plan, SWRCB

Identifies nonpoint source control programs and milestones, and effluent limitations.

Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program, SWRCB

"The information provided in this policy is designed to assist all responsible and/or interested parties in understanding how the State's NPS water quality control requirements will be implemented and enforced. The parties involved include the SWRCB and the RWQCBs, federal, state and local agencies, individual dischargers, designated third-party representatives and any other interested public and private parties."

Stream and Wetland System Protection Policy, NCRWQCB

This policy is a proposed amendment to the Water Quality Control Plans for the North Coast and San Francisco Bay Regions that will "protect stream and wetlands systems, including measures to protect riparian areas and floodplains." http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/streamandwetlands.shtml

8. Sources

EPA. 2005. National Management Measures to Control Nonpoint Source Pollution from Urban Areas. Chapter 9: Pollution Prevention. Available: http://water.epa.gov/polwaste/nps/urban/upload/2005_12_08_NPS_urbanmm_urban_ch04.pdf

NCRWQCB Monitoring Parameters, sample for Garcia River Sediment TMDL (NCRWQCB 2011)

SWRCB/ SWAMP Core Indicators for Beneficial Uses in California (SWAMP 2010/ SWAMP 2006)

SWRCB. 2009. NPS Encyclopedia. 3.1D — Planning and Design — Landscaping. http://www.waterboards.ca.gov/water_issues/programs/nps/encyclopedia/3_1d_plandes_landscp.shtml

USDA. No date. *Electronic Field Office Technical Guide for California*. U.S. Department of Agriculture, Natural Resource Conservation Service. (http://efotg.nrcs.usda.gov/)

CONSTRUCTION PRACTICES

(to include onsite wastewater treatment systems; grading/ excavation and land development)

1. Baseline Description

General Setting:

The Russian River watershed is currently 303(d) listed for sediment and land development has been identified as a potential source in some reaches. Construction occurs continuously in the watershed; traditional practices do not take impacts to water quality — both during and after construction — and post-construction impacts to water quantity into account. Onsite wastewater treatment systems (OWTS) are of particular concern in the lower watershed, where they contribute to pathogen impairment.

Causal Factors:

Traditional construction practices increase impervious areas by increasing peak flows and preventing the natural storm water treatment functions performed by vegetated areas. During construction, pollutant loading can occur with soil disturbance and other activities. Failing OWTS in the lower watershed are discharging pollutants to ground and surface waters and limited resources are preventing their replacement or repair.

2. Management Measure Description

The Construction Practices MM will ensure that destruction of natural water conveyance systems is limited, erosion during and post-construction is eliminated and/or reduced, peak load runoff is maintained — to the extent possible — at pre-construction levels, and to ensure that OWTS are located, designed, installed, operated, inspected, and maintained to prevent pollutant discharge to surface and groundwater.

3. Resource Concerns

Inadequate Water Quality

Soil Erosion — Roadbank and Construction Sites

Water Quantity — Reduced Capacity of Conveyances by Sediment Deposition

Water Quality — Excessive Nutrients, Pathogens, or Organics

Water Quality — Excessive Sediment

Water Quality — Harmful Levels of Heavy Metals

4. Management Practices

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
NRCS	Access Control (472)	AC
NRCS	Access Road (560)	FT
NRCS	Contour Buffer Strips (332)	AC
NRCS	Dust Control on Unpaved Roads and Surfaces	Sq Ft
NRCS	Land Clearing (460)	AC
NRCS	Obstruction Removal (500)	AC
NRCS	Precision Land Forming (462)	AC
NRCS	Recreation Area Improvement (562)	AC
NRCS	Recreation Land Grading and Shaping (566)	AC
NRCS	Road/Landing/Trail Closure and Treatment (654)	FT
NRCS	Sediment Basin (350)	NO
NRCS	Structure for Water Control (587)	NO
NRCS	Trails and Walkways (568)	FT
EPA	OWTS Permitting and Installation Programs (6.3.1)	NO
EPA	OWTS Operation and Maintenance Programs (6.3.2)	NO
EPA	Construction Site Erosion and Sediment Control Programs (8.3.1)	NO
EPA	Erosion Control Practices (8.3.2)	NO
EPA	Sediment Control Practices (8.3.3)	NO
EPA	Develop and Implement Programs to Control Chemicals and Other Construction Materials (8.3.4)	NO
SWRCB	Develop performance-based programs with specific goals and criteria that address public health and water quality	NO
SWRCB	Model system performance to determine the long-term impacts of OWTS on water resources	NO
SWRCB	Develop criteria for sitting OWTS, such as setback guidelines and official maps showing areas where conditions are suitable for installation	NO
SWRCB	Inspect newly installed systems	NO
SWRCB	Develop training and certification programs for qualified professionals to oversee OWTS design, construction, maintenance, and monitoring	NO
SWRCB	Inspect and maintenance programs	NO
SWRCB	Where possible, modification of natural drainage patterns should be avoided	NO
SWRCB	Consider using landform grading techniques to restore natural drainage features on the landscape	NO
SWRCB	Education/Outreach Pollution Prevention/Education (3.6A)	

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Landscape Condition	
Impervious Surfaces	**Impervious surface:** > 12.01 % of watershed by area 7.01 to 12 % 3.01 to 7 % 0 to 3 %
Landslides, fluvial, and surface erosion (agricultural activities)	
Stream crossing failures	
Density of unpaved roads	
Road Density	**Road Density**: From "Poor" to "Very Good" Road density: > 3 miles/ square mile, 3 to 2.5, 2.5 to 1.6, <1.6; Road density within 100 m. stream: >1 mile/ square miles, 1 to 0.5, 0.5 to 0.1, <0.1
Hydrology and Geomorphology	
Gravel Quality (Bulk)	**Gravel quality (bulk):** >17 % (D50=0.85), 15 to 17 %, 12 to 14 %, <12 %
Embeddedness	**Gravel quality (embeddedness):** <25 % of scores are Category 1 or 2, 25 to 50 %, >50 %, Not defined
Spawning gravel quantity & distribution	**Gravel quality (bulk):** >17 % (D50=0.85), 15 to 17 %, 12 to 14 %, <12 %
Substrate Composition	**Gravel quality (embeddedness):** <25 % of scores are Category 1 or 2, 25 to 50 %, >50 %, Not defined
Sediment-related barriers	**Physical barriers:** <50 of IP-km, 50 to 70 %, 70 to 90 %, >90 %
Chemical and Physical Characteristics	
Conventionals: Dissolved Oxygen (DO)	**Dissolved Oxygen:** Greater than 5 mg/L, 2 to 5 mg/L,Less than 2 mg/L
Conventionals: Water and/or sediment toxicity	**Sediment Quality Indicators:** Total Organic Carbon Sediment Contamination, Amphipod Toxicity, Species Richness - See Attachment B2.
Sediments/TDS	**Sediment Quality Indicators:** Total Organic Carbon Sediment Contamination, Amphipod Toxicity, Species Richness - See Attachment B2.
Biotic Condition	
Biological Conditions: Benthic Macro-invertebrates (BMI, streams)	BMIs: Threshold between "Good" and "Fair," out of 1.00 for reference condition. California Macroinvertebrate Observed/ Expected Index (O/E Index) score of 0.77; Western EMAP Macroinvertebrate Index of Biotic Integrity (IBI) score of 0.57.

Protocol & Data Sources

California Monitoring and Assessment Program (CMAP). The CAMP monitoring project was developed in collaboration with the SWRCB's Non-Point Source Pollution control Program (NPS), SWRCB's SWAMP program and the US EPA's Region IX.

Department of Water Resources (DWR) Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/

DWR Water Plan Information Exchange: hub with links to various databases http://www.waterplan.water.ca.gov/waterpie/index.cfm

DWR Water Plan and Updates: water quality improvement strategies and data on water use http://www.waterplan.water.ca.gov/waterquality/water_quality.cfm

EPA TMDL program http://www.epa.gov/OWOW/tmdl/

EPA WEMAP (Western Environmental Monitoring and Assessment Program; http://www.epa.gov/region09/water/wemap/surface.html) for physical habitat structure, sediment metabolism,

sediment chemistry, water quality parameters, and riparian vegetation.

SWAMP http://www.swrcb.ca.gov/water_issues/programs/swamp/, including water quality and toxicity data at http://swamp.mpsl.mlml.calstate.edu/online-data

SWRCB North Coast Basin Plan http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/basin_plan.shtml

California Rapid Assessment Method (CRAM) method for riparian condition measures: Collins et al 2008 http://www.cramwetlands.org/documents/

California Watershed Assessment Manual II Chapter 3 (Florsheim 2005) http://cwam.ucdavis.edu/Volume_2/TOC.htm

Florsheim 2005 and references therein provide methods for measuring discharge; measuring sediment transport; calculating effective discharge; assessing substrate and grain size distributions; and assessing morphology (http://cwam.ucdavis.edu/Volume_2/TOC.htm).

SWAMP BMI, stream assessment, and other reports including Ode 2007, SWAMP 2005, and Ode and Rehn 2005 http://www.swrcb.ca.gov/water_issues/programs/swamp/

SWAMP protocols ("Standard Operating Procedures") http://swamp.mpsl.mlml.calstate.edu/ and selected reports under "Bioassessment" at http://www.swrcb.ca.gov/water_issues/programs/swamp/reports.shtml#bioassessment

SWAMP physical habitat procedures (Ode 2007 http://swamp.mpsl.mlml.calstate.edu/resources-and-downloads/standard-operating-procedures)

USDA Forest Service: Cumulative watershed effects: Reid 1993 (http://www.fs.fed.us/psw/rsl/projects/water/reid_141.pdf), UCCCWE 2001

USEPA Watershed Assessment of River Stability and Sediment Supply (WARSSS) http://www.epa.gov/warsss/sedsource/streamflo.htm

USGS National Hydrography Dataset http://nhd.usgs.gov/

USGS National Water Information System (NWIS) http://waterdata.usgs.gov/nwis/rt

6. Relevant Programs

California's Critical Coastal Areas Program

The purpose of California's Critical Coastal Areas (CCA) Program is "to foster collaboration among local stakeholders and government agencies and better coordinate resources and efforts in coastal-zone watershed areas critically in need of protection from polluted runoff." The North Coast is one of four regional pilot CCAs in which the CCA Program will form teams comprised of local stakeholders and state, federal, and local agencies to develop community-based action plans to reduce polluted runoff in coastal zone watershed areas. www.coastal.ca.gov/nps/cca-nps.html

Clean Water Team Citizen Monitoring Program, SWRCB

The SWRCB provides support to citizens and local organizations who would like to improve water quality through pollution prevention and citizen-based monitoring programs.

Environmental Enhancement and Mitigation Program, The California Resources Agency

"The Environmental Enhancement and Mitigation Program was established by the Legislature in 1989. It offers a total of $10 million each year for grants to local, state, and federal governmental agencies and to nonprofit organizations for projects to mitigate the environmental impacts caused by new or modified state transportation facilities." Grants are awarded in three categories: 1) Highway landscape and urban forestry; 2) Resource lands, and 3) Roadside recreational.

Lake and Streambed Alteration Program, CDFG

"Fish and Game Code section 1602 requires any person, state or local governmental agency, or public utility to notify the Department before beginning any activity that will do one or more of the following: 1) substantially obstruct or divert the natural flow of a river, stream, or lake; 2) substantially change or use any material from the bed, channel, or bank of a river, stream, or lake; or 3) deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it can pass into a river, stream, or lake. Fish and Game Code section 1602 applies to all perennial, intermittent, and ephemeral rivers, streams, and lakes in the state."

Nonpoint Source Management Program — Clean Water Act Section 319, US Environmental Protection Agency

This Program was established through an amendment to the Clean Water Act in 1987 to provide grant money to support activities including technical and financial assistance, education and training, technology transfer,

demonstration projects, and project success monitoring. http://www.epa.gov/owow/nps/cwact.html

Nonpoint Source Pollution Control Programs, SWRCB

The State Water Resources Control Board administers several grant programs which assist local entities with nonpoint source pollution control. The grants are made available through voter approval of the following Propositions: 13, 40, 50, and 84.

Storm Water Program, SWRCB

The State Water Resources Control Board has four programs to assist with Storm Water Management: Construction, Industrial, Municipal, and Caltrans.

Surface Transportation Program, US Department of Transportation

This program is a block grant program that may be used by states and local governments for any roads that are not functionally classified as local or rural minor collectors. Ten percent of allocated STP funds must be set aside by each state for transportation enhancements, including mitigation of water pollution due to highway runoff.

Water Quality Service Learning Program, SWRCB

The State Water Resources Control Board has developed a web site designed to introduce teachers to student-centered investigation of polluted runoff. The site offers units of study, free lesson plans, online teacher support, and materials in Spanish.

7. Relevant Policies & Plans

California Water Plan Update 2013, DWR

Presents status and trends for water-dependent resources, supplies, and demands. Evaluates regional and statewide management strategies to identify effective actions and policies. Includes Regional Basin Plans.

National Environmental Protection Act, US EPA

"The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet this requirement, federal agencies prepare a detailed statement known as an Environmental Impact Statement (EIS)."

Pathogens in the Russian River Policy, NCRWQCB and Sonoma County Department of Health Services

Russian River and tributary monitoring at several sites to determine bacteria abundance and variability (1996-2010). 2011-2012 efforts aimed at development of Russian River Pathogen TMDL. Land use, beach use impacts on bacteria levels. Quality assurance project plans (QUAPP).
Establishes bacteria thresholds for human health.

Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program, SWRCB

"The information provided in this policy is designed to assist all responsible and/or interested parties in understanding how the State's NPS water quality control requirements will be implemented and enforced. The parties involved include the SWRCB and the RWQCBs, federal, state and local agencies, individual dischargers, designated third-party representatives and any other interested public and private parties."

Stormwater Final Rules, National Pollutant Discharge Elimination System (NPDES), USEPA

Website contains Phase I and Phase II NPDES regulations, extensions, and amendments.

Stream and Wetland System Protection Policy, NCRWQCB

This policy is a proposed amendment to the Water Quality Control Plans for the North Coast and San Francisco Bay Regions that will "protect stream and wetlands systems, including measures to protect riparian areas and floodplains."

Water Quality Control Policy for Siting, Design, Operation, and Maintenance of Onsite Wastewater Treatment Systems, NCRWQCB

Requires State to develop statewide regulations for septic systems to ensure surface and ground waters are not contaminated by domestic septic system waste and are safe for Beneficial Uses.

8. Sources

EPA. 2005. National Management Measures to Control Nonpoint Source Pollution from Urban Areas. Chapter 6: New and Existing On-Site Wastewater Treatment Systems. Available: http://water.epa.gov/polwaste/nps/urban/upload/2005_12_08_NPS_urbanmm_urban_guidance.pdf

EPA. 2005. National Management Measures to Control Nonpoint Source Pollution from Urban Areas. Chapter 8: Construction Site Erosion, Sediment, and Chemical Control. Available: http://water.epa.gov/polwaste/nps/urban/upload/2005_12_08_NPS_urbanmm_urban_guidance.pdf

SWRCB/ SWAMP Core Indicators for Beneficial Uses in California (SWAMP 2010/ SWAMP 2006)

SWRCB. 2009. NPS Encyclopedia. 3.2 — Construction Practices. http://www.waterboards.ca.gov/water_issues/programs/nps/encyclopedia/3_0_urb.shtml

USDA. No date. *Electronic Field Office Technical Guide for California*. U.S. Department of Agriculture, Natural Resource Conservation Service http://efotg.sc.egov.usda.gov/treemenuFS.aspx

URBAN AND RURAL FLOOD CONTROL

1. Baseline Description

General Setting:

The capacity for urban and rural towns and surrounding areas to absorb floodwaters has decreased in the Russian River watershed. When large storm events occur, the ability of the area to absorb stormwater are greatly diminished, resulting in the release of large pulses of pollutants into the Russian River and its tributaries and damage to property. Such occurrences are expensive, dangerous, and inconvenient for the human population, and can severely impact wildlife habitat. Measures taken by agencies and individuals to protect property from flood damage can degrade riparian and instream habitat and cause geomorphic and hydrologic changes that alter habitat function.

Causal Factors:

Development creates impervious surfaces, which limit recharge capacity and increase runoff. In an effort to protect property from flooding, individuals construct flood control structures such as canals, dams, and floodgates. These structures can change instream habitat by causing scour, retaining sediment, and altering instream flow. The Coyote Dam, which was built in 1958, was constructed as a flood control project by the Army Corps of Engineers. The dam and other instream flood control structures impede fish passage, preventing endangered salmonid access to hundreds of miles of suitable habitat.

2. Management Measure Description

The Urban and Rural Flood Control MM promotes practices which increase the ability of developed areas to absorb large amounts of rainfall while minimizing impacts to riparian and instream habitat. The goal of this MM is the enhancement of peak flow absorption in urban and rural developed areas that are prone to flooding using methods that protect and enhance instream and riparian habitat structure and function.

3. Resource Concerns

Water Quantity — Excessive Runoff, Flooding, or Ponding

Water Quantity — Inadequate Outlets

Water Quantity — Reduced Capacity of Conveyances by Sediment Deposition

Water Quantity — Reduced Storage of Water Bodies by Sediment Accumulation

Water Quality — Excessive Nutrients, Pathogens, or Organics

Water Quality — Excessive Sediment

Water Quality — Harmful Levels of Heavy Metals

4. Management Practices

Recommended practices for urban flood control should include the following principles:

- Project planning is critical to success.
- Public education and participation is recommended.
- Monitoring is vital to evaluate success and provide information for adaptive management.

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
CDFG	Emergent Transplant Installation	AC
CDFG	Dormant Willow or Cottonwood Sprig Installation	AC
CDFG	Container Plant Installation with Protective Shelters	AC
CDFG	Direct Seed Installation	AC
CDFG	Riparian Revegetation Project Maintenance	AC
CDFG	Native Material Revetment	FT
CDFG	Willow Wall Revetment	FT
CDFG	Brush Mattress	FT
CDFG	Checkdams (redwood board, brush)	FT
NRCS	Clearing and Snagging (326)	FT

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
NRCS	Dam (402)	NO
NRCS	Riparian Forest Buffer (391A)	AC
NRCS	Streambank and Shoreline Protection (580)	FT
NRCS	Wildlife Wetland Habitat Management (644)	AC
NRCS	Constructed Wetland (656)	AC
NRCS	Wetland Restoration (657)	AC
NRCS	Wetland Creation (658)	AC
NRCS	Wetland Enhancement (659)	AC

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Landscape Condition	
Impervious Surfaces	**Impervious surface:** > 12.01 % of watershed by area 7.01 to 12 % 3.01 to 7 % 0 to 3 %
Road Density	**Road Density**: From "Poor" to "Very Good" Road density: > 3 miles/ square mile, 3 to 2.5, 2.5 to 1.6, <1.6; Road density within 100 m. stream: >1 mile/square miles, 1 to 0.5, 0.5 to 0.1, <0.1
Land Use	**Land Use:** Unnatural Index (Agricultural + Urban) "Most Disturbed" is Greater than 40 %, "Least Disturbed" is less than 10 %; Percent Urban Greater than 25 %, Less than 5 %; Percent Agricultural Greater than 50 %, Less than 10 %
Hydrology and Geomorphology	
Complex Habitat Types	**Channel Morphology and Connectivity**: From "Poor" to "Very Good"
Floodplain Connectivity	**Floodplain connectivity:** <50 %, 50 to 80 %, >80 %, Not defined Physical barriers <50 of IP-km, 50 to 70 %, 70 to 90 %, >90 %
Stream Habitat Type	**Channel Morphology and Connectivity**: From "Poor" to "Very Good"
Chemical and Physical Characteristics	
Nitrates	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L
Pathogens (Drinking Water Rule, Basin Plan language)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Nutrients	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
E. coli, enterococci (freshwater)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Toxicity (Acute)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Metals	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Pesticides	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Bioaccumulative	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Chemical Indicators: DDTs	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Chemical Indicators: PCBs	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Sediments/TDS	**Total Suspended Solids**: "Most Disturbed" is greater than 50 mg/L, "Least Disturbed" is less than or equal to 15 mg/L
Biotic Condition	
Biological Conditions: Benthic Macro-invertebrates (BMI, streams)	BMIs: Threshold between "Good" and "Fair," out of 1.00 for reference condition. California Macroinvertebrate Observed/ Expected Index (O/E Index) score of 0.77; Western EMAP Macroinvertebrate Index of Biotic Integrity (IBI) score of 0.57.

Protocol & Data Sources

California Monitoring and Assessment Program (CMAP). The CAMP monitoring project was developed in collaboration with the SWRCB's Non-Point Source Pollution control Program (NPS), SWRCB's SWAMP program and the US EPA's Region IX.

Department of Water Resources (DWR) Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/

DWR Water Plan Information Exchange: hub with links to various databases http://www.waterplan.water.ca.gov/waterpie/index.cfm

DWR Water Plan and Updates: water quality improvement strategies and data on water use http://www.waterplan.water.ca.gov/waterquality/water_quality.cfm

EPA TMDL program http://www.epa.gov/OWOW/tmdl/

EPA WEMAP (Western Environmental Monitoring and Assessment Program;

http://www.epa.gov/region09/water/wemap/surface.html) for physical habitat structure, sediment metabolism, sediment chemistry, water quality parameters, and riparian vegetation.

EPA Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Control Measures — Urban, US Environmental Protection Agency. 1997. http://www.epa.gov/owow/nps/urban2.html

National Pollutant Discharge Elimination System (NPDES) Stormwater Final Rules. Available at: http://cfpub.epa.gov/npdes/regresult.cfm?program_id=6&view=all&type=1

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Methods to Observe, Estimate, or Measure Flow. SWRCB 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Measuring Suspended Solids and Water Column Turbidity. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Measuring Nitrate and Nitrite. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Measuring Orthophosphate. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: E. Coli and Total Coliform Counts Using the Enzyme Substrate Colilert Reagents with QuantiTrays. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Entercoccus Counts Using Enterolert. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html.

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: The California Streamside Biosurvey. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html.

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Methods for Particle Size Distribution Analyses. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html.

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Methods to Observe, Estimate, or Measure Flow. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Visual Observations in Streams and Shorelines. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html.

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Rapid Trash Assessment & Worksheet. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html.

SWAMP http://www.swrcb.ca.gov/water_issues/programs/swamp/, including water quality and toxicity data at http://swamp.mpsl.mlml.calstate.edu/online-data

SWRCB North Coast Basin Plan http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/basin_plan.shtml

SWAMP BMI, stream assessment, and other reports including Ode 2007, SWAMP 2005, and Ode and Rehn 2005 http://www.swrcb.ca.gov/water_issues/programs/swamp/

SWAMP protocols ("Standard Operating Procedures") http://swamp.mpsl.mlml.calstate.edu/ and selected reports under "Bioassessment" at http://www.swrcb.ca.gov/water_issues/programs/swamp/reports.shtml#bioassessment

USGS National Hydrography Dataset http://nhd.usgs.gov/

USGS National Water Information System (NWIS) http://waterdata.usgs.gov/nwis/rt

6. Relevant Programs

5 Star Restoration Program, USEPA

> "The Five Star Restoration Program brings together students, conservation corps, other youth groups, citizen groups, corporations, landowners and government agencies to provide environmental education and training through projects that restore wetlands and streams. The program provides challenge grants, technical support and opportunities for information exchange to enable community-based restoration projects."

California River Parkways Program, California Resources Agency

> "The Proposition 50 California River Parkways Program in the Resources Agency is a competitive grant program for river parkways projects. Eligible projects must provide public access or be a component of a larger parkway plan that provides public access."

California's Critical Coastal Areas Program

The purpose of California's Critical Coastal Areas (CCA) Program is "to foster collaboration among local stakeholders and government agencies and better coordinate resources and efforts in coastal-zone watershed areas critically in need of protection from polluted runoff (CCC undated)." The North Coast is one of four regional pilot CCAs in which the CCA Program will form teams comprised of local stakeholders and state, federal, and local agencies to develop community-based action plans to reduce polluted runoff in coastal zone watershed areas.

Environmental Enhancement and Mitigation Program, The California Resources Agency

"The Environmental Enhancement and Mitigation Program was established by the Legislature in 1989. It offers a total of $10 million each year for grants to local, state, and federal governmental agencies and to nonprofit organizations for projects to mitigate the environmental impacts caused by new or modified state transportation facilities." Grants are awarded in three categories: 1) Highway landscape and urban forestry; 2) Resource lands, and 3) Roadside recreational.

Environmental Justice Small Grants Program, Cal/EPA

"Cal/EPA has established the EJ Small Grants Program to assist eligible community-based, grassroots, non-profit entities, and federally recognized tribal governments to address environmental justice issues."

Flood Control Subventions Program, DWR

The Department of Water Resources implements the national flood control program for the North Coast of California. The national flood control program requires "nonfederal interests to pay the costs of rights of way and relocations for channel improvements and levee projects." Several state laws enacted subsequent to the federal program provide for varying cost-share percentages between state and local agencies.

Flood Protection Corridor Program, DWR

This DWR program funds acquisition of property rights from willing sellers and other activities that contribute to flood protection corridor projects.

Integrated Regional Water Management Grant Program, SWRCB

"The Integrated Regional Water Management (IRWM) Implementation Grants Program, funded by Proposition 50, Chapter 8, will provide approximately $64 million during Round 2. IRWM Implementation Grants will fund projects that meet one or more of the program objectives of protecting communities from drought, protecting and improving water quality, and improving local water security by reducing dependence on imported water. Implementation Grant proposals must be based on a qualified IRWM Plan."

National Coastal Wetland Conservation Grant Program, USFWS

Under the National Coastal Wetland Conservation Grant Program, the US Fish and Wildlife Service "provides matching grants to States for acquisition, restoration, management, or enhancement of coastal wetlands."

Urban Streams Restoration Program, DWR

"The objectives of the Urban Streams Restoration Program are to assist communities in reducing damages from stream bank and watershed instability and floods while restoring the environmental and aesthetic values of streams, and to encourage stewardship and maintenance of streams by the community. With voter approval of Proposition 84, the Urban Streams Restoration Program will have available grant funding. Proposition 84 includes $18 million for the Urban Streams Restoration Program. DWR anticipates holding the first of two application cycles in mid 2007."

Watershed Program, DWR

"The Department of Water Resources Watershed Program works with locally led stewardship efforts to integrate the needs of communities, urban and rural, with resource management that sustains watershed ecology."

Watershed Protection Programs, SWRCB

The State Water Resources Control Board administers several programs for watershed

protection under Propositions approved by voters. These Propositions are: 13, 40, and 50.

7. Relevant Policies

California Endangered Species Act (CESA), California Environmental Protection Agency

Compliance with the CESA may be required for environmental projects and management practices. The CDFG administers CESA and can authorize exceptions to the state's prohibition against take of a listed species.

California Environmental Quality Act (CEQA), California Resources Agency

CEQA is a statue requiring state and local agencies to identify significant environmental impacts of proposed activities and to avoid or mitigate those impacts if feasible.

City of Cloverdale Draft General Plan Update

Chapter 6 Conservation and Open Space Element, provides for protection of distinctive natural vegetation, including riparian, wetlands, and upland ecosystems. Contains policies specifically intended to protect and enhance the natural beauty, habitat and biotic productivity of the Russian River through the use of conservation buffers, stormwater runoff management, habitat improvement, and the use of natural wetland treatment for expansionof wastewater treatment facilities.

City of Cotati General Plan

Chapter 17.50 — Watercourse and Riparian Resource Protection, sets provisions for adequate buffer areas between watercourses and adjacent development.

Chapter 17.56 — Wetland Protection and Restoration, provides policy for protecting wetlands and permitting wetland restoration, enhancement, and mitigation projects.

City of Healdsburg General Plan

Chapter 7 — Natural Resources, establishes policies that improve water quality and flows in the Russian River and Dry and Foss Creeks, promote conservation and restoration of native ecosystems and waterways, preserve the city's natural setting, protect the viability of agriculture, reduce greenhouse gas emissions, and protect riparian resources.

City of Rohnert Park General Plan

Chapter 6 — Environmental Conservation, 6.2 Habitat and Biological Resources, sets policies for protection of special status species and special habitat areas, use of native plants for landscaping, and planting of low water use trees. Sets creek protection zones which prohibit development except greenway enhancement, requires evaluation and implementation of bank stabilization and erosion control measures.

Chapter 5 — Open Space, Parks and Public Facilities, 5.5 Water Supply and Conservation, sets policies for monitoring of the municipal wellfield, requirements for developers to dedicate new well sites in locations identified by the City, requirement of water-conserving devices for new development, development of water and wastewater bmps, adoptiong of a tiered water conservation rate schedule.

City of Sebastopol General Plan

Chapter III: Conservation, Parks and Open Space, sets policies which preserve areas with important biotic resources, ensure the maintenance of wetlands adjacent to City boundaries as permanent open space, protect, maintain and restore wetlands areas, protect and preserve soil as a natural resource, conserve, protect and enhance trees and native vegetation, conserve energy, protect and improve air quality, provide for water conservation, reduce the volume of solid waste the City generates, provides an attractive and comprehensive system of parks and trials that meets all citizens' recreational needs, ensures that recreational facilities are developed in harmony with the surroundings, and incorporates the 1992 Laguna Park Master Plan. The Plan sets minimum buffers for urban land and farming operations adjacent to Laguna habitats, and sets policy to minimize the impacts of backyards adjacent to the Laguna, restore and enhance Laguna habitats, and recover declining species.

Coastal Zone Act Reauthorization Amendments, USEPA, NOAA

Amendments to the Coastal Zone Act to more specifically address effects of NPS pollution on coastal water quality. These amendments

require each state with an approved Coastal Zone Management Program to develop a Coastal Nonpoint Pollution Control Program.

Coastal Zone Management Act, NOAA

Provides federal funding for wetlands programs in coastal states, including the preparation of Coastal Zone Management Plans.

Mendocino County General Plan. Land Use Element of the Mendocino County General Plan, Natural Resources.

Section 12 — Vegetation and Wildlife sets policies to retain and restore native vegetation, including riparian vegetation, wetlands, and rare and unique vegetation and to promote wildlife habitat protection and improvement and endangered species protection on private lands.

Section 13 — Water Resources sets policies to encourage land management to reduce water pollution, ensure adequate water supply, and protect the integrity of the flood plain.

National Environmental Protection Act, US EPA

"The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet this requirement, federal agencies prepare a detailed statement known as an Environmental Impact Statement (EIS)."

Santa Rosa Citywide Creek Master Plan

The Plan contains "recommended habitat preservation, enhancement, and restoration projects, and improvements to the creekside trail system are presented conceptually and specifically by watershed. Project recommendations are based on community input, literature reviews, and extensive field survey work. Site-specific recommendations are presented in the text and on a set of Geographical Information System-based maps, organized by watershed area."

Santa Rosa General Plan

Chapter 7: 7-3 Biological Resources and Waterways, sets policies which maximize the benefits of open space, conserve the City's open spaces, conserve agricultural soils, conserve wetlands, vernal pools, wildlife ecosystems, rare plant habitats, and waterways, and conserve significant vegetation and trees, conserve water and maintain water quality, and take actions to achieve and maintain ambient air quality standards.

Sonoma County General Plan

3.0 — Policies for Water Resources, provides for conservation of water and protection of water quality, preservation of watersheds and groundwater recharge areas, development standards for recharge areas, and preservation of surface water and groundwater quality.

3.1 — Policy for Critical Habitat Areas, provides protection for critical areas including wetlands, marshes, and remnant upland habitat.

3.2 -Policy for Riparian Corridors, establishes streamside conservation areas or riparian corridor setbacks from land use activities.

Stream and Wetland System Protection Policy, NCRWQCB

This policy is a proposed amendment to the Water Quality Control Plans for the North Coast and San Francisco Bay Regions that will "protect stream and wetlands systems, including measures to protect riparian areas and floodplains."

Town of Windsor General Plan — 2015

Chapter 4 Community Development, sets policies for the development of recreational opportunities and preservation of water supply.

Chapter 6 Environmental Resources, proposes strategies for the protection and enhancement of open space resources, agricultural resources, water supply and quality, biological resources, cultural resources, extractive resources, and scenic resources.

US Tax Code Tax Reform Act of 1986, IRS

Provides tax deductions for wetlands donors and certain nonprofit organizations.

Wetlands Loan Act, USFWS

Provides for interest-free loans for wetlands acquisition and conservation easements.

8. Sources

Flosi, Gary; Downie, Scott; Hopelain, James; Bird, Michael; Coey, Robert; and Barry Collins. 1998. California Salmonid Stream Habitat Restoration Manual, Third Edition. Sacramento, California, California Department of Fish and Game, Inland Fisheries Division.

Natural Resources Conservation Service (NRCS). 2003. Electronic Field Office Technical Guide. Available at: http://www.nrcs.usda.gov/Technical/efotg/.

NCRWQCB Monitoring Parameters, sample for Garcia River Sediment TMDL (NCRWQCB 2011)

NOAA/NMFS Habitat Attribute Indicators for Russian River Watershed CCC Coho (NMFS 2010)

SWRCB/ SWAMP Core Indicators for Beneficial Uses in California (SWAMP 2010/ SWAMP 2006)

Tetra Tech, Inc., 2006. California Nonpoint Source Encyclopedia. California State Water Resources Control Board. 281 pages.

U.S. Army Corps of Engineers (ACE). 2007. Lake Mendocino Fishway Concept Overview. Web Page. Available at: http://www.spn.usace.army.mil/russian/overview031600.html. Accessed 5/07.

U.S. Environmental Protection Agency (EPA). 2006. Hydromodification/Habitat Alteration. In: Polluted Runoff (Nonpoint Source Pollution). Web Site. Available at: http://www.epa.gov/owow/nps/categories.html. Accessed 5/07.

US Environmental Protection Agency. 2006. Polluted Runoff (Nonpoint Source Pollution). Web Site. Available at: http://www.epa.gov/owow/nps/categories.html. Accessed 6/07.

STORMWATER MANAGEMENT

1. Baseline Description

General Setting:

Stormwater runoff from urban areas carries pollutants into the Russian River and its tributaries, impacting instream habitat. Stormwater contains sediment, which causes turbidity and alters instream habitat; excessive nutrients, which may lead to low dissolved oxygen concentrations; bacteria and other pathogens, which can pose health hazards to humans, domestic animals, and wildlife; hazardous waste such as oil, pesticides, and solvents, which may poison or otherwise harm organisms which use the waterway; and debris, such as plastic bags, cigarette butts, six pack rings, and other trash, which are unsightly and pose a danger to wildlife. The cities of Ukiah, Healdsburg, Santa Rosa, Sebastopol, Rohnert Park, and Cotati have Stormwater Management Plans required by the National Pollutant Discharge Elimination System (NPDES) under the federal Clean Water Act.

Causal Factors:

Development creates impervious surfaces, which limit recharge capacity and increase runoff. Sources of pollutants carried by runoff include: residential, commercial, and municipal pesticide and fertilizer use, oil and gas leaks from automobiles, domestic animal waste, and litter and debris from roadways and parking lots.

2. Management Measure Description

The Stormwater Management MM promotes practices which increase the ability of developed areas to absorb large amounts of rainfall and decrease the amount of runoff. The goal of this MM is to enhance stormwater absorption in urban and rural developed areas and to reduce the quantity of urban stormwater runoff.

3. Resource Concerns

Threatened and Endangered Fish and Wildlife Species

Water Quantity — Excessive Runoff, Flooding, or Ponding

Water Quantity — Inadequate Outlets

Water Quality — Excessive Nutrients, Pathogens, or Organics

Water Quality — Excessive Sediment

Water Quality — Harmful Levels of Heavy Metal

4. Management Practices

Recommended practices for stormwater management include the following principles:

- Project planning is critical to success.
- Public education and participation is recommended.
- Monitoring is vital to evaluate success and provide information for adaptive management.

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
NRCS	Obstruction Removal (500)	AC
NRCS	Constructed Wetland (656)	AC
NRCS	Wetland Restoration (657)	AC
NRCS	Wetland Creation (658)	AC

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
NRCS	Wetland Enhancement (659)	AC
EPA	Site Planning Practices (4.3.1)	
EPA	On-Lot Impervious Surfaces (4.3.2)	
EPA	Residential Street and Right-of-Way Impervious Surfaces (4.3.3)	
EPA	Parking Lot Impervious Surfaces (4.3.4)	
EPA	Xeriscaping Techniques (4.3.5)	
EPA	Infiltration Practices (5.3.1)	
EPA	Vegetated Open Channel Practices (5.3.2)	
EPA	Filtering Practices (5.3.3)	
EPA	Detention and Retention Practices (5.3.4)	
EPA	Other Practices (5.3.5)	
EPA	WTS Permitting and Installation Programs (6.3.1)	
EPA	WTS Operation and Maintenance Programs (6.3.2)	
EPA	Household Chemicals (9.3.1)	
EPA	Lawn, Garden, and Landscape Activities (9.3.2)	
EPA	Commercial Activities (9.3.3)	
EPA	Trash (9.3.4)	
EPA	Nonpoint Source Pollution Education for Citizens (9.3.5)	
EPA	Establishing a Runoff Control Operation and Maintenance Program (11.3.1)	
EPA	Runoff Source Control Operation and Maintenance (11.3.2)	
EPA	Runoff Treatment Control Operation and Maintenance (11.3.3)	
SWRCB	Education/Outreach Pollution Prevention/Education (3.6A)	

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Landscape Condition	
Impervious Surfaces	**Impervious surface:** > 12.01 % of watershed by area 7.01 to 12 % 3.01 to 7 % 0 to 3 %
Road Density	**Road Density**: From "Poor" to "Very Good" Road density: > 3 miles/ square mile, 3 to 2.5, 2.5 to 1.6, <1.6; Road density within 100 m. stream: >1 mile/square miles, 1 to 0.5, 0.5 to 0.1, <0.1
Land Use	**Land Use:** Unnatural Index (Agricultural + Urban) "Most Disturbed" is Greater than 40 %, "Least Disturbed" is less than 10 %; Percent Urban Greater than 25 %, Less than 5 %; Percent Agricultural Greater than 50 %, Less than 10 %
Hydrology and Geomorphology	
Complex Habitat Types	**Channel Morphology and Connectivity**: From "Poor" to "Very Good"
Floodplain Connectivity	**Floodplain connectivity:** <50 %, 50 to 80 %, >80 %, Not defined Physical barriers <50 of IP-km, 50 to 70 %, 70 to 90 %, >90 %
Stream Habitat Type	**Channel Morphology and Connectivity**: From "Poor" to "Very Good"
Chemical and Physical Characteristics	
Nitrates	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L
Pathogens (Drinking Water Rule, Basin Plan language)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Nutrients	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L
E. coli, enterococci (freshwater)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Toxicity (Acute)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Metals	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Pesticides	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Bioaccumulative	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Chemical Indicators: DDTs	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Chemical Indicators: PCBs	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Sediments/TDS	**Total Suspended Solids**: "Most Disturbed" is greater than 50 mg/L, "Least Disturbed" is less than or equal to 15 mg/L
Biotic Condition	
Biological Conditions: Benthic Macro-invertebrates (BMI, streams)	BMIs: Threshold between "Good" and "Fair," out of 1.00 for reference condition. California Macroinvertebrate Observed/ Expected Index (O/E Index) score of 0.77; Western EMAP Macroinvertebrate Index of Biotic Integrity (IBI) score of 0.57.

Protocol & Data Sources

California Monitoring and Assessment Program (CMAP). The CAMP monitoring project was devel-

oped in collaboration with the SWRCB's Non-Point Source Pollution control Program (NPS), SWRCB's SWAMP program and the US EPA's Region IX.

Department of Water Resources (DWR) Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/

DWR Water Plan Information Exchange: hub with links to various databases http://www.waterplan.water.ca.gov/waterpie/index.cfm

DWR Water Plan and Updates: water quality improvement strategies and data on water use http://www.waterplan.water.ca.gov/waterquality/water_quality.cfm

EPA TMDL program http://www.epa.gov/OWOW/tmdl/

EPA WEMAP (Western Environmental Monitoring and Assessment Program; http://www.epa.gov/region09/water/wemap/surface.html) for physical habitat structure, sediment metabolism, sediment chemistry, water quality parameters, and riparian vegetation.

EPA Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Control Measures — Urban, US Environmental Protection Agency. 1997. http://www.epa.gov/owow/nps/urban2.html

National Pollutant Discharge Elimination System (NPDES) Stormwater Final Rules. Available at: http://cfpub.epa.gov/npdes/regresult.cfm?program_id=6&view=all&type=1

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Methods to Observe, Estimate, or Measure Flow. SWRCB 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Measuring Suspended Solids and Water Column Turbidity. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Measuring Nitrate and Nitrite. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Measuring Orthophosphate. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: E. Coli and Total Coliform Counts Using the Enzyme Substrate Colilert Reagents with QuantiTrays. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Entercoccus Counts Using Enterolert. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html.

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: The California Streamside Biosurvey. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html.

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Methods for Particle Size Distribution Analyses. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html.

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Methods to Observe, Estimate, or Measure Flow. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Visual Observations in Streams and Shorelines. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html.

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Rapid Trash Assessment & Worksheet. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html.

SWAMP http://www.swrcb.ca.gov/water_issues/programs/swamp/, including water quality and toxicity data at http://swamp.mpsl.mlml.calstate.edu/online-data

SWRCB North Coast Basin Plan http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/basin_plan.shtml

SWAMP BMI, stream assessment, and other reports including Ode 2007, SWAMP 2005, and Ode and Rehn 2005 http://www.swrcb.ca.gov/water_issues/programs/swamp/

SWAMP protocols ("Standard Operating Procedures") http://swamp.mpsl.mlml.calstate.edu/ and selected reports under "Bioassessment" at http://www.swrcb.ca.gov/water_issues/programs/swamp/reports.shtml#bioassessment

USGS National Hydrography Dataset http://nhd.usgs.gov/

USGS National Water Information System (NWIS) http://waterdata.usgs.gov/nwis/rt

6. Relevant Programs

The Coastal Watershed Planning and Assessment Program, CDFG

The Coastal Watershed Planning and Assessment Program (CWPAP) is a Department of Fish and Game (CDFG) program conducting fishery-based watershed assessments along the length of the California coast. Assessment basins are chosen as study areas based upon the nature of the socio-economic and natural resource problems within them. The CDFG Coho Recovery Plan and Steelhead Recovery Plan are useful in selecting basins as well. CWPAP has developed assessment methods, protocols and report outlines.

California Coastal Salmon and Watersheds Program, California Resources Agency

The goal of this program is to: recover harvestable salmon and steelhead populations, restore watersheds, and so contribute to building healthy communities."

California's Critical Coastal Areas Program

The purpose of California's Critical Coastal Areas (CCA) Program is "to foster collaboration among local stakeholders and government agencies and better coordinate resources and efforts in coastal-zone watershed areas critically in need of protection from polluted runoff (CCC undated)." The North Coast is one of four regional pilot CCAs in which the CCA Program will form teams comprised of local stakeholders and state, federal, and local agencies to develop community-based action plans to reduce polluted runoff in coastal zone watershed areas.

Clean Water Team Citizen Monitoring Program, SWRCB

The SWRCB provides support to citizens and local organizations who would like to improve water quality through pollution prevention and citizen-based monitoring programs.

Education and Public Outreach Programs, SWRCB

The State Water Resources Control Board provides a web site with information regarding water quality education outreach to various interest groups, including business and industry, municipalities, schools, and tribes.

Endangered Species Protection Program, USEPA

The Endangered Species Protection Program seeks to protect endangered species from the use of pesticides and to minimize the impact of the program on pesticide users.

Environmental Enhancement and Mitigation Program, The California Resources Agency

"The Environmental Enhancement and Mitigation Program was established by the Legislature in 1989. It offers a total of $10 million each year for grants to local, state, and federal governmental agencies and to nonprofit organizations for projects to mitigate the environmental impacts caused by new or modified state transportation facilities." Grants are awarded in three categories: 1) Highway landscape and urban forestry; 2) Resource lands, and 3) Roadside recreational.

Environmental Justice Small Grants Program, Cal/EPA

"Cal/EPA has established the EJ Small Grants Program to assist eligible community-based, grassroots, non-profit entities, and federally recognized tribal governments to address environmental justice issues."

Flood Protection Corridor Program, DWR

This DWR program funds acquisition of property rights from willing sellers and other activities that contribute to flood protection corridor projects.

Integrated Regional Water Management Grant Program, SWRCB

"The Integrated Regional Water Management (IRWM) Implementation Grants Program, funded by Proposition 50, Chapter 8, will provide approximately $64 million during Round 2. IRWM Implementation Grants will fund projects that meet one or more of the program objectives of protecting communities from drought, protecting and improving water quality, and improving local water security by reducing dependence on imported water. Implementation Grant proposals must be based on a qualified IRWM Plan."

Nonpoint Source Management Program — Clean Water Act Section 319, US Environmental Protection Agency

This Program was established through an amendment to the Clean Water Act in 1987 to provide grant money to support activities including technical and financial assistance, education and training,

technology transfer, demonstration projects, and project success monitoring.

Nonpoint Source Pollution Control Programs, SWRCB

The State Water Resources Control Board administers several grant programs which assist local entities with nonpoint source pollution control. The grants are made available through voter approval of the following Propositions: 13, 40, 50, and 84.

Pesticide Environmental Stewardship Program, USEPA

This is "a voluntary program that forms partnerships with pesticide users to reduce health and environmental risk and implement pollution prevention strategies."

Pollinator Conservation Program, The Xerces Society

"The Xerces Society's pollinator program works with farmers, land managers, golf course staff, public agencies, and gardeners to promote the conservation and recovery of native pollinator insects and their habitat."

Recovery Strategy for California Coho Salmon, CDFG

"The California Department of Fish and Game, with the assistance of recovery teams representing diverse interests and perspectives, created the Recovery Strategy for California Coho Salmon, a guide for the process of recovering coho salmon on the north and central coasts of California. The Recovery Strategy emphasizes cooperation and collaboration at many levels, and recognizes the need for funding, public and private support for restorative actions, and maintaining a balance between regulatory and voluntary efforts."

Storm Water Program, SWRCB

The State Water Resources Control Board has four programs to assist with Storm Water Management: Construction, Industrial, Municipal, and Caltrans.

Surface Transportation Program, US Department of Transportation

This program is a block grant program that may be used by states and local governments for any roads that are not functionally classified as local or rural minor collectors. Ten percent of allocated STP funds must be set aside by each state for transportation enhancements, including mitigation of water pollution due to highway runoff.

Urban Forestry Program, California Department of Forestry and Fire Protection

"The Urban Forestry Program offers grants of over $1 million dollars a year to plant trees and over $2.5 million for related projects in urban communities throughout California. Four Urban Forestry Field Specialists provide expert urban forestry support to communities, non-profit groups and other municipal governments to create and maintain sustainable urban forest."

Urban Streams Restoration Program, DWR

"The objectives of the Urban Streams Restoration Program are to assist communities in reducing damages from stream bank and watershed instability and floods while restoring the environmental and aesthetic values of streams, and to encourage stewardship and maintenance of streams by the community. With voter approval of Proposition 84, the Urban Streams Restoration Program will have available grant funding. Proposition 84 includes $18 million for the Urban Streams Restoration Program. DWR anticipates holding the first of two application cycles in mid 2007."

Volunteer Monitoring Program, USEPA

"The U.S. Environmental Protection Agency's (EPA) Office of Water encourages all citizens to learn about their water resources and supports volunteer monitoring because of its many benefits. Volunteer monitors build awareness of pollution problems, become trained in pollution prevention, help clean up problem sites, provide data for waters that may otherwise be unassessed, and increase the amount of water quality information available to decision makers at all levels of government."

Water Quality Service Learning Program, SWRCB

The State Water Resources Control Board has developed a web site designed to introduce teachers to student-centered investigation of polluted runoff. The site offers units of study, free lesson plans, online teacher support, and materials in Spanish.

WaterSense Program, USEPA

"WaterSense is a voluntary partnership program sponsored by the U.S. Environmental Protection Agency. Its mission is to protect the future of our nation's water supply by promoting and enhancing the market for water-efficient products and services."

Watershed Program, DWR

"The Department of Water Resources Watershed Program works with locally led stewardship efforts to integrate the needs of communities, urban and rural, with resource management that sustains watershed ecology."

Watershed Protection Programs, SWRCB

The State Water Resources Control Board administers several programs for watershed protection under Propositions approved by voters. These Propositions are: 13, 40, and 50.

Watershed Stewardship Program, Sotoyome Resource Conservation District

"The SRCD program focuses on education and collaboration within the community to restore resources, improve water quality and habitat, and monitor creeks and watersheds. Working together to find viable solutions for the restoration of the smaller tributary watersheds that will lead to improvements downstream in the main stem of the Russian River Watershed is one of the main goals of this program."

7. Relevant Policies

California Endangered Species Act (CESA), California Environmental Protection Agency

Compliance with the CESA may be required for environmental projects and management practices. The CDFG administers CESA and can authorize exceptions to the state's prohibition against take of a listed species.

California Environmental Quality Act (CEQA), California Resources Agency

CEQA is a statue requiring state and local agencies to identify significant environmental impacts of proposed activities and to avoid or mitigate those impacts if feasible.

City of Cloverdale Draft General Plan Update

Chapter 6 Conservation and Open Space Element, provides for protection of distinctive natural vegetation, including riparian, wetlands, and upland ecosystems. Contains policies specifically intended to protect and enhance the natural beauty, habitat and biotic productivity of the Russian River through the use of conservation buffers, stormwater runoff management, habitat improvement, and the use of natural wetland treatment for expansionof wastewater treatment facilities.

City of Cotati General Plan

Chapter 17.50 — Watercourse and Riparian Resource Protection, sets provisions for adequate buffer areas between watercourses and adjacent development.

Chapter 17.53 — Hillside and Ridgeline Development, sets limits to development to protect natural vegetation and prevent erosion, slope failure, and other environmental degradation.

Chapter 17.56 — Wetland Protection and Restoration, provides policy for protecting wetlands and permitting wetland restoration, enhancement, and mitigation projects.

City of Healdsburg General Plan

Chapter 7 — Natural Resources, establishes policies that improve water quality and flows in the Russian River and Dry and Foss Creeks, promote conservation and restoration of native ecosystems and waterways, preserve the city's natural setting, protect the viability of agriculture, reduce greenhouse gas emissions, and protect riparian resources.

City of Rohnert Park General Plan

Chapter 6 — Environmental Conservation, 6.2 Habitat and Biological Resources, sets policies for protection of special status species and special habitat areas, use of native plants for landscaping, and planting of low water use trees. Sets creek protection zones which prohibit development except greenway enhancement, requires evaluation and implementation of bank stabilization and erosion control measures.

Chapter 5 — Open Space, Parks and Public Facilities, 5.5 Water Supply and Conservation, sets policies for monitoring of the municipal wellfield, requirements for developers to dedicate new well sites in locations identified by the City, requirement of water-conserving devices for new development, development of water and wastewater bmps, adoptiong of a tiered water conservation rate schedule.

City of Sebastopol General Plan

Chapter III: Conservation, Parks and Open Space, sets policies which preserve areas with important biotic resources, ensure the maintenance of wetlands adjacent to City boundaries as permanent open space, protect, maintain and restore wetlands areas, protect and preserve soil as a natural resource, conserve, protect and enhance trees and native vegetation, conserve energy, protect and improve air quality, provide for water conservation, reduce the volume of solid waste the City generates, provides an attractive and comprehensive system of parks and trials that meets all citizens' recreational needs, ensures that recreational facilities are developed in harmony with the surroundings, and incorporates the 1992 Laguna Park Master Plan. The Plan sets minimum buffers for urban land and farming operations adjacent to Laguna habitats, and sets policy to minimize the impacts of backyards adjacent to the Laguna, restore and enhance Laguna habitats, and recover declining species.

Clean Water Act, EPA, Army Corps of Engineers, USFWS, NOAA

Establishes a permit program for the discharge of pollutants into all waters of the US.

Coastal Zone Act Reauthorization Amendments, USEPA, NOAA

Amendments to the Coastal Zone Act to more specifically address effects of NPS pollution on coastal water quality. These amendments require each state with an approved Coastal Zone Management Program to develop a Coastal Nonpoint Pollution Control Program.

Coastal Zone Management Act, NOAA

Provides federal funding for wetlands programs in coastal states, including the preparation of Coastal Zone Management Plans.

Mendocino County General Plan. Land Use Element of the Mendocino County General Plan, Natural Resources.

Section 11 — Soil Resources sets policies to reduce soil loss and erosion, stabilize streambanks, and to limit development on certain soil types.

Section 12 — Vegetation and Wildlife sets policies to retain and restore native vegetation, including riparian vegetation, wetlands, and rare and unique vegetation and to promote wildlife habitat protection and improvement and endangered species protection on private lands.

Section 13 — Water Resources sets policies to encourage land management to reduce water pollution, ensure adequate water supply, and protect the integrity of the flood plain.

National Environmental Protection Act, US EPA

"The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet this requirement, federal agencies prepare a detailed statement known as an Environmental Impact Statement (EIS)."

Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program, SWRCB

"The information provided in this policy is designed to assist all responsible and/or interested parties in understanding how the State's NPS water quality control requirements will be implemented and enforced. The parties involved include the SWRCB and the RWQCBs, federal, state and local agencies, individual dischargers, designated third-party representatives and any other interested public and private parties."

Porter-Cologne Water Quality Control Act, SWRCB

This act provides for regional water quality control under the supervision of

the State Water Resources Control Board. Regional Water Quality Control Boards were created to prescribe and define beneficial uses of water and to define standards necessary to maintain them.

Santa Rosa Citywide Creek Master Plan

The Plan contains "recommended habitat preservation, enhancement, and restoration projects, and improvements to the creekside trail system are presented conceptually and specifically by watershed. Project recommendations are based on community input, literature reviews, and extensive field survey work. Site-specific recommendations are presented in the text and on a set of Geographical Information System-based maps, organized by watershed area."

Santa Rosa General Plan

Chapter 7: 7-3 Biological Resources and Waterways, sets policies which maximize the benefits of open space, conserve the City's open spaces, conserve agricultural soils, conserve wetlands, vernal pools, wildlife ecosystems, rare plant habitats, and waterways, and conserve significant vegetation and trees, conserve water and maintain water quality, and take actions to achieve and maintain ambient air quality standards.

Sonoma County General Plan

2.2 — Prevention of Soil Erosion, sets policies to promote and encourage soil conservation and management practices that maintain the productivity of soil resources.

3.0 — Policies for Water Resources, provides for conservation of water and protection of water quality, preservation of watersheds and groundwater recharge areas, development standards for recharge areas, and preservation of surface water and groundwater quality.

3.1 — Policy for Critical Habitat Areas, provides protection for critical areas including wetlands, marshes, and remnant upland habitat.

3.2 -Policy for Riparian Corridors, establishes streamside conservation areas or riparian corridor setbacks from land use activities.

Stormwater Final Rules, National Pollutant Discharge Elimination System (NPDES), USEPA

Website contains Phase I and Phase II NPDES regulations, extensions, and amendments.

Stream and Wetland System Protection Policy, NCRWQCB

This policy is a proposed amendment to the Water Quality Control Plans for the North Coast and San Francisco Bay Regions that will "protect stream and wetlands systems, including measures to protect riparian areas and floodplains."

Town of Windsor General Plan — 2015

Chapter 4 Community Development, sets policies for the development of recreational opportunities and preservation of water supply.

Chapter 6 Environmental Resources, proposes strategies for the protection and enhancement of open space resources, agricultural resources, water supply and quality, biological resources, cultural resources, extractive resources, and scenic resources.

US Tax Code Tax Reform Act of 1986, IRS

Provides tax deductions for wetlands donors and certain nonprofit organizations.

Wetlands Loan Act, USFWS

Provides for interest-free loans for wetlands acquisition and conservation easements.

8. Sources

Flosi, Gary; Downie, Scott; Hopelain, James; Bird, Michael; Coey, Robert; and Barry Collins. 1998. California Salmonid Stream Habitat Restoration Manual, Third Edition. Sacramento, California, California Department of Fish and Game, Inland Fisheries Division.

Natural Resources Conservation Service (NRCS). 2003. Electronic Field Office Technical Guide. Available at: http://www.nrcs.usda.gov/Technical/efotg/.

NCRWQCB Monitoring Parameters, sample for Garcia River Sediment TMDL (NCRWQCB 2011)

NOAA/NMFS Habitat Attribute Indicators for Russian River Watershed CCC Coho (NMFS 2010)

State Water Resources Control Board (SWRCB). 2002. 2002 CWA Section 303(d) List of Water

Quality Limited Segments. 196 pages. Available at: http://www.swrcb.ca.gov/tmdl/docs/2002cwa303d_listof_wqls072003.pdf

SWRCB/ SWAMP Core Indicators for Beneficial Uses in California (SWAMP 2010/ SWAMP 2006)

Tetra Tech, Inc., 2006. *California Nonpoint Source Encyclopedia*. California State Water Resources Control Board. 281 pages.

US Environmental Protection Agency. 2006. Polluted Runoff (Nonpoint Source Pollution). Web Site. Available at: http://www.epa.gov/owow/nps/categories.html. Accessed 6/07

US Environmental Protection Agency (EPA). 2005. National Management Measures to Control Nonpoint Source Pollution from Urban Areas. Management Measure 9: Pollution Prevention. 41 pages. Available at: http://www.epa.gov/owow/nps/urbanmm/index.html#08

FORESTRY

ROAD MANAGEMENT & RECONSTRUCTION/ DECONSTRUCTION

1. Baseline Description

General Setting:

Historically, the Russian River watershed was an important source of timber and it bears legacy impacts. Former logging roads, some of which are abandoned and some that have been converted to rural residential roads or trails, crisscross the landscape. These roads were created without regard to storm runoff or erosion potential.

Causal Factors:

Traditional and historic road construction practices did not include consideration of surface flow, sedimentation, or habitat connectivity. Roads were temporary structures constructed to access timber stands. Stream crossings were put in place where convenient, without thought to impacts to stream morphology or habitat. Even though timber harvest is no longer a major industry in the watershed, legacy effects of both the timber harvest and the logging roads continues to the present.

2. Management Measure Description

The Road Management and Reconstruction/ Deconstruction MM implements sound planning, design, and construction measures to reduce road maintenance needs after construction. Existing roads will be maintained to control erosion, abandoned in accordance with CDF regulations, and all stream crossings will be managed to keep passage of water unrestricted.

3. Resource Concerns

Habitat Fragmentation
Inadequate Water Quality

Inadequate Wildlife Movement/Travel Corridors

Invasive Non-native Plants

Soil Condition — Compaction

Soil Erosion — Roadbank and Construction Sites

Soil Erosion - Sheet and Rill

Threatened and Endangered Fish and Wildlife Species

Water Quality — Excessive Sediment

4. Management Practices

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
NRCS	Access Control (472)	AC
NRCS	Access Road (560)	FT
NRCS	Contour Buffer Strips (332)	AC
NRCS	Dust Control on Unpaved Roads and Surfaces	Sq Ft
NRCS	Land Clearing (460)	AC
NRCS	Obstruction Removal (500)	AC
NRCS	Road/Landing/Trail Closure and Treatment (654)	FT
NRCS	Structure for Water Control (587)	NO
EPA	Preharvest Planning (3A)	NO
EPA	Streamside Management Area Establishment (3B)	AC
EPA	Road Construction/Reconstruction (3C)	MILES
EPA	Road Management (3D)	MILES
SWRCB	Prescribed Maintenance	NO
SWRCB	Abandonment of temporary roads in accordance with CDF regulations	MILES
SWRCB	Bridges, drainage structures and berms should be kept open to the unrestricted passage of water	NO
SWRCB	Road surfaces should be treated as necessary to prevent excessive loss of road surface materials	TONS/ GALS
SWRCB	Actions should be taken to prevent failures of cut, fill, or sidecast slopes	NO

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Landscape Condition	
Landslides, fluvial, and surface erosion (roads, landings, skid trails)	

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Landslides, fluvial, and surface erosion (agricultural activities)	
Landslides associated with timber harvest units	
Stream crossing failures	**Physical barriers:** <50 of IP-km, 50 to 70 %, 70 to 90 %, >90 %
Density of unpaved roads	**Road Density**: From "Poor" to "Very Good" Road density: > 3 miles/ square mile, 3 to 2.5, 2.5 to 1.6, <1.6; Road density within 100 m. stream: >1 mile/square miles, 1 to 0.5, 0.5 to 0.1, <0.1
Hydrology and Geomorphology	
Gravel Quality (Bulk)	**Gravel quality (bulk):** >17 % (D50=0.85), 15 to 17 %, 12 to 14 %, <12 %
Spawning gravel quantity & distribution	**Sediment Dynamics:** From "Poor" to "Very Good"
Road density (Riparian)	**Road Density**: From "Poor" to "Very Good" Road density: > 3 miles/ square mile, 3 to 2.5, 2.5 to 1.6, <1.6; Road density within 100 m. stream: >1 mile/square miles, 1 to 0.5, 0.5 to 0.1, <0.1
Embeddedness	**Gravel quality (embeddedness):** <25 % of scores are Category 1 or 2, 25 to 50 %, >50 %, Not defined
Substrate Composition	**Gravel quality (bulk):** >17 % (D50=0.85), 15 to 17 %, 12 to 14 %, <12 %
Sediment-related barriers	**Physical barriers:** <50 of IP-km, 50 to 70 %, 70 to 90 %, >90 %
Percent fines, gravel composition	**Gravel quality (bulk):** >17 % (D50=0.85), 15 to 17 %, 12 to 14 %, <12 %
D50 (particle size distribution)	**Gravel quality (bulk):** >17 % (D50=0.85), 15 to 17 %, 12 to 14 %, <12 %
Chemical and Physical Characteristics	
Conventionals: Water and/or sediment toxicity	**Sediment Quality Indicators:** Total Organic Carbon Sediment Contamination, Amphipod Toxicity, Species Richness
Sediments/TDS	**Total Suspended Solids**: "Most Disturbed" is greater than 50 mg/L, "Least Disturbed" is less than or equal to 15 mg/L **Turbidity:** "Most Disturbed" is greater than 20 NTU, "Least Disturbed" is less than or equal to 5 NTU

Protocol & Data Sources

California Department of Fish and Game, California Salmonid Stream Habitat Restoration Manual http://www.dfg.ca.gov/fish/resources/habitatmanual.asp

CalFire Fire and Resource Assessment Program (FRAP) Development and Vegetation Trends methodology http://frap.cdf.ca.gov/projects/development_vegetation/index.html

California Rapid Assessment Method (CRAM) method for riparian condition measures: Collins et al 2008 http://www.cramwetlands.org/documents/

California Watershed Assessment Manual II Chapter 3 (Florsheim 2005) http://cwam.ucdavis.edu/Volume_2/TOC.htm

California Monitoring and Assessment Program (CMAP). The CAMP monitoring project was developed in collaboration with the SWRCB's Non-Point Source Pollution control Program (NPS), SWRCB's SWAMP program and the US EPA's Region IX.

Department of Water Resources (DWR) Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/

DWR Water Plan Information Exchange: hub with links to various databases http://www.waterplan.water.ca.gov/waterpie/index.cfm

DWR Water Plan and Updates: water quality improvement strategies and data on water use http://www.waterplan.water.ca.gov/waterquality/water_quality.cfm

DWR Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/

EPA TMDL program http://www.epa.gov/OWOW/tmdl/

EPA WEMAP (Western Environmental Monitoring and Assessment Program; http://www.epa.gov/region09/water/wemap/surface.html) for physical habitat structure, sediment metabolism, sediment chemistry, water quality parameters, and riparian vegetation.

Florsheim 2005 and references therein provide methods for measuring discharge; measuring sediment transport; calculating effective discharge; assessing substrate and grain size distributions; and assessing morphology (http://cwam.ucdavis.edu/Volume_2/TOC.htm).

SWAMP physical habitat procedures (Ode 2007 http://swamp.mpsl.mlml.calstate.edu/resources-and-downloads/standard-operating-procedures)

SWAMP http://www.swrcb.ca.gov/water_issues/programs/swamp/, including water quality and toxicity data at http://swamp.mpsl.mlml.calstate.edu/online-data

SWRCB North Coast Basin Plan http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/basin_plan.shtml

USDA Forest Service: Cumulative watershed effects: Reid 1993 (http://www.fs.fed.us/psw/rsl/projects/water/reid_141.pdf), UCCCWE 2001

6. Relevant Programs

California Forest Stewardship Program, California Department of Forestry and Fire Protection

> "The California Forest Stewardship Program is designed to encourage good stewardship of private forestland. The program provides

technical and financial assistance to influence positive changes to forestland management, assists communities in solving common watershed problems, and helps landowners."

Conservation Planning Assistance, NRCS

"The Natural Resources Conservation Service (NRCS) provides conservation planning and technical assistance to clients (individuals, groups, and units of government). These clients develop and implement conservation plans to protect, conserve, and enhance natural resources (soil, water, air, plants, and animals) within their related social and economic interests."

Endangered Species Protection Program, USEPA

The Endangered Species Protection Program seeks to protect endangered species from the use of pesticides and to minimize the impact of the program on pesticide users.

Forestry Improvement Program (FIP), California Department of Forestry and Fire Protection, the Natural Resources Conservation Service, and the USDA Forest Service

This program provides technical and financial assistance for timber stand improvement and site preparation in an effort to enhance productivity of private nonindustrial forestland.

Forest Legacy Program, California Department of Forestry and Fire Protection

"The purpose of the Forest Legacy Program (FLP) is to protect environmentally important forestland threatened with conversion to non-forest uses, such as subdivision for residential or commercial development. To help maintain the integrity and traditional uses of private forestlands, the FLP promotes the use of permanent conservation easements."

Resource Management Program, California Department of Forestry and Fire Protection

The goal of this program is to maintain the sustainability of California's natural resources through administration of State and federal forestry assistance programs for landowners, operation of eight demonstration State Forests, enforcement of the California Forest Practice Act, provision of research and educational outreach, and coordination of fuel reduction to reduce fire danger and improve native ecosystems. http://www.fire.ca.gov/php/rsrc-mgt.php

Wildlife Habitat Incentives Program, NRCS

"The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land. Through WHIP USDA's Natural Resources Conservation Service provides both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat. WHIP agreements between NRCS and the participant generally last from 5 to 10 years from the date the agreement is signed."

7. Relevant Policies & Plans

California Endangered Species Act (CESA), California Environmental Protection Agency

Compliance with the CESA may be required for environmental projects and management practices. The CDFG administers CESA and can authorize exceptions to the state's prohibition against take of a listed species. http://www.essexenv.com/endangered_species/cesa.html

California Environmental Quality Act (CEQA), California Resources Agency

CEQA is a statue requiring state and local agencies to identify significant environmental impacts of proposed activities and to avoid or mitigate those impacts if feasible. http://www.ceres.ca.gov/ceqa/

California Forest Practice Rules, California Department of Forestry and Fire Protection Resource Management, Forest Practice Program

"The California Department of Forestry and Fire Protection (CDF) enforces the laws that regulate logging on privately-owned lands in California. These laws are found in the Forest Practice Act which was enacted in 1973 to ensure that logging is done in a manner that will preserve and protect our fish, wildlife, forests and streams."

Endangered Species Act (ESA), US Environmental Protection Agency

The US FWS works with landowners to provide incentives to manage land for endangered species. In some instances land use activities

qualify for exemptions to ESA prohibitions. http://www.fws.gov/endangered/landowner/index.html

Healthy Forests Restoration Act, Bureau of Land Management

"The Healthy Forests Restoration Act (HFRA) provides BLM and Forest Service land managers with legislative tools to expedite forest and rangeland restoration projects. HFRA aims to expedite the preparation and implementation of hazardous fuels-reduction projects on Federal land and assist rural communities, States, and private landowners in restoring healthy forest conditions on State and private lands."

Lake and Streambed Alteration Program, CDFG

"Fish and Game Code section 1602 requires any person, state or local governmental agency, or public utility to notify the Department before beginning any activity that will do one or more of the following: 1) substantially obstruct or divert the natural flow of a river, stream, or lake; 2) substantially change or use any material from the bed, channel, or bank of a river, stream, or lake; or 3) deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it can pass into a river, stream, or lake. Fish and Game Code section 1602 applies to all perennial, intermittent, and ephemeral rivers, streams, and lakes in the state."

Stream and Wetland System Protection Policy, NCRWQCB

This policy is a proposed amendment to the Water Quality Control Plans for the North Coast and San Francisco Bay Regions that will "protect stream and wetlands systems, including measures to protect riparian areas and floodplains."

Z'Berg-Nejedly Forest Practice Act, California Board of Forestry

This act authorizes regulation of timber harvest through the adoption of rules for each forest district in California. The rules are intended to be used as standards for preparing Timber Harvest Plans and evaluating effects of harvest operations.

8. Sources

EPA. 2005. National Management Measures to Control Nonpoint Source Pollution from Forestry. http://water.epa.gov/polwaste/nps/forestry/upload/2005_05_09_NPS_forestrymgmt_guidance.pdf

NCRWQCB Monitoring Parameters, sample for Garcia River Sediment TMDL (NCRWQCB 2011)

NOAA/NMFS Habitat Attribute Indicators for Russian River Watershed CCC Coho (NMFS 2010)

SWRCB/ SWAMP Core Indicators for Beneficial Uses in California (SWAMP 2010/ SWAMP 2006)

SWRCB. 2009. NPS Encyclopedia. Forestry: 2D — Road Management. http://www.waterboards.ca.gov/water_issues/programs/nps/encyclopedia/2d_rd_mgmt.shtml

USDA. No date. *Electronic Field Office Technical Guide for California*. U.S. Department of Agriculture, Natural Resource Conservation Service. (http://efotg.nrcs.usda.gov/)

FIRE MANAGEMENT

1. Baseline Description

General Setting:

The Pomo, the Native American people who inhabited the Russian River watershed prior to European/American settlement, used fire to improve habitat for game animals and provide conditions favorable for important plants. When Americans arrived with their permanent dwellings, fires became an event to fear and prevent. Fire prevention and suppression caused changes in forest structure and when wildfires occurred, they became catastrophic events that resulted in wide-scale destruction of both built and natural environments. In order to restore ecosystems, prescribed fire is sometimes used to provide the disturbance with which a native ecosystem has evolved.

Causal Factors:

Changes in land use led to drastic and long-term changes in forest structure and ecosystem function. The prevention and suppression of wildfires further impacted ecosystem services in ecosystems which rely on the conditions that occasional fires created. For example, certain pine species' cones require the heat of fire to release seed; the seeds require mineral soil exposed by forest fire to germinate. When wildfires currently occur, they are catastrophic, consuming entire landscapes and

leaving barren, erodible soils that are deposited in creeks and rivers during the next rain event.

2. Management Measure Description

The Fire Management MM recognizes that fire management practices are changing as the benefits of fire to forest ecosystems are becoming better understood and more widely accepted. Fire management practices include avoidance of high-intensity, catastrophic fires, proper timing of prescribed burns, and protection against excessive erosion and sedimentation when conducting prescribed fires.

3. Resource Concerns

Habitat Fragmentation
Inadequate Cover/Shade

Inadequate Food Sources for Wildlife

Inadequate Large Woody Debris

Inadequate Shelter

Inadequate Wildlife Territory

Soil Erosion — Mass movement

Water Quality — Excessive Sediment

4. Management Practices

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
EPA	Plan burning to take into account weather, time of year, and fuel conditions	AC
EPA	Execute the prescribed burn with qualified personnel	NO
EPA	Do no conduct intense prescribed fire for site preparation in the Streamside Management Area (SMA)	AC
EPA	Do not pile and burn for slash removal purposes in the SMA	AC
EPA	Avoid construction of fire lines in the SMA	FT and NO
EPA	Avoid conditions that require extensive blading of fire lines by heavy equipment when planning burns	AC
EPA	Use handlines, firebreaks, and hose lays to minimize blading of fire lines	AC
EPA	Avoid burning on steep slopes in high-erosion-hazard areas or areas that have highly erodible soils	AC
EPA	When possible, conduct burns in wetlands in a manner that does not completely remove the organic layer of the forest floor	TONS or AC
EPA	When conducting prescribed fire to regenerate fire-dependent species minimize consumption of the organic layer and openings in the vegetation	TONS or AC and NO
EPA	Do not construct firelines that could drain wetlands	AC
EPA	Avoid intense burning	AC
EPA	Whenever possible leave a 300-ft buffer on both sides of a waterways when using aerially applied fire retardants	AC
EPA	Do not clean fire retardant equipment in watercourses or locations that drain into watercourses	GAL
EPA	Close water wells and temporary water catchments excavated for wildfire-suppression activities as soon as practical following fire control	NO
EPA	During wildfire emergencies, firelines, road construction, and stream crossings are unrestricted by BMPs when necessary for health and safety of firefighters and the public and protection of resources from greater damage due to wildfire.	NO
SWRCB	Vegetative cover on fire lines and disturbed areas should be reestablished as soon as possible using native species	AC
SWRCB	A diligent aerial or ground inspection should be conducted within the first 2 hours after cessation of felling, yarding, or loading operations each day during the dry period when fire is likely to spread.	NO
SWRCB	Grades, ditches, and water bars to fire lines should be installed as soon as it is safe to begin rehabilitation work. Water bars should be installed on any fire line running up and down the slope, and runoff should be directed onto a filter strip or sideslope, not into a drainage area.	NO

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Biotic Condition	
Species Composition	
Stand Age	**DBH (North):** <39 % class 5 and 6, 40 to 54 %, 55 — 69 %, >69 % Species composition: < 25 %, 25 to 50 %, >50 %, Historical conditions
Nuisance plant Growth	
Canopy	
Species Diversity	
Species Distribution	
Land Use and Land Management	
Land use	

Protocol & Data Sources

California Department of Fish and Game protocols http://www.dfg.ca.gov/wildlife/nongame/survey_monitor.html

CalFire Fire and Resource Assessment Program (FRAP) Development and Vegetation Trends methodology http://frap.cdf.ca.gov/projects/development_vegetation/index.html

CalFire: CalVeg
http://www.fs.fed.us/r5/rsl/projects/mapping/accuracy.shtml

CalFire: Composite Dataset of California Landcover http://frap.cdf.ca.gov/data/frapgisdata/select.asp

CalFire: FRAP Watershed Data
http://frap.fire.ca.gov/watersheds/data.asp?HRID=1

6. Relevant Programs

California Forest Stewardship Program, California Department of Forestry and Fire Protection

"The California Forest Stewardship Program is designed to encourage good stewardship of private forestland. The program provides technical and financial assistance to influence positive changes to forestland management, assists communities in solving common watershed problems, and helps landowners."

Conservation Planning Assistance, NRCS

"The Natural Resources Conservation Service (NRCS) provides conservation planning and technical assistance to clients (individuals, groups, and units of government). These clients develop and implement conservation plans to protect, conserve, and enhance natural resources (soil, water, air, plants, and animals) within their related social and economic interests."

Endangered Species Protection Program, USEPA

The Endangered Species Protection Program seeks to protect endangered species from the use of pesticides and to minimize the impact of the program on pesticide users.

Forestry Improvement Program (FIP), California Department of Forestry and Fire Protection, the Natural Resources Conservation Service, and the USDA Forest Service

This program provides technical and financial assistance for timber stand improvement and site preparation in an effort to enhance productivity of private nonindustrial forestland.

Forest Legacy Program, California Department of Forestry and Fire Protection

"The purpose of the Forest Legacy Program (FLP) is to protect environmentally important forestland threatened with conversion to non-forest uses, such as subdivision for residential or commercial development. To help maintain the integrity and traditional uses of private forestlands, the FLP promotes the use of permanent conservation easements."

Resource Management Program, California Department of Forestry and Fire Protection

The goal of this program is to maintain the sustainability of California's natural resources through administration of State and federal forestry assistance programs for landowners, operation of eight demonstration State Forests, enforcement of the California Forest Practice Act, provision of research and educational outreach, and coordination of fuel reduction to reduce fire danger and improve native ecosystems. http://www.fire.ca.gov/php/rsrc-mgt.php

Vegetation Management Program, California Department of Forestry and Fire Protection

The Vegetation Management Program "allows private landowners to enter into a contract with CDF to use prescribed fire to accomplish a combination of fire protection and resource management goals."

Wildlife Habitat Incentives Program, NRCS

"The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land. Through WHIP USDA's Natural Resources Conservation Service provides both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat. WHIP agreements between NRCS and the participant generally last from 5 to 10 years from the date the agreement is signed."

7. Relevant Policies & Plans

California Endangered Species Act (CESA), California Environmental Protection Agency

Compliance with the CESA may be required for environmental projects and management practices. The CDFG administers CESA and can authorize exceptions to the state's prohibition against take of a listed species. http://www.essexenv.com/endangered_species/cesa.html

California Environmental Quality Act (CEQA), California Resources Agency

CEQA is a statue requiring state and local agencies to identify significant environmental impacts of proposed activities and to avoid or mitigate those impacts if feasible. http://www.ceres.ca.gov/ceqa/

California Fire Plan

The California Fire Plan is the state's road map for reducing the risk of wildfire. The Fire Plan is a cooperative effort between the State Board of Forestry and Fire Protection and the California Department of Forestry and Fire Protection. By placing the emphasis on what needs to be done long before a fire starts, the Fire Plan looks to reduce fire fighting costs and property losses, increase firefighter safety, and to contribute to ecosystem health. http://cdfdata.fire.ca.gov/fire_er/fpp_planning_cafireplan

California Forest Practice Rules, California Department of Forestry and Fire Protection Resource Management, Forest Practice Program

"The California Department of Forestry and Fire Protection (CDF) enforces the laws that regulate logging on privately-owned lands in California. These laws are found in the Forest Practice Act which was enacted in 1973 to ensure that logging is done in a manner that will preserve and protect our fish, wildlife, forests and streams."

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Healthy Forests Restoration Act, Bureau of Land Management

"The Healthy Forests Restoration Act (HFRA) provides BLM and Forest Service land managers with legislative tools to expedite forest and rangeland restoration projects. HFRA aims to expedite the preparation and implementation of hazardous fuels-reduction projects on Federal land and assist rural communities, States, and private landowners in restoring healthy forest conditions on State and private lands."

Lake and Streambed Alteration Program, CDFG

"Fish and Game Code section 1602 requires any person, state or local governmental agency, or public utility to notify the Department before beginning any activity that will do one or more of the following: 1) substantially obstruct or divert the natural flow of a river, stream, or lake; 2) substantially change or use any material from the bed, channel, or bank of a river, stream, or lake; or 3) deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it can pass into a river, stream, or lake. Fish and Game Code section 1602 applies to all perennial, intermittent, and ephemeral rivers, streams, and lakes in the state."

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8. Sources

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NOAA/NMFS Habitat Attribute Indicators for Russian River Watershed CCC Coho (NMFS 2010)

SWRCB. 2009. NPS Encyclopedia. Forestry: 2G — Fire Management. http://www.waterboards.ca.gov/water_issues/programs/nps/encyclopedia/2g_fire_mgmt.shtml

HYDROMODIFICATION

GRAVEL MINING

1. Baseline Description

General Setting:

In-channel gravel mining in the Russian River watershed began in 1940 and sand and gravel production

became the principal mining industry from Healdsburg north to Ukiah in the early 1950s. Currently, most gravel mining occurs along river miles 23 to 33 (Middle Reach) and miles 44 to 63 (Alexander Valley Reach).

Causal Factors:

Instream gravel mining has reduced the supply of sediment to downstream portions of the Russian River, which has prompted downcutting of the active channel by as much as 10 to 20 feet, creating vertical banks, lowering the groundwater table and isolating flood plains. In response, tributary streams have also eroded to match the lower elevationof the Russian River mainstem, resulting in the creation of vertical stream banks, lowering of the groundwater table, loss of riparian vegetation, and decreased stream bank stability.

2. Management Measure Description

The Gravel Mining MM incorporates hydraulic principals to reduce impacts to the river system from gravel removal. These management practices evaluate potential effects of proposed extraction activities, plan and design extraction to minimize impacts, operate and maintain gravel extraction sites to improve water quality and promote aquatic and riparian ecosystem function, and reduce or limit the number of service roads adjacent to stream channels.

3. Resource Concerns

Inadequate Shelter

Inadequate Wildlife Movement/Travel Corridors

Inadequate Wildlife Territory

Threatened and Endangered Fish and Wildlife Species

Water Quality — Excessive Sediment

4. Management Practices

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
NMFS	Prior to extraction, conduct comprehensive surveys and research to establish and document baseline environmental data.	NO
NMFS	Determine appropriate rates and locations for instream gravel extraction on the basis of: the rate of upstream recruitment, natural rates of river bed aggradation or degradation, historic sediment transport, bar growth, and bank erosion, predicted effects of gravel extraction on bed elevation and bar and bank stability, and the desirability or acceptability of the anticipated effects.	NO
NMFS	Monitor permitted operations and verify environmental safeguards	NO
NMFS	Establish and implement a long-term monitoring and restoration program	NO
SWRCB	**Reduce or eliminate the amount of service roads adjacent to channels.**	MILES or FT
SWRCB	Maintain streamside vegetative cover to protect or rehabilitate eroded streambanks.	AC
SWRCB	Limit the frequency and duration of clearing and/or dredging of sediment and materials from channels.	NO and HOURS
SWRCB	Grade control structures can be installed to mitigate for the loss of floodplain width or may be used for streams with naturally high sinuosity (such as headwaters or streams with a high elevation gradient).	NO

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Hydrology and Geomorphology	
Floodplain Connectivity	**Floodplain connectivity:** <50 %, 50 to 80 %, >80 %, Not defined Physical barriers <50 of IP-km, 50 to 70 %, 70 to 90 %, >90 %
Stream Habitat Type	**Salmonid Habitat:** North Coast and Central Coast ESU Salmonids freshwater habitat quality indicator benchmarks
Shelter Rating	**Salmonid Habitat:** North Coast and Central Coast ESU Salmonids freshwater habitat quality indicator benchmarks
Bank Composition	**Channel Morphology and Connectivity**: From "Poor" to "Very Good"
Flow Conditions	**Salmonid Habitat:** North Coast and Central Coast ESU Salmonids freshwater habitat quality indicator benchmarks
Sediment-related barriers	**Physical barriers:** <50 of IP-km, 50 to 70 %, 70 to 90 %, >90 %
Substrate Composition	**Gravel quality (bulk):** >17 % (D50=0.85), 15 to 17 %, 12 to 14 %, <12 %

Protocol & Data Sources

California Rapid Assessment Method (CRAM) method for riparian condition measures: Collins et al 2008 http://www.cramwetlands.org/documents/

California Watershed Assessment Manual II Chapter 3 (Florsheim 2005) http://cwam.ucdavis.edu/Volume_2/TOC.htm

DWR Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/

Florsheim 2005 and references therein provide methods for measuring discharge; measuring sediment transport; calculating effective discharge; assessing substrate and grain size distributions; and assessing morphology (http://cwam.ucdavis.edu/Volume_2/TOC.htm).

Sonoma County Aggregate Resources Management Plan http://www.sonoma-county.org/prmd/docs/misc/arm_plan.pdf

SWAMP physical habitat procedures (Ode 2007 http://swamp.mpsl.mlml.calstate.edu/resources-and-downloads/standard-operating-procedures)

USDA Forest Service: Cumulative watershed effects: Reid 1993 (http://www.fs.fed.us/psw/rsl/projects/water/reid_141.pdf), UCCCWE 2001

USEPA Watershed Assessment of River Stability and Sediment Supply (WARSSS) http://www.epa.gov/warsss/sedsource/streamflo.htm

6. Relevant Programs

Watershed Program, DWR

"The Department of Water Resources Watershed Program works with locally led stewardship efforts to integrate the needs of communities, urban and rural, with resource management that sustains watershed ecology."

Watershed Protection Programs, SWRCB

The State Water Resources Control Board administers several programs for watershed protection under Propositions approved by voters. These Propositions are: 13, 40, and 50.

7. Relevant Policies & Plans

California Endangered Species Act (CESA), California Environmental Protection Agency

Compliance with the CESA may be required for environmental projects and management practices. The CDFG administers CESA and can authorize exceptions to the state's prohibition against take of a listed species. http://www.essexenv.com/endangered_species/cesa.html

California Environmental Quality Act (CEQA), California Resources Agency

CEQA is a statue requiring state and local agencies to identify significant environmental impacts of proposed activities and to avoid or mitigate those impacts if feasible. http://www.ceres.ca.gov/ceqa/

Clean Water Act, EPA, Army Corps of Engineers, USFWS, NOAA

Establishes a permit program for the discharge of pollutants into all waters of the US.

Endangered Species Act (ESA), US Environmental Protection Agency

The US FWS works with landowners to provide incentives to manage land for endangered species. In some instances land use activities qualify for exemptions to ESA prohibitions. http://www.fws.gov/endangered/landowner/index.html

Lake and Streambed Alteration Program, CDFG

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National Environmental Protection Act, US EPA

"The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet this requirement, federal agencies prepare a detailed statement known as an Environmental Impact Statement (EIS)."

Porter-Cologne Water Quality Control Act, SWRCB

This act provides for regional water quality control under the supervision of the State Water Resources Control Board. Regional Water Quality Control Boards were created to prescribe and define beneficial uses of water and to define standards necessary to maintain them.

Safe Water Drinking Act, US EPA

This act was intended to protect public health by regulating public drinking water supply. It requires the protection of drinking water and its' sources, including rivers, lakes, reservoirs, springs, and ground water wells.

Stream and Wetland System Protection Policy, NCRWQCB

This policy is a proposed amendment to the Water Quality Control Plans for the North Coast and San Francisco Bay Regions that will "protect stream and wetlands systems, including measures to protect riparian areas and floodplains."

Wetland and Riparian Area Protection Policy (WRAPP) Phase I: Wetland Area Protection Policy and Dredge and Fill Regulations, SWRCB

Phase I is intended to protect all State waters from dredge and fill discharges. Defines "wetlands;" "riparian" tbd. Assessment framework for collecting and reporting aquatic resource information. Phase 2 (expands scope to other potential threats) and Phase 3 (expands scope to include "Riparian" definition, objectives, and restoration) are in development.

Policy for Maintaining Instream Flows in Northern California Coastal Streams (North Coast Instream Flow Policy), SWRCB

Applies to applications to appropriate water, small domestic use and stockpond registrations; and water right petitions. Focuses on protective measures for anadramous fish. Seasonally limits diversions to high-flow periods. Prohibits diversions until streamflows are higher than minimum instream flow needed by fishes. Limits diversion rate to maintain habitat. Considers cumulative effects of diversions on flow. Restricts permitting of new onstream dams. Monitoring and reporting requirements.

8. Sources

CDFG Habitat and Biological Inventory Parameters for Russian River Basin Fisheries (CDFG 2007)

NOAA/NMFS Habitat Attribute Indicators for Russian River Watershed CCC Coho (NMFS 2010)

Sonoma County Aggregate Resources Management Plan http://www.sonoma-county.org/prmd/docs/misc/arm_plan.pdf

SWRCB. 2009. NPS Encyclopedia. Hydromodification: 5.1A — Channelization/ Channel Modification. http://www.waterboards.ca.gov/water_issues/programs/nps/encyclopedia/5.1a_chnlmod_chnlz.shtml

Southwest Regional Office National Marine Fisheries Office. 1996. NMFS National Gravel Extraction Policy. http://swr.nmfs.noaa.gov/hcd/gravelsw.htm#V.%20OPTIMUM%20MANAGEMENT%20OF%20GRAVEL%20EXTRACTION%20OPERATIONS

FLOW AND TEMPERATURE MAINTENANCE

1. Baseline Description

General Setting:

Water quality and quantity are interrelated — stream flow affects surface water temperature and turbidity, which in turn affect dissolved oxygen concentrations. Stream flow also affects the mixing and concentration of hydrophilic chemicals and salts, with solubility increasing with increasing temperature. Streamflow also transports sediments, nutrients, and pollutants; in areas where flow is restricted, stagnant water can accumulate sediments, nutrients, and pollutants.

Causal Factors:

Human activities have caused extreme impacts to both water quality and quantity in the Russian River watershed. Activities including dam construction, vegetation removal, channelization, and instream mining have altered the hydrogeomorphology of the river and urbanization, forestry, agricultural and other land uses have caused sedimentation and introduction of pollutants into the waterways.

2. Management Measure Description

The Flow and Temperature Maintenance MM implements practices to maintain hydrologic stream flows that promote channel equilibrium and uses modeling to determine effects of stream channel and riparian management activities (including reservoir release operations) on temperatures and flows.

3. Resource Concerns

Inadequate Water Quality

Inadequate Water Quantity

Threatened and Endangered Fish and Wildlife Species

Water Quality — Harmful Temperatures of Surface Water

4. Management Practices

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
EPA	Flow Augmentation	GPM
EPA	Enhance Dissolved Oxygen with Gated Conduits	mg/L
EPA	Identify and preserve critical areas	NO

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
EPA	Reservoir Aeration	mg/L
EPA	Sediment traps	NO
EPA	Turbine operation to increase Dissolved Oxygen	mg/L
EPA	Turbine venting to increase Dissolved Oxygen	mg/L
SWRCB	Determine appropriate flow management regime and channel geometry for the site using the river continuum concept.	NO
SWRCB	Consider the use of flow augmentation from dams in the watershed.	AC-FT
SWRCB	Determine stream flow frequencies for peak and low flow conditions	NO
SWRCB	Manage water quantity so that minimum stream flows provide adequate water temperature for the designated beneficial uses.	GPM
SWRCB	Manage flow releases to take advantage of thermal stratification in reservoirs during the summer months. Release water from the spillway to eliminate warm water in reservoir. Release water from river outlets at the bottom of the dam to release cold water into the stream.	° F
SWRCB	Shift strategic hydroelectric power plant operations from peak use to base load use. This can theoretically reduce power plant outputs of warmer water during peak use times (which is coincidentally when air conditioner use is at its peak and temperatures are highest) - to more predictable times when releases can be scheduled in advance.	° F
SWRCB	Plant and maintain riparian vegetation, such as native trees, that provide shade to small creeks and streams.	° F

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Chemical and Physical Characteristics	
Water temperature (MWAT or MWMT)	**Temperature:** From "Poor" to "Very Good" (MWAT or MWMT) < 50 % IP-km (< 15 degrees Celsius MWAT), 50 to 70 %, 70 to 90 %, > 90 %
Conventionals: Temperature	**Temperature:** From "Poor" to "Very Good" (MWAT or MWMT) < 50 % IP-km (< 15 degrees Celsius MWAT), 50 to 70 %, 70 to 90 %, > 90 %
Conventionals: Dissolved Oxygen (DO)	**Dissolved Oxygen:** Greater than 5 mg/L, 2 to 5 mg/L,Less than 2 mg/L
Hydrology and Geomorphology	
Flow Conditions	
Flow	
Flow and/or stage height	
Instantaneous Flow	
Baseflow	
Stream Shading/ Canopy Cover	**Riparian Vegetation:** From "Poor to "Very Good" Canopy cover: <75 % average over IP-km, 75 to 85 %, 85 to 95 %, >95 %
Thalweg profile	
Miles of open stream channel	**Channel Morphology and Connectivity**: From "Poor" to "Very Good"
Floodplain Connectivity	**Floodplain connectivity:** <50 %, 50 to 80 %, >80 %, Not defined Physical barriers <50 of IP-km, 50 to 70 %, 70 to 90 %, >90 %

Protocol & Data Sources

California Monitoring and Assessment Program (CMAP). The CAMP monitoring project was developed in collaboration with the SWRCB's Non-Point Source Pollution control Program (NPS), SWRCB's SWAMP program and the US EPA's Region IX.

Department of Water Resources (DWR) Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/

DWR Water Plan Information Exchange: hub with links to various databases http://www.waterplan.water.ca.gov/waterpie/index.cfm

DWR Water Plan and Updates: water quality improvement strategies and data on water use http://www.waterplan.water.ca.gov/waterquality/water_quality.cfm

EPA TMDL program http://www.epa.gov/OWOW/tmdl/

EPA WEMAP (Western Environmental Monitoring and Assessment Program; http://www.epa.gov/region09/water/wemap/surface.html) for physical habitat structure, sediment metabolism, sediment chemistry, water quality parameters, and riparian vegetation.

SWAMP http://www.swrcb.ca.gov/water_issues/programs/swamp/, including water quality and toxicity data at http://swamp.mpsl.mlml.calstate.edu/online-data

SWRCB North Coast Basin Plan http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/basin_plan.shtml

California Rapid Assessment Method (CRAM) method for riparian condition measures: Collins et al 2008 http://www.cramwetlands.org/documents/

California Watershed Assessment Manual II Chapter 3 (Florsheim 2005) http://cwam.ucdavis.edu/Volume_2/TOC.htm

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USDA Forest Service: Cumulative watershed effects: Reid 1993 (http://www.fs.fed.us/psw/rsl/projects/water/reid_141.pdf), UCCCWE 2001

USEPA Watershed Assessment of River Stability and Sediment Supply (WARSSS) http://www.epa.gov/warsss/sedsource/streamflo.htm

USGS National Hydrography Dataset http://nhd.usgs.gov/

USGS National Water Information System (NWIS) http://waterdata.usgs.gov/nwis/rt

6. Relevant Programs

National Fish Passage Program, USFS

The US Fish and Wildlife's "National Fish Passage Program uses a voluntary, non-regulatory approach to remove and bypass barriers. The Program addresses the problem of fish barriers on a national level, working with local communities and partner agencies to restore natural flows and fish migration."

Watershed Program, DWR

"The Department of Water Resources Watershed Program works with locally led stewardship efforts to integrate the needs of communities, urban and rural, with resource management that sustains watershed ecology."

Watershed Protection Programs, SWRCB

The State Water Resources Control Board administers several programs for watershed protection under Propositions approved by voters. These Propositions are: 13, 40, and 50.

7. Relevant Policies & Plans

California Endangered Species Act (CESA), California Environmental Protection Agency

Compliance with the CESA may be required for environmental projects and management practices. The CDFG administers CESA and can authorize exceptions to the state's prohibition against take of a listed species. http://www.essexenv.com/endangered_species/cesa.html

California Environmental Quality Act (CEQA), California Resources Agency

CEQA is a statue requiring state and local agencies to identify significant environmental impacts of proposed activities and to avoid or mitigate those impacts if feasible. http://www.ceres.ca.gov/ceqa/

Clean Water Act, EPA, Army Corps of Engineers, USFWS, NOAA

Establishes a permit program for the discharge of pollutants into all waters of the US.

Endangered Species Act (ESA), US Environmental Protection Agency

The US FWS works with landowners to provide incentives to manage land for endangered species. In some instances land use activities qualify for exemptions to ESA prohibitions. http://www.fws.gov/endangered/landowner/index.html

Lake and Streambed Alteration Program, CDFG

"Fish and Game Code section 1602 requires any person, state or local governmental agency, or public utility to notify the Department before beginning any activity that will do one or more of the following: 1) substantially obstruct or divert the natural flow of a river, stream, or lake; 2) substantially change or use any material from the bed, channel, or bank of a river, stream, or lake; or 3) deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it can pass into a river, stream, or lake. Fish and Game Code section 1602 applies to all perennial, intermittent, and ephemeral rivers, streams, and lakes in the state."

National Environmental Protection Act, US EPA

"The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet this requirement, federal agencies prepare a detailed statement known as an Environmental Impact Statement (EIS)."

Porter-Cologne Water Quality Control Act, SWRCB

This act provides for regional water quality control under the supervision of the State Water Resources Control Board. Regional Water Quality Control Boards were created to prescribe and define beneficial uses of water and to define standards necessary to maintain them.

Safe Water Drinking Act, US EPA

This act was intended to protect public health by regulating public drinking water supply. It requires the protection of drinking water and its' sources, including rivers, lakes, reservoirs, springs, and ground water wells.

Stream and Wetland System Protection Policy, NCRWQCB

This policy is a proposed amendment to the Water Quality Control Plans for the North Coast and San Francisco Bay Regions that will "protect stream and wetlands systems, including measures to protect riparian areas and floodplains."

8. Sources

EPA. 2005. National Management Measures to Control Nonpoint Source Pollution from Hydromodification. http://www.epa.gov/owow/NPS/hydromod/

CDFG Habitat and Biological Inventory Parameters for Russian River Basin Fisheries (CDFG 2007)

NOAA/NMFS Habitat Attribute Indicators for Russian River Watershed CCC Coho (NMFS 2010)

NCRWQCB Monitoring Parameters, sample for Garcia River Sediment TMDL (NCRWQCB 2011)

SWRCB/ SWAMP Core Indicators for Beneficial Uses in California (SWAMP 2010/ SWAMP 2006)

SWRCB. 2009. NPS Encyclopedia. Hydromodification — 5.1C Dams and Levees, Operation and Maintenance. http://www.waterboards.ca.gov/water_issues/programs/nps/encyclopedia/5.1c_chnlmod_damopmntnt.shtml

SWRCB. 2009. NPS Encyclopedia. Hydromodification — 5.2B Flow and Temperature Maintenance. http://www.waterboards.ca.gov/water_issues/programs/nps/encyclopedia/5.2b_hydromod_flowmtn.shtml

STREAMBANK SEDIMENT & EROSION CONTROL

1. Baseline Description

General Setting:

The Russian River is currently 303(d) listed as impaired due to sediment because current erosion levels greatly exceed natural erosion rates. Erosion in riparian zones causes sediment to discharge directly to streams and other waterways. A Total Maximum Daily Load (TMDL) and TMDL Implementation Plan for sediment in the Russian River will be completed by the North Coast Regional Water Quality Control Board (NCRWQCB 2006).

Causal Factors:

Many anthropogenic activities near riparian areas such as development, agricultural operations, timber harvest, recreational trail use, and road use have contributed to riparian erosion above natural background levels. Additionally, stream bank instability caused by changes to flow regimes can lead to severe bank failure events, which can deliver large loads of sediment.

2. Management Measure Description

The Streambank Sediment & Erosion Control MM promotes the implementation of Best Management Practices (BMPs) to reduce erosion caused by anthropogenic activities in riparian areas. The goal of this MM is to reduce riparian erosion from anthropogenic activities to levels that more closely resemble natural erosion rates and to implement appropriate natural stream bank stabilization to reduce sediment input and bank erosion.

3. Resource Concerns

Soil Erosion - Sheet and Rill

Soil Erosion — Streambank

Soil Erosion — Shoreline

Soil Erosion — Mass movement

Threatened and Endangered Fish and Wildlife Species

Water Quality — Excessive Sediment

4. Management Practices

Recommended practices for promoting streambank sediment and erosion control should include the following principles:

- Project planning is critical for success
- Choose an appropriate approach to streambank stabilization and erosion control — a vegetative method for reducing erosion is preferable to a structural approach
- When using plant material, seeds, transplants and plant materials for propagation should be collected as close as possible to the project site (within project site watershed). Collection should be conducted to maximize genetic diversity of propagation material (from multiple plants in diverse locations and in the case of seeds, at

different time intervals) and in a manner that minimizes impacts to the collection site

- Project implementation should be conducted to minimize impacts to adjacent areas and resident wildlife
- Project should be monitored for success and potential adaptive management

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
CDFG	Emergent Transplant Installation	AC
CDFG	Dormant Willow or Cottonwood Sprig Installation	AC
CDFG	Container Plant Installation with Protective Shelters	AC
CDFG	Direct Seed Installation	AC
CDFG	Riparian Revegetation Project Maintenance	AC
CDFG	Slide Stabilization	FT
CDFG	Stream Bank Stabilization (boulder, log)	FT
CDFG	Native Material Revetment	FT
CDFG	Mulching	AC
CDFG	Willow Wall Revetment	FT
CDFG	Brush Mattress	FT
CDFG	Checkdams (redwood board, brush)	FT
CDFG	Waterbars	FT
SRCD	Exclusionary Fencing	FT
SRCD	Riparian Pastures	AC
NRCS	Channel Vegetation (322)	AC
NRCS	Conservation Cover (327)	AC
NRCS	Critical Area Planting (342)	AC
NRCS	Fence (382)	FT
NRCS	Riparian Herbaceous Cover (390)	AC
NRCS	Riparian Forest Buffer (391)	AC
NRCS	Grade Stabilization Structure (410)	NO
NRCS	Use Exclusion (472)	AC
NRCS	Mulching (484)	AC
NRCS	Prescribed Grazing (528)	AC
NRCS	Rock Barrier (555)	FT
NRCS	Animal Trails and Walkways (575)	FT
NRCS	Streambank and Shoreline Protection (580)	FT
NRCS	Pest Management (595A)	AC
NRCS	Tree/Shrub Establishment (612)	AC
NRCS	Tree/Shrub Establishment (A), Bareroot/Containerized Stock (612A)	AC
NRCS	Tree/Shrub Establishment (B), Direct Seeding (612B)	AC
NRCS	Tree/Shrub Establishment (C), Pole plantings/cuttings (612C)	AC

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Landscape Condition	
Impervious Surfaces	**Impervious surface:** > 12.01 % of watershed by area 7.01 to 12 % 3.01 to 7 % 0 to 3 %
Rainfall	
Landslides, fluvial, and surface erosion (agricultural activities)	
Stream crossing failures	
Density of unpaved roads	
Road Density	**Road Density**: From "Poor" to "Very Good" Road density: > 3 miles/ square mile, 3 to 2.5, 2.5 to 1.6, <1.6; Road density within 100 m. stream: >1 mile/square miles, 1 to 0.5, 0.5 to 0.1, <0.1
Hydrology and Geomorphology	
Gravel Quality (Bulk)	**Gravel quality (bulk):** >17 % (D50=0.85), 15 to 17 %, 12 to 14 %, <12 %
Embeddedness	**Gravel quality (embeddedness):** <25 % of scores are Category 1 or 2, 25 to 50 %, >50 %, Not defined
Spawning gravel quantity & distribution	**Gravel quality (bulk):** >17 % (D50=0.85), 15 to 17 %, 12 to 14 %, <12 %
Substrate Composition	**Gravel quality (embeddedness):** <25 % of scores are Category 1 or 2, 25 to 50 %, >50 %, Not defined
Sediment-related barriers	**Physical barriers:** <50 of IP-km, 50 to 70 %, 70 to 90 %, >90 %
Chemical and Physical Characteristics	
Conventionals: Dissolved Oxygen (DO)	**Dissolved Oxygen:** Greater than 5 mg/L, 2 to 5 mg/L,Less than 2 mg/L
Conventionals: Water and/or sediment toxicity	**Sediment Quality Indicators:** Total Organic Carbon Sediment Contamination, Amphipod Toxicity, Species Richness - See Attachment B2.
Sediments/TDS	**Sediment Quality Indicators:** Total Organic Carbon Sediment Contamination, Amphipod Toxicity, Species Richness - See Attachment B2.
Biotic Condition	
Biological Conditions: Benthic Macro-invertebrates (BMI, streams)	BMIs: Threshold between "Good" and "Fair," out of 1.00 for reference condition. California Macroinvertebrate Observed/ Expected Index (O/E Index) score of 0.77; Western EMAP Macroinvertebrate Index of Biotic Integrity (IBI) score of 0.57.

Protocol & Data Sources

California Monitoring and Assessment Program (CMAP). The CAMP monitoring project was developed in collaboration with the SWRCB's Non-Point Source Pollution control Program (NPS), SWRCB's SWAMP program and the US EPA's Region IX.

CDFG, Quantitative Protocols for Effectiveness Monitoring of Roads and Upland Restoration Following Stressing Events, Interim Restoration Effectiveness and Validation Monitoring Protocols, 2003.

CDFG, Photographic Monitoring, Interim Restoration Effectiveness and Validation Monitoring Protocols, 2003

Department of Water Resources (DWR) Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/

DWR Water Plan Information Exchange: hub with links to various databases http://www.waterplan.water.ca.gov/waterpie/index.cfm

DWR Water Plan and Updates: water quality improvement strategies and data on water use http://www.waterplan.water.ca.gov/waterquality/water_quality.cfm

EPA, Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Control Measures — Forestry, US Environmental Protection Agency. 1997. http://www.epa.gov/owow/nps/forestry/index.html

EPA TMDL program http://www.epa.gov/OWOW/tmdl/

EPA WEMAP (Western Environmental Monitoring and Assessment Program; http://www.epa.gov/region09/water/wemap/surface.html) for physical habitat structure, sediment metabolism, sediment chemistry, water quality parameters, and riparian vegetation.

SWAMP http://www.swrcb.ca.gov/water_issues/programs/swamp/, including water quality and toxicity data at http://swamp.mpsl.mlml.calstate.edu/online-data

SWRCB North Coast Basin Plan http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/basin_plan.shtml

California Rapid Assessment Method (CRAM) method for riparian condition measures: Collins et al 2008 http://www.cramwetlands.org/documents/

California Watershed Assessment Manual II Chapter 3 (Florsheim 2005) http://cwam.ucdavis.edu/Volume_2/TOC.htm

Florsheim 2005 and references therein provide methods for measuring discharge; measuring sediment transport; calculating effective discharge; assessing substrate and grain size distributions; and assessing morphology (http://cwam.ucdavis.edu/Volume_2/TOC.htm).

Sotoyome RCD, Conducting Effectiveness Monitoring, Grazing Handbook, 2006.

SWAMP BMI, stream assessment, and other reports including Ode 2007, SWAMP 2005, and Ode and Rehn 2005 http://www.swrcb.ca.gov/water_issues/programs/swamp/

SWAMP protocols ("Standard Operating Procedures") http://swamp.mpsl.mlml.calstate.edu/ and selected reports under "Bioassessment" at http://www.swrcb.ca.gov/water_issues/programs/swamp/reports.shtml#bioassessment

SWAMP physical habitat procedures (Ode 2007 http://swamp.mpsl.mlml.calstate.edu/resources-and-downloads/standard-operating-procedures)

University of California Division of Agriculture and Natural Resources, Sediment Delivery Inventory and Monitoring: A Method for Water Quality Management in Rangeland Watersheds, http://anrcatalog.ucdavis.edu/pdf/8014.pdf

USDA FS Pacific Northwest Research Station, Field Procedures, Photo Point Monitoring Handbook: Part A — Field Procedures, 2002. http://www.fs.fed.us/pnw/pubs/gtr526/

USDA Forest Service. Protocol for Monitoring Best Management Practices, 2006. http://www.na.fs.fed.us/ra/SpecialInitiatives/bestmgmtpractices/sib06_bmp.htm

USDA Forest Service: Cumulative watershed effects: Reid 1993 (http://www.fs.fed.us/psw/rsl/projects/water/reid_141.pdf), UCCCWE 2001

USEPA Watershed Assessment of River Stability and Sediment Supply (WARSSS) http://www.epa.gov/warsss/sedsource/streamflo.htm

USGS National Hydrography Dataset http://nhd.usgs.gov/

USGS National Water Information System (NWIS) http://waterdata.usgs.gov/nwis/rt

6. Relevant Programs

5 Star Restoration Program, USEPA

> "The Five Star Restoration Program brings together students, conservation corps, other youth groups, citizen groups, corporations, landowners and government agencies to provide environmental education and training through projects that restore wetlands and streams. The program provides challenge grants, technical support and opportunities for information exchange to enable community-based restoration projects."

Agricultural Management Assistance Program, NRCS

> "Agricultural Management Assistance (AMA) provides cost share assistance to agricultural producers to voluntarily address issues such as water management, water quality, and erosion control by incorporating conservation into their farming operations. Producers may construct or improve water management structures or irrigation structures; plant trees for windbreaks or to improve water quality; and mitigate risk through production diversification or resource conservation practices, including soil erosion control, integrated pest management, or transition to organic farming."

Agricultural Water Quality Grant Program, SWRCB

"The Agricultural Water Quality Grant Program provides funding for projects that reduce or eliminate non-point source pollution discharge to surface waters from agricultural lands. Funding from Propositions 40 and 50 were administered through two solicitations, most recently the 2005-2006 Consolidated Grants Process. Additional funds will be made available in the future through Proposition 84."

California Forest Stewardship Program, California Department of Forestry and Fire Protection

"The California Forest Stewardship Program is designed to encourage good stewardship of private forestland. The program provides technical and financial assistance to influence positive changes to forestland management, assists communities in solving common watershed problems, and helps landowners."

California's Critical Coastal Areas Program

The purpose of California's Critical Coastal Areas (CCA) Program is "to foster collaboration among local stakeholders and government agencies and better coordinate resources and efforts in coastal-zone watershed areas critically in need of protection from polluted runoff." The North Coast is one of four regional pilot CCAs in which the CCA Program will form teams comprised of local stakeholders and state, federal, and local agencies to develop community-based action plans to reduce polluted runoff in coastal zone watershed areas.

Clean Water Team Citizen Monitoring Program, SWRCB

The SWRCB provides support to citizens and local organizations who would like to improve water quality through pollution prevention and citizen-based monitoring programs.

Coastal Program, USFS

"The Coastal Program provides incentives for voluntary protection of threatened, endangered and other species on private and public lands alike."

Conservation Planning Assistance, NRCS

"The Natural Resources Conservation Service (NRCS) provides conservation planning and technical assistance to clients (individuals, groups, and units of government). These clients develop and implement conservation plans to protect, conserve, and enhance natural resources (soil, water, air, plants, and animals) within their related social and economic interests."

Education Program, Sotoyome Resource Conservation District

"The Sotoyome Resource Conservation District (SRCD) Education Program delivers adult and K-12 education that promotes an understanding of the interplay between agriculture and natural resources, and sponsors projects that address stewardship of our natural resources."

Environmental Quality Incentives Program, NRCS

"The Environmental Quality Incentives Program (EQIP) was reauthorized in the Farm Security and Rural Investment Act of 2002 (Farm Bill) to provide a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land."

Fish Friendly Farming, California Land Stewardship Institute

"Fish Friendly Farming provides an incentive-based method for creating and sustaining environmental quality and habitat on private land. Landowners and managers enroll in the program, learn environmentally beneficial management practices and carry out ecological restoration projects."

Integrated Regional Water Management Grant Program, SWRCB

"The Integrated Regional Water Management (IRWM) Implementation Grants Program, funded by Proposition 50, Chapter 8, will provide approximately $64 million during Round 2. IRWM Implementation Grants will fund projects that meet one or more of the program objectives of protecting communities from drought, protecting and improving water quality, and improving local water security by reducing dependence on imported

water. Implementation Grant proposals must be based on a qualified IRWM Plan."

Nonpoint Source Management Program — Clean Water Act Section 319, US Environmental Protection Agency

This Program was established through an amendment to the Clean Water Act in 1987 to provide grant money to support activities including technical and financial assistance, education and training, technology transfer, demonstration projects, and project success monitoring.

Nonpoint Source Pollution Control Programs, SWRCB

The State Water Resources Control Board administers several grant programs which assist local entities with nonpoint source pollution control. The grants are made available through voter approval of the following Propositions: 13, 40, 50, and 84.

Recovery Strategy for California Coho Salmon, CDFG

"The California Department of Fish and Game, with the assistance of recovery teams representing diverse interests and perspectives, created the Recovery Strategy for California Coho Salmon, a guide for the process of recovering coho salmon on the north and central coasts of California. The Recovery Strategy emphasizes cooperation and collaboration at many levels, and recognizes the need for funding, public and private support for restorative actions, and maintaining a balance between regulatory and voluntary efforts."

Resource Management Program, California Department of Forestry and Fire Protection

The goal of this program is to maintain the sustainability of California's natural resources through administration of State and federal forestry assistance programs for landowners, operation of eight demonstration State Forests, enforcement of the California Forest Practice Act, provision of research and educational outreach, and coordination of fuel reduction to reduce fire danger and improve native ecosystems.

Surface Transportation Program, US Department of Transportation

This program is a block grant program that may be used by states and local governments for any roads that are not functionally classified as local or rural minor collectors. Ten percent of allocated STP funds must be set aside by each state for transportation enhancements, including mitigation of water pollution due to highway runoff.

Urban Streams Restoration Program, DWR

"The objectives of the Urban Streams Restoration Program are to assist communities in reducing damages from stream bank and watershed instability and floods while restoring the environmental and aesthetic values of streams, and to encourage stewardship and maintenance of streams by the community. With voter approval of Proposition 84, the Urban Streams Restoration Program will have available grant funding. Proposition 84 includes $18 million for the Urban Streams Restoration Program. DWR anticipates holding the first of two application cycles in mid 2007."

Volunteer Monitoring Program, USEPA

"The U.S. Environmental Protection Agency's (EPA) Office of Water encourages all citizens to learn about their water resources and supports volunteer monitoring because of its many benefits. Volunteer monitors build awareness of pollution problems, become trained in pollution prevention, help clean up problem sites, provide data for waters that may otherwise be unassessed, and increase the amount of water quality information available to decision makers at all levels of government."

Water Quality Service Learning Program, SWRCB

The State Water Resources Control Board has developed a web site designed to introduce teachers to student-centered investigation of polluted runoff. The site offers units of study, free lesson plans, online teacher support, and materials in Spanish.

WaterSense Program, USEPA

"WaterSense is a voluntary partnership program sponsored by the U.S. Environmental Protection Agency. Its mission is to protect the future of our nation's water supply by promoting and enhancing the market for water-efficient products and services."

Watershed Program, DWR

"The Department of Water Resources Watershed Program works with locally led stewardship efforts to integrate the needs of communities, urban and rural, with resource management that sustains watershed ecology."

Watershed Protection Programs, SWRCB

The State Water Resources Control Board administers several programs for watershed protection under Propositions approved by voters. These Propositions are: 13, 40, and 50.

Watershed Stewardship Program, Sotoyome Resource Conservation District

"The SRCD program focuses on education and collaboration within the community to restore resources, improve water quality and habitat, and monitor creeks and watersheds. Working together to find viable solutions for the restoration of the smaller tributary watersheds that will lead to improvements downstream in the main stem of the Russian River Watershed is one of the main goals of this program."

7. Relevant Policies

California Endangered Species Act (CESA), California Environmental Protection Agency

Compliance with the CESA may be required for environmental projects and management practices. The CDFG administers CESA and can authorize exceptions to the state's prohibition against take of a listed species.

California Environmental Quality Act (CEQA), California Resources Agency

CEQA is a statue requiring state and local agencies to identify significant environmental impacts of proposed activities and to avoid or mitigate those impacts if feasible.

California Forest Practice Rules, California Department of Forestry and Fire Protection Resource Management, Forest Practice Program

"The California Department of Forestry and Fire Protection (CDF) enforces the laws that regulate logging on privately-owned lands in California. These laws are found in the Forest Practice Act which was enacted in 1973 to ensure that logging is done in a manner that will preserve and protect our fish, wildlife, forests and streams."

City of Cloverdale Draft General Plan Update

Chapter 6 Conservation and Open Space Element, provides for protection of distinctive natural vegetation, including riparian, wetlands, and upland ecosystems. Contains policies specifically intended to protect and enhance the natural beauty, habitat and biotic productivity of the Russian River through the use of conservation buffers, stormwater runoff management, habitat improvement, and the use of natural wetland treatment for expansionof wastewater treatment facilities.

City of Cotati General Plan

Chapter 17.50 — Watercourse and Riparian Resource Protection, sets provisions for adequate buffer areas between watercourses and adjacent development.

City of Healdsburg General Plan

Chapter 7 — Natural Resources, establishes policies that improve water quality and flows in the Russian River and Dry and Foss Creeks, promote conservation and restoration of native ecosystems and waterways, preserve the city's natural setting, protect the viability of agriculture, reduce greenhouse gas emissions, and protect riparian resources.

City of Rohnert Park General Plan

Chapter 6 — Environmental Conservation, 6.2 Habitat and Biological Resources, sets policies for protection of special status species and special habitat areas, use of native plants for landscaping, and planting of low water use trees. Sets creek protection zones which prohibit development except greenway enhancement, requires evaluation and implementation of bank stabilization and erosion control measures.

Chapter 5 — Open Space, Parks and Public Facilities, 5.5 Water Supply and

City of Sebastopol General Plan

Chapter III: Conservation, Parks and Open Space, sets policies which preserve areas with important biotic resources, ensure the maintenance of wetlands adjacent to City

boundaries as permanent open space, protect, maintain and restore wetlands areas, protect and preserve soil as a natural resource, conserve, protect and enhance trees and native vegetation, conserve energy, protect and improve air quality, provide for water conservation, reduce the volume of solid waste the City generates, provides an attractive and comprehensive system of parks and trials that meets all citizens' recreational needs, ensures that recreational facilities are developed in harmony with the surroundings, and incorporates the 1992 Laguna Park Master Plan. The Plan sets minimum buffers for urban land and farming operations adjacent to Laguna habitats, and sets policy to minimize the impacts of backyards adjacent to the Laguna, restore and enhance Laguna habitats, and recover declining species.

Clean Water Act, EPA, Army Corps of Engineers, USFWS, NOAA

Establishes a permit program for the discharge of pollutants into all waters of the US.

Coastal Zone Act Reauthorization Amendments, USEPA, NOAA

Amendments to the Coastal Zone Act to more specifically address effects of NPS pollution on coastal water quality. These amendments require each state with an approved Coastal Zone Management Program to develop a Coastal Nonpoint Pollution Control Program.

Coastal Zone Management Act, NOAA

Provides federal funding for wetlands programs in coastal states, including the preparation of Coastal Zone Management Plans.

Endangered Species Act (ESA), US Environmental Protection Agency

The US FWS works with landowners to provide incentives to manage land for endangered species. In some instances land use activities qualify for exemptions to ESA prohibitions.

Mendocino County General Plan. Land Use Element of the Mendocino County General Plan, Natural Resources.

Section 8 — Natural Areas sets policies to protect natural areas under public and private ownership.

Section 11 — Soil Resources sets policies to reduce soil loss and erosion, stabilize streambanks, and to limit development on certain soil types.

Section 12 — Vegetation and Wildlife sets policies to retain and restore native vegetation, including riparian vegetation, wetlands, and rare and unique vegetation and to promote wildlife habitat protection and improvement and endangered species protection on private lands.

National Environmental Protection Act, US EPA

"The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet this requirement, federal agencies prepare a detailed statement known as an Environmental Impact Statement (EIS)."

Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program, SWRCB

"The information provided in this policy is designed to assist all responsible and/or interested parties in understanding how the State's NPS water quality control requirements will be implemented and enforced. The parties involved include the SWRCB and the RWQCBs, federal, state and local agencies, individual dischargers, designated third-party representatives and any other interested public and private parties."

Santa Rosa Citywide Creek Master Plan

The Plan contains "recommended habitat preservation, enhancement, and restoration projects, and improvements to the creekside trail system are presented conceptually and specifically by watershed. Project recommendations are based on community input, literature reviews, and extensive field survey work. Site-specific recommendations are presented in the text and on a set of Geographical Information System-based maps, organized by watershed area."

Santa Rosa General Plan

Chapter 7: 7-3 Biological Resources and Waterways, sets policies which maximize the benefits of open space, conserve the City's open spaces, conserve agricultural soils, conserve wetlands, vernal pools, wildlife ecosystems, rare plant habitats, and waterways, and conserve significant vegetation and trees, conserve water and maintain water quality, and take actions to achieve and maintain ambient air quality standards.

Sonoma County General Plan

2.2 — Prevention of Soil Erosion, sets policies to promote and encourage soil conservation and management practices that maintain the productivity of soil resources.

3.2 -Policy for Riparian Corridors, establishes streamside conservation areas or riparian corridor setbacks from land use activities.

Stream and Wetland System Protection Policy, NCRWQCB

This policy is a proposed amendment to the Water Quality Control Plans for the North Coast and San Francisco Bay Regions that will "protect stream and wetlands systems, including measures to protect riparian areas and floodplains."

Town of Windsor General Plan — 2015

Chapter 6 Environmental Resources, proposes strategies for the protection and enhancement of open space resources, agricultural resources, water supply and quality, biological resources, cultural resources, extractive resources, and scenic resources.

Z'Berg-Nejedly Forest Practice Act, California Board of Forestry

This act authorizes regulation of timber harvest through the adoption of rules for each forest district in California. The rules are intended to be used as standards for preparing Timber Harvest Plans and evaluating effects of harvest operations.

8. Sources

Castro, Janine, and Frank Reckendorf. 1995. RCA III Effects of Sediment on the Aquatic Environment: Potential NRCS Actions to Improve Aquatic Habitat. Natural Resources Conservation Service and Oregon State University Department of Geosciences. Available at: http://www.nrcs.usda.gov/technical/land/pubs/wp06text.html

Flosi, Gary; Downie, Scott; Hopelain, James; Bird, Michael; Coey, Robert; and Barry Collins. California Salmonid Stream Habitat Restoration Manual, Third Edition. Sacramento, California, California Department of Fish and Game, Inland Fisheries Division.

Natural Resources Conservation Service (NRCS). 2003. Electronic Field Office Technical Guide. Available at: http://www.nrcs.usda.gov/Technical/efotg/.

North Coast Regional Water Quality Control Board (NCRWQCB). 2006. TMDLs. Web Site. Available at: http://www.swrcb.ca.gov/rwqcb1/programs/tmdl/Status.html. Accessed 6/07.

Russian River Watershed Council. 2002. Plan of Action: A Living Document for the Phase II Development of the Russian River Watershed Management Plan. 142 pages.

Smith, R. D. January 2007 (Draft). Russian River Watershed Management Plan: Baseline Watershed Assessment Synthesis Report. U.S. Army Engineer Research and Development Center - Environmental Laboratory. Vicksburg, MS 39180.

Sotoyome Resource Conservation District (SRCD). Undated. Grazing Handbook A Guide for Resource Managers for Coastal California. 68 pages.

Tetra Tech, Inc., 2006. California Nonpoint Source Encyclopedia. California State Water Resources Control Board. 281 pages.

US Environmental Protection Agency. 2006. Polluted Runoff (Nonpoint Source Pollution). Web Site. Available at: http://www.epa.gov/owow/nps/categories.html. Accessed 6/07.

US Environmental Protection Agency. 2005. National Management Measures to Protect and Restore Wetlands and Riparian Areas for the Abatement of Nonpoint Source Pollution.

DAMS, CHANNELS AND WATER DIVERSION CONSTRUCTION & MANAGEMENT

1. Baseline Description

General Setting:

The Russian River watershed has a long history of hydrologic modification. These modifications have resulted in changes to instream habitat conditions including reduced flow, channel incision, bank

erosion, aggradation, more uniform channel cross sections, steeper stream gradients and reduced average pool depths. Hydrologic modification activities can also change the ability of neighboring ecosystems to absorb hydraulic energy and filter pollutants, increase water temperature, and alter rates and paths of sediment transport. The modification structures may also present a barrier to fish passage.

Causal Factors:

Dams, water diversions, and channels created for agriculture or runoff control have impacted the hydrology and geomorphology of tributary creeks and streams and the Russian River. Warm Springs and Coyote dams represent major alterations to the hydrology and morphology of the mainstem and there are over 500 smaller permitted dams in the watershed with many more unpermitted dams in existence. Diversions have been created to supply water for ranching, vineyards, row crops, orchards, and residential water supply. The Laguna de Santa Rosa and other wetlands adjacent to the Russian River have been drained through channelization or other means in support of agricultural operations.

2. Management Measure Description

The Dams, Channels and Water Diversion Construction & Management MM provides technical information to reduce NPS pollution and abate impacts to instream habitat conditions. The goal of this MM is to promote hydrologic modification construction and management practices that contribute to altering hydrologic and geomorphic conditions to more closely resemble historic characteristics of the Russian River.

3. Resource Concerns

Habitat Fragmentation

Inadequate Shelter

Inadequate Water Quantity

Inadequate Wildlife Movement/Travel Corridors

Threatened and Endangered Fish and Wildlife Species

4. Management Practices

Recommended practices for dam, channel, and water diversion construction and management should include the following principles:

- Project planning is critical to success
- Projects should be evaluated to determine impacts and benefits prior to implementation
- Channels should be evaluated within a watershed management context
- Post-project monitoring should be conducted to evaluate project success and provide information for adaptive management

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
CDFG	Stream bank stabilization	1000 FT^2
CDFG	Checkdams (redwood board, brush)	FT
CDFG	Emergent Transplant Installation	
CDFG	Dormant Willow or Cottonwood Sprig Installation	
CDFG	Container Plant Installation with Protective Shelters	
CDFG	Direct Seed Installation	
CDFG	Riparian Revegetation Project Maintenance	
CDFG	Fishways	
EPA	Grade control structures	
EPA	Setback Levees and Flood Walls	
EPA	Spill Prevention and Control Plan	
EPA	Pumping and Injection Practices	
EPA	Turbine Venting	
EPA	Gated Conduits	
EPA	Spillways and Spillway Modifications	
EPA	Reregulation and Labyrinth Weirs	
EPA	Selective withdrawal	
EPA	Turbine Operation	
NRCS	Irrigation Canal or Lateral (320)	FT
NRCS	Critical Area Planting (342)	AC
NRCS	Dam, Diversion (348)	NO
NRCS	Sediment Basin (350)	NO
NRCS	Dam (402)	NO
NRCS	Grade stabilization Struction (410)	NO
NRCS	Streambank and Shoreline Protection (580)	FT
NRCS	Channel Stabilization (584)	FT
NRCS	Shallow Water Management for Wildlife (646)	AC

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Basin Storage	
Diversions	
Channel Alteration	**Channel Morphology and Connectivity**: From "Poor" to "Very Good"
Primary Pools	**Salmonid Habitat:** North Coast and Central Coast ESU Salmonids freshwater habitat quality indicator benchmarks
Embeddedness	**Gravel quality (embeddedness):** <25 % of scores are Category 1 or 2, 25 to 50 %, >50 %, Not defined
V* Metric	**Frequency of primary pools:** <30 % pools by order and length, 30 to 40 %, 40 to 50 %, >50 %
Percent Fines <0.85	**Gravel quality (bulk):** >17 % (D50=0.85), 15 to 17 %, 12 to 14 %, <12 %

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Floodplain connectivity	**Floodplain connectivity:** <50 %, 50 to 80 %, >80 %, Not defined Physical barriers <50 of IP-km, 50 to 70 %, 70 to 90 %, >90 %
Flow Conditions	
Flow and/or stage height	

Protocol & Data Sources

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Observing Fish from the Bank Standard Operating Procedure, SWRCB, undated. http://www.swrcb.ca.gov/nps/cwtguidance.html

Snorkeling Surveys, SWRCB, undated. http://www.swrcb.ca.gov/nps/cwtguidance.html

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Validation Monitoring of Watershed Restoration in California, CDFG, 2003. http://www.dfg.ca.gov/nafwb/pubs/2003/200303_Interim_Protocol_Manual.pdf

Field Procedures, Photo Point Monitoring Handbook: Part A — Field Procedures, USDA FS Pacific Northwest Research Station, 2002. http://www.fs.fed.us/pnw/pubs/gtr526/

6. Relevant Programs

Agricultural Management Assistance Program, NRCS

> "Agricultural Management Assistance (AMA) provides cost share assistance to agricultural producers to voluntarily address issues such as water management, water quality, and erosion control by incorporating conservation into their farming operations. Producers may construct or improve water management structures or irrigation structures; plant trees for windbreaks or to improve water quality; and mitigate risk through production diversification or resource conservation practices, including

soil erosion control, integrated pest management, or transition to organic farming."

Agricultural Water Use Program, DWR

The Department of Water Resources' "Office of Water Use Efficiency works to disseminate and transfer information on improved irrigation technologies and to identify and help develop technologies and farming methods that improve water use efficiency."

The Coastal Watershed Planning and Assessment Program, CDFG

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Education Program, Sotoyome Resource Conservation District

"The Sotoyome Resource Conservation District (SRCD) Education Program delivers adult and K-12 education that promotes an understanding of the interplay between agriculture and natural resources, and sponsors projects that address stewardship of our natural resources."

Endangered Species Protection Program, USEPA

The Endangered Species Protection Program seeks to protect endangered species from the use of pesticides and to minimize the impact of the program on pesticide users.

Environmental Quality Incentives Program, NRCS

"The Environmental Quality Incentives Program (EQIP) was reauthorized in the Farm Security and Rural Investment Act of 2002 (Farm Bill) to provide a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land."

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The California Department of Fish and Game coordinates this grant program, which works towards the conservation and restoration of anadromous fisheries and watershed health.

Flood Control Subventions Program, DWR

The Department of Water Resources implements the national flood control program for the North Coast of California. The national flood control program requires "nonfederal interests to pay the costs of rights of way and relocations for channel improvements and levee projects." Several state laws

enacted subsequent to the federal program provide for varying cost-share percentages between state and local agencies.

Flood Protection Corridor Program, DWR

This DWR program funds acquisition of property rights from willing sellers and other activities that contribute to flood protection corridor projects.

Integrated Regional Water Management Grant Program, SWRCB

"The Integrated Regional Water Management (IRWM) Implementation Grants Program, funded by Proposition 50, Chapter 8, will provide approximately $64 million during Round 2. IRWM Implementation Grants will fund projects that meet one or more of the program objectives of protecting communities from drought, protecting and improving water quality, and improving local water security by reducing dependence on imported water. Implementation Grant proposals must be based on a qualified IRWM Plan."

National Fish Passage Program, USFS

The US Fish and Wildlife's "National Fish Passage Program uses a voluntary, non-regulatory approach to remove and bypass barriers. The Program addresses the problem of fish barriers on a national level, working with local communities and partner agencies to restore natural flows and fish migration."

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The mission of this program is "to efficiently achieve voluntary habitat restoration on private lands, through financial and technical assistance, for the benefit of Federal Trust Species. Migratory birds, inter-jurisdictional fish, federally-listed endangered, threatened or other declining or imperiled species are public resources, which by their migratory nature or declining numbers on a national scale, have been identified as Federal Trust Species."

Recovery Strategy for California Coho Salmon, CDFG

"The California Department of Fish and Game, with the assistance of recovery teams representing diverse interests and perspectives, created the Recovery Strategy for California Coho Salmon, a guide for the process of recovering coho salmon on the north and central coasts of California. The Recovery Strategy emphasizes cooperation and collaboration at many levels, and recognizes the need for funding, public and private support for restorative actions, and maintaining a balance between regulatory and voluntary efforts."

Resource Assessment Program, CDFG

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that will lead to improvements downstream in the main stem of the Russian River Watershed is one of the main goals of this program."

Wildlife and Sport Fish Restoration Programs Division of Federal Assistance, USFWS

"The mission of the Federal Assistance Program is to strengthen the ability of State and Territorial fish and wildlife agencies to meet the consumptive and non-consumptive needs of the public for fish and wildlife resources. The Division of Federal Assistance is responsible for administering grant programs to help States meet these needs."

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The US FWS works with landowners to provide incentives to manage land for endangered species. In some instances land use activities qualify for exemptions to ESA prohibitions.

Lake and Streambed Alteration Program, CDFG

"Fish and Game Code section 1602 requires any person, state or local governmental agency, or public utility to notify the Department before beginning any activity that will do one or more of the following: 1) substantially obstruct or divert the natural flow of a river, stream, or lake; 2) substantially change or use any material from the bed, channel, or bank of a river, stream, or lake; or 3) deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it can pass into a river, stream, or lake. Fish and Game Code section 1602 applies to all perennial, intermittent, and ephemeral rivers, streams, and lakes in the state."

Mendocino County General Plan. Land Use Element of the Mendocino County General Plan, Natural Resources.

Section 5 — Fisheries, sets policies to enhance salmonid populations.

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"The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet this requirement, federal agencies prepare a detailed statement known as an Environmental Impact Statement (EIS)."

Sonoma County General Plan

6.0 — Fishery Resources, provides for protection and conservation of freshwater and marine fishery and harbor resources.

Stream and Wetland System Protection Policy, NCRWQCB

This policy is a proposed amendment to the Water Quality Control Plans for the North Coast and San Francisco Bay Regions that will "protect stream and wetlands systems, including measures to protect riparian areas and floodplains."

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NATURAL ENVIRONMENT & OPEN SPACE

FISH PASSAGE ENHANCEMENT

1. Baseline Description

General Setting:

Hydrologic modification and road construction in the Russian River watershed have drastically decreased the quantity of habitat available to anadromous salmonids by blocking fish passage. Coyote Dam alone is estimated to block about 143 miles of suitable salmonid habitat. Dams and other barriers often block upstream passage in tributaries, which are more productive salmonid spawning and rearing grounds than the mainstem reach.

Causal Factors:

Dams, diversions, culverts, weirs, large debris accumulations, and other instream structures often present barriers to upstream passage. Although many successful projects have been implemented to provide passage around or through these barriers, much historic salmonid habitat remains inaccessible.

2. Management Measure Description

The Fish Passage Enhancement MM promotes the remediation of barriers to fish passage. The goal of this MM is the restoration of salmonid access to suitable salmonid habitat in support of salmonid restoration efforts.

3. Resource Concerns

Habitat Fragmentation

Inadequate Wildlife Movement/Travel Corridors

Inadequate Wildlife Territory

Threatened and Endangered Fish and Wildlife Species

4. Management Practices

Recommended practices for fish passage enhancement projects should include the following principles:

- Project planning is critical to success.
- Projects should be evaluated to determine impacts and benefits prior to implementation
- Fish passage should be evaluated within a watershed management context
- Post-project monitoring should be conducted to evaluate project success and provide information for adaptive management

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
CDFG	Stream bank stabilization	1000 FT^2
CDFG	Checkdams (redwood board, brush)	FT
CDFG	Emergent Transplant Installation	
CDFG	Dormant Willow or Cottonwood Sprig Installation	
CDFG	Container Plant Installation with Protective Shelters	
CDFG	Direct Seed Installation	
CDFG	Riparian Revegetation Project Maintenance	
CDFG	Obstructions	
CDFG	Fishways	
CDFG	Culverts	
CDFG	Fish Passage Assessment	
EPA	Grade control structures	
EPA	Setback Levees and Flood Walls	
EPA	Spill Prevention and Control Plan	

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
EPA	Pumping and Injection Practices	
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EPA	Gated Conduits	
EPA	Spillways and Spillway Modifications	
EPA	Reregulation and Labyrinth Weirs	
EPA	Selective withdrawal	
EPA	Turbine Operation	
NRCS	Critical Area Planting (342)	AC
NRCS	Dam, Diversion (348)	NO
NRCS	Dam (402)	NO
NRCS	Grade stabilization Struction (410)	NO
NRCS	Streambank and Shoreline Protection (580)	FT
NRCS	Channel Stabilization (584)	FT
NRCS	Shallow Water Management for Wildlife (646)	AC

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Hydrology and Geomorphology	
Connected Floodplain	**Floodplain connectivity:** <50 %, 50 to 80 %, >80 %, Not defined Physical barriers <50 of IP-km, 50 to 70 %, 70 to 90 %, >90 %
Sediment Supply and Movement	**Gravel quality (embeddedness):** <25 % of scores are Category 1 or 2, 25 to 50 %, >50 %, Not defined
Biotic Condition	
Physical Habitat: PHab (streams)	**Salmonid Habitat:** North Coast and Central Coast ESU Salmonids freshwater habitat quality indicator benchmarks
Species Distribution	**Salmonids:** From "Poor" to "Very Good" Summer juvenile rearing density: < 0.2 fish/m2 0.2 to 0.7 0.5 to 1.0 >1.0

Protocol & Data Sources

California Department of Fish and Game protocols http://www.dfg.ca.gov/wildlife/nongame/survey_monitor.html

California Department of Fish and Game, California Salmonid Stream Habitat Restoration Manual http://www.dfg.ca.gov/fish/resources/habitatmanual.asp

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Field Procedures, Photo Point Monitoring Handbook: Part A — Field Procedures, USDA FS Pacific Northwest Research Station, 2002. http://www.fs.fed.us/pnw/pubs/gtr526/

6. Relevant Programs

5 Star Restoration Program, USEPA

> "The Five Star Restoration Program brings together students, conservation corps, other youth groups, citizen groups, corporations, landowners and government agencies to provide environmental education and training through projects that restore wetlands and streams. The program provides challenge grants, technical support and opportunities for information exchange to enable community-based restoration projects."

The Coastal Watershed Planning and Assessment Program, CDFG

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8. Sources

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INSTREAM HABITAT PROTECTION, RESTORATION, AND MANAGEMENT

1. Baseline Description

General Setting:

Hydromodification, development, and anthropogenic activities have decreased the quality and extent of instream habitat in the Russian River watershed. Remaining habitat is threatened by upland and instream activities and non-native invasive plant species. Habitat benefits to wildlife, particularly salmonids, have been reduced due to barriers to access and reduction in food and shelter availability.

Causal Factors:

Instream habitat quantity in the Russian River watershed has been severely reduced through the construction and maintenance of instream structures such as dams and diversions. Instream habitat quality has been degraded through a variety of instream and upland land uses, including logging, grazing, gravel mining (instream and upland), and construction and maintenance of flood control structures. Additionally, unpermitted discharges from some water treatment plants and leaking septic tanks have resulted in two reaches of the Russian River and Santa Rosa Creek to be classified as impaired by pathogens on the 303(d) list of impaired waterways.

2. Management Measure Description

The Instream Habitat Protection, Restoration, and Management MM promotes the restoration and management of degraded or destroyed instream habitat to re-establish ecological health, biodiversity, and habitat connectivity necessary to provide suitable habitat for salmonids and other wildlife. The goal of this MM is the restoration of instream structure and function including 1) hydro-geomorphically appropriate instream flow and sediment transport, 2) suitable dissolved oxygen concentrations, 3) passage for fish and other aquatic organisms into tributaries, and 5) provision of shelter such as pools and large debris accumulations.

3. Resource Concerns

Habitat Fragmentation

Inadequate Cover/Shade

Inadequate Food Sources for Wildlife

Inadequate Large Woody Debris

Inadequate Shelter

Inadequate Species Composition

Inadequate Water Quality

Inadequate Water Quantity

Inadequate Wildlife Movement/Travel Corridors

Inadequate Wildlife Territory

Invasive Non-native Plants

Threatened and Endangered Fish and Wildlife Species

Water Quality — Excessive Nutrients, Pathogens, or Organics

Water Quality — Excessive Sediment

Water Quality — Harmful Temperatures of Surface Water

4. Management Practices

Recommended practices for stream habitat restoration and protection should include the following principles:

- Project planning is critical to success
- Projects should be evaluated to determine impacts and benefits prior to implementation
- Stream habitat should be evaluated within a watershed management context and on a landscape scale, with emphasis on providing high quality habitat for critical species
- Post-project monitoring should be conducted to evaluate project success and provide information for adaptive management

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
CDFG	Emergent Transplant Installation	AC
CDFG	Dormant Willow or Cottonwood Sprig Installation	AC
CDFG	Container Plant Installation with Protective Shelters	AC
CDFG	Direct Seed Installation	AC
CDFG	Riparian Revegetation Project Maintenance	AC
CDFG	Slide Stabilization	FT
CDFG	Stream Bank Stabilization (boulder, log)	FT
CDFG	Native Material Revetment	FT
CDFG	Mulching	AC
CDFG	Willow Wall Revetment	FT
CDFG	Brush Mattress	FT
CDFG	Checkdams (redwood board, brush)	FT
CDFG	Waterbars	FT
CDFG	Cover Structures	
CDFG	Boulder Structures	
CDFG	Log Structures	
CDFG	Placement of Imported Spawning Gravel	
CDFG	Obstructions	
EPA	Wetland Evaluation	
EPA	Assessment of Functions and Values	
NRCS	Channel Vegetation (322)	AC
NRCS	Conservation Cover (327)	AC
NRCS	Critical Area Planting (342)	AC
NRCS	Fence (382)	FT
NRCS	Riparian Herbaceous Cover (390)	AC
NRCS	Riparian Forest Buffer (391A)	AC
NRCS	Stream Habitat Improvement & Management (395)	FT
NRCS	Fish Passage (396)	
NRCS	Grade Stabilization Structure (410)	NO
NRCS	Use Exclusion (472)	AC
NRCS	Mulching (484)	AC
NRCS	Obstruction Removal (500)	AC
NRCS	Streambank and Shoreline Protection (580)	FT

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
NRCS	Pest Management (595A)	AC
NRCS	Tree/Shrub Establishment (612)	AC
NRCS	Tree/Shrub Establishment (A), Bareroot/Containerized Stock (612A)	AC
NRCS	Tree/Shrub Establishment (B), Direct Seeding (612B)	AC
NRCS	Tree/Shrub Establishment (C), Pole plantings/cuttings (612C)	AC
NRCS	Restoration and Management of Declining Habitats (643)	AC
NRCS	Wildlife Wetland Habitat Management (644)	AC
NRCS	Shallow Water Management for Wildlife (646)	AC
NRCS	Constructed Wetland (656)	AC
NRCS	Wetland Restoration (657)	AC
NRCS	Wetland Creation (658)	AC
NRCS	Wetland Enhancement (659)	AC

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Hydrology and Geomorphology	
Floodplain connectivity	**Floodplain connectivity:** <50 %, 50 to 80 %, >80 %, Not defined Physical barriers <50 of IP-km, 50 to 70 %, 70 to 90 %, >90 %
Large Woody Debris	**Large woody debris (LWD) frequency (BFW 0 to 10m):** <4 key pieces/ 100m, 4 to 6/100m, 6 to 11/100m, >11/100m
LWD Freq. (BFW 10-100)	**LWD frequency (BFW 10 to 100m):** <1/100m, <1 to 1.3/100m, 1.3 to 4/100m, >4/100m
Embeddedness	**Gravel quality (embeddedness):** <25 % of scores are Category 1 or 2, 25 to 50 %, >50 %, Not defined
Substrate Composition	**Gravel quality (bulk):** >17 % (D50=0.85), 15 to 17 %, 12 to 14 %, <12 %
Biotic Condition	
Habitat Complexity	**DBH (North):** <39 % class 5 and 6, 40 to 54 %, 55 — 69 %, >69 % Species composition: < 25 %, 25 to 50 %, >50 %, Historical conditions
Instream Bioassessment - Aquatic Macroivertebrates	**BMIs:** Threshold between "Good" and "Fair," out of 1.00 for reference condition. California Macroinvertebrate Observed/ Expected Index (O/E Index) score of 0.77; Western EMAP Macroinvertebrate Index of Biotic Integrity (IBI) score of 0.57.
Salmonid Carcass Counts	
Redd Counts	
Density (adult, juvenile)	**Salmonids:** From "Poor" to "Very Good" Summer juvenile rearing density: < 0.2 fish/m2 0.2 to 0.7 0.5 to 1.0 >1.0
Species Composition	**Riparian Vegetation:** From "Poor to "Very Good" Canopy cover: <75 % average over IP-km, 75 to 85 %, 85 to 95 %, >95 %

Protocol & Data Sources

California Department of Fish and Game, California Salmonid Stream Habitat Restoration Manual http://www.dfg.ca.gov/fish/resources/habitatmanual.asp

California Department of Fish and Game protocols http://www.dfg.ca.gov/wildlife/nongame/survey_monitor.html

California Rapid Assessment Method (CRAM) method for riparian condition measures: Collins et al 2008 http://www.cramwetlands.org/documents/

California Watershed Assessment Manual II Chapter 4 (Shilling 2005a; periphyton) and 5 (Shilling 2005b; benthic macroinvertebrates) http://cwam.ucdavis.edu/Volume_2/TOC.htm

EPA rapid bioassessment protocol (Barbour et al. 1999) http://www.epa.gov/owow/monitoring/rbp/ch06main.html

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Observing Fish from the Bank Standard Operating Procedure, SWRCB, undated. http://www.swrcb.ca.gov/nps/cwtguidance.html

Snorkeling Surveys, SWRCB, undated. http://www.swrcb.ca.gov/nps/cwtguidance.html

Field Procedures, Photo Point Monitoring Handbook: Part A — Field Procedures, USDA FS Pacific Northwest Research Station, 2002. http://www.fs.fed.us/pnw/pubs/gtr526/

6. Relevant Programs

5 Star Restoration Program, USEPA

"The Five Star Restoration Program brings together students, conservation corps, other youth groups, citizen groups, corporations, landowners and government agencies to provide environmental education and training through projects that restore wetlands and streams. The program provides challenge grants, technical support and opportunities for information exchange to enable community-based restoration projects."

Arundo donax Removal Program, Sotoyome Resource Conservation District

The Sotoyome RCD is collaborating with Circuit Rider Productions, Inc. to implement a long-term effort to remove *Arundo donax* from the Russian River Watershed. *Arundo donax* removal is offered to landowners in the watershed free of charge.

The Coastal Watershed Planning and Assessment Program, CDFG

The Coastal Watershed Planning and Assessment Program (CWPAP) is a Department of Fish and Game (CDFG) program conducting fishery-based watershed assessments along the length of the California coast. Assessment basins are chosen as study areas based upon the nature of the socio-economic and natural resource problems within them. The CDFG Coho Recovery Plan and Steelhead Recovery Plan are useful in selecting basins as well. CWPAP has developed assessment methods, protocols and report outlines.

California Coastal Salmon and Watersheds Program, California Resources Agency

The goal of this program is to: recover harvestable salmon and steelhead populations, restore watersheds, and so contribute to building healthy communities."

California's Critical Coastal Areas Program

The purpose of California's Critical Coastal Areas (CCA) Program is "to foster collaboration among local stakeholders and government agencies and better coordinate resources and efforts in coastal-zone watershed areas critically in need of protection from polluted runoff." The North Coast is one of four regional pilot CCAs in which the CCA Program will form teams comprised of local stakeholders and state, federal, and local agencies to develop community-based action plans to reduce polluted runoff in coastal zone watershed areas.

Clean Water Team Citizen Monitoring Program, SWRCB

The SWRCB provides support to citizens and local organizations who would like to improve water quality through pollution prevention and citizen-based monitoring programs.

Coastal Program, USFS

"The Coastal Program provides incentives for voluntary protection of threatened, endangered and other species on private and public lands alike."

Conservation Planning Assistance, NRCS

"The Natural Resources Conservation Service (NRCS) provides conservation plan-

ning and technical assistance to clients (individuals, groups, and units of government). These clients develop and implement conservation plans to protect, conserve, and enhance natural resources (soil, water, air, plants, and animals) within their related social and economic interests."

Education Program, Sotoyome Resource Conservation District

"The Sotoyome Resource Conservation District (SRCD) Education Program delivers adult and K-12 education that promotes an understanding of the interplay between agriculture and natural resources, and sponsors projects that address stewardship of our natural resources."

Endangered Species Protection Program, USEPA

The Endangered Species Protection Program seeks to protect endangered species from the use of pesticides and to minimize the impact of the program on pesticide users.

Environmental Quality Incentives Program, NRCS

"The Environmental Quality Incentives Program (EQIP) was reauthorized in the Farm Security and Rural Investment Act of 2002 (Farm Bill) to provide a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land."

Fish Friendly Farming, California Land Stewardship Institute

"Fish Friendly Farming provides an incentive-based method for creating and sustaining environmental quality and habitat on private land. Landowners and managers enroll in the program, learn environmentally beneficial management practices and carry out ecological restoration projects."

Fish Passage Improvement Program, DWR

"The Fish Passage Improvement Program uses data collection to identify and evaluate the potential to modify or remove structures in waterways that impede migration and spawning of anadromous fish species within the Central Valley and Bay Area of California."

Fisheries Restoration Grant Program, CDFG

The California Department of Fish and Game coordinates this grant program, which works towards the conservation and restoration of anadromous fisheries and watershed health.

The Global Invasive Species Initiative, TNC

The Global Invasive Species Initiative is The Nature Conservancy's response to abating the damage caused to native biodiversity by the human-facilitated introduction of non-native, harmful invasive species. This web site provides many resources designed to help all conservationists deal most effectively with invasive species.

Integrated Regional Water Management Grant Program, SWRCB

"The Integrated Regional Water Management (IRWM) Implementation Grants Program, funded by Proposition 50, Chapter 8, will provide approximately $64 million during Round 2. IRWM Implementation Grants will fund projects that meet one or more of the program objectives of protecting communities from drought, protecting and improving water quality, and improving local water security by reducing dependence on imported water. Implementation Grant proposals must be based on a qualified IRWM Plan."

National Fish Passage Program, USFS

The US Fish and Wildlife's "National Fish Passage Program uses a voluntary, non-regulatory approach to remove and bypass barriers. The Program addresses the problem of fish barriers on a national level, working with local communities and partner agencies to restore natural flows and fish migration."

Partners for Fish and Wildlife Program, USFWS

The mission of this program is "to efficiently achieve voluntary habitat restoration on private lands, through financial and technical assistance, for the benefit of Federal Trust Species. Migratory birds, inter-jurisdictional fish, federally-listed endangered, threatened or other declining or imperiled species are public resources, which by their migratory nature or

declining numbers on a national scale, have been identified as Federal Trust Species."

Pest Management Program, California Department of Forestry and Fire Protection

"CDF's forest pest specialists help protect the state's forest resources from native and introduced pests, conduct surveys and provide technical assistance to private forest landowners, and promote forest health on all forest lands."

Recovery Strategy for California Coho Salmon, CDFG

"The California Department of Fish and Game, with the assistance of recovery teams representing diverse interests and perspectives, created the Recovery Strategy for California Coho Salmon, a guide for the process of recovering coho salmon on the north and central coasts of California. The Recovery Strategy emphasizes cooperation and collaboration at many levels, and recognizes the need for funding, public and private support for restorative actions, and maintaining a balance between regulatory and voluntary efforts."

Resource Assessment Program, CDFG

"The goal of this effort will be to develop and implement a long-term and strategic program to inventory, monitor, and assess the distribution and abundance of priority species, habitats, and natural communities in California."

Urban Streams Restoration Program, DWR

"The objectives of the Urban Streams Restoration Program are to assist communities in reducing damages from stream bank and watershed instability and floods while restoring the environmental and aesthetic values of streams, and to encourage stewardship and maintenance of streams by the community. With voter approval of Proposition 84, the Urban Streams Restoration Program will have available grant funding. Proposition 84 includes $18 million for the Urban Streams Restoration Program. DWR anticipates holding the first of two application cycles in mid 2007."

Volunteer Monitoring Program, USEPA

"The U.S. Environmental Protection Agency's (EPA) Office of Water encourages all citizens to learn about their water resources and supports volunteer monitoring because of its many benefits. Volunteer monitors build awareness of pollution problems, become trained in pollution prevention, help clean up problem sites, provide data for waters that may otherwise be unassessed, and increase the amount of water quality information available to decision makers at all levels of government."

Watershed Program, DWR

"The Department of Water Resources Watershed Program works with locally led stewardship efforts to integrate the needs of communities, urban and rural, with resource management that sustains watershed ecology."

Watershed Protection Programs, SWRCB

The State Water Resources Control Board administers several programs for watershed protection under Propositions approved by voters. These Propositions are: 13, 40, and 50.

Watershed Stewardship Program, Sotoyome Resource Conservation District

"The SRCD program focuses on education and collaboration within the community to restore resources, improve water quality and habitat, and monitor creeks and watersheds. Working together to find viable solutions for the restoration of the smaller tributary watersheds that will lead to improvements downstream in the main stem of the Russian River Watershed is one of the main goals of this program."

Wildlife and Sport Fish Restoration Programs Division of Federal Assistance, USFWS

"The mission of the Federal Assistance Program is to strengthen the ability of State and Territorial fish and wildlife agencies to meet the consumptive and non-consumptive needs of the public for fish and wildlife resources. The Division of Federal Assistance is responsible for administering grant programs to help States meet these needs."

Wildlife Habitat Incentives Program, NRCS

"The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land. Through WHIP USDA's Natural Resources Conservation

Service provides both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat. WHIP agreements between NRCS and the participant generally last from 5 to 10 years from the date the agreement is signed."

7. Relevant Policies

California Endangered Species Act (CESA), California Environmental Protection Agency

Compliance with the CESA may be required for environmental projects and management practices. The CDFG administers CESA and can authorize exceptions to the state's prohibition against take of a listed species.

California Environmental Quality Act (CEQA), California Resources Agency

CEQA is a statue requiring state and local agencies to identify significant environmental impacts of proposed activities and to avoid or mitigate those impacts if feasible.

City of Cloverdale Draft General Plan Update

Chapter 6 Conservation and Open Space Element, provides for protection of distinctive natural vegetation, including riparian, wetlands, and upland ecosystems. Contains policies specifically intended to protect and enhance the natural beauty, habitat and biotic productivity of the Russian River through the use of conservation buffers, stormwater runoff management, habitat improvement, and the use of natural wetland treatment for expansionof wastewater treatment facilities.

City of Cotati General Plan

Chapter 17.50 — Watercourse and Riparian Resource Protection, sets provisions for adequate buffer areas between watercourses and adjacent development.

City of Healdsburg General Plan

Chapter 7 — Natural Resources, establishes policies that improve water quality and flows in the Russian River and Dry and Foss Creeks, promote conservation and restoration of native ecosystems and waterways, preserve the city's natural setting, protect the viability of agriculture, reduce greenhouse gas emissions, and protect riparian resources.

City of Rohnert Park General Plan

Chapter 6 — Environmental Conservation, 6.2 Habitat and Biological Resources, sets policies for protection of special status species and special habitat areas, use of native plants for landscaping, and planting of low water use trees. Sets creek protection zones which prohibit development except greenway enhancement, requires evaluation and implementation of bank stabilization and erosion control measures.

City of Sebastopol General Plan

Chapter III: Conservation, Parks and Open Space, sets policies which preserve areas with important biotic resources, ensure the maintenance of wetlands adjacent to City boundaries as permanent open space, protect, maintain and restore wetlands areas, protect and preserve soil as a natural resource, conserve, protect and enhance trees and native vegetation, conserve energy, protect and improve air quality, provide for water conservation, reduce the volume of solid waste the City generates, provides an attractive and comprehensive system of parks and trials that meets all citizens' recreational needs, ensures that recreational facilities are developed in harmony with the surroundings, and incorporates the 1992 Laguna Park Master Plan. The Plan sets minimum buffers for urban land and farming operations adjacent to Laguna habitats, and sets policy to minimize the impacts of backyards adjacent to the Laguna, restore and enhance Laguna habitats, and recover declining species.

Coastal Zone Act Reauthorization Amendments, USEPA, NOAA

Amendments to the Coastal Zone Act to more specifically address effects of NPS pollution on coastal water quality. These amendments require each state with an approved Coastal Zone Management Program to develop a Coastal Nonpoint Pollution Control Program.

Coastal Zone Management Act, NOAA

Provides federal funding for wetlands programs in coastal states, including the preparation of Coastal Zone Management Plans.

Endangered Species Act (ESA), US Environmental Protection Agency

The US FWS works with landowners to provide incentives to manage land for endangered species. In some instances land use activities qualify for exemptions to ESA prohibitions.

Lake and Streambed Alteration Program, CDFG

"Fish and Game Code section 1602 requires any person, state or local governmental agency, or public utility to notify the Department before beginning any activity that will do one or more of the following: 1) substantially obstruct or divert the natural flow of a river, stream, or lake; 2) substantially change or use any material from the bed, channel, or bank of a river, stream, or lake; or 3) deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it can pass into a river, stream, or lake. Fish and Game Code section 1602 applies to all perennial, intermittent, and ephemeral rivers, streams, and lakes in the state."

Mendocino County General Plan. Land Use Element of the Mendocino County General Plan, Natural Resources.

Section 5 — Fisheries, sets policies to enhance salmonid populations.

Section 8 — Natural Areas sets policies to protect natural areas under public and private ownership.

Section 12 — Vegetation and Wildlife sets policies to retain and restore native vegetation, including riparian vegetation, wetlands, and rare and unique vegetation and to promote wildlife habitat protection and improvement and endangered species protection on private lands.

National Environmental Protection Act, US EPA

"The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet this requirement, federal agencies prepare a detailed statement known as an Environmental Impact Statement (EIS)."

Santa Rosa Citywide Creek Master Plan

The Plan contains "recommended habitat preservation, enhancement, and restoration projects, and improvements to the creekside trail system are presented conceptually and specifically by watershed. Project recommendations are based on community input, literature reviews, and extensive field survey work. Site-specific recommendations are presented in the text and on a set of Geographical Information System-based maps, organized by watershed area."

Santa Rosa General Plan

Chapter 7: 7-3 Biological Resources and Waterways, sets policies which maximize the benefits of open space, conserve the City's open spaces, conserve agricultural soils, conserve wetlands, vernal pools, wildlife ecosystems, rare plant habitats, and waterways, and conserve significant vegetation and trees, conserve water and maintain water quality, and take actions to achieve and maintain ambient air quality standards.

Sonoma County General Plan

3.1 — Policy for Critical Habitat Areas, provides protection for critical areas including wetlands, marshes, and remnant upland habitat.

3.2 -Policy for Riparian Corridors, establishes streamside conservation areas or riparian corridor setbacks from land use activities.

5.0 — Policy for Vegetation and Wildlife Resources, provides for conservation of biotic resources, and protection of rare and endangered species.

6.0 — Fishery Resources, provides for protection and conservation of freshwater and marine fishery and harbor resources.

Stream and Wetland System Protection Policy, NCRWQCB

This policy is a proposed amendment to the Water Quality Control Plans for the North Coast and San Francisco Bay Regions that will "protect stream and wetlands systems, including measures to protect riparian areas and floodplains."

8. Sources

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UPLAND HABITAT RESTORATION AND MANAGEMENT

1. Baseline Description

General setting:

The quality and extent of upland habitat in the Russian River watershed has drastically decreased, negatively impacting endangered plant and animal species, wildlife populations, and natural vegetation communities. Remaining upland habitat is impacted by encroachment of invasive non-native plant and animal species. Habitat benefits to wildlife have been reduced due to fragmentation and changes in food and shelter availability.

Causal Factors:

Upland habitat in the Russian River watershed has been severely reduced and degraded by a variety of land uses, including forestry, grazing, agricultural development, gravel mining, and urbanization. Extensive human mobility has increased the spread of invasive plants and animals, including pathogens such as Sudden Oak Death.

2. Management Measure Description

The Upland Habitat Restoration and Management MM promotes the restoration and management of degraded or destroyed upland habitat to re-establish ecological health, biodiversity and habitat connectivity necessary to comply with the habitat requirements of associated wildlife and improve the ecological function of the entire watershed. The goal of this MM is the restoration and management of upland habitat function including 1) carbon sequestration, 2) soil stabilization, 3) minimization of sediment delivery to surface waters, and 4) protection and enhancement of threatened and endangered species, native plant species, and native wildlife.

3. Resource Concerns

Habitat Fragmentation

Inadequate Food Sources for Wildlife

Inadequate Shelter

Inadequate Species Composition

Inadequate Wildlife Movement/Travel Corridors

Inadequate Wildlife Territory

Invasive Non-native Plants

4. Management Practices and Cost Information

Recommended practices for promoting the restoration and management of upland habitat areas should include the following principles:

- Project planning and adaptive management are critical to success.
- Project planning should be evaluated within a watershed context.
- Where practical, unused roads and landings should be decommissioned or removed and disturbed sites should be recontoured to approximate natural conditions.
- Restoration and revegetation should attempt to replicate the natural system — local unimpacted sites should be used as reference sites when possible/practical.
- To prevent erosion on steep slopes and highly erodible sites, seedlings should be planted by hand rather than by machine.
- Seeds, transplants, and plant materials for propagation should be collected as close as possible to the project site (within project site watershed). Collection should be conducted to maximize genetic diversity of propagation material (from multiple plants in diverse locations and in the case of seeds, at different time intervals) and in a manner that minimizes impacts to the collection site.
- Post-project monitoring is critical for project evaluation and to provide information for adaptive management

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
CDFG	Road decommissioning: Road Ripping or Decompaction	MI
CDFG	Road decommissioning: Construction of cross-road drains	FT
CDFG	Road decommissioning: Partial outsloping (local spoil site; fill against the cutbank)	MI
CDFG	Road decommissioning: Complete outsloping (local spoil site; fill against the cutbank)	MI
CDFG	Road decommissioning: Exported outsloping (fill pushed or hauled away and stored down-road)	YD^3
CDFG	Road decommissioning: Landing and fillslope excavations (with local spoil storage)	YD^3
CDFG	Road decommissioning: Stream crossing excavations (with local spoil storage)	YD^3
CDFG	Road upgrading: Outslope road and fill ditch	FT
CDFG	Road upgrading: Rolling dip	NO
CDFG	Road upgrading: Remove berm or clean ditch	10 FT
CDFG	Road upgrading: Rock road	FT
CDFG	Road upgrading: Install ditch relief culvert (assumes 40' of 18" culvert)	NO
CDFG	Straw mulch bare soils areas	$1000\ FT^2$
CDFG	Complete road upgrading	MI
CDFG	Road upgrading (watershed-wide average, 100-year design)	MI
CDFG	Road upgrading (high priority road, moderate to high difficulty)	MI
CDFG	Road decommissioning (range of roads from ridge spurs to moderate complexity mid-slope roads)	MI
CDFG	Road decommissioning (moderately difficult roads)	MI
CDFG	Road decommissioning (difficult roads and/or full Recontouring)	MI
SRCD	Grazing for Fire Hazard Management	AC
SRCD	Grazing for Weed Management	AC
NRCS	Brush Management (314)	AC
NRCS	Prescribed Burning (338)	AC
NRCS	Critical Area Planting (342)	AC
NRCS	Critical Area Planting, Woody Cuttings (342G)	AC
NRCS	Critical Area Planting, Container Plants (342H)	AC
NRCS	Fence (382)	AC
NRCS	Firebreak (394)	FT
NRCS	Land Reclamation, Landslide Treatment (453)	AC
NRCS	Precision Land Forming (462)	AC
NRCS	Use Exclusion (472)	AC
NRCS	Prescribed Grazing (528)	AC
NRCS	Land Reconstruction, Abandoned Mined Land (543)	AC
NRCS	Land Reconstruction, Currently Mined Land (544)	AC
NRCS	Grazing Land Mechanical Treatment (548)	AC
NRCS	Range Planting (native species) (550)	AC
NRCS	Animal Trails and Walkways (575)	FT
NRCS	Pest Management (595)	AC
NRCS	Tree/Shrub Establishment (612)	AC
NRCS	Tree/Shrub Establishment, Bareroot/Containerized Stock (612A)	AC
NRCS	Tree/Shrub Establishment, Direct Seeding (612B)	AC
NRCS	Tree/Shrub Establishment, Pole Plantings/Cuttings (612C)	AC
NRCS	Restoration and Management of Declining Habitats (643)	AC
NRCS	Upland Wildlife Habitat Management (645)	AC
NRCS	Early Successional Habitat Development/Management (647)	AC
NRCS	Wildlife Watering Facility (648)	NO
NRCS	Forest Trails and Landings (655)	AC
NRCS	Forest Stand Improvement (666)	AC
NRCS	Forest Stand Improvement, Coastal Douglas Fir/Redwood (666A)	AC
NRCS	Forest Stand Improvement, Competing Vegetation Control (666D)	AC
NRCS	Road/Landing Removal (722)	AC

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Biotic Condition	
Vegetation seral stage distribution	**DBH (North):** <39 % class 5 and 6, 40 to 54 %, 55 — 69 %, >69 % Species composition: < 25 %, 25 to 50 %, >50 %, Historical conditions
Change in forest canopy	**Vegetation:** From "Poor to "Very Good" Canopy cover: <75 % average over IP-km, 75 to 85 %, 85 to 95 %, >95 %

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Species composition, % cover native plants & non-native plants	**Vegetation:** From "Poor to "Very Good" Canopy cover: <75 % average over IP-km, 75 to 85 %, 85 to 95 %, >95 %
Plant survival and health	
Wildlife biodiversity	
Population density, distribution, structure T&E wildlife	
Landscape Condition	
Floodplain connectivity	**Floodplain connectivity**: <50 %, 50 to 80 %, >80 %, Not defined
Land use	**Land Use:** Unnatural Index (Agricultural + Urban) "Most Disturbed" is Greater than 40 %, "Least Disturbed" is less than 10 %; Percent Urban Greater than 25 %, Less than 5 %; Percent Agricultural Greater than 50 %, Less than 10 %
Road density	**Road Density**: From "Poor" to "Very Good" Road density: > 3 miles/ square mile, 3 to 2.5, 2.5 to 1.6, <1.6; Road density within 100 m. stream: >1 mile/ square miles, 1 to 0.5, 0.5 to 0.1, <0.1
Habitat connectivity	**Habitat connectivity**: <50 %, 50 to 80 %, >80 %, Not defined

Protocol & Data Sources

California Department of Fish and Game protocols http://www.dfg.ca.gov/wildlife/nongame/survey_monitor.html

California Rapid Assessment Method (CRAM) method for riparian condition measures: Collins et al 2008 http://www.cramwetlands.org/documents/

California Watershed Assessment Manual II Chapter 4 (Shilling 2005a; periphyton) and 5 (Shilling 2005b; benthic macroinvertebrates) http://cwam.ucdavis.edu/Volume_2/TOC.htm

EPA rapid bioassessment protocol (Barbour et al. 1999) http://www.epa.gov/owow/monitoring/rbp/ch06main.html

Riparian Bird Conservation Plan (California Partners in Flight and Riparian Habitat Joint Venture) methods for monitoring riparian bird populations http://www.prbo.org/calpif/htmldocs/riparian.html

SWAMP protocols ("Standard Operating Procedures") http://swamp.mpsl.mlml.calstate.edu/

and selected reports under "Bioassessment" at http://www.swrcb.ca.gov/water_issues/programs/swamp/reports.shtml#bioassessment

USGS National Water Quality Assessment Program (NAWQA) http://water.usgs.gov/nawqa/protocols/OFR02-150/index.html

California Department of Fish and Game (Regions 1 and 3 for the North Coast) http://www.dfg.ca.gov/about/data.html for Biogeographic Information and Observation System (BIOS; http://bios.dfg.ca.gov/), California Native Diversity Database (CNDDB; http://www.dfg.ca.gov/biogeodata/cnddb/),Coho stream habitat assessments, and other data sets; the

CDFG Watershed Assessment Program does fisheries-based assessments of coastal streams http://coastalwatersheds.ca.gov/

CalEpa and others: Environmental Protection Indicators for California (EPIC) project is responsible for developing and maintaining a set of "environmental indicators" for California. http://oehha.ca.gov/multimedia/epic/aboutepic.html

CalFlora (for specific plant species) http://www.calflora.org/

California Native Plant Society (for specific plant species) http://www.cnps.org/

EPAs Western Environmental Monitoring and Assessment Program (WEMAP) http://www.epa.gov/region09/water/wemap/surface.html

NOAA's National Marine Fisheries Service Central California Coast Coho Salmon Recovery Plan (in press)

NOAA's National Marine Fisheries Service Southern Oregon Northern California Coho Salmon Recovery Plan (in prep)

Riparian Habitat Joint Venture: data on riparian habitat restoration in California, especially for birds http://www.rhjv.org/

Riparian Bird Conservation Plan (California Partners in Flight and Riparian Habitat Joint Venture) monitoring data for some focal species http://www.prbo.org/calpif/htmldocs/riparian.html

Upland Erosion Control Protocols, Interim Restoration Effectiveness and Validation Monitoring Protocols, CDFG, 2003.

Habitat Unit Monitoring Procedures, Interim Restoration Effectiveness and Validation Monitoring Protocols, CDFG, 2003.

Quantitative Protocols for Effectiveness Monitoring of Roads and Upland Restoration Following Stressing Events, Interim Restoration Effectiveness and Validation Monitoring Protocols, CDFG, 2003.

Photographic Monitoring, Interim Restoration Effectiveness and Validation Monitoring Protocols, CDFG, 2003

Field Methods, Monitoring the Effectiveness of Upland Restoration, CDFG, 2005

Conducting Effectiveness Monitoring, Grazing Handbook, Sotoyome RCD, undated.

Best Management Practices (BMP) Monitoring Manual — Field Guide: Implementation and Effectiveness for Protection of Water Resources, USDA Forest Service, 2007. http://www.na.fs.fed.us/pubs/misc/bmp/06/bmp_field_guide_lr.pdf

Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Control Measures — Forestry, US Environmental Protection Agency. 1997. http://www.epa.gov/owow/nps/forestry/index.html

Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Control Measures — Agriculture, US Environmental Protection Agency. 1997. http://www.epa.gov/owow/nps/agfinal.html

Late-Successional and Old-Growth Forest Effectiveness Monitoring Plan for the Northwest Forest Plan, USDA Forest Service, 1998.

Resource Monitoring and Habitat Monitoring, US Department of the Interior and The Nature Conservancy, 1998.

Sediment Delivery Inventory and Monitoring: A Method for Water Quality Management in Rangeland Watersheds, University of California Division of Agriculture and Natural Resources, http://anrcatalog.ucdavis.edu/pdf/8014.pdf

Field Techniques for Measuring Vegetation, Measuring and Monitoring Plant Populations, USDA BLM, 1998.

Chapter 5, Vegetation Monitoring Protocols, Fire Monitoring Handbook, USDI NPS, 2003, http://www.nps.gov/fire/fire/fir_eco_mon_fmh.cfm

Section 12, Crowns: Measurements and Sampling, 2004 Field Guide Version 2.0, USDA FS, 2002. http://www.fs.fed.us/ne/fia/datacollection/manualver2_0/index.html

Section 13, Vegetation Diversity and Structure, 2004 Field Guide Version 2.0, USDA FS, 2002. http://www.fs.fed.us/ne/fia/datacollection/manualver2_0/index.html

Field Methods, Monitoring Bird Populations in Small Geographic Areas, Canadian Wildlife Service, 2006, http://www.cws-scf.ec.gc.ca/publications/spec/PDF/mon_e.pdf

Field Procedures, Photo Point Monitoring Handbook: Part A — Field Procedures, USDA FS Pacific Northwest Research Station, 2002. http://www.fs.fed.us/pnw/pubs/gtr526/

6. Relevant Programs

5 Star Restoration Program, USEPA

> "The Five Star Restoration Program brings together students, conservation corps, other youth groups, citizen groups, corporations, landowners and government agencies to provide environmental education and training through projects that restore wetlands and streams. The program provides challenge grants, technical support and opportunities for information exchange to enable community-based restoration projects."

Agricultural Water Quality Grant Program, SWRCB

> "The Agricultural Water Quality Grant Program provides funding for projects that reduce or eliminate non-point source pollution discharge to surface waters from agricultural lands. Funding from Propositions 40 and 50 were administered through two solicitations, most recently the 2005-2006 Consolidated Grants Process. Additional funds will be made available in the future through Proposition 84."

Arundo donax Removal Program, Sotoyome Resource Conservation District

> The Sotoyome RCD is collaborating with Circuit Rider Productions, Inc. to implement a long-term effort to remove *Arundo donax* from the Russian River Watershed. *Arundo donax* removal is offered to landowners in the watershed free of charge.

California Forest Stewardship Program, California Department of Forestry and Fire Protection

> "The California Forest Stewardship Program is designed to encourage good stewardship of private forestland. The program provides technical and financial assistance to influence positive changes to forestland management, assists communities in solving common watershed problems, and helps landowners."

The Coastal Watershed Planning and Assessment Program, CDFG

> The Coastal Watershed Planning and Assessment Program (CWPAP) is a Department of Fish and Game (CDFG) program conducting fishery-based watershed assessments along the length of the California coast. Assessment basins are chosen as study areas

based upon the nature of the socio-economic and natural resource problems within them. The CDFG Coho Recovery Plan and Steelhead Recovery Plan are useful in selecting basins as well. CWPAP has developed assessment methods, protocols and report outlines.

California Coastal Salmon and Watersheds Program, California Resources Agency

The goal of this program is to: recover harvestable salmon and steelhead populations, restore watersheds, and so contribute to building healthy communities."

California's Critical Coastal Areas Program

The purpose of California's Critical Coastal Areas (CCA) Program is "to foster collaboration among local stakeholders and government agencies and better coordinate resources and efforts in coastal-zone watershed areas critically in need of protection from polluted runoff (CCC undated)." The North Coast is one of four regional pilot CCAs in which the CCA Program will form teams comprised of local stakeholders and state, federal, and local agencies to develop community-based action plans to reduce polluted runoff in coastal zone watershed areas.

Coastal Program, USFS

"The Coastal Program provides incentives for voluntary protection of threatened, endangered and other species on private and public lands alike."

Conservation Planning Assistance, NRCS

"The Natural Resources Conservation Service (NRCS) provides conservation planning and technical assistance to clients (individuals, groups, and units of government). These clients develop and implement conservation plans to protect, conserve, and enhance natural resources (soil, water, air, plants, and animals) within their related social and economic interests."

Education and Public Outreach Programs, SWRCB

The State Water Resources Control Board provides a web site with information regarding water quality education outreach to various interest groups, including business and industry, municipalities, schools, and tribes.

Education Program, Sotoyome Resource Conservation District

"The Sotoyome Resource Conservation District (SRCD) Education Program delivers adult and K-12 education that promotes an understanding of the interplay between agriculture and natural resources, and sponsors projects that address stewardship of our natural resources."

Endangered Species Protection Program, USEPA

The Endangered Species Protection Program seeks to protect endangered species from the use of pesticides and to minimize the impact of the program on pesticide users.

Environmental Enhancement and Mitigation Program, The California Resources Agency

"The Environmental Enhancement and Mitigation Program was established by the Legislature in 1989. It offers a total of $10 million each year for grants to local, state, and federal governmental agencies and to nonprofit organizations for projects to mitigate the environmental impacts caused by new or modified state transportation facilities." Grants are awarded in three categories: 1) Highway landscape and urban forestry; 2) Resource lands, and 3) Roadside recreational.

Environmental Quality Incentives Program, NRCS

"The Environmental Quality Incentives Program (EQIP) was reauthorized in the Farm Security and Rural Investment Act of 2002 (Farm Bill) to provide a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land."

Fish Friendly Farming, California Land Stewardship Institute

"Fish Friendly Farming provides an incentive-based method for creating and sustaining environmental quality and habitat on private land. Landowners and managers enroll in the program, learn environmentally beneficial management practices and carry out ecological restoration projects."

Forestry Improvement Program (FIP), California Department of Forestry and Fire Protection, the Natural Resources Conservation Service, and the USDA Forest Service

This program provides technical and financial assistance for timber stand improvement and site preparation in an effort to enhance productivity of private nonindustrial forestland.

Forest Legacy Program, California Department of Forestry and Fire Protection

"The purpose of the Forest Legacy Program (FLP) is to protect environmentally important forestland threatened with conversion to non-forest uses, such as subdivision for residential or commercial development. To help maintain the integrity and traditional uses of private forestlands, the FLP promotes the use of permanent conservation easements."

The Global Invasive Species Initiative, TNC

The Global Invasive Species Initiative is The Nature Conservancy's response to abating the damage caused to native biodiversity by the human-facilitated introduction of non-native, harmful invasive species. This web site provides many resources designed to help all conservationists deal most effectively with invasive species.

Integrated Hardwood Range Management Program, University of California

The Integrated Hardwood Range Management Program "was established in 1986 to ensure the sustainability of the State's 10 million acres of hardwood rangelands."

Integrated Regional Water Management Grant Program, SWRCB

"The Integrated Regional Water Management (IRWM) Implementation Grants Program, funded by Proposition 50, Chapter 8, will provide approximately $64 million during Round 2. IRWM Implementation Grants will fund projects that meet one or more of the program objectives of protecting communities from drought, protecting and improving water quality, and improving local water security by reducing dependence on imported water. Implementation Grant proposals must be based on a qualified IRWM Plan."

Nonpoint Source Management Program — Clean Water Act Section 319, US Environmental Protection Agency

This Program was established through an amendment to the Clean Water Act in 1987 to provide grant money to support activities including technical and financial assistance, education and training, technology transfer, demonstration projects, and project success monitoring.

Nonpoint Source Pollution Control Programs, SWRCB

The State Water Resources Control Board administers several grant programs which assist local entities with nonpoint source pollution control. The grants are made available through voter approval of the following Propositions: 13, 40, 50, and 84.

Partners for Fish and Wildlife Program, USFWS

The mission of this program is "to efficiently achieve voluntary habitat restoration on private lands, through financial and technical assistance, for the benefit of Federal Trust Species. Migratory birds, inter-jurisdictional fish, federally-listed endangered, threatened or other declining or imperiled species are public resources, which by their migratory nature or declining numbers on a national scale, have been identified as Federal Trust Species."

Pest Management Program, California Department of Forestry and Fire Protection

"CDF's forest pest specialists help protect the state's forest resources from native and introduced pests, conduct surveys and provide technical assistance to private forest landowners, and promote forest health on all forest lands."

Pesticide Environmental Stewardship Program, USEPA

This is "a voluntary program that forms partnerships with pesticide users to reduce health and environmental risk and implement pollution prevention strategies."

Pollinator Conservation Program, The Xerces Society

"The Xerces Society's pollinator program works with farmers, land managers, golf course staff, public agencies, and gardeners to promote the conservation and recovery of native pollinator insects and their habitat."

Recovery Strategy for California Coho Salmon, CDFG

"The California Department of Fish and Game, with the assistance of recovery teams representing diverse interests and perspectives, created the Recovery Strategy for California Coho Salmon, a guide for the process of recovering coho salmon on the north and central coasts of California. The Recovery Strategy emphasizes cooperation and collaboration at many levels, and recognizes the need for funding, public and private support for restorative actions, and maintaining a balance between regulatory and voluntary efforts."

Resource Assessment Program, CDFG

"The goal of this effort will be to develop and implement a long-term and strategic program to inventory, monitor, and assess the distribution and abundance of priority species, habitats, and natural communities in California."

Resource Management Program, California Department of Forestry and Fire Protection

The goal of this program is to maintain the sustainability of California's natural resources through administration of State and federal forestry assistance programs for landowners, operation of eight demonstration State Forests, enforcement of the California Forest Practice Act, provision of research and educational outreach, and coordination of fuel reduction to reduce fire danger and improve native ecosystems.

Surface Transportation Program, US Department of Transportation

This program is a block grant program that may be used by states and local governments for any roads that are not functionally classified as local or rural minor collectors. Ten percent of allocated STP funds must be set aside by each state for transportation enhancements, including mitigation of water pollution due to highway runoff.

Urban Forestry Program, California Department of Forestry and Fire Protection

"The Urban Forestry Program offers grants of over $1 million dollars a year to plant trees and over $2.5 million for related projects in urban communities throughout California. Four Urban Forestry Field Specialists provide expert urban forestry support to communities, non-profit groups and other municipal governments to create and maintain sustainable urban forest."

Vegetation Management Program, California Department of Forestry and Fire Protection

The Vegetation Management Program "allows private landowners to enter into a contract with CDF to use prescribed fire to accomplish a combination of fire protection and resource management goals."

Volunteer Monitoring Program, USEPA

"The U.S. Environmental Protection Agency's (EPA) Office of Water encourages all citizens to learn about their water resources and supports volunteer monitoring because of its many benefits. Volunteer monitors build awareness of pollution problems, become trained in pollution prevention, help clean up problem sites, provide data for waters that may otherwise be unassessed, and increase the amount of water quality information available to decision makers at all levels of government."

Watershed Program, DWR

"The Department of Water Resources Watershed Program works with locally led stewardship efforts to integrate the needs of communities, urban and rural, with resource management that sustains watershed ecology."

Watershed Protection Programs, SWRCB

The State Water Resources Control Board administers several programs for watershed protection under Propositions approved by voters. These Propositions are: 13, 40, and 50.

Watershed Stewardship Program, Sotoyome Resource Conservation District

"The SRCD program focuses on education and collaboration within the community to restore resources, improve water quality and habitat, and monitor creeks and watersheds. Working together to find viable solutions for the restoration of the smaller tributary watersheds that will lead to improvements downstream in the main stem of the Russian River Watershed is one of the main goals of this program."

Wildlife Habitat Incentives Program, NRCS

"The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land. Through WHIP USDA's Natural Resources Conservation Service provides both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat. WHIP agreements between NRCS and the participant generally last from 5 to 10 years from the date the agreement is signed."

7. Relevant Policies

California Endangered Species Act (CESA), California Environmental Protection Agency

Compliance with the CESA may be required for environmental projects and management practices. The CDFG administers CESA and can authorize exceptions to the state's prohibition against take of a listed s pecies.

California Environmental Quality Act (CEQA), California Resources Agency

CEQA is a statue requiring state and local agencies to identify significant environmental impacts of proposed activities and to avoid or mitigate those impacts if feasible.

California Forest Practice Rules, California Department of Forestry and Fire Protection Resource Management, Forest Practice Program

"The California Department of Forestry and Fire Protection (CDF) enforces the laws that regulate logging on privately-owned lands in California. These laws are found in the Forest Practice Act which was enacted in 1973 to ensure that logging is done in a manner that will preserve and protect our fish, wildlife, forests and streams."

City of Cloverdale Draft General Plan Update

Chapter 6 Conservation and Open Space Element, provides for protection of distinctive natural vegetation, including riparian, wetlands, and upland ecosystems. Contains policies specifically intended to protect and enhance the natural beauty, habitat and biotic productivity of the Russian River through the use of conservation buffers, stormwater runoff management, habitat improvement, and the use of natural wetland treatment for expansion of wastewater treatment facilities.

City of Cotati General Plan

Chapter 17.53 — Hillside and Ridgeline Development, sets limits to development to protect natural vegetation and prevent erosion, slope failure, and other environmental degradation.

City of Healdsburg General Plan

Chapter 6 — Public Services, sets policies that govern recreational development.

Chapter 7 — Natural Resources, establishes policies that improve water quality and flows in the Russian River and Dry and Foss Creeks, promote conservation and restoration of native ecosystems and waterways, preserve the city's natural setting, protect the viability of agriculture, reduce greenhouse gas emissions, and protect riparian resources.

City of Rohnert Park General Plan

Chapter 6 — Environmental Conservation, 6.2 Habitat and Biological Resources, sets policies for protection of special status species and special habitat areas, use of native plants for landscaping, and planting of low water use trees. Sets creek protection zones which prohibit development except greenway enhancement, requires evaluation and implementation of bank stabilization and erosion control measures.

City of Sebastopol General Plan

Chapter III: Conservation, Parks and Open Space, sets policies which preserve areas with important biotic resources, ensure the maintenance of wetlands adjacent to City boundaries as permanent open space, protect, maintain and restore wetlands areas, protect and preserve soil as a natural resource, conserve, protect and enhance trees and native vegetation, conserve energy, protect and improve air quality, provide for water conservation, reduce the volume of solid waste the City generates, provides an attractive and comprehensive system of parks and trials that meets all citizens' recreational needs, ensures that recreational facilities are developed in harmony with the surround-

ings, and incorporates the 1992 Laguna Park Master Plan. The Plan sets minimum buffers for urban land and farming operations adjacent to Laguna habitats, and sets policy to minimize the impacts of backyards adjacent to the Laguna, restore and enhance Laguna habitats, and recover declining species.

Coastal Zone Act Reauthorization Amendments, USEPA, NOAA

Amendments to the Coastal Zone Act to more specifically address effects of NPS pollution on coastal water quality. These amendments require each state with an approved Coastal Zone Management Program to develop a Coastal Nonpoint Pollution Control Program.

Coastal Zone Management Act, NOAA

Provides federal funding for wetlands programs in coastal states, including the preparation of Coastal Zone Management Plans.

Endangered Species Act (ESA), US FWS

The US FWS works with landowners to provide incentives to manage land for endangered species. In some instances land use activities qualify for exemptions to ESA prohibitions.

Healthy Forests Restoration Act, Bureau of Land Management

"The Healthy Forests Restoration Act (HFRA) provides BLM and Forest Service land managers with legislative tools to expedite forest and rangeland restoration projects. HFRA aims to expedite the preparation and implementation of hazardous fuels-reduction projects on Federal land and assist rural communities, States, and private landowners in restoring healthy forest conditions on State and private lands."

Mendocino County General Plan. Land Use Element of the Mendocino County General Plan, Natural Resources.

Section 8, Natural Areas sets policies to protect natural areas under public and private ownership.

Section 11, Soil Resources sets policies to reduce soil loss and erosion, stabilize streambanks, and to limit development on certain soil types. Section 12, Vegetation and Wildlife sets policies to retain and restore native vegetation, including riparian vegetation, wetlands, and rare and unique vegetation and to promote wildlife habitat protection and improvement and endangered species protection on private lands. Section 13, Water Resources sets policies to encourage land management to reduce water pollution, ensure adequate water supply, and protect the integrity of the flood plain.

National Environmental Protection Act, US EPA

"The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet this requirement, federal agencies prepare a detailed statement known as an Environmental Impact Statement (EIS)."

Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program, SWRCB

"The information provided in this policy is designed to assist all responsible and/or interested parties in understanding how the State's NPS water quality control requirements will be implemented and enforced. The parties involved include the SWRCB and the RWQCBs, federal, state and local agencies, individual dischargers, designated third-party representatives and any other interested public and private parties."

Santa Rosa General Plan

Chapter 7: 7-3 Biological Resources and Waterways, sets policies which maximize the benefits of open space, conserve the City's open spaces, conserve agricultural soils, conserve wetlands, vernal pools, wildlife ecosystems, rare plant habitats, and waterways, and conserve significant vegetation and trees, conserve water and maintain water quality, and take actions to achieve and maintain ambient air quality standards.

Sonoma County General Plan

2.2 — Prevention of Soil Erosion sets policies to promote and encourage soil conservation and management practices that maintain the productivity of soil resources.

3.1 — Policy for Critical Habitat Areas, provides protection for critical areas including wetlands, marshes, and remnant upland habitat.

4.1 — Policy for Parks and Equestrian and Hiking Trails, establishes a countywide park and trial system to meet anticipated future needs and protect agricultural uses.

4.2 - Policy for Bikeways, establishes a bikeways network to support both transportation and recreational bike use.

5.0 — Policy for Vegetation and Wildlife Resources, provides for conservation of biotic resources, and protection of rare and endangered species.

Town of Windsor General Plan — 2015

Chapter 6 Environmental Resources, proposes strategies for the protection and enhancement of open space resources, agricultural resources, water supply and quality, biological resources, cultural resources, extractive resources, and scenic resources.

Z'Berg-Nejedly Forest Practice Act, California Board of Forestry

This act authorizes regulation of timber harvest through the adoption of rules for each forest district in California. The rules are intended to be used as standards for preparing Timber Harvest Plans and evaluating effects of harvest operations

8. Sources

California Environmental Protection Agency, California Resources Agency. 2005. *EPIC Update Environmental Protection Indicators for California*. Available at: http://www.oehha.ca.gov/multimedia/epic/2002epicreport.html

CDFG Habitat and Biological Inventory Parameters for Russian River Basin Fisheries (CDFG 2007)

Flosi, Gary; Downie, Scott; Hopelain, James; Bird, Michael; Coey, Robert; and Barry Collins. California *Salmonid Stream Habitat Restoration Manual, Third Edition*. Sacramento, California, California Department of Fish and Game, Inland Fisheries Division.

Natural Resources Conservation Service (NRCS). Undated. Electronic Field Office Technical Guide. Web Site. Accessed 6/07. Available at: http://www.nrcs.usda.gov/Technical/efotg/.

NOAA/NMFS Habitat Attribute Indicators for Russian River Watershed CCC Coho (NMFS 2010)

Sotoyome Resource Conservation District. 2006. *Grazing Handbook A Guide for Resource Managers for Coastal California*. 68 pages.

SWRCB/ SWAMP Core Indicators for Beneficial Uses in California (SWAMP 2010/ SWAMP 2006)

Tetra Tech, Inc., 2006. *California Nonpoint Source Encyclopedia*. California State Water Resources Control Board. 281 pages.

US Environmental Protection Agency. 2006. Polluted Runoff (Nonpoint Source Pollution). Web Site. Available at: http://www.epa.gov/owow/nps/categories.html. Accessed 6/07.

INVASIVE NON-NATIVE VEGETATION CONTROL

1. Baseline Description

General setting:

The quality and extent of riparian and upland habitat in the Russian River watershed has become degraded due to the increasing presence of invasive non-native plant species. Non-native invasive species can change nutrient cycling, plant species diversity, plant species composition, hydrologic regime, and ecosystem structure and function. Invasive species cost the US economy about 120 billion dollars each year in lost crops, unsuccessful endangered species recovery efforts, and control efforts. Invasive non-native species are considered to have played a significant role in the decline of 42% of species listed as federally endangered or threatened. In riparian habitat in the Russian River watershed, giant reed (*Arundo donax)* was planted for bank stabilization projects until it was realized that it actually weakens bank structure and is invasive. Other common non-native invasive species include French broom (*Genista monspessulana*), Scotch broom (*Cytisus scoparius*), giant reed (*Arundo donax*), Himalayan blackberry (*Rubus discolor*), pampas-grass (*Cortaderia selloana*), cape ivy (*Delairea odorata)*, periwinkle (*Vinca major*) and near the coast, jubata-grass (*Cortaderia jubata*) and gorse (*Ulex europaeus*).

Causal Factors:

Invasive non-native plants have spread throughout riparian areas in the Russian River watershed through a variety of mechanisms. Some have been planted for erosion control, some have escaped cultivation, others have hitchhiked as seeds in grain, on tires, and on pets and clothing. Still others, such

as giant reed and periwinkle, spread downstream during storm events. Extensive human mobility has increased the spread of invasive plants, including pathogens such as Sudden Oak Death.

2. Management Measure Description

The Invasive Non-native Plant Management Measure promotes the removal of invasive non-native plants in riparian and upland habitat. The goal of this MM is removal of non-native invasive plants to facilitate the restoration of native riparian habitat function and reduce the societal costs associated with invasive non-native plants.

3. Resource Concerns

Habitat Fragmentation

Inadequate Cover/Shade

Inadequate Shelter

Inadequate Species Composition

Inadequate Water Quantity

Inadequate Wildlife Movement Corridors

Inadequate Wildlife Territory

Invasive Non-native Plants

Threatened and Endangered Fish and Wildlife Species

4. Management Practices

Recommended practices for promoting the removal of invasive non-native plants should include the following principles:

- Project planning and adaptive management are critical to success.
- Non-native invasive plant species removal project sites should be evaluated for native plant restoration prior to project implementation.
- Care should be taken to minimize soil disturbance during the removal process; on steep slopes, mechanical methods should not be used.
- If after removal has occurred, a site is likely to experience erosion, mulch or other methods should be implemented to reduce or prevent erosion.
- If the removed biomass has the ability to resprout (e.g., *Arundo donax*), it should be removed from the site or finely mulched to prevent reinvasion.
- New infestations of non-native invasive plant populations should be prioritized to prevent their expansion into surrounding areas.
- When possible, removal projects should occur from the source population outward in order to prevent recolonization. For example, when removing *Arundo donax*, which spreads downstream, the most upstream populations should be removed first.
- Proper training with any tools or herbicides utilized is necessary for individuals implementing removal projects.
- Post-project monitoring is recommended to evaluate project success and to provide information for adaptive management.

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
CDFG	Straw mulch bare soils areas	1000 FT^2
SRCD	Grazing for Fire Hazard Management	AC
SRCD	Grazing for Weed Management	AC
NRCS	Prescribed Burning (338)	AC
NRCS	Riparian Herbaceous Cover (390)	AC
NRCS	Riparian Forest Buffer (391)	AC
NRCS	Mulching (484)	AC
NRCS	Prescribed Grazing (528)	AC
NRCS	Prescribed Grazing, Wetlands (528D)	AC
NRCS	Prescribed Grazing, Woodland/Forestland (528E)	AC
NRCS	Pest Management (595)	AC
NRCS	Restoration and Management of Declining Habitats (643)	AC
NRCS	Early Successional Habitat Development/Management (647)	Ac

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Biotic Condition	
Species composition, % cover native plants/ non-native plants	**Vegetation:** From "Poor to "Very Good" Canopy cover: <75 % average over IP-km, 75 to 85 %, 85 to 95 %, >95 %
Species Composition	**DBH (North):** <39 % class 5 and 6, 40 to 54 %, 55 — 69 %, >69 % Species composition: < 25 %, 25 to 50 %, >50 %, Historical conditions
Wildlife biodiversity	**Salmonids:** From "Poor" to "Very Good" Summer juvenile rearing density: < 0.2 fish/m2 0.2 to 0.7 0.5 to 1.0 >1.0
Population density, structure, and distribution, T&E wildlife	**Salmonids:** From "Poor" to "Very Good" Summer juvenile rearing density: < 0.2 fish/m2 0.2 to 0.7 0.5 to 1.0 >1.0
Canopy	**Riparian Vegetation:** From "Poor to "Very Good" Canopy cover: <75 % average over IP-km, 75 to 85 %, 85 to 95 %, >95 %

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Habitat connectivity	**Habitat connectivity:** <50 %, 50 to 80 %, >80 %, Not defined Physical barriers <50 of IP-km, 50 to 70 %, 70 to 90 %, >90 %

Protocol & Data Sources

California Department of Fish and Game protocols http://www.dfg.ca.gov/wildlife/nongame/survey_monitor.html

California Rapid Assessment Method (CRAM) method for riparian condition measures: Collins et al 2008 http://www.cramwetlands.org/documents/

California Watershed Assessment Manual II Chapter 4 (Shilling 2005a; periphyton) and 5 (Shilling 2005b; benthic macroinvertebrates) http://cwam.ucdavis.edu/Volume_2/TOC.htm

EPA rapid bioassessment protocol (Barbour et al. 1999) http://www.epa.gov/owow/monitoring/rbp/ch06main.html

Riparian Bird Conservation Plan (California Partners in Flight and Riparian Habitat Joint Venture) methods for monitoring riparian bird populations http://www.prbo.org/calpif/htmldocs/riparian.html

SWAMP protocols ("Standard Operating Procedures") http://swamp.mpsl.mlml.calstate.edu/

and selected reports under "Bioassessment" at http://www.swrcb.ca.gov/water_issues/programs/swamp/reports.shtml#bioassessment

USGS National Water Quality Assessment Program (NAWQA) http://water.usgs.gov/nawqa/protocols/OFR02-150/index.html

California Department of Fish and Game (Regions 1 and 3 for the North Coast) http://www.dfg.ca.gov/about/data.html for Biogeographic Information and Observation System (BIOS; http://bios.dfg.ca.gov/), California Native Diversity Database (CNDDB; http://www.dfg.ca.gov/biogeodata/cnddb/),Coho stream habitat assessments, and other data sets; the

CDFG Watershed Assessment Program does fisheries-based assessments of coastal streams http://coastalwatersheds.ca.gov/

CalEpa and others: Environmental Protection Indicators for California (EPIC) project is responsible for developing and maintaining a set of "environmental indicators" for California. http://oehha.ca.gov/multimedia/epic/aboutepic.html

CalFlora (for specific plant species) http://www.calflora.org/

California Native Plant Society (for specific plant species) http://www.cnps.org/

EPAs Western Environmental Monitoring and Assessment Program (WEMAP) http://www.epa.gov/region09/water/wemap/surface.html

NOAA's National Marine Fisheries Service Central California Coast Coho Salmon Recovery Plan (in press)

NOAA's National Marine Fisheries Service Southern Oregon Northern California Coho Salmon Recovery Plan (in prep)

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Best Management Practices (BMP) Monitoring Manual - Field Guide: Implementation and Effectiveness for Protection of Water Resources, USDA Forest Service, 2007. http://www.na.fs.fed.us/pubs/misc/bmp/06/bmp_field_guide_lr.pdf

Monitoring the Vegetation Resources in Riparian Areas, USDA Department of Agriculture, 2000. http://www.fs.fed.us/rm/pubs/rmrs_gtr047.pdf

Vegetation Resource Survey, Stream Inventory Project, Coyote Creek Riparian Station, 1996, revised 2007. http://www.swrcb.ca.gov/nps/cwtguidance.html

Chapter 5, Vegetation Monitoring Protocols, Fire Monitoring Handbook, USDI NPS, 2003, http://www.nps.gov/fire/fire/fir_eco_mon_fmh.cfm

Section 12, Crowns: Measurements and Sampling, 2004 Field Guide Version 2.0, USDA FS, 2002. http://www.fs.fed.us/ne/fia/datacollection/manualver2_0/index.html

Section 13, Vegetation Diversity and Structure, 2004 Field Guide Version 2.0, USDA FS, 2002. http://www.fs.fed.us/ne/fia/datacollection/manualver2_0/index.html

Field Methods, Monitoring Bird Populations in Small Geographic Areas, Canadian Wildlife Service, 2006, http://www.cws-scf.ec.gc.ca/publications/spec/PDF/mon_e.pdf

Visual Assessment of Riparian Health, University of California Division of Agriculture and Natural Resources, http://californiarangeland.ucdavis.edu/Publications%20pdf/8089HR.pdf

Stream Temperature Protocol, Forest Science Project, 1999. Available at: http://www.krisweb.com/krisbigriver/krisdb/html/krisweb/bigriver_backgrnd/tempkr_big.htm

NPS CWT Guidance Compendium for Watershed Monitoring and Assessment: Temperature Measurements Principles and Methods. SWRCB, 2006. Available at: http://www.swrcb.ca.gov/nps/cwtguidance.html

Field Procedures, Photo Point Monitoring Handbook: Part A — Field Procedures, USDA FS Pacific Northwest Research Station, 2002. http://www.fs.fed.us/pnw/pubs/gtr526/

6. Relevant Programs

5 Star Restoration Program, USEPA

> "The Five Star Restoration Program brings together students, conservation corps, other youth groups, citizen groups, corporations, landowners and government agencies to provide environmental education and training through projects that restore wetlands and streams. The program provides challenge grants, technical support and opportunities for information exchange to enable community-based restoration projects."

Agricultural Management Assistance Program, NRCS

> "Agricultural Management Assistance (AMA) provides cost share assistance to agricultural producers to voluntarily address issues such as water management, water quality, and erosion control by incorporating conservation into their farming operations. Producers may construct or improve water management structures or irrigation structures; plant trees for windbreaks or to improve water quality; and mitigate risk through production diversification or resource conservation practices, including soil erosion control, integrated pest management, or transition to organic farming."

Arundo donax Removal Program, Sotoyome Resource Conservation District

> The Sotoyome RCD is collaborating with Circuit Rider Productions, Inc. to implement a long-term effort to remove *Arundo donax* from the Russian River Watershed. *Arundo donax* removal is offered to landowners in the watershed free of charge.

California Forest Stewardship Program, California Department of Forestry and Fire Protection

> "The California Forest Stewardship Program is designed to encourage good stewardship of private forestland. The program provides technical and financial assistance to influence positive changes to forestland management, assists communities in solving common watershed problems, and helps landowners."

California Coastal Salmon and Watersheds Program, California Resources Agency

> The goal of this program is to: recover harvestable salmon and steelhead populations, restore watersheds, and so contribute to building healthy communities."

California Riparian Habitat Conservation Program, California Wildlife Conservation Board

> "The California Riparian Habitat Conservation Program was created within the Wildlife Conservation Board by legislation in 1991. The program has a basic mission to develop coordinated conservation efforts aimed at protecting and restoring the state's riparian ecosystems."

California River Parkways Program, California Resources Agency

> "The Proposition 50 California River Parkways Program in the Resources Agency is a competitive grant program for river parkways projects. Eligible projects must provide public access or be a component of a larger parkway plan that provides public access."

The Coastal Watershed Planning and Assessment Program, CDFG

> The Coastal Watershed Planning and Assessment Program (CWPAP) is a Department of Fish and Game (CDFG) program conducting fishery-based watershed assessments along the length of the California coast. Assessment basins are chosen as study areas based upon the nature of the socio-economic and natural resource problems within them. The CDFG Coho Recovery Plan and Steelhead Recovery Plan are useful in selecting basins as well. CWPAP has developed assessment methods, protocols and report outlines.

Conservation Planning Assistance, NRCS

> "The Natural Resources Conservation Service (NRCS) provides conservation planning and technical assistance to clients (individuals, groups, and units of government). These clients develop and implement conservation plans to protect, conserve, and enhance natural resources (soil,

water, air, plants, and animals) within their related social and economic interests."

Fisheries Restoration Grant Program, CDFG

The California Department of Fish and Game coordinates this grant program, which works towards the conservation and restoration of anadromous fisheries and watershed health.

The Global Invasive Species Initiative, TNC

The Global Invasive Species Initiative is The Nature Conservancy's response to abating the damage caused to native biodiversity by the human-facilitated introduction of non-native, harmful invasive species. This web site provides many resources designed to help all conservationists deal most effectively with invasive species.

Integrated Regional Water Management Grant Program, SWRCB

"The Integrated Regional Water Management (IRWM) Implementation Grants Program, funded by Proposition 50, Chapter 8, will provide approximately $64 million during Round 2. IRWM Implementation Grants will fund projects that meet one or more of the program objectives of protecting communities from drought, protecting and improving water quality, and improving local water security by reducing dependence on imported water. Implementation Grant proposals must be based on a qualified IRWM Plan."

Partners for Fish and Wildlife Program, USFWS

The mission of this program is "to efficiently achieve voluntary habitat restoration on private lands, through financial and technical assistance, for the benefit of Federal Trust Species. Migratory birds, inter-jurisdictional fish, federally-listed endangered, threatened or other declining or imperiled species are public resources, which by their migratory nature or declining numbers on a national scale, have been identified as Federal Trust Species."

Pest Management Program, California Department of Forestry and Fire Protection

"CDF's forest pest specialists help protect the state's forest resources from native and introduced pests, conduct surveys and provide technical assistance to private forest landowners, and promote forest health on all forest lands."

Pesticide Environmental Stewardship Program, USEPA

This is "a voluntary program that forms partnerships with pesticide users to reduce health and environmental risk and implement pollution prevention strategies."

Recovery Strategy for California Coho Salmon, CDFG

"The California Department of Fish and Game, with the assistance of recovery teams representing diverse interests and perspectives, created the Recovery Strategy for California Coho Salmon, a guide for the process of recovering coho salmon on the north and central coasts of California. The Recovery Strategy emphasizes cooperation and collaboration at many levels, and recognizes the need for funding, public and private support for restorative actions, and maintaining a balance between regulatory and voluntary efforts."

Resource Assessment Program, CDFG

"The goal of this effort will be to develop and implement a long-term and strategic program to inventory, monitor, and assess the distribution and abundance of priority species, habitats, and natural communities in California."

Riparian Habitat Joint Venture

"The Riparian Bird Conservation Plan is a collaborative effort of the Riparian Habitat Joint Venture and has been developed to guide conservation policy and action on behalf of riparian habitats and California's landbirds."

Urban Forestry Program, California Department of Forestry and Fire Protection

"The Urban Forestry Program offers grants of over $1 million dollars a year to plant trees and over $2.5 million for related projects in urban communities throughout California. Four Urban Forestry Field Specialists provide expert urban forestry support to communities, non-profit groups and other municipal governments to create and maintain sustainable urban forest."

Urban Streams Restoration Program, DWR

"The objectives of the Urban Streams Restoration Program are to assist communities in reducing damages from stream bank and watershed instability and floods while restoring the environmental and aesthetic values of streams, and to encourage stewardship and maintenance of streams by the community. With voter approval of Proposition 84, the Urban Streams Restoration Program will have available grant funding. Proposition 84 includes $18 million for the Urban Streams Restoration Program. DWR anticipates holding the first of two application cycles in mid 2007."

Watershed Program, DWR

"The Department of Water Resources Watershed Program works with locally led stewardship efforts to integrate the needs of communities, urban and rural, with resource management that sustains watershed ecology."

Watershed Protection Programs, SWRCB

The State Water Resources Control Board administers several programs for watershed protection under Propositions approved by voters. These Propositions are: 13, 40, and 50.

Watershed Stewardship Program, Sotoyome Resource Conservation District

"The SRCD program focuses on education and collaboration within the community to restore resources, improve water quality and habitat, and monitor creeks and watersheds. Working together to find viable solutions for the restoration of the smaller tributary watersheds that will lead to improvements downstream in the main stem of the Russian River Watershed is one of the main goals of this program."

Wildlife and Sport Fish Restoration Programs Division of Federal Assistance, USFWS

"The mission of the Federal Assistance Program is to strengthen the ability of State and Territorial fish and wildlife agencies to meet the consumptive and non-consumptive needs of the public for fish and wildlife resources. The Division of Federal Assistance is responsible for administering grant programs to help States meet these needs."

Wildlife Habitat Incentives Program, NRCS

"The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land. Through WHIP USDA's Natural Resources Conservation Service provides both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat. WHIP agreements between NRCS and the participant generally last from 5 to 10 years from the date the agreement is signed."

7. Relevant Policies

California Endangered Species Act (CESA), California Environmental Protection Agency

Compliance with the CESA may be required for environmental projects and management practices. The CDFG administers CESA and can authorize exceptions to the state's prohibition against take of a listed species.

California Environmental Quality Act (CEQA), California Resources Agency

CEQA is a statue requiring state and local agencies to identify significant environmental impacts of proposed activities and to avoid or mitigate those impacts if feasible.

City of Cloverdale Draft General Plan Update

Chapter 6 Conservation and Open Space Element, provides for protection of distinctive natural vegetation, including riparian, wetlands, and upland ecosystems. Contains policies specifically intended to protect and enhance the natural beauty, habitat and biotic productivity of the Russian River through the use of conservation buffers, stormwater runoff management, habitat improvement, and the use of natural wetland treatment for expansionof wastewater treatment facilities.

City of Cotati General Plan

Chapter 17.50 — Watercourse and Riparian Resource Protection, sets provisions for adequate buffer areas between watercourses and adjacent development.

City of Healdsburg General Plan

Chapter 7 — Natural Resources, establishes policies that improve water quality and flows

in the Russian River and Dry and Foss Creeks, promote conservation and restoration of native ecosystems and waterways, preserve the city's natural setting, protect the viability of agriculture, reduce greenhouse gas emissions, and protect riparian resources.

City of Rohnert Park General Plan

Chapter 6 — Environmental Conservation, 6.2 Habitat and Biological Resources, sets policies for protection of special status species and special habitat areas, use of native plants for landscaping, and planting of low water use trees. Sets creek protection zones which prohibit development except greenway enhancement, requires evaluation and implementation of bank stabilization and erosion control measures.

City of Sebastopol General Plan

Chapter III: Conservation, Parks and Open Space, sets policies which preserve areas with important biotic resources, ensure the maintenance of wetlands adjacent to City boundaries as permanent open space, protect, maintain and restore wetlands areas, protect and preserve soil as a natural resource, conserve, protect and enhance trees and native vegetation, conserve energy, protect and improve air quality, provide for water conservation, reduce the volume of solid waste the City generates, provides an attractive and comprehensive system of parks and trials that meets all citizens' recreational needs, ensures that recreational facilities are developed in harmony with the surroundings, and incorporates the 1992 Laguna Park Master Plan. The Plan sets minimum buffers for urban land and farming operations adjacent to Laguna habitats, and sets policy to minimize the impacts of backyards adjacent to the Laguna, restore and enhance Laguna habitats, and recover declining species.

Endangered Species Act (ESA), US Environmental Protection Agency

The US FWS works with landowners to provide incentives to manage land for endangered species. In some instances land use activities qualify for exemptions to ESA prohibitions.

Healthy Forests Restoration Act, Bureau of Land Management

"The Healthy Forests Restoration Act (HFRA) provides BLM and Forest Service land managers with legislative tools to expedite forest and rangeland restoration projects. HFRA aims to expedite the preparation and implementation of hazardous fuels-reduction projects on Federal land and assist rural communities, States, and private landowners in restoring healthy forest conditions on State and private lands."

Lake and Streambed Alteration Program, CDFG

"Fish and Game Code section 1602 requires any person, state or local governmental agency, or public utility to notify the Department before beginning any activity that will do one or more of the following: 1) substantially obstruct or divert the natural flow of a river, stream, or lake; 2) substantially change or use any material from the bed, channel, or bank of a river, stream, or lake; or 3) deposit or dispose of debris, waste, or other material containing crumbled, flaked, or ground pavement where it can pass into a river, stream, or lake. Fish and Game Code section 1602 applies to all perennial, intermittent, and ephemeral rivers, streams, and lakes in the state."

Mendocino County General Plan. Land Use Element of the Mendocino County General Plan, Natural Resources.

Section 8 — Natural Areas sets policies to protect natural areas under public and private ownership.

Section 12 — Vegetation and Wildlife sets policies to retain and restore native vegetation, including riparian vegetation, wetlands, and rare and unique vegetation and to promote wildlife habitat protection and improvement and endangered species protection on private lands.

National Environmental Protection Act, US EPA

"The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet this requirement, federal agencies

prepare a detailed statement known as an Environmental Impact Statement (EIS)."

Santa Rosa Citywide Creek Master Plan

The Plan contains "recommended habitat preservation, enhancement, and restoration projects, and improvements to the creekside trail system are presented conceptually and specifically by watershed. Project recommendations are based on community input, literature reviews, and extensive field survey work. Site-specific recommendations are presented in the text and on a set of Geographical Information System-based maps, organized by watershed area."

Santa Rosa General Plan

Chapter 7: 7-3 Biological Resources and Waterways, sets policies which maximize the benefits of open space, conserve the City's open spaces, conserve agricultural soils, conserve wetlands, vernal pools, wildlife ecosystems, rare plant habitats, and waterways, and conserve significant vegetation and trees, conserve water and maintain water quality, and take actions to achieve and maintain ambient air quality standards.

Sonoma County General Plan

3.2 — Policy for Riparian Corridors, establishes streamside conservation areas or riparian corridor setbacks from land use activities.

5.0 — Policy for Vegetation and Wildlife Resources, provides for conservation of biotic resources, and protection of rare and endangered species.

Stream and Wetland System Protection Policy, NCRWQCB

This policy is a proposed amendment to the Water Quality Control Plans for the North Coast and San Francisco Bay Regions that will "protect stream and wetlands systems, including measures to protect riparian areas and floodplains."

Town of Windsor General Plan — 2015

Chapter 4 Community Development, sets policies for the development of recreational opportunities and preservation of water supply.

Chapter 6 Environmental Resources, proposes strategies for the protection and enhancement of open space resources, agricultural resources, water supply and quality, biological resources, cultural resources, extractive resources, and scenic resources.

8. Sources

California Environmental Protection Agency, California Resources Agency. 2005. EPIC Update Environmental Protection Ind*icators for California*. Available at: http://www.oehha.ca.gov/multimedia/epic/2002epicreport.html

CDFG Habitat and Biological Inventory Parameters for Russian River Basin Fisheries (CDFG 2007)

Flosi, Gary; Downie, Scott; Hopelain, James; Bird, Michael; Coey, Robert; and Barry Collins. California *Salmonid Stream Habitat Restoration Manual, Third Edition*. Sacramento, California, California Department of Fish and Game, Inland Fisheries Division.

Natural Resources Conservation Service (NRCS). 2003. Electronic Field Office Technical Guide. Available at: http://www.nrcs.usda.gov/Technical/efotg/.

NOAA/NMFS Habitat Attribute Indicators for Russian River Watershed CCC Coho (NMFS 2010)

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Tetra Tech, Inc., 2006. *California Nonpoint Source Encyclopedia*. California State Water Resources Control Board. 281 pages.

US Environmental Protection Agency. 2006. Polluted Runoff (Nonpoint Source Pollution). Web Site. Available at: http://www.epa.gov/owow/nps/categories.html. Accessed 6/07.

US EPA. 2005. National Management Measures to Protect and Restore Wetlands and Riparian Areas for the Abatement of Nonpoint Source Pollution. Nonpoint Source Control Branch, Office of Wetlands, Oceans and Watersheds, Office of Water. 204 pages. Available at: http://www.epa.gov/owow/nps/wetmeasures/pdf/guidance.pdf

RECREATION AND PUBLIC ACCESS

1. Baseline Description

General Setting:

As the population in the Russian River watershed has grown, the opportunity for public access has diminished. Many existing recreational areas and public access points are in need of enhancement to better serve the public and the wildlife which utilize

them. Fragmentation of the landscape has created islands of wildlife habitat, which has led to population decreases for many species of wildlife.

Causal Factors:

The division of large properties into smaller units with an assortment of private owners and an increasingly litigious society have resulted in a decrease in public access through private property to access upland habitat or other natural areas. As the human population has grown in the Russian River watershed, the cost of land has increased, making it more difficult for NGOs and Public Agencies to purchase land for access and recreation. Additionally, lack of adequate funding for parks and other recreational areas has led to a general decline in facilities in many areas.

2. Management Measure Description

The Recreation and Public Access MM promotes the acquisition and enhancement of public access points and recreation areas to increase local quality of life, increase tourism potential and economic vitality, and improve wildlife habitat connectivity. The goal of this MM is to increase the number of public access points and the number and quality of upland recreational areas through a variety of methods including fee title, easements, regulations, enhancement funding, restoration, and local ordinances and laws.

3. Resource Concerns

Habitat Fragmentation
Inadequate Wildlife Movement/Travel Corridors

Inadequate Wildlife Territory

Invasive Non-native Plants

Soil Condition — Compaction

Soil Erosion — Roadbank and Construction Sites

Soil Erosion — Sheet and Rill

4. Management Practices and Cost Information

Recommended practices for upland recreation and public access should include the following principles:

- Project planning is critical to success
- Public participation should be solicited in the planning stages; a sense of ownership will likely result in greater compliance
- Educational materials should accompany exclusionary projects and other projects which curtail public use
- Projects should be evaluated to determine impacts and benefits prior to implementation
- Post-project monitoring should be conducted to evaluate project success and provide information for adaptive management

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
NRCS	Use Exclusion (472)	AC
NRCS	Heavy Use Area Protection (561)	AC
NRCS	Fence (382)	FT
NRCS	Recreation Area Improvement (562)	AC
NRCS	Recreation Land Grading and Shaping (566)	AC
NRCS	Recreation Trail and Walkway (568)	FT
CSP	Road-to-Trail Conversion	
USFS	Recreation Facilities Planning & Location	
USFS	Trail Construction and Maintenance	
SWRCB	Education and Outreach	
EPA	Land or Development Rights Acquisition Practices	

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Biotic Condition	
Plant Species Composition	**DBH (North):** <39 % class 5 and 6, 40 to 54 %, 55 — 69 %, >69 % Species composition: < 25 %, 25 to 50 %, >50 %, Historical conditions
Species-Specific Habitat Suitability	**Salmonid Habitat:** North Coast and Central Coast ESU Salmonids freshwater habitat quality indicator benchmarks
Wildlife biodiversity	
Population density, structure, and distribution, T&E wildlife	**Salmonids:** From "Poor" to "Very Good" Summer juvenile rearing density: < 0.2 fish/m2 0.2 to 0.7 0.5 to 1.0 >1.0
Other	
Quality of visitor experience	
Pest and disease related mortality along trails	
Recreational Trail connectivity	
Number of Access Points	

Protocol & Data Sources

Upland Erosion Control Protocols, Interim Restoration Effectiveness and Validation Monitoring Protocols, CDFG, 2003.

Habitat Unit Monitoring Procedures, Interim Restoration Effectiveness and Validation Monitoring Protocols, CDFG, 2003.

Quantitative Protocols for Effectiveness Monitoring of Roads and Upland Restoration Following Stressing Events, Interim Restoration Effectiveness and Validation Monitoring Protocols, CDFG, 2003.

Photographic Monitoring, Interim Restoration Effectiveness and Validation Monitoring Protocols, CDFG, 2003

Protocol for Monitoring Best Management Practices, USDA Forest Service. 2006. http://www.na.fs.fed.us/ra/SpecialInitiatives/bestmgmtpractices/sib06_bmp.htm

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Forest Service National Visitor Use Monitoring Process: Research Method Documentation. USFS 2001. Available at: http://www.fs.fed.us/recreation/programs/nvum/

Resource Monitoring and Habitat Monitoring, US Department of the Interior and The Nature Conservancy, 1998.

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6. Relevant Programs

California River Parkways Program, California Resources Agency

"The Proposition 50 California River Parkways Program in the Resources Agency is a competitive grant program for river parkways projects. Eligible projects must provide public access or be a component of a larger parkway plan that provides public access."

Environmental Enhancement and Mitigation Program, The California Resources Agency

"The Environmental Enhancement and Mitigation Program was established by the Legislature in 1989. It offers a total of $10 million each year for grants to local, state, and federal governmental agencies and to nonprofit organizations for projects to mitigate the environmental impacts caused by new or modified state transportation facilities." Grants are awarded in three categories: 1) Highway landscape and urban forestry; 2) Resource lands, and 3) Roadside recreational.

Environmental Justice Small Grants Program, Cal/EPA

"Cal/EPA has established the EJ Small Grants Program to assist eligible community-based, grassroots, non-profit entities, and federally recognized tribal governments to address environmental justice issues."

The Global Invasive Species Initiative, TNC

The Global Invasive Species Initiative is The Nature Conservancy's response to abating the damage caused to native biodiversity by the human-facilitated introduction of non-native, harmful invasive species. This web site provides many resources designed to help all conservationists deal most effectively with invasive species.

Pest Management Program, California Department of Forestry and Fire Protection

"CDF's forest pest specialists help protect the state's forest resources from native and introduced pests, conduct surveys and provide technical assistance to private forest landowners, and promote forest health on all forest lands."

Surface Transportation Program, US Department of Transportation

This program is a block grant program that may be used by states and local governments for any roads that are not functionally classified as local or rural minor collectors. Ten percent of allocated STP funds must be set aside by each state for transportation enhancements, including mitigation of water pollution due to highway runoff.

Urban Streams Restoration Program, DWR

"The objectives of the Urban Streams Restoration Program are to assist communities in reducing damages from stream bank and watershed instability and floods while restoring the environmental and aesthetic values of streams, and to encourage stew-

ardship and maintenance of streams by the community. With voter approval of Proposition 84, the Urban Streams Restoration Program will have available grant funding. Proposition 84 includes $18 million for the Urban Streams Restoration Program. DWR anticipates holding the first of two application cycles in mid 2007."

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7. Relevant Policies

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Chapter 17.50 — Watercourse and Riparian Resource Protection, sets provisions for adequate buffer areas between watercourses and adjacent development.

City of Healdsburg General Plan

Chapter 6 — Public Services, sets policies that govern recreational development.

City of Rohnert Park General Plan

Chapter 6 — Environmental Conservation, 6.2 Habitat and Biological Resources, sets policies for protection of special status species and special habitat areas, use of native plants for landscaping, and planting of low water use trees. Sets creek protection zones which prohibit development except greenway enhancement, requires evaluation and implementation of bank stabilization and erosion control measures.

City of Sebastopol General Plan

Chapter III: Conservation, Parks and Open Space, sets policies which preserve areas with important biotic resources, ensure the maintenance of wetlands adjacent to City boundaries as permanent open space, protect, maintain and restore wetlands areas, protect and preserve soil as a natural resource, conserve, protect and enhance trees and native vegetation, conserve energy, protect and improve air quality, provide for water conservation, reduce the volume of solid waste the City generates, provides an attractive and comprehensive system of parks and trials that meets all citizens' recreational needs, ensures that recreational facilities are developed in harmony with the surroundings, and incorporates the 1992 Laguna Park Master Plan. The Plan sets minimum buffers for urban land and farming operations adjacent to Laguna habitats, and sets policy to minimize the impacts of backyards adjacent to the Laguna, restore and enhance Laguna habitats, and recover declining species.

Endangered Species Act (ESA), US Environmental Protection Agency

The US FWS works with landowners to provide incentives to manage land for endangered

species. In some instances land use activities qualify for exemptions to ESA prohibitions.

Mendocino County General Plan. Land Use Element of the Mendocino County General Plan, Natural Resources.

Section 7 — Recreation sets policies for providing recreational activities.

Section 8 — Natural Areas sets policies to protect natural areas under public and private ownership.

Section 11 — Soil Resources sets policies to reduce soil loss and erosion, stabilize streambanks, and to limit development on certain soil types.

Section 12 — Vegetation and Wildlife sets policies to retain and restore native vegetation, including riparian vegetation, wetlands, and rare and unique vegetation and to promote wildlife habitat protection and improvement and endangered species protection on private lands.

National Environmental Protection Act, US EPA

"The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet this requirement, federal agencies prepare a detailed statement known as an Environmental Impact Statement (EIS)."

Santa Rosa Citywide Creek Master Plan

The Plan contains "recommended habitat preservation, enhancement, and restoration projects, and improvements to the creekside trail system are presented conceptually and specifically by watershed. Project recommendations are based on community input, literature reviews, and extensive field survey work. Site-specific recommendations are presented in the text and on a set of Geographical Information System-based maps, organized by watershed area."

Santa Rosa General Plan

Chapter 7: 7-3 Biological Resources and Waterways, sets policies which maximize the benefits of open space, conserve the City's open spaces, conserve agricultural soils, conserve wetlands, vernal pools, wildlife ecosystems, rare plant habitats, and waterways, and conserve significant vegetation and trees, conserve water and maintain water quality, and take actions to achieve and maintain ambient air quality standards.

Sonoma County General Plan

3.2 -Policy for Riparian Corridors, establishes streamside conservation areas or riparian corridor setbacks from land use activities.

4.1 — Policy for Parks and Equestrian and Hiking Trails, establishes a countywide park and trial system to meet anticipated future needs and protect agricultural uses.

4.2 - Policy for Bikeways, establishes a bikeways network to support both transportation and recreational bike use.

5.0 — Policy for Vegetation and Wildlife Resources, provides for conservation of biotic resources, and protection of rare and endangered species.

Town of Windsor General Plan — 2015

Chapter 4 Community Development sets policies for the development of recreational opportunities and preservation of water supply.

8. Sources

Merrill, B.R., C.E.G. and E. Casaday, C.P.E.S.C. 2003. Best Management Practices for Road Rehabilitation Road-to-Trail Conversion. Roads, Trails and Resources Maintenance Section, North Coast Redwoods District, California State Parks. 20 pages. Available at: http://www.parks.ca.gov/pages/23071/files/road%20to%20trail.pdf

Natural Resources Conservation Service (NRCS). 2003. Electroni Field Office Technical Guide. Available at: http://www.nrcs.usda.gov/Technical/efotg/.

Russian River Watershed Council. 2002. Plan of Action A Living Document for the Phase II Development of the Russian River Watershed Management Plan. 142 pages. Available at: http://www.rrwc.net/Resources/PlanofAction.pdf

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USDA Forest Service (USFS). 2006. Soil and Water Conservation Handbook Alaska Region Amendment. FSH 2509.22, R-10 Amendment 2509.22-96-1. 117 pages. Available at: http://www.fs.fed.us/r10/ro/policy-reports/bmp/

US Environmental Protection Agency. 2006. Polluted Runoff (Nonpoint Source Pollution). Web Site. Available at: http://www.epa.gov/owow/nps/categories.html. Accessed 6/07.

WATER QUANTITY MANAGEMENT

1. Baseline Description

General Setting:

Demand for water in the Russian River watershed has steadily increased, leading to low summer flows and increased temperatures in many tributaries. In addition to within-basin demand, about 33,000 acre-feet per year is transported from the Russian River to the North San Francisco Bay area. The lower watershed is projected to experience the highest urban growth of any part of the North Coast Region and the Bay area continues to experience a high growth rate, thus human demand for water will likely continue to increase. At the same time, regulations which protect environmental beneficial uses of water require that minimum instream flows are maintained, leading to water scarcity during dry years.

Causal Factors:

Agriculture, industry, residential, and municipal activities require water and increases in population increase demand for water. Declines in salmonid populations have resulted in their protection under the Endangered Species Act, triggering regulation of instream flow to protect salmonid habitat. When winter rain does not replenish the water supply stored in Lakes Sonoma and Mendocino, water shortages ensue despite the use of reclaimed water for industrial and other appropriate applications. Climate patterns are predicted to continue to change, with hotter weather — potentially causing increases in agricultural and environmental water needs —- and slightly less winter rain — thus less stored water — predicted for California.

2. Management Measure Description

The Water Quantity Management MM promotes the implementation of practices that conserve water. The goal of this MM is to ensure adequate year-round water supply for environmental and other beneficial uses in the Russian River watershed for current and future populations and climate patterns.

3. Resource Concerns

Inadequate Water Quantity

Inadequate Wildlife Territory

Water Quantity — Excessive Runoff, Flooding, or Ponding

Water Quantity — Inadequate Outlets

Water Quantity — Inefficient Water Use on Irrigated Land

Water Quantity — Inefficient Water Use on Non-Irrigated Land

Water Quantity — Reduced Capacity of Conveyances by Sediment Deposition

Water Quantity — Reduced Storage of Water Bodies by Sediment Accumulation

4. Management Practices

Recommended practices for water quantity enhancement projects should include the following principles:

- Project planning is critical to success.
- Projects should be evaluated to determine impacts and benefits prior to implementation
- Water quantity should be evaluated within a watershed management context
- Post-project monitoring should be conducted to evaluate project success and provide information for adaptive management

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
CDFG	Fishways	
EPA	Setback Levees and Flood Walls	
EPA	Selective withdrawal	
NRCS	Irrigation Canal or Lateral (320)	FT
NRCS	Dam, Diversion (348)	NO
NRCS	Irrigation Field Ditch (388)	FT
NRCS	Dam (402)	NO
NRCS	Irrigation Water Conveyance, Ditch	FT
NRCS	Irrigation Water Conveyance, Pipeline (430)	FT
NRCS	Irrigation Storage Reservoir (436)	NO
NRCS	Irrigation System, Microirrigation (441)	AC
NRCS	Irrigation System, Sprinkler (442)	AC
NRCS	Irrigation System, Surface and Subsurface (443)	NO
NRCS	Irrigation System, Tailwater Recovery (447)	NO
NRCS	Irrigation Water Management	AC

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
NRCS	Irrigation Land Leveling (464)	AC
NRCS	Lined Waterway or Outlet (468)	FT
NRCS	Pipeline (516)	FT
NRCS	Pond Sealing or Lining (521)	NO
NRCS	Pumping Plant (533)	NO
NRCS	Irrigation Regulating Reservoir (552)	NO
NRCS	Drainage Water Management (554)	AC
NRCS	Structure for Water Control (587)	NO
NRCS	Water Harvesting Catchment (636)	NO
NRCS	Restoration and Management of Declining Habitats (643)	AC
NRCS	Wildlife Wetland Habitat Management (644)	AC
NRCS	Shallow Water Management for Wildlife (646)	AC

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Chemical and Physical Characteristics	
Water temperature (MWAT or MWMT)	**Temperature:** From "Poor" to "Very Good" (MWAT or MWMT) < 50 % IP-km (< 15 degrees Celsius MWAT), 50 to 70 %, 70 to 90 %, > 90 %
Conventionals: Temperature	**Temperature:** From "Poor" to "Very Good" (MWAT or MWMT) < 50 % IP-km (< 15 degrees Celsius MWAT), 50 to 70 %, 70 to 90 %, > 90 %
Conventionals: Dissolved Oxygen (DO)	**Dissolved Oxygen:** Greater than 5 mg/L, 2 to 5 mg/L,Less than 2 mg/L
Hydrology and Geomorphology	
Flow Conditions	
Flow	
Flow and/or stage height	
Instantaneous Flow	
Baseflow	
Stream Shading/ Canopy Cover	**Riparian Vegetation:** From "Poor to "Very Good" Canopy cover: <75 % average over IP-km, 75 to 85 %, 85 to 95 %, >95 %
Thalweg profile	
Miles of open stream channel	**Channel Morphology and Connectivity**: From "Poor" to "Very Good"
Floodplain Connectivity	**Floodplain connectivity:** <50 %, 50 to 80 %, >80 %, Not defined Physical barriers <50 of IP-km, 50 to 70 %, 70 to 90 %, >90 %

Protocol & Data Sources

California Monitoring and Assessment Program (CMAP). The CAMP monitoring project was developed in collaboration with the SWRCB's Non-Point Source Pollution control Program (NPS), SWRCB's SWAMP program and the US EPA's Region IX.

Department of Water Resources (DWR) Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/

DWR Water Plan Information Exchange: hub with links to various databases http://www.waterplan.water.ca.gov/waterpie/index.cfm

DWR Water Plan and Updates: water quality improvement strategies and data on water use http://www.waterplan.water.ca.gov/waterquality/water_quality.cfm

EPA TMDL program http://www.epa.gov/OWOW/tmdl/

EPA WEMAP (Western Environmental Monitoring and Assessment Program; http://www.epa.gov/region09/water/wemap/surface.html) for physical habitat structure, sediment metabolism, sediment chemistry, water quality parameters, and riparian vegetation.

SWAMP http://www.swrcb.ca.gov/water_issues/programs/swamp/, including water quality and toxicity data at http://swamp.mpsl.mlml.calstate.edu/online-data

SWRCB North Coast Basin Plan http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/basin_plan.shtml

California Rapid Assessment Method (CRAM) method for riparian condition measures: Collins et al 2008 http://www.cramwetlands.org/documents/

California Watershed Assessment Manual II Chapter 3 (Florsheim 2005) http://cwam.ucdavis.edu/Volume_2/TOC.htm

DWR Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/

Florsheim 2005 and references therein provide methods for measuring discharge; measuring sediment transport; calculating effective discharge; assessing substrate and grain size distributions; and assessing morphology (http://cwam.ucdavis.edu/Volume_2/TOC.htm).

SWAMP physical habitat procedures (Ode 2007 http://swamp.mpsl.mlml.calstate.edu/resources-and-downloads/standard-operating-procedures)

USDA Forest Service: Cumulative watershed effects: Reid 1993 (http://www.fs.fed.us/psw/rsl/projects/water/reid_141.pdf), UCCCWE 2001

USEPA Watershed Assessment of River Stability and Sediment Supply (WARSSS) http://www.epa.gov/warsss/sedsource/streamflo.htm

USGS National Hydrography Dataset http://nhd.usgs.gov/

USGS National Water Information System (NWIS) http://waterdata.usgs.gov/nwis/rt

6. Relevant Programs

Agricultural Water Use Program, DWR

The Department of Water Resources' "Office of Water Use Efficiency works to disseminate and transfer information on improved irrigation technologies and to identify and help develop technologies and farming methods that improve water use efficiency."

The Coastal Watershed Planning and Assessment Program, CDFG

The Coastal Watershed Planning and Assessment Program (CWPAP) is a Department of Fish and Game (CDFG) program conducting fishery-based watershed assessments along the length of the California coast. Assessment basins are chosen as study areas based upon the nature of the socio-economic and natural resource problems within them. The CDFG Coho Recovery Plan and Steelhead Recovery Plan are useful in selecting basins as well. CWPAP has developed assessment methods, protocols and report outlines.

California Coastal Salmon and Watersheds Program, California Resources Agency

The goal of this program is to: recover harvestable salmon and steelhead populations, restore watersheds, and so contribute to building healthy communities."

Coastal Program, USFS

"The Coastal Program provides incentives for voluntary protection of threatened, endangered and other species on private and public lands alike."

Conjunctive Water Management Program, DWR

The Department of Water Resources works with "local agencies and the public to develop surface and groundwater conjunctive-management projects for improving regional water supply reliability."

Conservation Planning Assistance, NRCS

"The Natural Resources Conservation Service (NRCS) provides conservation planning and technical assistance to clients (individuals, groups, and units of government). These clients develop and implement conservation plans to protect, conserve, and enhance natural resources (soil, water, air, plants, and animals) within their related social and economic interests."

Education Program, Sotoyome Resource Conservation District

"The Sotoyome Resource Conservation District (SRCD) Education Program delivers adult and K-12 education that promotes an understanding of the interplay between agriculture and natural resources, and sponsors projects that address stewardship of our natural resources."

Environmental Quality Incentives Program, NRCS

"The Environmental Quality Incentives Program (EQIP) was reauthorized in the Farm Security and Rural Investment Act of 2002 (Farm Bill) to provide a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land."

Fish Friendly Farming, California Land Stewardship Institute

"Fish Friendly Farming provides an incentive-based method for creating and sustaining environmental quality and habitat on private land. Landowners and managers enroll in the program, learn environmentally beneficial management practices and carry out ecological restoration projects."

Fisheries Restoration Grant Program, CDFG

The California Department of Fish and Game coordinates this grant program, which works towards the conservation and restoration of anadromous fisheries and watershed health.

Integrated Regional Water Management Grant Program, SWRCB

"The Integrated Regional Water Management (IRWM) Implementation Grants Program, funded by Proposition 50, Chapter 8, will provide approximately $64 million during Round 2. IRWM Implementation Grants will fund projects that meet one or more of the program objectives of protecting communities from drought, protecting and improving

water quality, and improving local water security by reducing dependence on imported water. Implementation Grant proposals must be based on a qualified IRWM Plan."

Recovery Strategy for California Coho Salmon, CDFG

"The California Department of Fish and Game, with the assistance of recovery teams representing diverse interests and perspectives, created the Recovery Strategy for California Coho Salmon, a guide for the process of recovering coho salmon on the north and central coasts of California. The Recovery Strategy emphasizes cooperation and collaboration at many levels, and recognizes the need for funding, public and private support for restorative actions, and maintaining a balance between regulatory and voluntary efforts."

Urban Streams Restoration Program, DWR

"The objectives of the Urban Streams Restoration Program are to assist communities in reducing damages from stream bank and watershed instability and floods while restoring the environmental and aesthetic values of streams, and to encourage stewardship and maintenance of streams by the community. With voter approval of Proposition 84, the Urban Streams Restoration Program will have available grant funding. Proposition 84 includes $18 million for the Urban Streams Restoration Program. DWR anticipates holding the first of two application cycles in mid 2007."

Water Recycling Programs, SWRCB

The State Water Resources Control Board administers three programs designed to assist local entities with water recycling programs. These programs are: Proposition 50 Integrated Regional Water Management Program (described above), State Revolving Fund Loans, and Water Recycling Loans and Grants.

WaterSense Program, USEPA

"WaterSense is a voluntary partnership program sponsored by the U.S. Environmental Protection Agency. Its mission is to protect the future of our nation's water supply by promoting and enhancing the market for water-efficient products and services."

Watershed Program, DWR

"The Department of Water Resources Watershed Program works with locally led stewardship efforts to integrate the needs of communities, urban and rural, with resource management that sustains watershed ecology."

Watershed Protection Programs, SWRCB

The State Water Resources Control Board administers several programs for watershed protection under Propositions approved by voters. These Propositions are: 13, 40, and 50.

Watershed Stewardship Program, Sotoyome Resource Conservation District

"The SRCD program focuses on education and collaboration within the community to restore resources, improve water quality and habitat, and monitor creeks and watersheds. Working together to find viable solutions for the restoration of the smaller tributary watersheds that will lead to improvements downstream in the main stem of the Russian River Watershed is one of the main goals of this program."

Wildlife and Sport Fish Restoration Programs Division of Federal Assistance, USFWS

"The mission of the Federal Assistance Program is to strengthen the ability of State and Territorial fish and wildlife agencies to meet the consumptive and non-consumptive needs of the public for fish and wildlife resources. The Division of Federal Assistance is responsible for administering grant programs to help States meet these needs."

Wildlife Habitat Incentives Program, NRCS

"The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land. Through WHIP USDA's Natural Resources Conservation Service provides both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat. WHIP agreements between NRCS and the participant generally last from 5 to 10 years from the date the agreement is signed."

7. Relevant Policies

California Endangered Species Act (CESA), California Environmental Protection Agency

Compliance with the CESA may be required for environmental projects and management practices. The CDFG administers CESA and can authorize exceptions to the state's prohibition against take of a listed species.

California Environmental Quality Act (CEQA), California Resources Agency

CEQA is a statue requiring state and local agencies to identify significant environmental impacts of proposed activities and to avoid or mitigate those impacts if feasible.

Endangered Species Act (ESA), US Environmental Protection Agency

The US FWS works with landowners to provide incentives to manage land for endangered species. In some instances land use activities qualify for exemptions to ESA prohibitions.

Mendocino County General Plan. Land Use Element of the Mendocino County General Plan, Natural Resources.

Section 13 — Water Resources sets policies to encourage land management to reduce water pollution, ensure adequate water supply, and protect the integrity of the flood plain.

Local Urban Water Management Plans, Local Municipalities

These plans set policies for the conservation of water during periods of water scarcity and drought. The following entities have filed Urban Water Management Plans with the Department of Water Resources: Sonoma County Water Agency, Cotati, Healdsburg, Rohnert Park, Santa Rosa, Sebastopol, Ukiah, and Windsor.

National Environmental Protection Act, US EPA

"The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet this requirement, federal agencies prepare a detailed statement known as an Environmental Impact Statement (EIS)."

Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program, SWRCB

"The information provided in this policy is designed to assist all responsible and/or interested parties in understanding how the State's NPS water quality control requirements will be implemented and enforced. The parties involved include the SWRCB and the RWQCBs, federal, state and local agencies, individual dischargers, designated third-party representatives and any other interested public and private parties."

Porter-Cologne Water Quality Control Act, SWRCB

This act provides for regional water quality control under the supervision of the State Water Resources Control Board. Regional Water Quality Control Boards were created to prescribe and define beneficial uses of water and to define standards necessary to maintain them.

Safe Water Drinking Act, US EPA

This act was intended to protect public health by regulating public drinking water supply. It requires the protection of drinking water and its' sources, including rivers, lakes, reservoirs, springs, and ground water wells.

Santa Rosa Citywide Creek Master Plan

The Plan contains "recommended habitat preservation, enhancement, and restoration projects, and improvements to the creekside trail system are presented conceptually and specifically by watershed. Project recommendations are based on community input, literature reviews, and extensive field survey work. Site-specific recommendations are presented in the text and on a set of Geographical Information System-based maps, organized by watershed area."

Santa Rosa General Plan

Chapter 7: 7-3 Biological Resources and Waterways, sets policies which maximize the benefits of open space, conserve the City's open spaces, conserve agricultural soils, conserve wetlands, vernal pools, wildlife ecosystems, rare plant habitats, and waterways, and conserve significant vegetation and trees, conserve water and maintain

water quality, and take actions to achieve and maintain ambient air quality standards.

Sonoma County General Plan

2.2 — Prevention of Soil Erosion, sets policies to promote and encourage soil conservation and management practices that maintain the productivity of soil resources.

3.0 — Policies for Water Resources, provides for conservation of water and protection of water quality, preservation of watersheds and groundwater recharge areas, development standards for recharge areas, and preservation of surface water and groundwater quality.

3.1 — Policy for Critical Habitat Areas, provides protection for critical areas including wetlands, marshes, and remnant upland habitat.

3.2 -Policy for Riparian Corridors, establishes streamside conservation areas or riparian corridor setbacks from land use activities.

4.1 — Policy for Parks and Equestrian and Hiking Trails, establishes a countywide park and trial system to meet anticipated future needs and protect agricultural uses.

4.2 - Policy for Bikeways, establishes a bikeways network to support both transportation and recreational bike use.

5.0 — Policy for Vegetation and Wildlife Resources, provides for conservation of biotic resources, and protection of rare and endangered species.

6.0 — Fishery Resources, provides for protection and conservation of freshwater and marine fishery and harbor resources.

Stormwater Final Rules, National Pollutant Discharge Elimination System (NPDES), USEPA

Website contains Phase I and Phase II NPDES regulations, extensions, and amendments.

Stream and Wetland System Protection Policy, NCRWQCB

This policy is a proposed amendment to the Water Quality Control Plans for the North Coast and San Francisco Bay Regions that will "protect stream and wetlands systems, including measures to protect riparian areas and floodplains."

Town of Windsor General Plan — 2015

Chapter 4 Community Development, sets policies for the development of recreational opportunities and preservation of water supply.

Chapter 6 Environmental Resources, proposes strategies for the protection and enhancement of open space resources, agricultural resources, water supply and quality, biological resources, cultural resources, extractive resources, and scenic resources.

US Tax Code Tax Reform Act of 1986, IRS

Provides tax deductions for wetlands donors and certain nonprofit organizations.

Water Bank Act, Farm Service Agency

This Act provides for the leasing of wetlands and adjacent uplands from farmers for waterfowl habitats for 10-year periods.

Wetlands Loan Act, USFWS

Provides for interest-free loans for wetlands acquisition and conservation easements.

Z'Berg-Nejedly Forest Practice Act, California Board of Forestry

This act authorizes regulation of timber harvest through the adoption of rules for each forest district in California. The rules are intended to be used as standards for preparing Timber Harvest Plans and evaluating effects of harvest operations.

8. Sources

California Department of Water Resources (DWR). 2005. California Water Plan Update 2005. Volume 3, Chapter 2 North Coast Hydrologic Region. 16 pages. Available at: http://www.waterplan.water.ca.gov/regions/nc/

CDFG Habitat and Biological Inventory Parameters for Russian River Basin Fisheries (CDFG 2007)

Cayan, D., Lynd, A., Hanemann, M., and G. Franco. 2006. Scenarios of Climate Change in California: An Overview. A Report From: California Climate Change Center. White Paper. 53 pages. Available at: http://www.climatechange.ca.gov/biennial_reports/2006report/index.html

Flosi, Gary; Downie, Scott; Hopelain, James; Bird, Michael; Coey, Robert; and Barry Collins. 1998. California Salmonid Stream Habitat Restoration Manual, Third Edition. Sacramento,

California, California Department of Fish and Game, Inland Fisheries Division.

Natural Resources Conservation Service (NRCS). 2003. Electronic Field Office Technical Guide. Available at: http://www.nrcs.usda.gov/Technical/efotg/.

NCRWQCB Monitoring Parameters, sample for Garcia River Sediment TMDL (NCRWQCB 2011)

NOAA/NMFS Habitat Attribute Indicators for Russian River Watershed CCC Coho (NMFS 2010)

SWRCB/ SWAMP Core Indicators for Beneficial Uses in California (SWAMP 2010/ SWAMP 2006)

Tetra Tech, Inc., 2006. *California Nonpoint Source Encyclopedia*. California State Water Resources Control Board. 281 pages.

US Environmental Protection Agency. 2006. Polluted Runoff (Nonpoint Source Pollution). Web Site. Available at: http://www.epa.gov/owow/nps/categories.html. Accessed 6/07.

U.S. Environmental Protection Agency (EPA). 2006. Hydromodification/Habitat Alteration. In: Polluted Runoff (Nonpoint Source Pollution). Web Site. Available at: http://www.epa.gov/owow/nps/categories.html. Accessed 5/07.

WATER QUALITY MANAGEMENT

1. Baseline Description

General Setting:

The Russian River is classified as impaired due to sediment, pathogens (two reaches of the Russian River and Santa Rosa Creek), and temperature on the EPA 303(d) List of Impaired Waterbodies. Impaired water quality impacts fish and other aquatic wildlife. Excessive sediment causes aggradation and pool infilling and reduces water clarity, impacting reproduction, shelter, and forage and excessive temperatures can be lethal to or reduce the fitness of salmonids and other cold water fish. Additionally, pathogen contamination eliminates the opportunity for human water contact recreation.

Causal Factors:

Anthropogenic activities are the cause of impairments above background levels in the Russian River. Agriculture, timber harvest, road construction, recreational activities, development, and other activities that create disturbance increase erosion in the watershed. Water diversions for agriculture, ranching, and residential use, dams, and the aggradation of the river bed from sedimentation contribute to increased temperatures in the river. Releases from aging onsite and public wastewater treatment systems and runoff containing domestic and wild animal waste has led to the pathogen impairment

2. Management Measure Description

The Water Quality Management MM promotes the enhancement of water quality in the Russian River watershed. The goal of this MM is the removal of the Russian River from the EPA 303(d) List of Impaired Waterbodies.

3. Resource Concerns

Inadequate Food Sources for Wildlife

Inadequate Shelter

Inadequate Water Quality

Soil Erosion — Concentrated Flow (ag)

Soil Erosion — Irrigation Induced

Soil Erosion — Mass movement

Soil Condition — Organic Matter Depletion

Soil Erosion — Roadbank and Construction Sites

Soil Erosion - Sheet and Rill
Soil Erosion — Shoreline

Soil Erosion — Streambank

Soil Erosion — Wind

Threatened and Endangered Fish and Wildlife Species

Water Quality — Excessive Nutrients, Pathogens, or Organics

Water Quality — Excessive Sediment

Water Quality — Harmful Levels of Heavy Metals

Water Quality — Harmful Temperatures of Surface Water

4. Management Practices

Recommended practices for water quality enhancement projects should include the following principles:

- Project planning is critical to success.
- Project should be evaluated to determine impacts and benefits prior to implementation
- Water quality should be evaluated within a watershed management context

- Post-project monitoring should be conducted to evaluate project success and provide information for adaptive management

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
CDFG	Emergent Transplant Installation	AC
CDFG	Dormant Willow or Cottonwood Sprig Installation	AC
CDFG	Container Plant Installation with Protective Shelters	AC
CDFG	Direct Seed Installation	AC
CDFG	Riparian Revegetation Project Maintenance	AC
CDFG	Slide Stabilization	FT
CDFG	Stream Bank Stabilization (boulder, log)	FT
CDFG	Native Material Revetment	FT
CDFG	Mulching	AC
CDFG	Willow Wall Revetment	FT
CDFG	Brush Mattress	FT
CDFG	Checkdams (redwood board, brush)	FT
CDFG	Waterbars	FT
SRCD	Exclusionary Fencing	FT
SRCD	Riparian Pastures	AC
NRCS	Waste Storage Facility (313)	NO
NRCS	Channel Vegetation (322)	AC
NRCS	Conservation Cover (327)	AC
NRCS	Critical Area Planting (342)	AC
NRCS	Waste Treatment Lagoon (359)	NO
NRCS	Waste Facility Cover (367)	NO
NRCS	Windbreak/Shelterbelt Establishment (380)	FT
NRCS	Fence (382)	FT
NRCS	Riparian Herbaceous Cover (390)	AC
NRCS	Riparian Forest Buffer (391A)	AC
NRCS	Fish Stream Improvement (395)	FT
NRCS	Grade Stabilization Structure (410)	NO
NRCS	Irrigation System, Tailwater Recovery (447)	NO
NRCS	Irrigation Water Management	AC
NRCS	Use Exclusion (472)	AC
NRCS	Mulching (484)	AC
NRCS	Pond Sealing or Lining (521)	NO
NRCS	Prescribed Grazing	AC
NRCS	Drainage Water Management (554)	AC
NRCS	Roof Runoff Structure (558)	NO
NRCS	Runoff Management System (570)	NO
NRCS	Streambank and Shoreline Protection (580)	FT
NRCS	Nutrient Management (590)	AC
NRCS	Pest Management (595A)	AC
NRCS	Subsurface Drain (606)	FT
NRCS	Tree/Shrub Establishment (612)	AC
NRCS	Watering Facility (614)	NO
NRCS	Waste Treatment (629)	NO
NRCS	Waste Utilization (633)	AC
NRCS	Wastewater Treatment Strip (635)	AC
NRCS	Water Harvesting Catchment	NO
NRCS	Water and Sediment Control Basin (637)	AC

5. Indicators and Ranking Criteria

The table below lists indicators identified in the Russian River Baseline Assessment (Smith 2007) that are relevant to instream water quality and their relationship to watershed ranking criteria developed by Smith (2007). Smith developed the ranking criteria and indicators from Critical Issues identified in the Russian River Plan of Action (2002).

INDICATORS	PRIMARY RANKING CRITERIA	SECONDARY RANKING CRITERIA
Channel Alteration	Stream Physical and Chemical Condition, Anadromous Fish Suitability, Stream Vulnerability	Hydrologic Regime/ Indictors of Hydrologic Alteration
LULC Runoff Increase		
Magnitude of Monthly Condition		
Magnitude and Duration of Annual Extremes		
Timing of Annual Extremes		
Frequency and Duration of High and Low Pulses		
Rate and Frequency of Change		
Riparian Canopy	Anadromous Fish Suitability	Anadromous Fish Habitat Condition/ Sediment/ Upper Water Temperature
Upper Water Temperature Steelhead		
Upper Water Temperature Coho		
Upper Water Temperature Chinook		
Species #1	Stream Vulnerability	Hydrologic Regime/ Indictors of Hydrologic Alteration
Species #2		
Fire Threat		Fire Impact Potential
Post Fire Erosion Potential		
Vineyard Expansion		Non-Developed Land Use Change Potential
Logging		Non-Developed Land Use Change Potential
Projected Urban Growth		Development Potential
Projected Urban Growth		Development Potential
Non-Conserved Public Lands	Stream Conservation Potential	
Conserved Lands		
Upper Water Temperature Steelhead		
Upper Water Temperature Coho		
Upper Water Temperature Chinook		

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Hydrology and Geomorphology	
Flow Conditions	**Salmonid Habitat:** North Coast and Central Coast ESU Salmonids freshwater habitat quality indicator benchmarks
Flow	
Instantaneous Flow	
Baseflow	
Stream Shading/ Canopy Cover	**Riparian Vegetation:** From "Poor to "Very Good" Canopy cover: <75 % average over IP-km, 75 to 85 %, 85 to 95 %, >95 %
Complex Habitat Types	**Channel Morphology and Connectivity**: From "Poor" to "Very Good"

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Floodplain Connectivity	**Floodplain connectivity:** <50 %, 50 to 80 %, >80 %, Not defined Physical barriers <50 of IP-km, 50 to 70 %, 70 to 90 %, >90 %
Stream Habitat Type	**Channel Morphology and Connectivity**: From "Poor" to "Very Good"
Chemical and Physical Characteristics	
Nitrates	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L
Pathogens (Drinking Water Rule, Basin Plan language)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Nutrients	Water Quality Indicators: "High" "Medium" and "Low Quality" Nitrogen Concentration: less than 0.5 mg/L, 0.5 to 1.0 mg/L, greater than 1.0 mg/L Phosphorus: less than 0.01 mg/L, 0.01 to 0.1 mg/L, greater than 0.1 mg/L
E. coli, enterococci (freshwater)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Toxicity (Acute)	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Metals	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Pesticides	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Conventionals: Bioaccumulative	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Chemical Indicators: DDTs	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Chemical Indicators: PCBs	Toxicity: From "Poor" to "Very Good" Acute, Sub-lethal or Chronic, Not Acute or Chronic, No evidence of toxins or contaminants
Biotic Condition	
Biological Conditions: Benthic Macro-invertebrates (BMI, streams)	BMIs: Threshold between "Good" and "Fair," out of 1.00 for reference condition. California Macroinvertebrate Observed/ Expected Index (O/E Index) score of 0.77; Western EMAP Macroinvertebrate Index of Biotic Integrity (IBI) score of 0.57.

Protocol & Data Sources

California Monitoring and Assessment Program (CMAP). The CAMP monitoring project was developed in collaboration with the SWRCB's Non-Point Source Pollution control Program (NPS), SWRCB's SWAMP program and the US EPA's Region IX.

Department of Water Resources (DWR) Integrated Water Resources Information System (IWRIS) http://www.water.ca.gov/iwris/

DWR Water Plan Information Exchange: hub with links to various databases http://www.waterplan.water.ca.gov/waterpie/index.cfm

DWR Water Plan and Updates: water quality improvement strategies and data on water use http://www.waterplan.water.ca.gov/waterquality/water_quality.cfm

EPA TMDL program http://www.epa.gov/OWOW/tmdl/

EPA WEMAP (Western Environmental Monitoring and Assessment Program; http://www.epa.gov/region09/water/wemap/surface.html) for physical habitat structure, sediment metabolism, sediment chemistry, water quality parameters, and riparian vegetation.

SWAMP http://www.swrcb.ca.gov/water_issues/programs/swamp/, including water quality and toxicity data at http://swamp.mpsl.mlml.calstate.edu/online-data

SWRCB North Coast Basin Plan http://www.waterboards.ca.gov/northcoast/water_issues/programs/basin_plan/basin_plan.shtml

SWAMP BMI, stream assessment, and other reports including Ode 2007, SWAMP 2005, and Ode and Rehn 2005 http://www.swrcb.ca.gov/water_issues/programs/swamp/

SWAMP protocols ("Standard Operating Procedures") http://swamp.mpsl.mlml.calstate.edu/ and selected reports under "Bioassessment" at http://www.swrcb.ca.gov/water_issues/programs/swamp/reports.shtml#bioassessment

USGS National Hydrography Dataset http://nhd.usgs.gov/

USGS National Water Information System (NWIS) http://waterdata.usgs.gov/nwis/rt

6. Relevant Programs

Agricultural Management Assistance Program, NRCS

> "Agricultural Management Assistance (AMA) provides cost share assistance to agricultural producers to voluntarily address issues such as water management, water quality, and erosion control by incorporating conserva-

tion into their farming operations. Producers may construct or improve water management structures or irrigation structures; plant trees for windbreaks or to improve water quality; and mitigate risk through production diversification or resource conservation practices, including soil erosion control, integrated pest management, or transition to organic farming."

Agricultural Water Quality Grant Program, SWRCB

"The Agricultural Water Quality Grant Program provides funding for projects that reduce or eliminate non-point source pollution discharge to surface waters from agricultural lands. Funding from Propositions 40 and 50 were administered through two solicitations, most recently the 2005-2006 Consolidated Grants Process. Additional funds will be made available in the future through Proposition 84."

The Coastal Watershed Planning and Assessment Program, CDFG

The Coastal Watershed Planning and Assessment Program (CWPAP) is a Department of Fish and Game (CDFG) program conducting fishery-based watershed assessments along the length of the California coast. Assessment basins are chosen as study areas based upon the nature of the socio-economic and natural resource problems within them. The CDFG Coho Recovery Plan and Steelhead Recovery Plan are useful in selecting basins as well. CWPAP has developed assessment methods, protocols and report outlines.

California Coastal Salmon and Watersheds Program, California Resources Agency

The goal of this program is to: recover harvestable salmon and steelhead populations, restore watersheds, and so contribute to building healthy communities."

California's Critical Coastal Areas Program

The purpose of California's Critical Coastal Areas (CCA) Program is "to foster collaboration among local stakeholders and government agencies and better coordinate resources and efforts in coastal-zone watershed areas critically in need of protection from polluted runoff (CCC undated)." The North Coast is one of four regional pilot CCAs in which the CCA Program will form teams comprised of local stakeholders and state, federal, and local agencies to develop community-based action plans to reduce polluted runoff in coastal zone watershed areas.

Clean Water Team Citizen Monitoring Program, SWRCB

The SWRCB provides support to citizens and local organizations who would like to improve water quality through pollution prevention and citizen-based monitoring programs.

Conservation Planning Assistance, NRCS

"The Natural Resources Conservation Service (NRCS) provides conservation planning and technical assistance to clients (individuals, groups, and units of government). These clients develop and implement conservation plans to protect, conserve, and enhance natural resources (soil, water, air, plants, and animals) within their related social and economic interests."

Education and Public Outreach Programs, SWRCB

The State Water Resources Control Board provides a web site with information regarding water quality education outreach to various interest groups, including business and industry, municipalities, schools, and tribes.

Education Program, Sotoyome Resource Conservation District

"The Sotoyome Resource Conservation District (SRCD) Education Program delivers adult and K-12 education that promotes an understanding of the interplay between agriculture and natural resources, and sponsors projects that address stewardship of our natural resources."

Endangered Species Protection Program, USEPA

The Endangered Species Protection Program seeks to protect endangered species from the use of pesticides and to minimize the impact of the program on pesticide users.

Endocrine Disruptor Screening Program, USEPA

The Endocrine Disruptor Screening Program "was created to screen pesticides, chemicals, and environmental contaminants for their potential affect on estrogen, androgen and thyroid hormone systems. Of the 50 known vertebrate hormones, the estrogen, androgen, and thyroid hormones play major

roles in ensuring the reproductive, developmental, and growth capabilities of humans and wildlife. Because these hormones are so important, development of methods and procedures to assess harmful effects of chemicals on these systems is necessary."

Environmental Contaminants Program, USFWS

The US Fish and Wildlife Service's "Environmental Contaminants Program includes contaminants specialists stationed at more than 75 locations around the country. Service contaminants specialists are on the front lines in the fight against pollution. They specialize in detecting toxic chemicals; addressing their effects; preventing harm to fish, wildlife and their habitats; and removing toxic chemicals and restoring habitat when prevention isn't possible."

Environmental Enhancement and Mitigation Program, The California Resources Agency

"The Environmental Enhancement and Mitigation Program was established by the Legislature in 1989. It offers a total of $10 million each year for grants to local, state, and federal governmental agencies and to nonprofit organizations for projects to mitigate the environmental impacts caused by new or modified state transportation facilities." Grants are awarded in three categories: 1) Highway landscape and urban forestry; 2) Resource lands, and 3) Roadside recreational.

Environmental Justice Small Grants Program, Cal/EPA

"Cal/EPA has established the EJ Small Grants Program to assist eligible community-based, grassroots, non-profit entities, and federally recognized tribal governments to address environmental justice issues."

Environmental Quality Incentives Program, NRCS

"The Environmental Quality Incentives Program (EQIP) was reauthorized in the Farm Security and Rural Investment Act of 2002 (Farm Bill) to provide a voluntary conservation program for farmers and ranchers that promotes agricultural production and environmental quality as compatible national goals. EQIP offers financial and technical help to assist eligible participants install or implement structural and management practices on eligible agricultural land."

Fisheries Restoration Grant Program, CDFG

The California Department of Fish and Game coordinates this grant program, which works towards the conservation and restoration of anadromous fisheries and watershed health.

Integrated Regional Water Management Grant Program, SWRCB

"The Integrated Regional Water Management (IRWM) Implementation Grants Program, funded by Proposition 50, Chapter 8, will provide approximately $64 million during Round 2. IRWM Implementation Grants will fund projects that meet one or more of the program objectives of protecting communities from drought, protecting and improving water quality, and improving local water security by reducing dependence on imported water. Implementation Grant proposals must be based on a qualified IRWM Plan."

Nonpoint Source Management Program — Clean Water Act Section 319, US Environmental Protection Agency

This Program was established through an amendment to the Clean Water Act in 1987 to provide grant money to support activities including technical and financial assistance, education and training, technology transfer, demonstration projects, and project success monitoring.

Nonpoint Source Pollution Control Programs, SWRCB

The State Water Resources Control Board administers several grant programs which assist local entities with nonpoint source pollution control. The grants are made available through voter approval of the following Propositions: 13, 40, 50, and 84.

Pesticide Environmental Stewardship Program, USEPA

This is "a voluntary program that forms partnerships with pesticide users to reduce health and environmental risk and implement pollution prevention strategies."

Recovery Strategy for California Coho Salmon, CDFG

"The California Department of Fish and Game, with the assistance of recovery teams representing diverse interests and perspectives,

created the Recovery Strategy for California Coho Salmon, a guide for the process of recovering coho salmon on the north and central coasts of California. The Recovery Strategy emphasizes cooperation and collaboration at many levels, and recognizes the need for funding, public and private support for restorative actions, and maintaining a balance between regulatory and voluntary efforts."

Storm Water Program, SWRCB

The State Water Resources Control Board has four programs to assist with Storm Water Management: Construction, Industrial, Municipal, and Caltrans.

Surface Transportation Program, US Department of Transportation

This program is a block grant program that may be used by states and local governments for any roads that are not functionally classified as local or rural minor collectors. Ten percent of allocated STP funds must be set aside by each state for transportation enhancements, including mitigation of water pollution due to highway runoff.

Volunteer Monitoring Program, USEPA

"The U.S. Environmental Protection Agency's (EPA) Office of Water encourages all citizens to learn about their water resources and supports volunteer monitoring because of its many benefits. Volunteer monitors build awareness of pollution problems, become trained in pollution prevention, help clean up problem sites, provide data for waters that may otherwise be unassessed, and increase the amount of water quality information available to decision makers at all levels of government."

Wastewater Construction Programs, SWRCB

The State Water Resources Control Board administers three programs designed to assist local entities with the construction of wastewater facilities. These programs are: Proposition 50 Integrate Regional Water Management Program (described above), Small Community Wastewater Grants, and State Revolving Fund Loans

Water Quality Service Learning Program, SWRCB

The State Water Resources Control Board has developed a web site designed to introduce teachers to student-centered investigation of polluted runoff. The site offers units of study, free lesson plans, online teacher support, and materials in Spanish.

Watershed Program, DWR

"The Department of Water Resources Watershed Program works with locally led stewardship efforts to integrate the needs of communities, urban and rural, with resource management that sustains watershed ecology."

Watershed Protection Programs, SWRCB

The State Water Resources Control Board administers several programs for watershed protection under Propositions approved by voters. These Propositions are: 13, 40, and 50.

Watershed Stewardship Program, Sotoyome Resource Conservation District

"The SRCD program focuses on education and collaboration within the community to restore resources, improve water quality and habitat, and monitor creeks and watersheds. Working together to find viable solutions for the restoration of the smaller tributary watersheds that will lead to improvements downstream in the main stem of the Russian River Watershed is one of the main goals of this program."

7. Relevant Policies

California Endangered Species Act (CESA), California Environmental Protection Agency

Compliance with the CESA may be required for environmental projects and management practices. The CDFG administers CESA and can authorize exceptions to the state's prohibition against take of a listed species.

California Environmental Quality Act (CEQA), California Resources Agency

CEQA is a statue requiring state and local agencies to identify significant environmental impacts of proposed activities and to avoid or mitigate those impacts if feasible.

City of Cloverdale Draft General Plan Update

Chapter 6 Conservation and Open Space Element, provides for protection of distinc-

tive natural vegetation, including riparian, wetlands, and upland ecosystems. Contains policies specifically intended to protect and enhance the natural beauty, habitat and biotic productivity of the Russian River through the use of conservation buffers, stormwater runoff management, habitat improvement, and the use of natural wetland treatment for expansionof wastewater treatment facilities.

City of Cotati General Plan

Chapter 17.50 — Watercourse and Riparian Resource Protection, sets provisions for adequate buffer areas between watercourses and adjacent development.

City of Healdsburg General Plan

Chapter 7 — Natural Resources, establishes policies that improve water quality and flows in the Russian River and Dry and Foss Creeks, promote conservation and restoration of native ecosystems and waterways, preserve the city's natural setting, protect the viability of agriculture, reduce greenhouse gas emissions, and protect riparian resources.

City of Rohnert Park General Plan

Chapter 5 — Open Space, Parks and Public Facilities, 5.5 Water Supply and Conservation, sets policies for monitoring of the municipal wellfield, requirements for developers to dedicate new well sites in locations identified by the City, requirement of water-conserving devices for new development, development of water and wastewater bmps, adoptiong of a tiered water conservation rate schedule.

City of Sebastopol General Plan

Chapter III: Conservation, Parks and Open Space, sets policies which preserve areas with important biotic resources, ensure the maintenance of wetlands adjacent to City boundaries as permanent open space, protect, maintain and restore wetlands areas, protect and preserve soil as a natural resource, conserve, protect and enhance trees and native vegetation, conserve energy, protect and improve air quality, provide for water conservation, reduce the volume of solid waste the City generates, provides an attractive and comprehensive system of parks and trials that meets all citizens' recreational needs, ensures that recreational facilities are developed in harmony with the surroundings, and incorporates the 1992 Laguna Park Master Plan. The Plan sets minimum buffers for urban land and farming operations adjacent to Laguna habitats, and sets policy to minimize the impacts of backyards adjacent to the Laguna, restore and enhance Laguna habitats, and recover declining species.

Clean Water Act, EPA, Army Corps of Engineers, USFWS, NOAA

Establishes a permit program for the discharge of pollutants into all waters of the US.

Coastal Zone Act Reauthorization Amendments, USEPA, NOAA

Amendments to the Coastal Zone Act to more specifically address effects of NPS pollution on coastal water quality. These amendments require each state with an approved Coastal Zone Management Program to develop a Coastal Nonpoint Pollution Control Program.

Endangered Species Act (ESA), US Environmental Protection Agency

The US FWS works with landowners to provide incentives to manage land for endangered species. In some instances land use activities qualify for exemptions to ESA prohibitions.

Mendocino County General Plan. Land Use Element of the Mendocino County General Plan, Natural Resources.

Section 13 — Water Resources sets policies to encourage land management to reduce water pollution, ensure adequate water supply, and protect the integrity of the flood plain.

National Environmental Protection Act, US EPA

"The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet this requirement, federal agencies prepare a detailed statement known as an Environmental Impact Statement (EIS)."

Policy for Implementation and Enforcement of the Nonpoint Source Pollution Control Program, SWRCB

"The information provided in this policy is designed to assist all responsible and/or interested parties in understanding how the State's NPS water quality control requirements will be implemented and enforced. The parties involved include the SWRCB and the RWQCBs, federal, state and local agencies, individual dischargers, designated third-party representatives and any other interested public and private parties."

Porter-Cologne Water Quality Control Act, SWRCB

This act provides for regional water quality control under the supervision of the State Water Resources Control Board. Regional Water Quality Control Boards were created to prescribe and define beneficial uses of water and to define standards necessary to maintain them.

Safe Water Drinking Act, US EPA

This act was intended to protect public health by regulating public drinking water supply. It requires the protection of drinking water and its' sources, including rivers, lakes, reservoirs, springs, and ground water wells.

Santa Rosa General Plan

Chapter 7: 7-3 Biological Resources and Waterways, sets policies which maximize the benefits of open space, conserve the City's open spaces, conserve agricultural soils, conserve wetlands, vernal pools, wildlife ecosystems, rare plant habitats, and waterways, and conserve significant vegetation and trees, conserve water and maintain water quality, and take actions to achieve and maintain ambient air quality standards.

Sonoma County General Plan

3.0 — Policies for Water Resources, provides for conservation of water and protection of water quality, preservation of watersheds and groundwater recharge areas, development standards for recharge areas, and preservation of surface water and groundwater quality.

Stormwater Final Rules, National Pollutant Discharge Elimination System (NPDES), USEPA

Website contains Phase I and Phase II NPDES regulations, extensions, and amendments.

Stream and Wetland System Protection Policy, NCRWQCB

This policy is a proposed amendment to the Water Quality Control Plans for the North Coast and San Francisco Bay Regions that will "protect stream and wetlands systems, including measures to protect riparian areas and floodplains."

Town of Windsor General Plan — 2015

Chapter 6 Environmental Resources, proposes strategies for the protection and enhancement of open space resources, agricultural resources, water supply and quality, biological resources, cultural resources, extractive resources, and scenic resources.

8. Souces

Flosi, Gary; Downie, Scott; Hopelain, James; Bird, Michael; Coey, Robert; and Barry Collins. 1998. California *Salmonid Stream Habitat Restoration Manual, Third Edition*. Sacramento, California, California Department of Fish and Game, Inland Fisheries Division.

Natural Resources Conservation Service (NRCS). 2003. Electronic Field Office Technical Guide. Available at: http://www.nrcs.usda.gov/Technical/efotg/.

State Water Resources Control Board (SWRCB). 2002. 2002 CWA Section 303(d) List of Water Quality Limited Segments. 196 pages. Available at: http://www.swrcb.ca.gov/tmdl/docs/2002cwa303d_listof_wqls072003.pdf

Tetra Tech, Inc., 2006. *California Nonpoint Source Encyclopedia*. California State Water Resources Control Board. 281 pages.

US Environmental Protection Agency. 2006. Polluted Runoff (Nonpoint Source Pollution). Web Site. Available at: http://www.epa.gov/owow/nps/categories.html. Accessed 6/07.

WETLAND RESTORATION AND MANAGEMENT

1. Baseline Description

General setting:

The quality and extent of wetland habitat in the Russian River watershed has drastically decreased, negatively

impacting endangered plant and animal species and wildlife populations. Changes in groundwater flow and the hyporheic zone due to hydrologic modification can cause wetlands to become too inundated or dry to support native vegetation. Additionally, wetland habitat is impacted by encroachment of invasive non-native plant and animal species such as invasive Ludwigia (*Ludwigia* sp.) and bullfrogs (*Rana catesbeiana*). The loss wetlands results in the decline of an important ecosystem service in the Russian River watershed — filtration and sequestration of pollutants.

Causal Factors:

Wetland habitat in the Russian River watershed has been severely reduced and degraded due to land uses including agriculture, ranching, and urban and residential development. Wetlands such as the Laguna de Santa Rosa have been drained to make the fertile soil available for agricultural pursuits and for residential and commercial development. Hydrologic modification for flood control or water supply has altered groundwater availability, impacting the structure, composition, and function of associated wetlands.

2. Management Measure Description

The Wetland Restoration and Management MM promotes the restoration and management of degraded or destroyed wetland habitat to re-establish ecological health and biodiversity necessary to comply with the habitat requirements of associated wildlife and improve the ecological function of the entire watershed. The goal of this MM is the restoration and management of wetland habitat function including 1) pollutant sequestration, 2) soil stabilization, 3) minimization of sediment delivery to surface waters, and 4) protection and enhancement of native plant and animal species.

3. Resource Concerns

Habitat Fragmentation
Inadequate Cover/Shade

Inadequate Food Sources for Wildlife

Inadequate Shelter

Inadequate Species Composition
Inadequate Water Quality

Inadequate Water Quantity

Inadequate Wildlife Movement/Travel Corridors

Inadequate Wildlife Territory

Invasive Non-native Plants

Soil Condition — Compaction

Soil Condition — Subsidence

Threatened and Endangered Fish and Wildlife Species

Water Quantity — Excessive Runoff, Flooding, or Ponding

Water Quality — Excessive Nutrients, Pathogens, or Organics

Water Quality — Excessive Sediment

Water Quality — Harmful Levels of Heavy Metals

Water Quality — Harmful Temperatures of Surface Water

4. Management Practices

Recommended practices for promoting the restoration and management of wetland should include the following principles:

- Project planning and adaptive management are critical to success.
- Wetlands or potential wetland creation sites should be evaluated from within a watershed context.
- Restoration and revegetation should attempt to replicate the natural system — local unimpacted sites should be used as reference sites when possible/practical.
- Seeds, transplants, and plant materials for propagation should be collected as close as possible to the project site (within project site watershed). Collection should be conducted to maximize genetic diversity of propagation material (from multiple plants in diverse locations and in the case of seeds, at different time intervals) and in a manner that minimizes impacts to the collection site.
- Post-project monitoring is vital to evaluate success and to provide information for adaptive management.

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
SRCD	Grazing for Weed Management	AC
NRCS	Brush Management (314)	AC
NRCS	Prescribed Grazing Wetlands (528 D)	AC
NRCS	Pest Management (595)	AC
NRCS	Restoration and Management of Declining Habitats (643)	AC
NRCS	Early Successional Habitat Development/Management (647)	AC
NRCS	Constructed Wetland (656)	AC
NRCS	Wetland Restoration (657)	AC

SOURCE AGENCY	RECOMMENDED BEST MANAGEMENT PRACTICE NAME (CODE)	UNIT TYPE
NRCS	Wetland Creation (658)	AC
NRCS	Wetland Enhancement (659)	AC

5. Indicators and Monitoring

POTENTIAL INDICATORS	POTENTIAL BENCHMARKS
Biotic Condition	
Vegetation seral stage distribution	**DBH (North):** <39 % class 5 and 6, 40 to 54 %, 55 — 69 %, >69 % Species composition: < 25 %, 25 to 50 %, >50 %, Historical conditions
Change in forest canopy	**Vegetation:** From "Poor to "Very Good" Canopy cover: <75 % average over IP-km, 75 to 85 %, 85 to 95 %, >95 %
Species composition, % cover native plants & non-native plants	**Vegetation:** From "Poor to "Very Good" Canopy cover: <75 % average over IP-km, 75 to 85 %, 85 to 95 %, >95 %
Plant survival and health	
Wildlife biodiversity	
Population density, distribution, structure T&E wildlife	
Landscape Condition	
Floodplain connectivity	**Floodplain connectivity**: <50 %, 50 to 80 %, >80 %, Not defined
Land use	**Land Use:** Unnatural Index (Agricultural + Urban) "Most Disturbed" is Greater than 40 %, "Least Disturbed" is less than 10 %; Percent Urban Greater than 25 %, Less than 5 %; Percent Agricultural Greater than 50 %, Less than 10 %
Road density	**Road Density**: From "Poor" to "Very Good" Road density: > 3 miles/ square mile, 3 to 2.5, 2.5 to 1.6, <1.6; Road density within 100 m. stream: >1 mile/ square miles, 1 to 0.5, 0.5 to 0.1, <0.1
Habitat connectivity	**Habitat connectivity**: <50 %, 50 to 80 %, >80 %, Not defined

Protocol & Data Sources

California Department of Fish and Game protocols http://www.dfg.ca.gov/wildlife/nongame/survey_monitor.html

California Rapid Assessment Method (CRAM) method for riparian condition measures: Collins et al 2008 http://www.cramwetlands.org/documents/

California Watershed Assessment Manual II Chapter 4 (Shilling 2005a; periphyton) and 5 (Shilling 2005b; benthic macroinvertebrates) http://cwam.ucdavis.edu/Volume_2/TOC.htm

EPA rapid bioassessment protocol (Barbour et al. 1999) http://www.epa.gov/owow/monitoring/rbp/ch06main.html

Riparian Bird Conservation Plan (California Partners in Flight and Riparian Habitat Joint Venture) methods for monitoring riparian bird populations http://www.prbo.org/calpif/htmldocs/riparian.html

SWAMP protocols ("Standard Operating Procedures") http://swamp.mpsl.mlml.calstate.edu/

and selected reports under "Bioassessment" at http://www.swrcb.ca.gov/water_issues/programs/swamp/reports.shtml#bioassessment

USGS National Water Quality Assessment Program (NAWQA) http://water.usgs.gov/nawqa/protocols/OFR02-150/index.html

California Department of Fish and Game (Regions 1 and 3 for the North Coast) http://www.dfg.ca.gov/about/data.html for Biogeographic Information and Observation System (BIOS; http://bios.dfg.ca.gov/), California Native Diversity Database (CNDDB; http://www.dfg.ca.gov/biogeodata/cnddb/),Coho stream habitat assessments, and other data sets; the

CDFG Watershed Assessment Program does fisheries-based assessments of coastal streams http://coastalwatersheds.ca.gov/

CalEpa and others: Environmental Protection Indicators for California (EPIC) project is responsible for developing and maintaining a set of "environmental indicators" for California. http://oehha.ca.gov/multimedia/epic/aboutepic.html

CalFlora (for specific plant species) http://www.calflora.org/

California Native Plant Society (for specific plant species) http://www.cnps.org/

EPAs Western Environmental Monitoring and Assessment Program (WEMAP) http://www.epa.gov/region09/water/wemap/surface.html

NOAA's National Marine Fisheries Service Central California Coast Coho Salmon Recovery Plan (in press)

NOAA's National Marine Fisheries Service Southern Oregon Northern California Coho Salmon Recovery Plan (in prep)

Riparian Habitat Joint Venture: data on riparian habitat restoration in California, especially for birds http://www.rhjv.org/

Riparian Bird Conservation Plan (California Partners in Flight and Riparian Habitat Joint Venture) monitoring data for some focal species http://www.prbo.org/calpif/htmldocs/riparian.html

Upland Erosion Control Protocols, Interim Restoration Effectiveness and Validation Monitoring Protocols, CDFG, 2003.

Habitat Unit Monitoring Procedures, Interim Restoration Effectiveness and Validation Monitoring Protocols, CDFG, 2003.

Quantitative Protocols for Effectiveness Monitoring of Roads and Upland Restoration Following Stressing Events, Interim Restoration Effectiveness and Validation Monitoring Protocols, CDFG, 2003.

Photographic Monitoring, Interim Restoration Effectiveness and Validation Monitoring Protocols, CDFG, 2003

Field Methods, Monitoring the Effectiveness of Upland Restoration, CDFG, 2005

Conducting Effectiveness Monitoring, Grazing Handbook, Sotoyome RCD, undated.

Best Management Practices (BMP) Monitoring Manual - Field Guide: Implementation and Effectiveness for Protection of Water Resources, USDA Forest Service, 2007. http://www.na.fs.fed.us/pubs/misc/bmp/06/bmp_field_guide_lr.pdf

Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Control Measures — Forestry, US Environmental Protection Agency. 1997. http://www.epa.gov/owow/nps/forestry/index.html

Techniques for Tracking, Evaluating, and Reporting the Implementation of Nonpoint Source Control Measures — Agriculture, US Environmental Protection Agency. 1997. http://www.epa.gov/owow/nps/agfinal.html

Late-Successional and Old-Growth Forest Effectiveness Monitoring Plan for the Northwest Forest Plan, USDA Forest Service, 1998.

Resource Monitoring and Habitat Monitoring, US Department of the Interior and The Nature Conservancy, 1998.

Sediment Delivery Inventory and Monitoring: A Method for Water Quality Management in Rangeland Watersheds, University of California Division of Agriculture and Natural Resources, http://anrcatalog.ucdavis.edu/pdf/8014.pdf

Field Techniques for Measuring Vegetation, Measuring and Monitoring Plant Populations, USDA BLM, 1998.

Chapter 5, Vegetation Monitoring Protocols, Fire Monitoring Handbook, USDI NPS, 2003, http://www.nps.gov/fire/fire/fir_eco_mon_fmh.cfm

Section 12, Crowns: Measurements and Sampling, 2004 Field Guide Version 2.0, USDA FS, 2002. http://www.fs.fed.us/ne/fia/datacollection/manualver2_0/index.html

Section 13, Vegetation Diversity and Structure, 2004 Field Guide Version 2.0, USDA FS, 2002. http://www.fs.fed.us/ne/fia/datacollection/manualver2_0/index.html

Field Methods, Monitoring Bird Populations in Small Geographic Areas, Canadian Wildlife Service, 2006, http://www.cws-scf.ec.gc.ca/publications/spec/PDF/mon_e.pdf

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6. Relevant Programs

5 Star Restoration Program, USEPA

> "The Five Star Restoration Program brings together students, conservation corps, other youth groups, citizen groups, corporations, landowners and government agencies to provide environmental education and training through projects that restore wetlands and streams. The program provides challenge grants, technical support and opportunities for information exchange to enable community-based restoration projects."

California's Critical Coastal Areas Program

> The purpose of California's Critical Coastal Areas (CCA) Program is "to foster collaboration among local stakeholders and government agencies and better coordinate resources and efforts in coastal-zone watershed areas critically in need of protection from polluted runoff (CCC undated)." The North Coast is one of four regional pilot CCAs in which the CCA Program will form teams comprised of local stakeholders and state, federal, and local agencies to develop community-based action plans to reduce polluted runoff in coastal zone watershed areas.

Coastal Program, USFS

> "The Coastal Program provides incentives for voluntary protection of threatened, endangered and other species on private and public lands alike."

Conservation Planning Assistance, NRCS

> "The Natural Resources Conservation Service (NRCS) provides conservation planning and technical assistance to clients (individuals, groups, and units of government). These clients develop and implement

conservation plans to protect, conserve, and enhance natural resources (soil, water, air, plants, and animals) within their related social and economic interests."

Education Program, Sotoyome Resource Conservation District

"The Sotoyome Resource Conservation District (SRCD) Education Program delivers adult and K-12 education that promotes an understanding of the interplay between agriculture and natural resources, and sponsors projects that address stewardship of our natural resources."

Endangered Species Protection Program, USEPA

The Endangered Species Protection Program seeks to protect endangered species from the use of pesticides and to minimize the impact of the program on pesticide users.

Environmental Contaminants Program, USFWS

The US Fish and Wildlife Service's "Environmental Contaminants Program includes contaminants specialists stationed at more than 75 locations around the country. Service contaminants specialists are on the front lines in the fight against pollution. They specialize in detecting toxic chemicals; addressing their effects; preventing harm to fish, wildlife and their habitats; and removing toxic chemicals and restoring habitat when prevention isn't possible."

Fish Friendly Farming, California Land Stewardship Institute

"Fish Friendly Farming provides an incentive-based method for creating and sustaining environmental quality and habitat on private land. Landowners and managers enroll in the program, learn environmentally beneficial management practices and carry out ecological restoration projects."

The Global Invasive Species Initiative, TNC

The Global Invasive Species Initiative is The Nature Conservancy's response to abating the damage caused to native biodiversity by the human-facilitated introduction of non-native, harmful invasive species. This web site provides many resources designed to help all conservationists deal most effectively with invasive species.

Integrated Regional Water Management Grant Program, SWRCB

"The Integrated Regional Water Management (IRWM) Implementation Grants Program, funded by Proposition 50, Chapter 8, will provide approximately $64 million during Round 2. IRWM Implementation Grants will fund projects that meet one or more of the program objectives of protecting communities from drought, protecting and improving water quality, and improving local water security by reducing dependence on imported water. Implementation Grant proposals must be based on a qualified IRWM Plan."

National Coastal Wetland Conservation Grant Program, USFWS

Under the National Coastal Wetland Conservation Grant Program, the US Fish and Wildlife Service "provides matching grants to States for acquisition, restoration, management, or enhancement of coastal wetlands."

Nonpoint Source Management Program — Clean Water Act Section 319, US Environmental Protection Agency

This Program was established through an amendment to the Clean Water Act in 1987 to provide grant money to support activities including technical and financial assistance, education and training, technology transfer, demonstration projects, and project success monitoring.

Nonpoint Source Pollution Control Programs, SWRCB

The State Water Resources Control Board administers several grant programs which assist local entities with nonpoint source pollution control. The grants are made available through voter approval of the following Propositions: 13, 40, 50, and 84.

Partners for Fish and Wildlife Program, USFWS

The mission of this program is "to efficiently achieve voluntary habitat restoration on private lands, through financial and technical assistance, for the benefit of Federal Trust Species. Migratory birds, inter-jurisdictional fish, federally-listed endangered, threatened or other declining or imperiled species are public resources, which by their migratory nature or

declining numbers on a national scale, have been identified as Federal Trust Species."

Pesticide Environmental Stewardship Program, USEPA

This is "a voluntary program that forms partnerships with pesticide users to reduce health and environmental risk and implement pollution prevention strategies."

Volunteer Monitoring Program, USEPA

"The U.S. Environmental Protection Agency's (EPA) Office of Water encourages all citizens to learn about their water resources and supports volunteer monitoring because of its many benefits. Volunteer monitors build awareness of pollution problems, become trained in pollution prevention, help clean up problem sites, provide data for waters that may otherwise be unassessed, and increase the amount of water quality information available to decision makers at all levels of government."

Wildlife Habitat Incentives Program, NRCS

"The Wildlife Habitat Incentives Program (WHIP) is a voluntary program for people who want to develop and improve wildlife habitat primarily on private land. Through WHIP USDA's Natural Resources Conservation Service provides both technical assistance and up to 75 percent cost-share assistance to establish and improve fish and wildlife habitat. WHIP agreements between NRCS and the participant generally last from 5 to 10 years from the date the agreement is signed."

7. Relevant Policies

California Endangered Species Act (CESA), California Environmental Protection Agency

Compliance with the CESA may be required for environmental projects and management practices. The CDFG administers CESA and can authorize exceptions to the state's prohibition against take of a listed s pecies.

California Environmental Quality Act (CEQA), California Resources Agency

CEQA is a statue requiring state and local agencies to identify significant environmental impacts of proposed activities and to avoid or mitigate those impacts if feasible.

City of Cloverdale Draft General Plan Update

Chapter 6 Conservation and Open Space Element, provides for protection of distinctive natural vegetation, including riparian, wetlands, and upland ecosystems. Contains policies specifically intended to protect and enhance the natural beauty, habitat and biotic productivity of the Russian River through the use of conservation buffers, stormwater runoff management, habitat improvement, and the use of natural wetland treatment for expansionof wastewater treatment facilities.

City of Cotati General Plan

Chapter 17.56 — Wetland Protection and Restoration, provides policy for protecting wetlands and permitting wetland restoration, enhancement, and mitigation projects.

City of Healdsburg General Plan

Chapter 7 — Natural Resources, establishes policies that improve water quality and flows in the Russian River and Dry and Foss Creeks, promote conservation and restoration of native ecosystems and waterways, preserve the city's natural setting, protect the viability of agriculture, reduce greenhouse gas emissions, and protect riparian resources.

City of Rohnert Park General Plan

Chapter 6 — Environmental Conservation, 6.2 Habitat and Biological Resources, sets policies for protection of special status species and special habitat areas, use of native plants for landscaping, and planting of low water use trees. Sets creek protection zones which prohibit development except greenway enhancement, requires evaluation and implementation of bank stabilization and erosion control measures.

City of Sebastopol General Plan

Chapter III: Conservation, Parks and Open Space, sets policies which preserve areas with important biotic resources, ensure the maintenance of wetlands adjacent to City boundaries as permanent open space, protect, maintain and restore wetlands areas, protect and preserve soil as a natural resource, conserve, protect and enhance trees and native vegetation, conserve energy, protect and improve air quality, provide for water conservation, reduce the volume of solid

waste the City generates, provides an attractive and comprehensive system of parks and trials that meets all citizens' recreational needs, ensures that recreational facilities are developed in harmony with the surroundings, and incorporates the 1992 Laguna Park Master Plan. The Plan sets minimum buffers for urban land and farming operations adjacent to Laguna habitats, and sets policy to minimize the impacts of backyards adjacent to the Laguna, restore and enhance Laguna habitats, and recover declining species.

Coastal Zone Management Act, NOAA

Provides federal funding for wetlands programs in coastal states, including the preparation of Coastal Zone Management Plans.

Endangered Species Act (ESA), US Environmental Protection Agency

The US FWS works with landowners to provide incentives to manage land for endangered species. In some instances land use activities qualify for exemptions to ESA prohibitions.

Food, Agriculture, Conservation, and Trade Act of 1990, NRCS

Provides for acquisition perpetual non-development easements on farmed wetlands and subsidizes restoration of wetlands from croplands.

Food Security Act of 1985 (Swampbuster), FARM SERVICE AGENCY, USFWS

Suspends subsidies to farmers who convert wetlands to farmland. Allows Farmer's Home Administration and the Farm Service Agency to forgive farm debts in exchange for long-term easements that protect wetlands.

Mendocino County General Plan. Land Use Element of the Mendocino County General Plan, Natural Resources.

Section 8, Natural Areas sets policies to protect natural areas under public and private ownership.

Section 12, Vegetation and Wildlife sets policies to retain and restore native vegetation, including riparian vegetation, wetlands, and rare and unique vegetation and to promote wildlife habitat protection and improvement and endangered species protection on private lands. Section 13, Water Resources sets policies to encourage land management to reduce water pollution, ensure adequate water supply, and protect the integrity of the flood plain.

National Environmental Protection Act, US EPA

"The National Environmental Policy Act (NEPA) requires federal agencies to integrate environmental values into their decision making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions. To meet this requirement, federal agencies prepare a detailed statement known as an Environmental Impact Statement (EIS)."

Santa Rosa General Plan

Chapter 7: 7-3 Biological Resources and Waterways, sets policies which maximize the benefits of open space, conserve the City's open spaces, conserve agricultural soils, conserve wetlands, vernal pools, wildlife ecosystems, rare plant habitats, and waterways, and conserve significant vegetation and trees, conserve water and maintain water quality, and take actions to achieve and maintain ambient air quality standards.

Sonoma County General Plan

3.0 — Policies for Water Resources, provides for conservation of water and protection of water quality, preservation of watersheds and groundwater recharge areas, development standards for recharge areas, and preservation of surface water and groundwater quality.

3.1 — Policy for Critical Habitat Areas, provides protection for critical areas including wetlands, marshes, and remnant upland habitat.

5.0 — Policy for Vegetation and Wildlife Resources, provides for conservation of biotic resources, and protection of rare and endangered species.

Stream and Wetland System Protection Policy, NCRWQCB

This policy is a proposed amendment to the Water Quality Control Plans for the North Coast and San Francisco Bay Regions that will "protect stream and wetlands systems, including measures to protect riparian areas and floodplains."

Town of Windsor General Plan — 2015

Chapter 6 Environmental Resources, proposes strategies for the protection and enhancement of open space resources, agricultural resources, water supply and quality, biological resources, cultural resources, extractive resources, and scenic resources.

US Tax Code Tax Reform Act of 1986, IRS

Provides tax deductions for wetlands donors and certain nonprofit organizations.

Water Bank Act, Farm Service Agency

This Act provides for the leasing of wetlands and adjacent uplands from farmers for waterfowl habitats for 10-year periods.

Wetlands Loan Act, USFWS

Provides for interest-free loans for wetlands acquisition and conservation easements.

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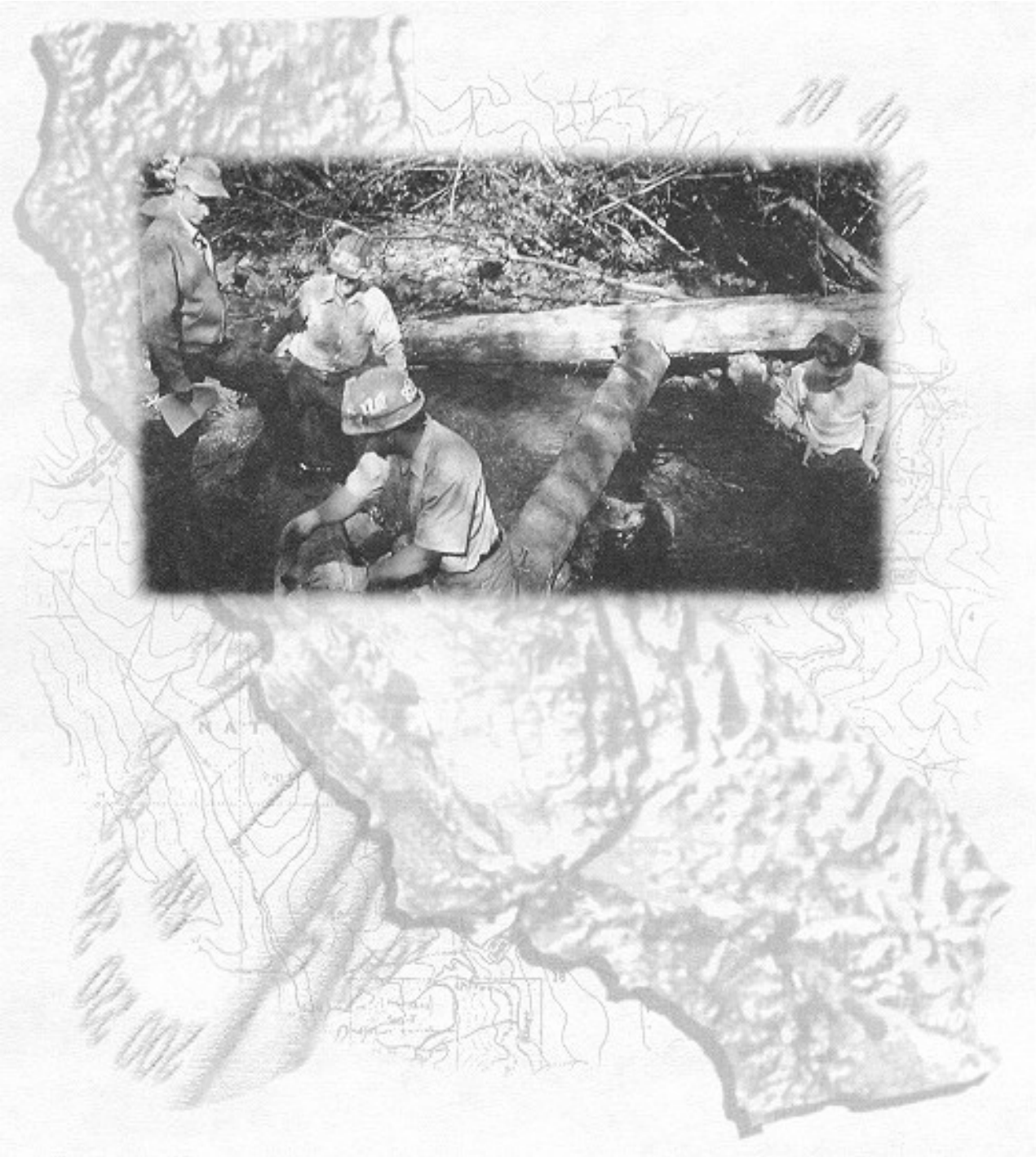
CALIFORNIA SALMONID STREAM HABITAT RESTORATION MANUAL

PART VII

PROJECT IMPLEMENTATION



PART VII PROJECT IMPLEMENTATION

When critical habitat has been determined to be lacking, placement of suitable structures or other remedial actions may be appropriate. If structural options are selected, some essential physical parameters must be considered. Project location and access, available structural materials, stream flow volume and velocity, current and expected land use practices, watershed stability, stream channel and bank stability, and bedload and debris transport are basic parameters that must be considered before instream improvement structures are installed. Hydraulic cross sectional analysis should always be performed to assure passage of bankfull flows.

Kinetic energy of a stream determines its ability to move materials. Maximum kinetic energy is generated during bankfull flow, usually related to storms. Bankfull flows may also occur because of released storage in regulated streams. It is during these bankfull flow events that maximum bedload transport and channel formation occurs. As flows subside, deposition and additional stream channel forming processes occur.

Numerous factors including watershed condition, channel configuration, and instream structure regulate bedload transport through a system. The coupling of water energy and bedload limits the opportunities for placement of stable fish habitat structures.

SELECTION OF STABLE SITES

Stable habitat restoration sites with appropriate hydrologic channel characteristics afford the greatest opportunity for successful structure installation. Review of site suitability for project work must incorporate an assessment of natural features of the stream. For example, observation of deposition and scour areas on stream banks will reveal the range of flows in the stream. At each potential structure site, the following factors should be analyzed to determine if a structure will be suitable, stable, and effective.

Gradient

For many structures, sites with gradients less than 0.5 percent or greater than four percent are poor candidates. Stream reaches with gradients of less than 0.5 percent are frequently depositional areas. Partial channel spanning structures that constrict flow such as single and opposing wing deflectors or constricting weirs, can be used to increase water velocities, creating habitat by deepening channels.

High gradient stream reaches greater than four percent are difficult to control. The substrate in these streams is often bedrock or boulder and usually lacks spawning gravel. Full channel spanning structures designed to trap gravel must be placed very close together to reduce the flushing effect of high stream flow velocity. Hydraulic forces present in excessively high gradient streams increase stress and the probability of structural failure, and reduces the number of alternative treatments and the chance of a project succeeding.

Stream Width

Sites in reaches that are slightly wider than mean stream width are the best candidates for successful channel spanning structures. Velocities in these areas will be lower than more constricted reaches, providing a natural energy control. However, overly wide channels will typically be areas of deposition and are unsuitable for other than channel constricting structures.

Substrate

Bedload deposition tends to occur in areas of mean stream width or wider. These areas provide the greatest opportunity for placement of substrate scour or deposition structures. Channel spanning structures may be placed to capture gravel or other bedload materials on the upstream side of the structure, and create scour downstream. A series of structures can redistribute bedload and create reaches containing gravel deposition, cover, and scoured pools. Free-standing structures are typically unstable because of periodic bedload movement associated with high flows.

Highly compacted substrate creates special construction problems for placement of instream fish habitat structures. Heavy equipment or specialized techniques may be required to securely anchor structures at these sites. For this reason, construction costs are often prohibitive and long term stability is uncertain.

Bedrock substrate provides a good anchor for instream structures using cable or rebar and polyester resin adhesive. The bedrock foundation for a stable structure must be un-fractured and durable.

Stream Order

Lower order streams, at appropriate sites, can usually be controlled with standard habitat restoration structures. Higher order streams typically have high stream power and require large construction materials and larger or more complex structures, making site selection even more critical.

Reach Length

Generally, a reach should be long enough so that structures can be placed in a series. When structures are placed in a series, the most upstream and downstream structures create velocity control points. These controls can be particularly important in areas where deposition of gravel is the purpose of the structure.

Channel Sinuosity

Sinuous stream reaches are areas of scour and deposition. To be effective in these reaches, a structure must be fitted to the bend in the stream. For example, diagonal weirs located on a bend will trap gravel while downstream-V weirs at the same site generally will not. Generally, sinuous stream reaches are not desirable locations for structures built in a series.

Bank Stability

The choice of suitable structures is limited by the stability of stream banks at the site. For example, structures that direct flow into unstable banks will result in bank erosion and possible structural failure. Stable banks are essential to structural integrity in channel spanning structures.

Bank Morphology

Stability of habitat structures will be affected by stream bank morphology. Especially steep banks will result in rapidly rising stream surface elevation with increased flows overtopping installed structures. Unconfined stream banks will result in rapid widening of the stream, with increased flows potentially relocating the stream channel and circumventing the structure. Bedrock or well consolidated stream banks provide a stable base for structure placement, whereas poorly consolidated stream banks require riprap or other durable material for protection.

The extent to which boulders and woody structures protrude from the stream bank into the channel will provide a reasonably good guideline for placement of stream bank associated habitat structures. For comparative purposes, look at natural channel features that presently produce habitat similar to that which needs to be increased. Projects should use successful natural features as guidelines for design and location of structures whenever possible.

HYDRAULIC IMPACTS

A familiarity with the principles of stream hydraulics is important when designing site specific instream habitat enhancement structures because it is necessary to predict hydraulic impacts of each project to ensure that it will achieve the desired result. Inter-Fluve Inc. has developed a method for predicting hydraulic impacts, "Using Basic Hydraulic Analysis for In-Channel Design" (G. Koonce and M. Kiesse, Inter-Fluve Inc., personal communication). However, due to the myriad of factors affecting streams it remains difficult to measure and predict the precise outcome of a new structure to a stream. Evaluation of each project site for successes, failures, and causes is useful for developing skills of selection, design, and construction of habitat improvement structures.

For any single structure such as a diagonal log weir, the location of stream scour and deposition is relatively predictable. As structures become more complex, or a series of structures is developed, scour and deposition becomes more difficult to predict.

Scour is predictable at four locations in a stream: on the outside of bends, below waterfalls or cascades, at a constriction, or at a steepened gradient. The amount of scour generated by a structure has built-in limitations controlled by the kinetic energy budget of the stream.

Similarly, deposition can be predicted at three locations in a stream: on the inside of bends, in quiet water areas such as eddies where stream energy has been dissipated, and on the upstream side of natural sills or structures where flow is obstructed.

Height of a structure or relative radius of a bend influences the amount of scour or deposition. For example, stream flow and energy gradient, combined with effective height of a structure will dictate the depth of scour. In general, the higher the structure the deeper the plunge, up to the point of energy limitations (Figure VII-1). The need for upstream migration of adults or juveniles is a very important consideration when deciding how high to build a structure. Jumps in excess of 12 inches are to be avoided. If the gradient of the stream dictates a structure of over 12 inches in height, a low-flow notch at the thalweg is required to improve upstream migration for juveniles.

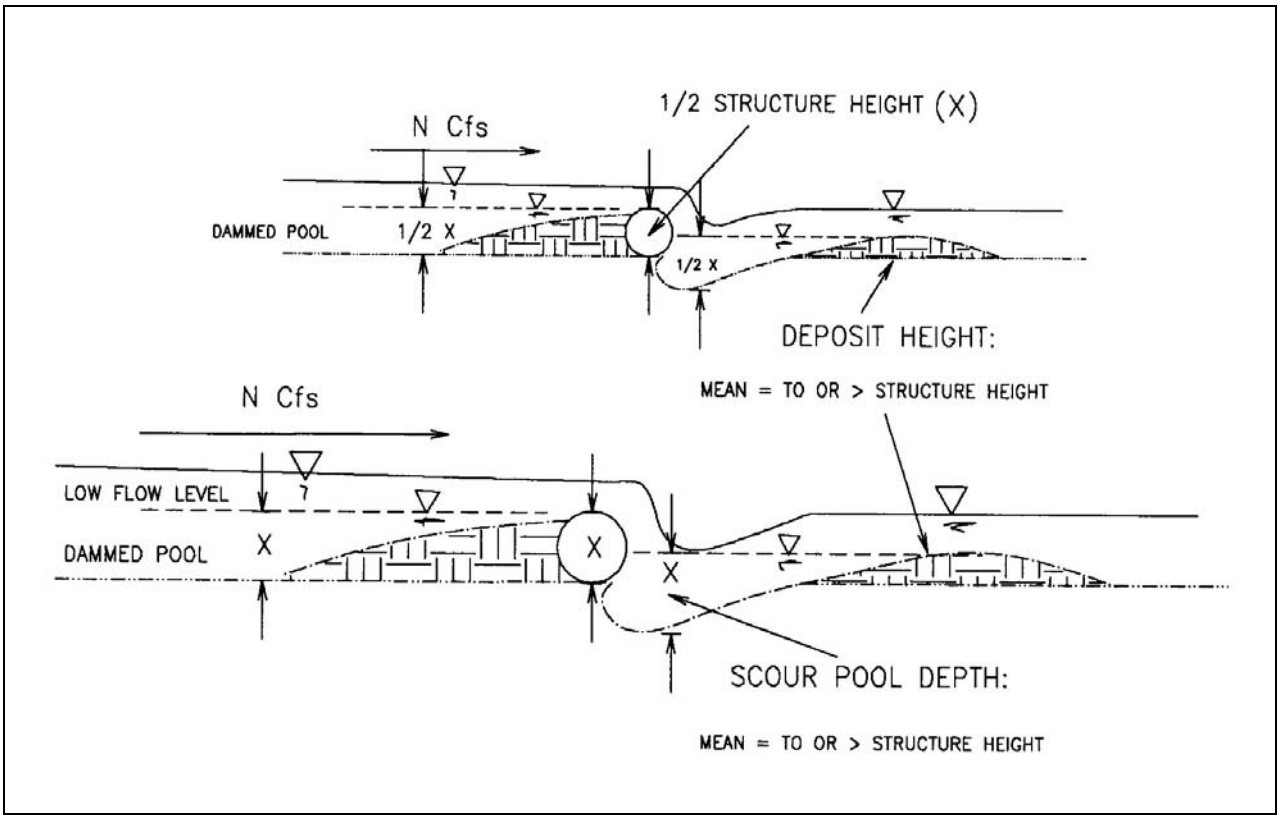


Figure VII-1. Typical structures of variable height in the same stream reach create pool depths and deposition heights directly related to structural heights (Anderson, 1988).

Without attempting formal hydraulic engineering analysis, observation of an existing structure in a stream will give a good indication of the scour that can be expected for a similar structure. Structures that obstruct flow tend to produce bars downstream that are nearly as tall as the structure.

Where water overtops a structure, the vertical angle of the downstream face strongly influences potential stability of the structure by directing the impact of the plunge flow. A vertical face will result in scour directly at the toe and may undercut the structure. With some designs of log structures this may be desirable but for boulder structures in deep alluvial streams this may result in structure failure. Undercutting can be avoided by placement of downstream rows of successively deeper boulders to provide a sloping face (Figure VII-2) that directs plunge flow away from the structure.

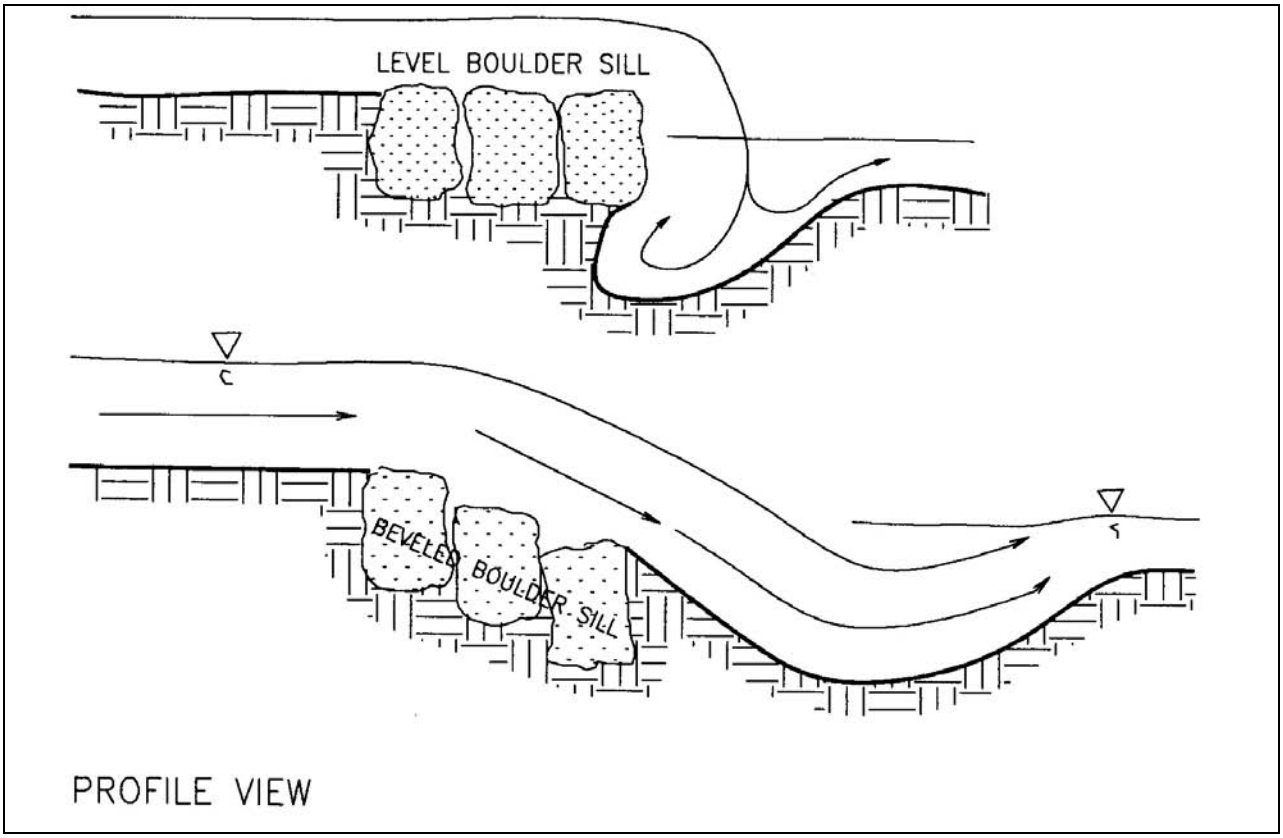


Figure VII-2. Comparison of level and sloping boulder face affect on flow into plunge pool (Overton, 1987).

Length of a full-spanning structure relative to the perpendicular stream width affects the stream's energy budget above and below the structure. Structures perpendicular to flow, such as straight log weirs, generally increase velocities because they narrow the high-flow channel. This happens because of the constriction created by the anchoring structures required to protect the ends of the weir. Structures such as diagonal log weirs that are two to three times the mean stream width will widen the hydraulic cross section, thus decreasing velocities.

Structures placed level on stream grade will produce even cross-sectional flows with very predictable deposition areas above and below the structure. Structures of irregular heights will break up these even flows and produce irregular scour and deposition areas. Although structures of irregular height are not as stable as those placed level, they can enhance salmonid spawning and rearing by increasing diversity of cover in the form of turbulence and scoured pools. The simpler the design the more likely it will be that hydraulic impacts can be forecast. It is more difficult to reliably predict the outcome of complex structural arrangements largely because of multiple and unequal flow vectors generated.

Channel constrictions are common natural occurrences and can be easily duplicated with structures. Bedload is moved through the constricted area and scour is created and maintained within the constraints of the available kinetic energy budget. Structures such as upstream-V weirs, and single and opposing wing-deflectors are examples of channel constrictors. A channel can also be widened to spread out the flow and diminish concentration of energy. This usually will result in

channel aggradation. Downstream-V weirs and diagonal weirs are common structures for this purpose.

Multiple structures placed in a stream reach or complex structures such as log, root wad, and boulder combinations can create complex habitat with a wide variety of habitat niches.

SELECTION OF MATERIALS

The site often dictates which types of materials and which techniques must be used to successfully accomplish a stream habitat enhancement project. Selection of materials should come only after considering all factors. Factors to consider include:

- What are project objectives?
- What are funding limitations?
- What is expected life of the structure?
- What materials are on-site or nearby?
- If materials must be imported, are they economically available in adequate quality and quantity?
- Can the material of choice successfully be held in place during a major hydrological event?
- Will placement of enhancement structures require mechanized equipment, a large work crew or a combination?
- Are there access roads to the project site or a feasible way to get equipment and materials to the stream?
- Are the materials of choice aesthetically acceptable?

These considerations, together with the following information should be useful for choosing appropriate materials for fish habitat improvement structures.

Basic Structural Materials

Gabions

Gabions are heavy wire-mesh baskets that are filled with rocks or other hard material. They have been used to build instream structures such as weirs and wing deflectors. After several years, the wire mesh typically deteriorates due to abrasion, leaving broken and protruding wire from the disintegrating baskets. This creates a hazard to fish and humans. DFG recommends that gabions never be used within the flood prone area. Gabions can be useful as buried dead man anchors.

Gabion wire baskets are formed using the wire ties provided with the gabions. The empty gabions are firmly anchored and filled with rock. It is best to use angular, durable, un-fractured rock with a flat side facing the exterior of the gabion. When more than one gabion is used, secure the gabions together with heavy wire.

Logs

Logs can be used individually, or in combination with other logs, root wads, or boulders. Longevity is highly dependent on the tree species and percentage of time that the log is saturated. Redwood, western red cedar, Port Orford cedar, and Douglas fir can be expected to last the longest. Spruce, hemlock, white fir, pine, and hardwoods are least durable. The longevity of most logs can also be increased by removing their bark. Logs are buoyant and will float if not secured or weighted down adequately.

Logs can be used for a variety of applications: weirs, wing-deflectors, digger logs, cover structures, cribbing, and bank armor. Full-channel log structures are susceptible to washout or destabilization during periods of high stream flow if not adequately secured.

Root Wads

A root wad with an extensive root network can provide complex fish habitat throughout the year depending on where it is placed. Root wads can be anchored in a variety of locations including mid-channel, at the stream margins, or in pools, to enhance summer and winter habitat. Root wads with a long section of log intact are most valuable since they are easier to secure in place. Root wads must be well secured, preferably to bedrock, boulders, or stable logs.

Boulders

Competent boulders can be used in a variety of applications. They are especially suited for instream structures including weirs, wing-deflectors, and boulder clusters. Boulders are used extensively as riprap to stabilize failing stream banks. Logs, root wads, and boulders are often used in combination to form cover structures.

Boulders are among the most aesthetically pleasing of all stream enhancement structural materials. It is often difficult to tell whether their presence or arrangement is natural, or the product of habitat improvement efforts. Stream size does not limit their suitability. In wide stream channels, boulder weirs are more stable than log weirs because of the tendency for logs to float and disassemble.

The ideal situation is to locate a source of boulders close to the work site. The boulders must be of appropriate size, only use boulders that are as large or larger than those already in the stream channel. They must also be available in adequate quantity, and be un-fractured so they will withstand rough treatment during loading, unloading, and placement. Highly durable boulders are essential if cable and polyester resin adhesive are used to secure the boulders.

Angular quarry boulders are more stable under high stream flow conditions than round stream boulders. Burying approximately one-third of a rounded boulder into the substrate can help compensate for this drawback. Boulders should not be taken from the streambed if their removal decreases existing suitable habitat.

Boulder weights can be estimated by the size of the boulder. The following table estimates the weight of a boulder as approximately 150 pounds per cubic foot.

Diameter (feet)	Volume (cubic feet)	Weight (lbs)
2.0	4.2	627
2.5	8.2	1224
3.0	14.1	2115
3.5	22.4	3359
4.0	33.4	5014
4.5	47.6	7139
5.0	65.3	9793

Heavy equipment is usually required for transporting and positioning boulders. If access to the project site is unsuitable for a dump truck, cost per boulder will increase because of the additional time necessary for a front end loader or bulldozer to deliver individual boulders. Under some circumstances it may be most cost effective to transport and place boulders by helicopter.

At remote sites, boulders may be moved a short distance with hand tools such as a griphoist. An effective method for preparing to move a boulder is to drill a hole in the boulder and secure a short section of cable to the boulder using polyester resin adhesive (Figure VII-3). The griphoist cable is secured to the cable in the boulder with cable clamps. In some cases, chokers or rock nets are also used to move boulders. Griphoists must be secured to an anchor that is either found or created and should be in-line with the boulder and the final desired location. If anchoring to a live tree, measures must be taken to protect the tree. An anchor can be made by drilling a hole in bedrock or in a large boulder and securing a section of cable with polyester resin adhesive.

An effective technique is for one person to operate the griphoist while a second person works behind the boulder with a pinch bar to help guide the boulder and to prevent binding. Snatch blocks can be used to increase the pulling capacity of the griphoist, or to change the angle of pull. A griphoist is equally effective in moving large logs.

Miscellaneous Structural Materials

Geotextile fabric and woven-wire fencing material are often used together on log bank stabilization structures before back-filling with cobble and boulders. The material serves to retain bedload or fill material and help establish and maintain the integrity of the habitat structure.

Geotextile Fabric

Geotextile fabric is available in a variety of textural weaves, strengths, and pore sizes. It is not easily punctured or torn and is available in UV-resistant form for applications where it may be exposed to sunlight. Regardless of pore size, it appears that accumulations of fine sediment and sand eventually prevent movement of water through it. It can also be used effectively as a silt trap during construction of instream structures.

Wire Fencing

High quality wire fencing is woven rather than welded and must be galvanized to ensure longevity. Some types of fencing are PVC-coated and generally have excellent longevity, especially if covered with rock.

Geotextile fabric and wire fencing are often used together on log bank stabilization structures. The geotextile fabric prevents the fine sediment from flowing under the logs and the wire fencing adds structural stability. When using wire fence to add structural stability to a log bank stabilization structure, care must be taken to ensure the wire is properly anchored down and back-filled.

It was once common practice to install geotextile fabric and wire fencing on the upstream side of log channel-spanning structures to prevent water from flowing under the log. This practice has been discontinued. Often, the fabric and wire are lifted over the log structure by the hydraulic force of the water. This can result in the wire posing a potential hazard to people and fish.

Concrete

Concrete is a building material made by mixing cement, sand and gravel with water. Concrete is used to build walls and floors in projects such as fishways and culverts. Concrete cures under water. However, care must be taken to prevent concrete from leaking into the stream, since it is toxic to fish (pH shock) until set and cured. Broken concrete has been used in some areas as riprap. This is not recommended, since its density and resistance to scour are less than that of most rock and it usually does not stay in place or last long.

Wire Rope

Wire rope or cable comes in a variety of diameters and types. Stainless steel cable has the longest life, but is very expensive. Galvanized wire rope is coated with zinc to improve rust resistance. It is relatively free of grease coating, making it suitable for polyester resin adhesive applications. Its longevity is probably greater than non-galvanized steel wire rope. Non-galvanized steel wire rope is lubricated to alleviate abrasion between wire strands when the cable is in motion and under stress. The grease also helps to retard rusting.

There are several ways to cut wire rope in the field. Guillotine type cable cutters are commonly used. These work well but tend to fray the end of the cable making it difficult to push the end of the cable into a hole drilled in a boulder or bedrock using polyester resin adhesive. A skill saw equipped with a metal cutting blade makes a clean cut of the cable, leaving no frayed ends.

ANCHORING TECHNIQUES

The failure of an anchor is probable unless the structure is properly constructed following these recommended techniques. Steel rebar, wire rope, and expansion bolts are the most commonly used materials for anchoring systems. All have several varied applications. Trenching and the use of a deadman are techniques used to stabilize and hold structures in place.

Cabling to Boulders or Bedrock Using Polyester Resin Adhesive

When dealing with durable, un-fractured boulders or bedrock, the cable and polyester resin adhesive technique is a cost effective method of anchoring stream enhancement structures (Figure VII-3). The technique can be used to secure boulders in sequence, or to secure logs or root wads to boulders or bedrock. This anchoring technique can be accomplished using rock drills capable of drilling holes up to one inch in diameter, at a variety of angles.

Before using polyester resin adhesives, read and follow all manufacturer's labels concerning use of this product. Polyester resin adhesives can be used in wet or dry conditions. The hole diameter drilled must be no more than one-eighth inch larger than the cable to be used and should be approximately 10 inches deep. Clean the hole using water or air and a brush to remove all debris. All the rock dust must be removed from the hole or the polyester resin adhesive will adhere to the dust and not to the rock. Use clear, clean water to thoroughly clean drilled holes and ensure the polyester resin adhesive will adhere to the rock, not the dust or silt. Cut the cable to the proper length, keeping cable slack to a minimum between the fastening points. Clean the cable using acetone or muriatic acid. Galvanized wire rope is relatively free of grease and requires much less cleaning than lubricated wire rope. The cable must be absolutely free of oil to get a good bond with the polyester resin adhesive. It is important when using acetone or muriatic acid that precautions are taken to protect the person doing the cleaning, and that it is accomplished away from the stream in case of an accidental spill. Fill the hole approximately two-thirds full with polyester resin adhesive. Insert the cable, turning slowly when possible, until the cable hits the bottom of the hole. Air pockets left at the bottom of the hole reduces bonding strength. Polyester resin adhesive must be used prior to the indicated expiration date.

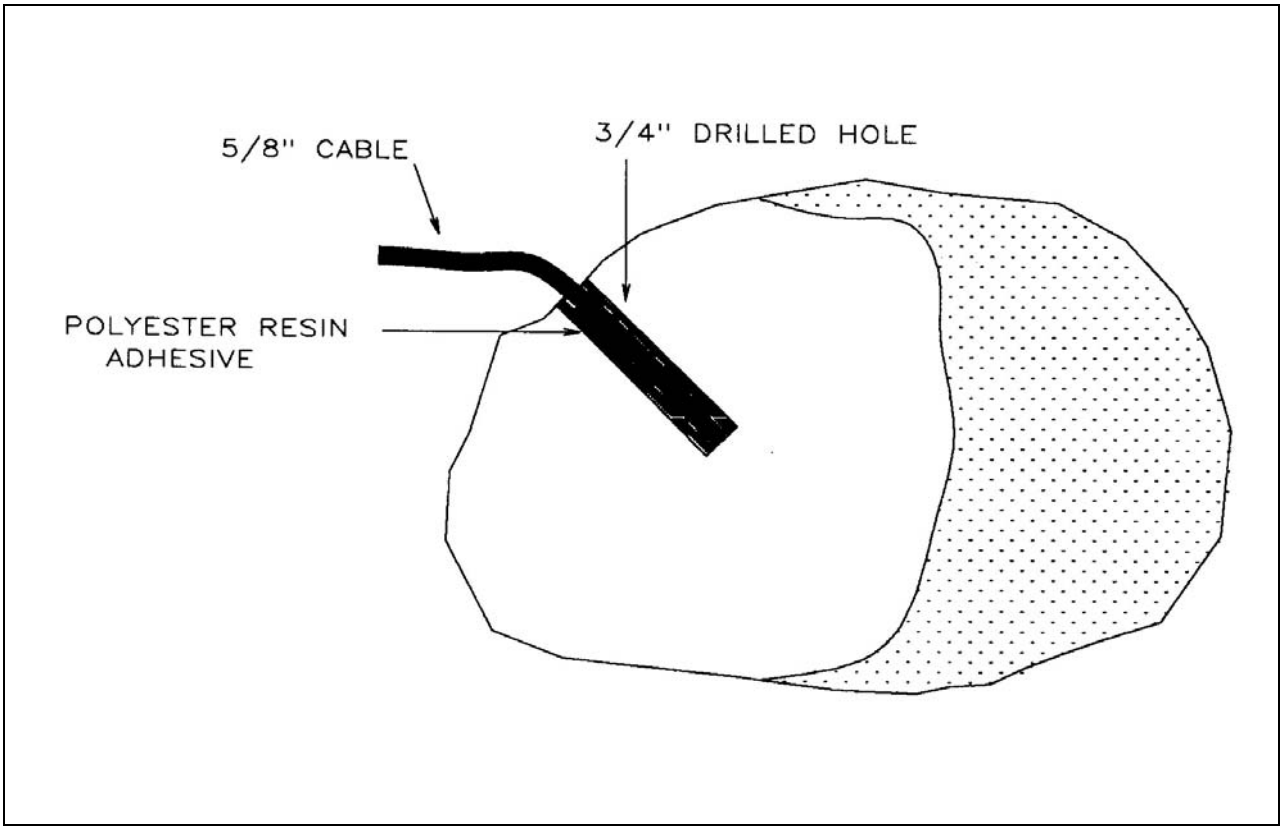


Figure VII-3. Cable secured to boulder using polyester resin adhesive.

Cabling to Logs and Root Wads

Woody material should be secured by inserting the cable through the log or root wad. Where this is not possible, notching the material to recess the cable is necessary. Always remove bark at the point of contact between the cable and the log or root wad because bark will rot, resulting in slack in the anchoring cable. When threading cable through augured holes, or wrapping it around logs or root wads, cable clamps should be used to fasten the cable. A minimum of two clamps is required to prevent slippage. The cable should be looped through the hole, and around the material and clamped back to itself. Simply placing a clamp on the end of the cable will not suffice because it can be pulled off, or pulled through (Figure VII-4).

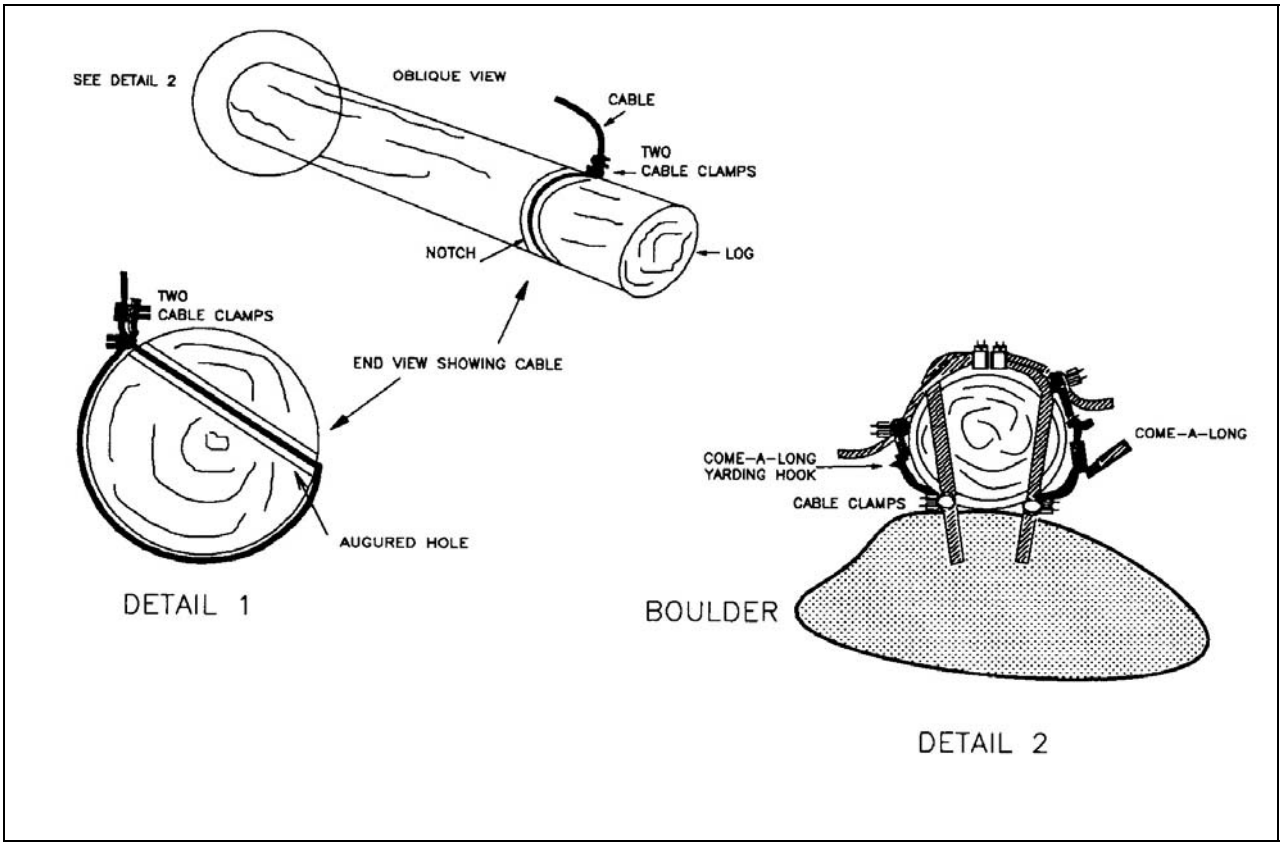


Figure VII-4. Cabling to log.

Cabling Logs and/or Root Wads to Boulders or Bedrock

Logs or root wads to be secured instream must be anchored tightly so they do not float or move. A procedure has been developed called the "two-cable method" for anchoring logs to boulders or bedrock. Two griphoists are used to pull the cables tight using this method. Commercially available cable grips, or a special tool called a cable-hook clamp can be used to facilitate tightening of cables with a griphoist.

To construct a cable-hook clamp, saw off the eye of a slip hook and weld it to a cable clamp base. Use a cable clamp one size smaller than the cable to be used (example 1/2-inch cable clamp for 5/8-inch cable). It may also be necessary to use welding rod to build up mounds in the cable cradle to aid in holding the cable ends (Figure VII-5).

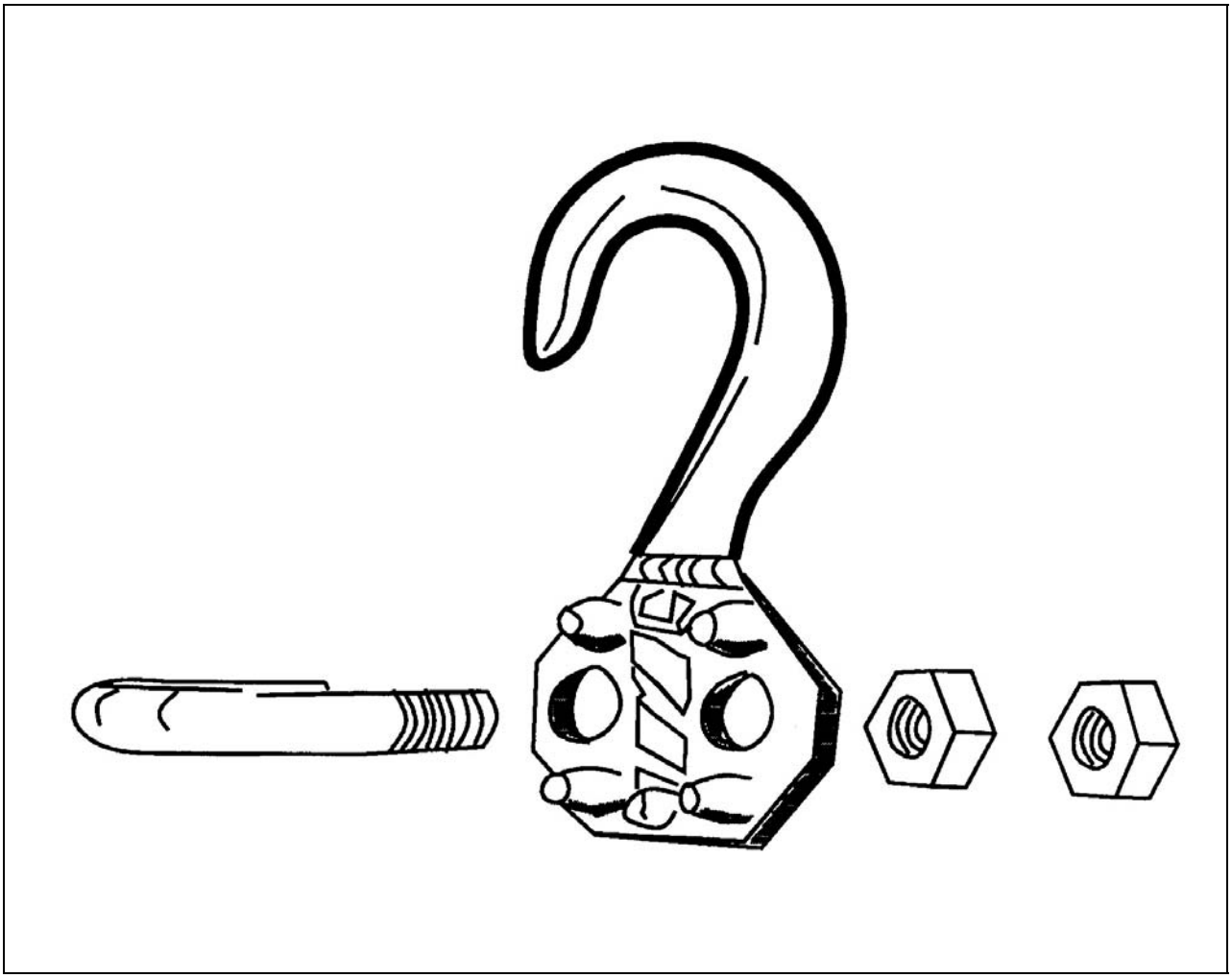


Figure VII-5. Cable hook clamp.

To cable a log to a boulder or bedrock using the two-cable method, drill two holes to a minimum depth of 10 inches. The angle of the holes should match the direction the cable will be pulled to prevent excessive bending at the rock face. The layout of the griphoist anchors must be arranged to set up opposing pulls in alignment with the log structure to be secured. Follow directions for use of the cable and polyester resin adhesive. Allow the adhesive to set up overnight. Drill holes for the cable through the log. Using the hook clamps, attach cable ends to the griphoist (Figure VII-6). Loosely attach a minimum of two cable clamps to the cables before tightening the cables with the griphoist. Pull both cable ends with the griphoist, avoiding binding as the cables move past each other. When cables are at maximum tension, tighten the cable clamps. Remove griphoists. Check cable tension. If cables are not tight, loosen the cable clamps and repeat the process. Secure the loose cable ends to the log with staples (Figure VII-7). Two variations of the two-cable method are shown in (Figures VII-8 and VII-9).

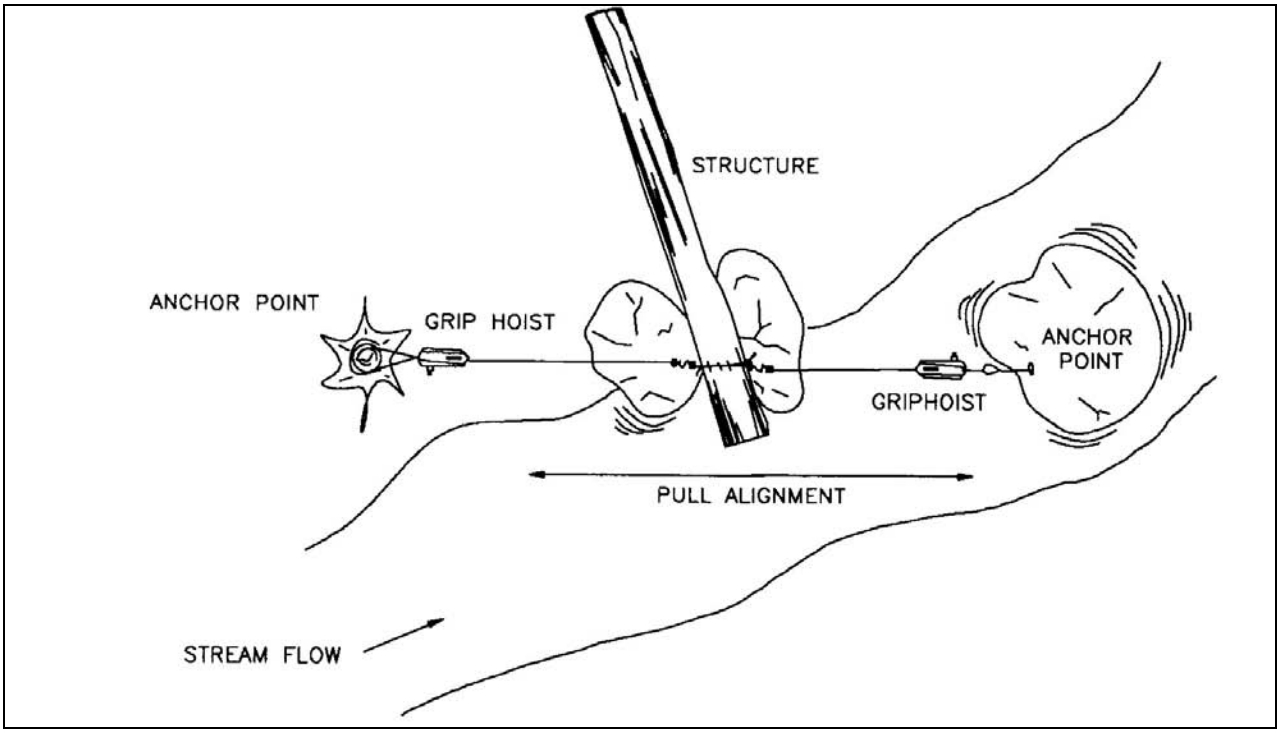


Figure VII-6. Tightening cable ends using two griphoists.

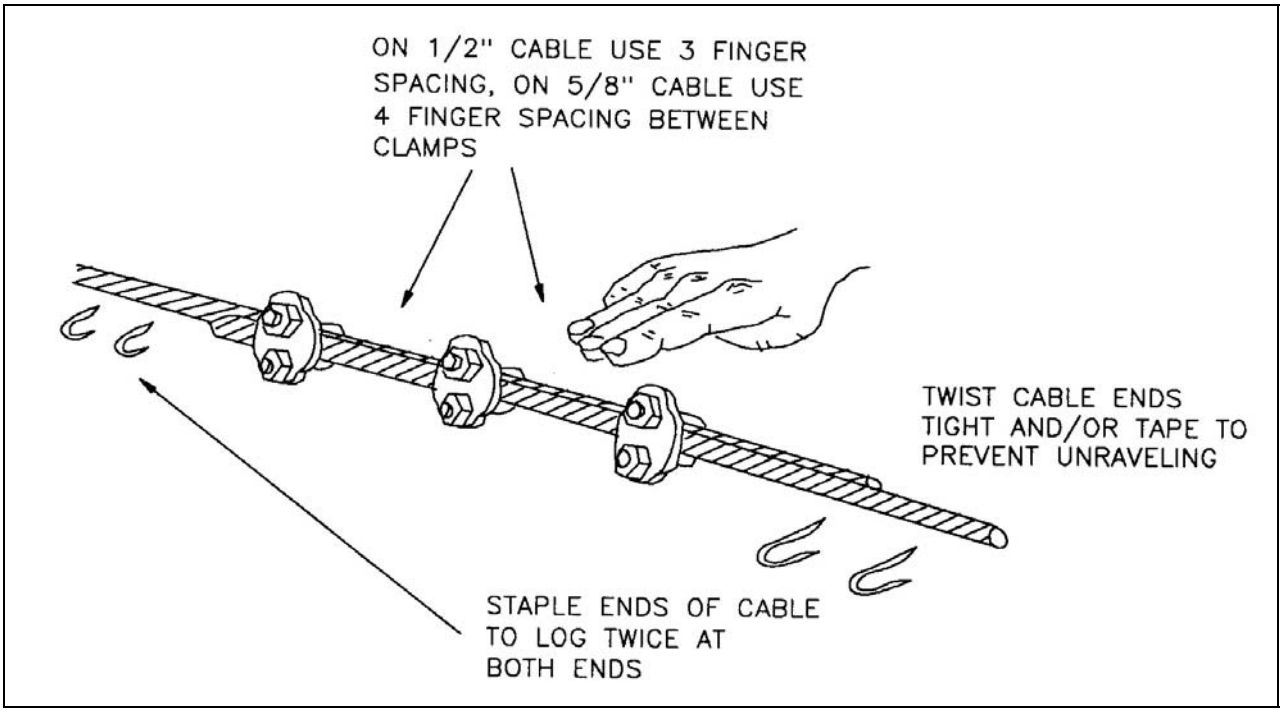


Figure VII-7. Attach cable clamps to cables.

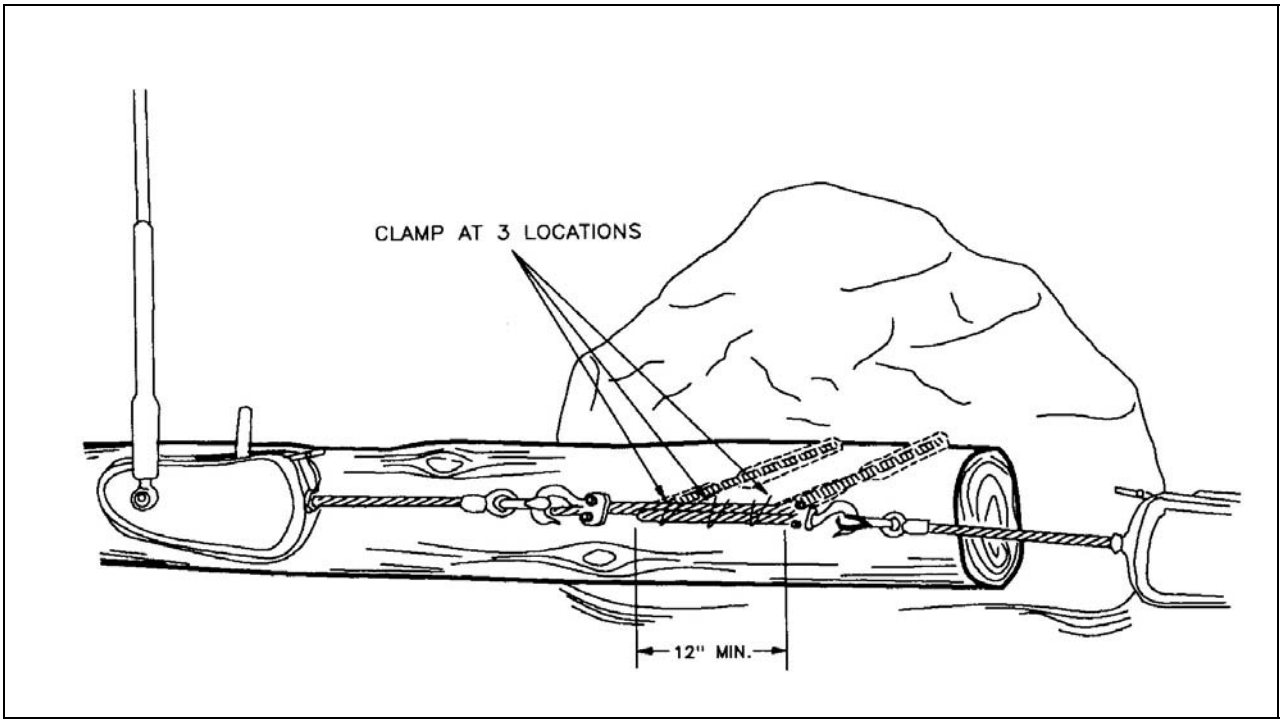


Figure VII-8. A variation of the two-cable method.

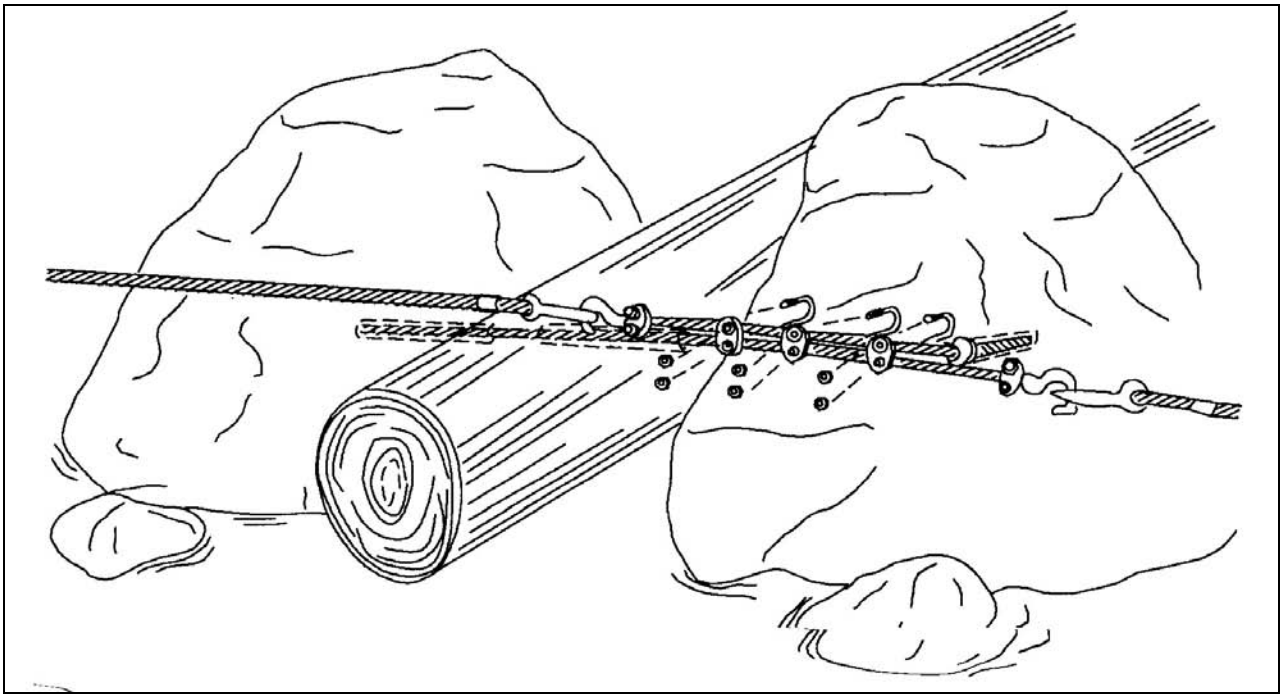


Figure VII-9. A variation of the two-cable method.

Log Pinning With Rebar

In addition to being a component of reinforced concrete, rebar can also be used in anchoring applications. To pin logs together with threaded rebar, an aligned hole is augered through both logs. A length of threaded rebar is inserted through the holes, a steel-plate washer and nut are then placed on both ends of the rebar and tightened to secure the logs. Before driving in threaded rebar, a nut must be threaded on the impact end of the rebar to protect the threads from being damaged (Figure VII-10). After the nut has been tightened, the end of the threaded rebar must be mushroomed to prevent the nuts from backing off. Minimum recommended size of threaded rebar is one-inch. The minimum size steel-plate washer recommended is three-inches square, by one-quarter inch thick.

If standard non-threaded rebar is used, a pilot hole slightly smaller than the diameter of the rebar should be drilled through the log(s). The rebar is then driven in far as possible using a metal fence post driver, then a sledge hammer is used to drive it the rest of the way. It is important to bend over the ends on the rebar at least at a right angle so logs will not lift off.

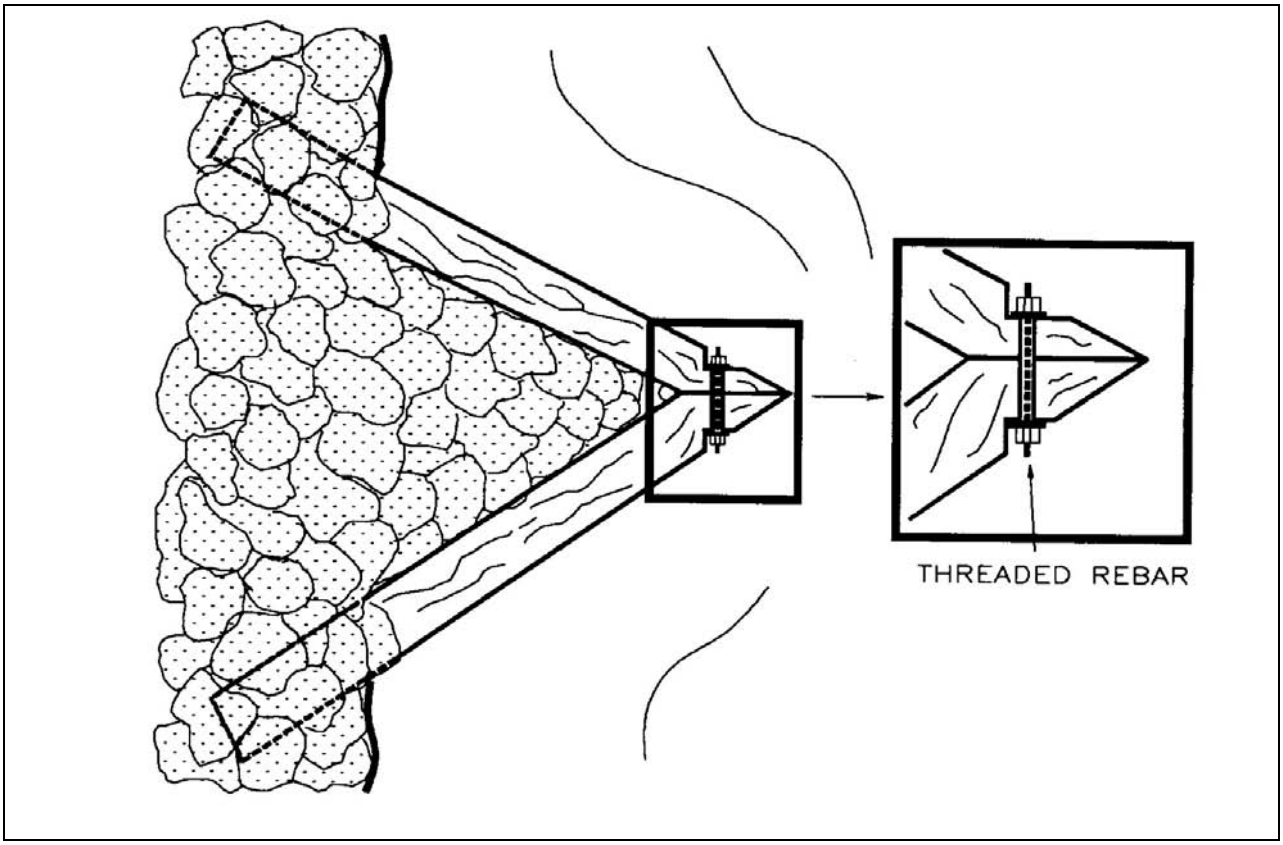


Figure VII-10. Threaded rebar used to secure two logs together.

Stream Bank Anchors Using Rebar

Steel rebar can be driven into the stream bank to hold log structures in place. This technique is only to be used in conjunction with additional anchoring techniques such as a deadman, cable secured with polyester resin adhesive to a boulder or bedrock, or with threaded rebar to a stable or embedded log (Figure VII-11). Logs are very buoyant and will float away if not securely anchored.

A post driver or sledge hammer are best suited to driving rebar. Rebar anchors must be at least 10 feet in length, to ensure that they are not uncovered by high stream flows. The rebar can be trimmed to create a point. The pointed end will help penetrate hard ground or buried woody debris. If scour is expected at the end of a structure, the ends should be anchored by other means.

Often, rebar cannot be driven into a heavily armored stream bank. It frequently bends at cobble and boulder obstructions, or reaches impenetrable bedrock. However, an increased number of rebar anchors may be able to compensate for shallow penetration.

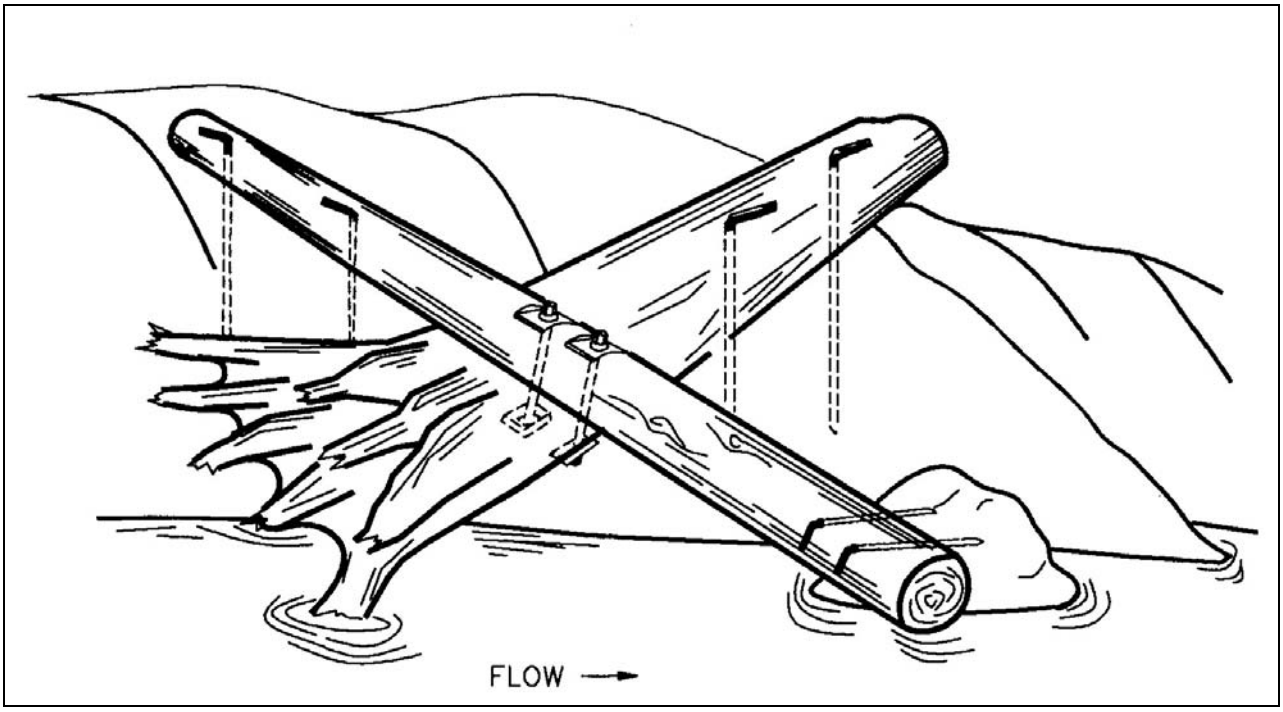


Figure VII-11. Rebar anchoring application.

Bedrock and Boulder Anchors Using Threaded Rebar

Threaded rebar can be secured to bedrock using polyester resin adhesive (Figure VII-12). Hole depth must be sufficient to reach competent, un-fractured rock in order to obtain maximum bonding strength. A minimum of 10 inches is recommended. Setting rebar into fractured rock or into a hole that has not been cleansed of rock dust may not produce a reliable bond.

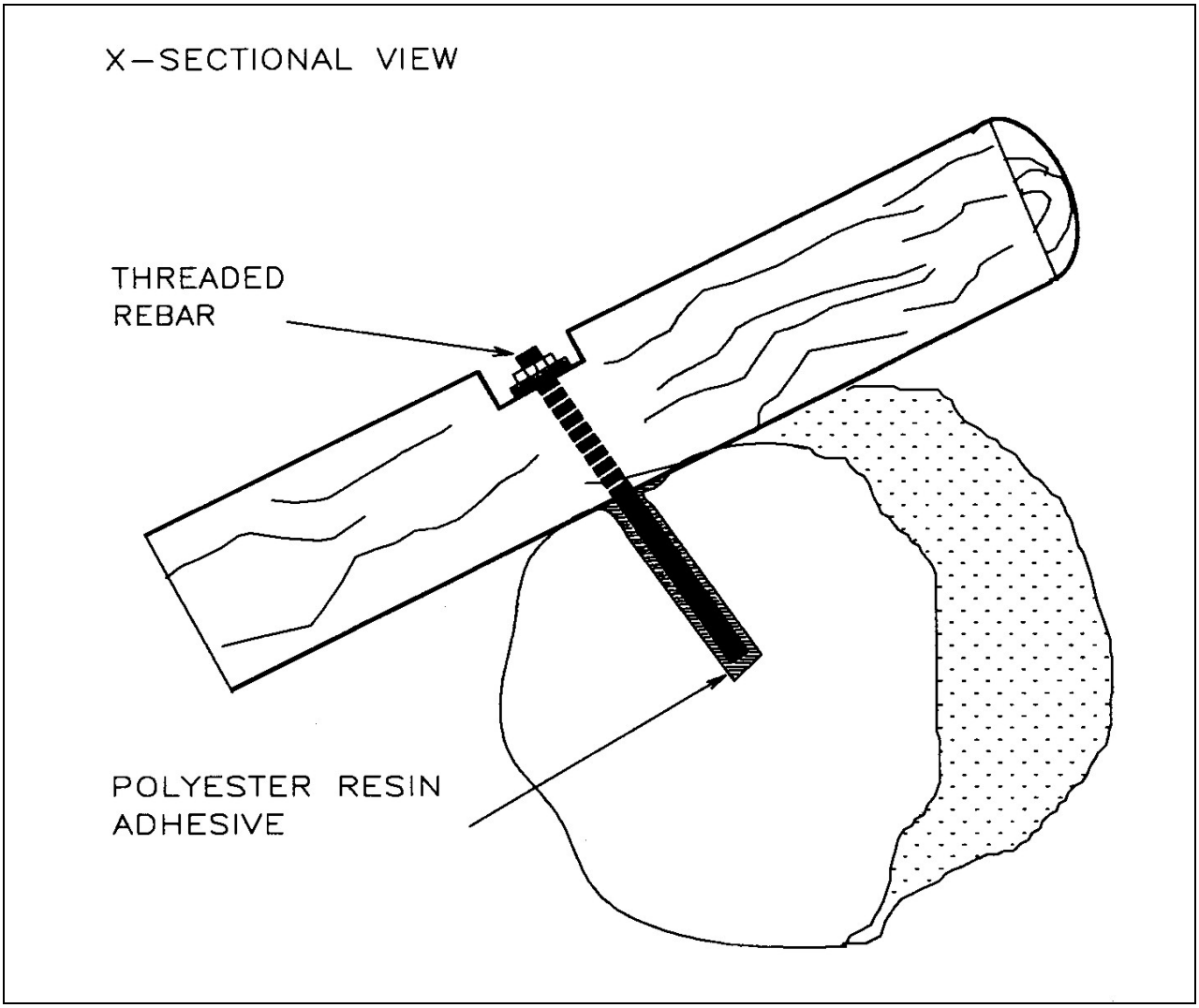


Figure VII-12. Threaded rebar anchoring log to boulder, using polyester resin adhesive.

Threaded Rebar and Cable Anchor to Boulder or Bedrock

North Coast Fisheries has developed an anchoring technique using threaded rebar, cable and polyester resin adhesive to secure logs or root wads to boulder or bedrock. The log is moved into position. Holes are drilled into the boulder or bedrock after the log is in-place. The cable is secured to the bedrock or boulder using polyester resin adhesive. The adhesive is allowed to cure overnight. A hole is drilled through the log in line with the cables. The bark and cambium layer of the log are removed so the plate will fit against the heartwood of the log. Threaded rebar is driven through the hole leaving three to four inches of rebar sticking out on each side. A loop is formed on the end of the cable using two cable clamps. The loop is tightly threaded over the rebar leaving as little slack as possible. The cable clamps used to form the loop in the cable are tightened down. The metal plate and nut are threaded on the rebar and tightened down (Figure VII-13).

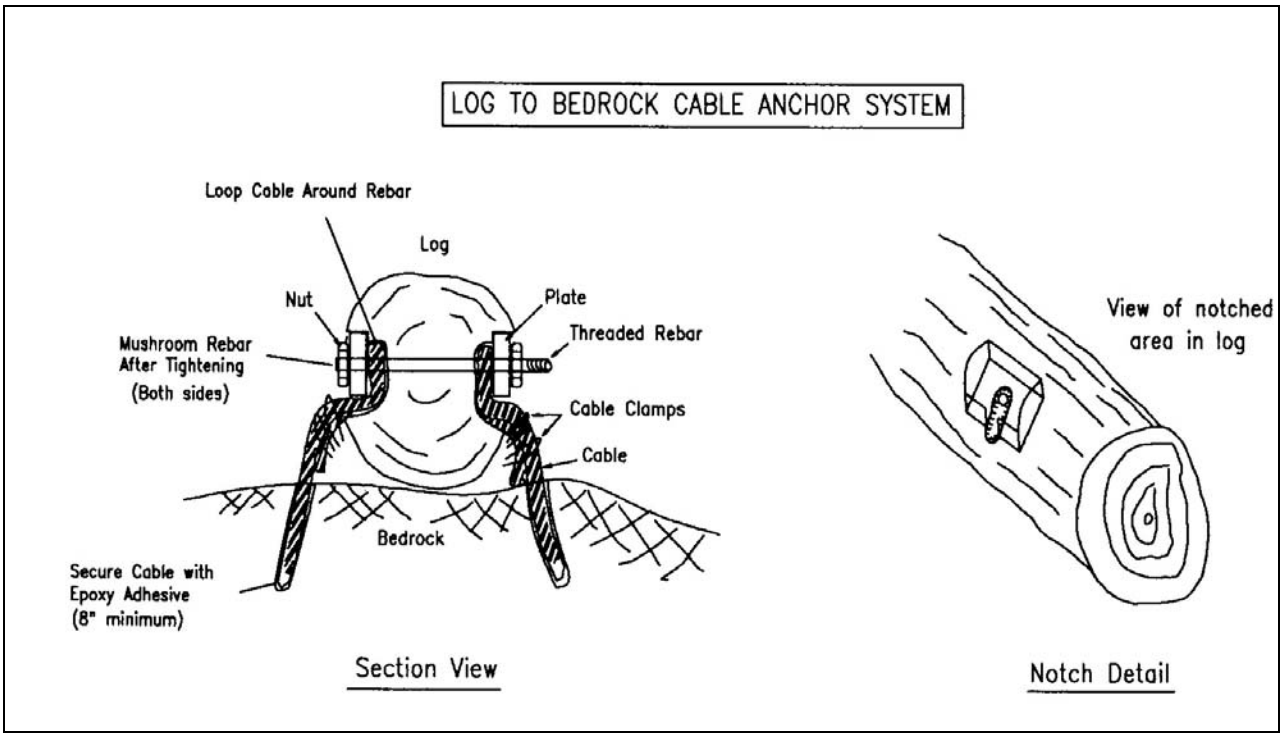


Figure VII-13. Threaded rebar and cable anchor to boulder or bedrock.

Expansion Bolts

Steel expansion bolts provide a means for establishing an anchor point in concrete. This method is commonly used when anchoring steel Washington baffles in concrete box culverts. There are a wide variety of commercially available anchors suitable for fish habitat construction purposes. Typically, a series of ridges on drop-in anchors are embedded in the sides of a drilled hole as the anchor is expanded by insertion of a threaded bolt; or a clip is expanded and wedged into the sides of a hole when a nut is tightened to compress it against the opposite end of the bolt (Figure VII-14).

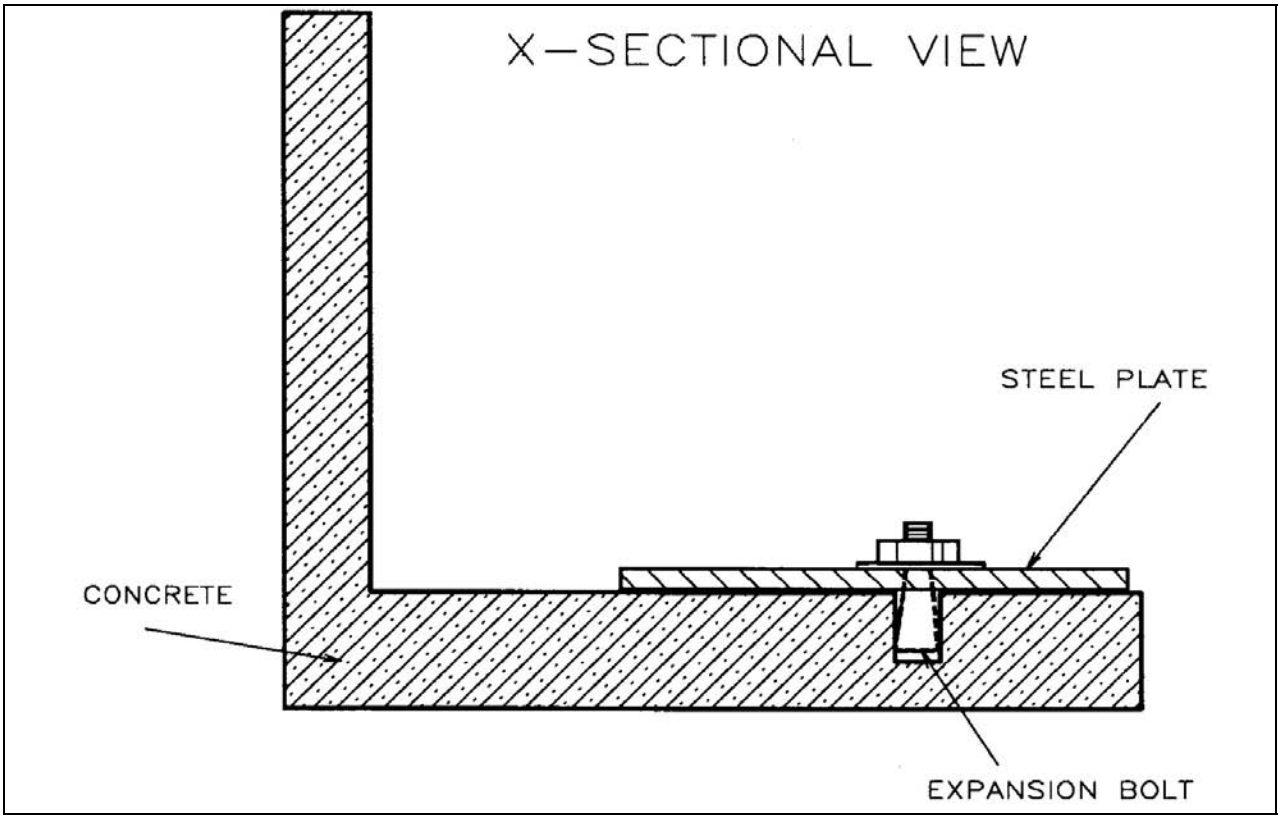


Figure VII-14. Expansion bolt into concrete.

Trenching

Trenching is an anchoring technique that is used to "key-in" or recess structures. Recessing a log or boulder into trenches excavated in the substrate or the bank reduces the chances of high stream flows undermining the structure or cutting around the structure's ends. Trenching stream banks to key in structures can only be accomplished where suitable, stable banks are present. Trenching can be performed either with heavy equipment or by hand (Figure VII-15).

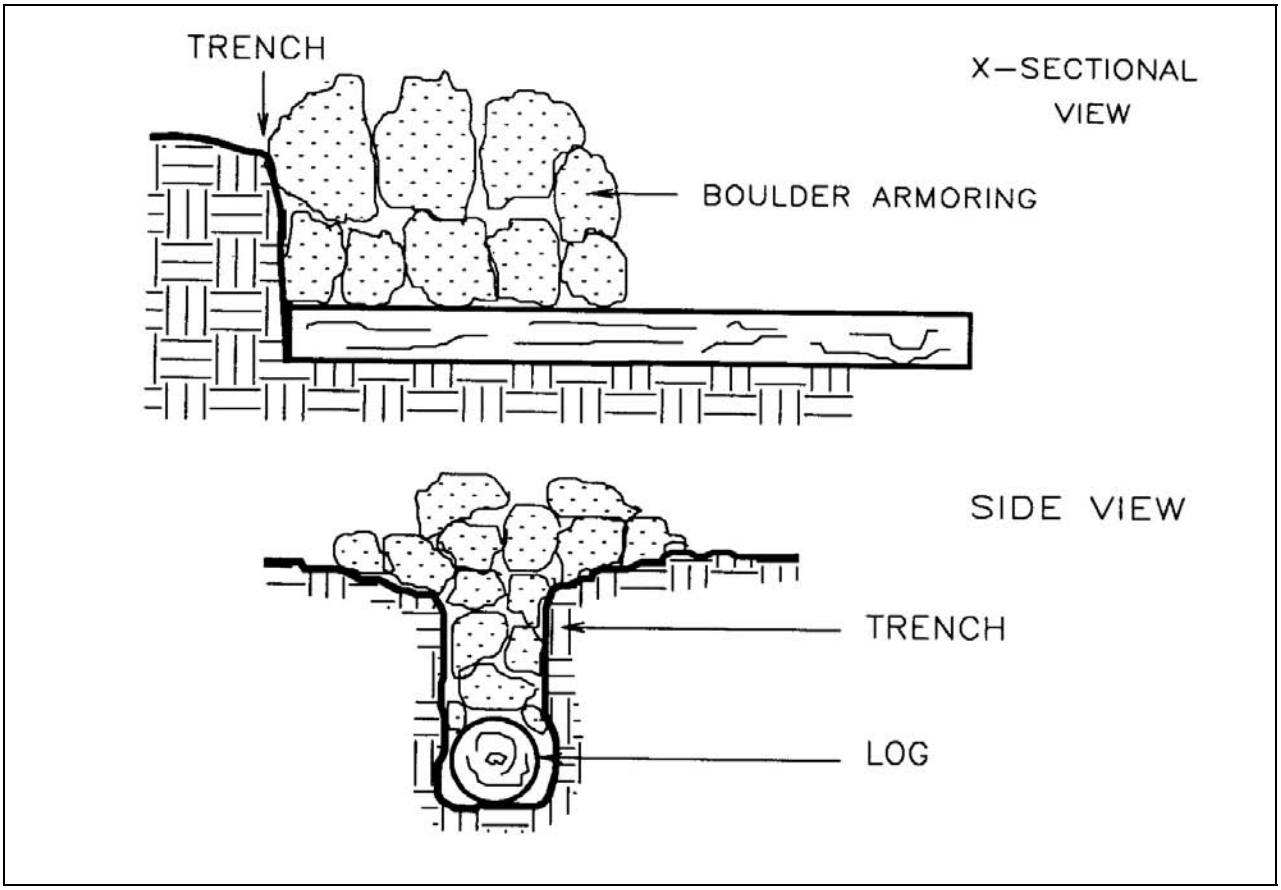


Figure VII-15. Trenching.

Deadman

Where no natural anchors, such as trees, stumps, or boulders are present, an anchor point must be constructed. This is possible using a "deadman". A log, boulder, gabion, or other structurally sound object can serve as a deadman. The deadman is buried in the stream bank, and becomes a stable substrate fixture.

The deadman must be buried at least 3-feet deep on the stream bank above bankfull flow. The deadman, with several attached anchoring cables, is placed in the pit. The cables extending from the deadman are placed in narrow trenches dug down to the instream structure. After attaching the cables to the habitat structure, the cables are tightened, and the pit and trenches are back-filled and compacted (Figure VII-16).

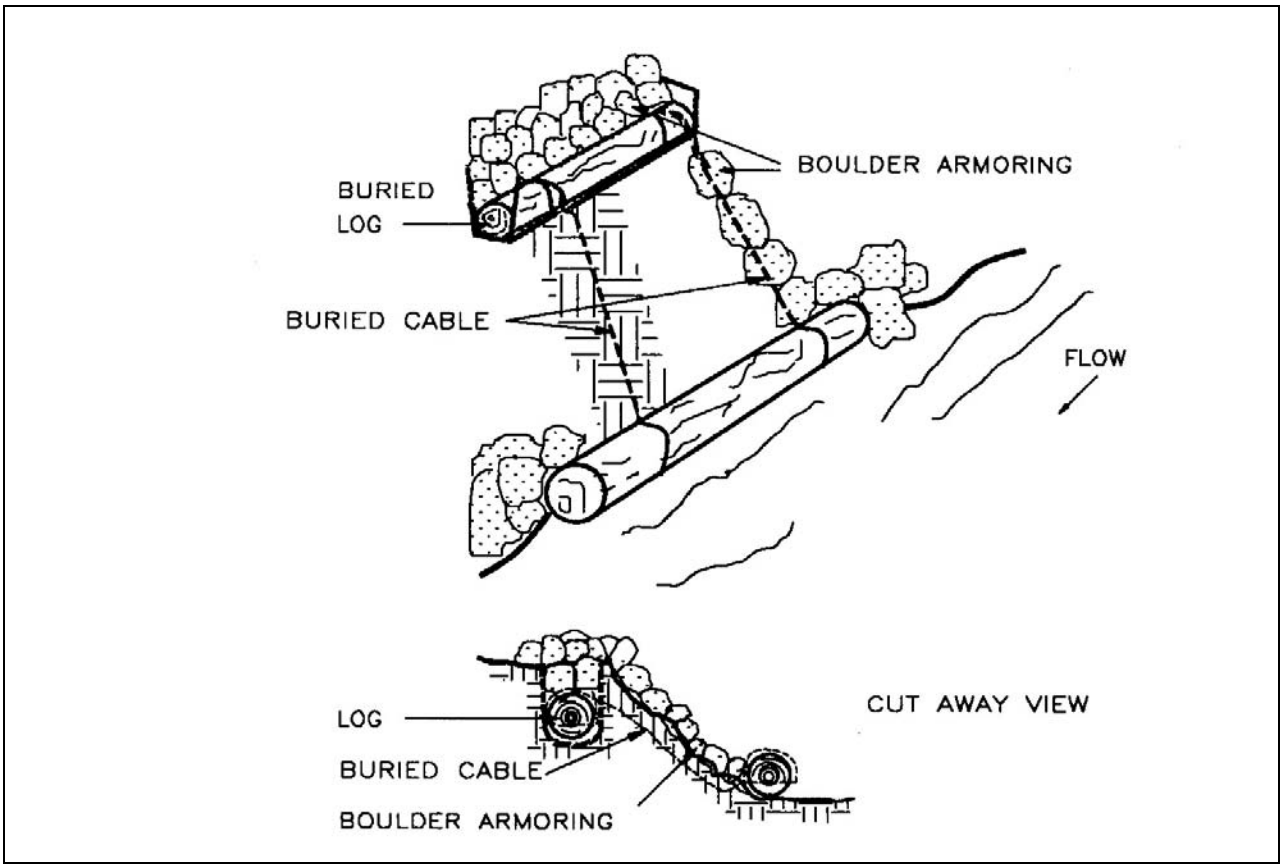


Figure VII-16. Deadman.

Unanchored Large Woody Debris

Most instream habitat enhancement structures require some type of anchoring technique to ensure they will remain in place during high flow events and to prevent high flows from altering their configuration and intended function. However, in particular cases the addition of unanchored large woody material may be beneficially used to enhance some streams and stream reaches. In small streams, large woody debris (LWD) is often the structural agent in pool formation or a key element associated with the habitat quality of a pool. The effect LWD has on channel morphology is influenced by its size, orientation, spacing, and association with other structural elements as well as a number of other variables including stream-flow energy, sinuosity, substrate, bank composition, and channel width. First through third order streams are generally best suited for unanchored LWD placement projects. Where appropriate, the placement of unanchored LWD requires no maintenance and are free to adjust naturally to the stream=s hydraulic regime.

In unanchored applications, logs selected for placement should have a minimum diameter of twelve inches and a minimum length 1.5 times the mean bankfull width of the stream channel type reach and the deployment site. A root wad should be selected with care and have a minimum root bole diameter of five feet and a minimum length of fifteen feet and at least half the channel type bankfull width. Regardless, a DFG Fish Habitat Specialist must be consulted prior to initiating these projects and obtaining necessary DFG permits.

INSTREAM HABITAT IMPROVEMENTS

There are three general categories of the most commonly used instream structures: 1) cover structures; 2) boulder structures; and 3) log structures. Often a single structure or combination of structures will provide for rearing, spawning, and cover. It is important that instream structures be monitored after high flows have occurred to determine if the desired habitat condition has been met (Part VIII, Project Monitoring and Evaluation). Often, maintenance or modification is needed to make the structure perform properly.

Cover Structures

Quality of a pool can be increased by adding cover structures. Amount of effective cover and the complexity of habitat is at least as important as the physical amount of pool created. Strategically placed cover can help keep pools scoured, while improperly placed cover will cause deposition of sediment.

A study on the effectiveness of placing tree bundles of fir, alder, maple, and myrtlewood was conducted on five different Oregon streams. Juvenile coho and steelhead populations were sampled in 16 pools before and after tree bundles were added. Before the tree bundles were added the pools sampled were holding 12 percent of their summer coho population during the winter. The following year, after tree bundles were added, these same pools contained 74 percent of their summer coho population during the winter sampling. The sampling showed an increase in steelhead populations between the summer and winter populations, the winter after tree bundles were added.

Riparian vegetation is a highly important source of cover. Overhanging vegetation or undercut banks, along with the associated roots, provide excellent, effective cover.

Logs, root wads, tree bundles, and boulders are the primary cover elements added to pools. Some guidelines concerning construction and installation of cover structures in a stream are:

- Cover should be incorporated with other stream enhancement structures such as log and boulder weirs, boulder clusters, and single and opposing wing-deflectors.
- Cover structures are often placed in pools, backwater areas, or along meanders to provide protection.
- Logs, tree bundles, or root wads can be cabled against the banks. Secure logs or root wads to a stump, a live tree, a bedrock outcropping, large boulders, or use a deadman. Cover can also be cabled to instream boulders using polyester resin adhesive.
- Cable all log and root wad cover structures tightly.
- Protect the upstream end of logs from direct flow of the stream.

Examples of cover structures are divide logs; digger logs; spider logs; and log, root wad and boulder combinations.

Divide Logs

Divide logs are installed mid-channel in spawning riffles to provide a visual barrier between adjacent spawning areas. This can increase spawner use of a riffle area and provide escape cover (Figure VII-17).

Divide logs require suitable substrate for anchoring. Such substrate consists of boulders or bedrock. Length and diameter of the log used will be dictated by length of the spawning channel and depth of flow. In general, divide logs should be 18 to 36 inches in diameter.

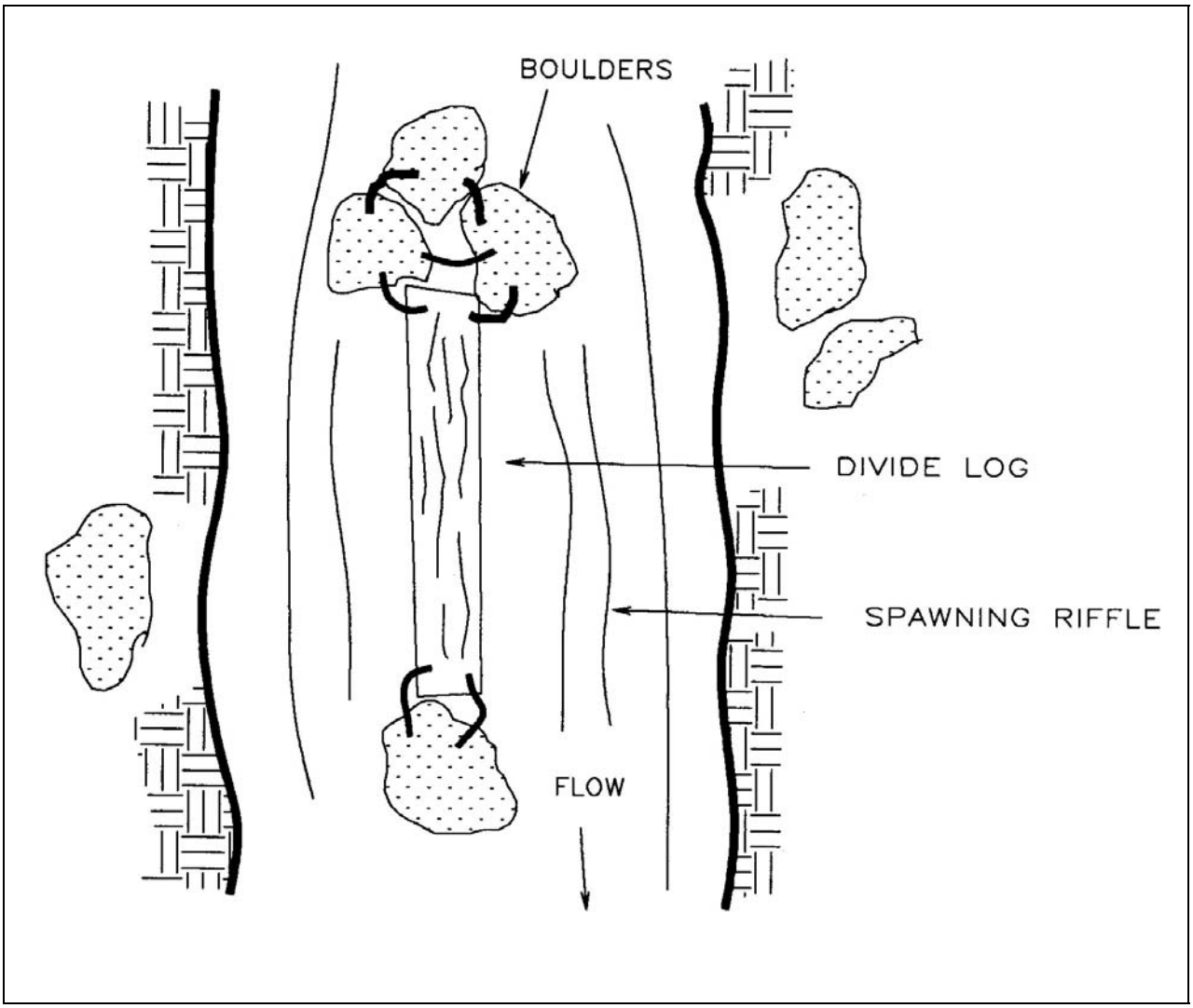


Figure VII-17. Divide log.

Digger Logs

Digger logs are placed with one end anchored securely on the bank and the other end plunging into the bottom of a pool. Primary use of digger logs is to enhance pool habitat by creating diverse cover for rearing juveniles as well as for migrating adults. They are also used to scour the channel, creating or expanding pool habitat. Logs with root wads intact should have the root wad end extending down into the pool to offer the most complexity for increasing rearing habitat and maximizing scour (Figure VII-18). Digger logs will be most secure when two-thirds of the log is on the bank and one-third of the log extends into the channel.

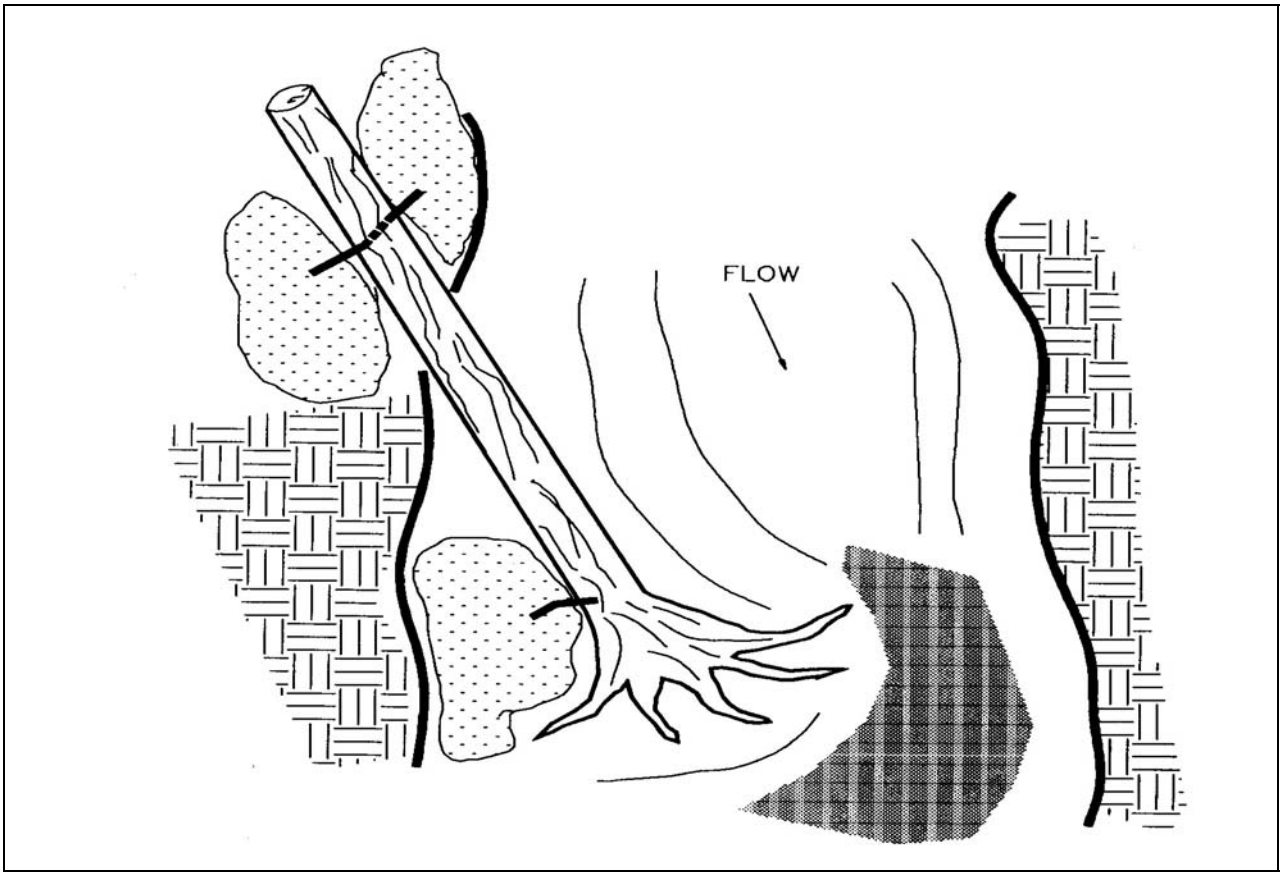


Figure VII-18. Digger log.

Digger logs are usually secured to bedrock and held in place using cable and polyester resin adhesive, or secured to live trees or downed wood with threaded rebar. The log must be anchored in at least two places, with anchors spaced as far apart on the log as possible to keep it secure during high flows. Digger logs can be set in a trench dug into the stream bank. At least one-third of the length of the log should be placed in the bank. This buried end of the log should be covered with boulders to anchor the structure. If the digger log is to successfully create scour, it is important that the end of the log in the water does not float during high flows. Digger logs will usually be positioned to point downstream, although there may be some situations where pointing them upstream would be appropriate (where the intention of the log placement is to create scour). The vertical angle of the log should usually be 30 to 45 degrees to the bank.

Spider Logs

Spider logs, also called mini log jams, are several logs placed at angles to mimic a log or debris jam. They provide cover for juvenile rearing and adult spawning and collect woody debris to increase diversity. Their use is restricted to areas where there is no danger of causing bank failure or channel migration. Pools and backwater eddy areas on the stream channel margins are the best locations for these structures (Figure VII-19).

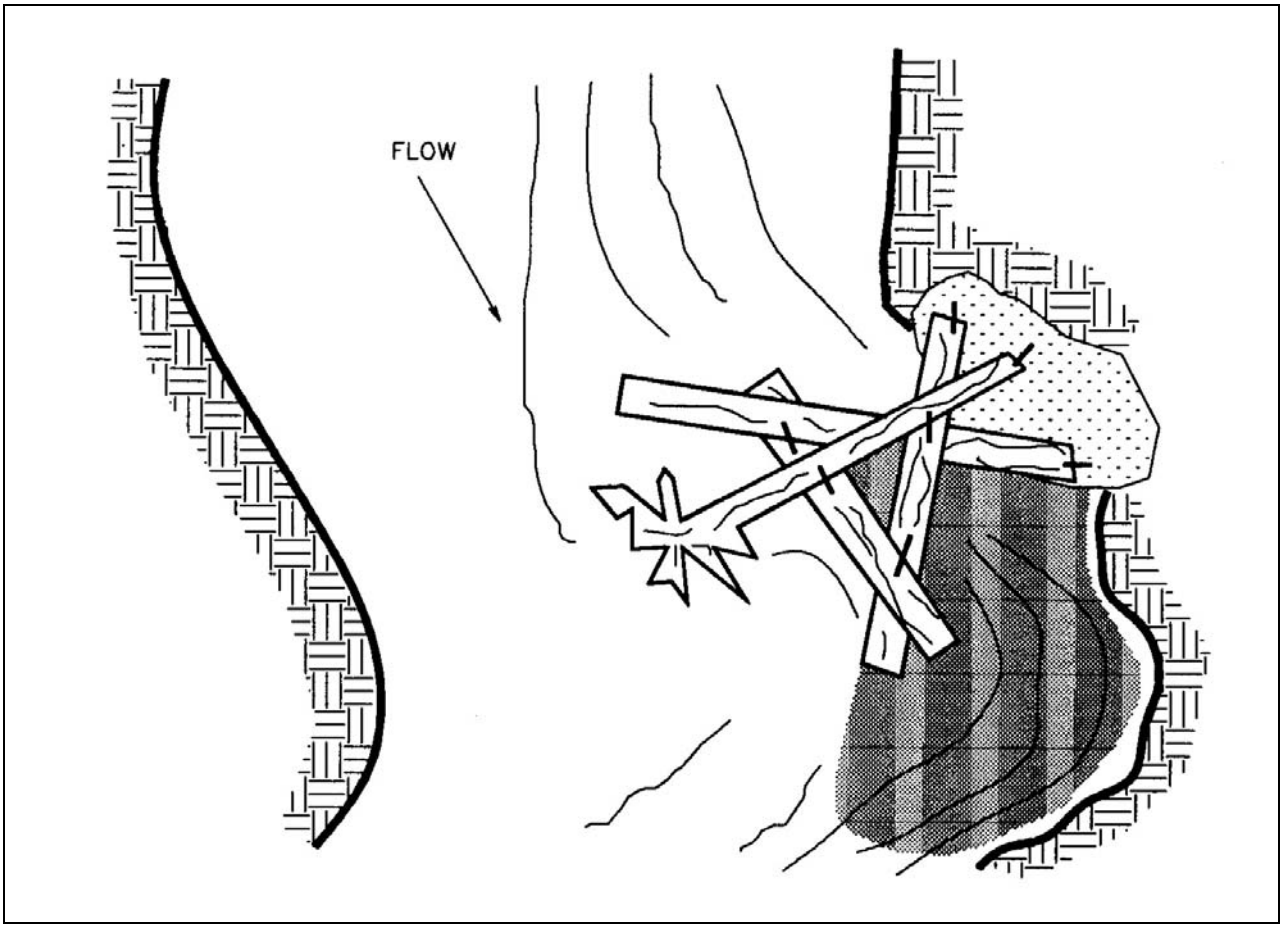


Figure VII-19. Spider logs.

The structures are composed of several logs placed across each other, in the shape of a triangle, to imitate a natural debris or log jam. Each of the logs must be secured to bedrock or large boulders in the channel with cable and polyester resin adhesive, or to live trees with threaded rebar. The logs are secured together with threaded rebar. Several other logs with branches and root wads attached are then fastened to these structure logs with cable or threaded rebar.

Caution must be used in locating these structures as the potential for an adverse effect is great. Before placing spider logs it is necessary to determine channel capacity and bankfull discharge that can be expected. Log structures should not reduce channel capacity below flood stage needs or a massive log jam and sediment trap could develop.

Log, Root Wad, and Boulder Combinations

Log, root wad, and boulder combinations combine the two main forms of structure added to a stream to enhance habitat. The longevity of boulders combined with the cover provided by logs can create habitat that is superior to that offered by either element individually.

Log, root wad, and boulder combinations are used to create cover for juvenile rearing. These structures also act as resting areas and escape cover for spawning salmonids. By creating velocity shear zones they create areas of deposition as well as scour, thereby enhancing spawning through gravel sorting (Figure VII-20).

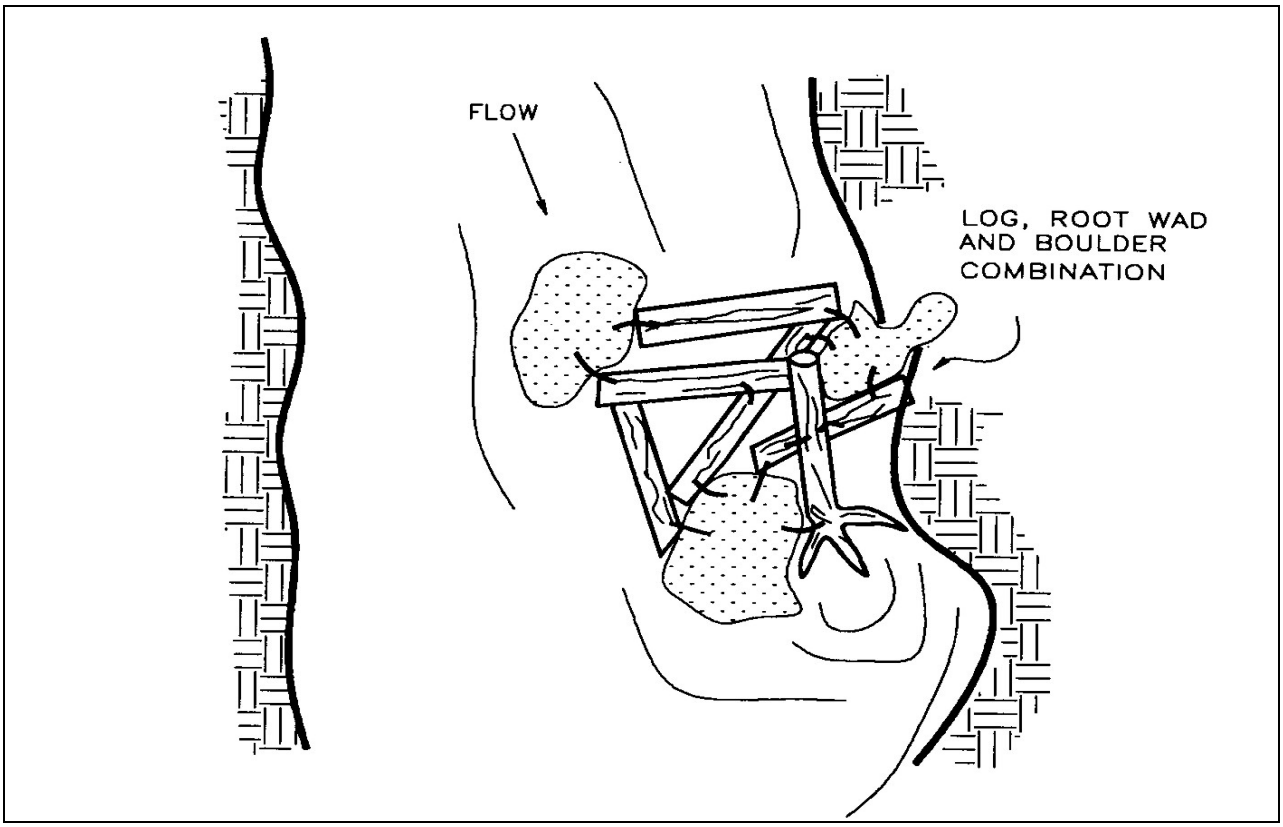


Figure VII-20. Log, root wad, and boulder combination.

Methods used to install log, root wads, boulder combination structures are the same as those used for installing log or boulder structures. The boulders used must be of sufficient size to counteract the buoyancy of the logs. Because of the potential for deflecting high flows into adjacent stream banks, it is important to make sure that banks are resistant to erosion or to take steps to increase their resistance by armoring them with boulders and/or logs.

Boulder Structures

Boulder structures are placed in the active channel and along stream banks for creating a desired habitat type. They are used to break up or diversify stream flow in a particular stream reach, to provide instream cover for juvenile salmonids and spawning adults, or to recruit spawning gravel. It is desirable to create a variety of stream flow velocities, because juvenile salmonids will select different velocities depending on whether they are feeding or resting. Different water velocities will also sort gravel and create diversity in the substrate.

Boulders are well suited for diversifying flows because they are resistant to being displaced by high flows. Because of this they can be placed mid-channel without constructing a full-channel spanning structure. The interstices in boulder clusters and between large boulders can provide escape cover for juvenile and adult salmonids. Boulders must be sized according to stream discharge and channel morphology. Whenever possible, it is best to individually select boulders for use in a project.

There are several disadvantages to using boulders. One is that boulders often must be hauled to the construction site from a quarry. If there is not a quarry nearby, the cost of buying and trucking boulders can be very high. A second problem with using boulders is that if they are placed in mobile substrate, perimeter scour may cause the boulder to bury itself. For this reason, it is necessary to use large boulders, or to secure boulders using polyester resin adhesive and cable to form a larger structure.

Design of boulder structures depends upon the primary function to be served. The range of flows to which a particular structure or series of structures may be subjected will dictate size of boulders to be used, and proper anchoring techniques to be employed.

Boulders can be used in a variety of situations and configurations to perform a desired function or fulfill a particular habitat need. Possible configurations of boulders include weirs, clusters, and single and opposing wing-deflectors.

Boulder Weirs

Boulder weirs are primarily used to collect and retain gravel for spawning habitat, or to create one or more jump pools to facilitate fish passage on marginally accessible or impassable stream reaches. Such fish barriers may be natural or human-induced.

When designing a boulder weir, the following factors must be considered. The boulders used should be larger than boulders occurring naturally in the stream. Large angular boulders are most desirable as they are least likely to roll out of place during high flows. Improper placement of downstream-V and diagonal weirs may direct flow in a manner creating undesirable erosion.

Weirs that span the full channel width can be configured in several shapes including: 1) perpendicular to the flow (if used for back-flooding); 2) diagonal; 3) downstream-oriented "V" (Figure VII-21); and 4) "U"-shaped (if used to improve spawning gravel). General construction principles are the same for all configurations; only one description of construction techniques is presented.

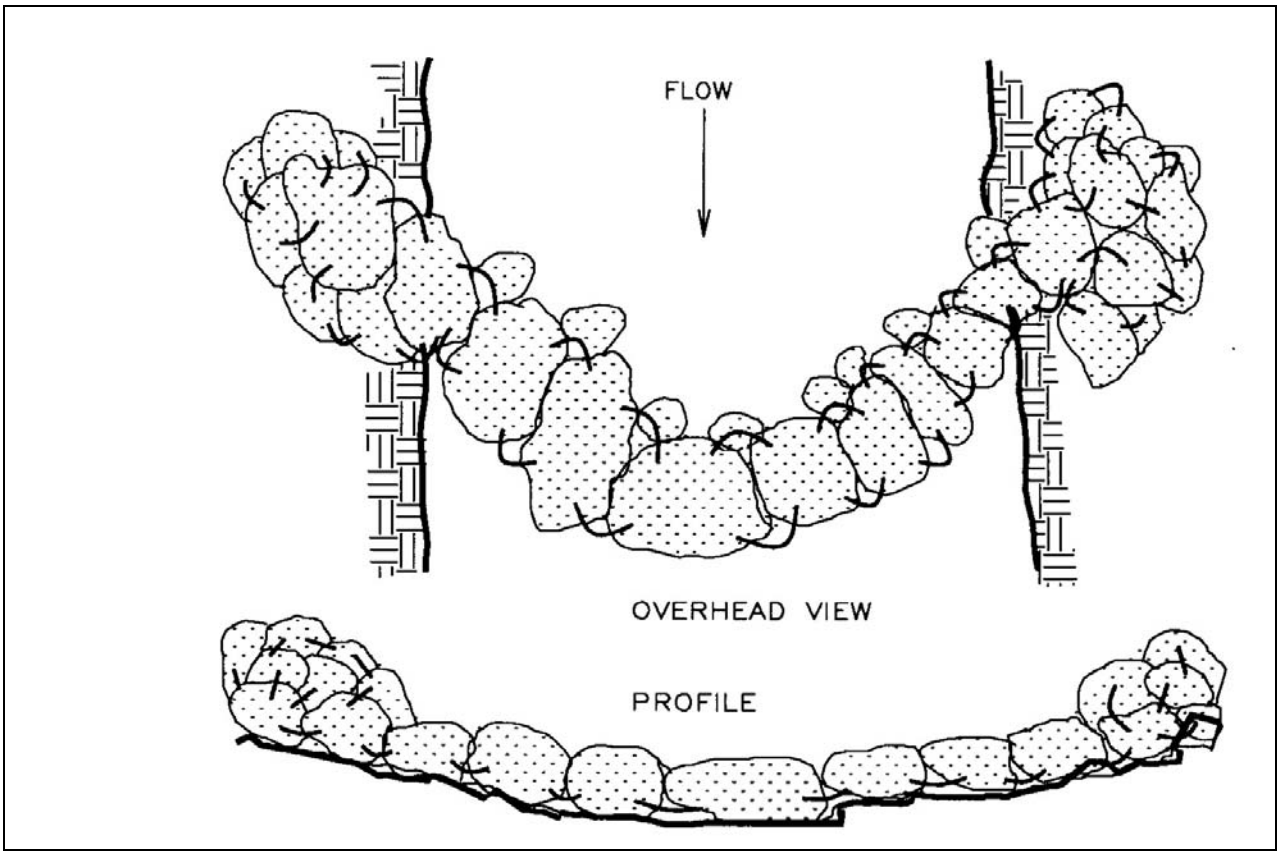


Figure VII-21. Downstream-V boulder weir.

Weirs should be keyed 4 to 6 feet horizontally into stream banks with a gradual downward slope of the weir height toward the thalweg. This slope can be adjusted to position the thalweg. The thalweg will tend to follow the low point in the weir. At the low point of the weir a "spillway" should be constructed by creating an opening one to two feet wide. This creates a notch through which flow is concentrated at low flows. The notch should be roughly triangular in shape with the apex of the triangle oriented down. Flat, broad spillways make fish passage difficult.

The weir should be sealed with smaller rock and cobble to prevent seepage flow and maintain flow over the spillway. This helps to prevent the weir from becoming a low flow barrier to juvenile salmonids.

To assure that the stream is not diverted around the end of the weir during high flows, ends of the weir should be extended to a point above normal high water level. Ends of the weir should be set in a trench dug to a depth of at least one boulder diameter. In bedrock substrate, the boulders on the ends of the weir should be cabled to bedrock. It is important that during high flows the stream does not flow around the end of the weir and cause bank erosion, or establish a new channel.

Quarry boulders will typically be more angular than stream boulders, and depending on the size of the boulders, will be fairly resistant to movement by stream flow. Therefore, they are usually considered to be superior to stream boulders for weir construction. Density of the boulder will also affect its stability in the stream, and how well it stands up to being drilled for cabling. Size of the boulder selected will depend on size available and the magnitude and velocity of stream flow. In general, the bigger the boulder the better. However, the boulder must suit the size of the channel (i.e., a 6-foot diameter boulder would not normally be placed in a 10-foot wide channel, or bank scour is likely).

Oversized boulders are seldom a problem. The opposite is more often the case. If boulders are relatively small and will be subjected to flows of such magnitude that they would not be stable in the stream, they should not be used. Even with suitably sized boulders it is often desirable to secure the boulders together using cable and polyester resin adhesive to create a stable structure. Cabling requires drilling holes into adjacent boulders and securing them with short lengths of cable. It is important that the cables are no longer than the distance between the boulders plus the depth of the holes. Drill the holes in the sides of the boulders (never the top). Any slack or flex in the cable will allow the boulders to move. By cabling adjacent boulders together, a series of boulders effectively creates a single unit which will remain stable during high flows.

Scour created on the downstream side of boulders may create a crater and cause boulders to roll into the scour hole. This is particularly true with stream boulders which tend to be rounded from abrasive action of years of high flows. Cabling boulders together will help reduce the tendency of the boulders to roll. Where possible, boulders should be imbedded into the substrate to a depth one third of their diameter to compensate for their tendency to roll downstream.

A boulder weir can be one or more rows wide. By setting the downstream row or rows of boulders at progressively lower elevations than the one above, a more gradual drop of stream elevation can be created so the energy in the plunge effect of the water flowing over the weir is dispersed over a wider area. Scour will occur slightly farther downstream and won't be as likely to undermine the boulders. Fish passage must be considered when designing weirs with wide crests.

If placed in a series, the appropriate distance between weirs depends on stream gradient and height of the weirs. In general, spacing should be such that water backed up by one weir will not affect the depth of the water in the plunge pool of the upstream weir. It is important to consider leaping abilities of the fish to be benefitted by the project. In general, no jump should be higher than 12 inches.

Vortex Boulder Weir

Vortex boulder weirs were designed by Wildland Hydrology for use in high bedload streams to maintain sediment transport capacity and low width/depth ratios (Figures VII-22, VII-23, and VII-24). These structures are most appropriate in >F= and >B= type channels. Vortex boulder weirs:

1) Provide instream cover and deepen feeding areas in riffle habitats;

2) Provide a wide range of velocities for salmonid holding water at high flow without creating backwater or sediment deposition;

3) Act as a grade control structure without upstream lateral migration, bank erosion or aggradation, characteristic of some log or boulder weir designs;

4) Maintain a low width/depth ratio to reduce sediment deposition and maintain the sediment transport capacity of the channel.

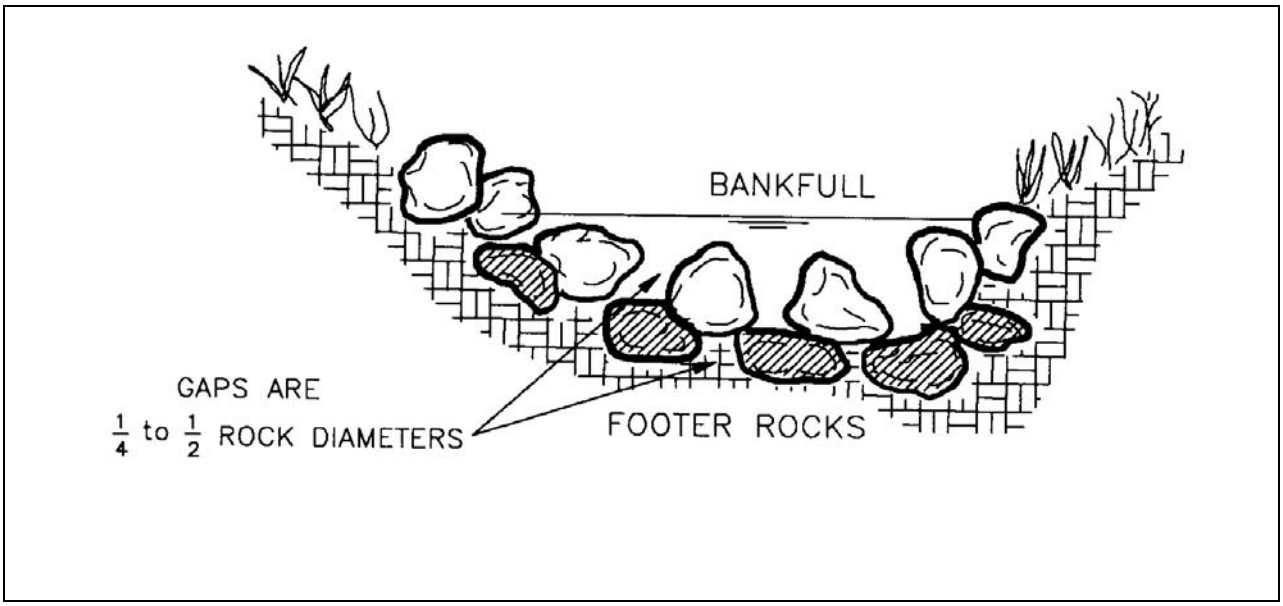


Figure VII-22. Vortex boulder weir, cross section view (Rosgen, 1993).

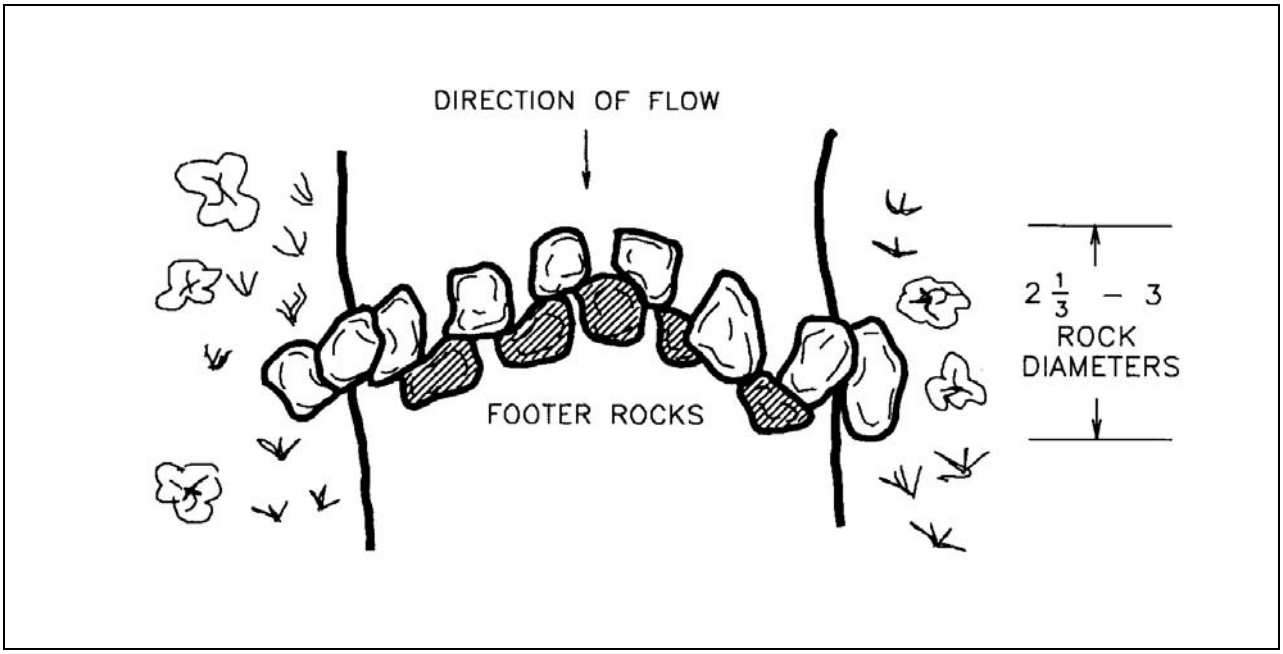


Figure VII-23. Vortex boulder weir, plan view (Rosgen, 1993).

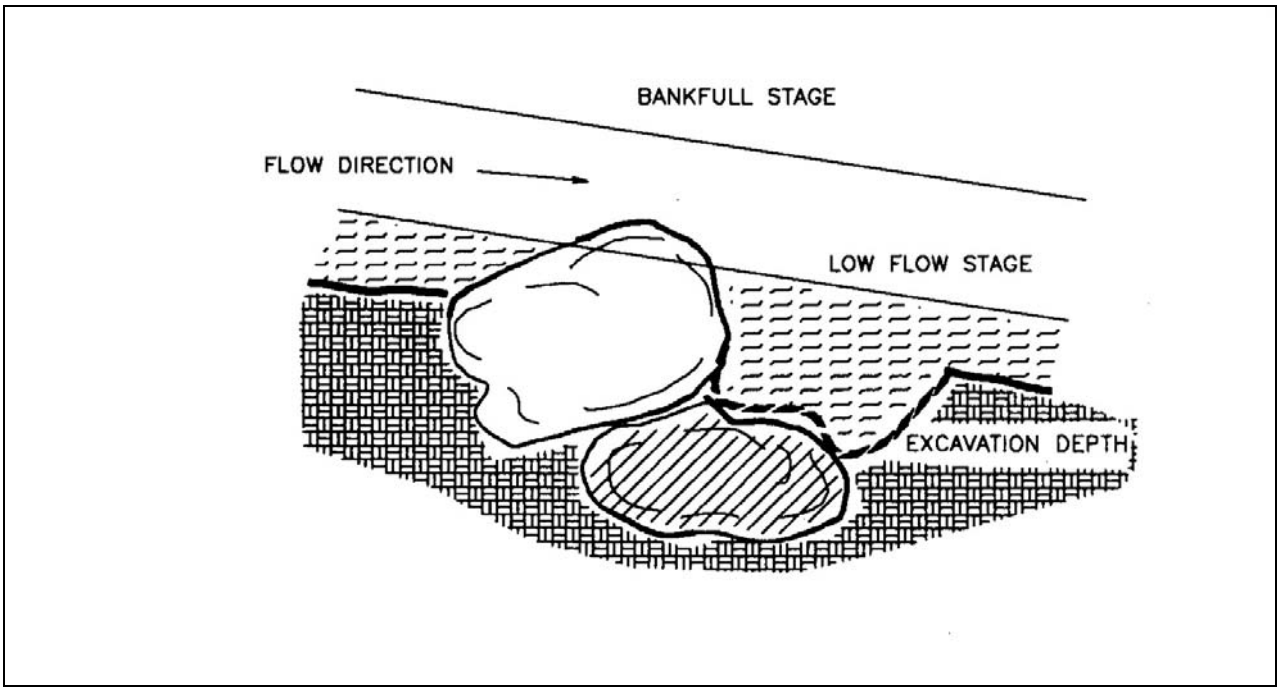


Figure VII-24. Vortex boulder weir, profile view (Rosgen, 1993).

Boulder Clusters

Boulder clusters are used to create scour pockets around boulders, to provide rearing habitat for juvenile salmonids, to build quiet water resting areas for upstream migrating spawners, and to sort spawning gravel (Figure VII-25).

Generally, clusters are located in straight, stable, moderately to well confined, low gradient riffles (0.5 to 1 percent slope) for spawning gravel enhancement; they are also placed in higher gradient riffles (1 to 4 percent slope) to improve rearing habitat and provide cover. At least 3 to 5 foot diameter boulders are recommended, except in very small streams.

To be effective in creating scour pockets and habitat niches around individual boulders, the correct distance between adjacent boulders and the configuration of the boulder clusters must be determined. In general, adjacent boulders should be 0.5 to 1 foot apart. The best configuration for boulders is usually a triangle of three boulders. Several of these clusters may be aggregated to increase scour area and create greater habitat complexity.

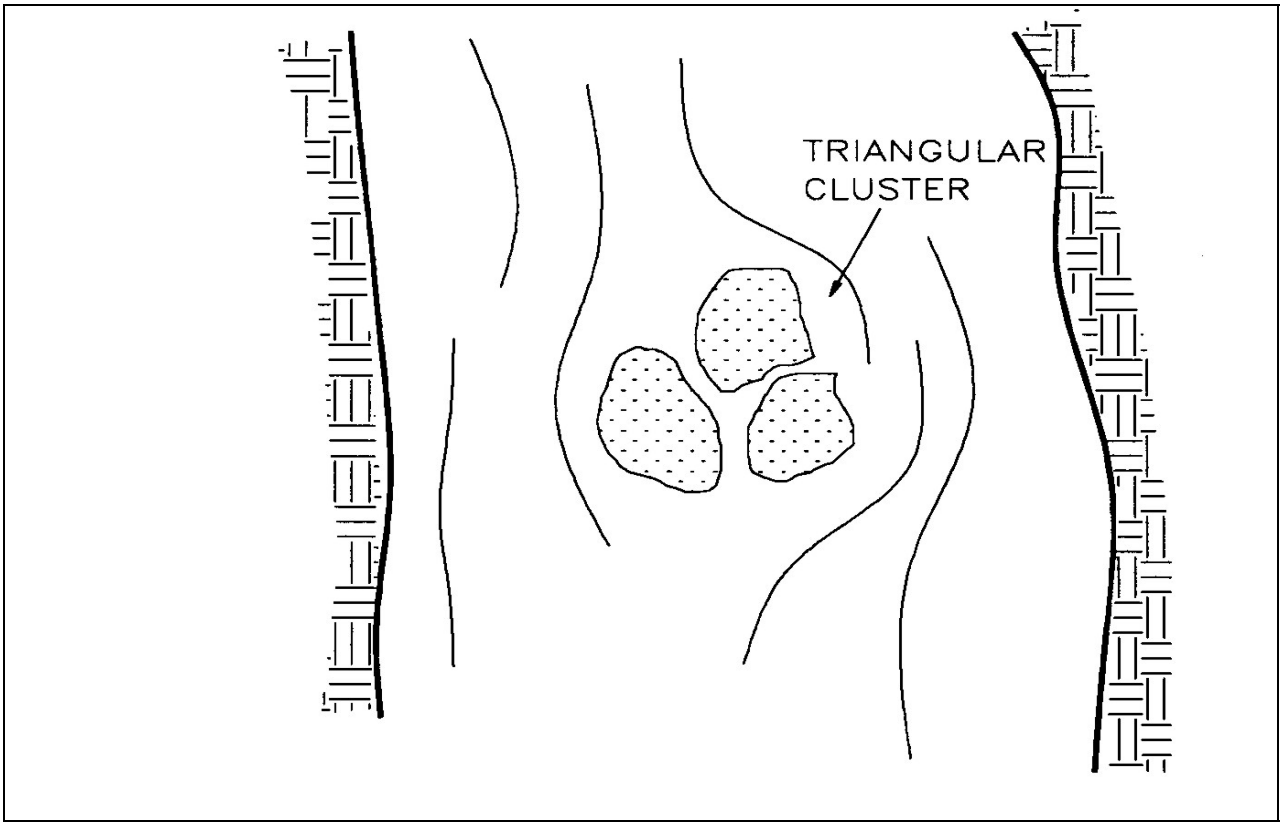


Figure VII-25. Boulder cluster.

If large angular quarry boulders are available, a single boulder can create good cover for juvenile and adult fish. Place the boulder within the middle two quarters of channel width, and not in a deposition zone. If the boulder is placed on a sand or silt bar, it may disappear into the bar. Do not use boulders that are so big that they divert the stream from its channel, or into soft stream banks.

Single and Opposing Boulder Wing-Deflectors

Single wing-deflectors are built to protect a portion of one bank, by deflecting the flow away from the bank. They are also used to create scour by constricting the channel thereby accelerating the flow (Figure VII-26). Wing-deflectors can also create quiet water resting areas for use by upstream migrating spawners.

Opposing wing-deflectors are built to constrict the flow to create a scour pool and sort spawning gravel. These structures are best installed in long, uniform glides or riffles. They create rearing habitat for juvenile salmonids as well as resting areas for upstream migrating spawners. The upstream side of the deflector will develop deposition that may become suitable spawning habitat.

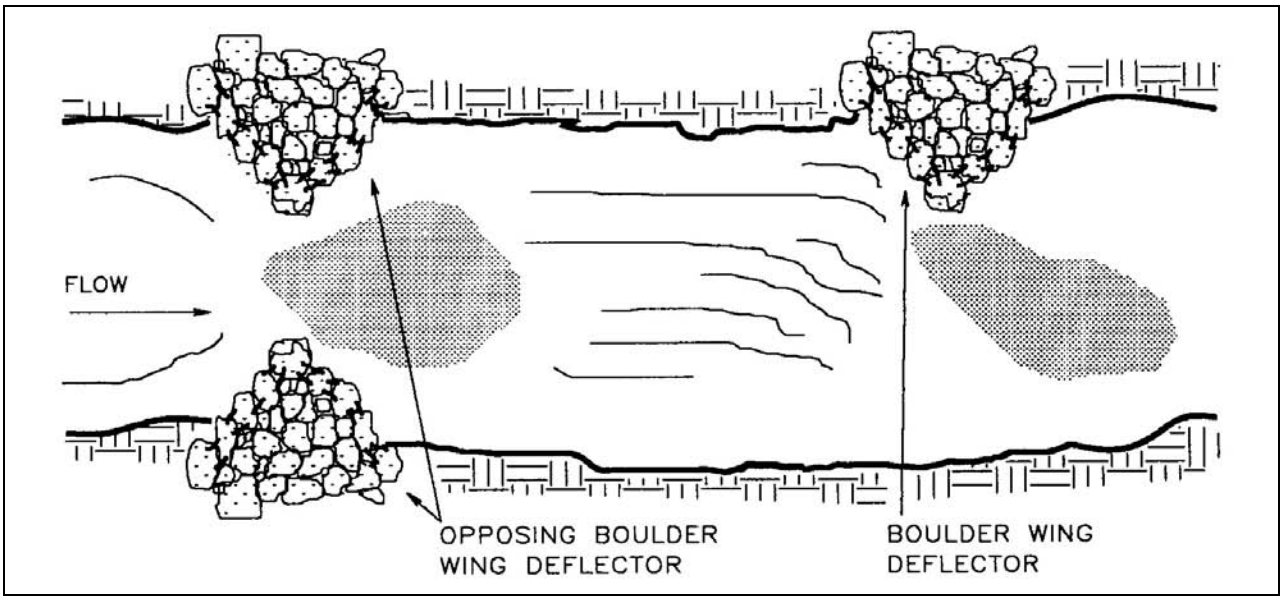


Figure VII-26. Single and opposing boulder wing-deflectors.

Wing-deflectors are similar to boulder weirs in that they are keyed into the stream banks, and slope to a low point near the center of the channel. Opposing wing-deflectors are created by constructing two single wing-deflectors opposite each other, reducing channel width by 40 to 80 percent. They should be constructed in low profile and their apexes should be equal in height.

Wing-deflectors are built in a triangular shape. This configuration will more effectively funnel flows between the apexes of opposing wing-deflectors, or to the apex of a single deflector.

Size of boulders will depend on the size of the channel, but oversized boulders are usually not a problem. To maintain the integrity of the structure it is desirable to secure the boulders with cable and polyester resin adhesive to create the perimeter of the structure. Smaller boulders or cobble can be used to fill the interior. The stream banks must either be naturally resistant to erosion or bank protection should be incorporated in construction of wing-deflectors.

Log Structures

Applications for log structures are similar to those for boulder structures. Logs may be used to provide instream cover for juvenile salmonids and spawning adults, to scour pools for rearing habitat, to recruit spawning gravel, and to stabilize eroding stream banks.

Log structures have a variety of shapes and uses. These include straight log weirs, downstream-V weirs, diagonal weirs, upstream-V weirs, upsurge weirs, wing-deflectors, divide logs, digger logs, and Hewitt ramps. The various structures have specific purposes which often dictate the specifications to which they are built. Many of these structures serve the dual purpose of trapping, sorting, and stabilizing gravel for spawning habitat as well as creating scour pools which act as rearing habitat for juvenile salmonids and escape cover or resting areas for spawning adults.

Log Weirs

As with boulder weirs, log weirs must be designed to specifications dictated by channel dimensions and range of flows that the stream may experience. It is important that log weirs are designed so that they do not become low-flow migration barriers. The maximum jump height that a log weir should create is 12 inches.

Log weirs are often placed in long, shallow riffles or runs. They may also be installed on straight reaches or meanders. The gradient should be between 1.5 and 4 percent in a moderately entrenched channel. Stream banks should be stable and composed of coarse, resistant material.

Log weirs have advantages and disadvantages compared to boulder weirs. The advantages are that logs are often available near the channel and are often obtainable at no cost other than the labor to bring them to the project site. A disadvantage of logs is that they will eventually rot, making the structure less durable than one of boulders. Redwood and cedar logs, however, can last for decades in a stream, are aesthetic, and are easy to work with.

Log weirs can be built in a variety of configurations. The type of log weir constructed is dependent on the desired habitat modification. Straight log weirs have been used extensively throughout the California coastal mountains. Constructed properly, they will trap gravel upstream and scour a pool downstream. Several problems have been associated with straight weir design. Straight log weirs can push too much water to sides, eroding fragile banks. Where there is not a proper downstream control, down-cutting immediately below the weir may create a jump in excess of 12 inches and a low-flow notch will be required (Figure VII-27). Generally, the only purpose for a straight log weir is to back-flood an area, such as a culvert. Downstream-V and diagonal weirs are more efficient at trapping gravel and upstream-V weirs are better for scouring pools.

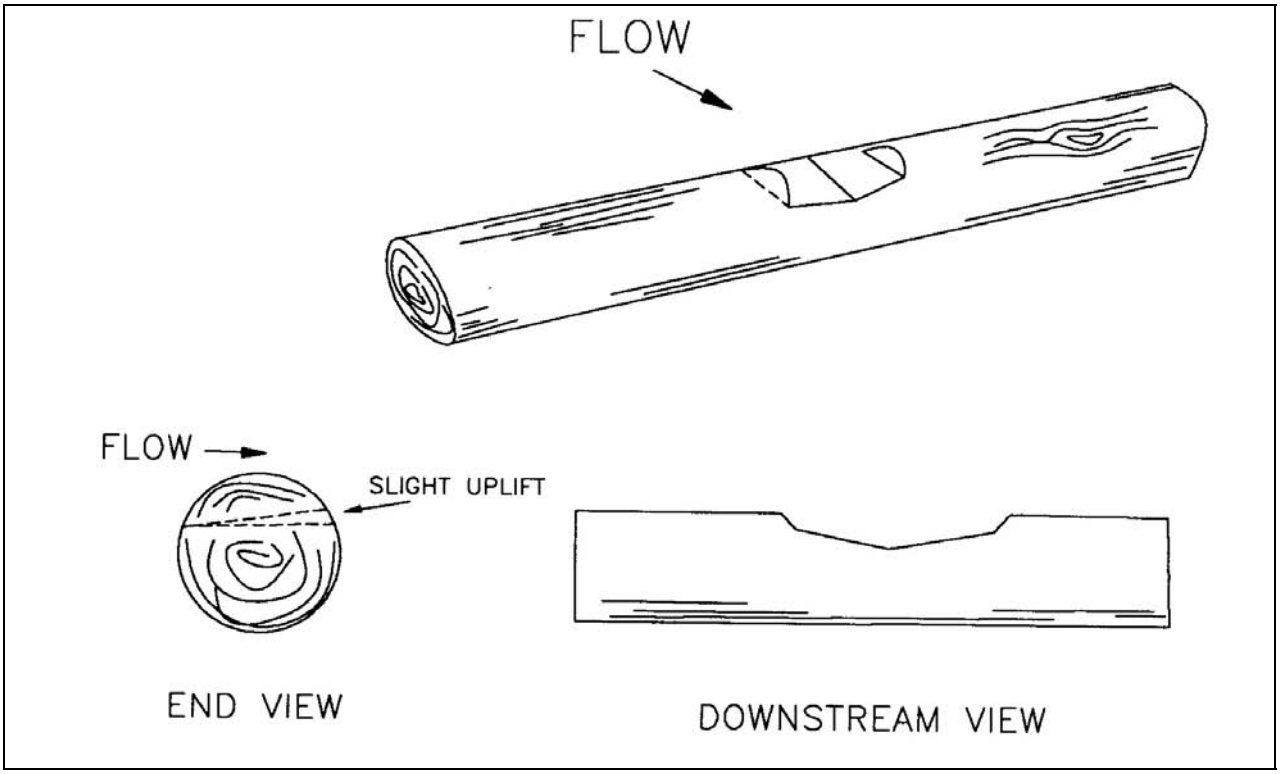


Figure VII-27. Straight log weir with low-flow notch.

Downstream-V weirs are effective in dissipating high flow energy and are used to collect spawning gravel. The downstream design forces water to the banks, therefore downstream-V weirs should only be constructed in areas of good bank stability (Figure VII-28).

Diagonal log weirs are placed diagonally to stream flow and span the full channel width. The upstream end of a diagonal log weir is set at a lower elevation than the downstream end. The drop in elevation should be approximately 6 inches in 10 feet. Diagonal log weirs cause stream flow to adjust direction so flow comes off the log at a right angle. Diagonal log weirs are good for creating lateral scour pools on river bends and for collecting spawning gravel, and they are also used to adjust direction of the stream. They can be very useful in directing flow away from unstable banks (Figure VII-29).

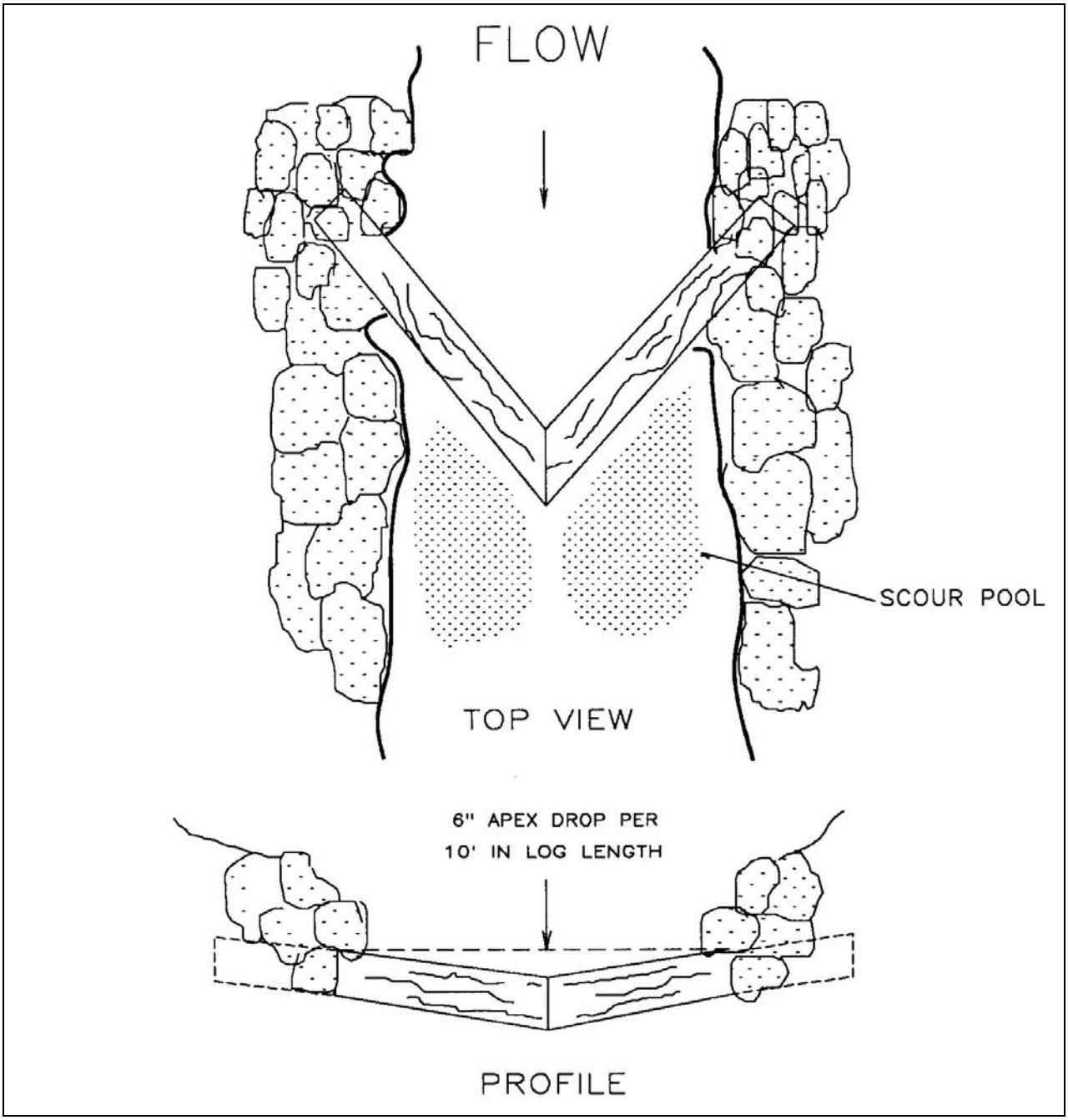


Figure VII-28. Downstream-V log weir.

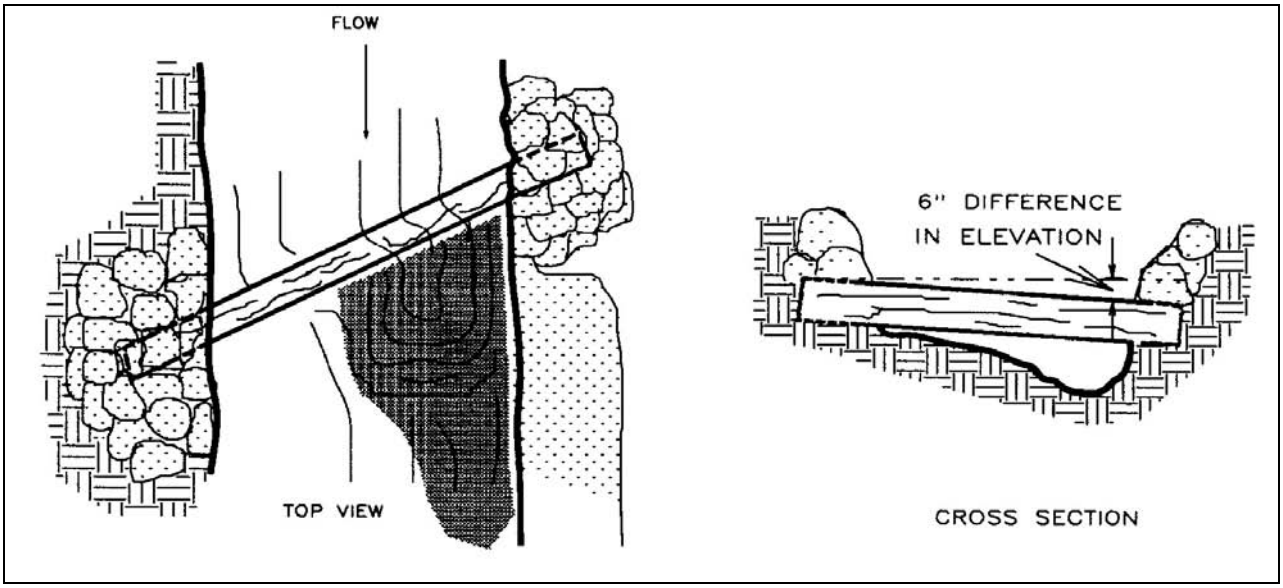


Figure VII-29. Diagonal log weir.

Upstream-V log weirs are used to scour deep pools. Principles of construction are the same for the various shapes of log weirs. Construction of an upstream-V weir will be described. These techniques of construction apply to other log weirs with some variations required to accommodate differences in configuration (Figure VII-30).

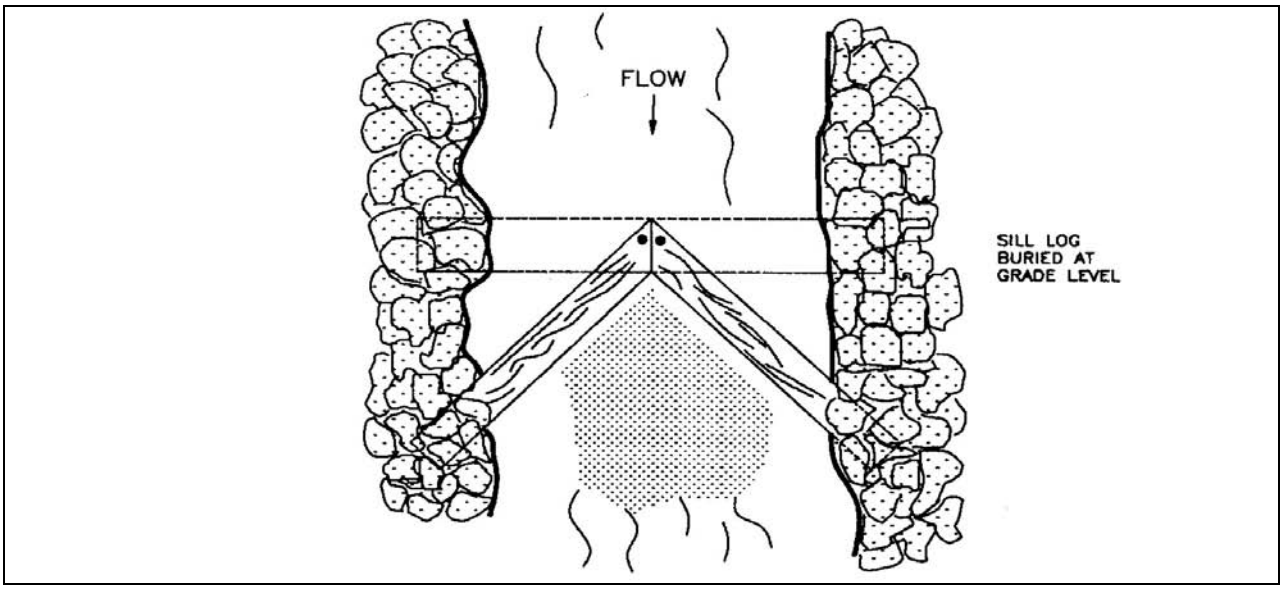


Figure VII-30. Upstream-V log weir.

Use redwood or cedar logs if available. Logs should be of appropriate size, determined by channel width, channel type, and bankfull discharge flows. Dig a trench perpendicular to the channel to bury the sill log at streambed grade. Key the ends of the sill log at least 6 feet into the bank. Place rock on keyed section of the log to prevent it from floating loose. Rock must be large enough and in sufficient quantity to protect banks.

Place the apex ends of the two logs forming the upstream "V" on top of the sill log. The two logs are placed so the apex is approximately 6 inches lower than the downstream keyed-in ends of the logs. The top of the logs at the apex should be no higher than 12 inches above the downstream water line. The apex of the logs must be shaped for a close fit. Drill through the apex ends of the two logs into the sill log, and hammer lengths of one-inch threaded rebar through both drill holes. Secure washers and nuts to the ends of the threaded rebar and tighten securely. Armor the bank ends of the logs with rock. Dig a 24-inch deep pool at the downstream apex so that fish can jump over the logs until high flows can create a scour pool.

If a series of weirs is to be installed, the downstream weir should be constructed first. Difference in elevation between lower and upper water surfaces should be 12 inches. Elevations can be determined with a hand or survey level and a stadia rod.

There are numerous variations of the upstream-V log weir. These include the upstream-V leaving a low-flow notch (Figure VII-31), the upstream-V using opposing log deflectors over a sill log (Figure VII-32), and log constrictors over a series of log planks (Figure VII-33).

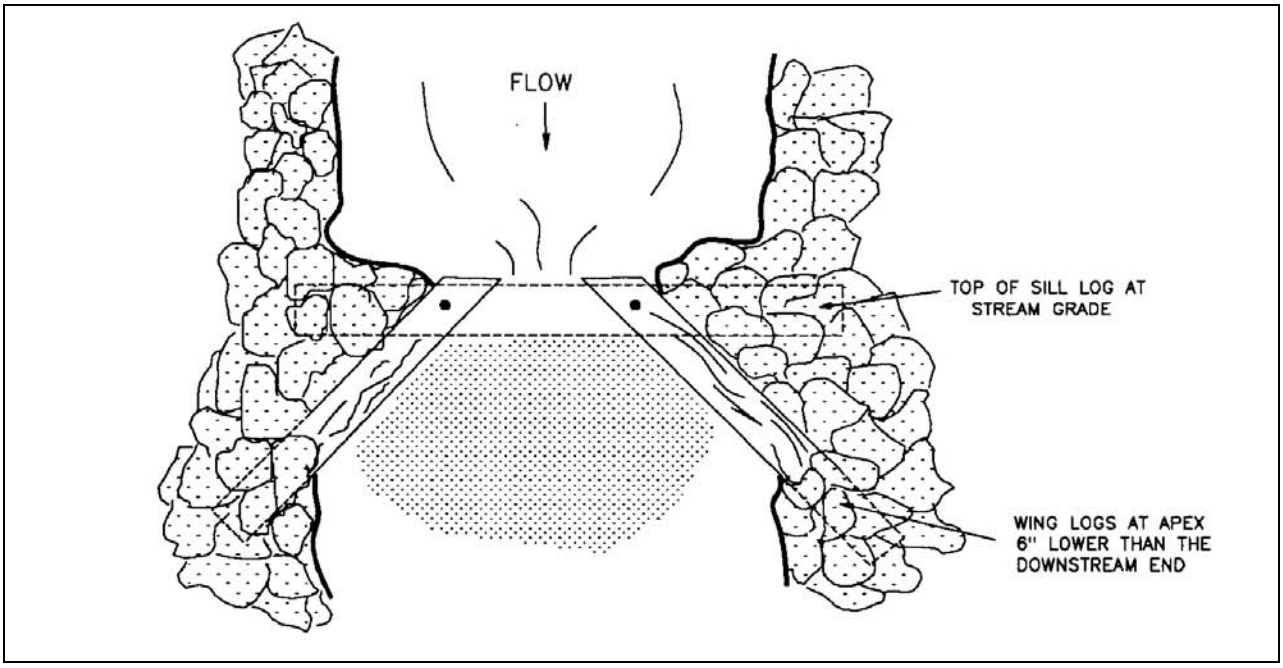


Figure VII-31. Upstream-V log weir with a low-flow notch.

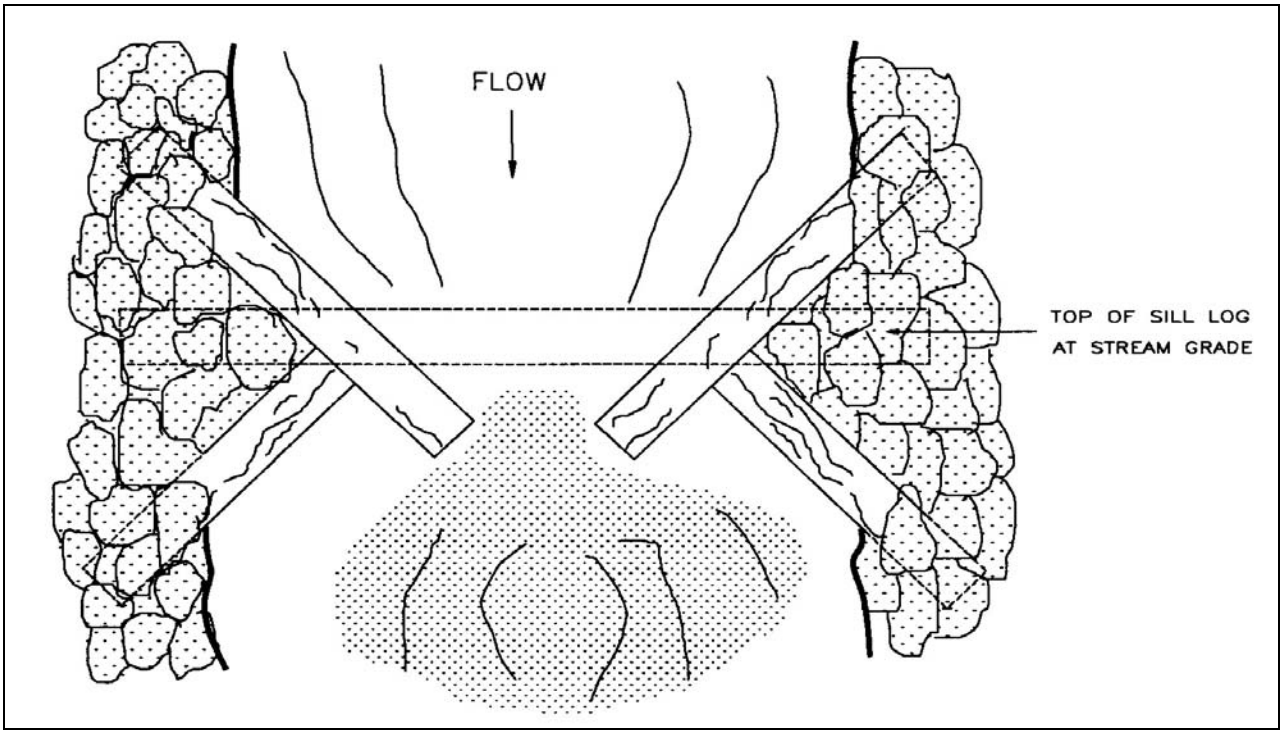


Figure VII-32. Upstream-V log weir with a low-flow notch.

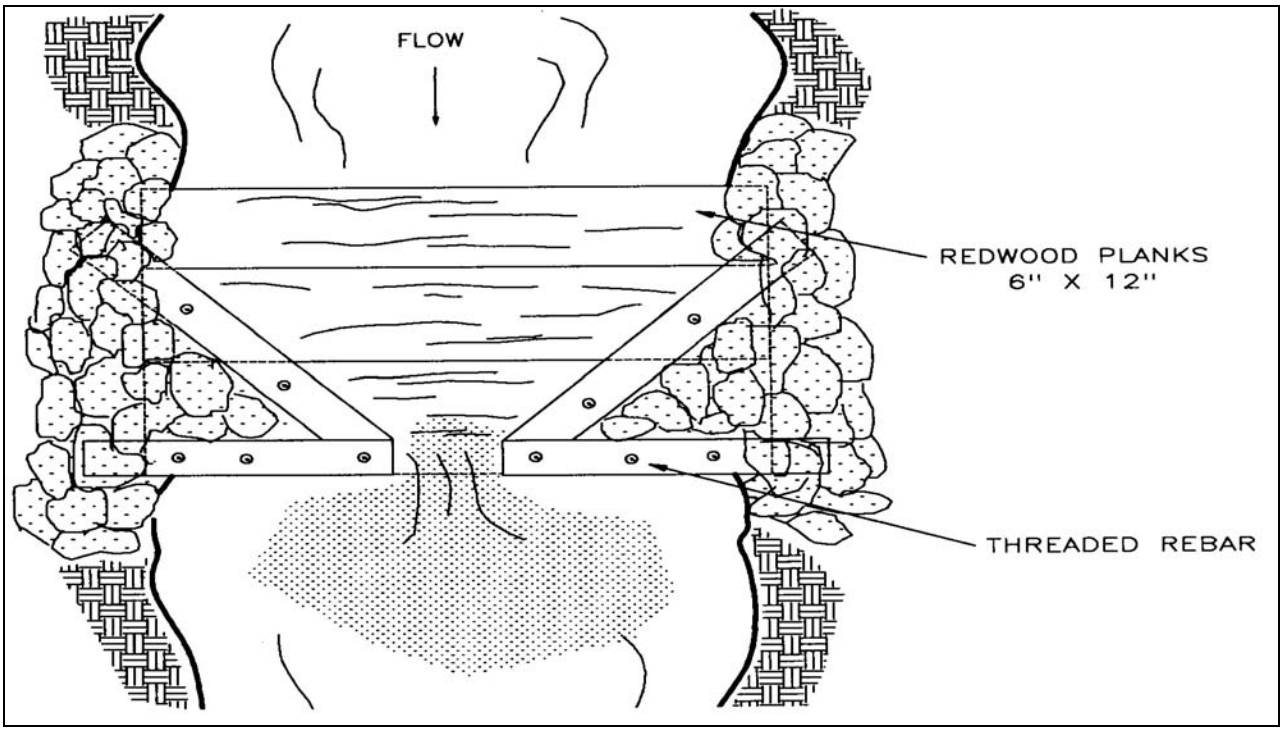


Figure VII-33. Log constrictors over planks.

Upsurge Weirs

Upsurge weirs are logs which span the full channel width. They are used to force stream flow under the log in order to scour the channel bottom to create or enhance pools for summer rearing habitat. Upsurge weirs are most effective when the bottom of the log is placed at the summer low-flow surface elevation (Figure VII-34).

Strong anchoring systems are required for upsurge weirs because of the strong hydraulic lifting force generated at scouring flows. Upsurge weirs should be anchored to stationary boulders on the banks or to bedrock. If this is not possible, both ends of the weir can be set into excavated trenches on opposite banks at the summer low-flow water level. Four to six feet of the log should be keyed into each bank. Enough weight must be placed on each log end to permanently secure it.

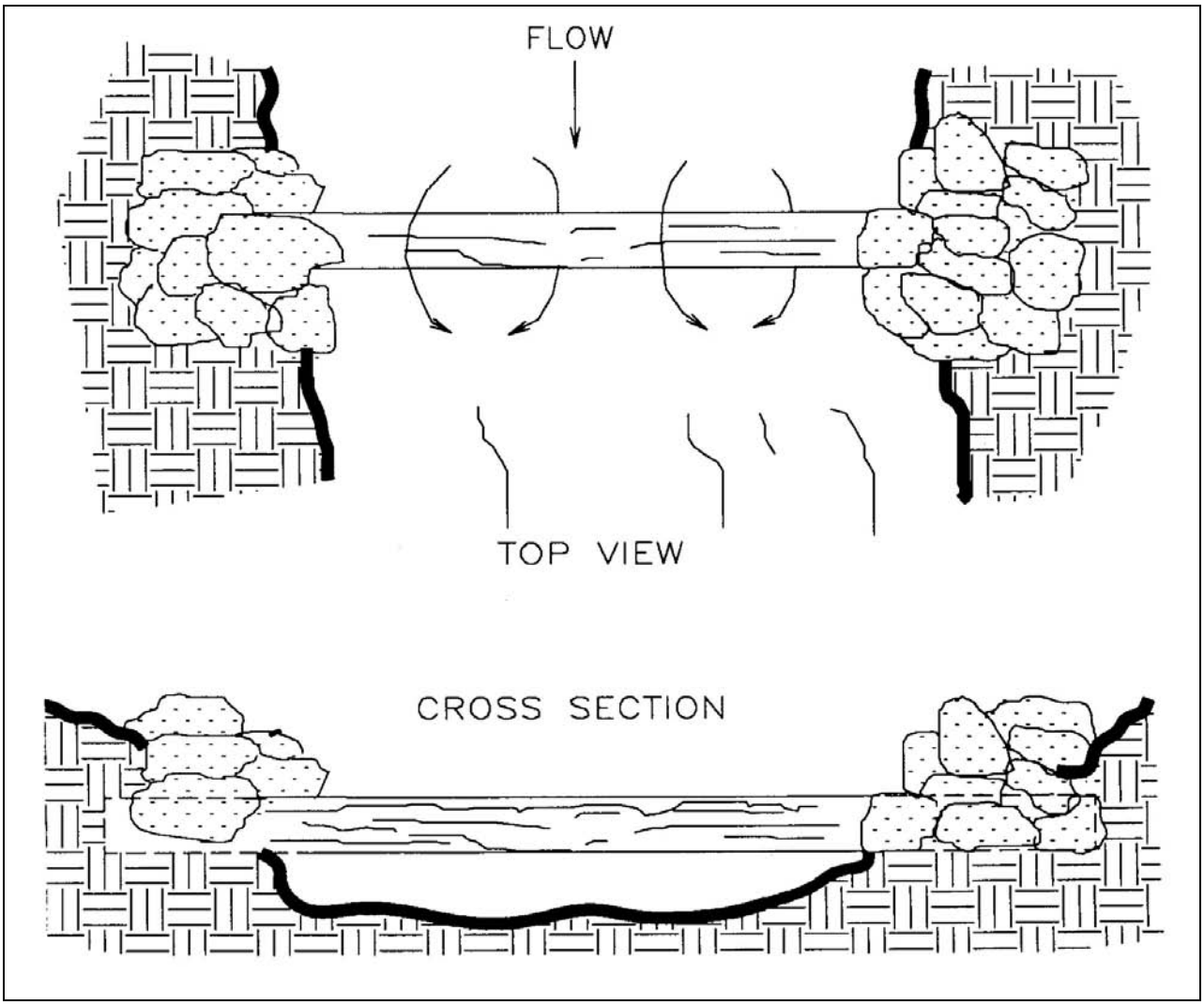


Figure VII-34. Upsurge weir.

Single and Opposing Log Wing-Deflectors

Wing-deflectors are used to concentrate the flow of water into a selected area of the channel to create scour. The scour creates a pool and the deflector(s) will act as cover and create a resting area for fish. They are primarily used in areas of long, uniform glides or riffles to diversify habitat and create velocity shear zones (Figure VII-35).

Wing-deflectors must not be placed or designed so that they create a severe channel constriction or deflect high flows into unstable or unprotected stream banks. The upstream log should extend into the summer low-flow channel so that it provides summer rearing habitat.

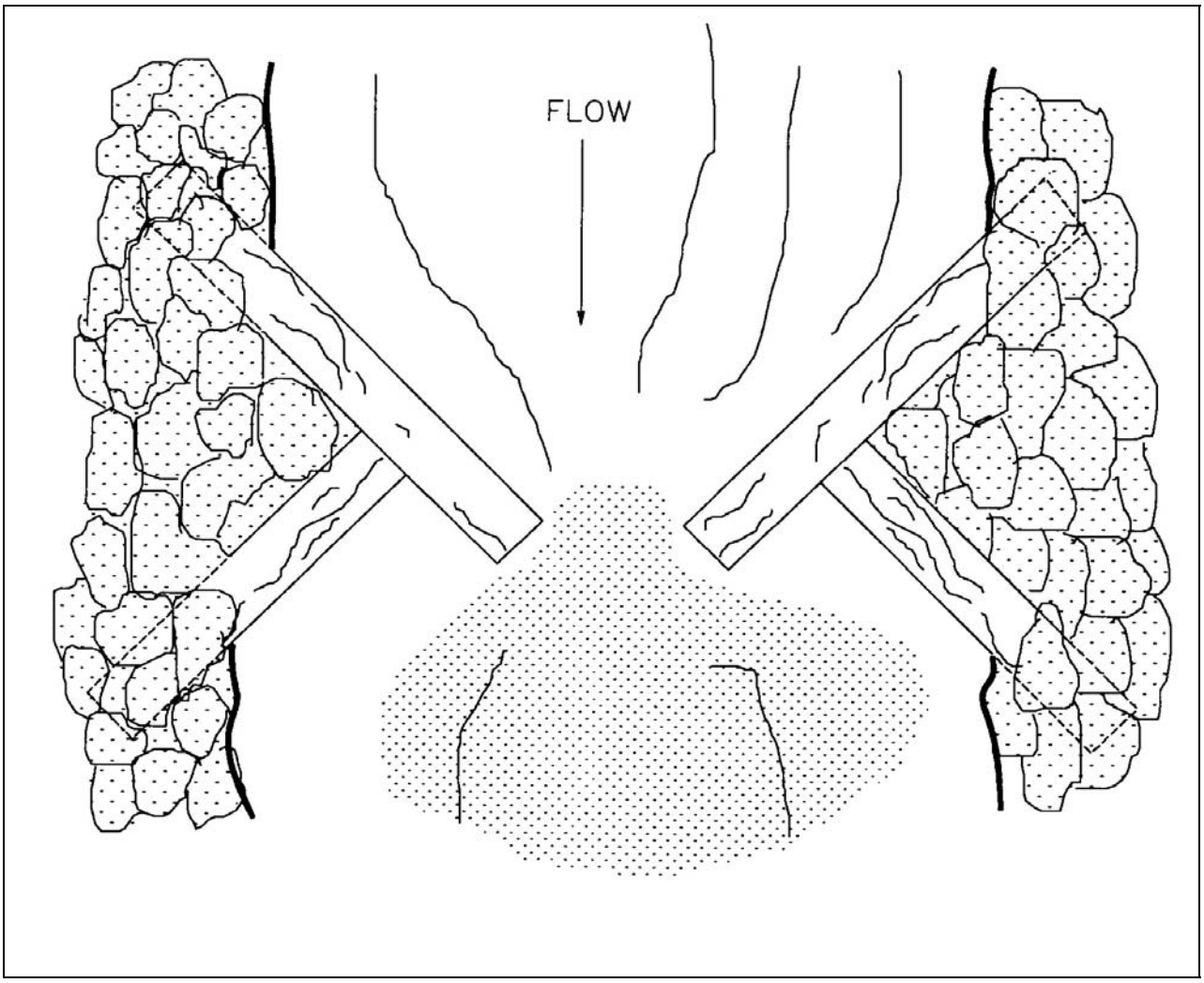


Figure VII-35. Opposing log wing-deflector.

The construction of the deflector involves making a "V" or a triangle whose base is parallel to the bank and whose two sides join to make the apex, which extends into the flow. A trench must be excavated into the bank to key-in the logs that make up the sides of the triangle. The trench must extend far enough into the bank to afford adequate anchoring for the deflector side logs. The angle of this trench will determine the angle at which the deflector sits. Orientation of the trenches will be determined by the desired apex angle. The apex angle will be 100 to 120

degrees. Location of the apex should be determined and the trenches should be laid out to conform to the desired angle of slope and the apex angle.

The ends of the side logs must be notched so that they fit together to create a joint that is the same diameter as the side logs (the top of the apex joint should form a smooth transition to either log). One log end (the one pointing downstream) can be extended past the apex to create scour and additional cover. The apex is held together with threaded rebar inserted through a hole drilled in the apex.

The base of the triangle parallels the bank. A smaller diameter log can be used to join the two sides of the apex. This will give the structure added strength, but if the bank ends of the logs are adequately anchored, the base log may not be needed.

Once logs are placed in their trenches and the ends have been joined to make the apex, the bank ends should secured to trees, stumps, boulders, or a deadman, then covered with boulders to weigh them down and act as anchors.

If opposing deflectors are installed, the distance between the apexes is important. This distance will determine velocity of water flowing between the deflectors and the amount of scour created. Opposing wing-deflectors typically should reduce channel width by 40 to 80 percent.

Hewitt Ramps

Hewitt ramps are constructed by installing base logs that support cedar or redwood planks. Planks are placed on the upstream side of the base log at an angle that will allow gravel to wash over the structure, creating a plunge pool on the downstream side of the structure. They are used to create pools in areas where there is a large volume of bedload movement. Construction costs for Hewitt ramps are high and the structures usually require periodic maintenance. Hewitt ramps must have a low profile or other design features to avoid creating a barrier to fish migration (Figure VII-36).

A Hewitt ramp is constructed with a base log placed in a trench excavated in the stream to one-third the log diameter. This log is secured by burying its ends in the stream banks. The log should be at least two feet in diameter. On the upstream side of the log, cedar or redwood planks (2 x 6 inch minimum) are laid to create a ramp at an angle of 30 to 45 degrees. Planks are set against each other and the ends are buried in the substrate to a depth of at least two feet. The area between the planks and the log should be filled with cobble to provide extra support for the planks. Tops of the planks are nailed to the log with 20d galvanized nails. The planks are cut off in a "V" configuration to concentrate stream flow into the thalweg during low flow conditions.

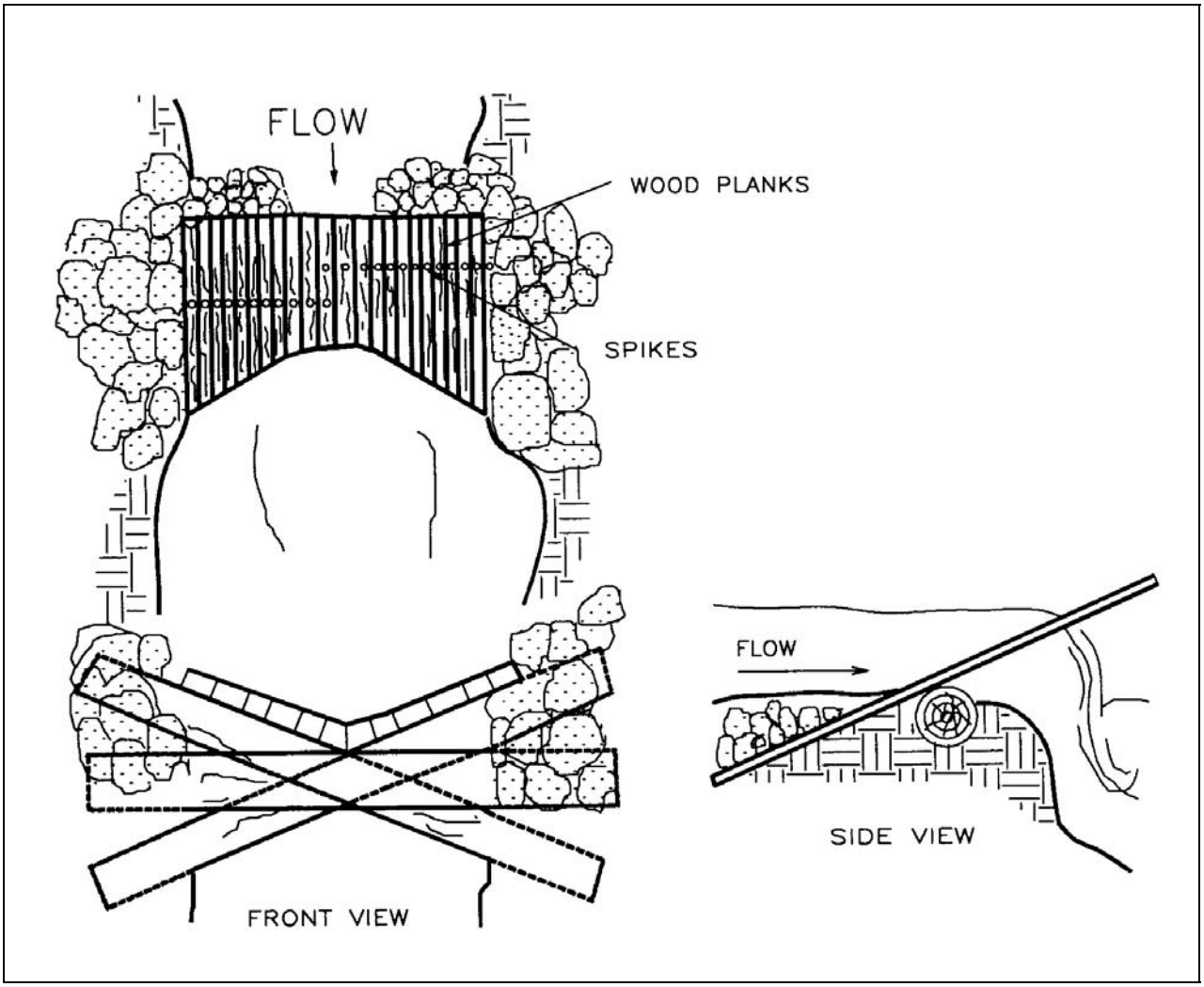


Figure VII-36. Hewitt ramp.

Placement of Imported Spawning Gravel

In streams that are deficient in spawning gravel, either naturally or because of artificial structures which prevent gravel recruitment or transport, addition of spawning size gravel may be beneficial. Several techniques may be used.

Gravel may be placed upstream of weir installations to a depth of about 18 inches. Spawning gravel for salmon should be clean, creek-run from 2 inch to 4 inches in diameter. Gravel would normally be dumped at a staging area on the bank and then picked up and placed with a front-end loader or hydraulic excavator.

In some streams that have high levels of fine sediment transported at normal flows, or in many streams after a high flow or watershed disturbance, fine sediment may be deposited in spawning gravel substrates. Therefore, periodic maintenance might be required to reduce fine sediment in spawning areas. This usually is done by plowing the gravel with a ripper attachment on a tractor and adding fresh gravel. Ripping is also an excellent technique for improving quality of natural spawning riffles infiltrated by fine sediment. Watersheds that have high levels of fine sediment yield should be treated to control the sediment source, if possible, before gravel seeding is considered as a project.

Gravel may be spread on spawning riffles without control weirs. This normally is appropriate where a dam or other artificial structure has blocked natural downstream movement of gravel, and gravel from once-productive spawning riffles has been washed away. It may be advisable to scrape off some of the armoring layer of cobble before fresh gravel is added. This technique should only be used in reasonably stable riffle areas, or there is an unacceptable risk of having the eggs and gravel wash downstream with high flows after fish use the gravel for spawning.

Sometimes, spawning habitat can be improved by simply dumping gravel in an area of high water velocity and allowing the stream to distribute the gravel downstream during high flows. An area of active bank erosion is usually a good site for this technique because the stream has demonstrated the ability to move substrate material. The project may also provide temporary protection for the bank until the gravel is washed away.

Fish Screens

Unscreened water diversions have been recognized as a serious problem for California's salmonid populations since the early 1900's. As a result, screens have been used to prevent entrainment of juvenile salmonids in water diverted for agriculture, power generations, or domestic use since the 1920's, and are needed on both gravity flow and pump diversion systems. Through the years, fish screen technology has improved dramatically, and high performance, low maintenance designs are now available. Screening criteria by DFG and NMFS (Appendix S) has established specifications which must be included in fish screen designs. This criteria requires water diversion screens to complete a barrier to salmonid entrainment.

Currently, most fish screens consist of perforated metal plate, or mesh material, with openings sized to prevent entrainment of juvenile salmonids. Screen systems that utilize light,

electric fields, sonic systems, and bubble curtains as barriers have been tested, but are not adequate. Screens utilize debris cleaning devices, typically brushes, water jets, or compressed air to prevent them from plugging. Bypass routes return fish to the stream channel. Normally a flow measuring device and head gate are required to monitor and control diversion flows. Screen designs are complex and site specific, and many require professional engineering; therefore, none are included in this manual. Consultations with staff from DFG fish habitat improvement shops and NMFS are recommended to determine fish screen suitability at a proposed diversion site.

FISH PASSAGE

Obstructions to upstream migration frequently restrict distribution of salmonids. When barriers to fish movement exist, reaches downstream of the blockage may become overcrowded with spawners or juvenile fish, while suitable areas upstream lie unused. Even a partial obstruction, which only poses a barrier under certain flow conditions, can be a serious problem.

Increasing the use of spawning and nursery areas above natural and human-induced obstructions is a sound approach to restoration which has met with considerable success. A note of caution that must be included, however, is: avoid situations in which newly created access for one species results in competition with a species or population already established in the area above the obstruction. Possible species interactions might include steelhead versus non-anadromous rainbow trout, or coho salmon versus established populations of cutthroat or steelhead trout. Competition with the introduced species may reduce the population of the established species or population.

The key physical characteristics of the stream which inherently affect salmonid migration should be understood before any attempt is made to remove or modify an obstruction. Low waterfalls (less than six feet), cascades, and chutes in natural watercourses can affect fish migration in several ways. When water drops vertically into a pool of depth at least 1.25 times height of the drop, fish have very little difficulty jumping over a low obstruction. The upwelling water, or Astanding wave@ created by flow plunging into the pool will actually assist fish by imparting an upward force as a fish leaps from the pool. However, an incline or chute can form a hydraulic jump further downstream; encouraging fish to jump too far from the crest of the drop (Figure VII-37).

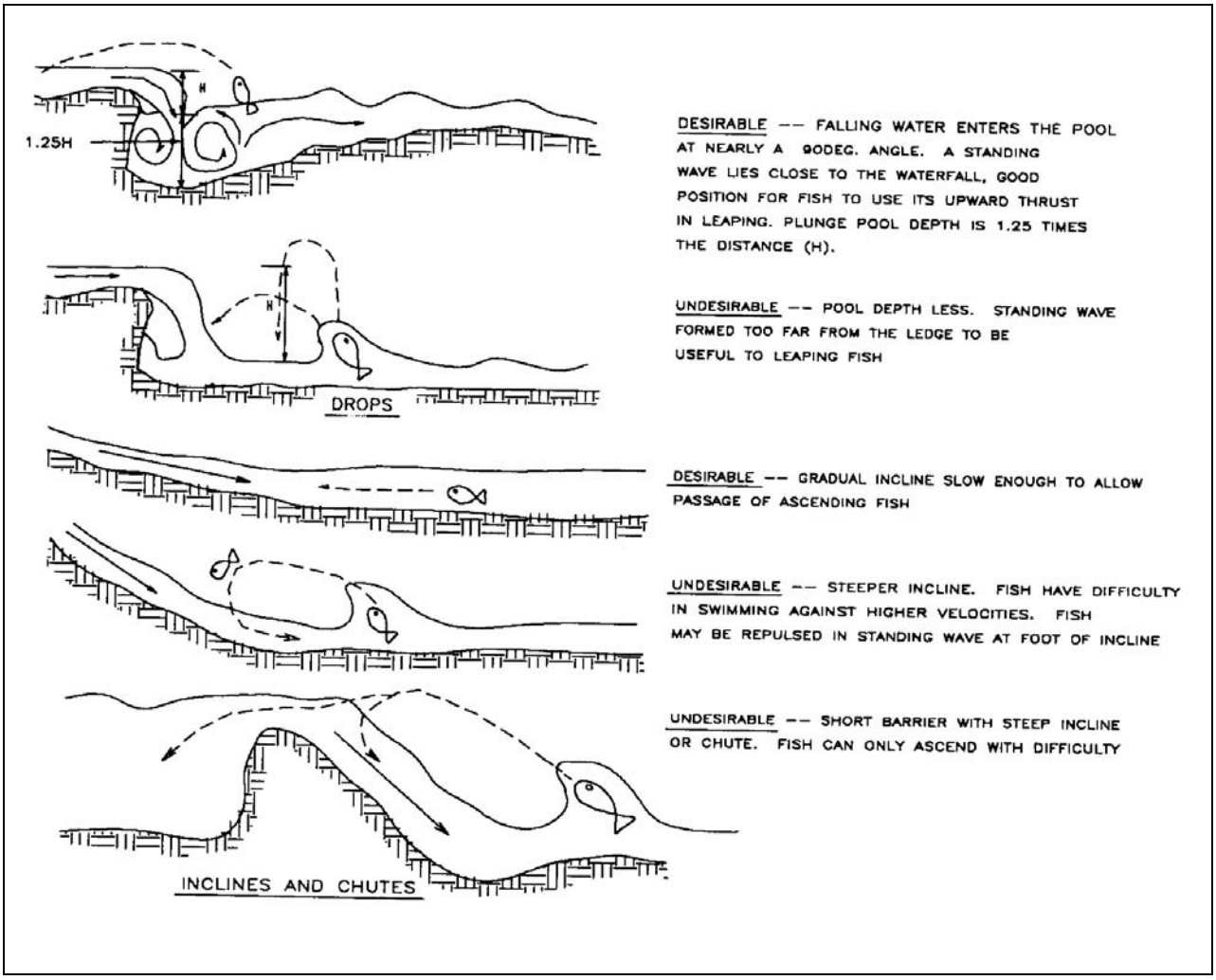


Figure VII-37. Movement of fish over natural obstacles (*Stream Enhancement Guide*, British Columbia Ministry of Environment, 1980, p. 27).

Obstructions

Natural obstructions to fish movement include waterfalls, chutes, logs and debris accumulations, and beaver dams. Any of these can create total or selective barriers. Often these barriers can be modified to provide fish passage, but regarding both log jams and beaver dams, care must be taken to preserve their rearing habitat benefits as well as to provide upstream passage. Removal of any natural obstruction during salmonid egg incubation may cause loss of the redd through silt deposition or changes in flow characteristics. Except for emergencies, any work to remove natural obstructions should be completed during low-flow periods outside the spawning or incubation season.

Log Jams

Log or debris jams can be either human-induced or a natural feature. It is sometimes difficult to establish whether or not a log jam is blocking migration. Often, a log jam which appears impassable has stable underwater passages for migrating fish. Careful surveys for salmonids, especially fry, above suspected jams should be conducted prior to any treatment. Large woody debris accumulations are preferred rearing habitat for steelhead trout and coho salmon because of the excellent cover they afford. Large stable pools created by log jams also provide important holding areas for adult salmonids.

Log and debris jams which become plugged with silt, gravel, fine debris, or other materials can form an impassable barrier or block flow and create a waterfall. In some cases, water diverting around log jams can create detrimental bank erosion. If a jam is creating an impassable barrier or creating erosion, modification of the log jam is desirable. In all instances, only the minimum amount of wood necessary to facilitate fish passage, or to eliminate a stream channel problem, should be manipulated.

The fastest and most efficient way to modify a log barrier is with heavy equipment. A self-propelled logging yarder, with a high lead, is most desirable. Hydraulic excavators are also useful. When this equipment is not available and access into the site is poor, manual labor, combined with a chain saw and griphoist operation, can satisfactorily modify log jams.

Beaver Dams

Beaver dams, like log jams, create benefits for salmonids as well as problems. Rearing juveniles, especially coho, use beaver ponds extensively. In addition, the pond can store water to help stabilize stream flow, augment the groundwater contribution to a stream's base flow, and reduce peak flows during freshet conditions.

Only when determined to be a problem, after thorough consultation with fish and wildlife personnel of the California Department of Fish and Game, should beaver dams be modified. If required, beaver dams can be altered with simple hand tools, a small backhoe, or by blasting.

Where frequent inspection of the beaver dam is possible, it is preferable to maintain an opening for fish passage over the crest of the dam. This results in a minimum of damage to the downstream areas, while still maintaining beneficial aspects of the impoundment.

Beavers are hard-working and persistent animals. When either a portion or all of a beaver dam is removed, the beaver family will normally attempt to restore the damaged structure. They often succeed.

Waterfalls and Chutes

Waterfalls and chutes can create fish migration barriers. Blasting to provide fish passage is usually the preferred method of altering waterfalls and chutes. Resting pools can be blasted into bedrock, forming a step-and-pool access (Figure VII-38).

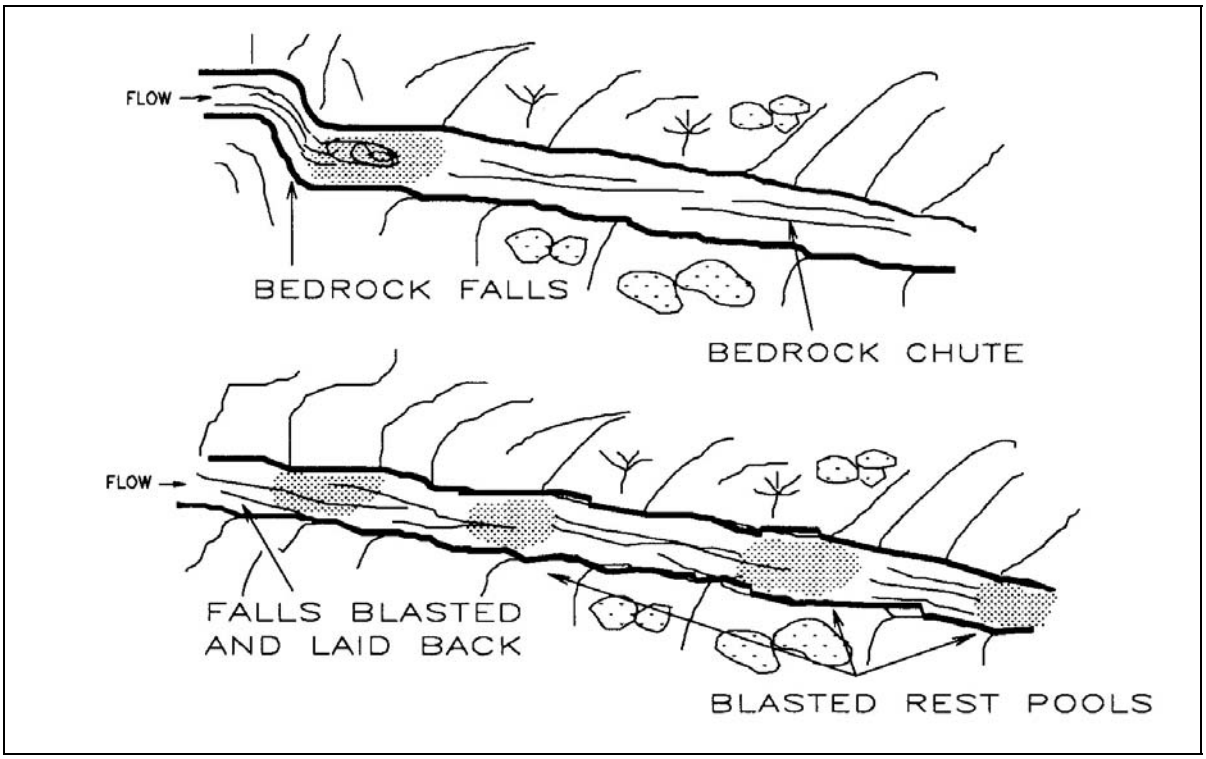


Figure VII-38. Before and after blasting of falls and bedrock chute.

Where a chute is causing a velocity barrier, it is sometimes possible to widen the chute by blasting to decrease the water velocity. Blasting can also be used to lower waterfalls. All blasting must be performed by a State of California, Division of Occupational Safety and Health, licensed blaster.

In some instances, use of log, boulder, or cement weirs to decrease velocity and back-flood a chute or waterfall is possible. As a last resort fishways can be installed to create fish passage.

Landslides

Landslides often occur during fall and spring freshets, which may also coincide with major fish migrations. If possible, slides should be removed or remedial work carried out immediately to avoid harmful effects on fish. If the slide is big enough, large earth moving equipment may be required to completely remove the obstruction.

Not all landslides require use of heavy equipment or large amounts of capital to improve fish migration. Often, in small landslides, selective removal or relocation of boulders and debris by hand crews, using steel rock bars or griphoists, can provide fish passage through or around an obstruction.

Large boulders may be reduced to a size that can be readily moved using a portable gasoline-powered rock drill and feather and wedges (hand rock-splitting tools). This may also be done with explosives, if a qualified blaster is available.

If it is not feasible to remove the obstruction, a possible alternative might be the use of a temporary step-and-pool fishway over or around the obstruction. This can be constructed using rock and debris from the slide. Often, selective blasting combined with handwork will provide a satisfactory fishway.

(Human-Induced Obstructions has been replaced by Part XII of Volume 2.)

~~**Human-Induced Obstructions**~~

~~Human-caused obstructions include such structures as dams, sills, and improperly installed culverts. The most obvious solution to fish passage problems, for example, culverts, is proper initial installation of the structure. An even better solution would be to install a bridge instead. Unfortunately numerous dams and improperly constructed structures exist. Various types of fishways can be built to provide access past dams and other barriers created by people.~~

~~**Fishways**~~

~~Fishways provide a way past obstructions that impede upstream migration of salmonids. The structures generally consist of a flume with baffles or a series of stepped pools that slow the water to a velocity more easily negotiated by fish. The three types of fishways to be discussed are: 1) the step-and-pool; 2) Denil ladders; and 3) the Alaskan steep-pass. All fishways require regular maintenance, and should be installed only when absolutely necessary.~~

~~Successful design, construction and operation of a fishway requires close cooperation between designers and biologists. Fishways should be designed to pass fish during at least 90 percent of the flow conditions that will be encountered. Downstream migrant smolts need a minimum 6 inches depth of water. Elements that effect fish passage include height of the jump, velocity of the water, and amount of space the fish has for maneuvering. There are six principal items of biological and hydrological information required prior to the design of a fishway:~~

- ~~Species of salmonids in the river system, as well as magnitude and timing of the runs;~~
- ~~Probable access route to the barrier, including areas where fish will congregate below the obstruction;~~
- ~~Extent of spawning and nursery areas and potential salmonid production from both above and below the obstruction;~~

- ~~Type and quantity of anticipated transportable debris;~~

- ~~Frequency, duration, timing, and magnitude of anticipated flows, especially extreme high and low flows;~~

- ~~Location of other barriers in the stream system, and their possible effects on distribution of salmonids.~~

~~After preliminary information is analyzed, these items must be considered to locate and design the final structure.~~

- ~~The entrance to a Denil ladder and Alaskan steep-pass fishways should be as close as possible to the foot of the obstruction, with the fishway extended into the pool so a swim-in condition exists at all operational flows;~~

- ~~Flows in and near the fishway entrance should be sufficient to attract fish at all water levels;~~

- ~~When fish must swim through high velocity water, changes in direction should be minimized;~~

- ~~Energy dissipation should be complete in a step-and-pool fishway, with no carryover from pool to pool;~~

- ~~Fishways must be deep enough for the largest known fish in the system;~~

- ~~Resting areas must be adequate;~~

- ~~Flow patterns in the fishway must be stable, with no water surges;~~

- ~~A debris deflector should be incorporated at the flow intake;~~

- ~~The upstream exit must allow fish to easily reach secure resting habitat;~~

- ~~Need for cleaning, regulating and repairing the fishway should be minimul.~~

~~Step-and-Pool Fishway~~

~~A step-and-pool fishway consists of a series of vertical partitions spaced down the length of a specially constructed channel or flume (Figure VII-39). Flow spills over the crests of the partitions, each slightly lower than the one above, creating a series of step-like pools which fish can ascend with ease. In streams where there is substantial movement of bedload, tops of concrete walls are capped with 1/4-inch steel angle or plate to provide greater durability. Pools must be carefully sized to dissipate the energy of the cascading flow. Standard specifications for a step-and-pool ladder require pools 8-feet long, 6-feet wide, and 4-feet deep, with no more than 12 inches of rise between steps. Step-and-pool fishways are most effective where water levels remain fairly constant. Depth of water cresting weir sills is critical, particularly in relation to pool size. Crest should not exceed 15 inches in depth or associated water velocities will likely impede~~

~~fish passage. In situations where water levels fluctuate, these fishways require regular adjustment at an upstream control to provide optimum depth and velocity for fish passage.~~

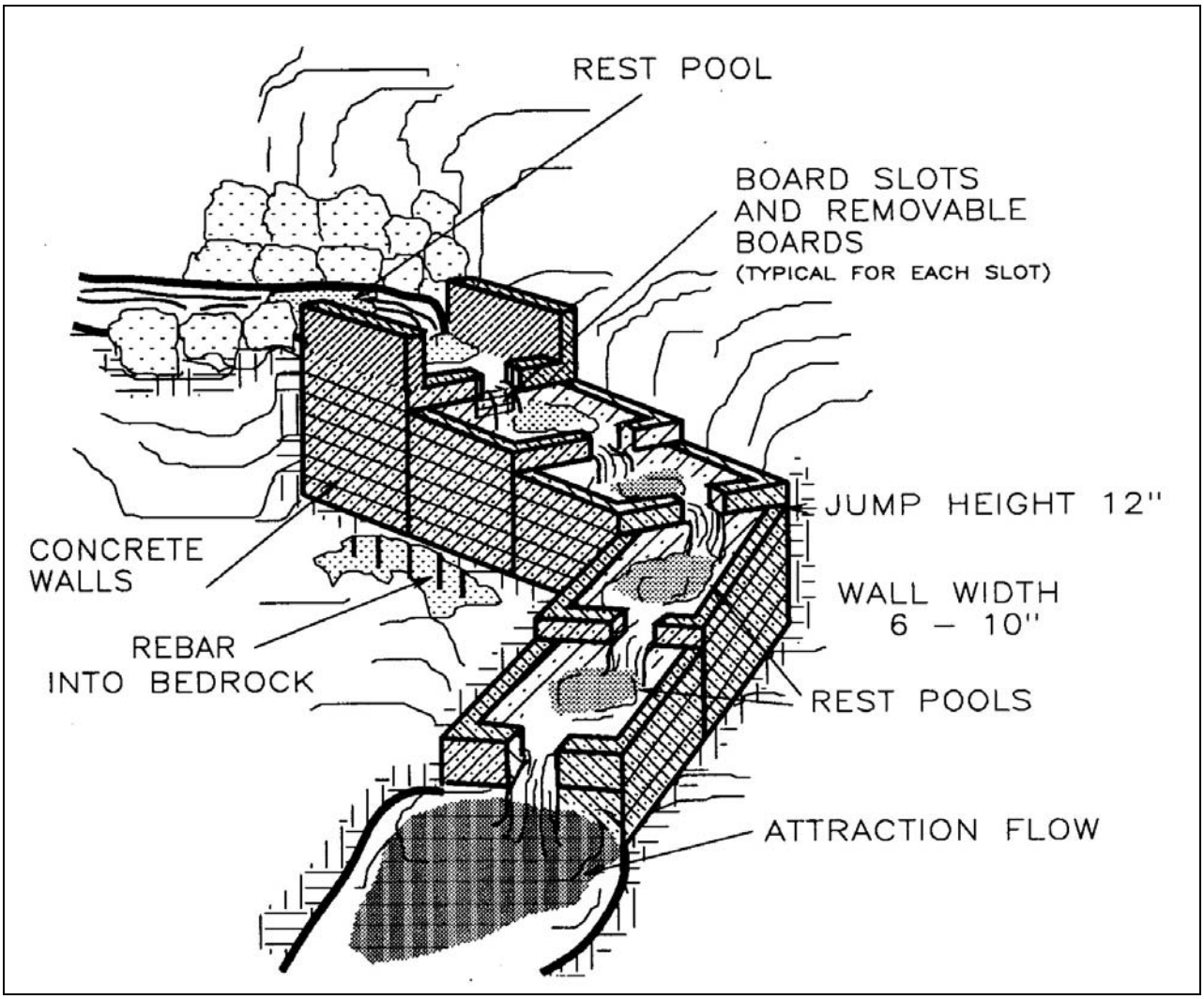
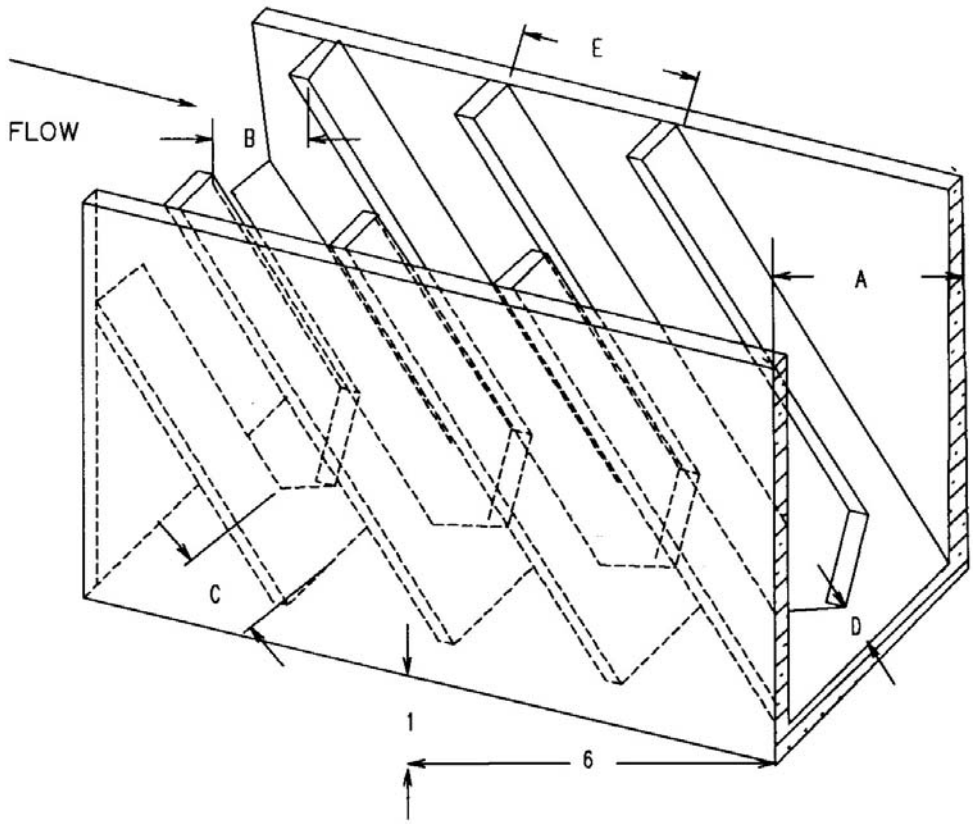


Figure VII-39. Step-and-pool fishway.

~~Denil Fishway~~

~~The Denil fishway is essentially a short section of flume with baffles affixed to the sidewalls and floor (Figure VII-40). The energy of water passing through the structures is dissipated in turbulence caused by baffles, which leave a narrow zone of low-velocity flow. The Denil fishway in most instances can be installed at steeper slopes than the step-and-pool, and for a given height of obstruction, can be substantially shorter. They are very efficient at passing bedload materials which would block other types of fishways. However, baffles can easily catch floating debris, resulting in partial or complete blockage to fish passage. They require daily maintenance during fish migration season to ensure clear passage.~~



A	B	C	D	E
4'–0"	2'–4"	2'–0"	1'–0"	2'–8"
3'–6"	2'–0"	1'–9"	10.5"	2'–4"
3'–0"	1'–9"	1'–6"	9"	2'–0"
2'–6"	1'–5.5"	1'–3"	7.5"	1'–8"
2'–0"	1'–2"	1'–0"	6"	1'–4"

Figure VII-40. Denil fishway.

~~Alaskan Steep-pass~~

~~A modification of the Denil fishway, the Alaskan steep-pass, is smaller, reduces velocities more effectively, can be prefabricated from lightweight aluminum, and is easily installed (Figure VII-41). However, it is more likely to plug with debris.~~

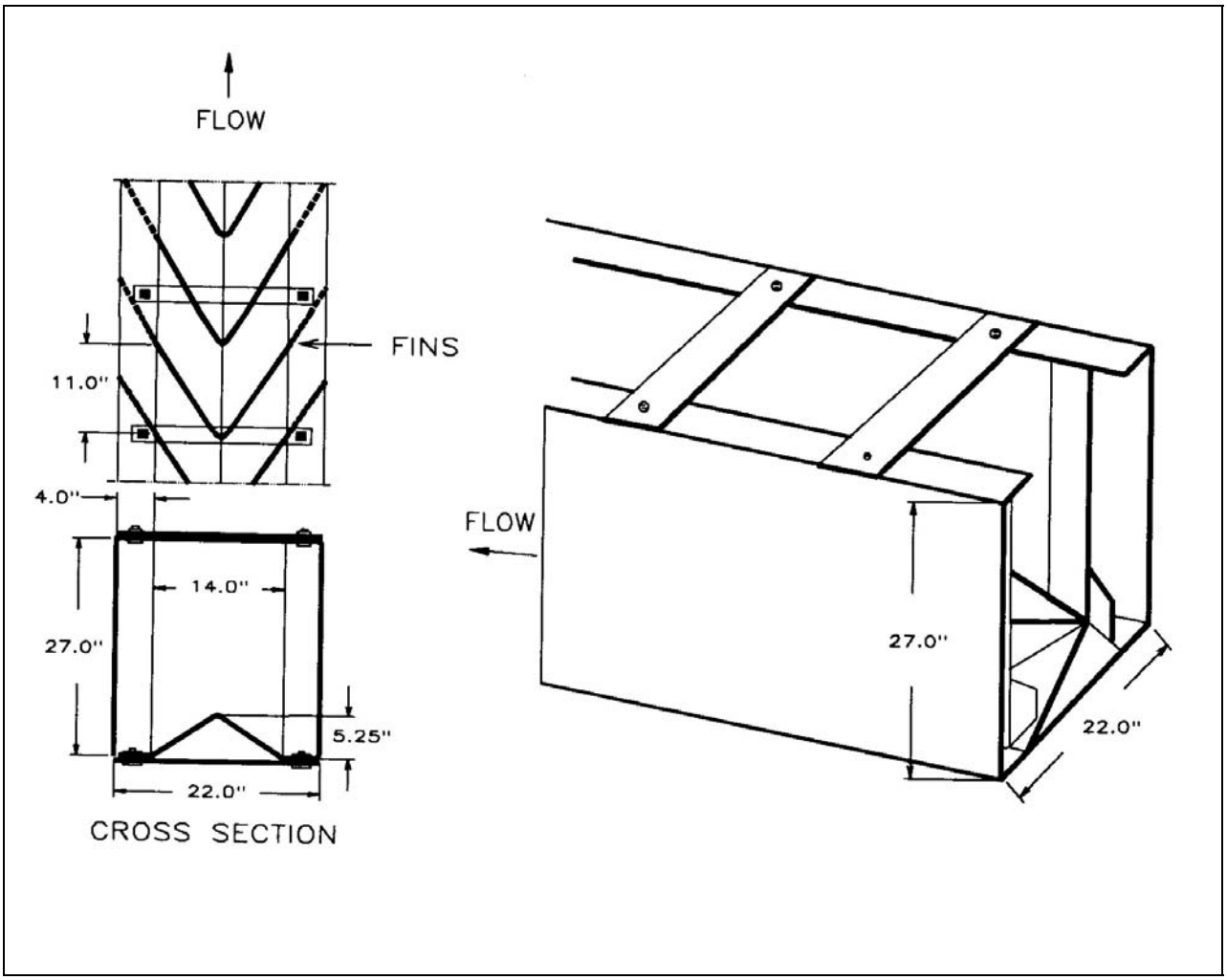


Figure VII-41. Alaskan steep-pass.

~~Placement of a fishway entrance is critical. The fishway entrance should be positioned where fish tend to congregate, normally in the area of greatest flow at the base of the obstruction. The bottom of the fishway must extend into the pool to provide a swim-in situation for the fish. Sometimes a rock wall, a training wall, or even a barrier dam, is needed to divert water and fish toward the fishway entrance. The Alaskan steep-pass has shown poor results in passing large salmon in California and is not recommended for that purpose. They have, however, proved efficient in passing steelhead.~~

~~Culverts~~

~~Properly installed culverts should pass fish during at least 90 percent of all anticipated flows. Migration barriers are frequently created by velocity chutes within culverts and jump barriers created by scour at the downstream end of culverts. Such barriers affect not only migrating adults, but they invariably prevent upstream juvenile movement during the low flows typical of summer rearing periods.~~

~~Back-Flooding Weirs~~

~~If the culvert is not installed with at least one-quarter of its diameter at or below the stream grade, the erosive hydraulic action of the discharged water will cut away the stream bed below the culvert outlet and create a waterfall. If this condition occurs, it can often be corrected by installing back-flooding weirs (Figure VII-42).~~

~~These weirs can be constructed of either logs or boulders. Ideally, the weir directly below the culvert should be of sufficient height to back-flood the culvert to a depth of 12 inches. Starting at the weir immediately below the culvert and proceeding downstream, each subsequent weir elevation should be no greater than a 12-inch drop (see section on boulder and log weirs).~~

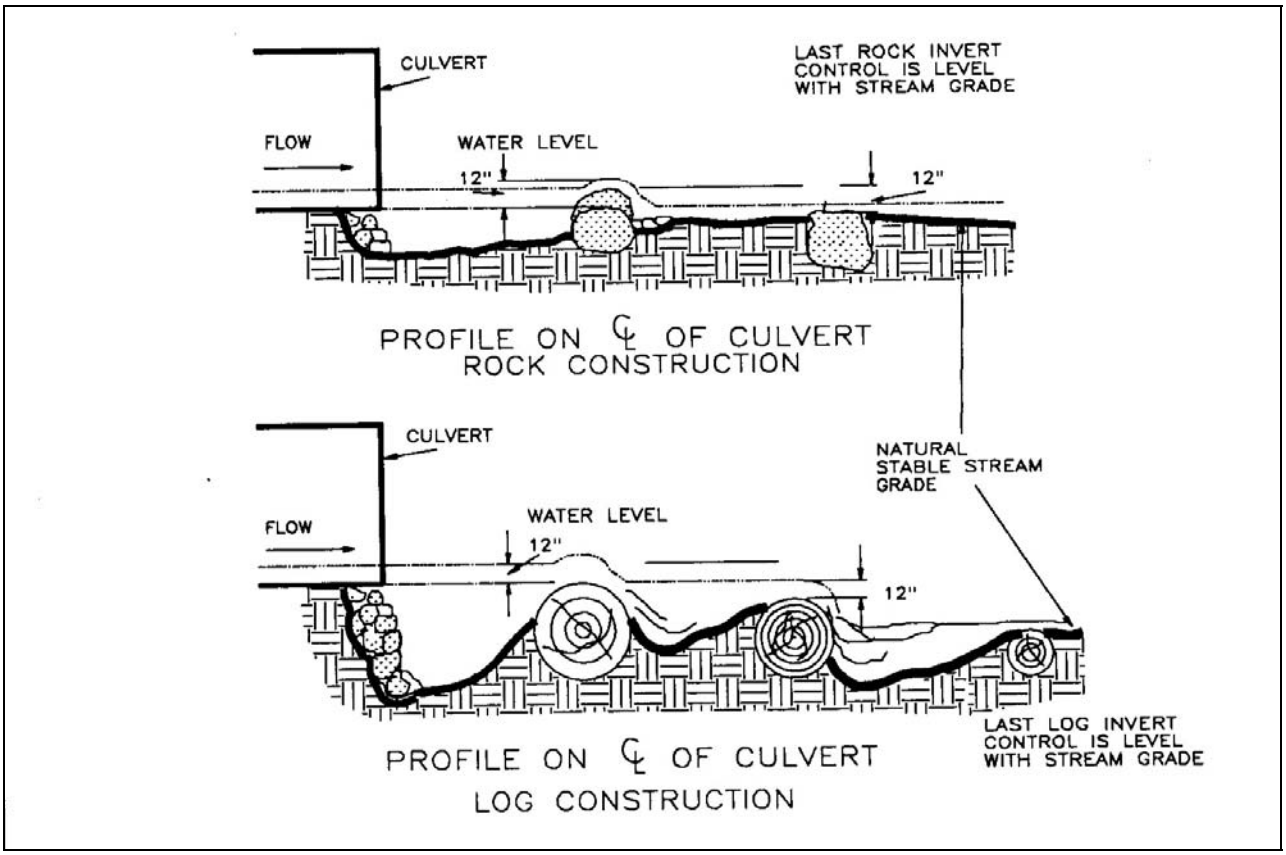


Figure VII-42. Back-flooding weirs.

~~Culvert Baffles~~

~~Culverts lack the natural roughness elements found in stream beds. Therefore, culverts often must be fitted with baffles to allow upstream fish migration. Installation of baffles in a culvert reduces the capacity of the culvert to pass water. It is important to calculate the discharge for the drainage area above the culvert to determine if the culvert will accommodate the expected discharge with baffles installed. The agency or landowner responsible for the culvert must be notified and be in agreement with the project before the baffle installation is begun. Two types of baffles are common in California: the Washington baffle, and the steel-ramp corrugated metal pipe baffle.~~

~~Washington Baffles~~

~~Washington baffles are designed to reduce velocities and increase water depths in concrete box culverts. These baffles should be constructed from either redwood or steel. In culverts exceeding 7 feet in width, a separator wall, two times the height of the baffles, should be installed to improve operating performance over a broad range of flows (Figure VII-43). To make the majority of flow go through the baffles during low flows, a flow barrier wall, half the height of the separator wall, should be constructed between the separator wall and the culvert wall. This will provide for low-flow passage of smolts and fry.~~

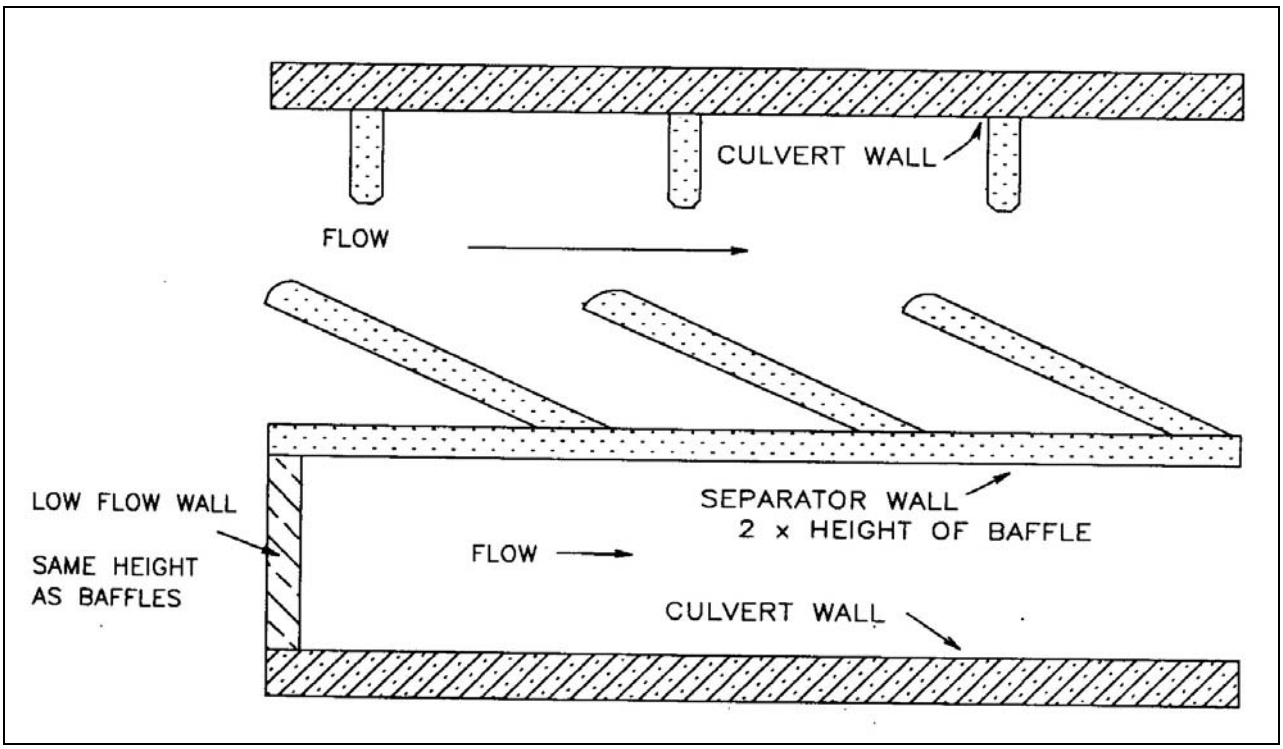


Figure VII-43. Washington baffles with a separator wall. (*Stream Enhancement Guide*, British Columbia Ministry of Environment, 1980, p. 42).

~~Baffles are installed with all long baffles on one side of the culvert, and all short baffles on the opposite side. Size of the baffle is determined relative to size of culvert. In box culverts less than 7 feet wide, length of the long baffle is 95 percent of the culvert width, and the length of the short baffle is 38 percent of the width of the culvert. The long baffle is oriented upstream 30 degrees from the culvert wall, and the short baffle is oriented 90 degrees from the culvert wall. Short baffles are positioned 26 percent of culvert width downstream from the leading edges of long baffles, facing the middle of the culvert. The first and last baffles in the culvert are spaced away from the ends a distance that equals 50 percent of the diameter of the culvert (Figure VII-44). Washington baffles must be placed in the thalweg. If the culvert is level, a low-flow training wall is needed at the head of the culvert to divert flows into the Washington baffles.~~

~~Redwood baffles are constructed from 6-inch by 6-inch redwood beams. This allows baffles to be installed easily in culverts with rough or cobbled bottoms because they can be cut to fit. Redwood baffles are secured to the culvert bottom with at least two 3/4-inch diameter, 18-inch-long threaded rods. Drill 7/8-inch holes, 6 inches deep in the culvert bottom, spaced 12 inches in from ends of the baffles. Secure threaded rods in holes with polyester resin adhesive. Drill holes in two 6-inch by 6-inch beams to match the spacing of the rods, forming a baffle 12 inches high. The upper beam must have a countersink hole drilled in the top side to allow recessing the washer and nut on the anchor bolt (Figure VII-45).~~

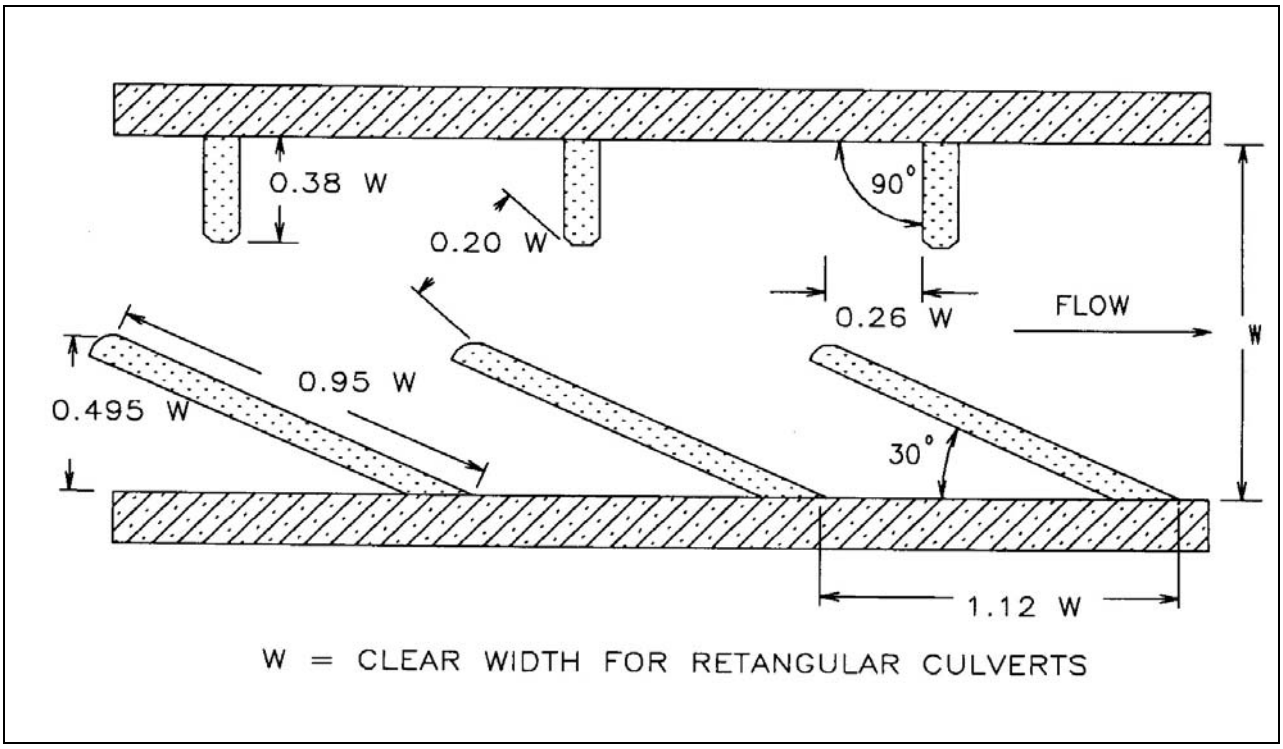


Figure VII-44. Washington baffles. (*Stream Enhancement Guide*, British Columbia Ministry of Environment, 1980, p.42).

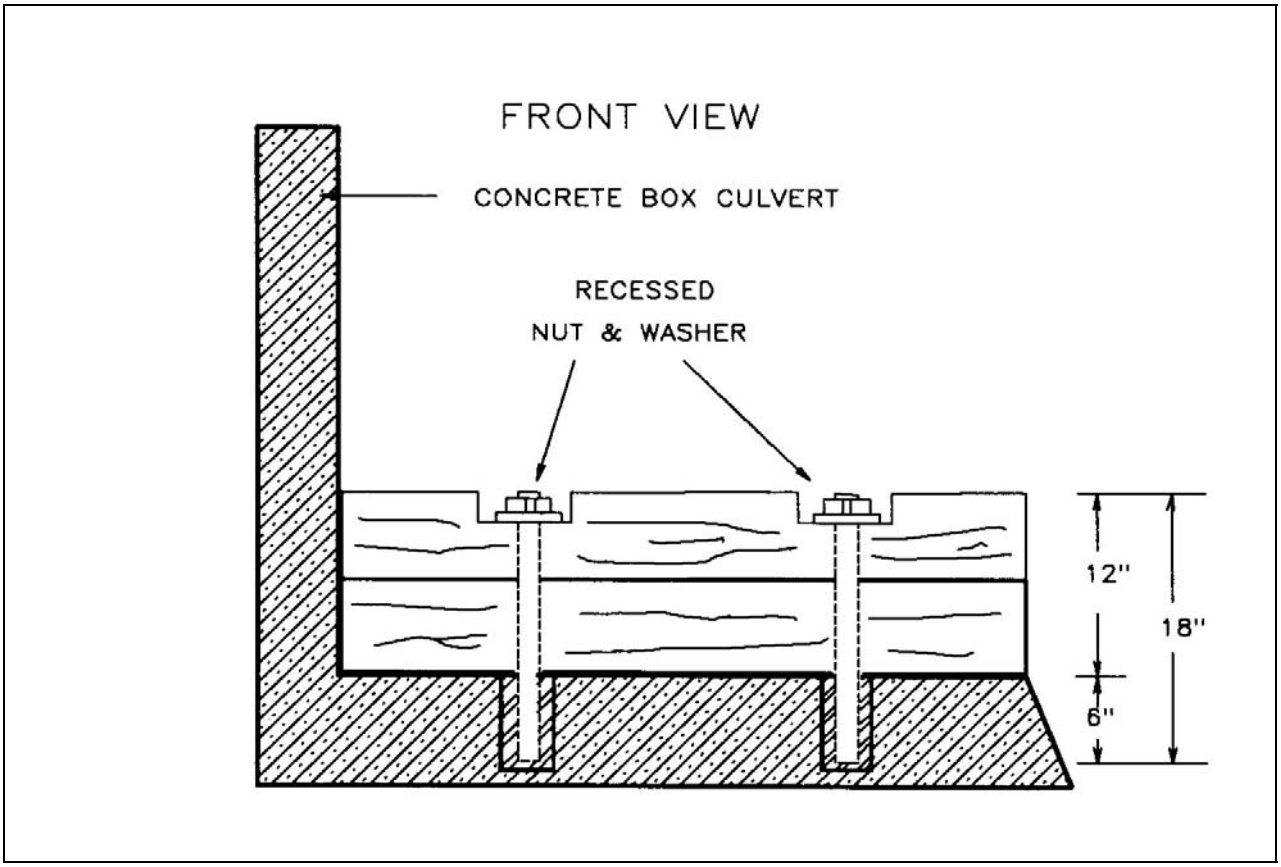


Figure VII-45. Redwood Washington baffle construction.

~~Steel Washington baffles are more resistant to bedload abrasion than wooden baffles (Figure VII-46). Steel Washington baffles are installed in the same manner as redwood Washington baffles with the following exceptions. Baffles are secured to the culvert bottom with 2-inch square mounting tabs, welded front and back. Each tab is drilled with a 3/4-inch bolt hole. Long baffles have four and short baffles have three tabs on each side. Drill 7/8-inch holes in the floor of the concrete culvert 6 inches deep to match the hole pattern on the baffles. Secure 7-inch X 3/4-inch threaded rods into the holes with polyester resin adhesive. Place the baffles over the rods and secure them with washers and nuts. The baffles may also be installed using expansion bolts.~~

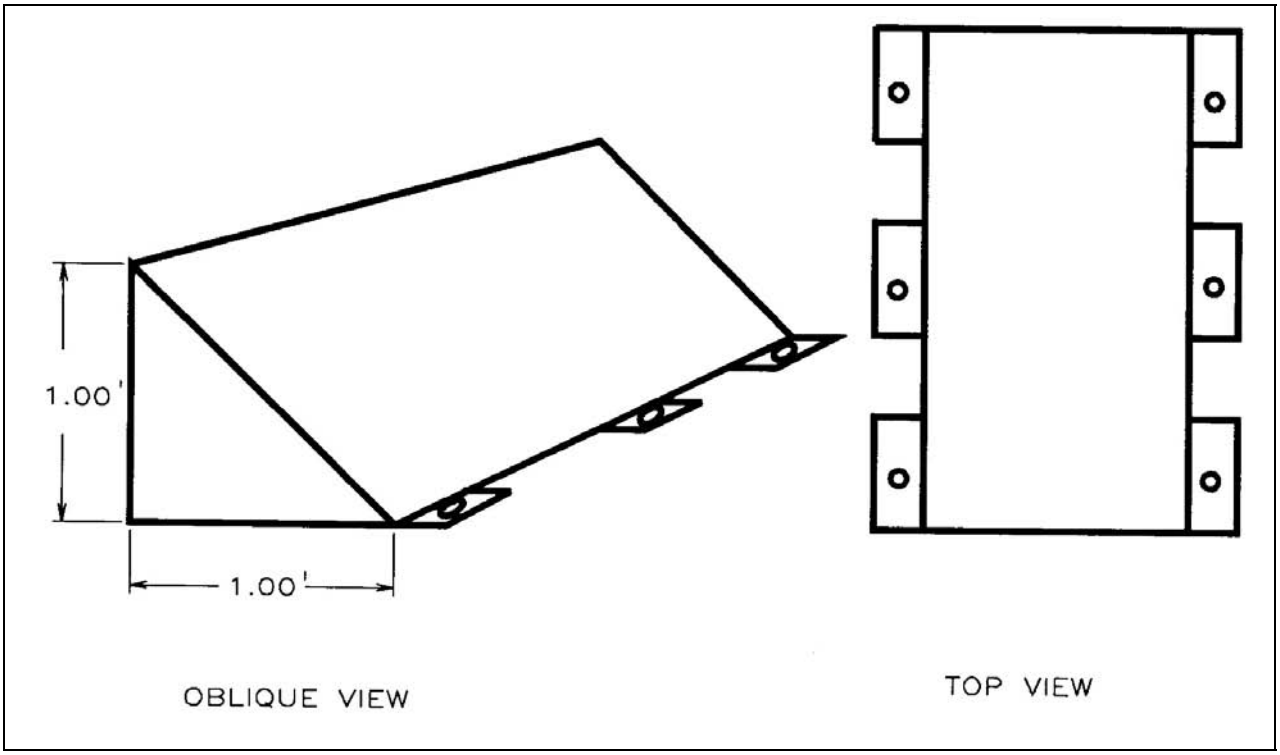


Figure VII-46. Steel Washington baffle.

~~Corrugated Metal Pipe (CMP) Steel Ramp Baffles~~

~~CMP steel ramp baffles are used in corrugated metal pipe where Washington baffles are difficult to install because of the curvature of the culvert. The narrow width of steel-ramp baffles allows them to be installed easily on the curved bottom of CMP culverts without leaving a gap under the baffle. Baffles should be attached to CMP culverts by welding, or with "L" bolts if the bottom of the culvert is in good condition (Figure VII-47).~~

~~Steel ramp baffles are installed alternating from side-to-side along the center line of the culvert bottom, with the ramp face of the baffle oriented upstream. They are spaced apart a distance equal to approximately 90 to 95 percent of the culvert diameter. Minimum thickness of the baffle material should be 1/4-inch steel plate. Baffles can be constructed to fit varying sizes of culverts. In culverts 6 feet in diameter and larger, 24-inch wide baffles are used. In culverts 4 feet in diameter, 16-inch-wide baffles are used. In culverts 3 feet in diameter, 12-inch-wide baffles are used. All baffles have 12-inch-high faces.~~

~~If baffles are bolted into the culvert, weld two tabs perpendicular to the bottom edge of the baffle's vertical side. Drill 3/4-inch holes in the leading edge of the baffle and in the tabs. The distance between the front and back holes must be matched to the distance between convex ridges in the corrugated pipe where the 3/4 inch "L" bolts are to be secured. Mark and drill the holes in the culvert bottom using the baffle as a template.~~

~~The "L" end of the anchor bolts are placed in the holes drilled in the culvert bottom. Baffle is then placed over the anchor bolts and secured with washers and nuts.~~

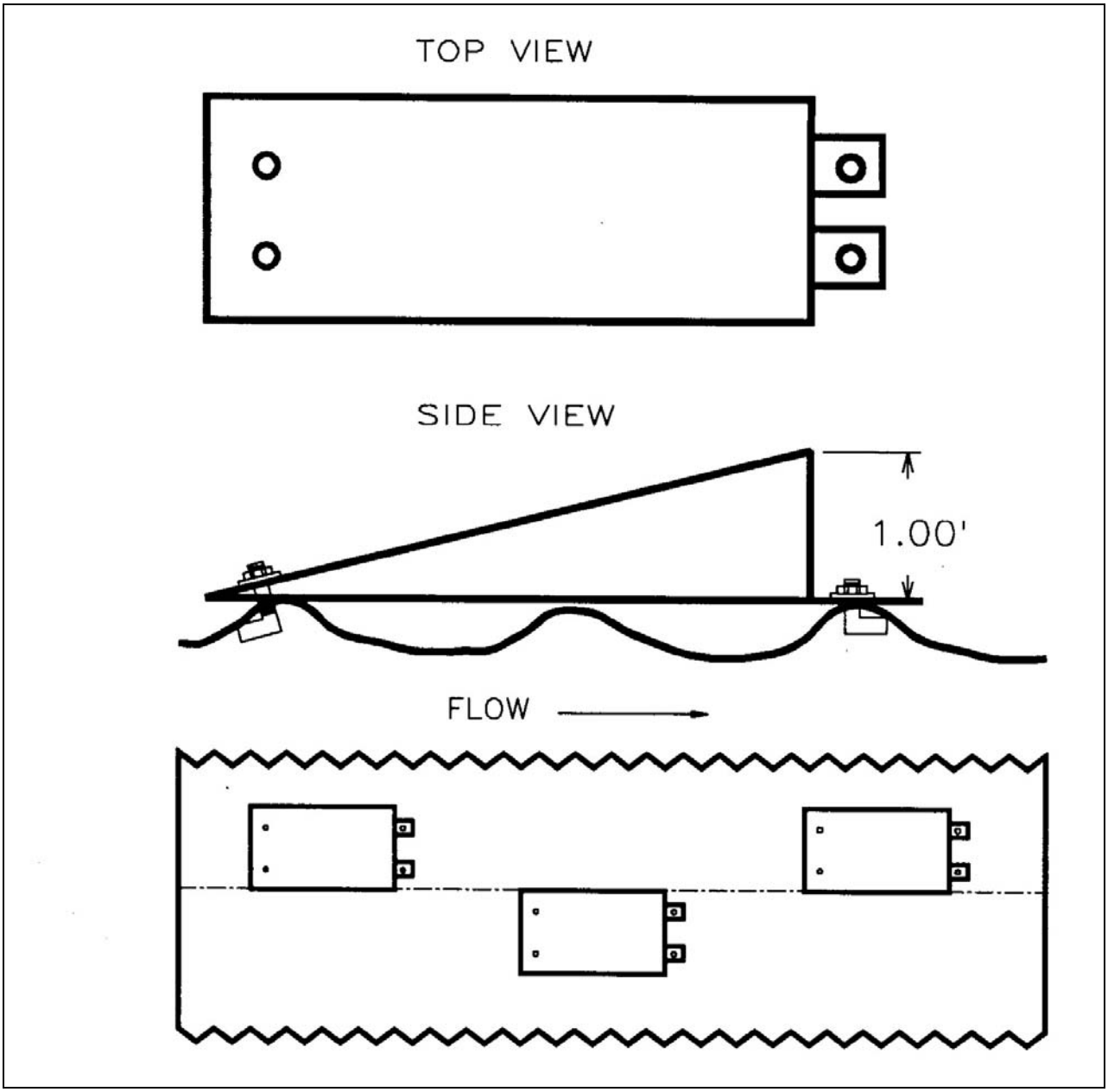


Figure VII-47. Corrugated metal pipe steel ramp baffles.

WATERSHED AND STREAM BANK STABILITY

Many streams are seriously affected by sediment from watershed and stream bank erosion. In all watersheds, erosion occurs in major storms. Other events occasionally occur which result in massive slope failure along a stream. These failures often introduce large amounts of fine sediment. However, they may also be a vital source of gravel, cobble, boulders, and large woody debris. Effects of each slope failure must be evaluated accordingly. Fine sediment may have a negative effect on fish habitat by covering spawning gravel, filling in pools, and creating high turbidity levels, which may cause gill abrasion, disease, stress, and egg or fish mortality. In some cases, these problems might be relatively short-term, especially when balanced against habitat benefits created by introduction of large, stable, structural elements.

When assessing erosion in watersheds, massive slope failures usually draw a great deal of attention but there are many other erosion sources that contribute fine sediment to streams. These are usually more easily treated than massive slope failure. This section will focus on: 1) landslide stabilization; 2) stream bank stabilization; 3) upslope erosion control with mulching; 4) revegetation in the riparian zone and upslope; 5) checkdam construction to control gully erosion; 6) waterbar construction to control erosion from dirt and gravel roads; and 7) exclusionary livestock fencing.

Slide Stabilization

Slide stabilization requires use of one or more complementary methods to control the slide toe, protect the slope surface, and treat the head and seat of the mobilized area of the slope. Mass slope failure can take many forms. These include slumps, rotational movements of "blocks" of soil, soil or mud flows, debris torrents, and slope creep. Slides are areas where the surface layer of soil and its accompanying vegetation move downhill under the influence of gravity. Slides are usually triggered by undercutting, or some force like heavy rain or earth tremors. Excess water that adds weight or liquidity to the slope may accumulate due to a heavy rainfall or snow melt, vegetation removal, or disruption of the natural drainage pattern.

Sometimes, dried out soil can result in a slide because the bonding of water molecules provided by moderate soil moisture is lost. This can happen if vegetation has been removed and the slope has lost its shade cover and the binding properties of roots.

The cause of a mass slope failure must be determined before an appropriate treatment can be prescribed. This may require an air photo analysis (historical sequence), geological and topographic map review, hydrological investigation, and field surveys to verify map and photo analysis (Part II). Once background information has been obtained and verified by field surveys, decisions on treatments can be made.

Slide stabilization is employed only where it is determined to be beneficial and feasible in reducing the amount of fine sediments entering the stream. Slides may best be stabilized and sediment input to streams reduced by a combination of toe protection, upslope drainage correction, and revegetation techniques.

Stream Bank Stabilization

Stream bank erosion is a natural process that can be beneficial by providing a source of boulders, cobble and gravel for fish habitat. However, when natural levels of erosion are exceeded, fish habitat balance may be lost and the stream and riparian zone may have difficulty recovering. In these situations, it is desirable to stabilize eroding stream banks. This can be accomplished with boulder and log structures, revegetation, and removal or relocation of obstructions that are deflecting flow into unstable banks. If there are relatively few isolated bank erosion problems, it is probably feasible to armor the eroding banks. However, when there are numerous landslides and bank failures along a channel, it may not be cost effective to undertake spot treatment. If the basic destabilizing process in a watershed, such as altered runoff rates, can not be controlled, treatment may not have a reasonable chance of success.

In some situations, stabilization of eroding banks may be detrimental to fish habitat. For example, on some levees built for flood or erosion control, development of riparian vegetation is prevented by manual or chemical means. In fisheries applications, bank stabilization must address the objective of improving fish habitat.

Access to an erosion site and availability of materials will partially determine the stabilization procedure, while stream hydrology and channel type will dictate the structure used. Hydraulic cross-sectional analysis will disclose stream dimensions required to assure passage of bankfull flows.

Boulder Stream Bank Stabilization Structures

Boulder structures are the preferred method for stabilizing stream banks because of their longevity and resistance to movement. Boulders can be used to riprap stream banks or construct wing-deflectors to deflect flow away from an unstable bank.

Boulder Riprap

Boulder riprap is a method for armoring stream banks with large boulders for preventing bank erosion. Riprap footing is laid in a "toe" trench dug along the base of the unstable bank. Boulder riprap is then laid on the bank slope up to the bankfull discharge level. Large angular boulders are best suited for this purpose. The exact size of boulder will vary with size of the channel and the stream. Revegetation with native species, including coniferous and deciduous trees, shrubs, and ground cover should be included as part of the treatment.

Boulder riprap can provide toe protection to a slide or other stream bank instability. It can be very useful for protecting banks in areas where log or boulder instream structures added to the stream could lead to stream bank erosion.

The type of boulder selected will be a major determinant of stability and longevity of the riprap. If boulders are imported, large, dense, angular boulders are preferable. It is important that only structurally competent boulders be used. Some kinds of boulders will break down rapidly and should be avoided, such as sandstone or some other types of sedimentary rock, which are poorly bonded and deteriorate rapidly.

The toe trench must be excavated to sufficient depth to prevent the structure from becoming undermined. If there is equipment access, this can be most effectively accomplished with a backhoe or excavator. Excavators work well on large streams that require relatively large rock. In smaller systems a backhoe can perform equally as well, is much faster to move, has the advantage of a front-end loading bucket, and is less expensive. Regardless of the machine in use, the key is to have an experienced, competent operator who is sensitive to the stream environment.

An excavator or backhoe can also be used to place boulders. Many machines have a bucket equipped with a thumb which makes it possible for them to grab boulders. These machines are ideal for setting riprap boulders. A front-end loader or bulldozer working in conjunction with a backhoe or excavator can greatly facilitate the construction process.

A toe trench that provides solid footing for riprap layers is necessary to prevent stream flow from undermining the riprap and causing it to collapse into the channel. Collapsed riprap could cause even more severe bank erosion. Riprap should not be attempted in streams with degrading streambeds. As the streambed degrades, riprap will be undercut and fail.

The largest boulders are placed in the toe trench to create the footing. They are placed tightly against each other. The next layer of boulders is placed so that it tapers back slightly from the base layer toward the near stream bank. The most stable riprap slope construction is achieved when each boulder has contact with at least three others, (three point contact). It first may be necessary to contour the bank above the channel, especially if it is vertical or nearly vertical. Slope should be no more than 1:1 or 45 degrees (the lower the angle of slope, the more stable it will be). Ideally, the finished angle of the riprap will be 2:1. The biggest boulders should be used in the lower layers and the smaller ones placed in the upper layers (Figure VII-48). Riprap should extend to above bankfull discharge. Riprap should also extend a little upstream and downstream from the treatment site to assure that the stream does not erode at the edges of the riprap. Riprap will resist erosion and may accelerate stream flow, creating a new erosion hazard downstream. It is essential that the banks at the end of the riprap are stable and resistant to erosion and that precautions are taken to avoid downstream damage.

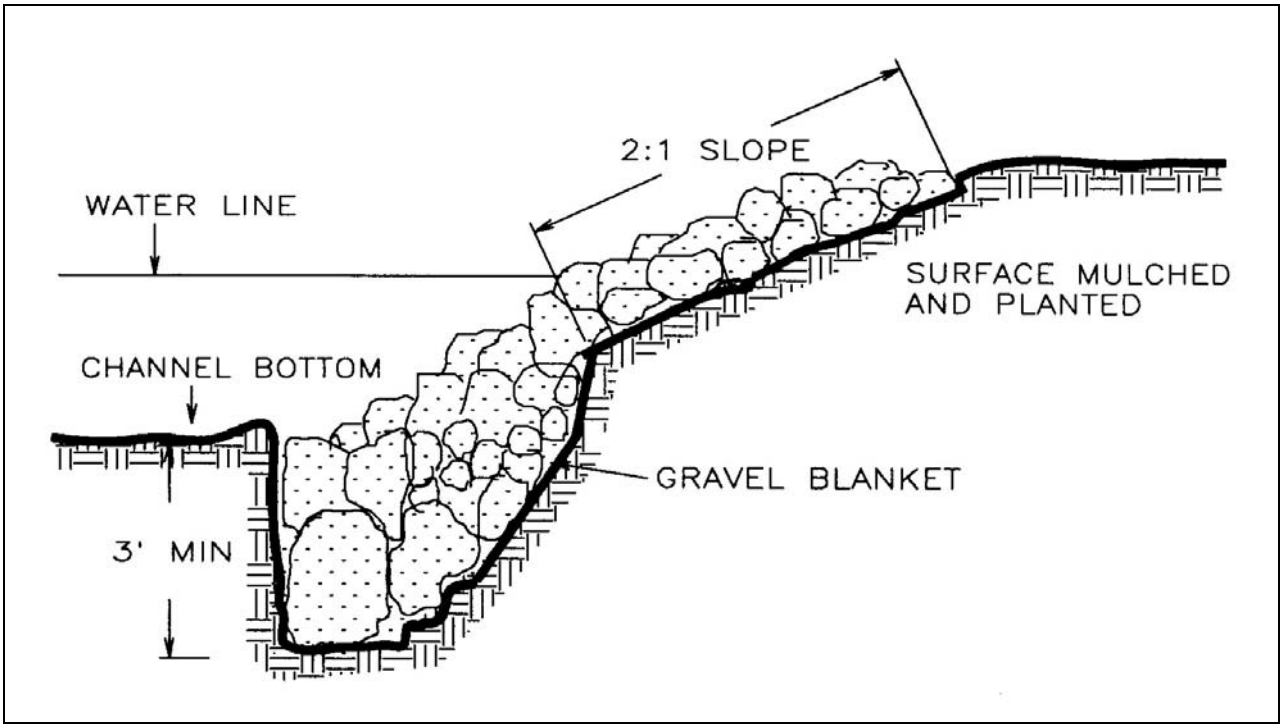


Figure VII-48. Riprap.

A gravel blanket or geotextile fabric should be used under riprap. In general, geotextile fabric is used on slopes which are 3/4 to 1 or less, simply because gravel will not stay on these slopes. A gravel blanket that is one foot thick should be used on slopes of 1:1 or greater. The purpose of the gravel blanket or geotextile fabric is to prevent soil underlying the placed riprap boulders from washing out and possibly causing the riprap to slump and fail. Use of geotextile fabric inhibits establishment and natural spread of plants on treated sites. Woody cuttings can be punched down through geotextile fabric, but other plants cannot push roots down through the material. Never install geotextile fabric where a gravel blanket can be used effectively.

It may be necessary to chink riprap interstices with small rock if bank material is particularly erosion prone. This protects underlying material from exposure to high-velocity flows.

Boulder Wing-Deflectors

Wing-deflectors used for bank stabilization are similar in construction to wing-deflectors used to create or enhance specific fish habitat features. In most cases, bank stabilization and habitat restoration benefits can be achieved. Wing-deflectors installed solely to provide bank stabilization may have a higher angle of intersection with the stream bank.

Wing-deflectors direct flow away from an unstable bank and provide armor (a hard point) to protect the toe of the slope from further erosion. Improper use of wing-deflectors can cause accelerated erosion on the opposing bank. Boulder faces in the deflector structures have the added benefit of providing invertebrate habitat, and space between boulders provides juvenile salmonid escape cover (Figure VII-49).

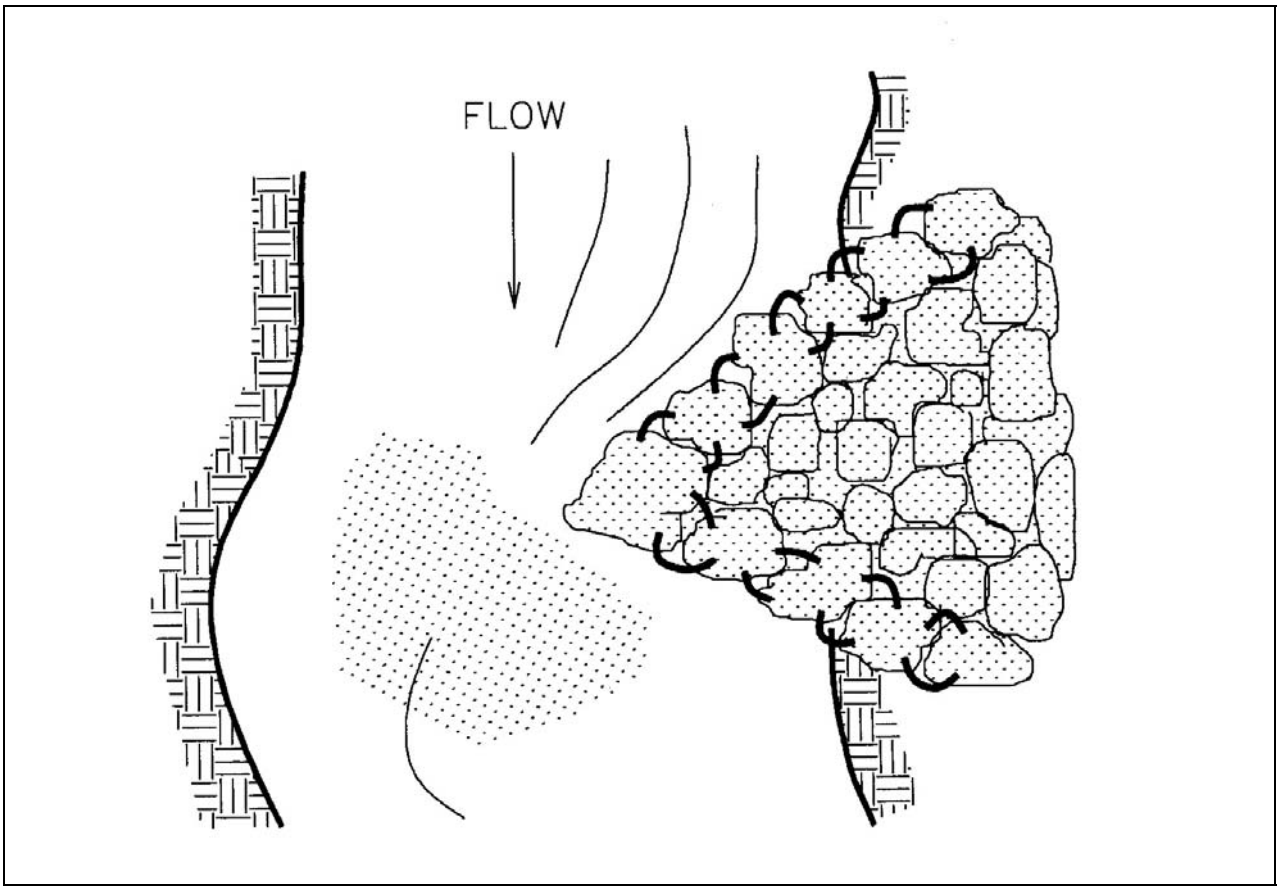


Figure VII-49. Boulder wing-deflector.

Depending on flow regime of the stream and size of the boulders used, it may be necessary to cable boulders together using polyester resin adhesive. The largest boulder(s) available is used for the apex of the deflector. The apex of the deflector is at the lowest elevation. The deflector should slope upwards to the bank. Rate of rise will be determined by bank conditions. This angle should be no more than 45 degrees. Additional layers of boulders may be placed on top of the base layer to reach the desired elevation and slope angle. If the substrate allows, a toe trench should be dug for the upstream and downstream legs of the deflector, and the structure must be keyed at least 4 to 6 feet into the stream bank.

The leading, or upstream edge of the deflector should be the longest side of the structure and should form an angle of approximately 30 degrees with the bank. The leading edge on the upstream side of the deflector should contain the largest available boulders. The downstream edge should be made with the remaining largest boulders. The interior of the triangle can be filled with smaller boulders. Depending on bank conditions upstream and downstream of the deflector, bank armor may be required adjacent to the wing-deflector.

Log Stream Bank Stabilization Structures

Log structures can be used where there is no access for heavy equipment, logs are available, and boulders are scarce. Log structures are generally not as durable as boulder structures. Banks can be further stabilized by planting vegetation, such as willows and cottonwoods, behind a log structure.

Cribbing

Cribbing construction is similar to building a log cabin. Logs are notched and cross logs are inserted between the layers and extended back into the bank. Cribbing protects the stream bank from high flows and holds soil in place (Figure VII-50).

Cribbing is used to reduce sediment input to a stream where bank erosion is a problem, logs are available, heavy equipment access is lacking or boulders are not available. Crib construction is labor intensive, but material costs are relatively low. If not available on site, suitable logs for cribbing must be located and delivered to the site. Logs should be selected for soundness, durability, uniformity of size, and ease of handling and delivery.

A base log(s) is placed in a toe trench below stream grade to prevent undercutting the structure. Base log(s) should be as long as can be manipulated while conforming to the contour of the stream bank. A good base log is necessary to insure stability and durability of the treatment.

Tieback logs are notched into the base log and placed at intervals along the base log (usually every 6 to 8 feet). Tieback logs are imbedded into the slope four to six feet, at grade with the base log. There should be at least two tiebacks per base log. Tiebacks are secured to the base log using threaded rebar. Approximately halfway up the backside of the base log, geotextile fabric is stapled every six inches, and placed to seal the bedding for the structure.

Once the first row of logs has had tiebacks and geotextile fabric installed, and has been back-filled to the top of the log, a second face log is placed on top of the tiebacks. This log is set back approximately 6 inches. The same procedure is repeated until desired height is reached. Stacked face-logs used in cribbing must be secured together using threaded rebar and/or cable. If cable is used to secure face logs together, the cable must be tightened using a fence stretcher or power pull. Finished height should reach the bankfull discharge level.

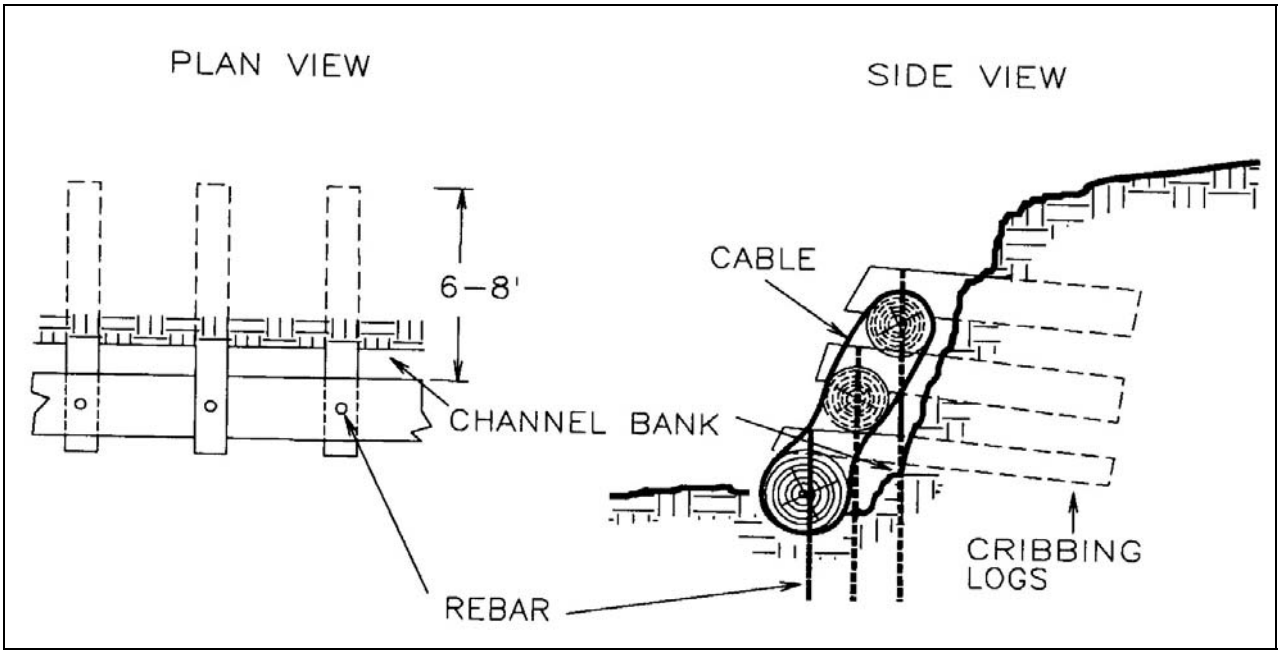


Figure VII-50. Log cribbing.

Live Vegetated Crib Wall

The basic construction of live vegetated crib walls on stream banks is the same as standard log crib walls. They may be built as either single or double walled structures. The double wall crib has far greater resistance to high flows (Figure VII-51). As each lift of the crib wall is installed, long cuttings of riparian plants are inserted on top of each fill layer. Willow can be used in combination with other fast rooting brush species such as native blackberry. The live willow cuttings function to replace crib logs as they decay over time. These riparian plants grow very rapidly and provide stream shade canopy and wildlife habitat during their first growing season.

1) As each lift is constructed, the face logs and tiebacks are filled with a mix of gravel and cobbles to the top of the face log. It is not necessary to use topsoil in the fill material, however, there should be enough fine grained materials to insure vegetation growth.

2) Live cuttings are laid in to form a complete cover layer. These live branches should have their butt ends into the soil behind the crib wall. The tips should stick out from the wall no more than one quarter of the cuttings total length.

3) The branches are then covered with a gravel/cobble mix to the top of the tiebacks.

4) Continue the next layer of the crib wall to the desired height.

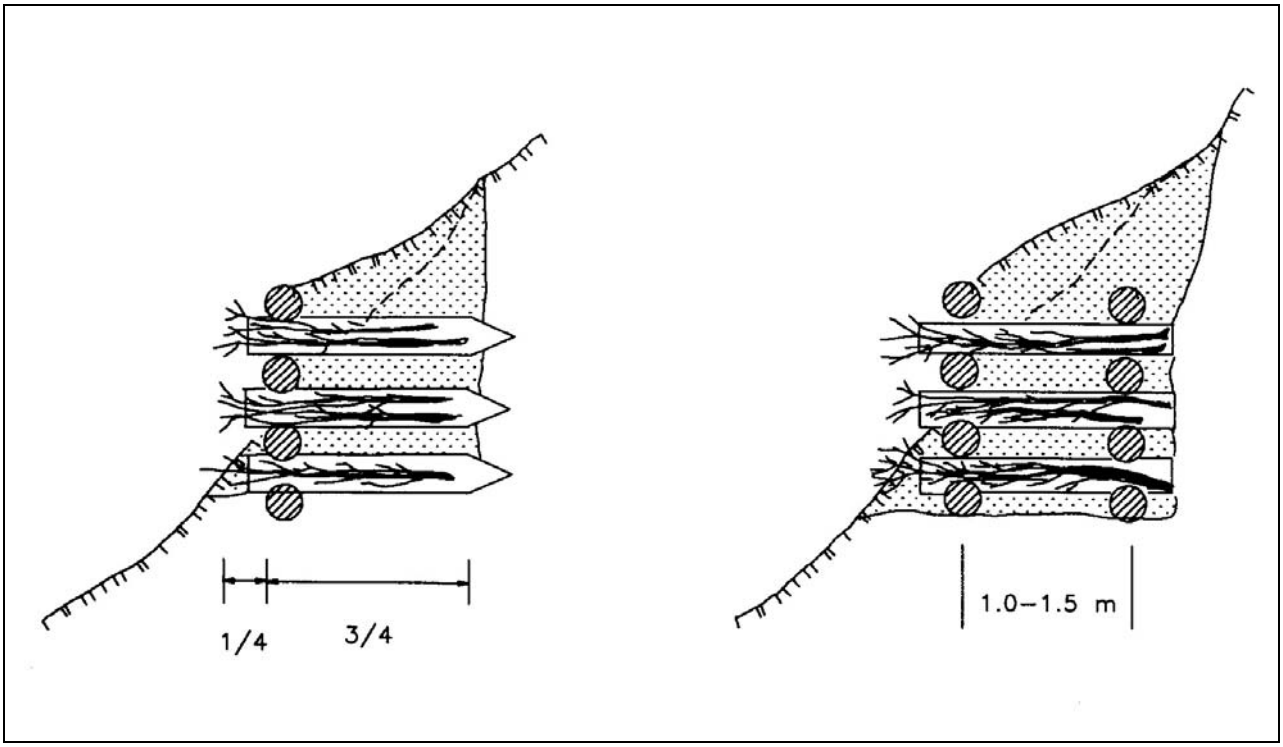


Figure VII-51. Live Vegetated Crib Wall (Schiechtl and Stern, 1996)

Bank Armor

Log bank armoring is accomplished by stacking logs against the stream bank, parallel to the stream flow, to protect the bank against erosion. The log or logs are held in place by cabling them to boulders, heavyweight metal fence posts, culvert stakes, or a deadman (Figure VII-52).

By protecting the toe of unstable stream side slopes, erosion of fine sediment can be reduced and the stream bank can be stabilized. Logs can be used for stream bank armor in combination with other instream structures that require bank protection.

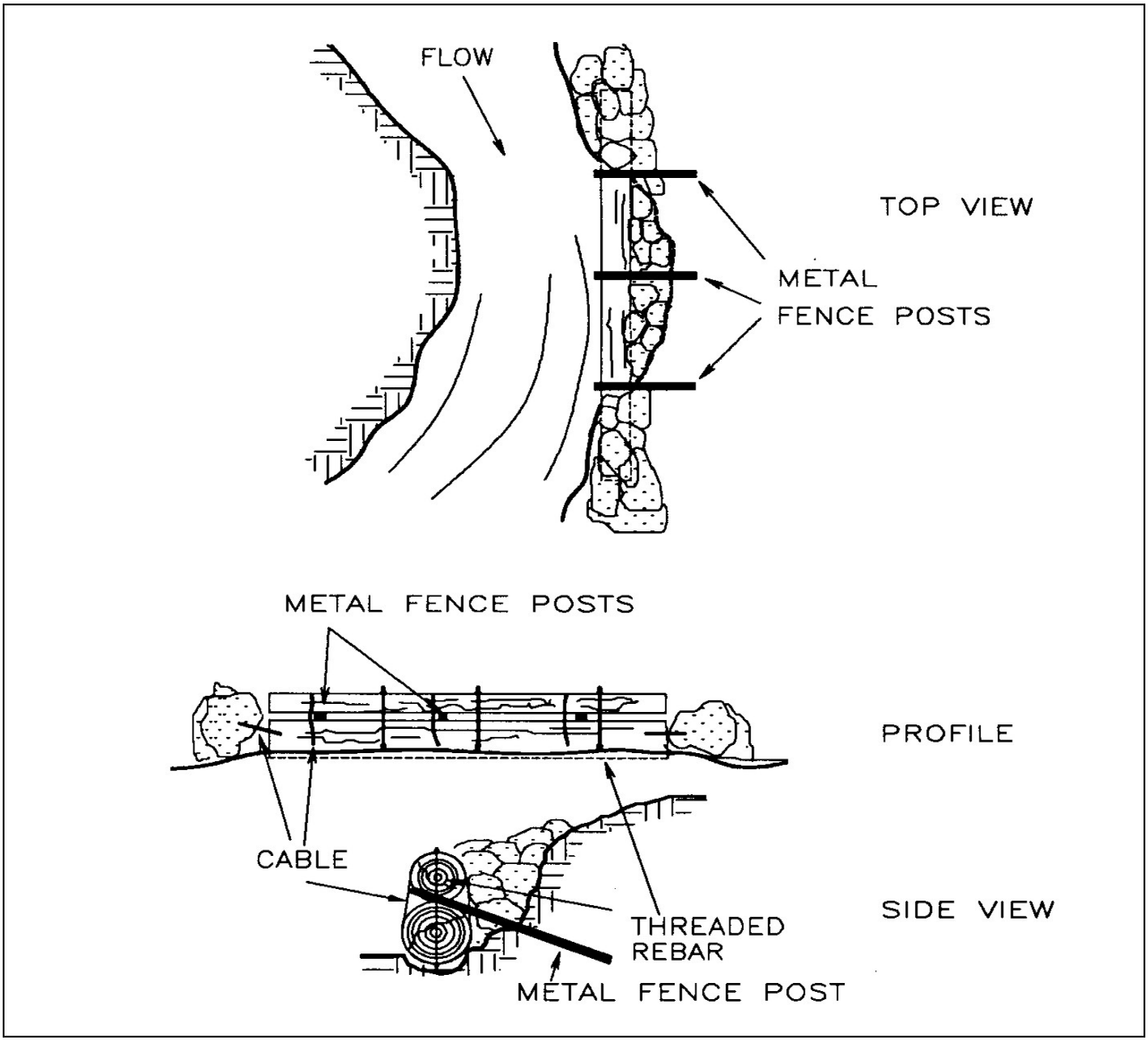


Figure VII-52. Log bank armor.

Bank armoring with logs requires excavation of a toe trench to accommodate a base log. The trench is dug along the base of the bank to be protected. Approximately one-third to one half-of the base log should be buried in the trench.

Once the toe trench is excavated, the log can be placed. If the angle of the bank behind the log is steep, a second log can be placed above the base log. This log should rest partly on the base log and partly on the stream bank. Finished height of the bank armor should be the elevation of bankfull discharge. If bank armor is needed to protect an unstable stream bank, it may be necessary to install cribbing instead of armor.

Large boulders can be used to secure the ends of the logs. If boulders are not available, smaller rocks can be stacked on the log and cabled together. Cable should be run through a drilled hole in the log and into a hole in the boulder anchor. If boulder anchors cannot be acquired, heavyweight fence posts or culvert stakes can be used. Stakes are placed on both sides of the log

at about 6-foot intervals. Stake sets should be placed at both ends of each log. Spacing and length of stakes will vary depending on size of the log and magnitude of bankfull discharge. Stakes should be twice the length of log diameter and should be driven in so they do not protrude above the top of the log. With large diameter logs the force of buoyancy during high flow events will exert great pressure on stakes and the greater the number of stakes anchoring the log, the greater the chances of avoiding structure failure.

Cable can be attached to culvert stakes by drilling through the stake, running the cable through the hole, and clamping the cable back to itself. Flexible, small-diameter cable, from 3/8-inch to 1/2-inch should be used. When using regular metal fence stakes, drilling a hole large enough to pass the cable may not be possible. The cable must be looped tightly around the stake, using two wraps to make it secure, and clamped so that the loop will be held by the knobs of the fence stake. Fence stakes should be driven in at an angle over the top of the log (Figure VII-52). This will keep the cable from slipping over the top of the stake. Once the cable is securely attached, the stake should be driven in to tighten the cable over the top of the log.

Another way to hold the log in place is to use cable attached to a deadman placed in the bank. Unless a deadman is placed lower than the top of the uppermost log and secured with a tight length of cable, the log will be able to rise with the water level in high flows and may actually cause stream bank scour. In almost any situation, it is very difficult to prevent the log from floating during high flows if a deadman is the only anchoring system used. The deadman anchors should be placed at the same intervals as stakes, every 6 to 8 feet.

To add to stability of the log armor and to prevent fine sediment from eroding beneath it, staple geotextile fabric and fencing to the backside of the logs. Log structures should then be back-filled with cobble or boulders. As with any bank stabilization technique, woody vegetation should be planted behind finished log armor.

Log Wing-Deflectors

Log wing-deflectors are used to direct flow away from an unstable bank and hold soil on the bank. The deflector usually incorporates boulders to fill the interior of the triangle and to anchor the logs. The boulders add stability to the structure (Figure VII-53).

When used for stream bank stability, deflectors are almost always installed on the scoured bank only. Wing-deflectors may be installed in series. Wing-deflectors used for bank protection are the same general design as deflectors used for stream channel improvement. Site-specific alterations are made depending on size and extent of bank protection needed and the angle of bank slopes.

Wing-deflectors installed for stabilizing stream banks require placement of rock or other armor to a height above bankfull discharge level, to assure that the bank is adequately protected under high flow conditions. A series of wing-deflectors can be made to protect a length of stream bank beyond the length that can be protected by a single deflector.

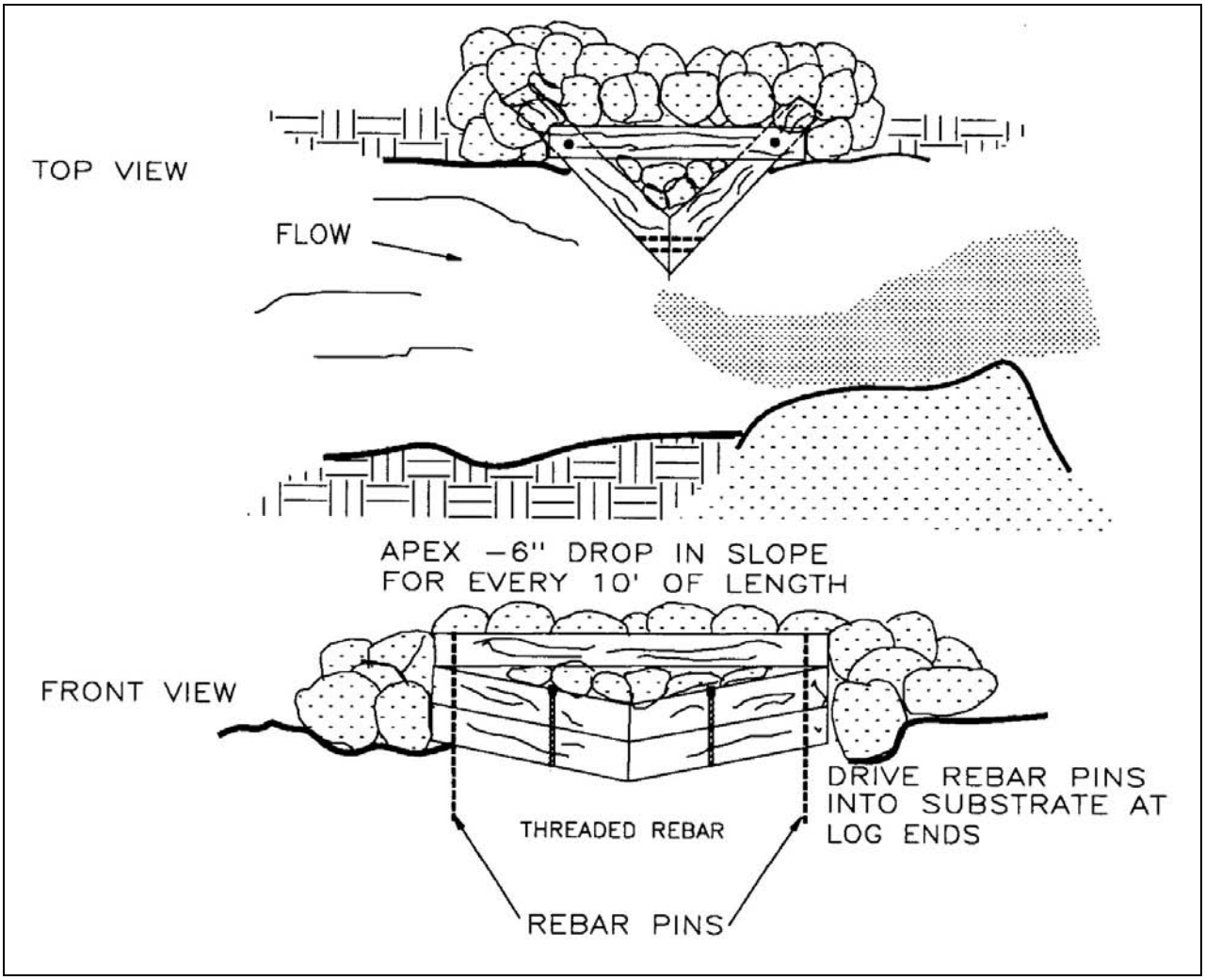


Figure VII-53. Log wing-deflector.

Tree Revetment

Tree revetment is used to stabilize vertical, eroding stream banks in low gradient meadow type streams. Trees are cut and laid against the vertical bank with tops angling downstream. Butts are tied off to the upper stream bank. Branches slow the water velocity and cause suspended sediment to settle, allowing bank building and revegetation to begin (Figure VII-54).

Cedar, Pacific yew, and juniper are preferred tree species, but almost any pre-commercial size conifer will suffice. Alders are not desirable due to their rapid decomposition. Care must be taken that water quality problems are not created in areas of low flow or standing water. Riparian vegetation generally should not be sacrificed for building material.

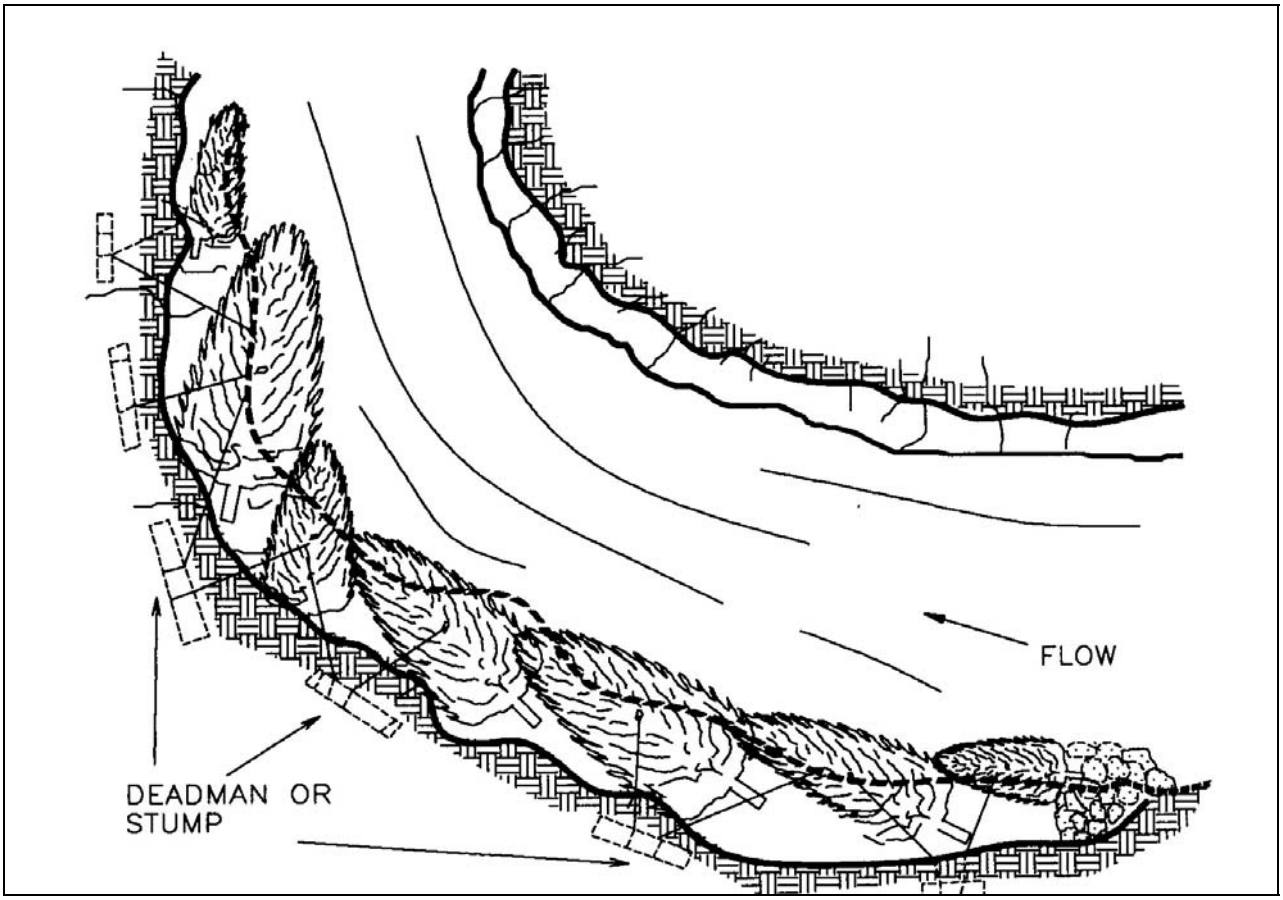


Figure VII-54. Tree revetment.

Native Material Revetment

Native material revetments are alternatives to boulder riprap armoring and crib wall type structures. By combining boulders, logs, and live plant material to armor a stream bank fish habitat is enhanced, in addition to creating a natural looking bank stabilization structure. Native material revetments can provide toe protection for slides or eroding banks and can also be used to re-establish natural stream channel dimensions (Figure VII-55).

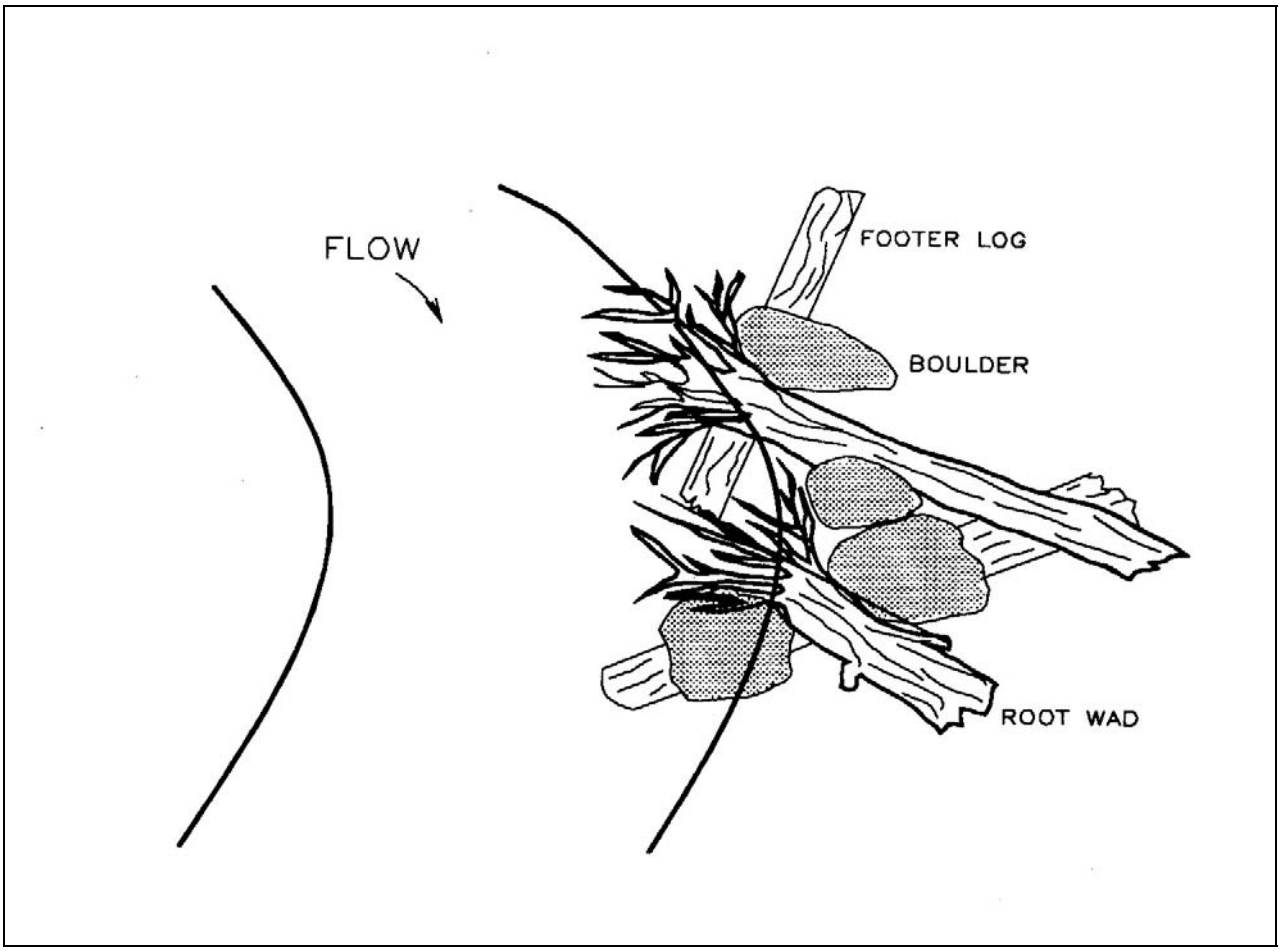


Figure VII-55. Plan view of native material revetment (Rosgen, 1993)

A backhoe or excavator are essential in construction of the revetment. The material sizes needed will vary depending on the stream size and hydrological factors. Logs, preferably redwood with root wads attached, boulders and live plant materials are placed in sequence to ensure stability and proper function of the structure.

Logs without root wads (footer logs) are set in a toe trench below the thalweg line, with the channel end pointed downstream and the butt end angled 45 to 60 degrees upstream. A second log with a root wad is set on top of the footer log diagonally, forming an "X." The root wad end is set pointing upstream and the butt end lying downstream 45 to 60 degrees. The apex of the logs are anchored with threaded rebar. Large boulders are secured in the spaces between the logs, at each apex. After all the logs and boulders have been set in place, any live plant material disturbed from

the site along with recruited willows are placed within the spaces of the structure, behind the boulders. Once this has been done the excavated gravel and streambed materials can be placed over the bank-end portion of the revetment (Figure VII-56).

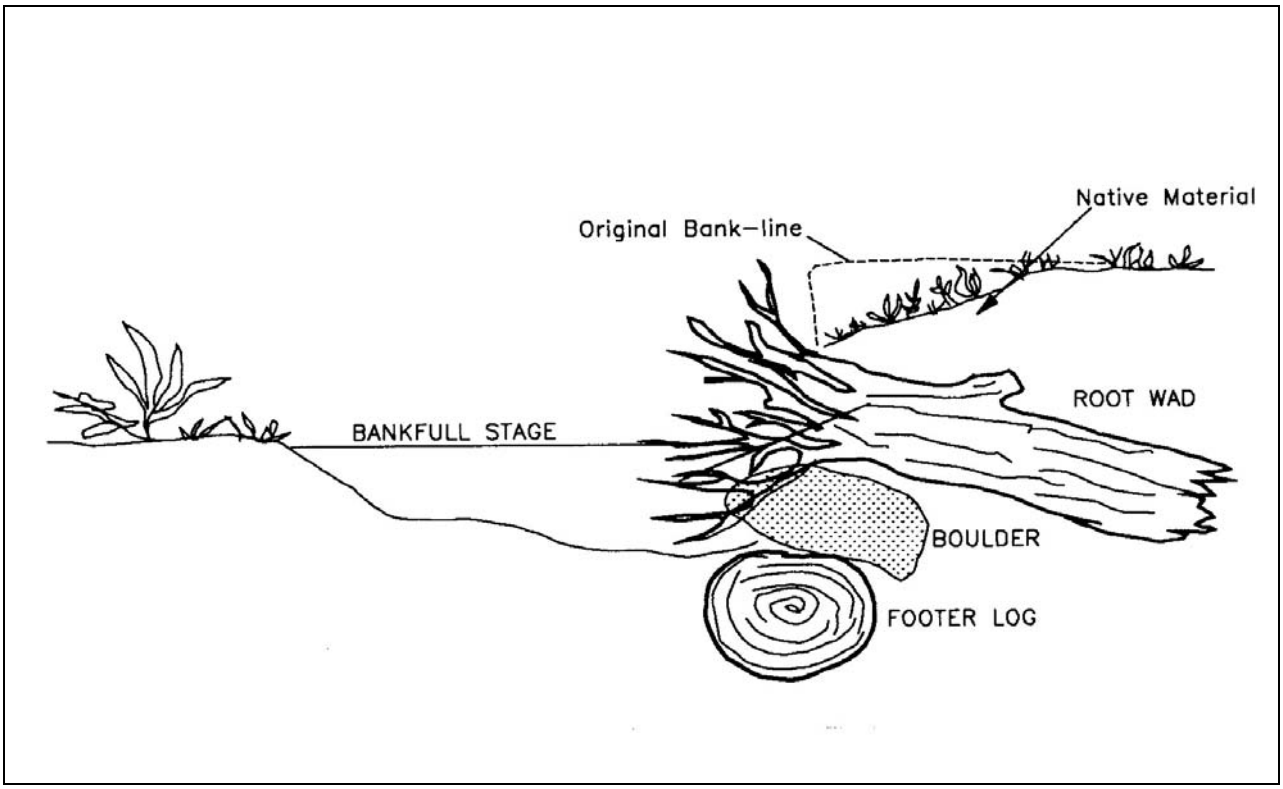


Figure VII-56. Native material revetment (Rosgen, 1993).

Mulching

Mulching for erosion control is covering soil with straw or similar material to discourage erosion and encourage revegetation. It is principally used to protect bare soil from rain and sheet erosion. In areas of heavy rainfall, erosion caused by raindrop impact can be significant. Mulching will also shade soil from the sun and prevent soil from drying. This assists in re-establishing vegetation by creating a stable seed bed and keeping soil moisture levels from becoming too low to sustain new vegetation.

Mulching can be accomplished by adding straw or forest leaf litter to bare soil. Other mulches can be used, but unwanted or exotic plant species may be introduced with them. Such plants can depress native vegetation and become established as a nuisance species. Leaf litter from the forest may be available for the cost of labor to collect it and will usually not contain seeds of undesirable species. Leaf mulches may have to be secured with jute netting. If it is necessary to buy and transport mulch, straw is the most economical and convenient but may contain seeds of undesirable plants. Straw mulch should be applied at the rate of two to three tons per acre. This results in a mulch coverage of about 80 percent. A 60 to 65 pound straw bale will cover approximately 500 square feet.

Revegetation

Planting or transplanting appropriate vegetation is a primary means for long-term restoration of the health of a watershed. Most other treatments are temporary measures until vegetative cover can be restored. Accelerating revegetation consists of selecting appropriate species for the treatment area and introducing them to a new site in a manner allowing them to prosper and grow. Appropriate species are usually those found growing nearby. Methods include planting stem cuttings from plants such as willow, cottonwood, thimbleberry, coyote bush, or other species that are able to root from cuttings. Planting container grown or bare root stock, such as alder, tan oak, *Ceanothus*, Douglas fir, redwood, and grand fir also is a good technique. Planting is appropriate for treatment of areas that have stable footing, adequate temperatures, and enough water for plant survival. Correct choice of plant species and proper planting technique are critical.

Transplanting

Relocation of plants found growing near the treatment site is sometimes appropriate. Some species are best acquired by thinning surpluses in nearby thickets and stands.

Revegetation with Willow Sprigs

Willow (*Salix*) sprigging (Figure VII-57) can be an effective and inexpensive way to armor active headcuts and eroding gully banks, and to stabilize stream banks where water is flowing parallel with the bank. Willows must be planted in sunny areas where the soil stays moist throughout the dry season. Sprigs should be collected and planted when the willows are dormant. However, sandbar willows do not sprig well and should be avoided; cottonwood is a good alternative to willows. Sprigs should be at least 1/2-inch in diameter and 18 inches long. Sprigs, 2 to 3 inches in diameter and 3 to 4 feet long work best, and should be used in the most actively eroding places. Cuttings should be planted the same day they are cut. If it is not possible, then the entire cutting should be placed in water in a cold area.

Willows respond well to heavy pruning, so they can be collected heavily from a grove. Thin, however, instead of clear-cutting in order to leave cover for resident fauna.

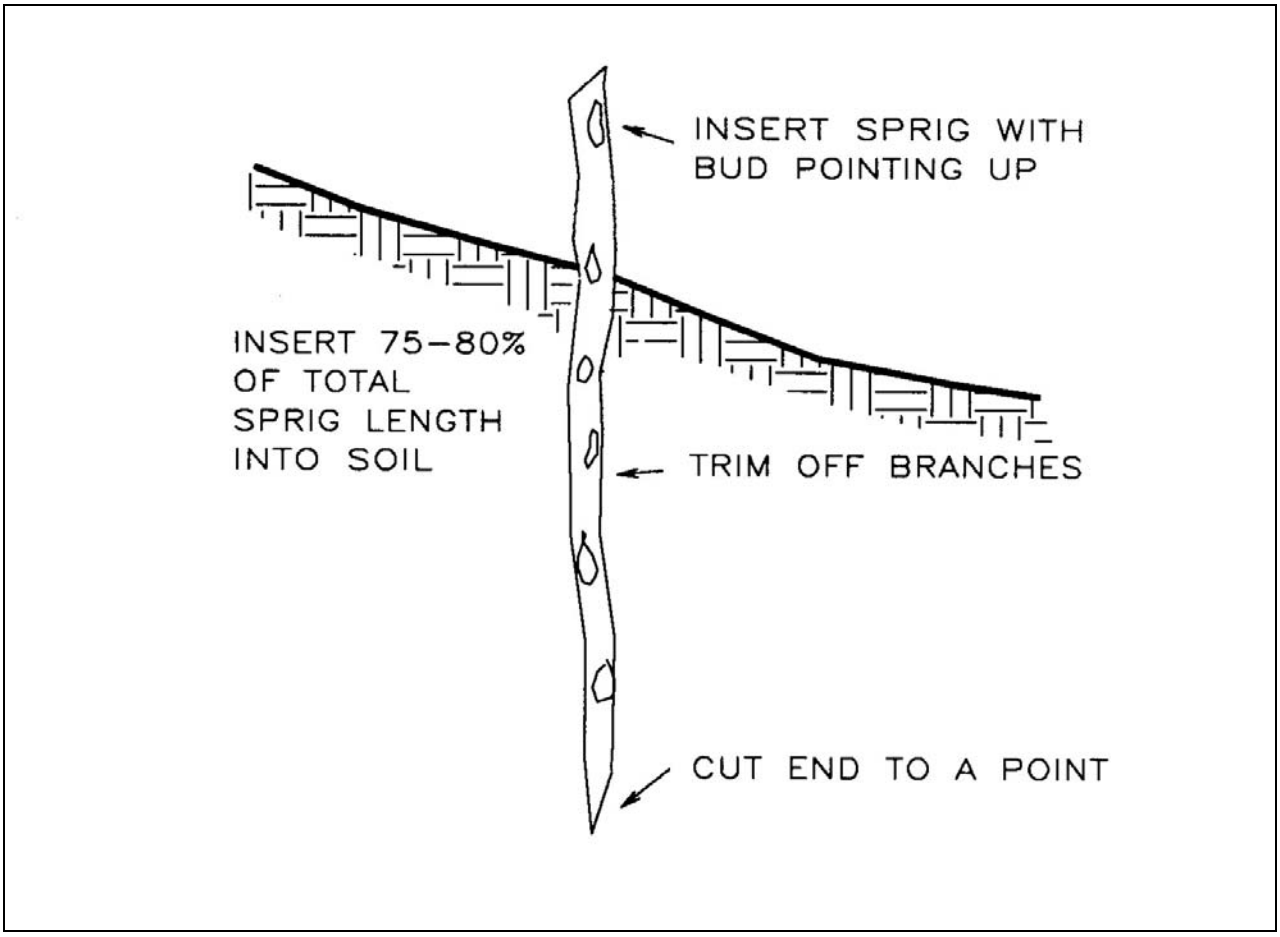


Figure VII-57. Willow sprigging. (Prunuske, 1987).

Plant the willows with the buds up, after sharpening the basal (bottom) end of the sprig with an axe or pruners right after it is cut from the tree. Sprigs should be driven into the soil 75 to 80 percent of their total length, at a slight angle downstream, to decrease their resistance to water flow. In hard soils an iron bar or a chain saw powered auger can be used to bore planting holes. After placing the cutting in the hole, tamp firmly around the cutting to remove air pockets in the soil. In soft soils, sprigs can be driven in with a wooden mallet or sledge hammer. Cut off the tops of the sprigs if they should split while hammering. Leave only one or two buds exposed.

In large rapidly eroding gullies, or along stream banks, appropriate spacing may be as close as one foot. In more stable gullies typical of relatively small watersheds, the sprigs can be placed 2 feet apart.

Cattle and deer tend to browse heavily on young willow. The revegetated areas may need protection by fencing, wire cones, or heavy netting.

Willow Wall Revetment

Willow wall revetments can be used for stream bank failures, eroding banks, and bank toe protection (Figure VII-58). Willow walls restrict sediment yield to a stream and also provide vegetation and canopy. The wall should be constructed along a stream bank at a height that will provide the willows with water during low flow months. If the wall is located upslope from the channel, irrigation may be required during summer months.

1) These walls are built at erosion sites along stream banks. If a rip-rap toe is desired, it should be placed below grade to prevent scouring. If more than one wall is to be constructed up a slope, there should be a three feet space between each successive wall.

2) Planting holes should be bored three feet apart from one end of the site to the other. Hole depth depends on the length of the willow poles being used. For example, an eight feet long willow pole requires a hole five feet deep. The poles should be two - three inches in diameter and as straight as possible. The poles should be set with the tops up and leaned slightly towards the bank at approximately a 15° degree angle to allow for the weight of the earth fill to be added later.

3) After the poles have been set and tamped, long, flexible willow branches from 3/4 to 2" in diameter are tightly woven through the standing poles. The woven branches should be packed down as tightly as possible. Both the woven material and the poles should be stripped of all small branches and tops less than two inches in diameter. These can be used later in the back fill brush material.

4) Once the wall is constructed, a backing of biodegradable erosion cloth or netting should be placed against the woven willow pole wall on the bank side. Using smaller tops and green willow branches, create a brush pack approximately one foot wide behind the netting. Backfill the wall with firmly packed down soil. All disturbed soil areas are mulched with litter and seeded. Each end of the wall can be anchored with 3/8" cable and attached to duck bill anchors to add stability.

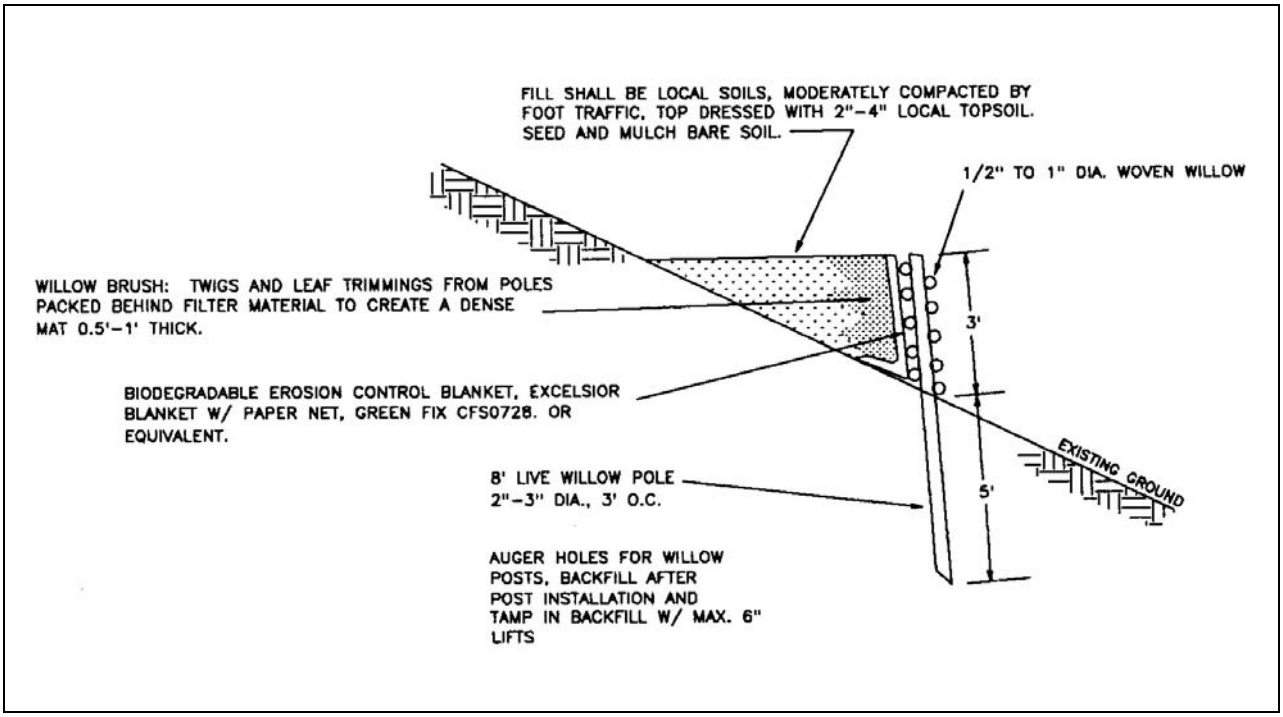


Figure VII-58. Willow Wall Revetment (L. Prunuske, 1997).

Brush mattress

Brush mattresses work well for bare eroding streambanks (Figure VII-59). These mattresses protect the stream banks from erosion caused by exposure and scour.

1) The disturbed bank should be sloped and smoothed to ensure that all willows are in contact with the soil. Excavate a toe trench two feet below streambed elevation at the base of the bank for the butt ends of the willow branches.

2) Partially drive wood, steel, or live willow stakes in rows on three foot centers along the area of the bank that will be covered by the mattress. After the stakes have been placed, lay live willow branches on the bank with their butt ends in the trench. It is best to use straight branches no shorter than four feet in length and approximately 2 to 1" in diameter. Place approximately twenty to fifty branches per linear yard, depending on their diameter. If the branches are not long enough to cover the upper bank area, several layers may be used, but it is necessary to lap, or “shingle,” each added layer with the layer below it by at least eighteen inches (Figure VII-60).

3) Once the bank has been covered with a thick layer of willows, cross branches are placed horizontally over the bottom layer. These branches should be placed against the stakes and then tied to the stakes using wire or string.

4) The stakes are then driven into the bank a minimum of two feet. The deeper the stakes are driven in, the tighter the mattress will be held against the soil of the bank. After completion of the mattress, the trench should be filled with small boulders or rocks to anchor the butt ends of the branches. The entire mattress should be lightly covered with earth or fine streambed material.

Stream channel dimensions, hydraulic factors, available material and other factors may dictate variations to this general design.

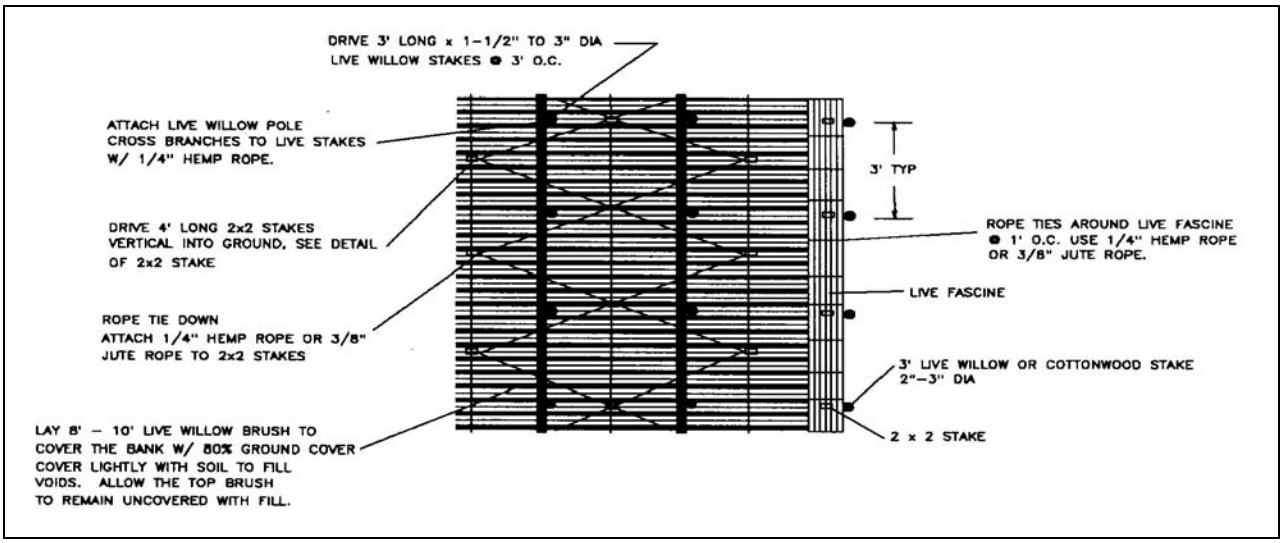


Figure VII-59. Brush Mattress Plan View (L. Prunuske, 1997).

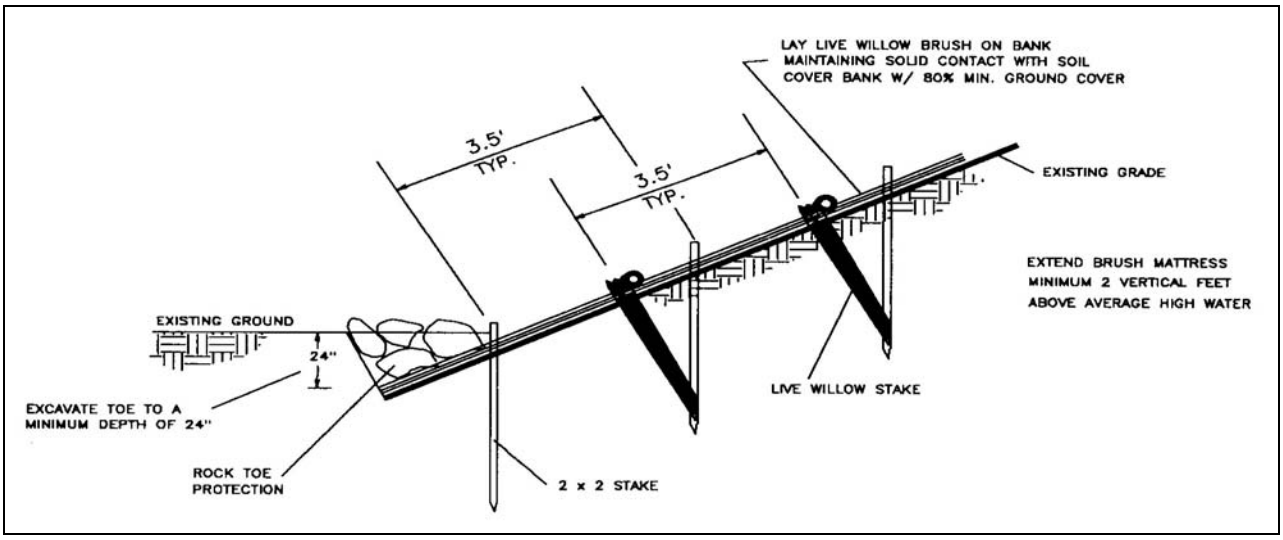


Figure VII-60. Brush Mattress Cross Section (L. Prunuske, 1997).

Willow Siltation Baffles

Willow siltation baffles are inexpensive structures that can achieve several objectives. Their function is similar to a wing deflector which can be used for bank protection and energy dissipation, as well as for channel constriction. Willow baffles are designed to work in series and pass flow through the structure, sort bedload, dissipate energy, and trap fines.

1) Dig toe trenches perpendicular to the bank approximately 1 2 - 3' deep. Extend the trenches into the stream channel a short distance. The baffles should be keyed into the bank at least three feet. The excavated material removed from the trench should be placed along the downstream side of the trench. Each successive baffle is installed at different angles. The most upstream baffle is placed at an acute angle with the bank, and the following baffles are placed at right-angles. The lower baffle is placed at an obtuse angle. The number and length of baffles is dependent on the dimensions of the stream channel and treatment area (Figure VII-61).

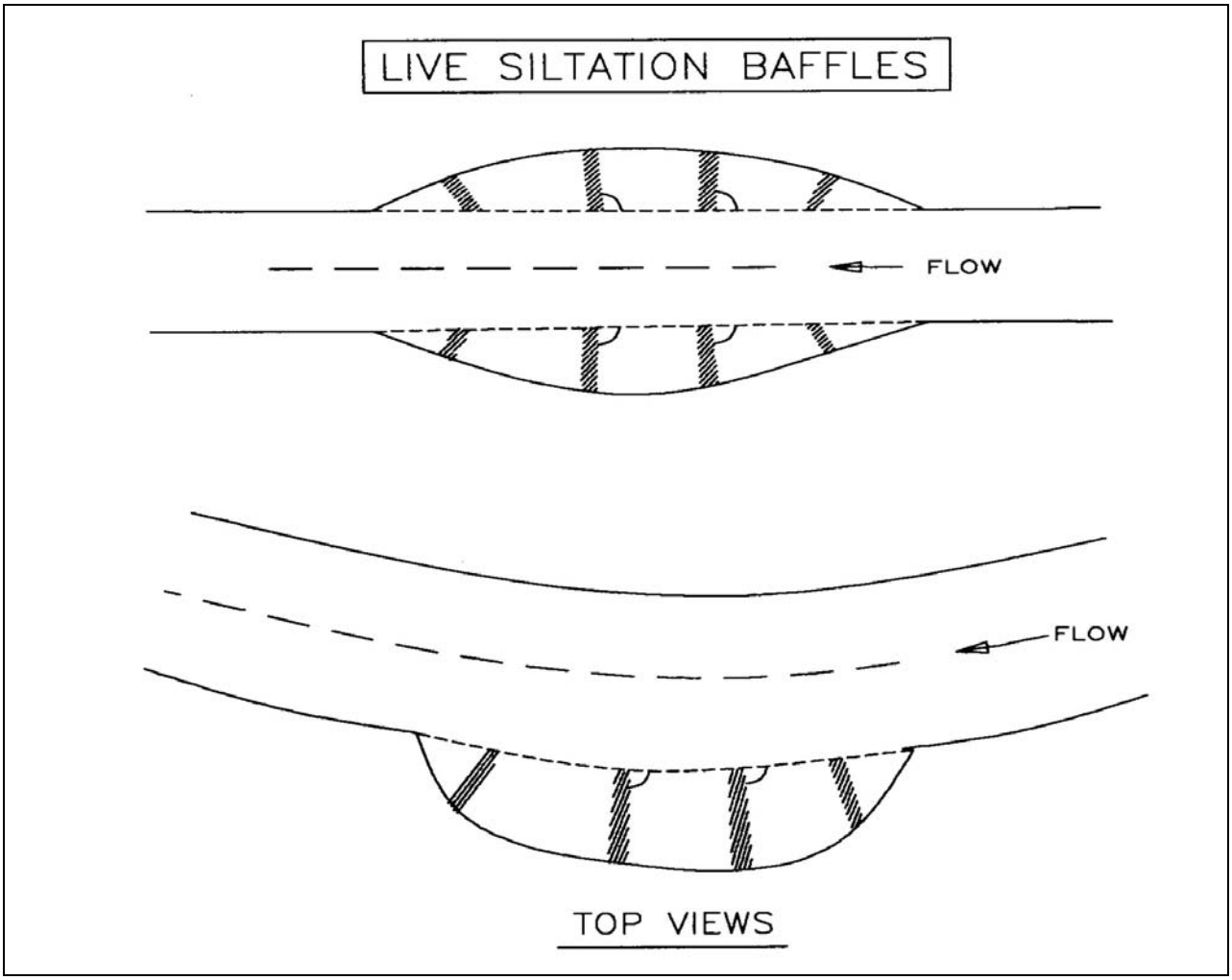


Figure VII-61. Arrangements of baffles (Schiechtl and Stern, 1996).

2) Willow branches approximately three to six feet long and 1/2" in diameter are placed in the trench pointing downstream . The ends of the baffles that extend into the channel have the willow branches wrapped around, forming an upstream facing "J." (Figure VII-62) The willows are densely packed with no gaps and form a standing mat. The trench is then back filled with streambed material and small cobble. Some topsoil may be placed at the bottom of the trench to help with root formation. Larger stone is placed on top of the backfill in order to secure the willow branches. The largest rocks available should be placed on the stream channel end of the baffle. Site specifications will be unique to stream channel dimensions, hydraulic factors, and available material and will dictate variations to this general design (Figure VII-63).

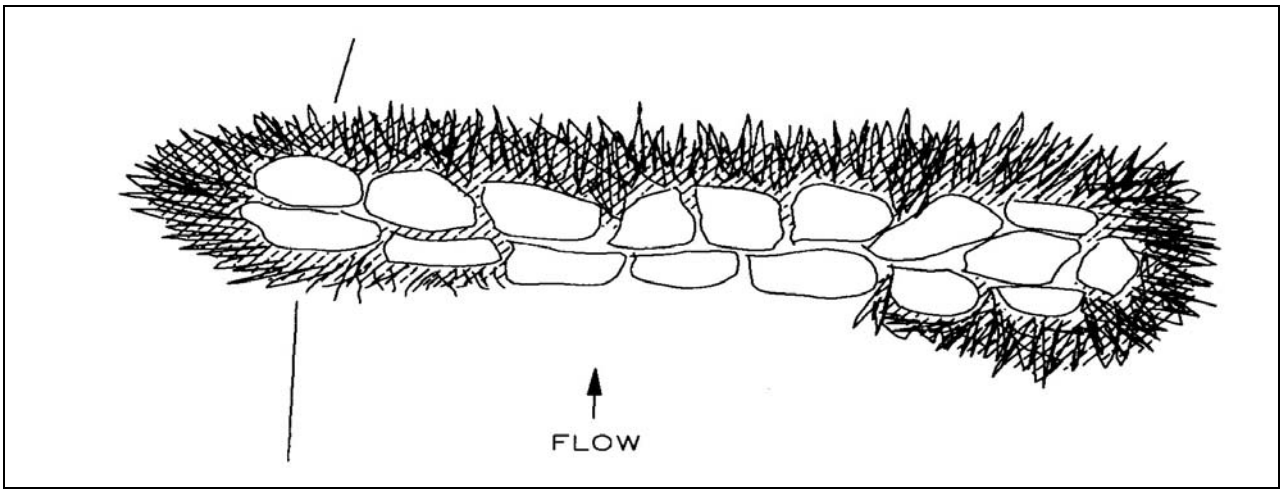


Figure VII-62. Top view of baffles (Schiechtl and Stern, 1996).

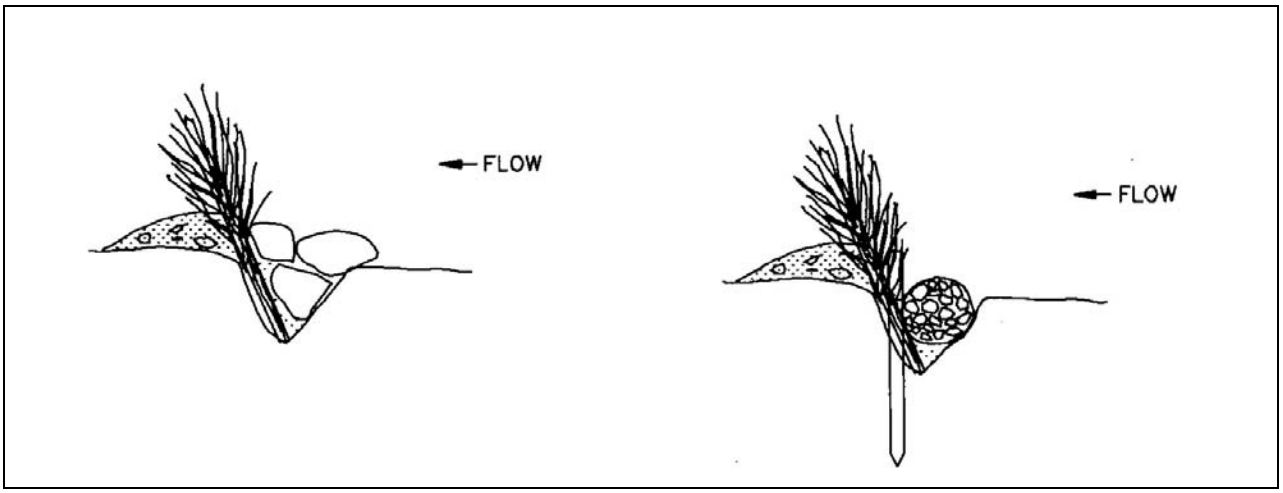


Figure VII-63. Side view of baffles (Schiechtl and Stern, 1996).

Planting Seedlings

Seedlings can be planted with shovels or western planting tools (also known as hoedads or planting hoes) in most situations. Planting bars may be used if the soil is not too rocky or compacted.

Power augers with carbide-tipped bits are also recommended for planting. Power augers come in two types: one with its own power head, and a second type that attaches to a chain saw power head.

A bucket, waterproof planting bag, or similar container is needed for carrying trees in the field. Use sawdust, peat moss, vermiculite or other moist material around the roots of bare root seedlings to keep them damp at all times. Do not keep seedlings immersed in water since it reduces oxygen and plants may suffocate. In some areas it is necessary to use shade cards or shingles to shelter seedlings. Plastic netting or tubes, spray repellents, or bud caps can be used to protect plants from animal damage.

Seedlings are delicate and must be handled carefully (Figure VII-64). For highest survival, treat trees carefully, and plant them immediately. If planting must be delayed a few days, keep the boxes in a cold, protected place. For containerized seedlings, cut the box down level with the container so that air can circulate between the trees. Keep trees out of rain and wind. To check if trees need water, feel the media at the bottom of the tube. If it is not damp, water the trees, and allow excess water to drain. In cool, damp weather, the biggest threat to seedlings is from mold.

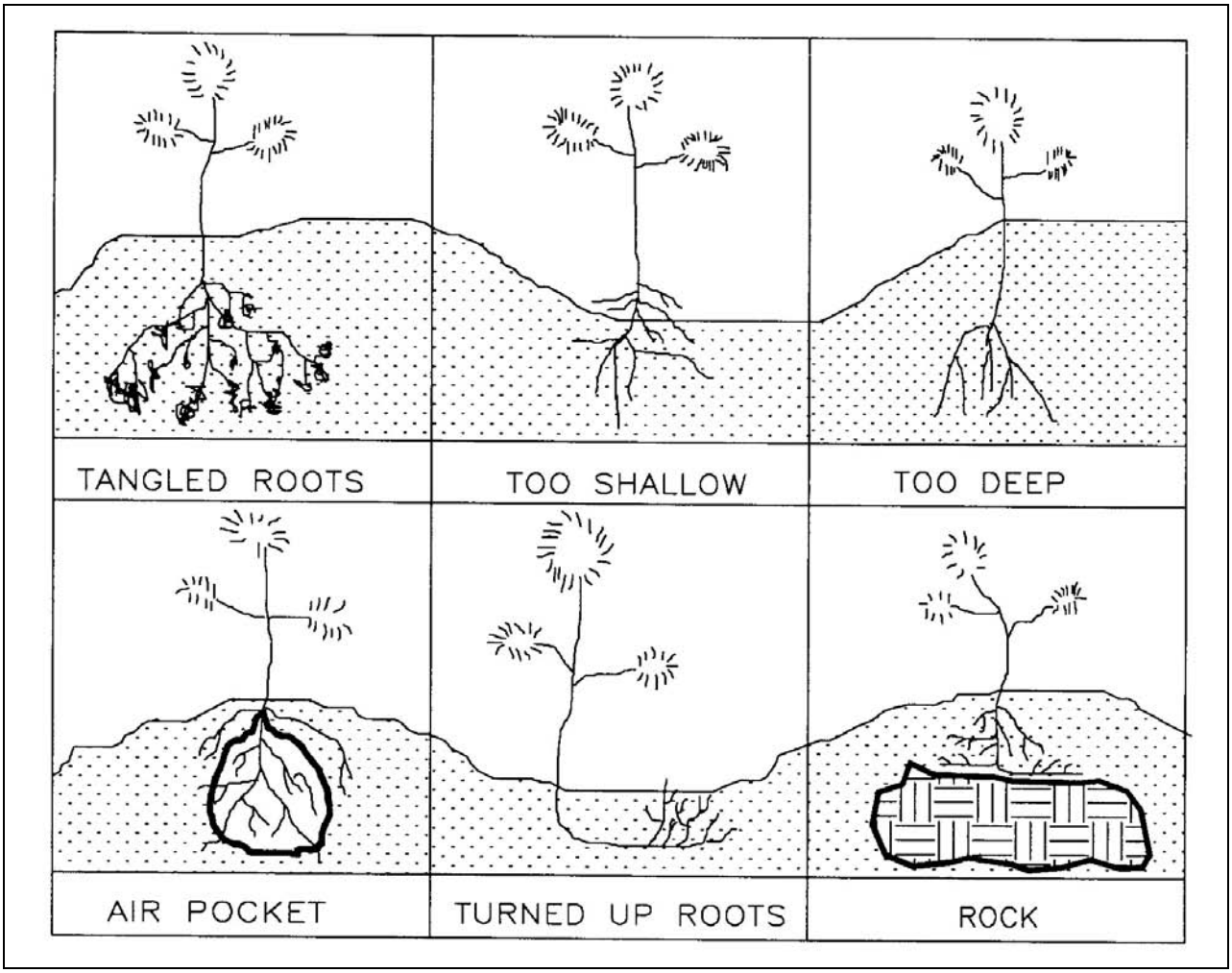


Figure VII-64. Problems to avoid during tree planting.

Ideal storage conditions for bare root seedlings are a temperature of 33E Fahrenheit and high humidity. If available, refrigerated storage is best. Check packing material around roots to make sure it is moist. If it is drying out, wet thoroughly and allow excess water to drain off. Keep roots moist, but not the tops. Wet tops can easily become moldy. The biggest threats to bare-root seedlings are dried roots and mold formation; which occurs if the trees become too warm.

Ideal planting days are cool and cloudy, with little or no wind. If possible, avoid planting on warm, windy days. The soil should be moist. Care in planting is more important than speed. Make sure roots never become dry. Planters should only carry about 50 trees at a time. Trees should be carried in a waterproof bag or bucket with plenty of moist material packed around the bare roots to keep them damp. Trees remaining in boxes should be left in boxes and kept in a cool, shady place. Ideally, bare root boxes should be kept refrigerated or packed on ice or snow.

Competition from weeds, grass, brush or other trees can kill or retard growth of seedlings. Choose areas free from this competition, or clear at least a three-square-foot area before planting. Seedlings should not be planted under direct shade of trees, or closer than 6 feet to existing brush, unless lethal temperatures are anticipated.

Clear away loose organic material such as leaves, grasses, etc. from the planting spot to expose mineral soil. If organic matter gets into the planting hole, it can decompose and leave air space. Roots will dry out when they grow into these spaces.

Open up the hole, making sure it is deep enough for the roots to be fully extended (Figure VII-65 and Figure VII-66). Take a tree out of the planting bag or bucket only after the hole is ready. When exposed, fine roots can dry out in as little as 30 seconds. Remember to remove the container before planting a containerized tree. This can be done by cutting container or by pushing up gently on the roots with a stick or broom handle. If roots are curled or bunched up, the tree will not be able to absorb water correctly, will often weaken and die, or may blow down in later life due to poor root structure.

After removing a seedling from the container, hold it in place in the hole, making sure roots are straight, fully extended, and that the seedling is neither too shallow nor too deep. Fill the hole, allowing soil to fall in around the roots. Tamp with hands or with your heel. Fill with more soil, if necessary, and tamp. Tamping is important. If soil is not firmly packed around the roots, air pockets will remain that can dry the roots, and the seedling may be weakly anchored. Addition of fertilizer and plant vitamins at the time of planting is not generally necessary.

Again, care is more important than speed. In regard to spacing, it is better to pick a planting spot shaded by a stump, log or rock, than to strictly follow recommended spacings. During planting of riparian species, care should be taken to ensure that roots have ready access to moist soil.

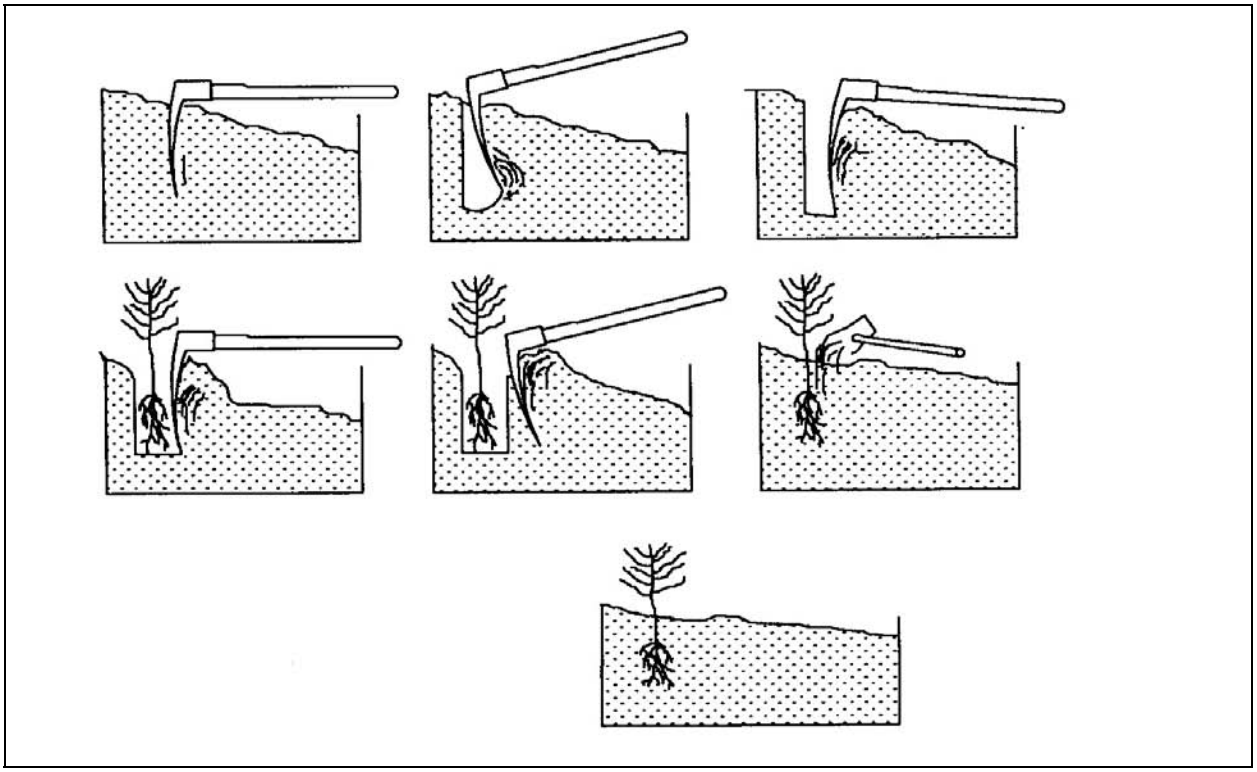


Figure VII-65. Steps in tree planting with hoedads. (California Department of Forestry, 1978).

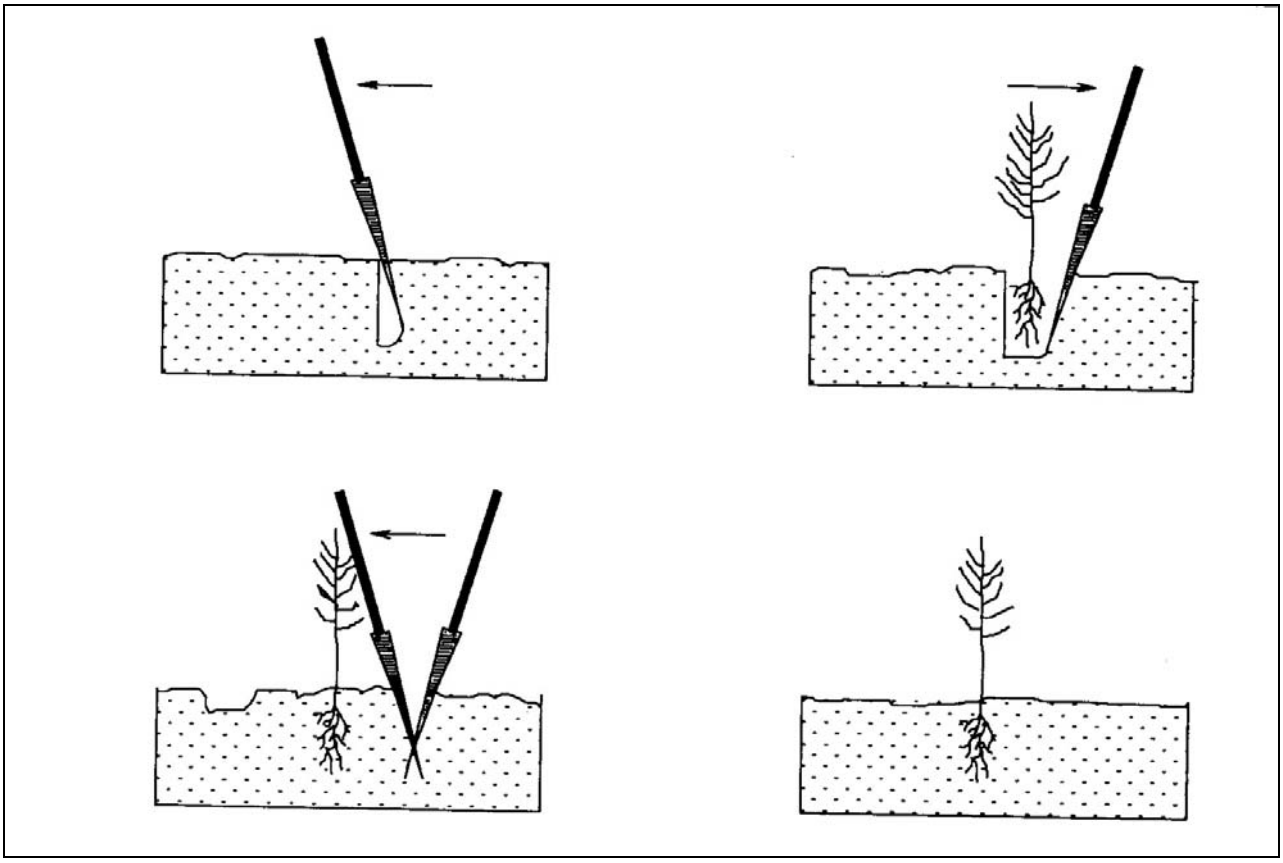


Figure VII-66. Tree planting. Planting bar method. (California Department of Forestry, 1978).

Checkdams

Checkdams are small dams constructed across a gully, ditch, or stream to reduce water velocity and trap sediment. All checkdams fall into two broad categories: permeable and impermeable. Permeable check dams allow water to pass through the dam face. Sediment is deposited more slowly above them than if water flow is stopped completely, but such dams are more resistant to blowouts than impermeable dams. Checkdams can be constructed from a variety of materials. Materials used to construct permeable checkdams include strawbales, woven willow branches, brush, loose rock, gabions, and logs. Impermeable checkdams include redwood board, compacted earth, mortared rock and concrete structures. Table VII-1, Selecting a checkdam type, summarizes various checkdams and their uses.

Guidelines for checkdam construction:

- A series of low dams is usually more effective than fewer high dams.
- Use a hand level to space checkdams so that the toe of one is level with, or slightly below, the spillway of the next downstream dam (Figure VII-67).

- All impermeable dams and most permeable dams require a spillway to reduce bank erosion and lessen the possibility of the stream eroding a new channel around the structure. The spillway should be large enough to accommodate normal storm flows. Be careful to aim spillway discharge toward the bottom of the gully, not the sides, even if this requires that the spillway be off-center.

- Always provide a non-erodible energy dissipator (or apron) for the checkdam discharge.

- The top of the checkdam must be level.

- Key all checkdams securely into gully banks and bottom.

- Construct checkdams perpendicular to flow.

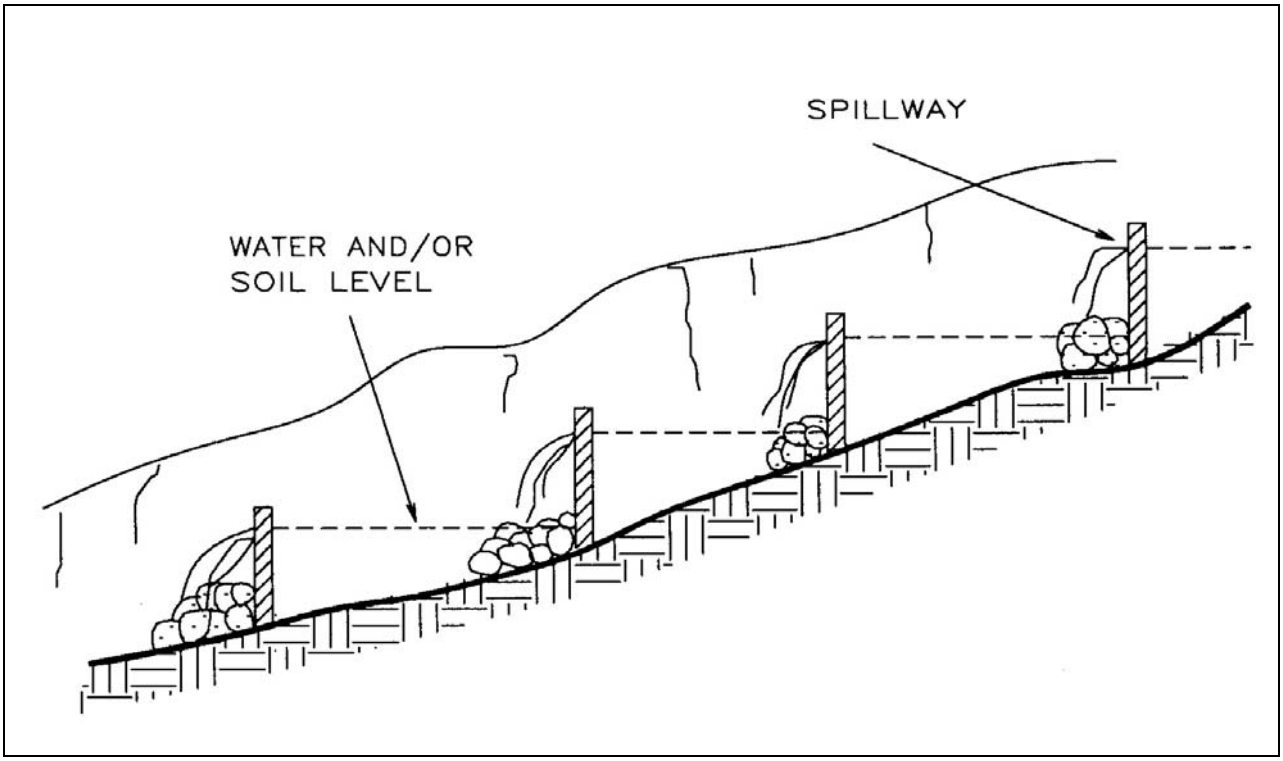


Figure VII-67. Checkdam placement. (Prunuske, 1987).

Table VII-1. Selecting a checkdam type (Prunuske, 1987).

Type of Checkdam	Gully Activity*	Optimum Gully Size	Soil Particle Size	Durability	Special Site Conditions	Common Reasons for Failure
Strawbale	low	3-6 ft. wide, up to 3 ft. deep	fine to coarse	2-3 years	Use only in areas that can be seeded or where natural vegetation will occur quickly.	Bales not keyed into banks and bottom securely; animal damage; gully too active; no follow-up revegetation.
Woven Willow	low	up to 4 ft. wide, up to 3 ft. deep	coarse	indefinite	Use only in winter swales and where minor flooding is acceptable. Best in gravelly soils with high organic content.	Sprigs planted upside down, too sparsely, not deep enough or too late; insufficient water in dry season; animal damage.
Brush	low to moderate	up to 4 ft. wide, up to 3 ft. deep	coarse	2-3 years indefinite if live willow stakes used		Brush not anchored securely; insufficient amount of brush; large poles used instead of smaller, leafy branches.
Loose Rock	low to high	up to 10 ft. wide, up to 10 ft. deep	fine to coarse if filter fabric used	indefinite	Rock on-site, or site accessible to dumptruck or loader.	Rock too small; not securely keyed into banks and bottom; spillway too small.
Gabion	low to high	One gabion width less 2 ft. key width, 3-10 ft. deep	fine to coarse if filter fabric used	20+ years	Rock on-site, or site accessible to dumptruck or loader.	Not securely keyed to banks and bottom; energy dissipator does not extend far enough downstream; spillway too small.
Log	low to moderate	up to 4 ft. wide, up to 3 ft. deep	coarse	5-20 years depending on type of wood	Works best in gravelly soils with much organic matter such as leaves and twigs.	Not securely keyed to banks and bottom; energy dissipator does not extend far enough downstream; gaps between logs too large; spillway too small.
Redwood Board	low to high	2-10 ft. wide, 2-5 ft. deep	fine to coarse if filter fabric used	20+ years depending on quality of redwood		Not securely keyed to banks and bottom; poor quality wood used; energy dissipator inadequate; active gully bank erosion; spillway too small.
Grouted Rock	moderate to high	3-10 ft. wide, 3-10 ft. deep	fine to coarse	50+ years		Not securely keyed to banks and bottom; air spaces left between rocks; energy dissipator inadequate; spillway too small.
Concrete	moderate to high	3-10 ft. wide, 3-10 ft. deep	fine to coarse	50+ years		Not securely keyed to banks and bottom; energy dissipator inadequate; spillway too small.
Compacted Earth	high	10-40 ft wide, 10-30 ft deep	fine to coarse	indefinite	Check with design engineer	Insufficient soil compaction; spillway not protected with non-erodible armor; energy dissipator too light and/or does not extend far enough downstream.

* **Low** - Headcut is shallow (less than 3 feet deep) and does not grow noticeably during heavy rainfall. Banks are gently sloped and mostly covered with grass, tree roots or other vegetation.

Moderate - Headcut is shallow, but expands noticeably during winter storms. Banks are gently sloped and mostly covered with vegetation with occasional steep areas of raw, exposed soil.

High - Headcut is more than 3 feet deep and moves rapidly uphill during heavy rainfall. Banks are steep with little vegetation.

Redwood Board Checkdams

Redwood board checkdams are suitable for spans up to 10 feet wide and up to 3 feet high. The redwood should be heartwood and free of large knots (Figure VII-68).

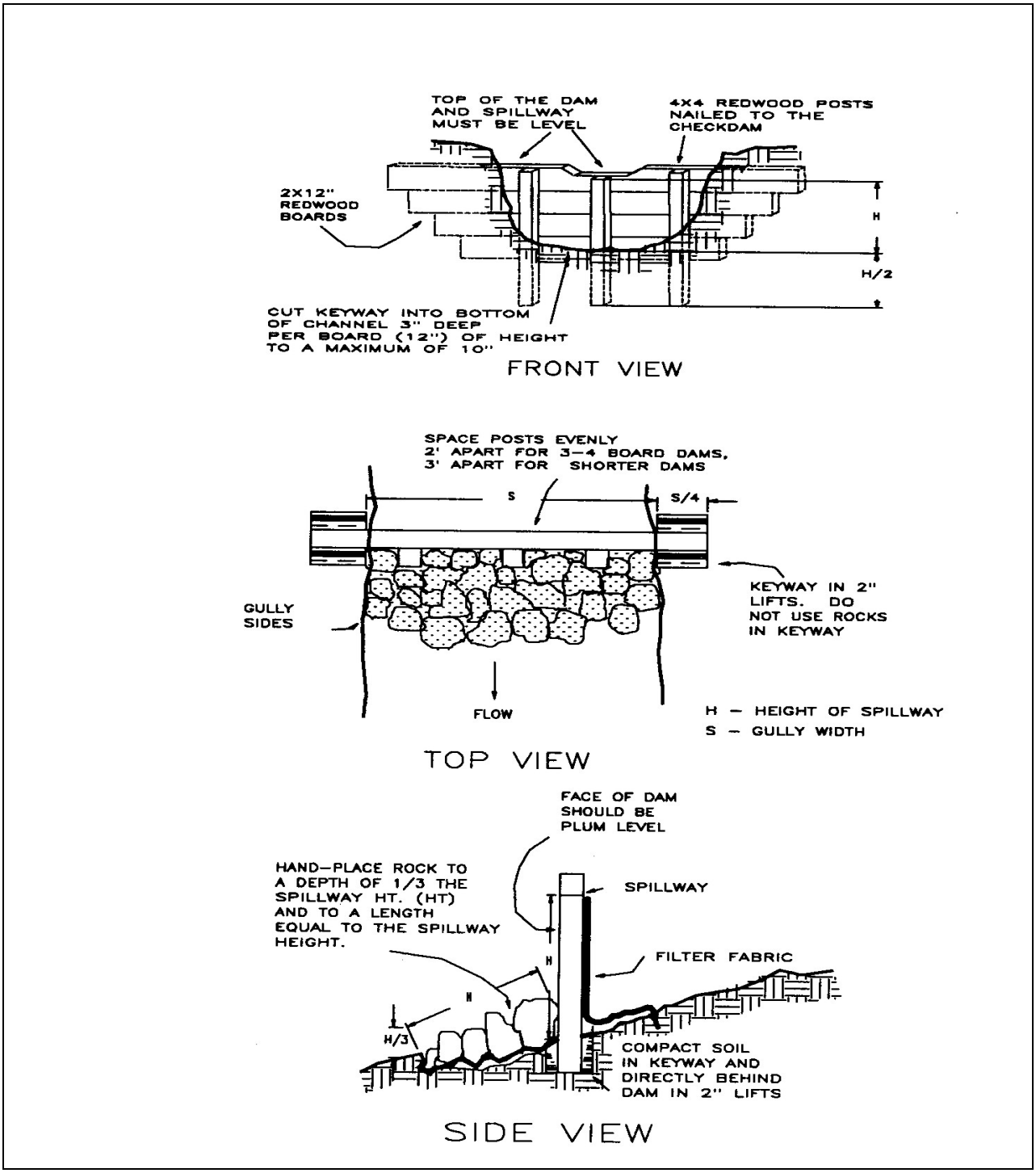


Figure VII-68. Redwood board checkdam. (Prunuske, 1987).

Brush Checkdams

Brush checkdams are very suitable to treat erosion sites in ephemeral gullies and headcuts. Their porous design allows water to pass through the structure and retain sediment. Since they are not hard obstructions, they do not divert water and cause bank scour. Live willow, cottonwood, fir and other types of branches which are usually pruned from the lower eight feet of a tree trunk can be used as "brush" in the construction of these dams. Any fine textured vegetative material raked up from under trees such as forest duff, pine needles, leaf mulch, straw, and rotted log pieces broken down with a hoe or mattock can be used as "litter" for mulch in each project type. These vegetated check dams can be constructed in a series or singularly in the same manner as the other check dams discussed.

Brush and Rock Checkdam

These are suitable for use within small, low activity ephemeral gullies (Figure VII-69).

1) Grade the gully banks to the slope angle of existing undisturbed banks. Retain the excavated soil for later use at completion of the project.

2) Place a six inch layer of litter along the gully=s bottom and along the sides to be treated.

3) Beginning at the downstream end of the gully, place an eight inch thick apron layer of brush on top of the litter. Butt ends must point downstream.

4) Near the upstream end of the brush apron layer, stack a row of rocks on top of the brush layer about one foot high perpendicular to the gully. When available, flat rocks are the most stable and preferable.

5) Place about a four foot layer of brush parallel to the gully, butt ends downstream, and extending just downstream over the rock dam.

6) Place another row of rocks at least one foot high across the middle of the brush layer. While adding rocks, walk on the brush to compact it as much as possible.

7) Repeat steps 4 - 6 to raise the dam to the desired height.

8) Weigh the last layer of brush with a row of rocks to hold it in place.

9) Cover the upstream face of the dam with the soil excavated during the initial site grading process. Mulch the soil layer with a four inch layer of litter. Disturbed areas not treated by the brush should be seeded and mulched.

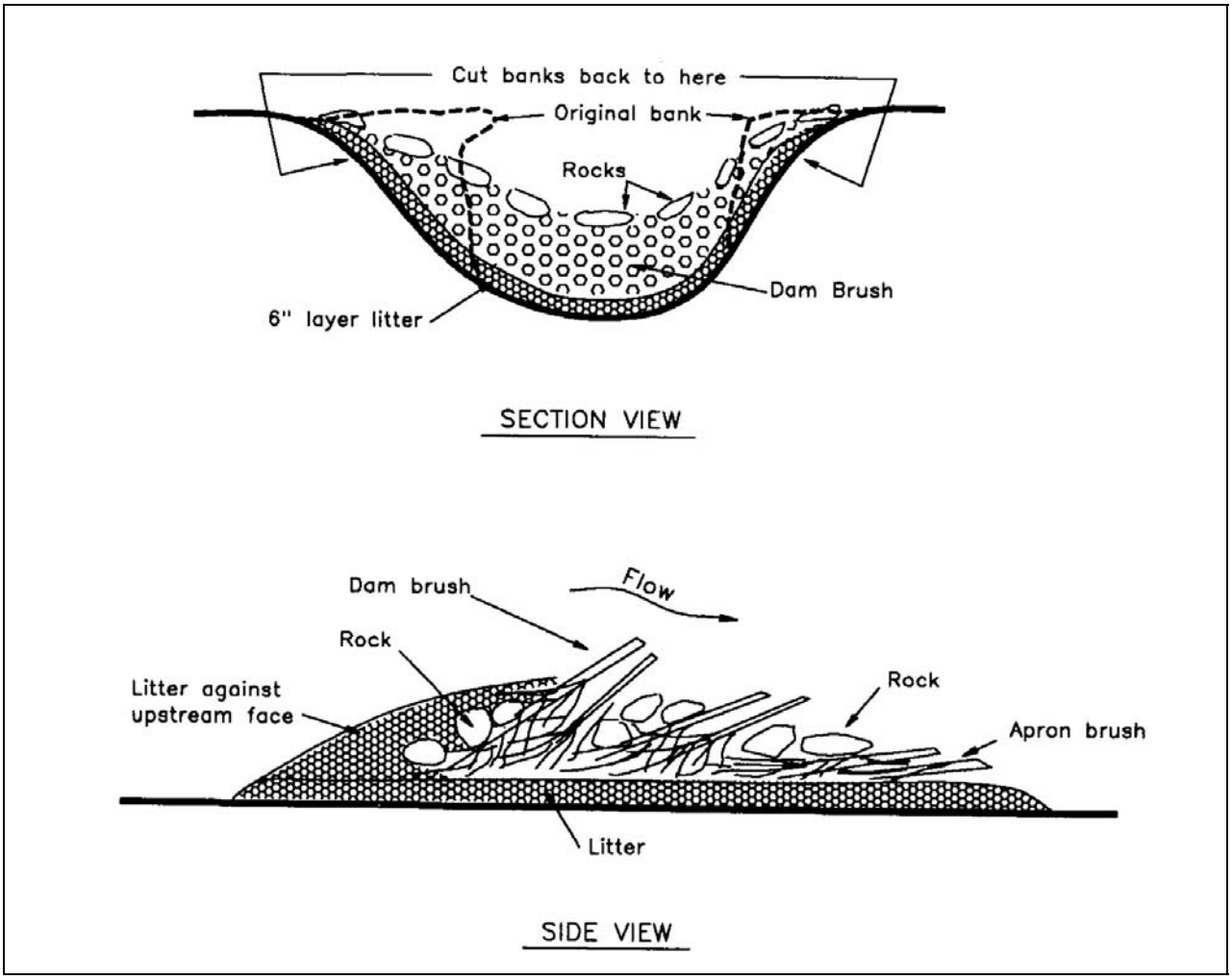


Figure VII-69. Brush and Rock Checkdam (Kraebel and Pillsbury, 1934).

Post Brush Checkdam

These are suitable for use within large, moderate to high activity ephemeral gullies (Figure VII-70).

1) Grade the gully banks to the slope angle of existing undisturbed bank. Retain the excavated soil for later use at completion of the project.

2) 2) Metal "T" posts, or wooden posts two to four inches in diameter, should be set on two foot centers across the watercourse and be driven a minimum of eighteen inches into the ground. Live willow poles can be used if high ground water is present year round.

3) 3) Layer small diameter brush parallel to the gully to act as a filter and soil erosion blanket. Each layer should be approximately six inches thick. The butt ends should extend beyond the posts at least six inches in an upstream direction.

4) Weave brush material through the posts at least one foot thick and continue adding material to the top of the posts. Attach branches or boards across the posts using rope or string to

hold the brush down firmly. Compact each layer of branches to ensure that no large gaps are present in the checkdam. At completion, the brush should be layered to the tops of the banks while leaving the middle section slightly lower to form a channel for flow.

5) Seed and mulch any disturbed areas after completion. Erosion cloth may be applied, if desired, behind each checkdam.

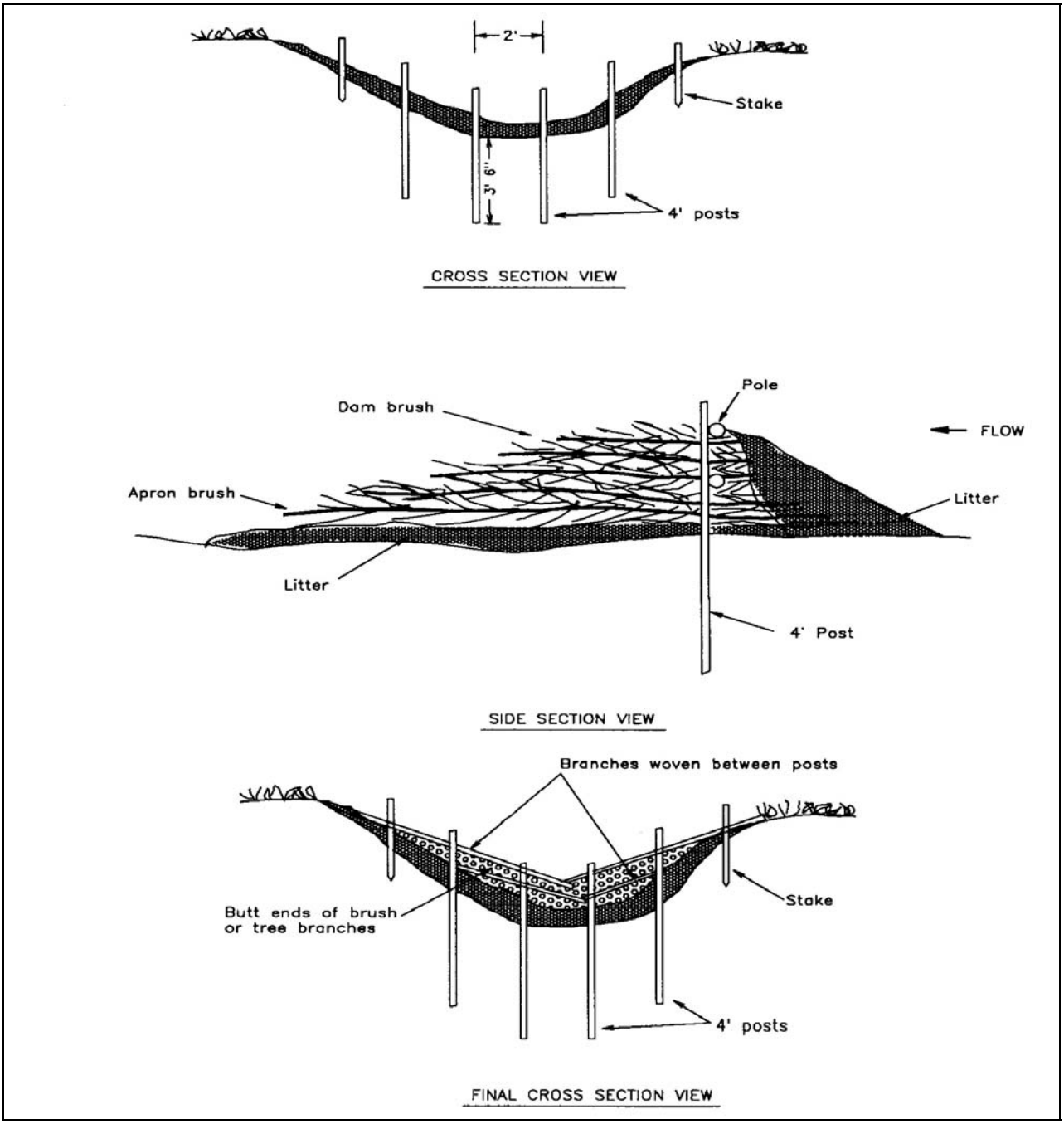


Figure VII-70. Post Checkdam (Kraebel and Pillsbury, 1934)

Tree Checkdam

This technique can be used where small trees are plentiful and need thinning (Figure VII-71).

1) Grade the gully banks to the slope of its undisturbed bank slopes. Retain the excavated soil for later use at the completion of the project.

2) Place a six inch layer of litter along the gully=s bottom and its sides where the first row of trees will be placed to form an apron.

3) Lay the first row of small trees (< 8' tall), butts downstream, across the gully and up the sides to form the apron.

4) Continue stacking several layers of trees, butts downstream, across the gully bottom and up the sides, staggered in an upstream direction. They should be piled to the desired height in the center of the gully, and several feet higher on the banks depending upon the depth of the gully.

5) If available, large rocks placed on the upstream end of the apron will increase the stability of the dam, especially in a gully subject to high flows.

6) Finally, place the soil excavated during the earlier grading process against the upstream face of the dam, and cover it with a two to three foot layer of litter. Seed and mulch disturbed areas.

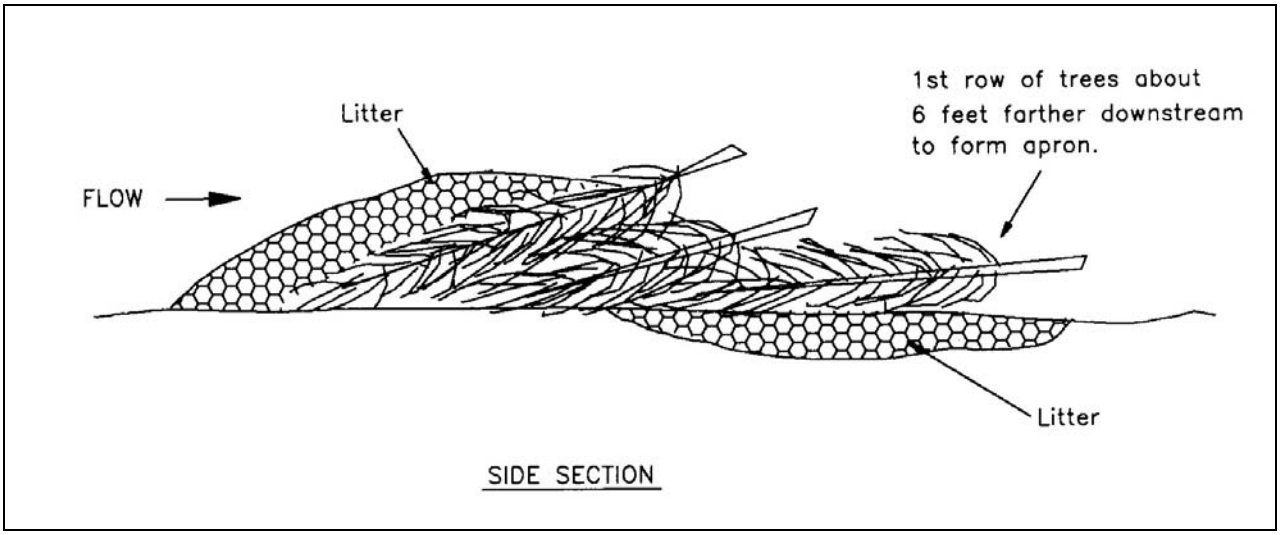


Figure VII-71. Tree Checkdam (Kraebel and Pillsbury, 1934)

Brush and Rock Mattress Headcut Repair

A headcut is a vertical break in slope at the uphill end of a gully or section of gully. Some gullies have multiple headcuts. Headcuts form a waterfall plunge which causes soil to erode from the scour of the cascade. This loss of soil causes the gully to migrate uphill. Headcuts often occur when water is concentrated by road drainage systems below stream crossings. Headcuts are also often associated with slope slumping along stream banks or in upslope areas.

1) Grade the banks near the upper end of the headcut to the slope of existing undisturbed bank slopes.

2) Place a six inch layer of litter in the gully and its side slopes along the area to be treated.

3) Cover the litter with a apron layer of brush. Start at the downstream end of the headcut and work upstream to the top. The butt ends of branches should be pointed downhill.

4) Cover the brush with a layer of large rocks, which will stabilize the mattress against the force of runoff. Use flat rocks where possible. Disturbed areas should be seeded and mulched (Figure VII-72).

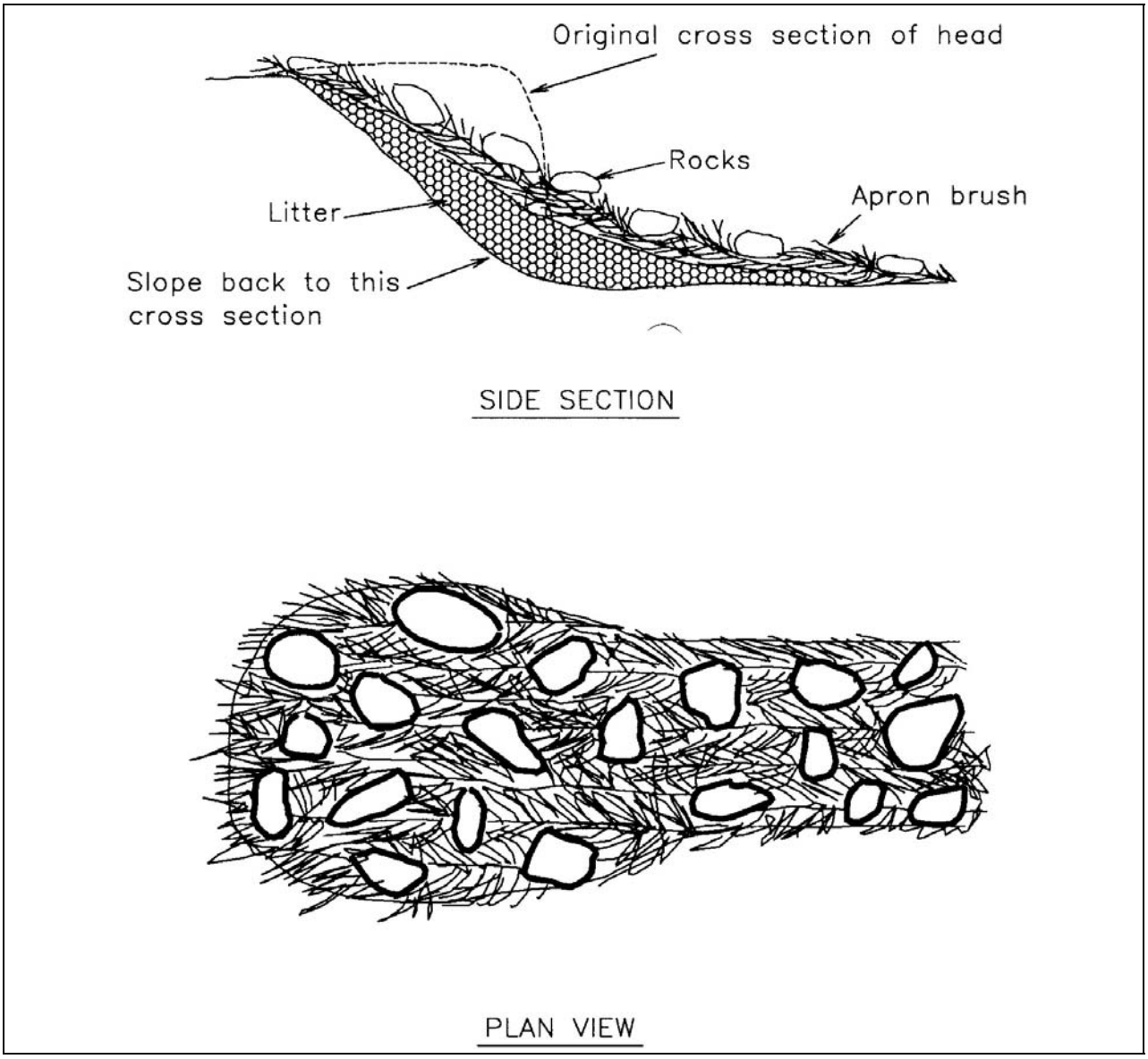


Figure VII-72. Brush and Rock Mattress (Kraebel and Pillsbury, 1934)

Waterbars

Waterbars (Figure VII-73) are a temporary means of breaking surface flow over sloped sections of road. They can be constructed with hand tools or heavy equipment. Waterbars are extremely effective at preventing rilling. They consist of a shallow ditch and rounded berm placed diagonally across the road surface. Often, they must be reconstructed every year because they either wear down during summer or are so annoying to those who regularly use the road that they are graded out in spring.

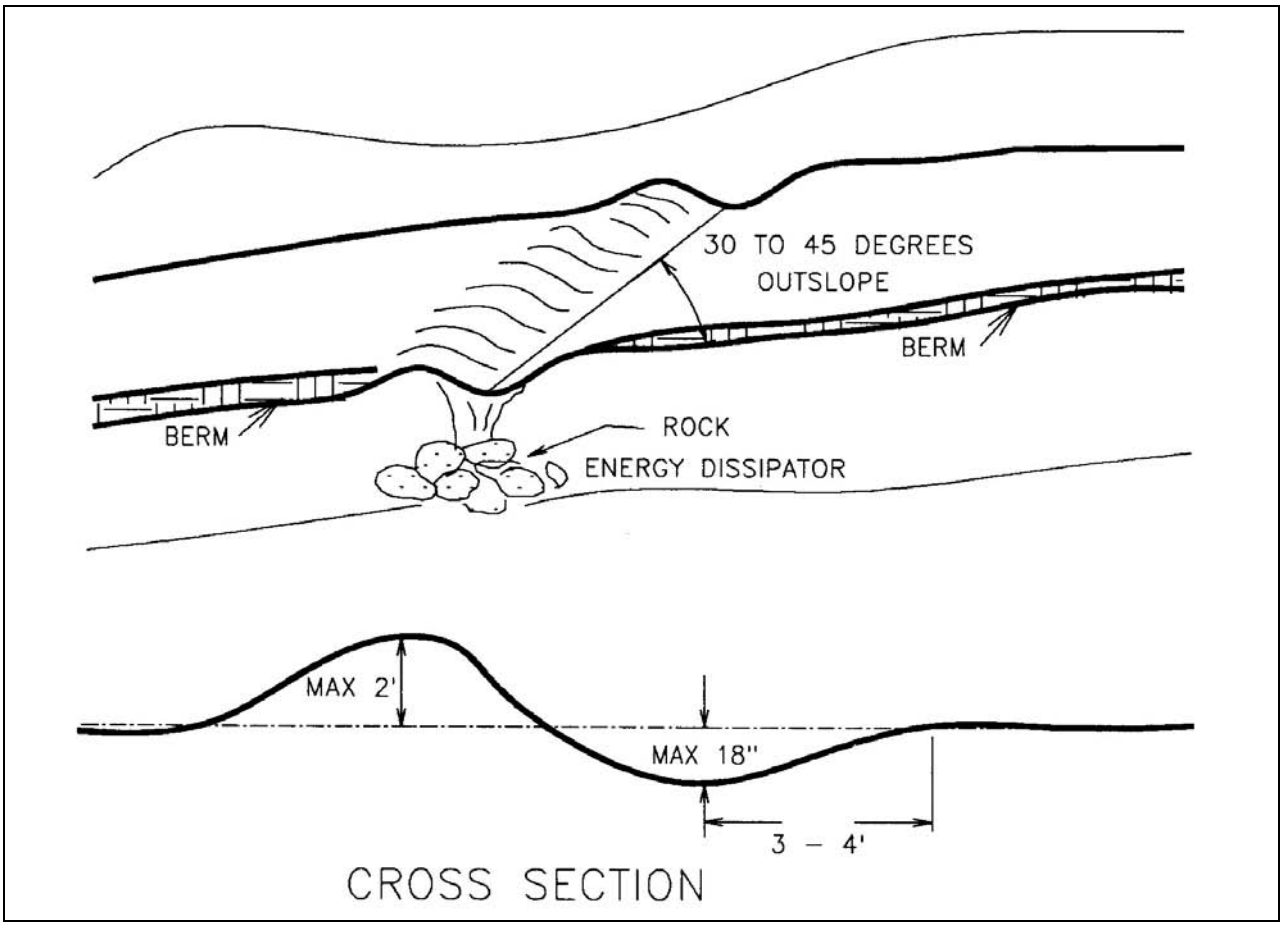


Figure VII-73. Waterbar.

Waterbars can be made easier to drive over by increasing the width and thereby reducing the slope of both the ditch and the berm. Installing waterbars in series will reduce the flow volume and hence the cutting action at each individual waterbar. Generally waterbars are spaced by dividing the road grade into 1000 feet. For example, if road grade is five percent, waterbars should be spaced approximately every 200 feet.

Waterbars can be reinforced with logs, gravel, or concrete. The outlet of the waterbar should open onto a wooded slope, existing stable channel, or onto a resistant slope that will not be adversely impacted by additional water. It may be necessary to create an energy dissipation mat by placing rocks or logs on the slope where water spills off the road.

Rolling dips function like waterbars when used as road cross drains. However, they do not require as much maintenance when properly installed, nor do they irritate motorists as much as waterbars. Rolling dips are installed by gradually ramping the road running surface down to a slightly outsloped low spot that is built across the roadbed, and then gradually ramping back up to the road grade. These installations often extend for a hundred feet or more. The low spot need only be about 12 inches below road grade in most installations. Site selection for rolling dips is similar to that used with waterbars.

Exclusionary Fencing

Streams passing through agricultural land are often adversely affected by livestock. Livestock can break down stream banks, destroy riparian vegetation, and by constant browsing, prevent new vegetation from becoming established. Overgrazed stream banks are highly susceptible to erosion and can add a significant amount of fine sediment to a stream. The best way to protect the riparian corridor and water quality of the stream is to exclude livestock access to the stream. This can be achieved by fencing the stream and riparian zone.

Generally, cattle require access to water every 1/4 mile. If livestock access to the stream for water is the only alternative, access points can be provided in areas with hard substrate where the stock will have the least effect on stream habitat. In most cases this will require fencing to cross the creek. In some instances, it may be more useful to develop an off stream water supply for livestock. There are also grazing rotation schemes that can alleviate effects to streams and riparian zones. The NRCS is a good source for further information on rotational grazing plans.

If exclusionary fencing is selected as a project, the DFG District Wildlife Biologist should be consulted prior to construction to make certain the location and type of fence will not be detrimental to wildlife in the area. Exclusionary fencing is constructed approximately parallel to the stream channel to keep livestock out of the stream and riparian zone. A setback of at least 25 feet from the stream bank should be used to establish an effective riparian zone.

Many types of fencing can be used. High-tensile wire fencing is probably the quickest and most economical to install. Electrical fencing can be economical to install but may require frequent maintenance. Barbed-wire, woven wire, wooden fence, or solid walls are more expensive to install. Regardless of the type of fence constructed, there will be an ongoing need for periodic maintenance.

Four or five strands of wire are usually necessary for permanent installations. To allow for wildlife passage the bottom wire is placed 18 inches from the ground. Redwood, cedar, yew, black locust, or pressure-treated posts are recommended for the wooden brace posts and corners.

A description of the construction of the many different types of fencing is beyond the scope of this manual. DFG's A *Gardener's Guide to Preventing Deer Damage* is a good reference on costs and designs used (Coey, 1994). NRCS is also a good source of information on fencing and improving grazing practices in watercourse areas. Many alternatives exist which have benefits to both stream channels and livestock production.

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Endangered Species Act
Section 7 Consultation

BIOLOGICAL OPINION

for

Water Supply, Flood Control Operations, and Channel Maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and the Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed

PCTS Tracking Number: F/SWR/2006/07316

Action Agency: U.S. Army Corps of Engineers, San Francisco District

Consultation Conducted By: National Marine Fisheries Service, Southwest Region

Date Issued: September 24, 2008

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Table of Acronyms

Ac-ft	acre-feet
BA	Biological Assessment
CDFG	California Dept. Fish & Game
CESA	California Endangered Species Act
CHART	Critical Habitat Analytical Review Team
CIE	Center for Independent Experts
Corps	U.S. Army Corps of Engineers
CVD	Coyote Valley Dam
CVFF	Coyote Valley Fish Facility
D1610	SWRCB Water Right Decision 1610
DCFH	Don Clausen Fish Hatchery
DPS	Distinct Population Segment
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
EWSL	Emergency water supply line
FMEP	Fishery Management & Evaluation Plan
HGMP	Hatchery and Genetic Management Plan
LMHPP	Lake Mendocino Hydroelectric Power Plant
LWD	Large woody debris
MCRRFCD	Mendocino County Russian River Flood Control and Water Conservation Improvement District
MOU	Memorandum Of Understanding
NCPA	Northern California Power Agency- (member: *City of Ukiah*)
NCRWQCB	North Coast Regional Water Quality Control Board
NMFS	National Marine Fisheries Service
PCE	Primary Constituent Element (*of critical habitat*)
ppm	parts per million
ppt	parts per thousand
RCD	Resource Conservation District
RPA	Reasonable and Prudent Alternative
RRCSCBP	Russian River Coho Salmon Captive Broodstock Program
SCWA	Sonoma County Water Agency
SWRCB	State Water Resources Control Board
TRT	Technical Recovery Team (*for listed species Recovery Plans*)
VSP	Viable Salmon Population
WSD	Warm Springs Dam
WWTP	Wastewater Treatment Plants
YOY	Young-of-Year (*i.e.*, age 0+ fish)

EXECUTIVE SUMMARY

Pursuant to Section 7(a)(2) of the Federal Endangered Species Act (ESA), NOAA's National Marine Fisheries Service (NMFS) consulted with the U.S. Army Corps of Engineers (Corps) regarding its operations of Warm Springs Dam (WSD) and Coyote Valley Dam (CVD) and a suite of activities that are authorized by the Corps and undertaken by the Sonoma County Water Agency (SCWA) and the Mendocino County Russian River Flood Control and Water Conservation Improvement District (MCRRFCD). The Corps, the SCWA, and the MCRRFCD have proposed to implement, for an additional 15 years, ongoing practices and operations at WSD and CVD and activities related to flood control, water diversion and storage, regulation of flows in the Russian River and Dry Creek, estuary management, hydroelectric power generation, channel maintenance, and fish hatchery production.

These actions likely affect Central California Coast (CCC) steelhead (*Oncorhynchus mykiss*), CCC coho salmon (*O. kisutch*), and California Coastal (CC) Chinook salmon (*O. tshawytscha*), each of which is protected as threatened or endangered under the ESA. The proposed actions also likely affect designated critical habitat for these species. The purpose of this consultation is to provide a determination regarding whether the Corps has insured that the proposed project is not likely to jeopardize one or more of these species or destroy or adversely modify their designated critical habitat. If a project is found to jeopardize a species or adversely modify its critical habitat, NMFS must develop a Reasonable and Prudent Alternative (RPA) to the proposed project in coordination with the federal action agency and any applicant. If the project is also expected to result in the incidental take of listed species, NMFS must also provide reasonable and prudent measures (RPM's) to minimize and monitor the impact of the incidental take of listed species.

In this document, we present our analysis and conclusions in the conventional format for biological opinions as described in the Endangered Species Consultation Handbook (U.S. Fish and Wildlife Service and NMFS 1998). This biological opinion includes reviews of the *Consultation History*, a *Description of the Proposed Action*, the *Status of the Species and Critical Habitat*, and the *Environmental Baseline*. Following those reviews we provide an analysis of the *Effects of the Proposed Action*, *Cumulative Effects*, and an *Integration and Synthesis* section in which we analyze the effects of the project in the context of the species status and environmental baseline. This biological opinion concludes with NMFS' determination regarding the impacts of this proposed project on the species' likelihood of survival and recovery, and on the value of the species' critical habitat. Because we have determined that this proposed project is likely to jeopardize the continued existence of some of the salmonid species affected by the proposed project, and adversely modify their critical habitats, we have provided a *Reasonable and Prudent Alternative* (RPA) to the proposed action that 1) avoids jeopardy to the species and adverse modification of critical habitat, 2) can be implemented in a manner consistent with the intended purpose of the action, 3) is economically and technically feasible, and 4) is within the legal authorities of the Corps, SCWA, and MCRRFCD.

The Proposed Action

NMFS analyzed the effects of continued operation of the Russian River Water Supply and Flood Control Project (Project) for a 15 year period on ESA-listed threatened and endangered salmonid species within the Russian River watershed. The Project includes operation of two dams and appurtenant facilities in the Russian River watershed. Together, these facilities are operated to control flooding within the watershed, to supply water to users within and outside the watershed, and to generate hydroelectric power. The altered flow regimes caused by the Project change the natural hydrology of the Russian River estuary, and artificial breaching of a barrier beach at the mouth of the river is often required to prevent flooding adjacent to the estuary. In addition, the Project includes channel maintenance activities that keep the water delivery system functional and reduce the impacts of flooding in the mainstem and some tributaries of the Russian River. The Project also includes operation of two fish hatchery facilities, the Don Clausen Fish Hatchery (DCFH) located at WSD and the Coyote Valley Fish Facility (CVFF) at CVD. SCWA's scope of maintenance responsibilities covered under this Biological Opinion includes maintenance of stream channels and small reservoirs throughout most of an area that SCWA terms Zone 1A, which consists of the Laguna de Santa Rosa watershed, as well as maintenance activities on the Russian River main stem and the segment of Dry Creek downstream from WSD. The Corps' maintenance activities include safety inspections at the two dams. In addition, MCRRFCD conducts channel maintenance activities related to the CVD in the Mendocino County portion of the Russian River. Channel maintenance by both counties is related to Federal sites and inspection of levees under Public Law 84-99 (non Federal sites), but this consultation does not include implementation of the current Corps Operations and Maintenance manual for channel maintenance in the Russian River watershed. Instead, NMFS is consulting on channel maintenance practices as described in Section III.B and referenced to the Corps and SCWA's Biological Assessment where appropriate.

In the initial draft of this Biological Opinion, dated July 11, 2007, NMFS analyzed the implementation of ongoing project operations for ten years, because SCWA and the Corps were contemplating potential complex, future changes in project flow release schedules associated with new water rights and other avenues for increasing reservoir water supplies. Such changes were likely to take at least ten years to accomplish. We were unable to fully analyze both short-term ongoing and future water supply scenarios because of the uncertainties and limited available information about those future scenarios. Originally, the Corps, SCWA, and NMFS agreed that it was prudent to evaluate project effects for the next ten year period because future changes in water supply operations contemplated by SCWA would likely take ten years to fully analyze and develop the permits and water rights agreements/decisions that may yield additional water rights and water supply that would affect flows and habitat in the Russian River and Dry Creek.

During work on the RPA, the Corps, SCWA, and NMFS determined that a major component of the RPA would take up to fifteen years to complete. The remediation of project impacts to designated critical habitat in Dry Creek would take 12 to 15 years to accomplish. NMFS transmitted a working draft biological opinion to the Corps and SCWA on August 1, 2008, and indicated that the timeframe for analysis of the original proposed project would need to be changed from ten years to fifteen years (NMFS 2008b). NMFS also indicated in transmitting the

working draft that the RPA did not ensure that resulting project operations would not likely jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. Because the project's impact on critical habitat could not be fully addressed in a ten year period, NMFS, the Corps, and SCWA agreed to amend the period of the proposed project from ten to fifteen years (Russian River Project Executive Committee Meeting August 4, 2008). The RPA's approaches to addressing impacts to critical habitat were also discussed between SCWA and NMFS and modified subsequent to the August 1, 2008 working draft.

The water supply and flood control elements of the Project involve the regulation of flood flows to control flooding in properties adjacent to the Russian River, and the storage of water in two reservoirs to be released for water supply in Sonoma, Mendocino, and Marin counties during the spring, summer, and fall. The water supply is released from the reservoirs and flows down the main stem Russian River and Dry Creek to diversion points downstream of the dams. Part of the water stays in the river channel and flows to the Pacific Ocean at the river's mouth near Jenner. The diverted water is delivered to end-users for municipal, industrial, agricultural, and domestic uses.

The keystone elements of the project are CVD, on the East Branch headwaters of the Russian River, and WSD on Dry Creek, a main tributary of the Russian. Russian River water is released from Lake Mendocino (the reservoir formed by CVD) for flood control, and, under the requirements of the State Water Resources Control Board's (SWRCB) Decision 1610 (D1610) for water supply. The Coyote Valley Fish Facility (CVFF) was constructed in 1992 at the base of CVD to mitigate for the loss of salmonid habitat and natural salmonid production upstream of CVD. Water released from Lake Sonoma (the reservoir formed by the WSD) is also released for flood control and water supply. The Don Clausen Fish Hatchery (DCFH) was built at the base of WSD to mitigate for the loss of fish habitat and anadromous salmonid production in the upper Dry Creek watershed. The operation and programmatic purpose of the hatchery has changed to a more adaptive program since its inception. There have been operational changes towards salmonid conservation and recovery to further mitigation goals and to fulfill the Corps' obligation under Section 7 (a)(1) of the ESA. D1610 establishes minimum flow requirements for both Dry Creek and the Russian River. Minimum stream flows under D1610 are specified for four different reaches in the Russian River watershed, assuring high enough summer flows to meet the diversion requirements as well as river-based recreational uses.

In addition to the two major dams in the Russian River watershed, there are several small storage reservoirs, levees, temporary dams, and other elements of the system that contribute to accomplishing the water supply and flood control goals of the Project and are discussed in subsequent sections of this consultation.

Status of the Species and Critical Habitat

In this opinion, NMFS assessed the condition of each of the three listed salmonid species relative to their extinction risk; we also describe the function and role of their respective critical habitats for species conservation. The CCC coho salmon includes coastal populations in rivers entering the ocean along the coasts of Mendocino, Sonoma, Marin, San Mateo and Santa Cruz counties.

The CCC steelhead includes populations ranging from those in the Russian River south to streams in Santa Cruz County, plus populations in streams entering San Francisco Bay (*e.g.*, Sonoma Creek, Napa River, Alameda Creek). CC Chinook salmon include populations of this species in coastal streams ranging from the Russian River north to Humboldt County's Redwood Creek. Our assessment of the status of these species examined the viability (per the framework described by McElhany *et al.* 2000) of populations in four to five distinct geographic areas (termed diversity strata) that constitute each species. For this, we used the diversity strata identified by Spence *et al*. (2008).

Our assessment of extinction risk focuses on the viability of individual populations in each diversity strata in order to appropriately apply the ESU viability criteria provided by Spence *et al*. (2008), which is the current definitive source for ESU viability evaluation. Spence *et al*. (2008) report that for an ESU or DPS to be viable, "representative", "redundancy", and "connectivity" criteria must be met.

CCC coho salmon, which is listed as Endangered, faces the highest risk of extinction of the three salmonid species considered in this opinion. This is evidenced by their precipitous decline in abundance during the last several decades and poor status of population viability metrics (abundance, population growth rates, spatial structure, and genetic diversity). Wild populations of this species were extirpated in the nearby Salmon and Walker Creek watersheds; their distribution has been very highly reduced in the Gualala watershed. The cause of this decline is likely the widespread degradation of habitat, particularly those habitat attributes that support freshwater rearing life stages. The loss of this habitat and the concurrent extirpation of local populations have resulted in a high degree of isolation for the remaining populations.

CCC steelhead is listed as a Threatened Species. Its habitat is degraded throughout the Distinct Population Segment, especially in the two diversity strata with streams bordering San Francisco Bay. However, the diverse life-history strategies of steelhead have helped reduce this species' extinction risk overall. For example, the highly variable time of instream residence (one year to several years) and spawning age allow for effective temporal dispersal within a population. Also individuals within this species are able to spawn in multiple years, unlike coho and Chinook salmon which die shortly after spawning. CCC steelhead appears to be doing best in the more coastal environments and seems more challenged, but persistent in the more inland and urbanized areas. The overall extinction risk of this species is moderate.

The extinction risk for CC Chinook salmon, which is listed as a Threatened Species, is likely intermediate between that of CCC coho salmon and CCC steelhead. Their habitat condition is somewhat better than for the other species mainly because their range lies well north of San Francisco Bay and they do not occupy rearing habitats throughout the summer when stream flows can be very low or negligible. However, habitat degradation is still widespread and is particularly an issue in the upper Eel River. Excluding the reduced returns in 2007, the resurgence in abundance in the Russian River and in other southerly watersheds of this ESU suggests favorable conditions not entirely explained by freshwater habitat analysis. In any case, the more restricted life-history strategy compared to steelhead, relative spatial isolation of the Russian River population, and habitat condition in the Eel River make the extinction risk for CCC Chinook salmon higher than for CCC steelhead.

Environmental Baseline

The environmental baseline section provides the reference point for the listed species and their habitats within the action area to which NMFS adds the effects of the proposed action. The action area includes the Russian River and its tributaries downstream of WSD and CVD. This large action area is necessary because of the need to address the impacts of straying hatchery fish in the watershed. However apart from that issue, our effects analysis was primarily focused on: 1) the East Branch Russian River below CVD and the main stem Russian River from the confluence of the East Branch to the river's mouth at Jenner, 2) Dry Creek downstream of WSD, and 3) areas of the Mark West Creek watershed that do not contain coho salmon, including Santa Rosa Creek and its tributaries, and the Laguna de Santa Rosa. Because channel maintenance activities in Zone 1A and other project actions were not proposed for portions of the Mark West Creek watershed upstream of its largest tributary the Laguna de Santa Rosa, it was unnecessary to focus on that portion of Zone 1A.

The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal Projects that have already undergone consultation under Section 7 of the ESA, and the impact of State or private actions which are contemporaneous with the consultation process. By establishing the historical and current condition of the species and their habitat in the action area, we describe those conditions to which the effects of the project under consultation are added in our analysis of the project. Our ability to understand factors contributing to the baseline condition is also important for predicting future baseline conditions and likely responses of salmonids to the effects of the proposed action.

Urban, residential, and agricultural developments, timber harvest, road construction, water supply and flood control management activities have had a collective adverse effect on the quality and quantity of spawning, rearing, and migratory habitats for steelhead, coho salmon, and Chinook salmon in the Russian River watershed. Prior to the construction in 1908 of the Potter Valley Hydroelectric Project, which conveys water from the upper Eel River to the upper Russian River, late summer flows in the Russian River were in the vicinity of 20 to 30 cfs. Now with that project, the construction of Scott Dam on the Eel River, CVD, and WSD, the Russian River sustains flows over 185 cfs throughout much of the mainstem and at least 125 cfs flows to the ocean in most summers. Prior to these projects, the river's estuary likely closed during summer months with a barrier beach that formed a large freshwater lagoon providing high quality rearing habitat for steelhead and coho salmon.

Prior to European settlement, the mainstem Russian River was a dynamic meandering river which migrated across its floodplain creating ox-bows and side sloughs. Most of the 110 miles of mainstem and many hundreds of more miles in the tributaries were likely historically available to salmonids for spawning and juvenile rearing (SEC 1996). Both the mainstem and tributaries very likely had an abundance of large woody debris in the form of root wads and fallen logs that created scour pools and provided cover and foraging sites for rearing salmonids (SEC 1996). Summer flows were much lower in the mainstem; however, numerous deep pools likely stratified and contained lower cooler layers. Stream channelization, road construction along stream

margins, bank stabilization, and water diversions in tributaries have significantly degraded stream habitats throughout the watershed by simplifying stream channels, isolating them from their flood plains, greatly increasing sedimentation, blocking fish migrations, and reducing or eliminating flow and cover.

Effects of the Proposed Action

Listed salmonids are adversely affected by operations for flood control at the two project dams, by project flow releases for water supply, by the management of estuary water levels, by the project related hatchery operations, and by channel maintenance activities in both the mainstem and Russian River tributaries. We did not find significant impacts specific to the operations of the small hydroelectric facilities at CVD and WSD.

Flood control releases at CVD have increased the duration of high flows that scour stream substrates and salmonid spawning habitats in the segment of the mainstem Russian River immediately downstream of the East Branch. In addition, the project's proposed rates of flow ramp down of 250 cfs/hr (when flows are 250-1000 cfs) and 1000 cfs/hr (when flows exceed 1000 cfs) likely cause both CC Chinook salmon and CCC steelhead fry and juveniles to be stranded in isolated pools or beached in dewatered areas. The stranded fry and juveniles are likely to experience higher rates of predation. Some fry and juveniles are likely to be stranded in disconnected pool areas that may not become reconnected depending on flow regime, resulting in the death of these fish. Pre-flood and five-year periodic inspections at CVD, which are conducted during late summer, adversely affect juvenile steelhead because the Corps shuts off stream flow at CVD for about two hours with resulting loss of salmonid rearing habitat in the East Branch and stranding of juvenile steelhead in the remaining isolated pools. CVD is also known to release highly turbid water for extended periods well after turbidity levels have diminished upstream of the mainstem's confluence with the East Branch and elsewhere in the river's unregulated tributaries.

Flood operations at WSD likely cause minor scouring of spawning habitat in Dry Creek in the three mile segment immediately below the dam. We estimate that 5 to 10% of the salmonid redds constructed in this segment are likely to be scoured (*i.e.*, lost) when WSD releases are 5000 cfs or greater. The proposed rates of ramp down for WSD flood control operations, which are the same as above for CVD, are expected to cause stranding of fry and juvenile salmon and steelhead in the three mile segment immediately below the dam. However, the steep banks and lack of side channels in this segment are generally not conducive to high stranding rates. The continuous 25 cfs minimum bypass flow at WSD will likely avoid stranding and beaching of juvenile steelhead or coho salmon during annual pre-flood and five-year periodic inspections.

Flood control operations at the dams will affect stream flows in Dry Creek and the main stem during and shortly after heavy precipitation and runoff in winter or early spring. These operations limit peak flows by storing water in the reservoirs, after which the Corps releases those waters downstream during an extended period when flood risk has abated.

During winter and early spring, the dams generally have a relatively modest influence on stream flow in the Russian River and Dry Creek because of the substantial, unregulated inflow from numerous tributaries. However, during the low flow season (approximately late May through October) releases from WSD and CVD for water supply significantly affect stream flow and available rearing habitat for steelhead and coho salmon, which rear in freshwater habitats throughout the summer months. The project's proposed flow management at WSD and CVD during late spring, summer, and fall has a clear adverse effect on the availability of rearing habitat for steelhead in the14.1 mile segment of Dry Creek, in 34 miles of the upper Russian River, and in the river's estuary. The project's proposed flow management also adversely affects the quality and quantity of rearing habitat and survival of juvenile coho salmon in Dry Creek. Although the upper main stem Russian River and Dry Creek support good quality spawning habitat for listed salmonid species, salmonid fry that emerge from the gravels of Dry Creek and the upper Russian River will encounter limited suitable quality rearing habitats because much of the stream areas have excessive current velocities. This will lead to increased mortality of juvenile steelhead and coho salmon. The proposed flow regime will also affect the survival of juvenile salmonids that emigrate downstream from tributaries into Dry Creek or the upper Russian River. Juvenile Chinook salmon rear in freshwater only until late spring or early summer when they then enter the ocean environment. For that reason, regulation of late spring and summer flows has much less effect on rearing juvenile Chinook than the other two species.

Proposed project operations will likely have significant adverse effects on the Russian River's estuarine rearing habitat for each salmonid species. The proposed project will sustain high, artificial inflows to the estuary during the low flow season and it will entail detrimental sandbar breaching activities at the mouth that will significantly affect water quality in the lowermost segment of the river. The artificial breaching creates a near marine environment, with shallow depths and high salinity throughout most of the water column; in some areas salinity stratification contributes to low dissolved oxygen at the bottom. The combination of artificially high flows entering the estuary during summer months and the proposed plan for breaching the estuary mouth is likely to result in the loss of productive rearing habitat for small juvenile salmonids at the mouth of the Russian River. This habitat is lost because the Russian River estuary will not remain closed long enough to form a freshwater lagoon during the low flow season in most years. This degradation of estuarine habitat will contribute to reduced survival of juvenile salmonids that emigrate to the estuary.

SCWA and MCRRFCD propose to continue bank protection, including repair or replacement of riprap, gravel bar grading, and vegetation maintenance on the main stem Russian River. Over the course of the 15 year project, no more than 30,000 lineal feet of the Russian River will be affected by channel maintenance activities. This represents about 6% of the entire Russian River mainstem. Each county may work as much as 2000 feet of main stem channel per year, but neither county may work on more than 15,000 feet of channel over the course of the 15 year project. Sonoma County will also conduct channel maintenance within constructed flood control channels and portions of natural waterways within Zone 1A (largely the Laguna de Santa Rosa and Santa Rosa Creek watersheds). We conclude that channel maintenance in the Russian River mainstem and Zone 1A will not appreciably degrade the value of critical habitat for listed salmonid species. However, we estimate numbers of juvenile steelhead that will likely perish

each year due to this maintenance activity. We also find that anticipated erosion control practices along the banks of Dry Creek are likely to degrade rearing habitats for salmonids.

The Corps' fish hatchery operations are required as mitigation for the loss of wild salmon and steelhead production due to construction of WSD and CVD. The hatchery program is currently operated to rear and stock coho salmon and steelhead trout. The DCFH coho salmon mitigation and enhancement program began in 1980; however, coho production at the facility was stopped entirely in 1996, after failing to meet mitigation goals. In 2001, the Russian River Coho Salmon Captive Broodstock Program (RRCSCBP) was initiated at DCFH to prevent extirpation of coho salmon in the Russian River basin, preserve genetic, ecological, and behavioral attributes of Russian River coho salmon while minimizing potential effects to other stocks and species, and to reestablish self-sustaining runs of coho salmon in tributary streams within the Russian River basin.

The RRCSCBP involves the collection of wild, juvenile coho salmon from Russian River tributaries. The wild juveniles are reared to reproductive maturity and then artificially spawned according to a genetic spawning matrix to maximize genetic diversity and avoid inbreeding. Juvenile coho salmon produced from the captive broodstock are then released into several Russian River tributaries as fry, where they rear, over-winter, migrate to the ocean, and then return as adults to spawn naturally in the streams. Each year since 2001, the program has reared and stocked coho salmon with lineage to wild juvenile coho salmon collected in Russian River tributaries. The RRCSCBP also includes an evaluation component, in which the survival of stocked juvenile coho salmon and the subsequent adult returns to tributary streams are monitored. At present, the genetics management and evaluation components (field monitoring) of this program do not have long term funding commitments.

The proposed continuation of the captive broodstock program will have objectives and methods similar to the existing RRCSCBP. The RRCSCBP is currently authorized under an ESA section 10(a)(1)(A) enhancement permit issued to CDFG, which acts as a contractor to the Corps for this hatchery requirement. Since the effects of the RRCSCBP have already been evaluated and covered by a permit, this program is not evaluated as part of the proposed action in this biological opinion, but it is included in the Environmental Baseline of this biological opinion. The lack of committed funding for the annual genetics management and field monitoring for the program threatens the viability of this program. The lack of an emergency water supply line to the DCFH also poses a significant threat to the RRCSCBP.

The steelhead hatchery program was not previously authorized under the ESA. That program involves the spawning of several hundred adults, the rearing of fry and juveniles, and the annual stocking of a combined total of about 500,000 steelhead smolts into Dry Creek and the upper Russian River. Recent genetic information on Russian River steelhead indicates that there are no substantial genetic differences between wild and hatchery propagated steelhead in the basin. Continued exclusion of wild steelhead from hatchery spawning stock could result in a divergent hatchery population with reduced genetic diversity and increased inbreeding. The stocking of hatchery smolts may have some adverse effects to wild populations through their predation or competition with wild fish. However, we believe those effects are relatively minor, because hatchery fish are stocked only into Dry Creek and the East Branch (near the confluence with the

upper main stem Russian River) when they are in a migratory stage and not acclimated to survival in the wild, and most migrate within a few weeks to the ocean. The hatchery program also promotes a fishery for marked adult hatchery fish in the mainstem Russian River; that fishery results in the capture (with barbless hooks) and release of wild steelhead, coho salmon, and Chinook salmon.

The principal effect of the water diversion facility at Mirabel Wohler is the loss of juvenile salmonids that may become entrained through or impinged on the water intake screens. Some minor loss of salmonids may also be caused by higher rates of predation from fishes (*e.g.*, pike minnow, smallmouth bass) in the Wohler impoundment or from stranding when the inflatable dam is inflated or deflated.

Integration and Synthesis

Project Effects on Critical Habitat

Because adult fall run CC Chinook salmon primarily migrate to spawning habitats during mid to late fall and the resulting progeny migrate downstream to the ocean during the following spring, flow management at WSD and CVD does not have significant adverse consequences for this species. Migrations of adult Chinook salmon appear to actually benefit from the elevated regulated flows during fall months, and rearing juveniles do not contend with the artificially high summer flows that limit available rearing habitat for the other Federally listed salmonid species. Although channel maintenance activities will likely have some adverse effect on spawning and rearing habitats for Chinook salmon, these effects will probably be minor because each year, channel maintenance will affect only a small portion (less than 1 mile) of the 94 mile long main stem Russian River. This 94 mile segment effectively supports rearing habitat for juvenile Chinook salmon along its entire length and spawning habitat at riffles along the approximately 58 mile segment upstream from Healdsburg. Ongoing channel maintenance activities in Dry Creek will likely diminish available rearing habitat for Chinook salmon; however, the extent of habitat loss for rearing Chinook salmon in Dry Creek due to ongoing channel maintenance activities is likely minor given the availability of rearing habitat for this species throughout the main stem Russian River. We conclude that, if the proposed project is implemented, critical habitat for Chinook salmon would remain functional to serve the intended conservation role for this species.

In contrast to the findings for Chinook salmon, the proposed project will likely have significant adverse effects on the critical habitat of steelhead and coho salmon. Because of these adverse effects, critical habitat for steelhead and coho salmon would not be functional to serve the intended conservation role for these species. Proposed flow releases from WSD and CVD during the approximately six-month long, low flow season will create excessively high current velocities that will greatly limit the value of 14 miles of Dry Creek and 34 miles of the upper Russian River as rearing habitat for steelhead. Flow management at the project's reservoirs and breaching of the estuary's bar will also adversely affect the value of steelhead rearing habitat in and near the vicinity of the estuary. Flow releases from WSD during summer and fall months will be so high that available habitat for rearing juvenile coho in Dry Creek will be minimal. Proposed continued channel maintenance activities in Dry Creek will contribute to armoring the

stream banks, reducing velocity refuge areas for fishes during high flows, and simplifying stream channel morphology with potential degradation of both summer and winter rearing habitats for steelhead and coho salmon. The significance of these impacts to critical habitat for rearing steelhead and coho salmon becomes apparent when the status of critical habitat for these species is considered.

Our review of the status of populations of CCC steelhead in the Russian River indicate that freshwater rearing habitat is one of the two primary types of critical habitat that are most degraded. In the Russian River watershed and nearby watersheds, degradation of steelhead rearing habitat is due to channel modifications, chronic deposition of fine sediments, and intensive diversions of surface flow in tributaries. The restoration of viable populations of steelhead within these watersheds will depend upon the restoration of good quality freshwater rearing habitats, including ecologically diverse habitats such as freshwater lagoons and deep main stem habitats for older age 1+ and 2+ fish. The restoration of viable populations of Russian River steelhead would substantially improve the chances for the recovery of the CCC steelhead DPS. However, as proposed, the project's flow management plan (*i.e.*, conformance with D1610, water supply releases, and water elevation management in the estuary) will hamper efforts to recover this species by degrading and, in some cases, eliminating important freshwater habitats in the Russian River.

Likewise, the availability of rearing habitat for coho salmon has been greatly reduced in the Russian River watershed and elsewhere as the result of numerous developmental activities. Coho salmon require especially cold water in which to rear, and developmental activities have undoubtedly limited the availability of such coldwater habitats. As discussed in the Effects Section, approximately 13 miles of Dry Creek provide temperatures that sustain rearing coho salmon; however, high flow releases from WSD during summer and fall months greatly limit the value of the PCE of critical habitat for rearing coho salmon. The proposed project operations appreciably degrade the value of Dry Creek's critical habitat for CCC coho salmon. Successful recovery of this species will very likely require protection, restoration, and enhancement of existing rearing habitats for this species. Given that the Russian River is the largest watershed occupied by CCC coho salmon and that it is centrally located in this ESU, it is unlikely that the CCC coho can be recovered without a successful restoration of coho salmon habitat and runs in the Russian River.

Project Effects on Species Survival and Recovery

We conclude that the proposed project operations are not likely to appreciably reduce the likelihood of CC Chinook salmon survival and recovery in the Russian River. We conclude this because the project is unlikely to reduce the abundance of spawners, the growth rate, spatial structure, or genetic diversity of the Russian River population of Chinook salmon. We base this finding on the following facts: 1) the population has experienced a generally positive growth over the past ten years, 2) the project does not cause significant adverse effects to the species' habitat, 3) the project will maintain the same freshwater conditions that have supported the recent growth of the Chinook salmon population, and 4) the action does not impact the species in such a way as to make it more vulnerable to other factors and environmental variation that are outside the control of the action.

Unlike the situation for Chinook salmon, the proposed project will likely have substantial adverse effects on both the coho salmon population and several steelhead populations in the Russian River watershed. The proposed flow management plan for CVD and WSD, the water level management plan for the river's estuary, and the ongoing channel maintenance activities in Dry Creek substantially influence the abundance, growth rate, and spatial structure of populations of steelhead and coho salmon in the Russian River. As proposed, the flow management plan will perpetuate status quo flows that strongly influence habitat suitability while the steelhead populations in the watershed experience negative growth trends due to other diverse developmental activities throughout the watershed. Elevated inflows to the estuary, the upper mainstem, and Dry Creek during the low flow season, and channel maintenance activities will continue to suppress populations of steelhead in the basin and impair recovery processes; instead populations of steelhead will likely continue to decline through degradation of habitats stemming from status quo project operations and diverse non-project related activities. Given that the Russian River supports nine steelhead populations, including one functionally independent population and six potentially independent steelhead populations, and that the river's populations span two of the five diversity strata (*i.e.*, major groups of populations) within the CCC steelhead, the survival and recovery of this DPS will likely depend on successful efforts to increase the abundance, spatial structure, diversity, and growth rates of Russian River steelhead populations. Likewise, given the central location of the Russian River in the range of CCC coho and that the watershed represents a third of the ESU by area, the survival and recovery of CCC coho salmon will likely depend on a substantial positive trend in the growth rate and abundance of coho salmon in the Russian River. The coho population is appreciably affected by the continued loss of juvenile coho that are likely displaced from Dry Creek due to high summer flows that limit habitat availability and by the continued channel maintenance practices that prohibit natural channel processes that create suitable rearing habitats for the species.

Conclusions

After reviewing the best available scientific and commercial data, the current status of the species, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' biological opinion that the continued operations of CVD and WSD for a fifteen year period in a manner similar to recent historic practices together with SCWA's proposed ongoing water diversions from the Russian River and its proposed stream channel maintenance activities, estuary management, and hydroelectric project operations at CVD and WSD are not likely to jeopardize the continued existence of threatened CC Chinook Salmon. However, we find that the continued operations of CVD and WSD in a manner similar to recent historic practices together with proposed Dry Creek stream channel maintenance activities and estuary management are likely to jeopardize the continued existence of threatened CCC steelhead and endangered CCC coho salmon.

After reviewing the best available scientific and commercial data, the current status of the critical habitat, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS biological opinion that the continued operations of CVD and WSD for a fifteen year period in a manner similar to recent historic practices together with

SCWA's proposed stream channel maintenance activities and estuary management are likely to adversely modify critical habitat for CCC coho salmon and CCC steelhead. It is NMFS opinion that the proposed project is not likely to adversely modify critical habitat for CC Chinook salmon.

Reasonable and Prudent Alternative

To avoid the likelihood of jeopardy to the species and adverse modification of critical habitat, NMFS has collaborated with the Corps and SCWA in developing a Reasonable and Prudent Alternative (RPA) for this project that is consistent with the intended purpose of the action, can be implemented consistent with the legal authority and jurisdictions of the Corps and SCWA, is economically and technologically feasible, and would avoid the likelihood of jeopardizing the continued existence of listed species or the destruction or adverse modification of critical habitat. This RPA involves implementation of the project as described in Section III of this biological opinion, with modifications and additional actions as described in Section X.A of this opinion. In summary, new or modified actions that will be part of the Russian River Water Supply and Flood Control Project will include:

1. SCWA will petition the SWRCB to change minimum bypass flows identified in D1610 for the mainstem Russian River and Dry Creek. SCWA will also complete all necessary environmental documentation and other activities within its jurisdiction to promote changes to D1610 minimum flow standards as identified in Section X.A.1
2. SCWA will collaborate with NMFS and modify their estuary water level management in order to reduce marine influence (*i.e.*, high salinity and tidal inflow) in the estuary and promote a higher water surface elevation in the estuary for purposes of enhancing the quality of rearing habitat for age 0+ and 1+ steelhead. A program of potential incremental steps is described to address this issue. These include adaptive management of the outlet channel, investigation and possible elimination of impacts of the jetty at the river's mouth on lagoon formation, and alternative approaches to flood risk reduction (e.g., elevating structures or other methods). SCWA will monitor the response of water quality, invertebrate production, and salmonids in and near the estuary to water surface elevation management in the estuary-lagoon system.
3. The Corps and SCWA will implement and monitor on-the-ground enhancements of rearing habitat that will avoid adverse modification of critical habitat and appreciably increase the survival of juvenile salmonids in Dry Creek during both summer and winter months. To do this, SCWA will enhance the quality and quantity of pool habitat along the 14 mile segment of Dry Creek and install boulder clusters to improve rearing habitat for steelhead and coho salmon in Dry Creek. These enhancements, which will ameliorate habitat conditions adversely affected by high summer flow releases, will be distributed at several locations along Dry Creek and the timing of their installation will be staggered to begin by Year 5 and be completed by Year 12. Because the initial design, permitting, and construction of this work will take up to five years to complete, SCWA will also restore or otherwise enhance rearing habitat for salmonids in tributaries that enter Dry Creek downstream of WSD or other Russian River tributaries supporting coho salmon and steelhead by the end of Year 3 covered by this opinion. The Corps will assist the

SCWA in promoting enhancements of winter high flow refuge habitat for rearing coho and steelhead in Dry Creek.

4. SCWA will investigate the feasibility of constructing a pipeline to deliver water from Lake Sonoma to the mainstem of the Russian River in order to reduce the adverse effects of relatively high flow releases from WSD on rearing habitat for coho salmon and steelhead. An assessment of bypass pipeline alternatives will enable SCWA to identify the best method to ensure water deliveries while meeting salmonid habitat needs in Dry Creek in the unlikely event that habitat enhancement efforts in Dry Creek are unsuccessful in supporting successful growth and survival of juvenile steelhead and coho salmon.
5. The Corps will strengthen the Russian River Coho Salmon Captive Broodstock Program (RRCSCBP) by conducting needed 1) annual genetics analysis and 2) annual monitoring of the distribution and survival of stocked juvenile salmon and the subsequent return of adult coho to the Russian River.
6. SCWA will fund the implementation of an expansion of the RRCSCBP to include the annual rearing and stocking of 10,000 coho smolts genetically managed via the wild coho broodstock program.
7. The Corps will install a new back-up water supply pipeline to the Warm Springs Hatchery, and complete construction of additional rearing facilities for the coho salmon broodstock program.
8. Consistent with recent historic monitoring efforts, SCWA will annually monitor the upstream migration of adult salmonids at the Mirabel Dam between late August and late fall, and they will annually monitor downstream migration of juvenile salmonids past the Mirabel Dam during spring and early summer for 15 years.

Incidental Take Statement

This biological opinion provides an Incidental Take Statement for the taking of listed salmonids that is likely to occur due to the implementation of the proposed action and RPA for this project. Under the terms of section 7(b)(4) and section 7(o)(2), the identified incidental take is not considered to be prohibited taking under the ESA, provided that it is in compliance with the Terms and Conditions included with the incidental take statement.

Key terms and conditions include:

1. The Corps will initiate a study, complete a feasibility report, and then construct a low flow bypass pipe at the CVD by October 1, 2013.
2. The Corps will conduct a field study to investigate potential alternative ramp down criteria for flood control releases to try and minimize stranding downstream from CVD. The Corps will adjust ramping rates to minimize impacts to fisheries if they will allow flood control to be maintained.
3. The Corps will conduct studies to investigate the effects of CVD and WSD operations on turbidity in the Russian River. If turbidity from CVD or WSD is adversely affecting listed salmonids, the Corps shall complete and begin implementation of a plan to minimize and avoid these adverse effects by no later than 2014.

4. The Corps, SCWA, MCRRFCD or their designees shall ensure that relocation of salmonids from in-channel flood control work areas is accomplished by means that minimize harm and mortalities of listed salmonids.
5. SCWA shall complete design of the new fish screen at Mirabel within three years of the issuance of this biological opinion, and replace the fish screen within three years after completion of the design. Also within three years of the issuance of this opinion, SCWA shall decommission or modify the infiltration ponds on the East side of the Russian River at the Mirabel/Wohler facility to prevent fish entrapment in these ponds during flood events.
6. For the next fifteen years, the Corps will conduct genetic management and genetic assessment of the DCFF and CVFF steelhead programs.
7. SCWA shall undertake measures to ensure that injury and mortality to listed salmonids resulting from fish monitoring at Mirabel dam, in the estuary, and in Dry Creek are low.
8. SCWA will undertake measures to ensure that harm and mortality to listed salmonids from adaptive management of the sandbar at the mouth of the Russian River are low.

I. INTRODUCTION

Section 7(a)(2) of the Endangered Species Act of 1973, as amended (ESA), requires Federal agencies to insure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of threatened or endangered species or destroy or adversely modify critical habitat. The section 7(a)(2) interagency consultation regulations define "jeopardize the continued existence of" as "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, number, or distribution of that species." The regulatory definition of critical habitat has been invalidated by Federal courts. This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR §402.02. Instead, we have relied upon the statutory provisions of the ESA and the guidance provided by NOAA's Assistant Administrator for Fisheries to complete the following analysis with respect to critical habitat (NMFS 2005a).

NOAA's National Marine Fisheries Service (NMFS) is conducting a formal consultation for actions carried out by the US Army Corps of Engineers (Corps), and activities undertaken by the Sonoma County Water Agency (SCWA) and the Mendocino County Russian River Flood Control and Water Conservation Improvement District (MCRRFCD) that are authorized by the Corps. The Corps, the SCWA, and the MCRRFCD propose to operate and maintain Federal facilities and conduct activities related to flood control, water diversion and storage, instream flow releases, estuary management, hydroelectric power generation, channel maintenance, and fish hatchery production. The Corps owns and operates Warm Springs Dam (WSD) and Coyote Valley Dam (CVD). The Corps owns and the California Department of Fish and Game (CDFG) operates the Don Clausen Fish Hatchery (DCFH) at WSD and the Coyote Valley Fish Facility (CVFF) at CVD. Also, the Corps undertakes flood protection and authorizes stream stabilization activities of SCWA and MCRRFCD.

The actions proposed by the Corps, the SCWA, and MCRRFCD may adversely affect Central California Coast (CCC) steelhead (*Oncorhynchus mykiss*), CCC coho salmon (*O. kisutch*), and California Coastal (CC) Chinook salmon (*O. tshawytscha*) protected as threatened or endangered under the ESA, and designated critical habitat; therefore, the proposed actions must undergo a formal consultation pursuant to section 7(a)(2) of the ESA. NMFS also considered potential impacts on the ESA listed Southern Resident Killer Whale (*Orcinus orca*) population due to their range, which includes the Pacific Ocean adjacent to the Russian River, and apparent dietary preference for Chinook salmon (NMFS 2008a).

As part of this consultation, the Corps, the SCWA, the MCRRFCD, and NMFS have entered into an MOU that sets a framework for the consultation on project activities that may directly or indirectly affect coho salmon, steelhead, and Chinook salmon in the Russian River. The MOU states that the parties will seek information and assistance from other local, state and Federal agencies, including the CDFG, the State Water Resources Control Board (SWRCB), the North Coast Regional Water Quality Control Board (NCRWQCB), the State Coastal Conservancy, and the Mendocino County Inland Water and Power Commission.

Our task in this consultation is to provide a determination regarding whether the Corps has insured the proposed federal action and interrelated and interdependent activities are not likely to jeopardize listed species or result in destruction or adverse modification of critical habitat over the next fifteen years. We are not consulting on possible future changes to operations based on increased water demands from anticipated human population growth or other changes to current operations, with the exception of a minor change to operation of the inflatable dam at Mirabel, and minor changes to some channel maintenance activities (see *Description of the Proposed Action*.)

A. Organization of the Biological Opinion

In this document, we present our analysis and conclusions in the conventional format for biological opinions as described in the Endangered Species Consultation Handbook (U.S. Fish and Wildlife Service and NMFS 1998). This biological opinion includes reviews of the *Consultation History*, a *Description of the Proposed Action*, the *Status of the Species and Critical Habitat*, and the *Environmental Baseline*. Following those reviews, we provide an analysis of the *Effects of the Proposed Action*, *the Cumulative Effects*, and an *Integration and Synthesis* section. This biological opinion concludes with NMFS' determination regarding the impacts of the proposed action on the function and role of critical habitat for species conservation, and on the species' likelihood of both survival and recovery. Because we have determined that the Corps has not insured the proposed action is not likely to jeopardize the continued existence of some of the salmonid species affected by the proposed project and not likely to adversely modify their critical habitat, we provide a *Reasonable and Prudent Alternative* (RPA) to the proposed action. The RPA does not eliminate all impacts to listed salmonids, and therefore, an *Incidental Take Statement* is also provided.

The *Status of the Species and Critical Habitat* section portrays the condition of the species and their habitats relative to the species probability of extinction by describing how the species is surviving given its life history strategy and the condition of its environment. The *Environmental Baseline* describes and analyzes the condition of the species and its habitat, including critical habitat, in the action area. The *Effects of the Proposed Action* section describes and analyzes the effects of the action on habitat, including critical habitat, the exposure of steelhead and salmon to these effects, and the expected response of salmon and steelhead, and critical habitat in the action area. Once the effects are described, we assess, in the *Integration and Synthesis*, the ramifications of these effects to critical habitat and listed species in the action area on the function and role of critical habitat for species conservation and the likelihood of both the survival and recovery of the species at the Evolutionarily Significant Unit (ESU) or Distinct Population Segment (DPS)[1] scale, given the *Status* of the ESU or DPS and the *Environmental*

[1] Historically, NMFS used the concept of ESUs to define "species" in its administration of the ESA for anadromous salmon populations. For purposes of conservation under the ESA, an ESU is a distinct population segment that is substantially reproductively isolated from other conspecific population units and represents an important component in the evolutionary legacy of the species (Waples 1991). However, NMFS recently delineated steelhead populations as distinct population segments (DPS) rather than ESUs (71 FR 834). A DPS is a group of organisms that are discrete from other populations and are significant to their taxon. A group of organisms is discrete if they are "markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, and behavioral factors." Significance is measured with respect to the taxon (species or subspecies) as opposed to the full species (71 FR 834).

Baseline. Following this assessment, and based on our conclusions of jeopardy and adverse modification, we provide an RPA to the proposed project. The *Reasonable and Prudent Alternative* section describes the changes to the proposed project that are needed, and indicates how these changes avoid jeopardy and adverse modification and otherwise meet the regulatory requirements governing RPAs (50 CFR 402.02).

B. Uncertainty and Key Assumptions

The issues NMFS is obliged to address in this opinion are wide-ranging, complex, and often not directly referenced in scientific literature. We base many of our conclusions on explicit assumptions informed by the available evidence. By this, we mean to make a reasonable effort to compile the best scientific and commercial empirical evidence related to the analysis and to then apply general and specific information on salmonid biology from the published literature to make inferences and establish our conclusions.

In some cases, we have used the results of recent project specific studies or analyses conducted in the action area. For example, SCWA has studied water quality in the Russian River estuary before, during, and after estuary bar breaching for the last several years. In other situations, only more general local data are available on species presence or absence, and habitat condition. Where necessary, we have used this information and combined it with more general information from the scientific literature to infer salmonid response to the proposed project. In several instances, we make reasonable inferences that rely mainly on information in the scientific literature, because local data are not available.

For our analysis we searched for all existing literature pertaining to physical and biological dynamics of California estuaries and other estuaries with Mediterranean climates. We then subjected our analysis to an academic peer review described in the consultation history and requested references to any additional scientific reports that might elucidate the effects of current estuarine management activities on physical and biological conditions in the estuary. To address instream flow issues within Dry Creek and the mainstem Russian River, we requested that SCWA conduct a state of the art study involving the Instream Flow Incremental Methodology (Annear *et al.* 2004). As described in the Effects section VI.F, we ultimately agreed to examine habitat-flow relations using an intensive, quantitative Demonstration Flow Assessment (Annear *et al.* 2004; Railsback and Kadvany 2008).

Because we make reasoned inferences from the best available information, we do not address uncertainty in a rigorous quantitative sense in this biological opinion. For example, we assume that recent data on fish abundance in the action area is roughly accurate. We do not provide quantitative measures of uncertainty for these data such as error bars, confidence intervals, or standard deviations because: 1) in some cases the data available were obtained in a manner that does not allow for accurate quantification of these types of uncertainty, and 2) our use of this data does not require such precise measure of uncertainty. We often use fish abundance data to determine if relatively large or small numbers of listed salmonids are present in different portions of the action area. We assume that uncertainty in the data is not so great as to invalidate our relative comparisons of abundance. We support this assumption with information on the current

condition of habitat in which the species reside. We assume species abundance in areas with poor habitat conditions is likely to be low.

When we address uncertainty in our analyses, we apply that portion of section 7(a)(2) which dictates that action agencies are to "insure" that their actions are not likely to jeopardize the continued existence of listed species or adversely modify designated critical habitat. In other words, action agencies are charged with avoiding conclusions that there was no effect when, in fact, there was an effect.

The need to minimize the potential for this type of error results in providing the benefit of the doubt to the species. This approach is supported by the 1979 Congressional Record created when Congress amended the ESA to allow the Services to develop their biological opinions using the best information currently available or that can be developed during the consultation and concluded that the language "continues to give the benefit of the doubt to the species, and it would continue to place the burden on the action agency to demonstrate to the consulting agency that its action will not violate Section 7(a)(2)."[2]

In addition to the assumptions described above, NMFS relied on other key assumptions when assessing effects of the proposed action on listed salmonids and their critical habitat. Several assumptions are described elsewhere in this opinion; however, the following assumptions have considerable importance in our ability to analyze effects of the proposed action. If new information indicates an assumption is invalid, the Corps, SCWA, and NMFS may be required to re-assess effects of the proposed action on SONCC coho salmon and their critical habitat and reinitiation of consultation may be warranted.

1. Water Temperatures Limiting Steelhead Distribution in the Main Stem

Based on limited data, we assumed that water temperatures in the mainstem Russian River during July, August, and September are, in general, naturally too warm to support rearing juvenile steelhead between Cloverdale and the river's estuary (near the mouth of Austin Creek). We recognize that juvenile steelhead are occasionally seen in this segment, but we assume these are "dropdown fish" from tributaries and that coldwater refuges (*e.g.*, groundwater seeps) are few in number and that numbers of rearing juvenile steelhead in this segment are negligible during mid to late summer.

2. Russian River Estuary

Because local data on the Russian River estuary are limited, and historical data almost non-existent, we utilized data from other California estuaries and lagoons to help us evaluate the impacts of breaching the sand bar at the estuary's mouth. Our key assumption in this analysis is that with reduced inflow and without artificial breaching, in the spring and summer the estuary would likely naturally form a perched or closed lagoon that in many years would contain a highly productive environment for rearing juvenile steelhead (mostly freshwater, high food supplies, *etc*.). We assume that with current minimum flows, water levels can be managed to form a perched lagoon. Both of these assumptions are based on the documented formation of

[2] U.S House of Representatives Conference Report No. 697, 96th Congress, 2d Session 12. 1979.

perched or closed lagoons at river mouths on the coast of California, success in creating a perched lagoon via construction of an overflow channel across the bar at the mouth of the Carmel River, and other sources of information. Our reasoning is further described in the *Environmental Baseline, Effects of the Proposed Action, and Reasonable and Prudent Alternative.*

3. Global Climate Change

The acceptance of global climate change as a scientifically valid and anthropogenic driven phenomenon has been well established by the United Nations Framework Convention on Climate Change (UNFCCC), the Intergovernmental Panel on Climate Change, and others (Davies *et al.* 2001; Watson *et al.* 2001; Walther *et al*. 2002; UNFCCC 2006). The most relevant trend in global climate change is the warming of the atmosphere from increased greenhouse gas emissions. This warming is inseparably linked to the oceans, the biosphere, and the world's water cycle. Changes in the distribution and abundance of a wide array of biota confirm a warming trend is in progress, and that it has great potential to affect species' survival (Davies *et al.* 2001; Schneider and Root 2002). In general, as the magnitude of climate fluctuations increases, the population extinction rate also increases (Good *et al*. 2005). Global warming is likely to manifest itself differently in different regions. For example, in California, the California Energy Commission predicts an increase in the frequency of critically dry years (Cayan *et al.* 2006). Future climate change may therefore substantially increase risk to the species by exacerbating dry conditions.

In our analysis, the key assumptions we make about global climate change is that local impacts from this phenomenon, although ongoing, will be limited and difficult to predict during the next fifteen years. In general, natural climate variability within a ten year period is more prominent than the impacts of global warming (Cox and Stephenson 2007). While progress is being made on forecasting changes likely from climate change within the next ten years at global and large regional scales (Smith *et al.* 2007), predicting impacts on more local geographic areas in short time frames such as the fifteen years of this proposed project remain elusive.

Smith *et al.* (2007) predict that natural variability will partially offset the impacts of global climate change during the years 2005-2014. However, they predict the warming trend will continue, and at the global scale at least half of the years from 2010 to 2014 are likely to be warmer than 1998, one of the warmest years on record. Local impacts may not follow global trends. For example, a recent article in the Press Democrat reports the incidence of high temperatures in the Ukiah Valley (which includes a large portion of the mainstem Russian River) has decreased during the last 50 years, while the incidence of high temperatures in Napa Valley have increased (Press Democrat, August 4, 2008). This information suggests that climate change may actually be decreasing the incidence of high temperatures in the vicinity of the Russian River. Due to the absence of peer reviewed climate change models linking global temperature changes to the Russian River watershed, we cannot confidently project cooler temperatures in the Ukiah Valley forward for the next fifteen years. Based on the best available information, we cannot reliably predict if any water temperature increase (or decrease) will occur in the Russian River watershed during the next fifteen years due to global climate change.

In most instances in this biological opinion we used recent data (within the previous 10 to 15 years), to predict future stream flows, estuary bar breaching, and other conditions affected by the proposed project. We make the assumption that these data sets are representative of conditions likely to occur during the next fifteen years, because global climate change is unlikely to result in dramatic changes to local environmental conditions during this period. In addition, we assume any changes resulting from global climate change that have already occurred (such as the cooling in the Ukiah Valley) are captured by the previous 10 to 15 years of data we used and are reflected in current habitat conditions.

C. Ecological Conceptual Framework

As described above, the regulations implementing section 7(a)(2) of the ESA direct NMFS to assess proposed project impacts on species and critical habitat in order to determine whether the proposed project will not appreciably reduce the species' likelihood of survival and recovery or result in the destruction or adverse modification of critical habitat. In our biological opinions, NMFS conducts two separate but related analyses to make these determinations.

1. Critical Habitat

The basis of our critical habitat analysis is to evaluate whether the proposed project affects the function and role of the critical habitat for the conservation of the species. As a result, our analysis is organized around the structure of the habitat to be conserved. To do this, we use a hierarchical model that includes: 1) the primary constituent elements (PCEs) of critical habitat (spawning habitat, rearing habitat, freshwater migration corridors, *etc*.) and the habitat attributes that make up each PCE (such as spawning gravel quality or pool depth) for each salmonid life history stage, 2) the critical habitat within the stream reach or river, larger watershed areas, and whole watersheds, and 3) critical habitat in the geographic areas used by diversity strata[3] and then 4) the whole critical habitat designation.

The first step in our critical habitat analysis is to identify the PCEs of critical habitat in each ESU or DPS and diagnose their role in the conservation of each species and their current condition for supporting that role. We do this by identifying PCEs for each species based on guidance from critical habitat designations, and identifying the habitat attributes that make up each PCE for each salmonid life history stage. For example, we determined that the rearing PCE for CCC coho salmon is made up of the following habitat attributes: proximity to redds, complexity/cover, pool area and depth, water temperatures, and stream flows.

Once we diagnose the current condition of PCEs by diversity strata, we integrate this information to determine the current condition of critical habitat for supporting species conservation at the ESU or DPS level. We also identify the factors likely contributing to the current condition of critical habitat.

The next step is to analyze the current condition of PCEs in the action area for this proposed project. We did this by dividing the action area into four sub-areas: the Russian River

[3] Groups of populations of a species that inhabit areas with similar environmental and ecological background conditions. A more comprehensive definition is available in the Status of the Species section.

mainstem, Dry Creek, the Russian River Estuary, and Zone 1A (several Russian River tributaries where channel maintenance work will occur). We then describe the current conditions of PCEs in these areas and the factors likely contributing to those conditions. We also describe the relationship between important PCEs in the action area and the entire designated critical habitat with respect to the conservation of the listed species.

After determining the current condition of PCEs in the action area, we determine if these PCEs are likely to be affected by the proposed action and how any effects will influence the function of PCEs in the habitat units or areas affected. To do this, we use an exposure and response framework to identify what PCEs of critical habitat in the action area will likely experience as a result of the proposed action. We first identify the environmental "stressors" (physical, chemical, or biotic) directly or indirectly caused by the proposed action to which PCEs would be exposed. Next, we evaluate the likely response of PCEs to these stressors, based on the best available scientific and commercial information, and using an approach where severity increases along a continuum. For example, a project that releases water into the salmonid rearing PCE in an action area may increase water velocities within the PCE, potentially degrading the condition of the rearing habitat if high current velocities would hinder juveniles from feeding. If water velocities are high enough, juveniles may be prevented from feeding. If water velocities are higher still, the rearing habitat may become unusable because juveniles cannot swim against the current and would likely be swept downstream.

The proposed action has several complex components which may affect different PCE attributes in different areas, and information regarding the likely effects of some components is limited. Therefore, we used different approaches within our exposure and response framework to evaluate effects on different PCEs in the same area, and the same PCEs in different habitat areas. For example, we used the results of a Demonstration Flow Assessment conducted in 2001 to determine how the proposed project will impact the PCE of summer rearing habitat for juvenile coho salmon and steelhead in the mainstem of the Russian River and Dry Creek. In contrast, in Zone 1A, we used a process of qualitative identification of likely effects to the PCE of juvenile steelhead summer rearing habitat based on information from the scientific literature regarding the likely impacts of habitat simplification on salmonids.

Once we determine the effects of the proposed action on PCEs in the action area, we evaluate whether these impacts will affect the current ability of critical habitat to remain functional or retain its current ability for PCEs to be functionally established (NMFS 2005a). We did this by evaluating the project effects to PCEs in the action area when added to the environmental baseline and the importance of PCEs in the action area to the conservation of the species within the affected diversity starta and then the ESU or DPS. We did this with consideration of any cumulative effects to PCEs from future, non-federal actions that are reasonably certain to occur. If our assessment indicates that the action does affect critical habitat's ability to remain functional or establish functioning PCEs, or if we cannot determine that the action does not have that effect, we conclude that the action agency has not insured the action is not likely to result in the destruction or adverse modification of critical habitat.

2. Species

Similar to our critical habitat approach, we use a hierarchical conceptual model to evaluate project impacts on a species likelihood of survival and recovery. The model is based on a hierarchical organization of individual fish, population unit, diversity stratum (a group of populations), and the ESU or DPS (the species level group of diversity strata). The guiding principle behind this conceptual model is that the likelihood of survival and recovery of a species is dependent on the likelihood of survival and recovery of populations in each diversity strata that comprise that species; and the likelihood of survival and recovery of each population unit is dependent upon the fitness (growth, survival, or reproductive success) of the individuals that comprise that population.

Our use of this conceptual model incorporated the concept of Viable Salmonid Populations (VSP), which provides a framework for conducting Pacific salmonid risk assessments (McElhany *et al*. 2000). For Pacific Salmonids, viability is the state in which extinction risk of a population is negligible over 100 years and full evolutionary potential is retained (McElhany *et al*. 2000). We equate a species' "extinction risk" with the "likelihood of both the survival and recovery of the species" in the wild for purposes of conducting jeopardy analyses under section 7(a)(2) of the ESA. A species with a high extinction risk has a low likelihood of survival and recovery. A species with a low extinction risk has a high likelihood of survival and recovery. Our assessment focuses on whether a proposed action appreciably increases extinction risk[4], which is a surrogate for appreciable reductions in the likelihood of survival and recovery.

In our analysis, a viable salmonid population is an independent salmonid population that has negligible extinction risk and long-term persistence (over a 100 year time frame), which is consistent with recovery objectives. We begin our analysis by evaluating the current status of the species to diagnose how near, or far, the species is from this viable state. For that, we use the VSP framework and standard life history concepts. Four principal VSP parameters are used to evaluate the risk of extinction for the populations of salmonids affected by this proposed project: abundance, population growth rate (productivity), population spatial structure, and population diversity. These specific parameters are important to consider because they are predictors of population viability, and the parameters reflect general biological and ecological processes that are critical to the growth and survival of salmon populations (McElhany *et al*. 2000). Within this framework, NMFS considers the impacts of risk factors such as climate change and ocean conditions. Our analysis of species status concludes with our opinion as to the level of extinction risk the species faces. Similar to a species with a low likelihood of survival and recovery, a species with a high extinction risk does not equate to a species that does not have the potential to survive and recover. Instead, "high extinction risk" indicates that the species faces significant risks that can drive a species to extinction.. The results of the viability analysis serve as the current "benchmark" of species condition to which we add the impacts of the proposed project.

[4] We note that our use of extinction risk is generally non-quantitative. Spence *et al*. 2008 use a more quantitative definition for extinction risk that includes effective population size per generation and population viability analysis. Like Spence *et al*. 2008, we found we could not apply rigorous quantitative estimates of extinction risk to these species due to the limited data available.

To determine the impacts of the proposed project, we first examine the impacts of the project on the fitness of individuals in the action area, using the exposure and response framework described above to identify what individual salmonids will likely experience as a result of the proposed action. We first identify the environmental "stressors" (physical, chemical, or biotic) directly or indirectly caused by the proposed action to which salmonids would be exposed. Next, we evaluate the likely response of salmonids to these stressors, based on the best available scientific and commercial information, and using an approach where severity increases along a continuum. The ends of the continuum are bounded by no response at one end and death at the other. In between are such responses as startle, temporary cessation of feeding, minor injury, reduced growth, reduced reproductive success, *etc.* Importantly, we utilize the information from our critical habitat analysis on the current condition of PCEs in the action area, and the likely impacts of the proposed project on those PCEs, to help us determine what salmonids are exposed to, and how they are likely to respond.

Once fitness impacts on individuals are assessed, NMFS determines if these impacts are likely to affect the population(s) to which these individuals belong. For that, we use the VSP framework and standard life history concepts. Standard life history concepts are used to assess the impacts at a particular life history stage on the population's abundance, growth rate, distribution, and diversity (The VSP parameters discussed above). For example, if a proposed project results in the death of juvenile salmonids, NMFS will assess the impact of the amount of loss at this life history stage to the population's abundance, growth rate, distribution, and diversity. This analysis includes consideration of the condition of critical habitat used by the population.

We use the VSP population parameters (abundance, growth rate, spatial structure, and diversity), and Spence *et al.*'s 2008 ESU/DPS level criteria, as surrogates for numbers, reproduction, and distribution, the criteria found within the regulatory definition of jeopardy (50 CFR 402.02). For example, the first three VSP parameters are used as surrogates for numbers, reproduction, and distribution. We relate the fourth VSP parameter, diversity, to all three regulatory criteria. Numbers, reproduction, and distribution are all affected when genetic or life history variability is lost or constrained resulting in reduced population resilience to environmental variation at local or landscape-level scales. Similarly, Spence *et al.*'s (2008) ESU/DPS criteria address the viability of populations that make up an ESU or DPS via groups of populations called diversity strata. For example, ESU/DPS criteria for redundancy and connectivity assess whether or not the distribution of populations within diversity strata maintains connectivity (gene flow via straying) among populations within the strata and between that stratum and neighboring strata.

Consistent with our hierarchical approach, we determine if effects of the proposed action were likely to impact salmonid population numbers, growth rate, distribution, or diversity, and if any resultant changes to these parameters were likely to affect population extinction risk. We do this with consideration of the impacts of cumulative effects both in the action area and at the strata and ESU or DPS scales. If population extinction risk is likely to be increased, we assess whether this increase is likely to negatively affect ESU or DPS extinction risk by reducing the ability of the population's diversity stratum to support a viable ESU or DPS. If no increase in a population's extinction risk is expected, we conclude that the diversity stratum, and therefore the ESU or DPS, are not appreciably affected by the proposed action. Conversely, if we determine that a proposed project is likely to increase a population's extinction risk, or that we cannot

determine that the project is not increasing a population's extinction risk, we consider whether the risk of extinction of the ESU or DPS is likely to increase as a result. NMFS uses the ESU/DPS-level criteria (representation, redundancy, and connectivity) for the North-Central California Coast Recovery Domain provided by Spence *et al.* (2008) and described in the **Status of the Species and Critical Habitat** section of this biological opinion to determine if the population's extinction risk increase will increase the species' extinction risk. Our determination looks at the population's role in meeting the representation, redundancy, and connectivity criteria for the species and assesses the consequences of population extinction on the risk of extinction of the species.

II. CONSULTATION HISTORY

NMFS, the Corps, and the SCWA entered into a Memorandum of Understanding (MOU) on December 31, 1997. The purpose of the MOU was to establish a framework for a section 7 consultation under the ESA for existing operations and actions carried out by the Corps, SCWA, and the MCRRFCD. Existing actions to be covered in the Section 7 consultation are described in Section 3 of the MOU; they include CVD and WSD operations, hatchery operations, channel maintenance actions, water diversions, estuary management, channel maintenance in the Zone (1A) area of Santa Rosa and Rohnert Park, and water transmission within Sonoma County. The Corps, SCWA, and the MCRRFCD had been operating facilities for flood control, water supply and hydroelectric energy for many years before the three salmonid species in the Russian River were listed under the ESA. Starting with the listing of coho salmon in 1996 (61 FR 56138), the SCWA and the Corps engaged NMFS in preconsultation technical assistance to evaluate the potential risk to coho salmon from those operations and facilities.

After the MOU was signed in December 1997, the signatory agencies established an Executive Committee for the consultation, consisting of representatives of each of the signatory agencies, as well as representatives from the MCRRFCD and the CDFG. The Executive Committee has met regularly since 1998 and is responsible for all major shared policy decisions regarding the consultation.

Recognizing the regional significance of the consultation to fisheries resources and the communities affected by changes in operations, and based on public interest in the consultation, the signatory agencies also established a Public Policy Facilitating Committee (PPFC) to provide updates to the public regarding the progress of the consultation, and to receive input from the public. Public participation is not required for a Section 7 interagency consultation under the ESA, but it was included in the Russian River Section 7 consultation by the Executive Committee. Nineteen PPFC meetings were conducted between April 1998 and November 2004. Public comments were taken at these meetings and were considered by the Corps, and the SCWA during preparation of the Biological Assessment (BA).

The Executive Committee also established an Agency Working Group for the consultation, which included representatives from SCWA, the Corps, NMFS, CDFG, MCRRFCD, and the Regional Water Quality Control Board. The Agency Working Group met regularly to discuss the analyses for the BA for the consultation.

In 1999, SCWA contracted with Entrix Inc.(Entrix) to prepare the BA for the consultation, along with any necessary supporting documents. Entrix prepared an interim report for each of eight subject areas of the consultation describing existing facilities and operations and the resulting impacts to salmonids. The reports included:

Report Number	Report Topic	Report Date
Interim Report 1	Flood Control Operations	August 18, 2000
Interim Report 2	Fish Facility Operations	April 28, 2000
Interim Report 3	Flow-Related Habitat	April 5, 2002
Interim Report 4	Water Supply and Diversion Facilities	January 12, 2001
Interim Report 5	Channel Maintenance	May 11, 2001
Interim Report 6	Restoration and Conservation Actions	May 11, 2001
Interim Report 7	Hydroelectric Projects Operations	August 18, 2000
Interim Report 8	Russian River Estuary Management Plan	January 12, 2001

As part of the evaluation of existing operations, and as part of evaluating potential future alternatives, the Executive Committee approved a study of certain flow rates during the dry season. In September and October 2001, a flow-habitat study was conducted concurrent with flow reductions for the Corps's pre-flood inspections at CVD and WSD. A group of professional fisheries biologists from the represented agencies, as well as the consultant, Entrix, evaluated salmonid habitat at various locations of Dry Creek and the Russian River. Three flow release rates for each stream were evaluated by the team of biologists. A full discussion of the workscope history and results of the flow-habitat study is included in the Effects Section VI.F.1.

When all of the interim reports were complete, Entrix worked with representatives of the Agency Working Group to identify potential alternatives for facilities and operations that had been identified as having potential impacts for listed salmon species in the Russian River. When a range of alternatives was identified, two reports were prepared to describe alternatives and present recommendations for the alternatives that would be provided to the Executive Committee for consideration of modifying the project description. One report dealt with potential changes to minimum flow requirements in the main stem Russian River and Dry Creek (February 3, 2003), and the other report (September 13, 2002) dealt with all of the other subject areas.

Following completion of the Alternatives reports, Entrix, in concert with the Corps and SCWA, incorporated the recommended alternatives into the project description for the BA, and conducted an analysis of the impacts of the proposed actions (including proposed alternatives to reduce impacts) on listed fish species. On June 13, 2003, Entrix produced part 1 of the draft BA, which included the project description and status of the species. Entrix completed the full draft BA on January 16, 2004, and the final BA on September 29, 2004. As described in that BA, the proposed project would significantly change flow releases from WSD and CVD, including a low-flow proposal for the main stem Russian River with changes in minimum stream flows.

Following completion of the BA, the Executive Committee and the Agency Working Group continued to meet to discuss outstanding issues in the consultation (*e.g.*, the need for more data before requesting a change in the minimum flows required in the Russian River and Dry Creek

per SWRCB Decision 1610). NMFS provided comments on the BA to the Corps and SCWA on June 27, 2005, and requested additional information in certain areas. The SCWA and the Corps provided the additional information on July 5, 2006.

The parties to the Section 7 consultation discussed the need for obtaining more data before addressing potential changes in flow management on the main stem Russian River and Dry Creek. In the interest of ensuring ESA compliance for existing facilities and operations, NMFS agreed to prepare a biological opinion for existing facilities and operations (see Chapter 3 of the BA), with minor changes to operation of Mirabel Dam and channel maintenance, and including the hatchery programs, as specified in Chapter 4 of the BA and/or described below. On May 4, 2006, the Corps submitted a letter to NMFS requesting formal consultation and listing the facilities and operations to be included in the project description.

NMFS transmitted a draft biological opinion to the Corps and SCWA on June 11, 2007. The draft opinion indicated that the operation of the existing facilities were likely to jeopardize the species and adversely modify critical habitat for CCC coho salmon and CCC steelhead. NMFS did not provide any draft reasonable and prudent alternatives. Instead, NMFS invited the Corps and SCWA to work collaboratively with NMFS on the development of project changes necessary to avoid jeopardy and adverse modification, and meet the other requirements of 50 CFR 402.14 (g)(5) and 402.02.

Subsequent to the issuance of the draft biological opinion, NMFS contacted the Center for Independent Experts (CIE)[5] to initiate outside peer review of the estuary analysis in the draft biological opinion. NMFS sought outside review because of the limited amount of peer reviewed scientific literature, commercial data, and other information available on salmonid use of California estuaries for rearing in the summer and fall.

NMFS received written comments from the Corps on September 14, 2007, and from SCWA on January 17, 2008. In October, November, and December of 2007, as well as January, February, and March of 2008, NMFS met with the Corps and/or SCWA to develop the components of a reasonable and prudent alternative (RPA) to the proposed project.

On March 28, 2008, NMFS received the final CIE Independent Peer Review reports. Two of the three reviewers indicated that the draft biological opinion made a scientifically credible argument and/or provided reasonable support that high flows to the estuary coupled with artificial breaching degrade steelhead rearing habitat (Largier 2008, Marston, 2008). A third reviewer provided additional support that the project adversely affects estuary habitat, however, he indicated the draft opinion's conclusion that the estuary would convert to a freshwater lagoon if not breached was not well supported (Bradford 2008). The comments of the reviewers have been considered and addressed as appropriate in this final biological opinion.

CDFG participated in the review of the June 11, 2007 draft biological opinion; CDFG also provided input in the development of the draft RPA for purposes of reaching a "consistency

[5] The CIE is part of the Rosentiel School of Marine and Atmospheric Science at the University of Miami. Its goal is to "provide both independent and expert reviews of the science necessary for the management of marine fisheries resources that are under the purview of the National Oceanic and Atmospheric Administration (NOAA) Fisheries."

determination" that the project will be implemented consistent with the California Endangered Species Act (CESA). Work on the RPA was largely completed by early April 2008.

During work on the RPA, the Corps, SCWA, and NMFS determined that a major component of the RPA would take up to fifteen years to complete. The remediation of project impacts to designated critical habitat in Dry Creek would take 12 to 15 years to accomplish. NMFS transmitted a working draft biological opinion to the Corps and SCWA on August 1, 2008, and indicated that the timeframe for analysis of the original proposed project would need to be changed from ten years to fifteen years (NMFS 2008b). NMFS also indicated in transmitting the working draft that the RPA did not ensure that resulting project operations would not likely jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. Because the project's impact on critical habitat could not be fully addressed in a ten year period, NMFS, the Corps, and SCWA agreed to amend the period of the proposed project from ten to fifteen years (Russian River Project Executive Committee Meeting August 4, 2008). The RPA's approaches to addressing impacts to critical habitat were also discussed between SCWA and NMFS and modified subsequent to the August 1, 2008 working draft.

NMFS received additional comments on the working draft biological opinion from SCWA and the Corps on August 22, 2008. These comments were incorporated as appropriate. A complete administrative record of this consultation is on file at the NMFS Santa Rosa Office, 777 Sonoma Avenue, Santa Rosa, California 95404.

III. DESCRIPTION OF THE PROPOSED ACTION

A. Overview

This biological opinion analyzes the effects of the Russian River Water Supply and Flood Control Project (Project), operated or authorized by the Corps, on ESA-listed threatened and endangered salmonid species within the Russian River watershed. The Project includes operation of two dams and appurtenant facilities in the Russian River watershed. Together, the facilities are operated to control flooding within the watershed, to supply water to users within and outside the watershed, and to generate hydroelectric power. The altered flow regimes caused by the Project change the natural hydrology of the Russian River estuary, and artificial breaching of the sandbar is often required to prevent flooding adjacent to the estuary. In addition, the Project includes the operation of two fish hatchery facilities, and channel maintenance activities that keep the water delivery system functional and reduce the impacts of flooding in the mainstem and some tributaries of the Russian River. SCWA's scope of maintenance responsibilities covered under this Biological Opinion include maintenance of stream channels and small reservoirs in an area that SCWA terms Zone 1A, which consists of the Laguna de Santa Rosa and Mark West Creek watersheds, as well as maintenance activities on the Russian River main stem and the segment of Dry Creek downstream from WSD. The Corps maintenance activities include safety inspections at the two dams. In addition, MCRRFCD conducts channel maintenance activities related to the CVD in the Mendocino County portion of the Russian River. Channel maintenance by both counties is related to Federal sites and inspection of levees under Public Law 84-99 (non Federal) sites, but this consultation does not include implementation of the current Corps Operations and Maintenance manual for channel maintenance in the Russian River watershed. Instead, NMFS is consulting on channel maintenance practices as described below and referenced to the BA where appropriate.

In this Biological Opinion NMFS analyzes the implementation of the current operations of the Project for the next fifteen years. Fifteen years of current operations has been chosen due to future Russian River flow regime alternatives being considered by the Corps and SCWA. These agencies are working together to evaluate the impacts of flow regime changes on water supply, fisheries, recreation, and other uses and resources of the Russian River watershed. Potential water supply and stream flow regulation alternatives under consideration by these agencies cannot be fully analyzed based on the limited available information at this point in time. The Corps, SCWA, and NMFS agreed that it was prudent to evaluate project affects for the next fifteen year period because future changes in water supply operations contemplated by SCWA would likely take fifteen years to fully analyze and develop permits, water rights agreements/decisions that may affect additional water rights and related flow changes in the Russian River and Dry Creek.

The water supply and flood control elements of the Project involve the regulation of flood flows to control flooding in properties adjacent to the Russian River, and the storage of water in two reservoirs to be released for water supply in Sonoma, Mendocino, and Marin counties during the spring, summer, and fall. The water flows from the reservoirs down the main stem Russian River and Dry Creek to diversion points downstream of the dams. Part of the water stays in the river channels and flows into the Pacific Ocean at the river's mouth near Jenner. The diverted

water is delivered to end-users for municipal industrial, agricultural, and domestic uses. The keystone elements of the project are CVD, near the headwaters of the Russian, and WSD on Dry Creek, a main tributary of the Russian River. Russian River water is released from Lake Mendocino (the reservoir formed by CVD) for flood control, and, under the requirements of Decision 1610 (D1610), for water supply. Water released from Lake Sonoma (the reservoir formed by the WSD) is also released for flood control and water supply. D1610 set forth by SWRCB establishes minimum flow requirements for Dry Creek and the Russian River. Minimum stream flows under D1610 are specified for four different reaches in the Russian River watershed, assuring high enough summer flows to meet the diversion requirements as well as river-based recreational uses.

Lake Mendocino was created by the construction of CVD on the East Branch of the Russian River in 1958. The lake has a surface area of 1,922 acres (122,400 acre feet). The earthen dam, built and maintained by the Corps, is 160 feet high and 3,500 feet long. The project was developed to provide flood control, water for municipal, industrial, and agricultural uses, hydroelectric power, and recreational opportunities. The CVFF was constructed in 1992 at the base of CVD to mitigate for the loss of salmonid habitat upstream of the dam and the related loss of salmonid production.

Lake Sonoma was created by the construction of WSD on Dry Creek in 1983. The dam's purposes are flood control, and water delivery for industrial and municipal uses, and recreation. When full, the lake has a surface area of more than 3,600 acres (381,000 acre feet) and 50 miles of shoreline. At the time of construction, the DCFH was built at the base of WSD to mitigate for the elimination of fish habitat in the upper Dry Creek watershed and the related loss of salmonid production. The operation and programmatic purpose of the hatchery has changed to a more adaptive program since its inception. There have been operational changes towards salmonid conservation and recovery to further enhance mitigation goals and to fulfill the Corps obligation under Section 7 (a)(1) of the ESA. The current operation is described later in this document.

In addition to the two major dams in the Russian River watershed, there are several small storage reservoirs, levees, temporary dams, and other elements of the system that contribute to accomplishing the water supply and flood control goals of the Project and are discussed in subsequent sections of this consultation.

B. Project Elements

This section describes the specific Project elements that will be analyzed below in the Effects of the Action section.

1. Non-flood Water Supply Releases

D1610 of the State Water Resources Control Board (Board) requires SCWA, under its water right permits, to maintain minimum stream flows throughout specific reaches on the Russian River and Dry Creek. Minimum stream flows under D1610, summarized in Figure 1 are specified for four different reaches in the Russian River watershed: the East Branch Russian River from CVD to the confluence with the main stem, the main stem Russian River between the

East Branch Confluence and Dry Creek, the main stem Russian River between Dry Creek and the mouth, and Dry Creek downstream of WSD to the confluence with the Russian River.

Under D1610, required minimum flows in both the upper and lower Russian River vary depending upon defined water supply condition (Figure 1). Water supply condition is determined based on the cumulative inflow to Lake Pillsbury on the first of each month between January and June and is represented as *critically dry*, *dry*, or *normal*. The water supply condition can vary from month to month until June 1 when it becomes set until the following January. Because of the minimum flow requirements of D1610 in the Russian River and Dry Creek, SCWA must release additional flows above those necessary for municipal water supply.

Within the *normal* water supply condition, there is an alternate schedule commonly referred to as the *dry spring* criteria that is dependent upon the total combined storage in Lake Mendocino and Lake Pillsbury on May 31 of each year. The *dry spring* time water supply criteria affect releases from Lake Mendocino. These criteria allow reductions in minimum flows for the main stem Russian River when the combined storage falls below 90 percent and 80 percent of the combined capacities of Lake Pillsbury and Lake Mendocino. This provision reflects the “flashy” hydrology of the basin and the fact that the water supply is dependent on not only the quantity of runoff, but also the timing of runoff. Flood control operations do not allow conservation of winter runoff so fully filling the water supply pool requires spring runoff. Of the 90 water years simulated by the SCWA, approximately 11 percent of years consist of *dry spring* water supply conditions from June through December. *Dry spring* conditions do not apply to the January through May period.

The instream flow requirements for the Russian River downstream from its confluence with Dry Creek during *normal* water supply conditions were based primarily on a desire to maintain flows upon which the recreational industry on the Russian River had previously developed. The reduced minimum instream flow requirements for *dry* and *critically dry* water supply conditions were determined in consideration of warmwater fish species (such as smallmouth bass - *Micropterus dolomieu*) and wildlife needs, particularly for the lower portion of the Russian River. Salmonid needs were not considered. D1610 indicates that the required flows are beneficial for fish species, but that the flow releases to benefit fisheries can be reauthorized after D1610 was in place. D1610 states that "We (the Board) reserve jurisdiction to amend SCWA's permit if a fishery study is conducted which shows that a different flow schedule would be better, or if further evidence otherwise becomes available which may affect the minimum flows".

In 2002, NMFS issued a biological opinion on the Federal Regulatory Energy Commission’s (FERC) proposed license amendment for the operation of the Potter Valley Project. The biological opinion analyzed the effects on ESA-listed salmon and steelhead associated with the proposed operational changes and determined that the proposed amendment would cause jeopardy to listed salmon and steelhead in the Eel River (NMFS 2002). The biological opinion provided a reasonable and prudent alternative that reduces the historic annual average diversion from the Eel River to the Russian River at Potter Valley, requiring FERC to require the licensee to notify the State Water Resources Control Board so the board can assess the efficacy of D1610 (NMFS 2002). In January 2004, FERC issued an amended license for the Potter Valley Project

that incorporated the reasonable prudent alternative contained in the NMFS 2002 biological opinion.

The flow requirements for Dry Creek were based on the CDFG instream flow needs investigation performed in 1975 and 1976 (Barraco 1977). These requirements were developed to meet the fish spawning, passage, and rearing needs as determined by CDFG at that time. These flows were to sustain the native fish populations below WSD, to enhance steelhead and salmon spawning and nursery habitat in Dry Creek, and to facilitate operations of the DCFH at WSD.

Under current demand, during a normal summer, SCWA must release close to, and occasionally exceed, 300 cubic feet per second (cfs) from Lake Mendocino to allow for water supply demands above Healdsburg and still meet the 185 cfs minimum currently required by D1610 at Healdsburg. During the summer months, flow release targets are at least 10 to 20 cfs above the minimum flows at Healdsburg to ensure that instream flow requirements are met regardless of fluctuating demands. Because a change in release at Lake Mendocino may take 4 days to appear at Healdsburg, changes in demand must be anticipated several days in advance.

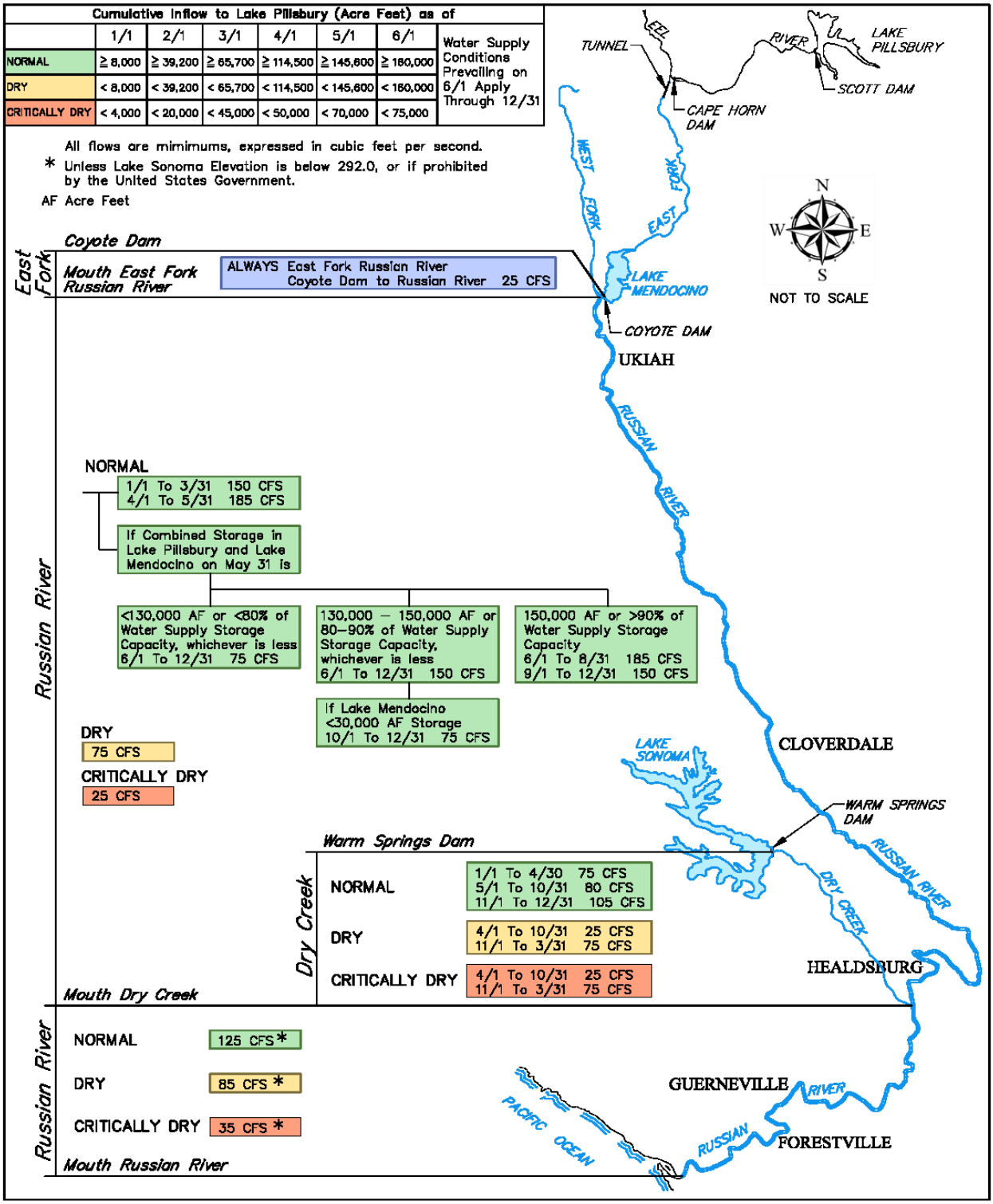

Figure 1. D1610 Russian River Basin Streamflow Requirements.

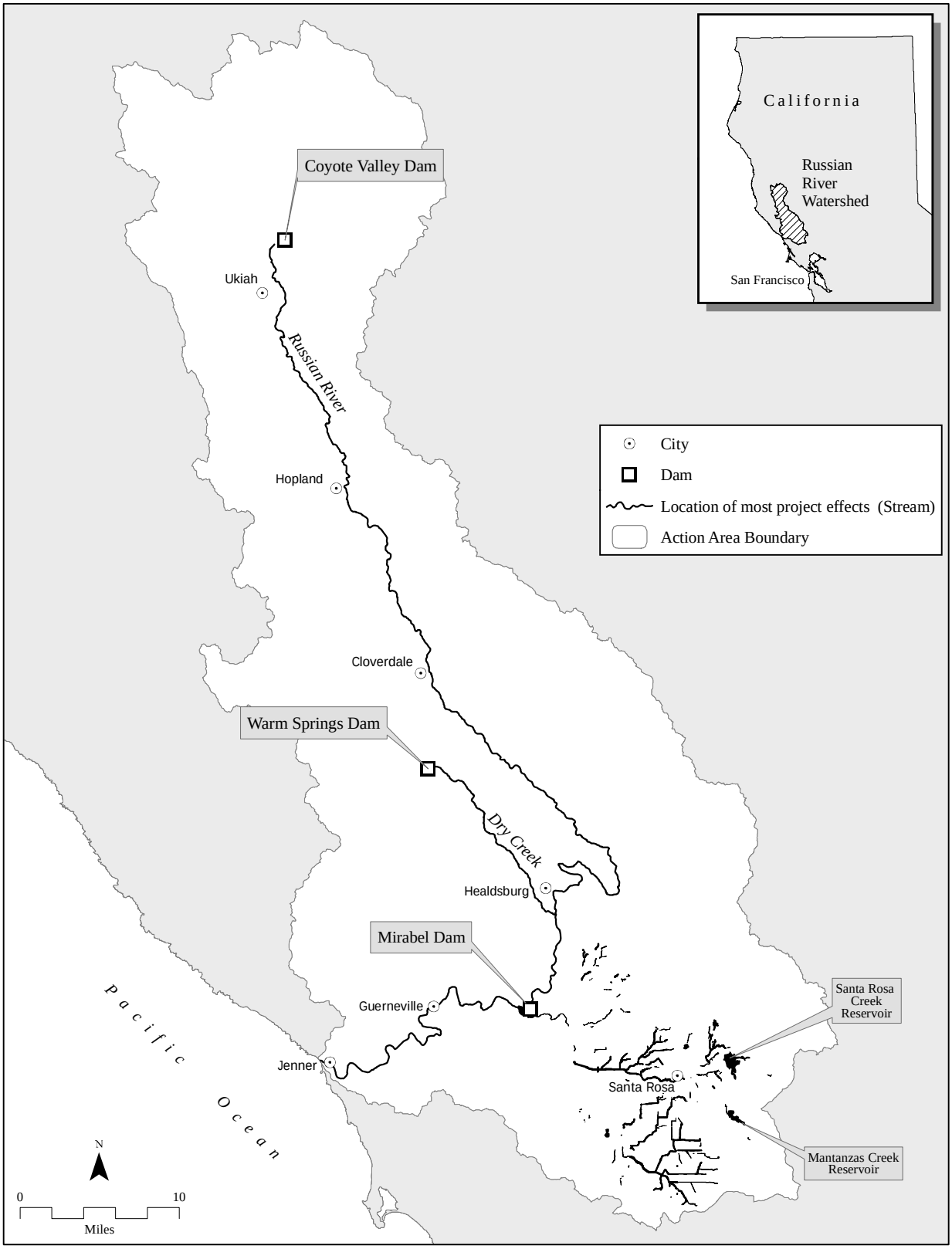

Figure 2. Main Action Area Streams. Action area includes all streams in Russian River watershed accessible to steelhead.

2. Estuary Management

NMFS completed a biological opinion on May 20, 2005, for issuance of a Corps 404 permit authorizing the SCWA to conduct breaching actions at the mouth of the Russian River from 2005 through 2009. This biological opinion will supersede the May 20, 2005, biological opinion.

The Russian River estuary is located near the town of Jenner, California. To breach it, SCWA will periodically excavate a pilot channel across the lowest point of the sand bar at the mouth of the Russian River when the estuary elevation rises to a point where low lying properties are threatened with flooding. The breaching actions will likely take place 4 to 11 times per year for the next fifteen years. SCWA will breach the sandbar with a bulldozer or excavator, allowing the estuary water to flow into the Pacific Ocean.

a. Breaching Criteria

The sandbar will be breached when water levels in the estuary are between 4.5 and 7.0 ft in elevation. SCWA's goal is to breach before water levels reach 7.0 ft at the Jenner gauge. Water levels are determined from an automated tide recorder[6] located at the Jenner Visitor's Center near the mouth of the Russian River (Corps and SCWA 2004). The maximum water elevation (7.0 ft) was selected to prevent flooding of property, minimize the potential for discharge of anoxic water from the Willow Creek Marsh into the estuary when the estuary is breached at high water levels, and to avoid high flushing velocities caused by high water elevations in the estuary prior to breaching.

b. Breaching Operations

The sandbar will be accessed from the paved parking lot at Goat Rock State Beach located at the end of Goat Rock Road off of Highway 1. Equipment (a bulldozer) will be off-loaded at the parking lot and driven onto the beach via an existing access point. A pilot channel will be created in the sandbar at a sufficient depth to allow river flows to begin transporting sand to the ocean. While the channel is dug, it will remain disconnected from the estuary by a portion of the sand bar to allow construction equipment to avoid flowing water. Excavated sand will be placed on the beach adjacent to the pilot channel. This excavation work will usually generate up to 1,000 cubic yards of sand, sidecast onto the sand bar below the high tide line (NMFS 2005). Once the channel is complete, the remaining portion of the sandbar will be removed by heavy equipment allowing the river water to flow to the ocean. The size of the resulting pilot channel varies depending on the height of the sand bar to be breached, the tide level, and the elevation of the estuary at the time of breaching. Typically, the breaching work proposed will result in a pilot channel approximately 100 ft long by 25 ft wide and 6 to 8 ft deep (Corps and SCWA 2004, NMFS 2005).

[6] Data from the tide recorder is displayed at the SCWA's Operations Center in Santa Rosa by remote telemetry.

c. Breaching Timing

The breaching schedule varies from year to year depending on the frequency of the closure of the Russian River mouth. As noted above, the periodic breaching is likely to occur from 4 to 11 times per year, based on data from past breaching events (Corps and SCWA 2004). Breaching can occur during any month of the year, though it most frequently occurs in the spring and fall. The following events or conditions are likely to result in breaching (Corps and SCWA 2004):

- If the estuary is closed to the ocean in mid-October, water releases from Lake Mendocino and Lake Sonoma for flood control will likely result in the need to breach.
- If the estuary is closed in the spring when late rain storms occur that are likely to raise water levels over 8.0 ft.
- D1610 water releases during the summer are expected to require estuary breaching to prevent flooding.
- Dry winters may result in the need for breaching if the mouth closes in the winter and rainstorms are imminent.

From 1996 through 2007, most breaching occurred in the late summer and fall, with spring breaching occurring in 8 out of 12 years (Table 26).

3. Channel Maintenance Actions

SCWA conducts channel maintenance activities in the Russian River and its tributaries for the purposes of flood and erosion control. SCWA's scope of responsibilities in the Sonoma County portion of the Russian River watershed include activities related to the Central Sonoma Watershed Project, portions of various creeks in Zone 1A, a large portion of the Russian River main stem in Sonoma County, and portions of Dry Creek below WSD. The Central Sonoma Watershed Project includes five flood protection reservoirs and constructed flood control channels that were built in the late 1960s to reduce flooding in the Santa Rosa area. The channels and reservoirs in this project are contained within SCWA's geographic Zone 1A (*i.e*, the Laguna de Santa Rosa and Mark West Creek watersheds). The areas along the main stem Russian River maintained by the SCWA include the sites originally constructed by the Corps as a response to anticipated changes to channel morphology following construction of WSD and CVD, and Public Law 84-99 sites. The MCRRFCD conducts channel maintenance and erosion control activities related to the Coyote Valley Dam Project (CVDP) in Mendocino County that encompass a large portion of mainstem Russian River. This includes channel maintenance related to Federal sites and inspection of levees under Public Law 84-99 (nonfederal) sites.

a. Channel Maintenance in the Mainstem Russian River and Dry Creek

SCWA and MCRRFCD propose to continue to conduct bank stabilization activities, gravel bar grading, and vegetation and debris removal activities in the mainstem Russian River in Sonoma and Mendocino counties, respectively. SCWA will also continue to maintain bank stabilization

sites in Dry Creek. These activities are conducted under Corps oversight[7]. SCWA's and MCRRFCD's bank stabilization activities on the Russian River mainstem will be limited to maintenance of past channel flood control improvement projects, including Public Law 84-99 for which the counties have assumed responsibility. In addition to maintaining channel flood control improvements installed for CVD and WSD, SCWA and MCRRFCD will continue to inspect and maintain channel flood control sites that were constructed between 1956 and 1963. SCWA also assists property owners with Public Law 84-99 sites. Where property owners agree to follow the methods and measures provided in the BA (Corps and SCWA 2004) to limit impacts to salmonids and their habitats, work done at these sites will be included as part of the proposed project. SCWA will then include these sites in the total length limits described below for channel maintenance activities in the mainstem Russian River.

Russian River. In general, SCWA and MCRRFCD will grade instream gravel bars that may be impeding flow, and inspect and maintain approximately 21 channel flood control improvement sites. Typical maintenance activities for channel improvement sites in the mainstem Russian River are similar to those on Dry Creek (see below), and include removing loose anchor jacks from the river, repairing and replacing loose grout or riprap, adding bank erosion protection at sites found to be eroding, and managing vegetation and removing flood debris to reduce blockage of the river channel that is causing bank erosion or preventing inspection of channel improvement sites.

MCRRFCD will perform stream bank maintenance consisting of obstacle[8] removal, stream bank repair, and preventive maintenance over a 36-mile reach of the Russian River in Mendocino County from the county line north of Cloverdale upstream along the river north to the town of Calpella. The MCRRFCD also is responsible for any channel maintenance actions in the East Branch Russian below CVD downstream to the confluence with the Russian River, a one mile reach (B.Spazek, MCRRFCD, personal communication 2007). SCWA will maintain a 22-mile reach from river mile 41 near the confluence of Maacama Creek upstream along the Russian River to river mile 63 just north of Cloverdale, including minor work at PL 84-99 sites. In addition, SCWA will, if necessary, repair failing banks at Mirabel and Riverfront Park.

No more than four maintenance sites are proposed for work in each county during the summer months. Each site will be limited in size and typically no more than 1,000 feet of maintenance work along the Russian River is expected for each county during any given year (Ron Benkert, SCWA, personal communication, 2-5-2008). As much as 2,000 feet of work may be done in any given year, with no more than 15,000 feet done in each county during the fifteen year project period (B. Spacek, MCRRFCD, personal communication, 2-8-2008). Channel Maintenance that may be performed at these sites includes:

[7] For example, the Corps inspects these sites in the Russian River and Dry Creek and indicates the amount and type of work that may be needed at each site. The most recent inspection was conducted in 1999 (Corps and SCWA 2001)

[8] Any in-channel obstacle which causes the stream to be directed into the riverbank. Typically the obstacles removed would be old jacks. However, MCRRFCD may remove LWD when it spans the channel (B. Spacek, MCRRFCD, personal communication, 5-7-08).

(1). Gravel Bar and Overflow Channel Maintenance in the Main stem Russian River

Certain conditions may warrant some degree of gravel bar grading. Grading activities may be conducted if one or more of these conditions exist:

-Occurrence of severe bank erosion.
-Recent substantial changes in channel morphology likely to lead to severe bank erosion.
-Evidence of weakened levees.
-Threats of flooding to infrastructure or private property.

SCWA and MCRRFCD will implement protocols described in the BA (Corps and SCWA 2004) to limit the potential for negative effects on salmonids or their habitat. For example:

-Gravel bar grading will only occur between July 1 and October 1.
-A buffer of at least 25 feet or 10 percent of the maximum bar width, whichever is less,will be maintained along the edge of the low flow channel, whether vegetation is present or not.
-The elevation of post graded bars will be at least 1.5 feet higher than the elevation of the edge of the low flow channel
-Sediment will be contoured to create a slope that runs up and away from the centerline of the main low-flow channel that is at least a 2 percent grade from the water surface elevation at low flow, or baseline elevation at the water surface, whichever is higher.
-Large woody debris removed or extracted will be placed either on the upstream buffer area or along the low flow channel buffer where it can be redistributed in the high flows of the next rainy season. If it poses a risk to property, it may be anchored or placed elsewhere in the river.

(2) Vegetation Maintenance in the Mainstem Russian River

Under the proposed Project, MCRRFCD will continue to perform vegetation maintenance to control bank erosion. Vegetation can be removed from river banks, levees, or gravel bars that contribute to bank erosion, consistent with protocols described in the BA (Corps and SCWA 2004) that limit the potential for negative effects on salmonids or their habitat. For example:

-Vegetation removal will occur outside of a 25 foot buffer zone next to the low-flow channel.
-Vegetation within the buffer will be cropped (mowed).
-In channels that are wider than 200 feet, a vegetated buffer of no less than 50 feet will be maintained.
- All vegetation removal work will occur during low flows, between July 1 and October 1.
-Native vegetation that is removed will be relocated to the extent possible.

Vegetation maintenance work may be conducted if one or more of these conditions exist:

-Encroachment by Giant Reed *(Arundo donax)* or other exotic pest plant species.

-Occurrence of severe bank erosion.
-Recent substantial changes in channel morphology that are likely to lead to severe bank erosion.
-Evidence of weakened levees.
-Threats of flooding to infrastructure or private property.

SCWA manages vegetation on the bed or banks of the Russian River from the Mendocino County line downstream to just above the confluence with Brooks Creek several miles upstream of the City of Headsburg, and several miles of the lower river just upstream from the estuary (as shown on Figure 3-5 in Corps and SCWA (2004). In these locations, SCWA manages the Russian River mainstem as a natural waterway. This management approach is described below in the Zone 1A description.

(3) Site-Specific Bank Stabilization in the Russian River.

Past channel maintenance areas, including those identified in the Corps Maintenance Manual for Dry Creek and Mainstem Channel Improvements, where frequent and/or extensive channel maintenance actions are required to prevent bank erosion will be identified. These sites may be candidates for bank stabilization projects by SCWA and MCRRFCD during the next fifteen years.

In addition, SCWA will conduct bank stabilization projects in the Mirabel or Riverfront Park sites in response to flood damage. SCWA anticipates flood damage may occur two to three times during the 15 year duration of the BO. When needed, this bank work will be included in the amount of work per year anticipated above (*i.e.*, the length of banks worked for these projects will be subtracted from 2,000 feet, leaving a smaller length of other bank work that may be done that year). Unless damage necessitates emergency repairs, remediation of bank failures will entail isolation and dewatering of the site using coffer dams. To avoid impacts to listed salmonids, fish would be removed from the site and construction would occur between July 1 and August 15.

Bank stabilization techniques employed by SCWA will favor a bioengineering approach with rock rip-rap placed only at the toe of banks upslope to the ordinary high water line. Any such project would heavily feature native vegetation re-planted on fill that is protected by erosion control fabric. Bank stabilization activities conducted by MCRRFCD will follow the methods described below for Dry Creek (*Methods 5 - 15*).

Dry Creek. SCWA Channel maintenance activities on Dry Creek are mostly limited to maintaining Corps channel flood control improvements at 15 locations that were installed to prevent bank erosion following construction of WSD. The total length of these sites is 5,800 feet and includes rock banks (3180 feet) and board fences (1600 feet). Other sites include concrete weirs, concrete sills and one rock sill and bank. There were no lengths provided for these other sites (Table 1).

Under the proposed project, SCWA will continue to maintain these 15 channel flood control improvement sites. Maintenance work associated with these sites can involve incidental

sediment removal, vegetation removal, removal of debris, and bank stabilization. Vegetation removal will only occur to improve bank stability if trees are leaning or otherwise directing high flows against the bank, causing erosion, and/or to visually inspect a bank stabilization structure. Bank stabilization work typically will involve replacing lost riprap and, if necessary, regrading the bank slope to its previous contours in order to provide a stable base for the riprap. SCWA anticipates that bank stabilization work will be limited to 10% per year of the total length of the 15 sites (Ron Benkert, SCWA, personal communication, 2-5-2008). Riparian vegetation on the channel banks and bars will be left in place, if not threatening bank stability, to maintain shade for aquatic habitat. The BMPs used in natural waterways described below (in *b. Zone 1A*) will apply to maintenance practices on Dry Creek as well.

Table 1. Channel improvement sites on Dry Creek. Source: Corps and SCWA 2004.

Site	Type	Length (feet)
1	Rock Bank	600
2	Rock Bank	750
3	Board Fence	700
4	Rock Bank	200
5	Concrete Weir	
6	Rock Bank	450
7	Board Fence	900
8	Rock Bank	480
9	Concrete Weir	
10	½ Rock Sill and Bank	
11	Rock Bank	200
12	Concrete Sill	
13	Concrete Sill	
14	Concrete Sill	
15	Rock Bank	500

Some of these sites only require annual inspections while others may require repair. The methods of repair for these sites are described below.

The following is the Corps and SCWA (2004) description of the methods of bank repair in Dry Creek:

"Standardized maintenance methods and BMPs have been developed in conjunction with the Bay Area Storm Water Management Agencies Association (BASMAA) to minimize negative environmental effects (SCWA 1996b). (Method numbers not discussed in this section apply to sediment and debris removal, vegetation control, or activities in constructed channels)."

"*Method 5*: A dump truck, or excavator with an extended arm, is used to repair rock riprap or place rock in areas of slope undercutting, scour hole or bank slope erosion. Rock is dumped directly on the bank from a dump truck. If the face of the slope has eroded, the excavator digs a 2- to 3-foot-deep trench at the toe of the bank for the width of the eroded area. The excavating

equipment places 2 to 3 feet of rock into the toe, and rock riprap is placed up the bank from the toe. Smaller rock may be dumped to fill voids in the larger riprap.

Method 6 is used to repair large and long erosion areas. In addition to activities in Method 5, the excavating equipment may fill the area farthest from the channel slope with native soil or road-base shale and then compact the area. Rock riprap is placed up the band from the toe. Smaller rock may be dumped to fill the voids.

Method 7: Erosion areas around culverts are repaired by excavating the trench containing the culvert with excavating equipment, dumping sand, or native soil on the bank, and then using the excavating equipment to place the material into the trench. Portable compactors compact the fill. Six inches of road base is dumped into the excavated area and compacted using a roller/compactor.

Method 9: Dirt or rock access roads are repaired by dumping dirt or rock from a dump truck over the areas of road, spreading the material with a grader, and using a roller/compactor to compact the surface.

Method 10: Undercut pipe outfalls are repaired by replacing rock in scour holes below the pipe and reshaping the channel to direct flows away from the affected areas. If the erosion is deep, Method 6 is applied.

Method 11: Grouted rock is repaired by clearing the area of broken or damaged material with an excavator with an extended arm or a backhoe operated from the service road. Bank disturbance is kept to a minimum because equipment is not operated on the bank. Deeply eroded areas are repaired if necessary with Method 6. Rock riprap is placed on the bank of the stream channel bottom with Method 5 and grouted with ready-mix concrete from a shoot or a concrete pump.

Method 12: Minor underlining of a lined channel is repaired by accessing the area behind the lining from the top of the bank using hand tools or a backhoe to open a small access. A concrete/sand slurry ready mix would be distributed using a shoot or a concrete pumper.

Method 13: Major undermining repair would be contracted out. Historically, significant undermining has not occurred.

Method 15: When drop structures or check dams are repaired, water is diverted around the affected area. Isolation from flow would minimize sediment input and direct injury to fish. If the diversion is large, a dozer with a blade brings in or moves on-site material for construction of a berm or diversion dam.

b. Zone 1A

There are two types of channels managed by the SCWA in Zone 1A: constructed flood control channels and natural waterways. Most of the creeks in this zone are managed as both constructed flood control channels and natural waterways (Table 2). The upper portions of the creeks are usually managed as natural waterways and the lower portions, found in the more

urban areas, are typically constructed flood control channels. The activities implemented by SCWA for flood control purposes in the Zone 1A area (see Figure 3) include sediment removal, channel debris clearing, vegetation maintenance, and bank stabilization (on natural waterways only).

Constructed flood control channels (many of which are part of the Central Sonoma Watershed Project) are channels that have been altered (mainly by widening and straightening) based on flood control criteria. The purpose of the alterations is to increase hydraulic capacity. These channels have been straightened and in some places lined with concrete or riprap, converting the channel shape to a trapezoid. Also, these streams have been disconnected from their floodplains.

Natural waterways are waterways that have not recently been modified for flood control purposes by SCWA or USACE. Between 1958 and 1983 some of the natural waterways were straightened, shaped and stabilized. Regular maintenance on natural channels was historically performed with the objective of maximizing the hydraulic capacity without enlarging the channels. In the 1980's, SCWA staff would use heavy equipment and hand crews with chainsaws to clear vegetation from the bottom of natural channels. The use of heavy equipment ended in 1987, with clearing continuing to be performed by four-man crews using hand labor.

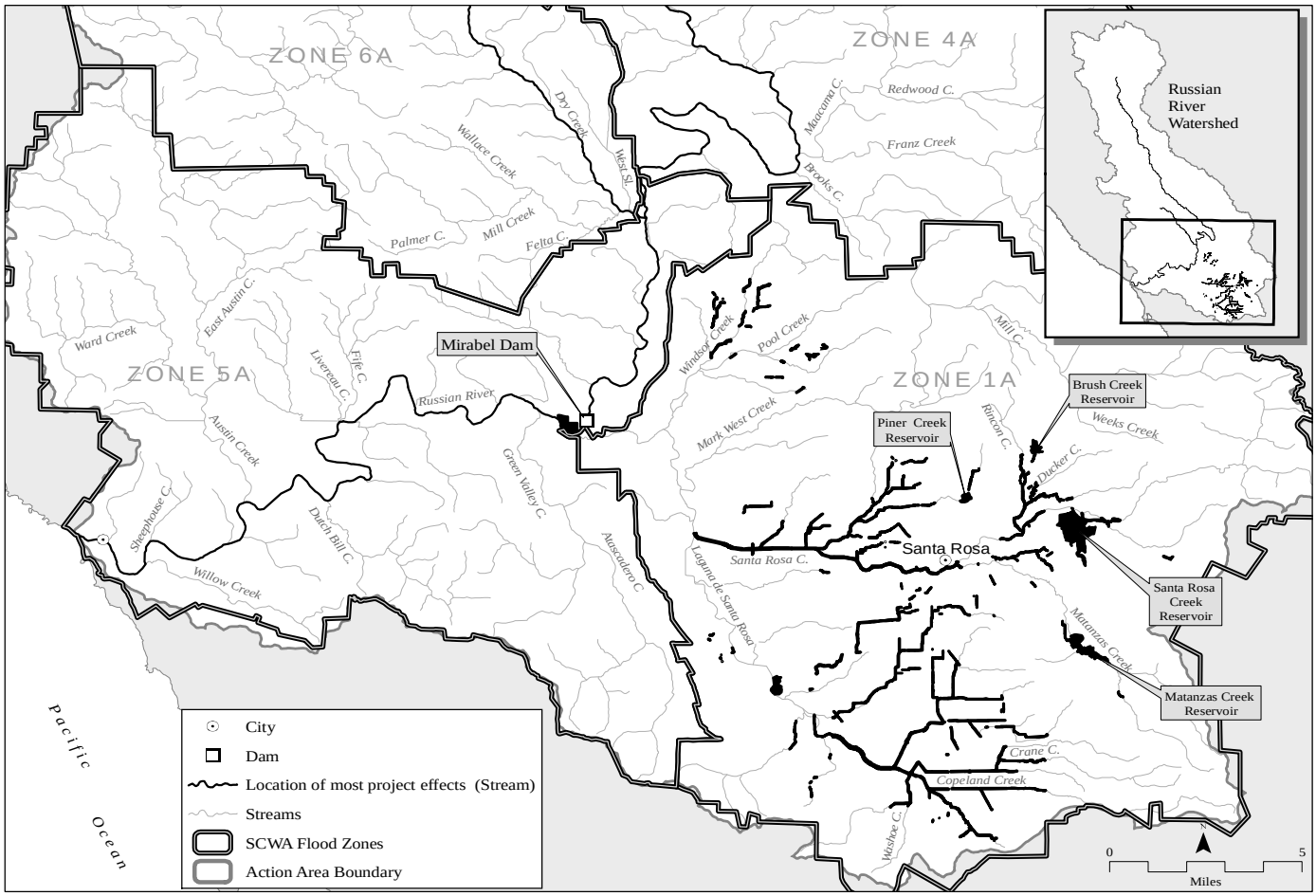

Figure 3. Detail of Action Area for Lower Russian River and Zone 1A

Table 2. Streams in Zone 1A where SCWA has proposed channel maintenance activities. F = flood control channels; N = natural waterways; S = known to contain steelhead (Corps and SCWA 2004, NMFS 2005d, CDFG 2006d). Streams are placed in three geographic groups: Rohnert Park – Cotati area streams, Santa Rosa Creek and its tributaries, and tributaries of Mark West Creek downstream of the confluence with the Laguna de Santa Rosa. Note: some streams have both channel types. Source: Modified from Corps and SCWA 2004.

Rohnert Park-Cotati Area		**Santa Rosa Creek**		**Mark West Creek**	
Blucher Creek	N, S	Austin Creek	F,S	Airport Creek	F
Coleman Creek	F, N, S	Brush Creek	F, S	Faught Creek	F
Colgan Creek	F, N	College Creek	F	Redwood Creek	F
Copeland Creek	F, N, S	Ducker Creek	F	Starr Creek	F
Cook Creek	F	Forestview Creek	F	Windsor Creek	F, N, S
Cotati Creek	F	Fountain Grove	N		
Crane Creek	F, N, S	Hood Mountain	N		
Five Creek	F	Indian Creek	F		
Gossage Creek	F, N	Lornadell Creek	F		
Hessel Creek	N	Matanzas Creek	N, S		
Hinebaugh Creek	F, S	Oakmont Creek	F, S		
Hunter Lane Channel	F	Paulin Creek	F, N, S		
Kawana Creek	F	Peterson Creek	F, S		
Laguna de Santa Rosa	F, N, S	Piner Creek	F, N, S		
Moorland Creek	F	Rinconada Creek	F, S		
Roseland Creek	F, N	Russel Creek	F		
Spivok Creek	F	Santa Rosa Creek	F, N, S		
Todd Creek	N	Sierra Park Creek	F, S		
Washoe Creek	N	Spring Creek	F, N, S		
Wilfred Creek	F, N	Steele Creek	F, N		
		Wendell Creek	F		

In addition to constructed flood control channels and natural waterways (discussed in the following section), SCWA maintains four flood control reservoirs built in the late 1960s to reduce flooding in the Santa Rosa area. Part of the Central Sonoma Watershed Project, these four flood control reservoirs are located on Santa Rosa, Brush, Paulin, and Matanzas creeks. The Santa Rosa Creek Reservoir (Spring Lake) is located off-stream. A diversion structure at the inlet allows relatively low flows to bypass the reservoir, routing the flow downstream into Santa Rosa Creek, while a portion of the higher flows are diverted into the reservoir. A diversion structure on Spring Creek also diverts water to Spring Lake. Spring Lake drains back to Santa Rosa Creek through a stand pipe when water levels become too high. Other than the Santa Rosa Creek Reservoir, the other flood control reservoirs are situated on-stream and are equipped with facilities (low-flow bypass and principal spillway) that allow minimum streamflows to be released. All of these reservoirs operate passively and are not equipped with flood control gates.

Facilities are not provided for anadromous fish passage above the in-stream flood control reservoirs or the diversion on Spring Creek. However, a fish ladder and vortex weir are located on Santa Rosa Creek to assist anadromous fish passage around Spring Lake.

Sediment removal and vegetation removal activities are necessary to maintain channel capacity and control stream bank erosion. Many of the constructed flood control channels maintained by the SCWA were designed to provide 100-year-flood capacity. The original design capacity assumed that stream banks will be predominantly grass, with little or no tree growth, and the streambed will be maintained clear of vegetation and sediment.

Under the proposed project, SCWA will continue to conduct channel maintenance activities within constructed flood control channels and natural waterways in Zone 1A, and maintain the four flood control reservoirs described above. Because emergency channel maintenance actions may occur when adult and smolt salmonids are in streams, and because the frequency and magnitude of these actions cannot be reliably estimated, NMFS is not addressing emergency actions in this biological opinion that occur during times when adult and smolt salmonids may be present in streams (November 1 through June 14). These emergency actions will need to be addressed by the Corps and SCWA through the separate emergency consultation procedures available under section 7 of the ESA.

Constructed Flood Control Channels in Zone 1A. Excessive sediments tend to be deposited during winter and spring flows at locations where the channel gradient significantly decreases and as the channel traverses from the steep gradient headwaters to the low-gradient valley plain. In these areas, and others, vegetation can also reduce channel capacity. Sediment and vegetation removal are conducted on an as-needed basis. For example, some of the constructed flood control channels require annual sediment removal, some require sediment removal less frequently, and some have never required sediment removal. Culverts (box culverts and metal culverts), culvert outfalls, and bridges also may require sediment removal.

These channels generally have service roads to facilitate maintenance access. SCWA will schedule stream sediment removal when field inspections indicate that the invert elevation of outfall structures is generally less than 12 inches above the streambed elevation. Sediment removal will be performed during summer or fall months until October 31. Only segments of constructed flood control channels that have become hydraulically impaired will have sediment removed. Sediment removal will consist of 1) excavation of bars that have accumulated bed material and have become enlarged by deposition over time, and 2) removal of sediment at road crossings and culvert outfalls.

A hydraulic assessment of selected Zone 1A constructed flood control channels was performed in 2000 to identify flood capacity under various vegetation management scenarios (Entrix 2002). The hydraulic assessment showed that for many of the channels, moderately dense shrubby vegetative growth with young developing willows (approximately 5 years old) on portions of the stream bank, and tule growth on the streambed, will cause impairment of hydraulic capacity, so that the 100-year flood might not be contained. To maintain original-design-flood capacity in these channels, SCWA will keep vegetation from growing into a dense brushy stage. Should the amount of vegetation in these channels be greater than that described above, these channels will likely not be able to accommodate the flows necessary to prevent floods.

Since the early 1990s, access roads have been cleared with aquatic contact herbicides (which are effective only at the time of application [*i.e.*, early spring]) and mowing. SCWA uses a truck

mounted tank and spray bar to apply Aquamaster® (EPA Reg. No. 524-343). The spray bar is eight feet wide and set one foot above the road surface to minimize drift. For road applications, the surfactant Agri-Dex®, Cal. Reg No. 5905-50094-AA, is added to the herbicide. The concentration is 1.5 gallons of Aquamaster® per 100 gallons of water. The concentration of Agri-Dex® is 0.5 gallons per100 gallons of water. Spraying occurs during the early morning hours and is discontinued if wind speed exceeds 5 mph (SCWA 2008a).

(1) Sediment Maintenance and Channel Debris Clearing Practices. Sediment removal will be conducted with excavators with extended arms, and in some areas, with bulldozers and front-end loaders as well. Excavating equipment with a reach appropriate for the channel being cleared will be used. The equipment will be driven along the access road, and sediment removal will be done perpendicular to the channel length. Bulldozers will be used in high width/depth ratio channels where excavators cannot reach the channel bottom from the service road. A bulldozer will stockpile sediment to a closer area and then stockpiles will be removed with an excavator.

Before large woody debris is to be removed, it will be evaluated by SCWA staff. If it is determined to be stable (*i.e.*, not likely to be dislodged, washed downstream, and threaten the integrity of a structure), it will be left in place. For example, a piece of large woody debris was left in place on Brush Creek recently because it was downstream of the Highway 12 bridge and was not in a position to float downstream and cause a debris jam at any bridges. Loose pieces of large woody debris may be anchored in place if found in an area where they are not likely to pose a threat. If large woody debris appears in a constructed channel in downtown Santa Rosa, particularly if it is 20 feet or longer, it is likely to become lodged at a bridge and create a blockage. Large woody debris presenting this kind of threat to infrastructure will be removed. If large woody debris is determined to pose a hazard, it will be removed in consultation with CDFG and NMFS. Large woody debris will be removed with a winch from the top of the bank, cut up with chain saws, and transported away. Brush will be chipped and put on landscaped areas.

(2) Sediment removal at road crossings and culvert outfalls. Removing sediment from culverts (metal and concrete box), under bridges, and transition areas near these road crossings will typically be accomplished with small sized construction equipment (a Bobcat or powershovel, for example) working within the structure or channel. The in-channel equipment will move material to an excavator positioned at the top of the bank. Sediment will then be transferred to a dump truck for offsite disposal. Transition areas will typically extend 25-50 feet upstream and downstream from the structure, depending on the volume of material being removed.

Removing sediment at culvert outfalls will involve the the use of a backhoe at the top of a channel bank to extract accumulated sediment within 5 to 10 feet adjacent to the outfall. Similar to sediment removal at road crossings, sediment removed from outfalls will be disposed off-site. Sediment removal at road crossings and culvert outfalls will be done during the summers when streambeds are dry.

(3) Vegetation Maintenance Zones. To manage vegetation in constructed flood control channels, SCWA has apportioned the vegetation maintenance activities into five “zones”: top-of-bank, upper channel bank, middle channel bank, lower channel bank, and the channel bottom. Maintenance activities in top-of-bank and upper channel are consistent among all constructed

flood control channels. Maintenance activities in the lower three zones (middle, lower channel bank and channel bottom) will vary depending on channel capacity and flood risk.

- **Top-of-Bank**. The top-of-bank zone maintenance includes:

  -landscape maintenance
  -fence/gate maintenance
  -V-ditch and drop inlet maintenance
  -service road maintenance

- ***Upper, Middle, and Lower Banks.*** The upper and middle channel bank zones typically consist of the upper two-thirds of the channel bank (which is generally everything above 5 feet higher than the channel bed). The lower channel bank zone comprises the area in the lower third of the channel bank (typically lower than approximately 5 feet above the channel bed), including the toe of the channel.

(3) Vegetation Maintenance Levels

The level of vegetation maintenance applied will depend on the hydraulic capacity required in the constructed flood control channel. One of three vegetation management practices will be applied, maintenance of the original design capacity, intermediate vegetation maintenance, or mature riparian vegetation maintenance.

- ***Original Design Capacity Maintenance*.** In site-specific areas where the hydraulic assessment (Entrix 2002) indicates that simulated flows are near or just over-bank, vegetation will be maintained at the original-design-capacity scenario. Vegetation maintenance practices may include limiting vegetation on stream banks to predominantly grass with little or no woody stem growth; maintaining the channel bottom clear of vegetation; and frequent maintenance.

- ***Intermediate Vegetation Maintenance*.** Channel maintenance practices in the lower channel zone will consist of the removal of understory vegetation. Understory vegetation removal (*e.g*., blackberries) will be accomplished by hand-clearing and use of aquatic herbicides**.** Small, mechanized equipment may be used to transport the cut vegetation to the top-of-bank so that it may be efficiently removed from the channel. Removal of plants will be selective, based on the species present, with an emphasis on protecting native riparian species wherever possible. Native trees (typically willows) that are growing along the lower one-third of the bank, including the toe of the bank where it intersects the channel bed, will be allowed to colonize as young trees. Herbicides are applied directly to cut stumps below top of bank. A 100% concentration of Aquamaster® mixed with Turf Mark®, a blue dye spray indicator, is applied using a paint brush.

- ***Mature Riparian Vegetation Maintenance***. In some channels, complete canopy cover could be achieved by allowing the development of mature, single-trunk trees with most of the canopy above the floodway elevation. Native trees will be

maintained (*i.e.*, thinning or pruning) or planted. Vegetation at the channel toe and in the lower third of the bank will be maintained parallel with the flow and spaced 15 to 25 feet, depending on the species. Lower limbs will be pruned to maintain channel capacity. To achieve a mature canopy cover, adequate flood capacity must exist in the channel both during the period when young trees are growing within the floodway and at later mature stages when these trees have canopies that rise above the floodway elevation.

- ***Channel Bottom.*** The channel bottom of constructed flood control channels will be cleared of vegetation through the use of spray aquatic contact herbicides and hand clearing. Future selected vegetation clearing from the channel banks may be necessary to allow access to the channel bottoms for silt removal operations. Small, mechanized equipment may be used to transport the cut vegetation to the top-of-bank so that it may be efficiently removed from the channel. SCWA will utilize backpack sprayers containing Aquamaster® without a surfactant to control invasive non-native species. Backpack spraying would also help control established nuisance species such as cattails (*Typha sp*.) and blackberry (*Rubus sp*.) that compromise channel hydraulic capacity.

(4) Application of Vegetation Maintenance Levels in Constructed Flood Control Channels

Portions of some channels with potential salmonid habitat will require design-capacity maintenance practices. An adaptive management approach will be implemented to assess which channels may in the future have maintenance protocols that allow more vegetation to grow.

For bridges and culverts that do not have the capacity to pass the 100-year discharge under intermediate maintenance, it will be necessary to implement design capacity vegetation maintenance practices near the bridge structures. These may include removing all vegetation except grasses within approximately a distance equal to the channel top-width both upstream and downstream from the bridge.

Natural Waterways in Zone 1A. SCWA has hydraulic maintenance easements that are permissive, and SCWA will continue to access various natural creeks to remove debris (LWD and trash) or vegetation to restore hydraulic capacity. SCWA will not perform routine sediment removal activities in natural waterways. In addition, SCWA will not perform any flood control maintenance activities in the Mark West Creek mainstem or tributaries of Mark West Creek upstream of the confluence with its largest tributary, the Laguna de Santa Rosa. This latter area is the only portion of Zone 1A with high potential to support coho salmon.

SCWA has developed BMPs and other guidelines for planning and implementing sediment removal and bank stabilization work performed in natural waterways to protect listed species and to minimize the potential for significant habitat alterations. SCWA will continue to use the BMPs and guidelines summarized below:

-Bank stabilization projects are not to exceed 1,000 feet in length for any single project.
-Projects cannot occur within 1,000 feet of a previously armored site.
-Construction will occur during the summer to avoid salmonid spawning and incubation periods.

-A qualified fisheries biologist will consult on the project design prior to implementation to consider all feasible alternatives. Habitat and biological resources in the area will be evaluated.
-Projects will develop in consultation with CDFG.
-Bio-engineering bank stabilization methods will be given priority where they will provide effective erosion control.
-Where bio-engineering bank stabilization methods are not deemed to be practical, priority will be given to incorporating vegetative plantings into the hard-armoring techniques that are implemented.
-Fish habitat restoration elements (such as native material revetments) will be incorporated into bank stabilization practices where they are feasible with the intention of replacing lost habitat.
-Large woody debris will be removed from the channel only if it threatens to de-stabilize a section of stream bank.

(1). Vegetation Management Practices in Natural Waterways

For the natural channels within Zone 1A where vegetation removal may occur, SCWA does not have routine or regularly implemented maintenance obligations. Maintenance on natural waterways (Table 2) will consist of clearing vegetation from the bottom of natural waterways to restore hydraulic capacity. Hand labor is the typical clearing method. Heavy equipment will only be used to lift out or clear debris jams not accessible to hand crews.

Flood Control Reservoirs. Flood control reservoirs are designed to impound water during the rainy season to reduce the potential for flooding in downstream urbanizing areas. Brush Creek Reservoir (130-AF capacity), Piner Creek Reservoir (230-AF capacity), and Spring Creek diversion (negligible capacity) are relatively small reservoirs. Both Brush Creek Reservoir and Spring Creek reservoir typically dry up by the summer (B. Oller, SCWA, personal communication 2001). Matanzas and Spring Lake reservoirs have larger capacities (1,500 AF and 3,500 AF, respectively). Spring Lake is located offstream of Santa Rosa Creek and does not dry up or release water downstream during the summer. Matanzas Creek Reservoir is a flow through reservoir that does not impound water in the summer.

Maintenance activities in the flood control reservoirs include desiltation and removal of noxious pondweeds. Desiltation, debris removal, and vegetation removal will also be performed at the inlets and outfalls to the reservoirs. Sediments will be excavated to restore the flood control capacity.

4. <u>Reservoir Flood Control Operations - Coyote Valley Dam and Warm Springs Dam</u>

a. Coyote Valley Dam Flood Operations

The Corps' main objective for flood control releases from Lake Mendocino is to prevent flood flows on the East Fork Russian River from contributing to overbank flood stages on the Russian River below CVD, to the extent possible. The specific criteria for flood control operations are described in the Water Control Manual for Coyote Valley Dam (Corps 1986a). The general criteria for releases from the flood control pool call for successively increasing releases in three stages as reservoir levels rise toward the emergency spillway. The USGS Hopland stream gage, 14 miles downstream of CVD, is the most downstream monitoring point for decisions affecting

flood control releases from Lake Mendocino. The Corps limits releases from Lake Mendocino to prevent local flooding at Hopland that generally occurs when flows exceed 8,000 cfs. Because bank sloughing is likely to occur when flows decrease too rapidly, the Corps has imposed a maximum ramp down rate of 1,000 cfs per hour for Lake Mendocino.

The Corps has developed modified guidelines for the rates at which releases from WSD and CVD may be changed during flood control operations. The existing Water Control Manuals allow releases to be changed at up to 1,000 cfs per hour when outflows from the reservoir exceed 1,000 cfs. To protect spawning gravel and juvenile salmonids within the Russian River and Dry Creek, the Corps developed interim guidelines (Corps 1998) for release changes with technical assistance from NMFS and CDFG (Table 3).

Table 3. Maximum ramping rates for CVD and WSD.

Reservoir Outflow	Down Ramping	Up Ramping
0-250 cfs	25 cfs/hour	1000 cfs/hour
250-1,000 cfs	250 cfs/hour	1000 cfs/hour
>1,000 cfs	1,000 cfs/hour	2000 cfs/hour

The Corps follows the existing guidelines 90 percent of the time (P. Pugner, Corps, personal communication, 2000). More specific directions are included in Exhibit A of the CVD water control manual, entitled "Standing Instructions to Damtenders" (Coyote Valley Dam Standing Instructions). Operation for flood control is described by the Flood Control Diagram summarized in Exhibit A:

> *Flood Control Schedules 1, 2 and 3 releases are used to empty the flood control space following a storm. Under these schedules, releases will be limited to: (1) the discharge that does not cause the flow at the Russian River near Hopland to exceed 8,000 cfs, and (2) the discharge that results in flow at Hopland being less than that reached during the previous storm or storm series. The previous storm or storm series is defined as the events which caused the highest pool at Lake Mendocino. In addition, releases will be limited to (1) at least 2,000 cfs and up to a maximum of 4,000 cfs if the reservoir pool did not reach elevation 746.0 feet, (2) up to a maximum of 4,000 cfs if the highest reservoir pool reached was between elevation 746.0 feet and 755.0 feet, and (3) up to a maximum of 6,400 cfs if the pool exceeded elevation 755.0 feet. Releases will not be increased or decreased at a rate greater than 1,000 cfs per hour. Schedules 1, 2, and 3 are used if no significant rainfall is predicted.*
>
> *When the QPF[9] is 1 inch or more for the next 24 hours or 1/2 inch or more for any 6-hour period in the next 24 hours, outflow from the lake should be limited to 2,000 cfs or less to the extent possible, so that the release can be reduced to 25 cfs within 1-1/2 hours if necessary (includes 2 hours to travel to control tower and make first gate change). Also, when the flow in the Russian River at Ukiah*

[9]. The QPF (quantitative prediction forecast) is generated by the California Nevada River Forecast Center.

exceeds 2,500 cfs and is rising, releases from Lake Mendocino will be reduced to 25 cfs, insofar as possible.

Outlet gates may be used when the pool is above the spillway crest (elevation 764.8) for Flood Control Schedule 3 releases, however the sum of the spill and the releases must not exceed 6,400 cfs, subject to the above limitations.

The Emergency Release Schedule is used when the pool elevation is above 771.0 feet. Continue to follow the Emergency Release Schedule if the pool elevation is between 771.0 feet to 773.0 feet. At elevation 773 feet and above, the flood control gates are fully open. The flood control gates will remain fully open until the lake has receded below elevation 773 feet. If the pool is receding and is between elevation 773.0 feet and 771.0 feet, follow the Emergency Release Schedule. Flood Control Schedule 3 releases are made when the lake has receded below elevation 771.0 feet.

Discharge capacity from the reservoir, with all gates open, is 5,950 cfs when the water surface elevation (WSE) is at the bottom of the flood control pool (*i.e*., when the water WSE reaches the stage when the reservoir is converted from water supply operation to flood control operation), and 6,700 cfs at full pool. Releases above this level would require use of the spillway. The design discharge capacity of the spillway is 35,800 cfs.

b. Warm Springs Dam Flood Control Operations

The Corps' primary objective for flood control operation at Warm Springs Dam is to reduce peak flood discharges in Dry Creek and the Russian River below Healdsburg to the extent possible. Because of the long travel time for water flow between CVD and the Russian River/Dry Creek confluence, flood control operations at WSD are generally independent of the CVD operation; however, operations of the two facilities are coordinated to avoid downstream flooding. The criteria for flood control operation of Lake Sonoma are similar to those for Lake Mendocino, and are described in the Warm Springs Dam Water Control Manual (Corps 1984). As with Lake Mendocino, flood control includes three successive flood release schedules. For Lake Sonoma, the Hacienda gage near Guerneville, located 16 miles downstream of WSD, is the most downstream monitoring point for decisions affecting flood control releases from Lake Sonoma.

To the extent possible, the Corps manages releases from Lake Sonoma to limit flows on the Russian River at Guerneville to 35,000 cfs, which is the approximate channel capacity in Guerneville. The Corps also limits releases to prevent flooding downstream along Dry Creek, which generally occurs when flows just below the dam exceed 6,000 cfs. As with releases from Lake Mendocino, the Corps limits changes in releases to 1,000 cfs per hour to prevent downstream bank sloughing.

More specific directions are included in Exhibit A to the Warm Springs Dam Water Control Manual (Corps 1998b), entitled "Standing Instructions to Damtenders". Operation for flood control is described in the Flood Control Diagram that is summarized below:

Flood Control Schedule 1, 2, and 3 releases are used to empty the flood control space following a storm. Under these schedules, releases will be limited to: (1)

the discharge that does not cause the flow in the Russian River near Guerneville to exceed 35,000 cfs, and (2) the discharge that results in flow at Guerneville being less than that reached during the previous storm or storm series. The previous storm or storm series is defined as the event(s), which caused the highest pool at Lake Sonoma. In addition, releases will be limited to a maximum of: (1) 2,000 cfs if the reservoir pool did not reach elevation 456.7 feet, (2) 4,000 cfs if the highest reservoir pool reached was between elevation 456.7 feet and 468.9 feet, and (3) 6,000 cfs if the pool exceeded elevation 468.9 feet. Releases will not be increased or decreased at a rate greater than 1,000 cfs per hour. When the pool elevation is at or below 502.0 feet and inflow is at or above 5,000 cfs no gate releases will be made. Schedules 1, 2, and 3 are used only if no significant rainfall is forecasted.

Significant rain is forecasted when the QPF is 1 inch or more for the next 24 hours or ½ inch or more for any 6-hour period in the next 24 hours. Under this condition, outflow from the lake should be limited to 2,000 cfs or less to the extent possible, so that the release can be reduced to the minimum required flow within 1½ hours if necessary. The 1½ hours includes time to travel to the control tower and make the first gate change.
Flood Control Schedule 3 releases will be maintained until elevation 502.0 feet is reached by regulation of the outlet so that the combined flow from spills (pool above elevation 495.0 feet) and releases through the outlet works does not exceed 6,000 cfs.

The Emergency Release Schedule is used when the pool elevation is between 502.0 feet to 505.0 feet. At elevation 505 feet and above, the flood control gates will be fully opened. The flood control gates will remain fully open until the lake has receded below elevation 505 feet, at which time the Emergency Release Schedule is again implemented. When the lake has receded below elevation 502.0 feet, Flood Control Schedule 3 is implemented.

Because of the watershed's configuration above Lake Sonoma, direct measurement of reservoir inflow by stream gaging is impractical. Consequently, inflow is calculated as the algebraic sum of releases, changes in storage, and estimated evaporation.

Water is released from WSD for flood control purposes through the outlet works or through the spillway, which are located on the left abutment of the dam. The control structure accommodates multiple intakes that can be used to meet water quality requirements. Maximum discharge capacity of the outlet works is 8,100 cfs when the reservoir pool is at 513.1 feet above MSL. The spillway was designed for a discharge of 29,600 cfs, with the maximum reservoir pool elevation being 18 feet above the spillway crest.

c. CVD and WSD ramping rates

Working with NMFS and CDFG in 1998, the Corps evaluated ramping rates for flood control releases at CVD and WSD. The result of this coordination was "Interim Ramping Rates" that have been implemented since 1999 at both dams (see Table 3).

In the summer months when main stem Russian River and Dry Creek flows are predominately controlled by D1610, ramping rates are generally 25 cfs per hour (A. Mai, SCWA, personal communication, January 2006). The adjustments to reservoir releases are provided by SCWA to the Corps for WSD, and to the Northern California Power Agency (NCPA) for CVD to meet D1610 minimum flow requirements at Healdsburg, Guerneville, and Dry Creek.

d. Pre-Flood and Periodic Dam Inspections

*Coyote Valley Dam***.** Pre-flood inspections at CVD will be conducted annually, and occur on one day during the month of September for the fifteen year period under consultation. Periodic inspections occur once every five years. The inspections will involve ramping down flow releases from the dam to zero, a two-hour inspection period will occur with zero flow release, and then ramping up to normal operating flow (Table 4). Ramping down to the zero phase for inspections will not exceed a period of more than four hours. During this phase, the project will ramp down in increments of 25 to 50 cfs. During the zero flow release phase of the action, the Corps will inspect the 5 by 9-foot service and emergency gates, the 720-ft long steel-lined concrete conduit, and the facility outlet works. Other activities the Corps conducts on the day of the inspection will include inspection of the dam embankments,

Table 4. Typical schedule of release flows and various actions related to inspections of CVD. Source: Corps and SCWA 2004.

Time	Flow Release (cfs) from Coyote Valley Dam	Action	Flow Release (cfs) to East Branch Russian River from Coyote Valley Dam
0600	125	Start ramp down.	125
0700	100	Ramp down.	100
0800	75	Ramp down.	75
0900	50	Ramp down.	50
1000	0	Inspection period.	5-10 from stilling basin
1100	0	Inspection period.	5 from stilling basin
1200	100	Start ramp up.	100
1300	125	Normal operating flow.	Approximately 125-250

instrumentation, spillway, tower access bridge, bulkhead and slide gates, hydraulic power system, emergency generator, reservoir rim, and access roads. During the two-hour time period of zero flow release from CVD, the Corps will provide a minimum of five cfs of flow from the stilling basin[10] below the dam. The flow of five cfs from the stilling basin is provided from discharge that is released from the basin as it drains during the zero flow release period.

The Corps proposes to monitor stream reaches below CVD during the pre-flood inspection activities. Two person stream survey crews will survey specific stream reaches below the dam

[10] A basin constructed to dissipate the energy of fast-flowing water from a spillway or bottom outlet and to protect the streambed from erosion.

(within the action area) and make observations related to changes in stream characteristics and fish distribution as a result of the proposed action.

Warm Springs Dam. A pre-flood or periodic inspection of dam structure and operating systems also occurs during August or September at WSD. The Corps conducts inspections of WSD at specific times of the year and manner to avoid adverse effects to juvenile and adult salmonids. Unlike CVD, which must halt flow during inspections; WSD is able to provide a minimum of 25 cfs during the pre-flood and periodic flood inspections. The Corps provides a minimum bypass flow of 25 cfs, but actual flows measured by the U.S. Geological Survey-Water resources Division (Ukiah Field Office) are typically 40 cfs. Inspections are conducted in late August or September to allow juvenile steelhead to reach a sufficient size to avoid stranding impacts during the ramp down of flow to the minimum stream levels maintained during the inspection. Surveys conducted by NMFS and the Corps during the inspections have not found stranding of juvenile salmonids. Conducting inspections in late August or September also allows the Corps to avoid Chinook salmon spawning in Dry Creek that usually begins in October.

By avoiding adverse effects to juvenile steelhead and adult Chinook salmon with inspection timing and bypass flows, the Corps has obtained NMFS' yearly concurrence (since 1998) that these activities are not likely to adversely affect listed salmonids or their critical habitats. NMFS expects that future inspections at WSD will also not likely adversely affect listed salmonid species or critical habitat, unless the Corps changes the manner in which the WSD inspections are carried out. Therefore, this aspect of the project is only considered briefly in the remainder of this biological opinion.

5. Hatchery Operations

The DCFH, also known as Warm Springs Hatchery, is located at the base of WSD. Its satellite facility, CVFF, is located at the base of CVD. Construction of DCFH was authorized by the Flood Control Act of 1962. Additionally, Section 95 of Public Law 93-251, of the Water Resources Development Act of 1974, required a program to compensate for fish losses attributed to the operation of CVD, and allowed for expansion of DCFH. The DCFH and CVFF facilities went into service in 1980 and 1992, respectively. Because the hatchery operations are required as mitigation for the purpose of the proposed action, NMFS is analyzing the effects of all hatchery operations in this biological opinion.

Both fish facilities are owned by the Corps, however, the facilities and hatchery programs are operated by CDFG under contract with funding from the Corps. Although funding for some operational components is uncertain, the Corps proposes to continue operations of the DCFH and CVFF fish production facilities, including the coho salmon and steelhead programs, but not Chinook salmon (Corps and SCWA 2004). Both of the fish facilities and hatchery programs were intended to serve as mitigation for the loss of historical salmonid spawning and rearing habitat blocked by the construction of WSD and CVD. Annual escapement goals of 1,100 adult coho salmon, 6,000 adult steelhead and 1,750 adult Chinook salmon in the Dry Creek drainage, and 4,000 adult steelhead in the upper Russian River drainage, were established to provide mitigation for losses resulting from construction and operation of WSD and CVD (Corps 1986b).

a. *Russian River Coho Salmon Captive Broodstock Program (RRCSCBP)*

The DCFH coho salmon mitigation and enhancement program began in 1980, and coho production at the facility was stopped entirely in 1996, after failing to meet mitigation goals. In 2001, the RRCSCBP was initiated at DCFH to prevent extirpation of coho salmon in the Russian River basin, and to reestablish self-sustaining runs of coho salmon in tributary streams within the Russian River basin. The Corps proposes continuation of the RRCSCBP as an integrated recovery program (Corps and SCWA 2004).

The RRCSCBP was initiated at DCFH with juvenile wild coho salmon collected from Russian River tributaries. The juveniles were reared to reproductive maturity. The program then artificially spawned the adult captive broodstock while adhering to a genetic spawning matrix to maximize genetic diversity of the coho salmon produced, and to minimize adverse affects to the genetic composition of the Russian River coho salmon. Juvenile coho salmon produced from the captive broodstock were then released into several Russian River tributaries as fry, so that they could return to the streams as adults and spawn naturally. Each year since 2001, the program has reared and stocked coho salmon with lineage to wild juvenile coho salmon collected in Russian River tributaries. The RRCSCBP is currently authorized under an ESA section 10(a)(1)(A) enhancement permit issued to CDFG (Permit 1067, modification 3). Since the effects of the RRCSCBP have already been evaluated in the September 26, 2001, NMFS biological opinion on the issuance of the section 10(a)(1)(A) enhancement permit for the program, the specific effects of the program will not be evaluated as part of the proposed action in this biological opinion, but are included in the Environmental Baseline of this biological opinion.

The proposed continuation of the captive broodstock program will have similar objectives to the existing RRCSCBP (Corps and SCWA 2004). The program will continue to collect naturally-produced juvenile coho salmon, rear the fish to maturity, and use them as broodstock to produce fingerlings (Corps and SCWA 2004). Spawning will be conducted following a genetic spawning matrix to maximize genetic diversity of the coho salmon produced. The juvenile coho salmon would then be released into appropriate streams in the Russian River basin (Corps and SCWA 2004). The objectives of the captive broodstock program are to: 1) prevent extirpation of Russian River coho salmon; 2) preserve genetic, ecological, and behavioral attributes of Russian River coho salmon while minimizing potential effects to other stocks and species; and 3) build a naturally-sustaining coho salmon population (Corps and SCWA 2004).

The Corps proposes to continue the monitoring program to evaluate the effectiveness and performance of hatchery operations. As part of monitoring, the results of population status monitoring programs conducted by others will be tracked closely (Corps and SCWA 2004). Hatchery operations will incorporate adaptive management practices, which could lead to changes in hatchery production guidelines (such as number of juveniles released, size of juveniles released, or use of wild fish for broodstock) based on monitoring program findings (Corps and SCWA 2004). The monitoring program will be used to monitor and evaluate release strategies, over-summer survival, over-winter survival, and adult coho salmon returns. Data collected from the monitoring and evaluation program will be used to continue to assist in the adaptive management of the program.

b. Steelhead Mitigation Program

The Corps (and CDFG) have recently taken initial steps to begin transitioning the steelhead mitigation program from an isolated hatchery program[11] to an integrated hatchery program[12], and they have incorporated operational changes that have been implemented due to revisions in CDFG policy and guidelines (Corps and SCWA 2004). Since the steelhead program is not authorized under the ESA, the specific effects of the steelhead hatchery programs are considered in this opinion.

Broodstock Collection and Spawning. Russian River adult steelhead broodstock are collected from the DCFH and CVFF fish ladders and traps. DCFH and CVFF steelhead are collected randomly across natural run-timing, with weekly capture goals formulated from weekly adult return records for a 9 to 11 year period. Steelhead from both facilities are managed separately, that is steelhead collected from DCFH are only spawned with other steelhead collected from DCFH, and steelhead from CVFF are only spawned with steelhead collected from CVFF. Steelhead program guidelines routinely aim to collect and spawn a minimum of 180 females at DCFH and a minimum of 120 females at CVFF, and generally 2.5 to 3 times those numbers for males. Adult returning hatchery steelhead are spawned randomly at both fish facilities. More individuals are spawned than are necessary to achieve egg-take goals, both in an attempt to increase genetic diversity and as a means to protect against catastrophic loss during incubation and early rearing of hatchery steelhead. Adult wild steelhead that return to DCFH are relocated into Dry Creek and adult wild steelhead that return to CVFF are relocated to the West Branch Russian River above Mumford Dam. Adult hatchery steelhead that return to DCFH that are not needed for broodstock are released into the main stem Russian River, upstream of the confluence with Dry Creek. Adult hatchery steelhead that return to CVFF that are not needed for broodstock are relocated to the Ukiah and Cloverdale reach of the main stem Russian River, and to tributaries to the upper Russian River including: Ackerman, Feliz, Orr, Gibson, Doolan, Mill (tributary to Forsythe), Hensley, McClure, McNab, Morrison, Parsons, Howell, Dooley, McDowell, Twining, and Walker creeks. Beginning in 2004, adult excess hatchery steelhead from both facilities are not relocated above natural barriers in the Russian River in order to avoid compromising the genetic integrity of isolated resident trout stocks (based on results from Deiner (2004) discussed in the Environmental Baseline section).

Rearing. Based on a fecundity of 5,000 eggs per female and a 50 percent survival rate from egg to yearling, 600,000 steelhead eggs are collected for DCFH releases, and 320,000 eggs for CVFF releases. Juvenile steelhead from each facility are reared separately at DCFH and are not graded during the rearing process. Grading of hatchery fish is typically carried out to sort the sizes of fish during the rearing process to minimize aggressive behavior and potential cannibalism of smaller fish by larger faster growing fish.

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[11] A hatchery program in which artificially propagated fish are produced primarily for harvest and the primary goal is to maintain hatchery broodstock that are distinct from their wild counterparts by using predominately or exclusively hatchery origin adults returning to the hatchery (HSRG 2004, Spence *et al.* 2008). .

[12] A hatchery program in which the primary goal is to minimize genetic divergence between hatchery broodstock and naturally spawning wild populations by systematically incorporating wild fish into the hatchery broodstock (HSRG 2004, Spence *et al.* 2008).

Approximately 40,000 pounds of yearling smolt stage fish are trucked to CVFF in three separate lots in late January/early February and March, for 4 to 6 weeks of rearing for acclimation and imprinting before volitional release into the East Branch Russian River.

Fish Marking. All steelhead produced at DCFH and CVFF are marked with a clipped adipose fin prior to release to identify the steelhead as a hatchery fish.

Releases. DCFH and CVFF steelhead are released as smolts at approximately 4 to 5 fish to the pound (FishPro Inc. and Entrix Inc. 2000), a size that encourages rapid emigration to the Russian River estuary (FishPro Inc. 2004). Releases occur between mid-January and late April, after steelhead juveniles transition from freshwater parr to euryhaline smolts, having the ability to live in salinities varying from fresh water to full-strength seawater (Zaugg 1981). DCFH steelhead are transported and released 3 miles downstream from the hatchery in Dry Creek at the Yoakim Bridge to facilitate out-migration. CVFF steelhead are volitionally released from the facility after the 4 to 6 week acclimation and imprinting time period. A maximum number of 300,000 steelhead are released from DCFH, and a maximum of 200,000 are released from CVFF.

c. Program Management

Water Supply. The water supply for DCFH is provided from Lake Sonoma (at WSD), and the water supply for CVFF is provided from Lake Mendocino (at CVD). The Corps has upgraded the water supply at CVFF to help ensure emergency backup should the primary water supply fail. The emergency water supply line for DCFH is currently non-functional and plans for its repair remain uncertain.

Monitoring and Evaluation.
Monitoring data are collected annually at both fish facilities on returning adult steelhead, including numbers, gender, and mark type (ad-clip hatchery or wild).

6. Hydroelectric Facilities at Coyote Valley and Warm Springs Dams

a. Hydroelectric Power Plant at Coyote Valley Dam

The Lake Mendocino Hydroelectric Power Plant (LMHPP), owned and operated by the City of Ukiah (City), was completed in May 1986 at a total cost of approximately $22 million. The power plant was added as an external facility to the downstream base of CVD, which was not originally designed to supply a hydroelectric plant (City of Ukiah 1981). The power plant has a total generation capacity of 3.5 MW through two generators rated at 1 MW and 2.5 MW, respectively. The City operates the project under a 50-year license issued April 1, 1982, by FERC (Project No. 2481-001). The City is a member of the Northern California Power Authority (NCPA).

NCPA owns and operates various power generation plants throughout California and provides power to their members. The LMHPP supplements other power sources within the City's system and has no contractual minimum power output requirements to maintain. Power output is determined by the amount of water released from the dam for water supply, minimum instream

flow requirements, and flood control, rather than power generation needs. During 2005, the City worked with NMFS to develop an operations plan to minimize impacts to salmonids in the Russian River. NMFS technical assistance focused on potential effects to salmonids during the transitions between flood and power operations. The City, NCPA, and NMFS settled on an operations plan (dated August 25, 2005) that included operation criteria to reduce potential effects to listed salmonids. The City has made modifications to the tainter gate at Lake Mendocino and operation of the power plant resumed bypassing flow in January 2007

b. Hydroelectric Power Plant at Warm Springs Dam

SCWA owns and operates the Warm Springs Dam Hydroelectric Facility (WSDHF). This hydroelectric facility was completed in December 1988 at a total cost of $5 million. SCWA operates the facility under a 50-year license issued by FERC on December 18, 1984 (Project No. 3351-002). The 3,000-KW Francis turbine generator has a power rating of 2.6 MW (Corps 1984). The facility is located within the control structure of the outlet works for WSD.

Water from Lake Sonoma flows to the hydraulic turbine via a vertical wet well located in the control structure that draws water from the horizontal, low-flow tunnels. The upper tunnel was non-operational, but was repaired in 2002. Water from the tunnels travels down the vertical well between (approximately) 115 and 194 feet feet to the turbine. Water passing through the turbine flows into the flood control tunnel to a stilling basin located at the base of the dam. A 20-inch emergency water supply line installed inside the conduit provides water to the hatchery in the event of a gate failure. This bypass line was engineered to divert water through the hatchery and to Dry Creek at a maximum flow capacity of approximately 35 cfs. As noted above, the emergency water supply line is currently not functional.

From the stilling basin, water flows through a channelized portion of Dry Creek, or is diverted for use in DCFH adjacent to WSD. The stilling basin is a concrete-lined basin at the mouth of the outlet tunnel. A two-step weir, approximately 18 feet high, is used to reduce the water velocity from the outlet tunnel and to keep fish downstream of the dam from entering the outlet tunnel.

The hydroelectric facility operates during normal releases of water through the low-flow tunnels and the wet well. A minimum flow of approximately 70 cfs is needed to operate the turbine. The maximum flow capacity for the turbine is approximately 185 cfs. During flood control operations (when releases from WSD exceed 3,000 cfs), flow through the wet well and turbine are shut off to prevent hydraulically unstable conditions from developing in the outlet piping. When water releases of more than 500 cfs are required, service gates in the left abutment of the intake conduit are opened, and flows bypass the wet well and turbine. The minimum opening allowed for the service gates is 0.2 feet, which relates to a release of 100-120 cfs. Also, flows of 185 cfs through the turbine can continue, with the remaining flow bypassed through the service gates. However, the total flow through the wet well and the service gate must be less than 3,000 cfs.

Flows through the hydroelectric facility are determined by water supply needs and minimum instream flow requirements. The turbines can operate at flows of 70 to 185 cfs. The water

supply needs and minimum instream flow requirements set by D1610 (SWRCB 1986) generally provide flows sufficient for hydroelectric power generation, and the plant operates on flow releases for other purposes. No flow releases are made solely for the benefits of hydroelectric generation.

C. Interrelated and Interdependent Actions

Interrelated actions are those are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consultation (50 CFR 402.02). NMFS considers SCWA's water diversion and transmission system to be interdependent with water releases at CVD and WSD.

1. Water Diversion Operations

SCWA delivers water to its customers through its water transmission system, which has a peak monthly average delivery of 84 million gallons per day (mgd), and a capacity of up to 92 mgd. The diversion and treatment facilities are located along the Russian River in Forestville at Mirabel (an area near the former Mirabel resort) and Wohler (a site near Wohler Road). The transmission system, which includes pipelines, storage tanks, pumps, and conventional wells, conveys water from the diversion facilities on the Russian River to service areas in Sonoma County and Marin Counties.

a. Diversion Facilities

SCWA's diversion facilities along the Russian River include an inflatable dam, the Mirabel diversion facility and infiltration ponds, and the Wohler diversion facility and infiltration ponds. The ability of the Russian River aquifer to produce water is generally limited by the rate of recharge to the aquifer through the streambed near the Mirabel and Wohler diversion facilities. To augment this rate of recharge, SCWA has constructed seven infiltration ponds and a water-filled inflatable dam located on the Russian River just upstream of the Mirabel area (Figure 2). When the dam is inflated, it raises the water level and submerges the intakes to three diversion pumps which can deliver up to 100 cfs. The water is pumped through pipes in the levee adjacent to the river into a sedimentation pond that outlets to a lined channel, which conveys water to four Mirabel infiltration ponds encompassing a total area of approximately 40 acres. The increase in water level also increases recharge to the Wohler collectors and allows SCWA to flood two infiltration ponds (1.7 acres combined) in the Wohler area.

The Inflatable Dam. The inflatable dam at Mirabel is fabricated of a rubberized material and is attached to a concrete foundation in the riverbed. When inflated, the dam is 11 feet (ft) high and spans the width of the entire river. The inflatable dam usually will be raised in late spring when water demands increase and the Russian River stream flow drops below 2,000 cfs. The dam is inflated slowly with water. Under current protocols, inflation of the dam generally takes approximately 12 hours (hrs) to complete, whereas deflation takes 24 hrs. Given that the dam is 11 ft high, stage-change in the river upstream of the dam is about 0.92 feet per hour (ft/hr) during inflation and 0.46 ft/hr during deflation. Stream flow spills over the dam until the dam is two-thirds inflated, at which point most of the flow passes through fish ladders and associated bypass

structures. The dam will be operating for about 7 months each year, on average. The dam will be lowered in the fall or early winter when stream flow approaches 2,000 cfs. When the dam is deflated, it does not impede migration or create a backwater. The inflatable dam is equipped with Denil-style fish ladders near the riverbank on each side of the dam, both of which are in operation when the dam is raised. Each fish ladder has an approximate flow capacity of 40 cfs. Two 24 to 36-inch bypass pipelines provide water at each of the fish ladder entrances to attract adult fish to the ladder. Each bypass pipeline allows about 22 cfs of flow. In an effort to reduce juvenile salmonid residency and migration time through the Wohler Pool, which is formed by the Mirabel Dam, the SCWA has proposed a minor change in the operation of the inflatable dam. The SCWA will create a depression in the crest of the inflatable dam during outmigration periods (spring through June 15) to provide concentrated flow at a point along the crest of the dam to reduce delay of smolts at the forebay.

Infiltration Ponds. The Mirabel diversion facility is located on the west side of the river adjacent to the inflatable dam. At the inflatable dam, water is drawn through two submerged fish screens that are 11 ft in diameter, about 5 ft high, and rotate on vertical axes. The current fish screen's openings are 5/32 of an inch, which do not meet NMFS fish screen criteria of 3/32 of an inch. A small water jet drives paddle blades attached to the top of the screen to rotate the screens; vertical fixed brushes clean the screens of debris and biological fouling as the screens rotate. After flowing through a sedimentation pond adjacent to the diversion caisson, diverted water enters a small open channel, which distributes water to up to four infiltration ponds through manually-operated slide gates.

SCWA will replace the rotary drum fish screens at Mirabel to meet NMFS criteria for screen openings within the next ten years. Replacement will entail diversion of the Russian River around the site using coffer dams. SCWA anticipates it will require 5 to 7 years to design and construct this project element in coordination with NMFS.

The Wohler diversion facilities consist of two ponds with a combined surface area of 1.7 acres. Currently, each pond is connected independently to the Russian River by a canal. These canals function as both inlets and outlets to the ponds. The Wohler ponds operate only when the inflatable dam is raised. Flows diverted into the Wohler ponds are not measured. A screen constructed out of metal T-posts and ¼-inch hardware cloth, which does not meet NMFS screen criteria, is installed in front of the inlet to the Wohler infiltration ponds. These ponds have not been used by SCWA for several years.

The infiltration ponds at Wohler and Mirabel are sometimes overtopped during floods, trapping fish in the ponds after the river level recedes. This happens at the Wohler ponds during most winters due to a lack of levees around the ponds, and less frequently at the Mirabel ponds, which are protected by levees. To relocate trapped fish, biologists from the SCWA use beach seine nets after pond levels drop to a depth where wading is possible.

To provide the primary water supply for the transmission system, the SCWA operates six radial horizontal collector wells and seven vertical wells adjacent to the Russian River near Wohler Road and Mirabel, which extract water from the aquifer beneath, and adjacent to, the streambed.

Collector Wells. Each collector well consists of a 13- to 18-foot-diameter concrete caisson that extends 80 to 100 ft deep into the alluvial aquifer. Perforated horizontal intake pipes extend radially from the bottom of each caisson to a maximum of 350 ft into the aquifer. Each collector well houses two vertical turbine pumps that are driven by 1,000 to 2,000 horsepower (hp) electrical motors. Pumps at Wohler are rated to deliver up to 10.0 to 21 mgd, and at Mirabel each pump is rated to deliver up to 10.0 mgd.

Vertical Wells. Seven vertical wells, collectively referred to as the Russian River Well Field, are located in the Mirabel area shown on Figure 2. These wells withdraw water from the aquifer adjacent to the Russian River. The wells provide up to 7 mgd of emergency production capacity.

Since the construction of the 54-inch Wohler-Forestville Pipleline, the Mirabel and Wohler collector wells are interconnected. Water may be sent to the Cotati Intertie or the Santa Rosa aqueduct from either the Mirabel or Wohler facilities, depending on the relative activity of pumping at each facility. The SCWA system also includes three groundwater wells located along the Russian River-Cotati Intertie pipeline at Occidental Road, Sebastopol Road (Highway 12), and Todd Road.

b. Treatment Facilities

Filtration. Water is diverted from the Russian River after it is filtered through the sand and gravel aquifer below and adjacent to the streambed and infiltration ponds, and thus requires no further treatment other than disinfection.

Water Chemistry. SCWA operates pH adjustment/corrosion control facilities to limit lead and copper content in drinking water. These facilities are located at the SCWA Wohler maintenance yard and the River Road chlorination building. There water is treated with caustic soda to raise the pH of pumped Russian River water. Although the water produced by the existing collectors contains no detectable levels of lead and copper, the water is naturally moderately corrosive and can leach lead and copper from indoor plumbing and water fixtures. The caustic soda for water treatment is stored in two 10,000-gallon containers (one at Wohler and one at the River Road facilities). The pH control buildings are located about 200 yards from either the Russian River or Mark West Creek; however, the concrete masonry walls of the pH control buildings are designed to provide secondary containment to prevent the caustic soda from contaminating a large area if a leak occurs within the pH control buildings.

SCWA currently disinfects the water produced at the well facilities with approximately 0.6 parts per million (ppm) of chlorine. Chlorine gas is mixed with water inside three chlorine facilities to form a concentrated chlorine and water solution. This chlorine and water solution is transported through underground pipes to each collector and is injected into the caissons to disinfect the water. The buildings used to store chlorine are equipped with leak detection alarm systems that send a signal to the operations and maintenance center indicating any leak locations. At the Occidental, Sebastopol Road and Todd Road wells, calcium hypochlorite tablets are used on-site to generate an aqueous chlorine solution.

c. Transmission System

Currently, the SCWA water transmission system has 86 miles of 16 to 54-inch diameter pipe in place to distribute water from the diversion facilities to water users in Sonoma and Marin counties. The SCWA has 18 storage tanks in southern Sonoma County with 129.6 million gallon total storage capacity. Presence of the pipelines or storage tanks do not likely affect ESA-listed salmonid species or critical habitat, though unplanned releases from the transmission system may affect ESA-listed salmonid species or critical habitat. The pipelines contain approximately 17 air relief valves, which may potentially discharge potable water to various creeks and drainage swales or ditches. These valves were installed to protect pipelines by relieving the pressure surges created when an abrupt change in flow occurs (and overflow lines from tanks). The maximum residual chlorine concentration in these discharges is approximately 0.6 ppm. To reduce the likelihood of corrosion of the pipelines, the SCWA has buried magnesium alloy anodes at regular intervals (typically every 20 to 40 feet) to generate a small electrical current on the exterior of the pipelines.

d. Maintenance Activities

Maintenance of Levees, Access Roads, and Infiltration Ponds. Routine maintenance of levees, access roads, and infiltration ponds at Mirabel and Wohler will likely have a negligible effect on ESA-listed species or critical habitat (see *Effects of the Project*). Maintenance of these areas involves removing vegetation with the use of herbicides as described above and mowing of vegetation along levee roads. Vegetation maintenance does not occur on stream banks near the river, but does occur along roads that are 200 to 250 feet from the Russian River and provide access to the Mirabel area.

Inflatable Dam Maintenance. Each time the dam is lowered, the fish screens at Wohler are removed so they are not damaged during high-water events. Raising the dam sometimes requires removing sediment that has accumulated during the winter on the flattened dam fabric and within the fish ladders. The accumulated sediment is removed using a portable suction dredge, and discharge is directed to a temporary settling pond to prevent turbid water from reaching the river channel. The water is allowed to re-enter the river after the sediment has settled. Spoils are then stored out of the flood plain or hauled away.

Groundwater Wells Maintenance. Operation of SCWA's Occidental Road, Sebastopol Road, and Todd Road wells can require discharging well water to surface drainages for sampling or flushing purposes. However, these discharges usually involve unchlorinated water and are conducted infrequently. The discharged water at the Occidental well discharges into a reclamation pond; the Todd Road well discharge is spread over nearby fields not adjacent to salmonid bearing streams, and the Sebastopol Road well discharge is sent to a drainage ditch which does not enter a salmonid bearing stream (A. Mai, SCWA, personal communication, 2007). As such these activities should have no effect on salmonids, and therefore, these releases are not discussed further.

Water Storage Tanks Maintenance. Maintenance of the water storage tanks includes periodic recoating of the interior tank surfaces, which requires that the tanks be emptied. To the extent

possible, the water in the tanks is drained into the transmission system. However, to maintain pressures within the transmission system, a portion must be released from the tank to surface water drainage. In these cases, prior to discharging, the SCWA maintenance staff estimates the remaining volume of water in the storage tanks and adds a corresponding amount of dechlorinating chemical (metabisulfide) to eliminate any chlorine residual in the discharge. Controlled discharges occur approximately once every 4 years as part of maintenance activities. Overflow pipelines in each water storage tank are necessary to provide an emergency release route if water levels in the tank should rise too high. While automated control valves in the water transmission system have been installed to prevent this, overflow of chlorinated water may occur under certain unforeseen circumstances.

Equipment Maintenance. Routine maintenance of equipment and buildings will occur outside of the active channels. All facilities used to store hazardous materials are designed, manufactured, and constructed in accordance with the Uniform Fire Code, the Uniform Building Code, and applicable local codes and ordinances.

Gravel Bar Grading in the Mirabel/Wohler Diversion Area. Gravel bar grading will continue to be conducted in the Russian River near the Mirabel/Wohler diversion areas. The protocols for gravel bar grading operations conducted to increase infiltration capacity may differ from those conducted for channel maintenance. Therefore, these activities are discussed separately.

Infiltration capacity at the Wohler and Mirabel diversion facilities will be augmented by periodically recontouring three gravel bars in the Russian River upstream of the inflatable dam (Wohler, McMurray, and Bridge gravel bars) and one bar (Mirabel Bar) downstream of the inflatable dam. Work in other gravel bars may be required in the future if the pattern of gravel bar formation in the river changes so that new bars are formed. These will likely be located between Caisson 6 and Caisson 3. The McMurray and Mirabel bars are approximately 1,000 ft long and 200 ft wide. The other two gravel bars are approximately 500 ft long and 100 ft wide.

The following best management practices (BMPs) for gravel bar grading operations were evaluated by SCWA during a 5-year monitoring study (Chase *et al*. 2000) and will be implemented as part of the proposed project. Biological oversight will be provided by fisheries biologists. SCWA biologists will inspect the gravel bars before beginning gravel skimming work to: a) evaluate the need for silt fences, and b) identify environmentally sensitive areas. Permanent vegetation on the riverbanks may in some cases be thinned to allow equipment access to the bar, but will not be completely removed. Sediment fences will be employed to prevent the input of sediment into the river. Cofferdams will be constructed both upstream and downstream of the work areas, if necessary, to isolate the work areas from flowing water. Operation of heavy equipment in the active stream channel will be limited to moving equipment to and from the mid-channel gravel bars and breaching cofferdams when needed, and will be very short in duration. All equipment will be removed from the gravel bars at the end of each day. No fueling or equipment service will be performed on the gravel bars or within the active floodplain. Gravel skimming operations will be limited to material above the waterline. After gravel bar grading operations are completed, gravel bars will be contoured to at least a 2 percent grade to reduce the potential for stranding fish. Continuously recording turbidity meters will be installed upstream and downstream of gravel bar grading operations to document turbidity levels

associated with this action. Breaching of the lower berm for the Mirabel Bar will be conducted late in the evening or early in the morning to reduce visual effects to recreational visitors at Steelhead Beach.

2. Wastewater Treatment

Project operations for purposes of water supply result in the diversion of approximately 65,000 acre-feet of water from the Russian River (Corps and SCWA 2004). A substantial portion of this water supply is consumed, eliminated as waste, treated as wastewater, and ultimately discharged back into the Russian River watershed or San Pablo Bay as treated effluent. Corps and SCWA (2004) state that eleven wastewater treatment plants (WWTPs) serve SCWA's primary and secondary water contractors, including contractors who divert water under SCWA's water rights.

Wastewater discharges are controlled and scheduled under the established policies of the Water Quality Control Plan for the North Coast (NCRWQCB 1993). Water treated to the secondary level or better (as described in the *Environmental Baseline*) is discharged back into the Russian River, Jones Creek, Dutch Bill Creek, Mark West Creek, and the Laguna de Santa Rosa tributaries of the Russian River. While discharge schedules vary between treatment facilities, the WWTP generally limit their discharges to months with relatively high seasonal flows. None of the facilities discharge to tributaries of the Russian River between May 15 and October 1; some commence discharges beginning in November, some end discharges April 30. Under the permits filed with NCRWQCB, the identified treatment plants can only discharge at 1% of the current flow rate, with the exception of the Santa Rosa Subregional Wastewater Reclamation System (SRSWRS), which has a discharge allowance of 5% of ambient flow.

D. Action Area

The action area is defined as all areas affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). Most of the direct and indirect effects of the project occur in: 1) the East Branch Russian River below CVD and the main stem Russian River from the confluence of the East Branch Russian River to the mouth of the Russian River at Jenner (including the Russian River Estuary), 2) Dry Creek downstream of WSD, and 3) areas of the Mark West Creek watershed that do not contain coho salmon, including Santa Rosa Creek and its tributaries, and the Laguna de Santa Rosa, in Area Zone 1A (Figures 2, 3, and Table 4). However, the action area is extended to include the entire Russian River and its tributaries downstream of WSD and CVD because of our need to also consider the impacts of straying hatchery fish in the watershed. Interrelated and interdependent activities, such as wastewater discharge, and water transmission, can also occur in or near streams in Sonoma County and Marin County outside of the three main areas of effects identified above.

IV. STATUS OF THE SPECIES AND CRITICAL HABITAT

The purpose of this section is to characterize the condition of the three salmonid species under consultation relative to their likelihood of viability (extinction risk) and to describe the conservation role and function of their respective critical habitats. The three principle components to this section are: 1) a summary of relevant life-history characteristics for each species; 2) a viability assessment for all three species; and 3) an analysis of critical habitat. This information will be used as the foundation for determining whether the proposed project is not expected to appreciably reduce the likelihood of the survival and recovery of a species by reducing the reproduction, numbers, or distribution of that species, or result in the destruction or adverse modification of critical habitat.

In the previous draft of this opinion, NMFS applied Viable Salmonid Population (VSP) criteria (McElhany *et al*. 2000) to population diversity strata to diagnose ESU/DPS status. Subsequent to that analysis, the NMFS Southwest Fisheries Science Center published the results of the Technical Recovery Team's (TRT) status assessment for the ESUs and DPS under consideration in this biological opinion (Spence *et al*. 2008). We have updated our status section below to reflect this more recent scientific information. Because we maintained contact with the TRT during our previous diagnosis of status, our previous conclusions regarding ESU and DPS status are consistent with the TRT's work. We have changed organization, and refocused our analysis on the viability of populations and ESUs or DPSs to better comport with the TRT's status assessment. We have also clarified terms in our critical habitat analysis and provided ESU or DPS summaries of critical habitat. In our previous draft we included predation as an attribute of the migratory corridor PCE of critical habitat; however, to be consistent with our designation of critical habitat (70 FR 52488), we eliminated this habitat attribute in our analysis of critical habitat.

In addition, we considered Southern Resident Killer Whales. This species is known to occur in the Pacific Ocean off the coast of California as far south as Monterey Bay. Because these marine mammals prey mainly on Chinook salmon (78 percent of identified prey)[13] (NMFS 2008a), and this proposed project is likely to adversely affect some Chinook salmon in the Russian River, we considered whether or not this proposed project would adversely affect Southern Resident Killer Whales. However, as described below in the *Effects of the Proposed Action* and *Integration and Synthesis* sections, the proposed project has little, if any, effect on overall Chinook salmon numbers and distribution in the Russian River, and overall has beneficial impacts to Chinook salmon critical habitat. Therefore, with minimal impacts on CC Chinook salmon numbers, distribution, or reproduction, NMFS expects the proposed project is unlikely to adversely affect Southern Resident Killer Whales. For that reason, Killer Whales are not discussed further in this biological opinion.

A. Life History

A brief overview of the life history of each salmonid is provided below in order to illustrate the importance of survivorship at each life stage in the overall abundance and productivity of each

[13] Coho salmon and steelhead are thought to comprise 5 percent and 2 percent of their diet, respectively (NMFS 2008a).

species. More detailed information is available in Good *et al.* (2005) and the NMFS final rule listing the CCC steelhead DPS (71 FR 834).

1. Chinook Salmon

Chinook salmon are the largest anadromous member of *Oncorhynchus*, with adults weighing more than 120 pounds having been reported from North American waters (Scott and Crossman 1973, Page and Burr 1991). Chinook salmon exhibit two main life history strategies: "ocean type" and "river type" (Healy 1991). Ocean type fish typically are fall or winter run fish that spawn shortly after entering freshwater, and their offspring emigrate shortly after emergence from the redd. River type fish are typically spring or summer run fish that have a protracted adult freshwater residency, sometimes spawning several months after entering freshwater. Progeny of river type fish frequently spend one or more years in freshwater before emigrating. The CC Chinook salmon are fall-run, ocean-type fish. A spring-run (river-type) component existed historically, but is now considered extinct (Bjorkstedt *et al*. 2005).

Chinook salmon in the CC Chinook salmon ESU generally remain in the ocean for two to five years (Healy 1991), and tend to stay along the California and Oregon coasts. CC Chinook salmon usually enter rivers from August to January. These fall-run Chinook salmon typically enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the main stem or lower tributaries of rivers, and spawn within a few weeks of freshwater entry (Healy 1991). However, some return from the ocean to spawn one or more years before full sized adults return; these are referred to as jacks (males) and jills (females). Run timing is, in part, a response to stream flow characteristics, with most spawning occurring in November and December. They typically spawn in the lower reaches of rivers and tributaries at elevations of 200 to 1,000 feet.

Egg deposition must be timed to ensure that fry emerge during the following spring at a time when the river or estuary productivity is sufficient for juvenile survival and growth. Adult female Chinook salmon prepare redds in stream areas with suitable gravel composition, water depth, and velocity. Spawning generally occurs in swift, relatively shallow riffles or along the edges of fast runs at depths greater than 24 cm. Optimal spawning temperatures range between 5.6 and 13.9°C (Allen and Hassler 1986). Redds vary widely in size and location within the river. Preferred spawning substrate is clean, loose gravel, mostly sized between 1.3 and 10.2 cm, with no more than 5 percent fines (Allen and Hassler 1986). Gravels are unsuitable when they have been cemented with clay or fines or when sediments settle out onto redds, reducing intergravel percolation (62 FR 24588). Minimum intergravel percolation rate depends on flow rate, water depth, and water quality. The percolation rate must be adequate to maintain oxygen delivery to the eggs and remove metabolic wastes. The Chinook salmon's need for a strong, constant level of subsurface flow may indicate that suitable spawning habitat is more limited in most rivers than superficial observation would suggest. After depositing eggs in redds, adult Chinook salmon guard the redd from 4 to 25 days before dying (Healy 1991).

Chinook salmon eggs incubate for 90 to 150 days, depending on water temperature. Successful incubation depends on several factors including DO levels, temperature, substrate size, amount of fine sediment, and water velocity. Maximum survival of incubating eggs and pre-emergent

fry occurs at water temperatures between 5.6 and 13.3°C with a preferred temperature of 11.1°C. Fry emergence begins in December and continues into mid April (Leidy 1984). Emergence can be hindered if the interstitial spaces in the redd are not large enough to permit passage of the fry. In laboratory studies, Bjornn and Reiser (1991) observed that Chinook salmon and steelhead fry had difficulty emerging from gravel when fine sediments (6.4 mm or less) exceeded 30 to 40 percent by volume.

After emergence, Chinook salmon fry seek out areas behind fallen trees, back eddies, undercut banks, and other areas of bank cover. As they grow larger, their habitat preferences change (Everest and Chapman 1972). Juveniles move away from stream margins and begin to use deeper water areas with slightly faster water velocities, but continue to use available cover to minimize the risk of predation and reduce energy expenditure. Fish size appears to be positively correlated with water velocity and depth (Chapman and Bjornn 1969, Everest and Chapman 1972). Optimal temperatures for both Chinook salmon fry and fingerlings range from 12 to 14°C, with maximum growth rates at 12.8°C (Boles 1988). Chinook salmon feed on small terrestrial and aquatic insects and aquatic crustaceans. Cover, in the form of rocks, submerged aquatic vegetation, logs, riparian vegetation, and undercut banks provide food, shade, and protection from predation.

The low flows, high temperatures, and sand bars that develop in smaller coastal rivers during the summer months favor an ocean type life history of Chinook salmon (Hooton *et al*. 1995). With this life history, subyearlings typically undergo a physiological transformation called smoltification. This process, which begins as they migrate downstream, prepares them for living in the marine environment. The smolt out-migration typically occurs from April through July (Myers *et al*. 1998). In California, ocean type Chinook salmon tend to use estuaries and coastal areas for rearing more extensively than stream type Chinook salmon (Thorpe 1994). Brackish water in estuaries moderates the physiological stress that occurs during the parr-smolt transition.

Many of the fry of ocean-type Chinook salmon migrate downstream immediately after emerging from spawning beds and take up residence in river estuaries to rear to smolt size (Healy 1991). In the Sixes River, Oregon, Reimers (1973) reports that the most common juvenile life-history pattern was three months rearing in the river and three months rearing in the estuary. In the Campbell River, British Columbia, juvenile Chinook entered the estuary between April and June, spending 40 to 60 days in low salinity water (0 to 5.5 parts per thousand (ppt) salinity) before moving into a transition zone (5.5 to 25 ppt salinity) between May and July. After that they move into a more marine zone (>25 ppt salinity) (Thorpe 1994). In the Sacramento-San Joaquin River delta, Sazaki (1966) observed that young Chinook salmon were most abundant from April through June, similar to the timing observed in more northern deltas. However, MacFarlane and Norton (2002) demonstrated little estuarine dependency for juvenile Chinook salmon in the San Francisco estuary. These conflicting results suggest variability in the use of estuaries, some of which may be attributable to the highly modified condition of San Francisco Bay.

2. Coho Salmon

The life history of coho salmon in California has been well documented by Shapovalov and Taft (1954) and Hassler (1987). In contrast to the life history patterns of other anadromous

salmonids, coho salmon in California generally exhibit a relatively simple 3-year life cycle (Shapovalov and Taft 1954, Hassler 1987). Adult coho salmon typically begin the freshwater migration from the ocean to their natal streams after heavy late-fall or winter rains breach the sand bars at the mouths of coastal streams (Sandercock 1991). Delays in river entry of over a month are not unusual (Salo and Bayliff 1958; Eames *et al*. 1981). Adult migration continues into March, generally peaking in December and January, with spawning occurring shortly after the fish return to the spawning grounds (Shapovalov and Taft 1954).

Coho salmon are typically associated with small to moderately-sized coastal streams characterized by heavily forested watersheds, perennially-flowing reaches of cool water, dense riparian canopy, deep pools with abundant cover consisting of large, stable woody debris and undercut banks, and gravel or cobble substrates.

Female coho salmon choose spawning sites usually near the head of a riffle, just below a pool, where water changes from a laminar to a turbulent flow and there is small to medium gravel substrate. Flow characteristics at the redd usually ensure good aeration of eggs and embryos, and the flushing of metabolic waste products. The water circulation in these areas also facilitates fry emergence from the gravel. Preferred spawning grounds have nearby overhead and submerged cover for holding adults, water depths of 10 to 54 cm, water velocities of 20 to 80 cm/s, clean, loosely compacted gravel (1.3 to 12.7 cm diameter) with less than 20 percent fine silt or sand content, cool water (4 to 10°C) with high DO (8 mg/l), and intergravel flow sufficient to aerate the eggs. The lack of suitable gravel often limits successful spawning in many streams.

Each female builds a series of redds, moving in an upstream direction. At each redd site, the female creates a hollowed depression in the gravel into which she releases several hundred eggs. As they are deposited, the eggs are fertilized with milt from one or more attending males. The fertilized eggs are then covered with gravel by the female. Briggs (1953) noted a dominant male accompanies a female during spawning, but one or more subordinate males also may engage in spawning. The female may guard a nest for up to two weeks (Briggs 1953). Fecundity of coho salmon is directly proportional to female size; at the southern end of the species range (*i.e*., California and Oregon) average fecundity is about 2000 eggs (Sandercock 1991). Coho salmon are semelparous (they spawn once and then die).

Coho salmon eggs generally incubate for four to eight weeks, depending on water temperature. Egg survival and development rates depend on temperature and DO levels within the redd. According to Baker and Reynolds (1986), under optimum conditions, egg mortality can be as low as 10 percent, but under adverse conditions of high scouring flows or heavy siltation, mortality may be close to 100 percent. McMahon (1983) found that egg and pre-emergent fry survival drops sharply when fines make up 15 percent or more of the substrate. The newly-hatched fry remain in the gravel from two to seven weeks before emergence (Shapovalov and Taft 1954).

Upon emergence from the gravel, coho salmon fry seek out shallow water, usually along stream margins. As they grow, they often occupy habitat at the heads of pools, which generally provide an optimum mix of high food availability and good cover with low swimming cost (Nielsen 1992). Chapman and Bjornn (1969) determined that larger parr tend to occupy the head of pools,

with smaller parr found further down the pools. As the fish continue to grow, they move into deeper water and expand their territories until, by July and August, they are in the deep pools. Juvenile coho salmon prefer well shaded pools at least 1 meter deep with dense overhead cover; abundant submerged cover composed of undercut banks, logs, roots, and other woody debris; DO levels of 4 to 9 mg/l; and water velocities of 9 to 24 cm/s in pools and 31 to 46 cm/s in riffles. Water temperatures for good survival and growth of juvenile coho salmon range from 10 to 15°C (Bell 1973; McMahon 1983). Growth is slowed considerably at 18°C and ceases at 20°C (Stein *et al*. 1972; Bell 1973). The likelihood of juvenile coho salmon occupying habitats that exceed 16.3 ^{o}C maximum weekly average temperature declines significantly (Welsh *et al*. 2001).

Preferred rearing habitat has little or no turbidity and high sustained invertebrate forage production. Juvenile coho salmon feed primarily on drifting terrestrial insects, much of which are produced in the riparian canopy, and on aquatic invertebrates growing in the interstices of the substrate and in the leaf litter within pools. As water temperatures decrease in the fall and winter months, fish stop or reduce feeding due to lack of food or in response to the colder water, and growth rates slow down. During December-February, winter rains result in increased stream flows and by March, following peak flows, fish again feed heavily on insects and crustaceans and grow rapidly.

During late March and early April, coho salmon yearlings begin to smoltify and migrate downstream to the ocean. Out-migration usually peaks in mid-May, if conditions are favorable. Emigration timing is correlated with peak upwelling currents along the coast. Ocean entry at this time facilitates more growth and, therefore, greater marine survival (Holtby *et al*. 1990). At this point, the smolts are about 10 to 13 cm in length. After entering the ocean, the immature salmon initially remain in nearshore waters close to their parent stream. They gradually move northward, staying over the continental shelf (Brown *et al*. 1994). Although they can range widely in the north Pacific, the oceanic movements of California coho salmon are poorly understood.

The amount of time coho spend in estuarine environments is variable, but the time spent in estuaries may be less in the southern portion of their range (CDFG 2002). The extensive trapping studies of Shapovalov and Taft (1954) indicate that nearly all coho salmon in Waddell Creek (on the California coast south of the Russian River) migrate downstream as yearlings (1+) to enter the marine environment as smolts. Research conducted by Moser *et al*. (1991), suggests that coho salmon smolt migration through estuaries is slower than riverine migration due to the need for a period of estuarine residency that allows for developmental changes in osmoregulatory capability, orientation for their return migration, feeding, and reduction in vulnerability to predators. Nevertheless, estuarine residence times for radio tracked age 1+ coho smolts are often short, and can average 1 to 3 days (Miller and Sadro 2003).

Not all coho salmon migrate to estuaries as smolts. Miller and Sadro (2003) and Wallace (2006) report that a portion of young-of-the year (YOY) coho salmon juveniles move to estuaries during the spring months. Movement of YOY coho salmon has been attributed to displacement by high spring runoff, freshet events during fry emergence, or over-seeding and displacement of sub-dominant juveniles (Miller and Sadro 2003; Murphy *et al*. 1997). Information from Miller and

Sadro (2003) and Wallace (2006) shows that juvenile coho salmon movements and residency times in estuaries can be complex.

Some of the YOY coho salmon that moved to Oregon's Winchester Creek estuary in the spring were found to remain in the estuary to rear during the summer, and appeared to move further upstream in the estuary as the seasons changed. Miller and Sadro (2003) indicate that rising water temperatures and salinity may cause fish to move upstream in the summer, and higher flows may be responsible for YOY moving out of the estuary in the fall. Similarly, in California's Freshwater Creek, some YOY reared in the estuary during the summer, but they also appeared to move upstream when lower sloughs became saltwater in the late spring and summer (Wallace 2006). YOY coho salmon appeared to move upstream in both estuaries studied when salt content and temperatures rose to similar levels, making either or both reasonable explanations for the observed movements.

NMFS notes that some of the physical conditions in the estuaries discussed above are different in many ways from those in some other coastal California estuaries. For example, the Winchester Creek and Freshwater Creek estuaries are located on wide, flat floodplains with abundant wetlands and sloughs, whereas the Russian River is much more constrained by hillsides near its mouth and it has more limited marsh and slough habitats. Miller and Sadro (2003) indicate that the importance of estuarine rearing to coho salmon populations may be based on the amount of wetland and slough habitats present.

Coho salmon juveniles have been found in other estuaries in coastal California. Small numbers of YOY coho salmon have been found during the summer in the Redwood Creek estuary in Humboldt County in Northern California and in the Albion River estuary in Mendocino County (Maahs and Cannata 1998; S. Cannata, CDFG, personal communication, December 2004). Somewhat larger numbers of coho salmon YOY (roughly 1,000) have been found in Big Lagoon at the terminus of Redwood Creek in Marin County (Golden Gate National Recreation Area, 2008).

3. Steelhead

Steelhead spend anywhere from one to five years in saltwater, however, two to three years are most common (Busby *et al*. 1996). Some return as "half-pounders" that over-winter one season in freshwater before returning to the ocean in the spring. The distribution of steelhead in the ocean is not well known. Coded wire tag recoveries indicate that most steelhead tend to migrate north and south along the continental shelf (Barnhart 1986).

Only "winter" steelhead are found in the CCC steelhead ESU. The timing of upstream migration is correlated with seasonal high flows and associated lower water temperatures. Steelhead begin returning to the Russian River in December, with the run continuing into April. The minimum stream depth necessary for successful upstream migration is about 13 cm (Thompson 1972). The preferred water velocity for upstream migration is in the range of 40-90 cm/s, with a maximum velocity, beyond which upstream migration is not likely to occur, of 240 cm/s (Thompson 1972). Most spawning takes place from January through April. Steelhead may spawn more than one season before dying (iteroparity), in contrast to other species of the genus *Oncorhynchus*. Most

adult steelhead in a run are first time spawners, although Shapovalov and Taft (1954) reported that repeat spawners are relatively numerous (about 17 percent) in California streams. Among repeat spawners, the representation of each group declines as the number of spawnings increases. There is a sharp decline in numbers from second spawners (about 15 percent) to third spawners (about 2 percent). Fish spawning four or more times are rare (less than 1 percent).

Because rearing juvenile steelhead reside in freshwater all year, adequate flow and temperature are important to the population at all times. Generally, throughout their range in California, steelhead that are successful in surviving to adulthood spend at least two years in freshwater before emigrating downstream. Emigration appears to be more closely associated with size than age. In Waddell Creek, Shapovalov and Taft (1954) found steelhead juveniles migrating downstream at all times of the year with the largest numbers of age 0+ and yearling steelhead moving downstream during spring and summer. Smolts can range from 14-21 cm in length.

Steelhead spawn in cool, clear streams featuring suitable water depth, gravel size, and current velocity. Intermittent streams may be used for spawning (Everest 1973, Barnhart 1986). Reiser and Bjornn (1979) found that gravels of 1.3-11.7 cm in diameter were preferred by steelhead. The survival of embryos is reduced when fines smaller than 6.4 millimeters (mm) comprise 20 to 25 percent of the substrate. Studies have shown a higher survival of embryos when intragravel velocities exceed 20 cm/hr (Coble 1961; Phillips and Campbell 1961). The number of days required for steelhead eggs to hatch is inversely proportional to water temperature and varies from about 19 days at 15.6^{o}C to about 80 days at 5.6^{o}C. Fry typically emerge from the gravel two to three weeks after hatching (Barnhart 1986).

Upon emerging from the gravel, fry rear in edgewater habitats and move gradually into pools and riffles as they grow larger. Instream cover is an important habitat component for juvenile steelhead both as velocity refuge and as a means of avoiding predation (Meehan 1991). However, steelhead tend to use riffles and other habitats not strongly associated with cover more than other salmonids during summer rearing. Young steelhead feed on a wide variety of aquatic and terrestrial insects, and emerging fry are sometimes preyed upon by older juveniles. In winter, they become inactive and hide in any available cover, including gravel or woody debris.

Water temperature influences juvenile steelhead growth rates, population density, swimming ability, and their abilities to capture and metabolize food, and withstand disease (Barnhart 1986; Bjornn and Reiser 1991). Rearing steelhead juveniles prefer water temperatures of 7.2-14.4^{o}C and have an upper lethal limit of 23.9^{o}C. However, they can survive short periods up to 27°C with saturated dissolved oxygen (DO) conditions and a plentiful food supply. Fluctuating diurnal water temperatures also aid in survivability of salmonids (Busby *et al*. 1996).

DO levels of 6.5-7.0 mg/l affect the migration and swimming performance of steelhead juveniles at all temperatures (Davis *et al*. 1963). Reiser and Bjornn (1979) recommended that DO concentrations remain at or near saturation levels with temporary reductions no lower than 5.0 mg/l for successful rearing of juvenile steelhead. Low DO levels decrease juvenile steelhead swimming speed, growth rate, food consumption rate, efficiency of food utilization, threat avoidance behavior, and ultimately survival.

During rearing, suspended and deposited fine sediments can directly affect salmonids by abrading and clogging gills, and indirectly cause reduced feeding, avoidance reactions, destruction of food supplies, reduced egg and alevin survival, and changed rearing habitat (Reiser and Bjornn 1979). Bell (1991) found that suspended silt loads of less than 25 mg/l permit good rearing conditions for juvenile salmonids. It is unlikely that steelhead differ substantially from other salmonids in this respect, so we assume this finding applies to steelhead as well.

The migration of juvenile steelhead to lagoons occurs throughout the year, but is concentrated in the late spring/early summer and in the late fall/early winter period (Zedonis 1992; Shapovalov and Taft 1954).

Two discrete groups of juvenile steelhead utilize different kinds of habitat provided by lagoons: steelhead juveniles that use coastal lagoons for freshwater rearing throughout the year, and smolts that drop down from the watershed and use the lagoon primarily in the spring prior to seawater entry. Juveniles, especially those of small size such as YOY, are unlikely to be able to survive for long periods of time in the salt water environments of estuaries that are open to the ocean. McCormick (1994) indicates that steelhead juveniles need to be 2+ in age (or 150 mm in size) to be able to withstand full seawater (35 ppt). Survival time increases with juvenile size and decreases with salt concentration. For example, YOY rainbow trout/steelhead (80 - 100 mm) exposed to 25 ppt salinity were able to survive for about 19 hours, while larger age 2+ steelhead/rainbow trout (150-200 mm) were unaffected for the duration of the experiment (Parry 1960).

Small steelhead juveniles are likely to avoid salt water and brackish environments, and while they can be acclimated to brackish water, their growth is likely hindered. In the Navarro River estuary north of the Russian River, steelhead juveniles segregated by size when the estuary was open to the ocean. YOY and age 1+ juveniles were found mostly in the upper areas of the estuary (a few were found in the middle area), where salinity in the surface layers remained lower and was less influenced by tidal action (Cannata 1998). In the Mattole River lagoon, juvenile movement to the upper areas of the lagoon in one year was attributed to substantial salt water overwash into the lower lagoon (Zedonis 1992). In Redwood Creek, the substantial decrease in steelhead numbers in the estuary following breaching was likely caused, in part, by the sudden shift from fresh to salt water (Larson 1987). Steelhead juveniles can be acclimated to different concentrations of salt water if done relatively slowly. Morgan and Iwama (1991) acclimated steelhead fry and juveniles to 4, 8, 12, and 16 ppt salinity by raising salinities 1-2 ppt per day with less than 5% mortality. Nevertheless, growth rates declined as salinity increased. Steelhead growth rates declined 16% over the range of salinities tested. The distribution of juveniles seen in the lagoons described above, and the avoidance of salt water by smaller juveniles indicates that acclimation, especially for YOY, is not the norm in tidally influenced (or overwashed) estuaries in Northern California.

Because rearing juvenile steelhead often migrate downstream in search of available freshwater habitat (Bjornn 1971), significant percentages of the juvenile steelhead population can end up rearing in coastal lagoons and estuaries (Zedonis 1992; Shapovalov and Taft 1954). If estuarine

or coastal lagoon rearing habitat is unavailable or of poor quality, the potential survival of these emigrants is low.

B. Species Viability Assessment

1. Species Legal Status

For the latest ESA status review of listed salmonids, NMFS formed Biological Review Teams (BRTs) comprised of a core group of scientists from the NMFS Northwest and Southwest Fisheries Science Centers, supplemented by experts on particular species from NMFS and other federal agencies. The BRTs assembled the best available information on the condition of listed salmonids and used a risk-matrix method to quantify risks faced by each ESU[14] based on the VSP concept (Good *et al*. 2005). This information was transformed into risk scores. Based on these risk scores (including interactions among different risks) each member of the BRT voted using a "likelihood point method" to distribute 10 points among three ESU risk categories: not at risk, likely to become endangered, or in danger of extinction (Good *et al*. 2005).

a. CC Chinook Salmon

Although there are limited data available, recent status reviews for CC Chinook salmon conclude that population abundance levels remain depressed relative to historical levels and that this ESU is "likely to become endangered" (NMFS 2001; Good *et al*. 2005). In the most recent status review, the BRTs evaluation of available data indicated moderately high risk in all VSP elements. The BRTs main concerns were the low abundance relative to historical abundance, potential loss of populations in the southern part of the ESU, and the loss of spring-run salmon in the Eel River and other areas. A majority (67%) of the BRTs votes for CC Chinook salmon were "likely to become endangered". Of the remainder, votes for "in danger of extinction" out numbered "not warranted" by two to one. NMFS issued a final rule maintaining the threatened status of CC Chinook salmon on June 28, 2005 (70 FR 37160).

b. CCC Coho Salmon

The BRTs evaluation of available data in the most recent status review indicated that CCC coho salmon are at very high risk of extinction because of conditions associated with the VSP categories of abundance, growth rate, and spatial structure. The BRT's main concerns were low abundance across the ESU, long term downward trends in abundance across the ESU, and extirpation of most populations in the southern two-thirds of the ESU. In addition, loss of genetic diversity from range reductions, loss of brood years, and historical hatchery influence were considered high concerns. A large majority (74%) of the BRT's votes for CCC coho salmon were "in danger of extinction" (Good *et al*. 2005). NMFS issued a final rule confirming the endangered status of CCC coho salmon on June 28, 2005 (70 FR 37160).

[14] Subsequent to the BRT's work, steelhead ESUs were re-evaluated as DPSs. This reevaluation did not result in listing status determinations different from the BRT's work.

c. CCC Steelhead

The BRT's evaluation of available data for CCC steelhead indicated abundance and productivity, as well as spatial structure, were relatively high concerns. A majority of the BRT's votes for CCC steelhead were "likely to become endangered" (69%) with 25% for "in danger of extinction". On January 5, 2006, NMFS issued a final determination that the CCC steelhead DPS is a threatened species, as previously listed (71 FR 834).

2. Factors Responsible for Species Status

a. Freshwater Habitat Degradation

The condition of freshwater habitats has been degraded from conditions known to support viable salmonid populations. NMFS has determined that present depressed population conditions are, in part, the result of the following human-induced factors affecting habitat (including critical habitat): logging, agricultural and mining activities, urbanization, stream channelization, dams, wetland loss, and water withdrawals, including unscreened diversions for irrigation. Impacts of concern include alteration of stream bank and channel morphology, alteration of water temperatures, loss of spawning and rearing habitat, fragmentation of habitat, loss of downstream recruitment of spawning gravels and large woody debris, degradation of water quality, removal of riparian vegetation resulting in increased stream bank erosion, increases in erosion entry to streams from upland areas, loss of shade (higher water temperatures) and loss of nutrient inputs (Busby *et al*. 1996; 69 FR 33102, 70 FR 52488). Depletion and storage of natural river and stream flows have drastically altered natural hydrologic cycles in many of the streams in the ESU. Alteration of flows have caused migration delays, loss of suitable habitat due to dewatering, stranding of fish from rapid flow fluctuations, entrainment of juveniles into poorly screened or unscreened diversions, and increased water temperatures harmful to salmonids.

b. Climate and Ocean.

As described in the **Introduction**, the best available scientific information indicates that the Earth's climate is warming, driven by the accumulation of greenhouse gasses in the atmosphere (Lindley *et al.* 2007; Battin *et al.* 2007; Oreskes 2004). Our climate influences freshwater streams and the oceans. Warming is likely to affect many of the physical, chemical, and biological conditions of these water bodies[15]. Because salmon and steelhead depend upon freshwater streams and oceans during different stages of their life history cycle, their populations are likely to be impacted by climate change.

Beyond the scientific consensus that warming is occurring, predicting what is likely to happen, and when, involves uncertainty. Predictions become less and less certain as one moves from the global scale to regional and smaller scales, and less certain as models attempt to predict far into the future (50 to100+ years). In addition to increasing uncertainty as geographical scale decreases and length of time increases, there is less certainty about changes to the ocean

[15] There is strong evidence that warming has already affected ecosystems. See for example Walther *et al*. 2002, Harvell *et al*. 2002, Schneider and Root 2002, and Quinn and Adams 1996.

environment than for terrestrial environments such as freshwater streams (Climate Impacts Group [CIG] 2004).

Several complex climate models are now being used to forecast future climate conditions. Model predictions show relatively low to relatively high impacts depending upon which model is used and which greenhouse gas emissions scenario is considered. Regardless, even the relatively low impact results from most models of low emissions scenarios indicate changes in temperatures, rainfall, snowpack, vegetation, *etc.* by mid to late century that are likely to have serious negative impacts on salmonid population numbers, distribution, and reproduction.

In California, average summer air temperatures are expected to increase (Lindley *et al*. 2007). Heat waves are expected to occur more often, and heat wave temperatures are anticipated to be higher (Hayhoe *et al.* 2004). The snowpack is expected to decrease, potentially as much as 60 to 80% by the end of the century (Luers *et al.* 2006). Total precipitation in California may decline; critically dry years may increase (Lindley *et al*. 2007; Schneider 2007). Wildfires are expected to increase in frequency and magnitude, by as much as 55% under the highest emission scenarios modeled (Luers *et al.* 2006). Vegetative cover may also change, with decreases in evergreen conifer forest and increases in grasslands and mixed evergreen forests. Forest productivity is also expected to decline (Luers *et al.* 2006).

These changes are likely to further degrade habitat for salmon and steelhead in the North Central California Coast Recovery Domain[16]. Air temperature is an important influence on stream temperature (Poole and Berman 2001). Increasing air temperatures have the potential to limit the quality and availability of summer rearing habitat for salmonids in streams. For example, modeling reported by Lindley *et al.* (2007) shows that as overall warming increases from 2° C under lower greenhouse gas emission scenarios, to 8°C under high emissions scenarios, the geographic area experiencing mean August air temperature exceeding 25°C moves further into coastal drainages and closer to the Pacific Ocean. Stream temperatures will likely increase in these areas.

The likely amount of rainfall in Coastal California under various warming scenarios is less certain, although as noted above, total rainfall across the state is expected to decline. For the California North Coast, some models show large increases (75% to 200%) while other models show decreases of 15% to 30 % (Hayhoe *et al.* 2004). In the interior, precipitation is expected to decrease (Bell 2004). Increases in rainfall during the winter have the potential to increase scour and loss of salmon and steelhead redds. Reductions in precipitation will likely lower flows in streams during the spring and summer, likely reducing the availability of flows to support smolt migration to the ocean and the availability of summer rearing habitat.

The link between fires and sediment delivery to streams is well known (Wells 1987; Spittler 2005). Fires can increase the incidence of erosion by removing vegetative cover from steep slopes. Subsequent rainstorms produce debris flows which carry sediments to streams.

[16] Recovery Domains are part of NMFS' recovery planning process. Each recovery planning domain encompasses a specific geographic area and has a Technical Recovery Team (Scientists from NMFS, other Federal agencies, State agencies, and academia). NMFS Recovery Coordinators lead the development of recovery plans for each domain. Domains typically encompass more than one ESU or DPS.

Increases in stream sediment can reduce egg to emergence survival, and can reduce stream invertebrate production, an important food source for rearing salmon and steelhead juveniles (Bjornn and Reiser 1991; Waters 1995)

Changes in vegetative cover can impact salmon and steelhead habitat by reducing stream shade (thereby promoting higher stream temperatures), and changing the amount and characteristics of woody debris in streams. High quality salmonid habitat in many salmonid streams in the northern part of the NCCC Domain is dependent upon the recruitment of large conifer trees to streams. Once these trees fall into streams, their trunks and root balls provide hiding cover for salmonids and, by interacting with stream flows and stream beds and banks, often create deep stream pools needed by salmonids to escape high summer water temperatures. For coho salmon, these pools are essential for feeding and rearing.

Ocean changes resulting from climate change are more uncertain (CIG 2004). Global warming may impact coastal upwelling along the California Coast in the NCCC Domain by decreasing early upwelling and increasing mid and late upwelling. (Diffenbaugh *et al.* 2003). Weak early season upwelling can have serious consequences for the marine food web, impacting invertebrates, birds, and potentially other biota (Barth *et al.* 2007). Salmon and steelhead smolts entering these California Coastal waters could be impacted by reduced food supplies.

Estuaries are likely to become increasingly vulnerable to eutrophication (excessive nutrient loading and subsequent depletion of oxygen) due to changes in precipitation and freshwater runoff patterns, temperatures, and sea level (Scavia *et al.* 2002). These changes can affect water residence time, dilution, vertical stratification, water temperature ranges, and salinity. Salinities in San Francisco Bay have already increased because increasing air temperatures have led to earlier snow melt, reducing freshwater flows in the spring. Should this trend continue and strengthen, salinities during the dry season will increase, contributing additional stress to an ecosystem that is already highly altered and degraded (Scavia *et al.* 2002).

Thus, habitat conditions for salmonids in the ESU's and DPS under consideration in this biological opinion are likely to worsen by mid to late century. Reliable predictions of specific levels of impacts, or localized impacts, during the fifteen year period of the proposed action cannot currently be made based on the best available scientific information.

Global climate change has likely already had some impacts on salmonids and their habitats on the west coast of the United States. For example, changes in water temperature and Sockeye salmon spawning times in the Columbia River have been attributed to global climate change (Quinn and Adams 1996). Similar information is not available for the rivers and streams in the ESUs and DPS under consideration in this biological opinion. We assume any climate change impacts that have occurred are generally reflected in the current status of listed species and their critical habitats.

Variability in ocean productivity has been shown to affect salmon production both positively and negatively. Beamish and Bouillion (1993) showed a strong correlation between North Pacific salmon production and marine environmental factors from 1925 to 1989. Beamish *et al.* (1997) noted decadal-scale changes in the production of Fraser River sockeye salmon that they

attributed to changes in the productivity of the marine environment. They also reported the dramatic change in marine conditions occurring in 1976-77 (an El Niño year), when an oceanic warming trend began. These El Niño conditions, which occur every three to five years, negatively affect ocean productivity. Johnson (1988) noted increased adult mortality and decreased average size for Oregon Chinook salmon and coho salmon during the strong 1982-83 El Niño. Of greatest importance is not how these species perform during periods of high marine survival, but how prolonged periods of poor marine survival affect the viability of populations. It is reasonable to assume that salmon populations have persisted over time, under pristine conditions, through many such cycles in the past. But it is less certain how they will fare in periods of poor ocean survival when their freshwater, estuary, and nearshore marine habitats are degraded (Good *et al*. 2005).

As noted above, dramatic declines in coho salmon and Chinook salmon adult returns for 2006/07 are likely the result of poor ocean conditions. Due to their low numbers, some coho salmon populations may not be resilient enough to survive extended periods of exceptionally low ocean productivity.

c. Artificial Propagation

Releasing large numbers of hatchery fish can pose threats to salmonid stocks through genetic impacts, competition for food and other resources, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production (Waples 1991). The genetic impacts of artificial propagation programs are primarily caused by the straying of genetically distinct hatchery fish and the subsequent hybridization of hatchery and wild fish. Artificial propagation threatens the genetic integrity and diversity that protect overall productivity against changes in the environment (61 FR 56138).

d. Reduced Marine-Derived Nutrient Transport

Reduction of marine-derived nutrients (MDN) to watersheds is a consequence of the past century of decline in salmon abundance (Gresh *et al.* 2000). MDN are nutrients that are accumulated in the biomass of salmonids while they are in the ocean and are then transported to their freshwater spawning sites. Salmonids may play a critical role in sustaining the quality of habitats essential to the survival of their own species. MDN (from salmon carcasses) has been shown to be vital for the growth of juvenile salmonids (Bilby *et al*. 1996; Bilby *et al*. 1998). The return of salmonids to rivers can make a significant contribution to the flora and fauna of both terrestrial and riverine ecosystems (Gresh *et al.* 2000). Evidence of the role of MDN and energy in ecosystems suggests this deficit may result in an ecosystem failure contributing to the downward spiral of salmonid abundance (Bilby *et al*. 1996). The loss of this nutrient source may perpetuate salmonid declines in an increasing synergistic fashion.

e. Marine Mammal Predation

Predation by marine mammals is not believed to be a major factor contributing to the decline of west coast salmon relative to the effects of fishing, habitat degradation, and hatchery practices. Harbor seal (*Phoca vitulina*) and California sea lion (*Zalophus californianus*) numbers have

increased along the Pacific Coast (NMFS 1999a). However, at the mouth of the Russian River in Sonoma County for example, Hanson (1993) reported foraging behavior of California sea lions and harbor seals with respect to anadromous salmonids was minimal. Hanson (1993) also stated predation on salmonids appeared to be coincidental with the salmonid migrations, and that the harbor seal population at the mouth of the Russian River was not dependent upon them. Nevertheless, this type of predation may have substantial impacts in localized areas.

3. Method for Determining Current Species Extinction Risk

One prerequisite for predicting the effects of a proposed action on a species is understanding the species extinction risk, and the mechanisms by which the proposed action is expected to affect this risk. As described above in the analytical framework, we equate high extinction risk with a low likelihood of survival and recovery, and vice versa. To determine the current extinction risk for CC Chinook salmon, CCC coho salmon, and CCC steelhead, we used the historic population structure of these species as presented by the Technical Recovery Team (TRT) for the North-Central California Coast Recovery Domain in Bjorkstedt *et al.* (2005), the VSP concept, and ESU viability criteria provided by the TRT in Spence *et al*. (2008).

The TRT analyzed the historical population structure of salmon and steelhead ESUs or DPSs to develop an understanding of the population dynamics that supported these species prior to European settlement. The TRT intends the historical condition of the salmonid populations in each ESU or DPS to serve as a point of reference for evaluating the current viability (extinction risk)[17]. Bjorkstedt *et al*. (2005) described the demographic structure of each ESU and DPS within the North–Central California Coast Recovery Domain (NCCCRD). Distinct historical populations were defined as those individuals that spawn and rear in a single watershed that is tributary to the Pacific Ocean. Larger basins were further subdivided into multiple populations if sufficient physical, behavioral, or selective barriers to effective dispersal were evident. This model of geographically explicit populations was supported by information on geographic structure, genetic structure, and life history variation.

These historical populations were further categorized by Bjorkstedt *et al.* (2005) based on their distribution and demographic role (*i.e.*, independent, dependent, or ephemeral). Functionally independent populations were sufficiently large to be viable in isolation, and had a high likelihood of persisting over a 100 year timescale, absent human impacts (*i.e.*, a negligible extinction risk). Potentially independent populations were potentially viable in isolation, but were likely influenced by immigrants from adjacent populations. Dependent populations were unlikely to persist over a 100 year time period in isolation, but with immigration from other nearby populations, their risk of extinction is reduced. .Ephemeral populations were unlikely to persist for a 100 year time period and did not receive enough immigration to reduce this risk. These populations were only intermittently present.

Bjorkstedt *et al.* (2005) arranged the historical populations in each ESU or DPS into diversity strata to provide a diversity and spatial structure framework to evaluate ESU viability (extinction risk). These diversity strata represent groups of populations that are located in generally similar

[17] The TRT did not propose that historical conditions are the criteria or benchmark for evaluating population or ESU viability (extinction risk).

sets of environmental conditions within an ESU, and the populations within diversity strata are expected by Bjorkstedt *et al.* (2005) to reflect these conditions phenotypically and genotypically. Groups of populations spread out across an ESU help to ensure viability by "*buffer*[ing] *the ESU against catastrophic loss of populations by ensuring redundancy,* provid[ing] *sufficient connectivity among populations to maintain long-term demographic and evolutionary processes, and ensur*[ing] *sufficient genetic and phenotypic diversity to maintain the ESUs evolutionary potential in the face of changing environmental conditions*" (Spence *et al.* 2008).

Spence *et al*. (2008) provide a set of rules to address the ESU viability issues identified above. In order for an ESU or DPS to be viable, *i.e*., have a negligible extinction risk, representation, redundancy, and connectivity criteria should be met:

Representation Criteria

1a. All diversity strata that include historical functionally independent (or potentially independent) populations within an ESU or DPS should be represented by populations with viable populations (populations with negligible extinction risk) for the ESU or DPS to be considered viable (having negligible extinction risk).

2a. Within each diversity stratum, all extant phenotypic diversity (*i.e*., major life history types) should be represented by viable populations (populations with negligible extinction risk).

Redundancy and Connectivity Criteria

2a. At least fifty percent of historically independent (or potentially independent) populations in each diversity stratum must be demonstrated to be at low risk of extinction. For strata with three or fewer independent populations, at least two must be viable (have a negligible risk of extinction).

2b. Within each diversity stratum, the total aggregate abundance of independent populations selected to satisfy 2a above must meet or exceed fifty percent of the aggregate viable population abundance (provided by Spence *et al*. 2008) for all independent and potentially independent populations in the ESU.

3. Remaining populations, including historical dependent populations and any historical independent and potentially independent populations not expected to attain a viable status must exhibit occupancy patterns consistent with those expected under sufficient immigration subsidy arising from the 'core' independent populations selected to satisfy the criteria above.

4. The distribution of extant populations, regardless of historical status, must maintain connectivity within the diversity stratum, as well as connectivity to neighboring diversity strata.

We evaluated the current extinction risk for CC Chinook salmon, CCC coho salmon, and CCC steelhead (Figure 4) by examining the extinction risk for each population within each diversity strata (as defined by Spence *et al.* 2008- Figure 5) for these ESUs or DPS. With the results of this analysis, we then used the ESU level criteria above to determine the ESU and DPS

extinction risk. Our analysis of extinction risk at the ESU/DPS scale relies heavily on the work of Spence *et al.* 2008.

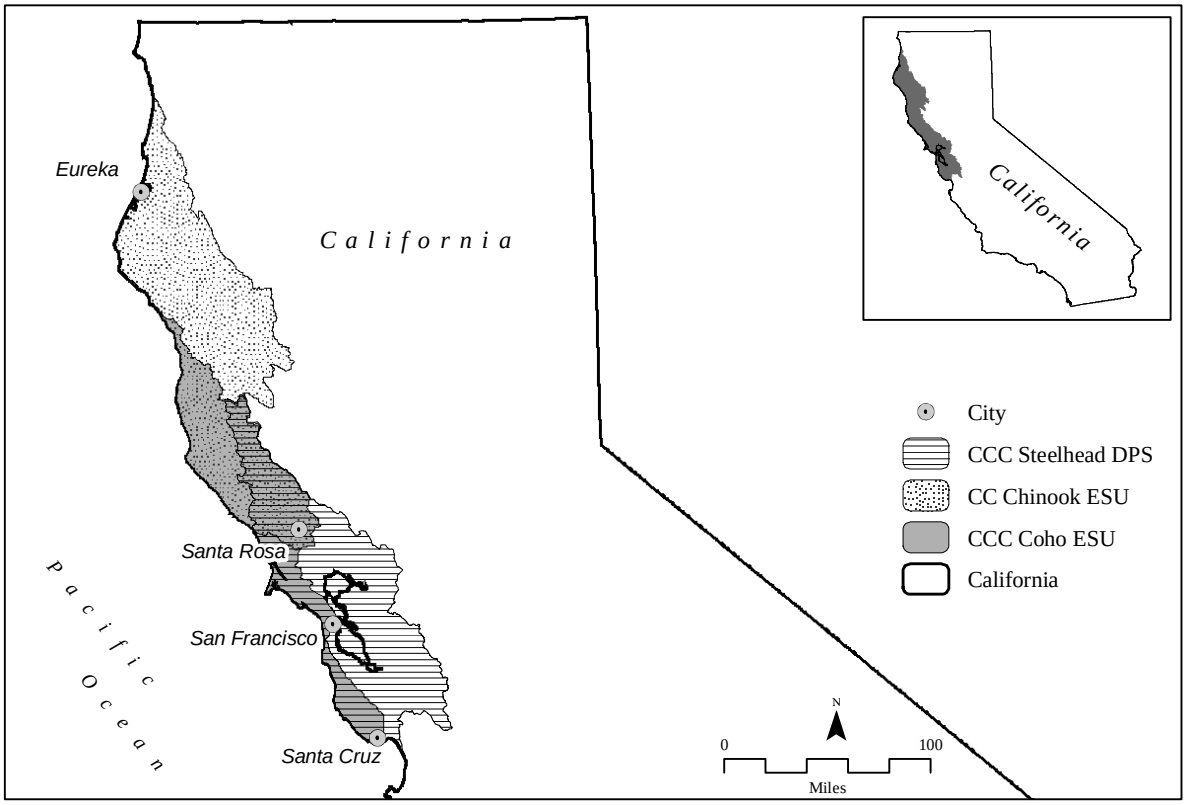

Figure 4. Location of the CC Chinook salmon ESU, the CCC coho salmon ESU, and the CCC steelhead DPS along the coast of California.

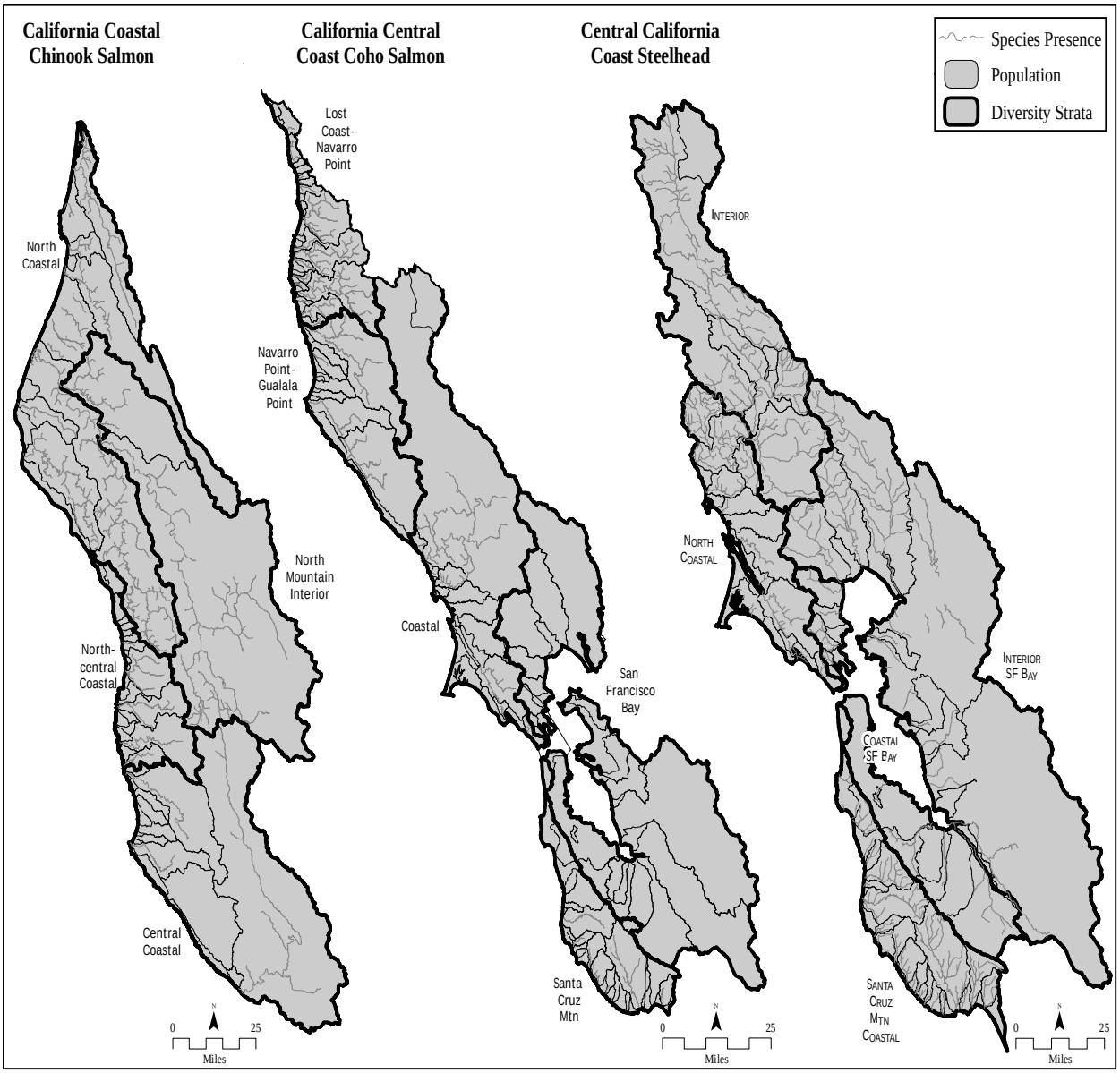

Figure 5. ESU/DPS maps of CC Chinook salmon, CCC coho salmon, and CCC steelhead showing their range, current distribution, and historical population structure. CC Chinook salmon diversity strata are for Fall-Run populations only. Figure based on Spence *et al.* 2008.

Note that our analysis in the draft June 11, 2007 biological opinion applied the VSP criteria to strata directly. In that earlier analysis, information on the general status of the species in the watersheds within the strata was used to determine strata viability (*i.e*. extinction risk). For this final biological opinion we recast our analysis to focus more on the extinction risk of individual populations in each diversity strata in order to appropriately apply the ESU viability criteria provided by Spence *et al*. (2008). As noted above, we rely heavily on the results of Spence *et al*. (2008) as the definitive source for ESU viability evaluation. We do this because Spence *et al*. (2008) is the work of the TRT and provides the best available scientific information.

Our analysis of the viability of the populations that make up each strata in each ESU or DPS used the four population viability criteria described in McElhany *et al.* (2000): abundance, population growth rate, spatial structure, and diversity. Abundance is defined as the estimated number of spawning adults in a given year in a population. Population growth rate is defined as a population's ability to replace itself given its intrinsic reproductive rate in the context of its environment. Spatial structure concerns the geographic distribution of a population at any life stage. Consideration was given to the loss of a population's ability to support certain life stages, such as spawning and rearing, even if the species was still considered present (*e.g.*, the area functions as a migration corridor). Diversity is defined as the genetic, morphologic, physiological, behavioral, or ecological variation that exists within a population. We assumed that the trajectory of these evolutionary traits is influenced by the environmental conditions that impose a selective regime on the population. Since the actual genetic and other forms of diversity were often unknown, the diversity of habitats and their divergence from historical conditions were at times, used as a surrogate.

4. <u>CC Chinook Salmon Extinction Risk</u>

CC Chinook salmon is the only species with a population that Bjorkstedt *et al*. (2005) split between two diversity strata. One of the sub-populations (South Fork Eel River) in the Lower Eel River population was placed in the North Coastal Diversity Stratum because this subpopulation experiences conditions environmentally similar to other populations in this stratum. Spence *et al.* (2008) maintained this split.

a. North Coastal Diversity Stratum Populations

Adult abundance is substantially reduced from historic levels and the Spring-run populations are extinct in this stratum (Bjorkstedt *et al*. 2005, Good *et al*. 2005). For these reasons, we consider the populations in the North Coastal stratum to have very high extinction risk. However, the northern latitude, coastal climate, and generally wetter condition tend to provide high potential for favorable conditions for the survival of these populations, though anthropogenic disturbance detracts from this potential. In addition, the populations in this stratum remain widely distributed and, with the exception of a spring-run component, probably maintain much of their genetic diversity. Also, recent data (prior to 2007) indicates a moderate short-term increase in adult abundance (Good *et al*. 2005).

b. North Mountain Interior Diversity Stratum Populations

The populations in this stratum have very high extinction risk, due mainly to the status of the Upper Eel River population. It, along with the Lower Eel River population (also part of the North Coastal Diversity Stratum), was historically one of the largest in the ESU and functioned as an important source population (Bjorkstedt et al. 2005). The Upper Eel River population is also particularly important to the conservation of the ESU because it possesses unique geographic and ecologic features that have likely fostered adaptations not provided for in most other habitats in the ESU. In particular, it contains most of the high altitude areas where snowmelt contributes substantially to stream flows. This provides cooler and more abundant stream flows later into, and perhaps throughout, the summer. These conditions have historically

allowed for the persistence of a spring-run population. However, spring-run Chinook salmon are also considered extinct in the populations that make up this diversity stratum (Good *et al.* 2005). The area occupied by the Upper Eel River population is characterized by long migration routes which may have selected for a unique component of the fall run population.

c. North-Central Coastal Diversity Stratum Populations

There is some question as to whether historical populations existed within this diversity stratum. Most anecdotal evidence indicates Chinook salmon have been absent from the major rivers in this stratum since at least the early twentieth century (A. Grass, CDFG, personal communication, October 25, 2006). However, an analysis of habitat potential conducted by Bjorkstedt *et al*. (2005) indicates these same rivers possess the necessary size, gradient, and flow to have supported viable populations. In terms of evaluating extinction risk, we find it prudent to assume the later analysis is correct and to rate the current extinction risk in the context of assumed historical populations.

We consider the populations in this stratum to have very high extinction risk, based primarily on the low observed abundance in the context of presumed historical population abundances. This suggests declines in the abundance and productivity of these populations. Some habitat attributes, however, are favorable for the populations in this stratum due to the dominant influence of the coastal climate.

d. Central Coastal Diversity Stratum Populations

Our assessment of the extinction risk of the populations in this stratum is greatly influenced by the observed adult abundance and inferred productivity of the Chinook salmon population in the Russian River. SCWA estimated the Chinook salmon run size at 1,500 in 2000 and 2001, and observed 5,474 in 2002, 6,103 in 2003, 4,788 in 2004[18] 2,572 in 2005, 3,410 in 2006, and 1,959 in 2007 (Chase *et al*. 2005, www.scwa.ca.gov/ environment/natural_resources/ Chinook_ salmon.php, SCWA 2008c). The apparent increase in abundance is tempered by the 2007 decline in this, and other, Chinook populations across the State. Recent information on Chinook salmon adult returns for 2007 indicates low returns likely due to poor ocean conditions and other factors (SWFSC 2008). In the Russian River, returns for 2007 are estimated at 1,959 fish, down from 3,410 fish in 2006 and a high of 6,081 fish in 2003 (SCWA 2008c). This species has also been observed recently in the Navarro and Gualala rivers, but sightings are uncommon and we believe the species occurs only sporadically in these latter basins. In this stratum, only one independent population appears to remain, but the moderate abundance in the Russian River population may suggest a trend toward sustainable production for this population.

e. ESU Extinction Risk

The CC Chinook Salmon ESU appears to contain only one population (the Russian River population) that may be trending toward viability. All other populations are substantially reduced from historical levels. Both the North- Central Coastal and Central Coast Diversity Stratum are poorly represented in terms of functionally independent populations (and dependent

[18] Estimates are based on partial counts of adult fish passage at the Wohler Dam fish ladder.

populations); only the Russian River population appears to remain in the Central Coast Diversity Stratum. As described below in **C. Critical Habitat Analysis**, CC Chinook salmon critical habitat does not currently support the conservation of the species. The degraded conditions of PCEs limit the ability of many Chinook salmon populations to increase in abundance, and may foster further declines in some areas. We conclude that this ESU is at an elevated risk of extinction. Spence *et al.* (2008) reach similar conclusions:

"*In summary, the lack of data from which to assess viability of extant populations in the northern part of the ESU, the apparent lack of extant populations, with the exception of the Russian River, in the southern half of the ESU, the loss of important life history diversity (i.e., spring-run populations), and the substantial gaps in the distribution of Chinook salmon throughout the CC ESU strongly indicate that this ESU fails to meet low-risk criteria and is therefore at elevated risk of extinction*" (Spence *et al.* 2008).

5. <u>CCC Coho Salmon Extinction Risk</u>

This is the only ESU of the three we analyze that is listed as endangered, and the results of the extinction risk assessment reflect that special status. While the populations in the Lost Coast-Navarro Point diversity stratum rated better than the populations in the other four strata, we still consider these populations reduced from a viable state given their current status. The viability of the populations within the ESU generally follow a trend of increasing extinction risk in a southerly direction. The populations in the Santa Cruz Mountains Diversity stratum have the highest extinction risk outside of the populations of the San Francisco bay stratum, which are presumed extinct. With the exception of Lagunitas Creek in Marin County, the distribution and abundance of coho salmon in watersheds south of Big Salmon Creek is very limited.

The populations in this ESU suffer from extremely low contemporary abundance compared to historical abundance, widespread local extinctions, clear downward trends in abundance, extensive habitat degradation, and associated decreases in carrying capacity (Good *et al*. 2005). Both juvenile density and presence-absence data suggest that coho salmon continue to decline across the ESU (NMFS 2001). These low numbers reduce the resilience of CCC coho salmon populations to respond to changes in ocean conditions and other climatic factors. Preliminary data from adult return counts and estimations in 2007/08 indicates a severe decline in returning adults across the range of coho salmon on the coast of California and Oregon compared to the same cohort in 2004/05. Ocean conditions are suspected as the principal short term cause because of the wide geographic range of declines (Southwest Fisheries Science Center 2008). This year's cohort has not been detected in Redwood Creek (in Marin County), suggesting this cohort may be extirpated in this stream.

a. Lost Coast-Navarro Point Diversity Stratum Populations

The extinction risk of populations in this stratum, while better than most others in the ESU, appears to be increased by consistent declines in abundance and reductions in distribution of rearing habitats. However, given the poor status of populations to the south, the greater amount of precipitation and more consistent influence of cool coastal climate, it is likely that this stratum contains the majority of coho salmon remaining in the ESU. Historical time series estimates of

spawner abundance for three major rivers in the area (Ten Mile River, Noyo River, and Big River) show substantial reductions from 1963 to 1991 (Table 5) (Good *et al*. 2005). While the accuracy of these early abundance estimates is somewhat suspect due to the lack scientific rigor, they are indicative of a general decline. More sophisticated adult abundance estimates based on redd counts by Gallagher (2005) suggest that depressed abundance continues to the present day.

Table 5. Recent historical estimates of coho salmon spawner abundance for functionally independent populations in the Lost Coast-Navarro Point diversity stratum of the CCC coho salmon ESU. Table adapted from Good *et al*. (2005).

Functionally Independent Population	CDFG (1965) 1963	Wahle and Pearson (1987) 1984-1985	Brown *et al*. (1994) 1987-1991	% Reduction
Ten Mile River	6000	2000	160	97
Noyo River	6000	2000	3740	38
Big River	6000	2000	280	95

The limited ability of populations to successfully spawn, rear, and therefore reproduce may be the proximal cause of the decline in their abundance. Juvenile data from the Noyo River indicate strong year-classes in 1995, 1996 (this year was strong coastwide), and 1997. More recent data however, suggests that these strong years did not carry over to subsequent generations (NMFS 2001).

The spatial structure of rearing juvenile populations in this stratum is likely moderately reduced from historical condition. Usal Creek was historically one of the northern most populations in the ESU and is now considered extinct (NMFS 2001). Coho salmon populations persist in Cottoneva, Pudding, Hare, Caspar, Little River, Albion, and Big Salmon watersheds (CDFG 2002). Additional occupancy data suggest that populations also continue to persist in Big, Noyo, and Ten Mile rivers but that their distributions have been substantially reduced within those basins (Good *et al*. 2005). We therefore consider the populations within this diversity stratum to have a moderate risk of extinction.

b. Lost Coast-Gualala Point Diversity Stratum Populations

There is a pronounced increase in extinction risk for the populations in the Navarro Point-Gualala Point diversity stratum relative to the populations in the stratum to the north. Evidence suggests that abundance and distribution of coho salmon populations in this area is greatly reduced from historical levels. Historically, the functionally independent populations in this stratum were found in the Navarro, Garcia, and Gualala rivers. Currently, the Navarro River is the only watershed to support persistent, albeit limited, areas of rearing coho salmon. Good *et al*.'s (2005) data show substantial reductions in abundance from 1963 to 1991 (Table 6).

Most of the Navarro River was occupied at one time (Spence *et al*. 2005). Johnson *et al*. (2002) estimated 130 stream miles in the Navarro River supported coho salmon as of 1963. The current distribution of coho salmon in the Navarro watershed is now primarily limited to the North Fork

and Flynn Creek (CDFG 2002; Johnson *et al*. 2002). Johnson *et al*. (2002) estimated a 78 percent reduction in the distribution of rearing coho salmon within the Navarro River watershed over the previous 12 year period. CDFG (2002) reports that annual surveys conducted since 1989 have detected coho presence only in the South Fork Garcia River and only in 1994 and 1996.

There are also isolated occurrences of coho salmon in the North Fork of the Gualala River. Limited surveys in the Gualala River have documented occasional occurrence of coho in the last 15 years, but the distribution of fish has been sparse. NMFS (2001) reported that coho were present in the Little North Fork Gualala River in 1988, but have not been documented since, despite being surveyed in 9 of the 12 years prior to 2001. For these reasons, we consider the extinction risk of the historically functionally independent populations in this stratum to be high.

Table 6. Recent historical estimates of coho salmon spawner abundance for functionally independent populations in the Navarro Point-Point Arena diversity stratum of the CCC coho salmon ESU. Table adapted from Good *et al*. (2005). Percent reductions were calculated using Wahle and Pearson (1987) estimates only when Brown *et al*. (1994) estimates were not available.

	CDFG (1965)	**Wahle and Pearson (1987)**	**Brown *et al*. (1994)**	
Watershed	**1963**	**1984-1985**	**1987-1991**	**%Reduction**
Navarro River	7000	2000	300	96
Garcia River	2000	500	-	75
Gualala River	4000	1000	200	95
Other	10000	7000	470	95

c. Coastal Diversity Stratum Populations

Current abundance of coho salmon populations is highly variable within this diversity stratum. The Lagunitas Creek population (functionally independent) has the most persistent and abundant population in the strata. Redwood Creek and Pine Gulch populations also appear to remain persistent. Coho salmon in the Russian River population (functionally independent) have declined to a population that is very nearly extirpated (Table 7). Those few fish that remain spawn and rear in select tributary reaches. Many of these tributaries, however, are occupied intermittently or have not supported coho salmon at all in recent years. The Russian River is unique in that it is the location of a captive broodstock program that supports recovery of the coho salmon population within the Russian River basin. The program to date, has successfully produced, reared, and released four year classes of juvenile coho salmon, and two of the year classes have reached an age sufficient to yield returning adult spawners. Spawning survey efforts by RRCSCBP in the best habitat areas, detected only one adult female in the 2006/07 spawning season, and no adult coho salmon were detected during the 2007/08 spawning season (M. Obedzinski, U.C.Davis Extension, personal communication, 2008)[19]. However, during spring 2008, downstream migrant trapping data documented more than 500 wild spawned coho

[19] This female was observed in Mill Creek and was later found dead and unspawned. Video monitoring of adult escapement in Austin Creek also yielded a possible lone female, but its identification to species is unconfirmed due to image quality.

salmon YOY in Felta Creek, a watershed where broodstock fry have been planted annually since 2004 (J.L.Conrad, PSMFC, personal communication, May 21, 2008).

NMFS (2001) reports an overall decline in abundance in coho salmon populations in Marin County based on juvenile surveys through 2000. A minimum of 86 adult coho salmon have, on average, spawned annually in Olema Creek (a Lagunitas Creek tributary) over the last eight years. Ettlinger *et al*. (2006) reported observations of 679 adult coho salmon in Lagunitas Creek, and 190 redds for the 2005/06 spawning season. Expansions from redd counts led to an estimated 630 coho salmon adults. As noted above, adult returns are further reduced for 2007/08. In Lagunitas Creek, initial reports indicate returns are down by almost 80% (SWFSC 2008).

Table 7. Recent historical estimates of coho salmon spawner abundance for populations in the Coastal diversity stratum of the CCC coho salmon ESU. Table adapted from Good *et al*. (2005). While these early abundance estimates are hampered by very limited data, they are indicative of a general decline.

Population	CDFG (1965) 1963	Wahle and Pearson (1987) 1984-1985	Brown *et al*. (1994) 1987-1991	% reduction
Russian River	5000	1000	255	95
Other-Sonoma	1000	-	180	80
Other-Marin	5000	-	435	91

Coho salmon populations were historically widely distributed in the streams of this stratum (Spence *et al*. 2005), but have since suffered substantial range restriction (Good *et al*. 2005). For example, coho salmon once reared in the headwaters of the Russian River, which is approximately 100 miles inland from the coast. Despite many survey efforts, they are currently detected in only a few tributaries in the lower, western portion of the watershed, and are nearly extirpated. With the exception of some Marin County streams, the distribution of populations is highly fragmented throughout the streams of this stratum. Coho salmon populations were extirpated in Sonoma County's Salmon Creek and Marin County's Walker Creek, although the RRCSCBP has successfully reintroduced a small spawning population of coho salmon into Walker Creek (CDFG, unpublished data).

Genetic analysis of fish from both Green Valley Creek and Dutch Bill Creek in the Russian River provide evidence of recent population bottlenecks, indicating that they were derived from just a few breeding individuals (Bjorkstedt *et al*. 2005). This lack of genetic variation represents reduced diversity within the population and is suggestive of increased extinction risk.

The overall viability of populations in this stratum is poor. The Russian River population alone was once the largest and most dominant source population in the ESU. The fact that it is now on the verge of extirpation suggests not only a high risk of extinction for this population, but for other nearby populations in this ESU. The historical role of the Russian River population highlights the importance of this population to the survival and recovery of the species.

d. San Francisco Bay Diversity Stratum Populations

Coho salmon populations in this stratum are presumed extinct. NMFS (2001) based this conclusion on the absence of positive detections (Brown *et al*. 1994; CDFG 2002; Good *et al*. 2005) and widespread elimination of habitat.

CDFG (2002) summarized the status of coho salmon in San Francisco Bay tributaries as follows: Leidy (1999) conducted fisheries surveys on 79 Bay Area streams between 1992 and 1998, and coho salmon were not observed in any of the surveys. The last known observation of coho salmon was in 1981. Leidy and Becker (2001) consequently determined that coho salmon populations are now extinct in San Francisco Bay tributaries.

e. Santa Cruz Mountains Diversity Stratum Populations

The populations in this diversity stratum have the highest risk of extinction of populations in any extant coho salmon stratum primarily due to extremely low abundances, loss and fragmentation of historical spawning and rearing habitats, and loss of year-classes. In 1965, CDFG estimated the annual run size in the San Lorenzo River (historically a functionally independent population) to be 1600 adults (Table 8). In 1989, 183 adults were documented in the San Lorenzo River (Brown *et al*. 1994). Fifty adult spawners (mostly marked hatchery fish) were observed during the 2004-05 spawning season (Brian Spence, unpublished data). Table 8 indicates substantial reductions in adult populations between 1963 and 1991 (Good *et al*. 2005).

Table 8. Recent historical estimates of coho salmon spawner abundance for populations in the Santa Cruz Mountains diversity stratum of the CCC coho salmon ESU. Table adapted from Good *et al*. (2005). Percent reductions were calculated using Wahle and Pearson (1987) estimates only when Brown *et al*. (1994) estimates were not available. While the accuracy of these early abundance estimates is hampered by limited scientific data, they are indicative of a general decline.

Streams or Population	CDFG (1965) 1963	Wahle and Pearson (1987) 1984-1985	Brown *et al*. (1994) 1987-1991	% Reduction
Santa Cruz Co. Streams	1500	50	-	97
San Lorenzo River	1600	500	183	89

In the San Lorenzo River, annual summer surveys failed to produce evidence of successful reproduction by coho salmon from 1994 to 2004. But planting of hatchery smolts into Pescadero Creek (another historically functionally independent population) in the spring of 2003 apparently resulted in successful reproduction in the 2004-05 spawning season.

Coho salmon populations were likely present historically in the Tunitas, San Gregorio, Pescadero, Gazos, Waddell, Scott, San Vicente, San Lorenzo, Soquel, and Aptos watersheds

(Brown *et al*. 1994, Spence *et al*. 2005). Populations in this portion of the range of CCC coho salmon have suffered substantial reductions in range (Good *et al*. 2005).

Spence *et al*. (2005) report confirmed presence historically throughout most of the San Lorenzo watershed, including Boulder Creek, Fall Creek, Zayante Creek, and Bean Creek. Though the watershed had been systematically surveyed since 1998, no juvenile coho salmon had been observed since 1981 (Alley 2006). Two adult coho salmon were observed in the watershed in 2005 (Alley and Associates 2005). However, the presence of a viable population remains questionable based on the low numbers observed. This population is likely extinct.

The populations in Gazos, Waddell, and Scott creeks remain in low abundance, but coho salmon distribution in each watershed is variable by year with some year classes almost entirely absent (Smith 2006). Juvenile coho salmon have also recently been observed in San Vicente and Laguna Creeks (J. Ambrose, NMFS, personal communication, October, 2006)

The NMFS status review updates for coho salmon (NMFS 2001; Good *et al*. 2005) concluded in general that the likelihood of coho salmon being present decreased from 1989 to 2000, and that this trend was more pronounced in the southern part of the range where extirpation or near extirpation of the ESUs populations has occurred.

Given the generally low abundance, apparent negative trend in population growth rate, reduced and fragmented distribution, and compromises to diversity, the populations that remain in this stratum have a high risk of extinction.

f. ESU Extinction Risk

CCC coho salmon face the highest risk of extinction of any of the three species considered in this biological opinion. This is evidenced primarily by their precipitous decline in abundance during the last several decades and poor status of population viability metrics in general. The cause of this decline is likely from the widespread degradation of habitat, particularly those habitat attributes that support the freshwater rearing life-stages of the species as described below in **C. Critical Habitat Analysis**. The loss of this habitat and the concurrent extirpation of local populations have resulted in a high degree of isolation for the populations that remain. None of the Spence *et al.* (2008) ESU viability criteria are met. We conclude that this ESU is not presently viable and currently faces a high risk of extinction. Spence *et al.* (2008) reach similar conclusions:

"*In summary, the lack of demonstrably viable populations (or lack of data from which to assess viability) in any of the strata, the lack of redundancy in viable populations in any of the strata, and the substantial gaps in the distribution of coho salmon throughout the CCC ESU strongly indicate that this ESU is currently in danger of extinction*".

6. CCC Steelhead Extinction Risk

Our extinction risk analysis for steelhead is based on anadromous *O. mykiss* only. While resident *O. mykiss* likely interbreed with anadromous forms in some circumstances, we assume this to be a minor component of the DPSs populations (Bjorkstedt *et al*. 2005).

The extinction risk of CCC steelhead is influenced by their life history diversity, which tends to buffer population responses to adverse environmental variation in several ways. For example, the highly variable time of instream residence and spawning age allow for effective temporal dispersal within a population. This reduces the susceptibility of a cohort to extinction by reducing the proportion of the population exposed to temporally limited adverse conditions (*e.g.*, critically dry years). Temporal dispersion therefore acts to maintain population viability in the face of environmental variability (Bjorkstedt *et al*. 2005). This unique strategy may have helped steelhead avoid the recent downturns in numbers seen in Chinook salmon and coho salmon populations in 2007/08. For example, steelhead returns to Russian River fish facilities do not reflect the low numbers seen in coho salmon and Chinook salmon populations (Jeffry Jahn, NMFS, personal communication, 3-4-08). Another adaptive advantage is that individual adult steelhead are able to spawn in multiple years, unlike coho and Chinook salmon that die shortly after spawning.

a. Interior Diversity Stratum Populations

Six populations[20] comprise the Interior Diversity Stratum all of which are within the Russian River watershed. We have assessed their abundance to be substantially reduced from historical abundance, but persistent. The growth rates of these populations appear moderately negative as indicated by a long-term decrease in abundance (SEC 1996). The Upper Russian River population (historically functionally independent) has lost 21 percent of its historic potential habitat to CVD and the distribution of the Dry Creek population (historically potentially independent) has been reduced by 56 percent by the installation of WSD alone (Brian Spence, NMFS, personal communication, March 8, 2007). We therefore consider the distribution of some steelhead populations in this stratum to be substantially reduced from historical condition. Additional disruption of the remaining habitat has likely further reduced the other populations in this stratum as well.

In addition, some loss of genetic diversity in these populations is apparent from genetic analyses and is attributed to previous among-basin transfers of stock and intense local hatchery production (Bjorkstedt *et al*. 2005). We also assume some loss of diversity from the reduction in, and degradation of, habitat.

While steelhead populations appear to be reduced in abundance and experience loss of genetic diversity in this stratum, they remain persistent and widespread below major barriers such as WSD and CVD. Given the reductions in key viability criteria, we consider the extinction risk of populations in this stratum to be moderate.

[20] The Middle Russian River and Sausal populations are actually groups of very small dependent populations that inhabit minor tributaries to the middle reach of the Russian River.

b. North Coastal Diversity Stratum Populations

The North Coastal diversity stratum is composed of three populations in the lower Russian River[21], and nine coastal populations immediately south of the Russian River. Most populations in this stratum, along with the populations in the Interior and Santa Cruz Mountains diversity strata, are at high risk of extinction because evidence suggests their population metrics have been compromised. Population abundance varies from zero in Estero Americano and Stemple Creeks, to fairly abundant in Lagunitas Creek. The Russian River populations are probably less than 15 percent of what they were 30 years ago (Good *et al*. 2005). We conclude that steelhead have been extirpated from Americano Creek and Stemple Creek based on: 1) the Bjorkstedt *et al*. (2005) determination that populations existed historically in these watersheds; and 2) there is no evidence of current presence in these watersheds (NMFS 2005*b*). However, steelhead populations, although often substantially reduced in number, remain widely distributed outside of these two areas.

c. Coastal and Interior SF Bay Diversity Strata Populations

The two San Francisco Bay diversity strata share the populations with the highest extinction risk ratings of the DPS. Overall abundance is exceptionally low, with even the healthiest remaining populations, Sonoma Creek and Napa River (both historically functionally independent) far below historical abundance. For example, the Napa River is the largest watershed in the northern San Francisco Bay (426 square miles), and has 48 major tributaries; this watershed is estimated to have historically supported an annual spawning run of 6,000 to 8,000 steelhead (Leidy *et al*. 2005). At present, the steelhead run is believed to be less than a few hundred adults (Stillwater Sciences 2002). Many tributaries of San Francisco Bay have lost the ability to support spawning and rearing habitat due to ongoing urban and agricultural developments. This suggests, in combination with the declines in abundance, a negative growth rate for populations in these strata.

Historical populations existed in almost every watershed tributary to San Francisco and San Pablo Bays (Leidy *et al*. 2003; Bjorkstedt *et al*. 2005), but now they are extirpated from many streams, and those streams that remain occupied frequently have reduced distributions within them (Leidy *et al*. 2005). This has led to a highly fragmented distribution overall, particularly in the East and South bay areas. Reduced population size, reduced distribution, and severe alteration of habitat conditions have all likely led to loss of diversity, both genetic and ecologic.

d. Santa Cruz Mountains Diversity Stratum Populations

The San Lorenzo River historically had one of the largest functionally independent populations in the ESU. Run sizes in that river have been reduced by 85 percent of what they were just 30 years ago. This pattern is also evident in other populations in the stratum (Good *et al*. 2005). For example, analysis of juvenile data for the San Lorenzo, Scott (historically functionally independent), Waddell (historically potentially functionally independent), and Gazos watershed

[21] The Lower Russian River population is actually a group of very small dependent populations that inhabit minor tributaries to the lower Russian River and we lump them into one for convenience.

(historically dependent) populations by Good *et al*. (2005), indicate declines in juvenile populations consistent with the more general estimates of declining abundance in the region.

The populations in this stratum have a high risk of extinction. We consider abundance to be substantially reduced from historical levels, and the population growth rate to be negative based on observed long-term declines in abundance. Spatial structure and diversity remain in fairly good condition, although their distribution is somewhat reduced and fragmented.

e. DPS Extinction Risk

As described below in **C. Critical Habitat Analysis,** CCC steelhead habitat is degraded throughout the DPS, especially in the San Francisco Bay tributaries. However, their diverse life-history strategy has helped to improve their likelihood of viability overall, relative to CCC coho salmon and CC Chinook salmon. The life-history factor is reflected in their widespread distribution, and lack of spatial isolation, in three of the five diversity strata. However, because viable populations do not clearly appear in any strata, and the *Coastal and Interior SF Bay Diversity Strata* appear to have widespread population extirpations, we rate this DPS as having medium risk of extinction. Spence *et al.* (2008) arrive at similar conclusions:

"*The presence of dams that block access to substantial amounts of historical habitat (particularly in the east and southeast portions of San Francisco Bay), coupled with ancillary data … that suggest that it is highly unlikely that the Interior San Francisco Bay strata has any viable populations, or that [DPS] redundancy criteria would be met. Elsewhere in the [DPS], the lack of demonstrably viable populations remains a significant concern.*

C. Critical Habitat Status

To assess the proposed action's effects on critical habitat, we must determine whether, with implementation of the proposed action, critical habitat would remain functional (or retain the current ability for the primary constituent elements to be functionally established) to serve the intended conservation role for the species.

The primary purpose of this section is to identify the current function of critical habitats within the ESU or DPS of each species to support the intended conservation role for each species. Such information is important for an adverse modification analysis because it establishes the context for the evaluation of any effects to habitat that the proposed action may have on critical habitat. We begin by considering the current quantity, quality and distribution of each Primary Constituent Element (PCE) of critical habitat (migration, spawning, rearing, and estuarine), or essential habitat features, for each species. To fully understand the conservation role of these habitats, however, we identify the specific habitat attributes (*e.g*., pool depth, water temperature, complex cover, *etc*.) needed by individual life-stages. This provides us with the necessary link between habitat and the conservation of the species by defining the role and quality of habitat necessary to sustain the species life history cycle.

Linking habitat to the salmonid life stages that it supports also facilitates the secondary purpose of this analysis, which is to identify factors threatening to further deteriorate salmonid critical

habitat. In this portion of the critical habitat analysis we consider the factors responsible for the existing habitat conditions. This information was used in the preceding species viability assessments.

When it designated critical habitat for steelhead and Chinook salmon, NMFS developed a list of PCEs specific to these species (NMFS 2005*a*). These PCEs include sites essential to support one or more of the life stages of the species to which it applies (*i.e.*, sites for spawning, rearing, migration and foraging). These sites in turn contain physical or biological features essential to the conservation of the species (for example, spawning gravels, water quality and quantity, side channels, forage species). Specific types of sites and the features associated with them include, but are not limited to the following:

1. Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.

2. Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development.

3. Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.

4. Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

NMFS developed a similar list of species habitat requirements and essential features (PCEs) for CCC coho salmon (64 FR 24049):

1. Juvenile summer and winter rearing areas,

2. Juvenile migration corridors,

3. Areas for growth and development to adulthood,

4. Adult migration corridors, and

5. Spawning areas.

Within these areas, essential features of coho salmon critical habitat include adequate: (1) substrate, (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food, (8) riparian vegetation, (9) space, and (10) safe passage conditions.

In this section, and throughout this biological opinion, we use the term PCE to refer to the essential habitat features for all three species under consideration. To help clarify the role of PCEs, we identified specific habitat attributes of each PCE that were most influential in determining the current condition of the PCE to support each life-stage. For example, we identified pool area and depth as one habitat attribute within the freshwater rearing PCE that is a measure of the quality of rearing habitat for YOY steelhead through the summer and into the fall season.

1. Ranking Method

We developed a qualitative method for evaluating the condition of each habitat attribute in terms of its current condition relative to its role and function in the conservation of the species. We chose to evaluate the current condition of critical habitat at the diversity stratum level to facilitate our species viability assessment which follows. Diversity strata are groups of salmonid populations that share similar environmental and ecological background conditions. For example, salmonid populations in interior watersheds likely experience higher stream temperatures than coastal populations due to natural climatic factors. Human impacts may or may not exacerbate these conditions.

By characterizing the general condition of a given habitat attribute across each diversity stratum as either: good, fair, inadequate, or poor, we were able judge how each habitat attribute is able to generally support specific life stages within the stratum, and thereby identify specific conditions likely to be affecting the current abundance, growth rate, distribution, and diversity of each population in the stratum. Once we determined the current condition of PCE attributes in each stratum, we used this information to draw conclusions about the current ability of critical habitat to support the conservation of each species at the ESU or DPS level. This information is then used in the **Integration and Synthesis** and **Reasonable and Prudent Alternative** sections to understand the significance of any project-related changes to habitat in terms of how those changes are likely to affect the conservation role and function of the PCEs of critical habitat for each species.

We began the ranking process by defining four habitat condition classes. We described a habitat attribute as “good” when evidence suggested the current condition was conducive to high survival from one salmonid life stage to the next. In the absence of any other factors limiting the population, a “good” condition would allow for some population growth given a species current abundance. A “fair” rated habitat attribute indicates that within the subject watersheds, the condition of the habitat attribute probably does not currently limit most populations; however, conditions for that attribute are degraded for many populations and they may contribute to limiting some populations or subpopulations. An “inadequate” habitat condition indicates limited functional habitat for that life stage such that the PCE of critical habitat has a strong potential to limit many or most populations. A “poor” rating indicates severely limited amounts of functional habitat for that PCE in that diversity strata.

It is important to note that the standard of "good" habitat we use for this analysis is not directly comparable to properly functioning condition as used in NMFS (1999). In that document, properly functioning condition is defined as the sustained presence of natural habitat-forming processes (*e.g.*, riparian community succession, bedload transport, precipitation runoff pattern, channel migration) that are necessary for the long-term survival of the species through the full range of environmental variation. Our definition emphasizes the current condition of habitat in terms of how it supports the biological requirements of the species at this time; though we do assume this condition will persist for the next 15 years in the absence of any additional perturbation. We have not evaluated the geophysical processes responsible for these habitat formations, and do not intend to imply that "good" habitat is sufficient to support a fully recovered population into the foreseeable future.

We also acknowledge that these habitat rankings are generalizations and that actual conditions may substantially vary spatially within a diversity stratum, and seasonally (*e.g.*, dependent on precipitation and available surface water). The rankings therefore take these considerations into account and describe habitat performance overall. For example, pool area and depth may be rated as "fair" in a given diversity stratum, which would imply that, across the landscape, this habitat attribute may limit some populations during the summer rearing life stage. In dry years, and in some areas, pools may be more limiting, and in wet years they may be less limiting, but in general the condition of this habitat attribute averages out to be "fair". Attribute rankings for each diversity stratum were compiled by NMFS staff based on local staff knowledge of watershed conditions, review of watershed reports such as Total Maximum Daily Load (TMDL) listings, GIS map data on passage barriers, and other sources of information.

2. CC Chinook Salmon

Unlike the two species that follow, habitat attributes for rearing CC Chinook salmon were rarely rated "poor" or "inadequate". Poor conditions, where they exist, are spread across multiple life stages and are not always consistent among diversity strata. The only PCE with all "good" or "fair" ratings across strata is adult migration, suggesting that, in the absence of other factors, migration corridors for Chinook salmon are generally sufficient to promote some population growth.

a. North Coastal Diversity Stratum

Estuarine rearing quality is the only habitat attribute rated as inadequate or poor, and thus the availability of good quality estuarine habitat may be a factor limiting population growth in this stratum (Table 9). There are, however, several habitat attributes that are degraded and may limit some populations or subpopulations (*i.e.*, rated fair). These include upstream passage, spawning gravel quality, redd scour, availability of rearing habitat, water temperature, and predation. These conditions suggest that chronic habitat degradation affecting multiple attributes is responsible for the low population abundances seen in this stratum, rather than impairment of a single habitat attribute. Nonetheless, estuarine habitats may play an influential role in the mix of factors, especially considering the importance of estuaries in the life cycle of the species and the habitat's vulnerability to anthropogenic impacts.

The dominant land use in this stratum is timber harvest, although urbanization, rural development, and exploitation of coastal resources (*e.g.*, fishing) are also prevalent. Estuarine habitats have been reduced in size and degraded by over 100 years of flood control, encroachment, and harbor developments. In addition, increased sedimentation from landscape disturbances upstream have resulted in aggraded channels and estuaries, particularly in the Eel River.

b. North Mountain Interior Diversity Stratum

This stratum has the only "poor" ratings, and the most "inadequate" ratings in the ESU, suggesting that habitat conditions are worse here than in other diversity strata. Aside from inadequate habitat for YOY to rear in briefly before their downstream migration, all other potentially limiting habitats involve the migration of juveniles to the ocean. These poor conditions are driven primarily by the loss of flows behind Van Arsdale and Scott dams upstream. The loss of flows to the lower main stem of the Middle Fork Eel River creates a thermal barrier each summer as flows pass through the hot inland canyon. This barrier impedes the downstream migration of juvenile Chinook salmon in early summer and significantly increases juvenile mortality, particularly in dry and normal water years. The introduction and subsequent success of pikeminnow (*Ptychocheilus grandis*) into this system has added another stressor to Chinook salmon smolts. As warm-water tolerant predators of smolts, they likely have a substantial impact on smolt mortality.

c. North-Central Coastal Diversity Stratum

This stratum is the only one in the ESU to have no "poor" or "inadequate" ratings associated with it, indicating that, in general, habitat conditions should favor the maintenance of Chinook salmon populations. This assessment however, does not comport with results of the viability analysis which indicates depressed populations. It is possible that a "fair" rating may be too generous for adult migration flows. Given the early fall run timing and small watershed size (and correspondingly smaller discharges), combined with timing of rainfall events, conditions for successful migration may not be as consistent as is immediately evident.

This stratum is comprised almost entirely of forested landscape, and timber harvest is therefore the dominant land use. Coastal and rural developments also prevail. Sedimentation from timber harvest (past and present) likely affects many of the habitat attributes for this species.

d. Central Coastal Diversity Stratum

Spawning gravel quality is the lowest rated habitat attribute in this stratum. The main stem channels of the three major rivers in the stratum (Navarro, Gualala, and Russian rivers), where the majority of spawning habitat occurs, are all impacted by the intrusion of fine sediment into spawning gravels, but for different reasons. The banks of the Navarro River are destabilized in many areas from removal of riparian vegetation and other disturbances associated with grazing; agriculture and forestry also likely increase sedimentation, but to a lesser extent. Historical timber harvest is likely the primary source of sedimentation in the Gualala River, although roads

and rural development may also be a contributing factor. Flow releases from CVD have been shown to extend the duration of turbid flow events beyond what would occur naturally and at levels harmful to juvenile salmonids (Ritter and Brown 1971, Newcombe and Jensen 1996). This is likely a primary source of sedimentation in the Russian River as well, and combines with sedimentation associated with active agricultural lands, rangeland, and rural development to create high fine sediment loads in the watershed.

Table 9. PCEs of CC Chinook Salmon critical habitat divided into habitat attributes specific to supporting the life-cycle of this species. Habitat attribute condition ratings are applied as defined above. We place NA in habitat attribute cells not utilized by this species due to their unique life history.

PCE	Life Stage	Habitat Attribute	North Coastal	North Mountain Interior	North Central Coastal	Central Coastal
Migration	Adult (fertile)	Access to Watershed	Good	Good	Good	Fair
Migration	Adult (fertile)	Instream Passage (Barriers)	Fair	Fair	Good	Fair
Migration	Adult (fertile)	Migration Flows	Good	Fair	Fair	Good
Spawning	Incubating Eggs	Amount of Spawn Gravel	Good	Good	Good	Good
Spawning	Incubating Eggs	Distribution of Spawn Gravel	Good	Good	Good	Fair
Spawning	Emergent Fry	Spawn Gravel Quality	Fair	Fair	Fair	Inadequate
Spawning	Emergent Fry	Amount of Redd Scour	Fair	Fair	Good	Fair
Rearing	Summer YOY	Proximity to Redds	Fair	Inadequate	Fair	Fair
Rearing	Parr	Complexity/cover	NA	NA	NA	NA
Rearing	Parr	Pool area and depth	NA	NA	NA	NA
Rearing	Parr	Water Temperatures	Fair	Poor	Good	Good
Rearing	Parr	Stream Flow	NA	NA	NA	NA
Estuarine	Parr and Smolt	Rearing Quality	Inadequate	Inadequate	Fair	Fair
Rearing	Parr (winter)	Velocity Refuge	NA	NA	NA	NA
Migration	Smolt	Migration Flows	Good	Poor	Good	Good
Migration	Smolt	Instream Passage (Barriers)	Good	Good	Good	Good
	Adult	Ocean Condition	Fair	Fair	Fair	Fair

e. The ESU -- CC Chinook Salmon Critical Habitat

Although all diversity strata in this ESU possess some PCE attributes rated as good or fair, some PCE attributes are rated as inadequate or poor in each strata. As we defined it, a rating of good suggests the attribute promotes some population growth. However, we do not equate a rating of good with fully supporting the conservation of a species. Thus, the relatively large number of fair and inadequate PCE attribute ratings is a clear indication that PCEs of critical habitat in the CC Chinook salmon ESU, while not as degraded as those in other ESUs described below, are either not currently functioning, and/or have been degraded in their ability to establish the functions necessary to serve their intended role to conserve the species.

3. CCC Coho Salmon

Our assessment of habitat for this species shows a distinct trend of increasing degradation as one progresses southerly through the species range, with the Lost Coast – Navarro Point Diversity Stratum (LC-NP) supporting most of the more favorable habitats and the Santa Cruz Mountains stratum supporting the least (Table 10). There also appears to be a concentration of poor and inadequate habitat conditions associated with the rearing PCE across all strata, which suggests the condition of rearing habitat is likely continuing to erode species abundance across its range. This hypothesis is consistent with published research that identifies freshwater rearing habitat as the primary limiting factor for other coho salmon populations (Quinn and Peterson 1996).

a. Santa Cruz Mountains Diversity Stratum

The Santa Cruz Mountains stratum has more poor habitat ratings than any other strata. More specifically, nearly every habitat attribute related to summer rearing is rated as poor. Poor or inadequate habitat conditions also exist for spawning gravel quality and the amount of redd scour. The only attributes rated as good are within the migration PCE (access to watershed and instream passage barriers - for both adults and smolts). This suggests that juvenile rearing PCE is continuing to reduce coho salmon abundance in this diversity stratum.

The degradation of rearing PCE in the Santa Cruz Mountains stratum is a result of the combined effect of land use practices on a terrain that is predisposed to erosion and sedimentation. The substrate in this region is sand dominated, which tends to produce spawning substrate high in fine particles, and spawning beds susceptible to scour from flood events. These conditions are easily exacerbated by anthropogenic watershed disturbances. This region has experienced widespread agricultural, rural, and urban developments, such as road development, which have likely contributed to this type of habitat degradation. Other sources of degradation include historic removal of LWD, water diversions, and stream channelization associated with flood control projects.

b. San Francisco Bay Diversity Stratum

We did not complete a PCE attribute by PCE attribute ranking analysis for this area. However, the lack of species presence now and general habitat analysis in this stratum indicates that PCEs of critical habitat in this stratum are generally likely to be in inadequate or poor condition.

Table 10. PCEs of CCC coho salmon critical habitat divided into habitat attributes specific to supporting the life-cycle of this species. Habitat attribute condition ratings are applied as defined above.

PCE	Life Stage	Habitat Attribute	LC-NP	NP-GP	Coastal	SC Mtns.
Migration	Adult (fertile)	Access to Watershed	Good	Fair	Fair	Fair
Migration	Adult (fertile)	Instream Passage (Barriers)	Fair	Fair	Fair	Fair
Migration	Adult (fertile)	Migration Flows	Good	Good	Fair	Fair
Spawning	Incubating Eggs	Amount of Spawn Gravel	Fair	Fair	Fair	Fair
Spawning	Incubating Eggs	Distribution of Spawn Gravel	Fair	Fair	Fair	Fair
Spawning	Emergent Fry	Spawn Gravel Quality	Fair	Fair	Inadequate	Poor
Spawning	Emergent Fry	Amount of Redd Scour	Good	Good	Fair	Inadequate
Rearing	Summer YOY	Proximity to Redds	Good	Good	Fair	Fair
Rearing	Parr	Complexity/cover	Fair	Inadequate	Inadequate	Poor
Rearing	Parr	Pool area and depth	Inadequate	Inadequate	Inadequate	Poor
Rearing	Parr	Water Temperatures	Inadequate	Poor	Poor	Poor
Rearing	Parr	Stream Flow	Good	Inadequate	Poor	Poor
Estuarine	Parr and Smolt	Rearing Quality	Fair	Fair	Inadequate	Inadequate
Rearing	Parr (winter)	Velocity Refuge	Inadequate	Inadequate	Inadequate	Inadequate
Migration	Smolt	Migration Flows	Good	Fair	Fair	Fair
Migration	Smolt	Instream Passage (Barriers)	Good	Good	Good	Good
	Adult	Ocean Condition	Fair	Fair	Fair	Fair

c. Coastal Diversity Stratum

Ratings for habitat attributes for the Coastal diversity stratum also indicate critical habitat is degraded, though not as severely as in the Santa Cruz Mountains stratum. Again, there is a concentration of poor conditions associated with the rearing PCE, although inadequate ratings appear in spawning and migration PCEs as well.

The inadequate rating for spawning gravel quality is influenced by increased sedimentation associated with agricultural, rangeland, and rural developments. A similar rating for velocity refuge is indicative of widespread channelization and stream simplification, particularly in the Russian River. Degraded rearing habitat conditions are likely a consequence of water withdrawals, sedimentation, disturbance to riparian vegetation, and channel modifications.

d. Navarro Point – Gualala Point Diversity Stratum

The pattern of degraded rearing PCEs continues within this stratum. Migration and spawning PCEs, although rated better than the strata to the south, remain only able to support current low population abundances. This region, more so than the previous strata, is dominated by forestry and rangeland land uses, which are likely the cause of increased sedimentation and degraded riparian conditions that impair rearing habitats.

e. Lost Coast – Navarro Point Diversity Stratum

In this stratum, pool area and depth, velocity refuge, and stream temperature were rated as inadequate, indicating that these habitat factors are probably the most likely to be limiting population growth of coho salmon. Other attributes were generally rated higher, although spawning gravel, and estuarine rearing habitat, were rated fair indicating that conditions are degraded and may limit populations in some locations.

More than any other stratum in the ESU, this region is dominated by a forested landscape. Timber harvest has been, and continues to be, the dominant land use in the area. Typical impacts from this activity include: increased rates of sedimentation, reduced riparian shading, and reduced recruitment of large woody debris in streams. Stream management in the form of active removal of woody debris, historical damming of rivers, and other forms of channel modification have also contributed to these conditions.

f. The ESU-- CCC Coho Salmon Critical Habitat

As described above, the current condition of PCEs of CCC coho salmon critical habitat indicates they are not currently functioning, and/or have had substantial degradation in their ability to establish the functions necessary to serve their intended role to conserve the species. Juvenile rearing habitat is particularly degraded, and this degradation occurs across the entire ESU. The current condition of PCEs for CCC coho salmon is likely to result in continued decline in the abundance, population growth rates, distribution, and diversity of this species.

4. CCC Steelhead

Our assessment of critical habitat for this species shows degraded conditions spread throughout the DPS. The degraded habitat primarily involves estuarine and rearing PCEs, but also occurs in other PCEs, depending on location (Table 11). Habitat in San Francisco Bay and its tributaries is most impaired, followed by the upper Russian River. Whereas, those watersheds most influenced by coastal climate tend to have habitat that is least impaired.

a. Interior Diversity Stratum

Six of seventeen habitat attributes in this diversity stratum were rated less than fair, yet no attributes were rated as poor. This suggests that population growth may be limited by many factors rather than one or just a few. Inadequate habitat attribute ratings apply to all PCEs except for adult migration. Spawning gravel quality is likely degraded by widespread sedimentation from roads and agriculture. The availability of transitional rearing habitat for newly emerged fry is likely impacted by channel modifications and the chronic deposition of fine sediments in edge-water habitats in the main stem due to turbid releases from CVD. Stream desiccation is likely the result of intensive groundwater pumping in this semi-arid region. Inadequate velocity refuge for over-winter rearing is due to various channel simplification actions, such as removal of LWD. Estuary conditions will be discussed separately below.

b. North Coastal Diversity Stratum

Three of seventeen habitat attributes are rated less than fair, and none are rated as poor. Ten of the seventeen habitat attributes received a fair rating which, by definition, suggests those habitats are degraded and may be limiting some populations at their current levels. Given the population status described below for this stratum, the preponderance of fair ratings should not be interpreted as a positive indication of habitat condition. Spawning gravel quality and stream desiccation, and estuary condition appear to be the most degraded PCE attributes limiting production for this diversity stratum.

Degraded spawning gravel quality is likely the result of widespread sedimentation associated with farming, grazing, and rural road developments. Watersheds likely to be most affected by this are Green Valley Creek, Salmon Creek, Estero Americano, Stemple Creek, and Walker Creek. Stream desiccation is related to intensive groundwater pumping and other water uses associated with agricultural, rangeland, and residential developments.

c. Santa Cruz Mountains Diversity Stratum

This diversity stratum has two habitat attributes rated as inadequate, none as poor, and six rated as good. As with the previous strata, habitat degradation seems to be spread among all PCEs and is of a chronic nature.

Table 11. PCEs of CCC steelhead critical habitat divided into habitat attributes specific to supporting the life-cycle of this species. Habitat attribute condition ratings are applied as defined above.

PCE	Life Stage	Habitat Attribute	Interior	North Coastal	SC Mtns.	Coastal SF Bay	Interior SF Bay
Migration	Adult (fertile)	Access to Watershed	Good	Good	Good	Good	Fair
Migration	Adult (fertile)	Instream Passage (Barriers)	Fair	Fair	Good	Poor	Poor
Migration	Adult (fertile)	Migration Flows	Fair	Good	Fair	Fair	Poor
Spawning	Incubating Eggs	Amount of Spawn Gravel	Good	Fair	Good	Poor	Fair
Spawning	Incubating Eggs	Distribution of Spawn Gravel	Good	Fair	Good	Fair	Fair
Spawning	Emergent Fry	Spawn Gravel Quality	Inadequate	Inadequate	Fair	Poor	Fair
Spawning	Emergent Fry	Amount of Redd Scour	Good	Good	Inadequate	Fair	Good
Rearing	Summer YOY	Proximity to Redds	Inadequate	Fair	Good	Inadequate	Inadequate
Rearing	Parr	Complexity/cover	Fair	Fair	Fair	Inadequate	Poor
Rearing	Parr	Pool area and depth	Fair	Fair	Fair	Fair	Fair
Rearing	Parr	Water Temperatures	Fair	Fair	Fair	Fair	Fair
Rearing	Parr	Stream Flow	Inadequate	Inadequate	Fair	Fair	Fair
Estuarine	Parr and Smolt	Rearing Quality	Inadequate	Inadequate	Inadequate	Inadequate	Inadequate
Rearing	Parr (winter)	Velocity Refuge	Inadequate	Fair	Fair	Fair	Poor
Migration	Smolt	Migration Flows	Inadequate	Fair	Fair	Fair	Fair
Migration	Smolt	Instream Passage (Barriers)	Good	Good	Good	Good	Good
	Adult	Ocean Condition	Fair	Fair	Fair	Fair	Fair

The redd scour attribute is rated as inadequate primarily because the parent geology of this area is sandstone, which results in sand dominated stream substrates and increased susceptibility to erosion and streambed mobility. Agricultural and urban developments have exacerbated erosion and have therefore contributed to the degraded condition of this attribute. Most of the attributes rated as fair are related to rearing PCEs, which suggests rearing habitat in general may be limiting population growth in some populations.

d. Coastal and Interior SF Bay Strata

These diversity strata have the most poor and inadequate habitat attributes, and the least good ratings of any other strata. The same trend of chronic degradation spread across multiple PCEs is apparent here, but is taken to an extreme not observed elsewhere. Adult migration is impaired by barriers and altered flow conditions; spawning and egg incubation are limited by the amount and quality of spawning gravels; transitional rearing habitat for fry, and lack of channel complexity and cover limit the juvenile rearing life stage in both summer and winter. The role of estuary habitat in supporting these populations is also greatly altered as discussed below.

e. Estuarine PCE

We single out the estuarine PCE for discussion because it is the only habitat that we ranked as inadequate in supporting steelhead populations across all strata in the DPS. Estuaries constitute highly variable, large scale ecotones[22] in which salmonids rear in and pass through as smolts and as returning adults. Passage and rearing of juveniles in estuarine habitats is thought to be an integral phase of salmonid life history at a time when physiological adaptation, foraging, and refugia from predators are critical (Healey 1982; Simenstad *et al*. 1982). Occupation and utilization of estuarine habitats contributes to the fitness of juvenile salmonids preparing for survival at sea (Kotyk *et al*. 1986).

Two discrete groups of juvenile steelhead utilize different kinds of habitat provided by lagoons: steelhead juveniles using coastal lagoons for freshwater rearing throughout the year, and smolts from throughout the watershed using the lagoon primarily in the spring prior to seawater entry. Significant portions of steelhead populations rearing in upstream habitats migrate downstream to rear in coastal lagoons and estuaries (Bjornn 1971; Zedonis 1992; Shapovalov and Taft 1954). If rearing habitat is unavailable or of poor quality, these individuals' potential for survival is low (Hayes *et al.* 2006).

The Russian River, Tomales Bay, and San Francisco Bay are the three largest estuarine systems in the DPS. Smaller, but significant estuaries include: Salmon Creek, Estero Americano, Bolinas Lagoon, Pilarcitos, Tunitas, San Gregorio, Pescadero, Gazos, Waddell, Scott, Laguna, Wilder, San Lorenzo, and Soquel, Aptos estuaries. The Russian River estuary supports all populations from the Interior Diversity Stratum and three of 12 populations of the North Coastal Diversity Stratum. Tomales Bay supports Lagunitas and Walker Creek populations. San Francisco Bay supports all populations within both the Coastal and Interior SF Bay strata. The Santa Cruz Mountains Diversity stratum has more estuaries than any other stratum in the DPS.

[22] An ecotone is defined as a transitional habitat zone between different environments.

The Russian River receives artificially high summer flows and is maintained as an open-mouth estuary by frequent mechanical breaches. The repeated turnover from salt to fresh water reduces food productivity. The presence of saltwater also likely impedes the successful rearing of steelhead YOY and smaller parr. Though San Francisco Bay has likely always been a saltwater estuary, it has lost approximately 90 percent of the tidal marsh habitat associated with it (San Francisco Bay Area Wetlands Ecosystem Goals Project 1999). This has likely had a significant impact on its ability to support steelhead rearing and migration. Estuary conditions in the Santa Cruz Mountains Diversity Stratum are highly variable. Aptos and San Lorenzo estuaries are reduced in size from flood control developments and land use encroachments. Pescadero has an unexplained annual fish kill associated with its estuary. The Pilarcitos estuary typically dries up in response to over allocation of water in the basin, and Scott, Waddell, Gazos, and San Gregorio are functioning fairly well.

The generally inadequate condition of the estuarine PCE across the DPS has potentially important consequences for the conservation of CCC steelhead. Given their dependence on estuaries, and the high proportion of populations that depend on them, estuaries may function as keystone habitats. Their condition is likely to strongly influence the abundance and growth of all steehead populations upstream.

f. The DPS-- CCC Steelhead Critical Habitat

As described above, the current condition of PCEs of CCC steelhead critical habitat indicates that many PCEs are not currently functioning, and/or have had substantial degradation in their ability to establish the functions necessary to serve their intended role to conserve the species. Juvenile rearing habitat in streams and estuaries is particularly degraded, and this degradation is spread throughout the DPS. The current condition of PCEs for CCC steelhead is likely to maintain low population abundance across the DPS and result in continued loss of distribution and diversity in San Francisco Bay watersheds and the upper Russian River.

V. ENVIRONMENTAL BASELINE

The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process (50 CFR §402.02).

The *Environmental Baseline* describes the current condition of the habitat, including critical habitat, and the ESA-listed salmonid species within the action area. The *Environmental Baseline* provides the foundation upon which the effects analysis is built. By establishing the historical and current condition of the species and the habitat in the action area, we describe and analyze the conditions to which we will add the effects of the project under consultation. Our description (Section A.1 below) of the historical condition of the ecosystem (prior to European settlement and development) provides a context for subsequent trends, and for describing the current condition of critical habitat and the viable state of salmonid populations. Current conditions of habitat and salmonid populations within the action area (Section A.2. and B below) are followed by a description of the impacts of all the activities (such as the construction of dams, estuarine breaching, Russian River flow regulation, agriculture, fishing, ocean conditions, *etc*.) that have contributed to the current status of habitat and the species sub-populations (Section C below). Our ability to understand factors contributing to the baseline condition is also important for predicting future conditions and likely responses of salmonids to the effects of the proposed action, interrelated and interdependent actions, and cumulative effects.

A. Condition of Habitat/Critical Habitat within the Action Area

1. Historical Habitat Conditions within the Action Area

Conditions in the Russian River watershed prior to European settlement and development were often dramatically different from the conditions found today. Stream flow in the Russian River and it tributaries was characterized by episodic flows associated with climatic patterns. The Mediterranean climate of the Russian River watershed, was (and is) characterized by warm summers, mild winters, and winter-dominant precipitation regimes (SEC 1996). Most precipitation in the Russian River basin occurred between October and May, with resulting higher stream flows. During precipitation events, the steep slopes of the surrounding basin conveyed water into channels at discharges much higher than the mean annual flow. In the summer, stream flow in the Russian River's main stem was about 20 cubic feet per second (cfs) (SEC 1996); these low flow conditions likely persisted until the first winter rains.

The main stem of the Russian River was a dynamic meandering river which migrated across its floodplain creating ox-bows and side sloughs, and had a profusion of side channels, sand bars, islands and sloughs (Florsheim and Goodwin 1993). Rivers hydraulically segregate their sediments such that the coarser, larger gravels are stored in depositional sites in upland reaches, while smaller gravels are stored in the lower reaches (Mount 1995). This was probably the case for the Russian River and its tributaries in their unaltered state; most of the suitable spawning gravels were likely in upper reaches, with reduction of suitable spawning gravel in the middle

and lower reaches. Most of the 110 miles of main stem Russian River, and hundreds more miles in the tributaries, were likely historically available for salmonid spawning. The gravel available for spawning purposes was likely of suitable size and relatively free of fine silt. There was likely a high pool/riffle ratio which provided sufficient habitat for spawning purposes. An abundance of LWD was probably available in the form of root wads and fallen logs to create scour pools and provide cover and foraging sites for rearing salmonids. Low summer flows in the summer were likely, resulting in high water temperatures; however, the main stem probably contained numerous deep pools with lower cooler layers (Circuit Rider Productions 1994). Salmonids were able to survive in summer by seeking refuge in these stratified pools. The tributaries provided good quality habitat consisting of pools, instream cover, clean gravels, and sufficient canopy cover. In the tributaries there was likely more LWD instream as trees were recruited into the streams during storm events, bank erosion, land slides, and windthrow. This allowed for the creation of rearing pools and other elements of complex habitat. While there were likely ephemeral or intermittent streams in some areas of the Russian River watershed historically, Russian River tributary streams likely had more surface flow available throughout the year than currently available.

Zone 1A is roughly the same geographic area as the Mark West Creek watershed, which includes the Laguna de Santa Rosa. Information from this section comes primarily from two sources: Smith Consulting (1990) and the Laguna de Santa Rosa Foundation. The Mark West Creek watershed (≈160,000 acres) comprises approximately ten percent of the entire Russian River drainage. Several streams occur within this watershed, including the Laguna de Santa Rosa (the largest drainage), its main tributary Santa Rosa Creek, and several other smaller streams (*e.g.*, Copeland Creek). Historically, the Laguna de Santa Rosa consisted of oak woodland and savanna, riparian forests, streams, lakes, and perennial and seasonal freshwater wetlands. The qualitative factors affecting habitat discussed previously in this section in the paragraph related to the Russian River main stem (*e.g.*, LWD and gravel) are likely accurate for the Laguna de Santa Rosa watershed too. Salmonids likely used all of the perennial streams within the Laguna de Santa Rosa watershed for spawning and rearing. The Laguna de Santa Rosa acted as a natural reservoir during high stream flow events, and could store up to an estimated 80,000 Acre-feet of water. For the area of Guerneville, this could have resulted in a 14-foot reduction in the height of the 100-year flood.

NMFS has inferred historical estuarine habitat conditions by combining information on current conditions, limited historical and present day information about river flow and bar closures in the Russian River and other California estuaries, and information from the hydrologic study conducted by the Russian River Estuarine Task Force (RREITF) in 1993.

Given the information available[23], NMFS expects that prior to dams and diversions in the Russian River watershed, the estuary was likely open to ocean tides for several months between late fall and early spring in nearly all years, and then closed to ocean tides sometime during the late spring through the early fall of most years. This pattern of open estuarine conditions in the late fall, winter and early spring, followed by estuary closure to ocean tides in the spring,

[23] For example, RREITF compared the hydrologic conditions in the Russian River estuary with other estuaries in California. Their results indicate that tidal forces are not strong enough to maintain an opening in the barrier beach under all conditions (RREITF 1994).

summer, or early fall, remains evident today. For example, the bar at the mouth of the estuary closed in the spring (April-June) in 8 out of 12 years for the period 1996-2007 (Table 26 in *Effects Section*). This occurred even with inflows augmented by the dam releases.

Closure of the Russian River estuary's bar is a fairly complex process related to tides, waves and swells, sediment transport, and river flows (Largier 2008, RREITF 1994). For example, closure of the bar in 1992 occurred during both spring and neap tides, but favored neap tides (RREITF 1994). In general, the timing of the highest anticipated Russian River stream flows coincides with larger coastal waves at the mouth of the Russian River; with these conditions, the Russian River likely flowed to the ocean. As Russian River stream flow waned in the spring, sufficient hydraulic energy was not available to maintain a direct connection to the ocean. This, combined with the presence of bar building wave events[24], would often cause a barrier beach to form at the outlet of the estuary. In some instances, closure may not have occurred until late summer (Largier 2008) due to the absence of bar building wave events in the spring.

Historically, flows during the summers were low and were unlikely to have breached the barrier beach once it formed. Only limited flow data is available prior to the construction of the Potter Valley Project. At Geyserville, flows have been estimated at 20 cfs or less during most summers (SEC 1996). Flows were likely higher at the estuary, but not anywhere near the average 200 cfs summer season flow documented at the Guerneville gauge for the period 1940 - 1980 (RREITF 1994). Other information supporting the conclusion of a barrier beach at the Russian River's mouth in most summers includes reports in the late 1800s from early settlers, the Coastal Pilot, and the U.S. Coast and Geodetic Survey (RREITF 1994). In some wetter years, a perched lagoon[25] may have formed, with freshwater outflow over the estuaries' bar. The duration of the perched lagoon through the summer as river flows receded is unknown.

The migration timing of Russian River salmonids evolved to correspond with higher stream flows and open estuary connection to the ocean (Fukushima and Lesh 1998). Migration opportunities for adult Russian River salmonids usually began around October or November following sufficient rainfall. Chinook salmon would be the first salmonid to begin adult immigration, followed by coho salmon, then steelhead. Anticipated juvenile Russian River salmonid emigration corresponds with high winter and spring flows. In some years, depending upon weather and hydrology patterns, the estuary may have opened late or closed early, which may have prevented some portion of migrating adult salmonids from entering the Russian River to spawn, or preventing some juveniles to migrate to the ocean as smolts. Given the likely larger historical size of salmonid populations in the Russian River, these natural climate fluctuations are unlikely to have had any long-term impacts on salmonid population viability in the watershed.

[24] Under stormy seas conditions, sand is eroded from a barrier beach by long period swells that break high on the beach and then transport beach sand offshore. When the storm seas subside and shorter period waves and swells predominate, sand is transported back onshore, rebuilding barrier beaches (Dean 1974).

[25] NMFS defines a perched lagoon as having water surface elevation above mean high tide. Although this definition can include freshwater lagoons with closed sandbars, when we use the term perched lagoon in this biological opinion, we are referring to lagoons where freshwater flows out to the ocean over the sandbar at the lagoon's mouth.

Salmonid spawning in the lower Russian River estuary is highly unlikely to have occurred because water depth and flow levels during the spring would have made any spawning gravels unavailable for use. In the upper estuary it is possible that Chinook salmon and steelhead spawning may have occurred in some years if flow levels were low enough to provide spawning habitat. Coho salmon would have been unlikely spawners in the upper estuary based on their life history preference for spawning in smaller tributary streams.

NMFS expects that historically, the Russian River estuary either converted to freshwater after bar closure, or stratified, with denser salt water remaining at depth. The estuary's condition after bar closure was likely variable. Closed estuaries in California can become productive freshwater lagoons (Smith 1990), dependent upon the time of initial closure and freshwater inflow to the estuary. Conversion to freshwater occurs when freshwater from upstream builds up on top of the salt water layer, gradually forcing the salt water layer to seep back into the ocean through the barrier beach. In the estuary/lagoon systems Smith (1990) studied, it took at least one month for a freshwater lagoon to form. Freshwater conditions can also result from perched lagoons, a condition (as described above) where the estuary is closed to ocean tides but freshwater flows out over the bar. The freshwater outflow entrains some of the salt water at the boundary between fresh and salt layers, steadily removing salt water from the lagoon[26]. NMFS staff have observed such a conversion in the Carmel Lagoon from 2005-2007 (John McKeon, NMFS, personal communication, 2008). Closed estuaries may also remain stratified, with heavier salt water on the bottom.

Information does not exist on water quality conditions in the Russian River estuary prior to increased summer flows in the Russian River from the Potter Valley Project. Currently, the Russian River estuary is known to stratify after formation of the barrier beach in the summer. Creation of a freshwater lagoon has not been observed. However, the Russian River estuary has not been studied for long time periods after bar closure. The available data on the water quality condition of the closed Russian River estuary are limited to three weeks or less duration after bar closure. (M. Fawcett, Merritt Smith Consulting, personal communication, 2005).

If the estuary converted to freshwater historically, habitat was likely high quality for salmonids rearing during the summer months. Smith (1990), Zedonis (1992), Larson (1987), and Bond (2006) evaluated closed freshwater lagoons in California and found good salmonid rearing habitat in those lagoons, including abundant food supplies and increased salmonid growth rates over stream-raised fish. If the Russian River remained stratified during the summer, rearing salmonid productivity was also likely relatively high. The Navarro River estuary, which is more similar in size and configuration to the Russian River estuary than the smaller estuary/lagoons studied by Smith and Bond, did not convert to freshwater after it closed and became a lagoon in September of two consecutive years (1996 and 1997). Nevertheless, steelhead productivity appears higher than productivity in other open, salt water estuaries in California as shown in Table 12, although not as high as productivity in closed freshwater lagoons. Steelhead productivity in the Navarro was high due to abundant food and a stable surface freshwater layer (Cannata 1998).

[26] Several studies have demonstrated salt water flushing related to freshwater flows over salt water layers. See, for example, Debler and Imberger (1996), Western et al. (1998), Coates et al. (2001), and Coates and Guo (2003).

Table 12. Summary of juvenile steelhead data from California estuaries (modified from Bradford 2008). Estuarine type and steelhead densities characterize conditions in summer through fall. Area is from cited reports or rough approximations by comparison with other estuaries of known size.

River	Estuary Type (summer -fall)	Area (1000m^2)	Steelhead (1,000s)	Steelhead Density (#/m^2)	Reference
Scott	Freshwater	8	2	0.25	Bond 2006
Mattole	Freshwater	180	25-30	0.15	Zedonis 1992
Pescadero	Freshwater/ Stratified	30	9.9	0.30	Smith 1990
San Gregario	Freshwater	43	11	0.25	Smith 1990
Waddell	Freshwater	18	9-15	0.67	Smith 1990
Navarro	Stratified	377	9	0.024	Cannata 1998
Russian	managed as open and largely saline	585	Few	Very low	SCWA 2006
Garcia	Open/largely saline	200	Few	Very low	Higgins 1995
Albion	Open/largely saline	160	Few	Very low	Maahs and Cannata 1998
Smith	Open/largely saline	1171	5.4-13.4	0.005-0.01	Quinones and Mulligan 2005

[1] While the condition (open, freshwater, *etc.*) of these waterbodies appear to correlate well with steelhead productivity, other factors not represented on this table (e.g., steelhead prey abundance) likely play a major role in steelhead productivity in estuaries and may not be directly correlated with estuary type as described in this table.

Uncertainty remains regarding the historical frequency of: bar closure, conversion to freshwater or stratification, and steelhead productivity in the Russian River estuary during the summer and fall. Nevertheless, we believe our conclusion, that the estuary closed in most years and steelhead productivity during the summer and fall was higher than when the estuary remained open to the ocean, is reasonable.

2. Current Condition of Habitat/Critical Habitat within the Action Area

The condition of CC Chinook, CCC coho salmon, and CCC steelhead habitat and critical habitat within the Russian River basin has been degraded from conditions known to support viable salmonid populations (64 FR 24049, 70 FR 52488). Habitat, including critical habitat, in the streams within the action area currently consists of limited quantity and quality summer and winter rearing habitat, as well as marginal spawning habitat for all three species. Compared to historical conditions, there are fewer pools, limited cover, and reduced habitat complexity. The limited instream cover that does exist is provided mainly by large cobble and overhanging vegetation. Instream large woody debris, needed for foraging sites, cover, and velocity refuges is especially lacking in most of the streams throughout the basin. NMFS has determined that these degraded habitat conditions are, in part, the result of many human-induced factors affecting critical habitat including: dam construction, agricultural and mining activities, urbanization, stream channelization, water diversion and logging among others. These factors will be discussed in more depth in subsequent sections of the *Environmental Baseline*.

Not all streams in the Russian River watershed were designated as critical habitat for CC Chinook salmon, CCC coho salmon, and CCC steelhead. For example, only the mainstems of the Russian River (including its estuary) and some of its largest tributaries (such as Dry Creek below WSD) were designated as critical habitat for CC Chinook salmon. Steelhead critical habitat includes these areas and numerous smaller tributaries in the Russian River watershed. Not all the smaller tributaries are designated. For example, the Santa Rosa Creek watershed was not designated as CCC steelhead critical habitat. Complete descriptions of the locations of Chinook salmon and steelhead critical habitat in the Russian River watershed can be found in 70 FR 52488.

Designated critical habitat for CCC coho salmon includes all river reaches accessible to coho salmon within the range of the ESU. NMFS defines accessible as all reaches below longstanding natural barriers and several dams, including CVD and WSD (64 FR 24049). Therefore, all of the stream reaches accessible to coho salmon in the action area are part of critical habitat for CCC coho salmon, including stream reaches upstream of culverts which currently block coho salmon access.

The number of stream miles of existing spawning, rearing, and migration habitat (PCEs) for CC Chinook salmon critical habitat included in the action area are provided in Table 13. The current condition of critical habitat for CCC steelhead in the action area is shown in Table 14. The ratings for current habitat conditions completed by NMFS' Critical Habitat Analytical Review Team (CHART) were conducted on a broad basis and may not accurately reflect site specific conditions. The CHARTs did not assess the current condition of coho salmon critical habitat. A more detailed assessment of habitat conditions, including coho salmon habitat, is provided following Tables 13 and 14.

Table 13. The number of stream miles containing each PCE for CC Chinook salmon within the action area, with current habitat condition rated as good, fair, poor, and unknown by the CHART (NMFS 2005b).

Area	PCE	Good	Fair	Poor	Unknown	Total
Russian River	Spawning	35.4	18.0	21.6	0.0	75.0
	Rearing	0.0	0.0	58.3	43.9	102.2
	Migration	35.4	58.3	0.0	8.5	102.2
Dry Creek	Spawning	14.3	0.0	0.0	0.0	14.3
	Rearing	0.0	14.3	0.0	0.0	14.3
	Migration	14.3	0.0	0.0	0.0	14.3
Mark West Creek	Spawning	0.0	0.0	3.5	0.0	3.5
	Rearing	0.0	3.5	0.0	0.0	3.5
	Migration	0.0	3.5	0.0	0.0	3.5
All Action Area	Spawning	49.7	18.0	25.1	0.0	92.8
	Rearing	0.0	17.8	58.3	43.9	120.0
	Migration	49.7	61.8	0.0	8.5	120.0

Table 14. The number of stream miles containing each PCE for CCC steelhead within the action area, with current habitat condition rated as good, fair, poor, and unknown by the CHART (NMFS 2005b).

Area	PCE	Good	Fair	Poor	Unknown	Total
Russian River	Spawning	0.0	39.7	23.3	11.0	74.0
	Rearing	0.0	40.3	59.4	0.0	99.7
	Migration	60.2	39.5	0.0	0.0	99.7
Dry Creek	Spawning	14.4	0.0	0.0	0.0	14.4
	Rearing	0.0	14.4	0.0	0.0	14.4
	Migration	14.4	0.0	0.0	0.0	14.4
Mark West Creek (excluding Laguna de Santa Rosa)	Spawning	4.4	17.6	5.2	1.1	28.3
	Rearing	14.1	14.2	3.6	0.0	31.9
	Migration	31.9	0.0	0.0	0.0	31.9
Laguna de Santa Rosa	Spawning	0.0	0.0	0.0	0.0	0.0
	Rearing	0.0	0.0	0.0	0.0	0.0
	Migration	0.0	1.5	0.0	0.0	1.5
All Action Area	Spawning	18.8	57.3	28.5	12.1	116.7
	Rearing	14.1	68.9	63.0	0.0	146.0
	Migration	106.5	41.0	0.0	0.0	146.0

a. *Current Condition of Habitat in the Russian River Main Stem*

Overall, migration habitat in the main stem appears to be in moderate condition for all three species. Winter flows generally provide unimpeded passage conditions for adult salmonids that utilize the main stem and tributaries for spawning. During dry water years stream flow in reaches downstream of Cloverdale may be insufficient for adult salmonid passage between storm events. Seasonal dams and seasonal road crossings may cause minor delays for early adult Chinook salmon migrating in the main stem. Given their later spawning migration times, coho salmon and steelhead are not impacted by these impediments. The seasonal dams and road crossings are typically out of the main stem by the time adult coho salmon and steelhead immigrate, and fish ladders are present on the Mirabel and Healdsburg dams. Runs of coho salmon and steelhead generally commence only after early season rain events. Passage conditions in most years are suitable for salmonid smolts emigrating from the Russian River (SCWA 2005); however, smolt emigration during dry water years may have been reduced, exposing them to stressful water temperatures and increased predation (Corps and SCWA 2002). Smolt migration may be slowed by the Mirabel Rubber Dam (Manning *et al*. 2006).

Overall salmonid spawning habitat in the main stem has been negatively affected by geomorphic changes to the stream channel caused by dam construction and concomitant changes in sediment delivery and stream flow patterns, gravel extraction, channelization, and agricultural impacts. Nevertheless, the majority of the remaining good Chinook salmon spawning habitat is located in the river's main stem. About half of the spawning habitat for Chinook salmon in the Russian River is rated as good, with the rest being rated either fair or poor by the CHARTs (NMFS 2005*b*). Elevated fall flows associated with water management provide good spawning habitat for adult Chinook prior to the onset of winter rain events. Most information suggests that coho salmon do not utilize the main stem Russian River for spawning. About half the spawning habitat for steelhead in the Russian River is rated as fair, with the rest being rated either poor or unknown (NMFS 2005*b*). Steelhead use Russian River tributary streams for spawning more often than Chinook salmon.

Salmonid rearing conditions in the Russian River main stem vary considerably from the lower river near Monte Rio to the upper river in Ukiah. Rearing conditions for steelhead are marginally suitable in the segment from Cloverdale upstream to Ukiah, with the best habitat in the "Canyon" reach just north of Cloverdale. Streamflow conditions are largely controlled by sustained releases from CVD of more than 250 cfs for many weeks or months during the summer. The interagency flow-habitat assessment study, described in the *Effects of the Action* section, found a clear negative relationship between flow levels and availability of rearing habitat for steelhead in the upper Russian River.

The alluvial valley reaches between Ukiah and Hopland and Cloverdale and Healdsburg have been affected more by channelization, aquatic habitat simplification, loss of riparian vegetation, bank stabilization, gravel extraction, and agricultural practices as compared to more confined reaches such as the Canyon reach between Hopland and Coverdale. Summer rearing habitat in the main stem from Cloverdale downstream to Monte Rio is poor due to summer water temperatures that typically exceed thermal tolerances of rearing salmonids (Corps and SCWA

2004). This segment provides both minimal amounts and marginal quality rearing habitats for these species. Therefore, our overview of summer rearing conditions in the Russian River main stem will focus primarily on juvenile steelhead rearing habitat from Ukiah downstream to Cloverdale, a 34 mile stream segment.

The 20 mile reach of the upper Russian River from Ukiah downstream to Hopland is characterized by its low gradient, which influences the quality of habitats used by steelhead. SCWA surveyed segments of this reach in 2002, and found 94% flatwater habitat, 1% deep pool, less than 1% cascade, and 5% riffle habitat (SCWA 2003). Habitat utilization by juvenile steelhead during the summer was found to be almost exclusively in cascade and riffle habitat types (SCWA 2003). Halligan (2004) reports that this reach is dominated by gravel substrates, with 80% of the embeddedness values rated as good (*i.e.*, pool tailouts <25% embedded), or fair (25-50% embedded). Halligan (2004) considered rearing habitat for steelhead to be poor because shelter ratings are low in riffles, pools and flat habitats. As a result of flood conditions that occurred in late 2006, current shelter ratings may have improved slightly over those reported by Halligan. NMFS staff conducting monitoring work in the upper main stem has observed recruitment of groups of alder trees (*Alnus* spp.) that form complex habitat and velocity refuges that have likely improved shelter ratings within this reach.

Shade canopy in the reach is relatively low at 18%, which is partially influenced by the wide wetted channel. Riparian areas throughout the reach consist of willows (S*alix* spp.), and alder near the waters edge and Fremont cottonwood (*Populus fremontii*), and black walnut (*Juglans californica*) at the top-of-bank. Agricultural or urban activities usually limit the riparian zone to the top-of-bank where vineyards or other activities encroach up to the rivers banks. The non-native invasive giant reed (*Arundo donax*) occurs throughout the upper Russian River reach from Ukiah to Hopland. Circuit Rider Productions (2001) reports that this reach has a total of 16.39 acres of giant reed that has been identified and mapped in order to prioritize eradication and restoration of existing sites. Giant reed has been found to have negative effects on diversity and abundance of terrestrial insects in the riparian zone that are important as food sources for rearing salmonids (Circuit Riders Productions (2001).

The Canyon Reach extends from Hopland downstream 14 miles to Cloverdale. The upper four mile section from Hopland downstream to Squaw Rock is similar to the upper Russian River reach with dominant flatwater habitats and a well developed riparian zone; whereas the 10 mile segment from Squaw Rock to Cloverdale is characterized by steep canyon topography, fast water habitats, and substrates consisting of large boulders and bedrock. Surveys conducted by SCWA (2003) found that riffle habitat comprised 34% of the segment, the greatest concentration of this preferred rearing habitat for steelhead in the Russian River. Cascade habitat, also preferred by juvenile steelhead, makes up 2% of the habitat in the canyon reach below Squaw Rock. Stream gradient and channel confinement below Squaw Rock results in fast water habitat that is preferred by juvenile steelhead. This reach also has suitable stream temperatures that are conducive to juvenile steelhead rearing during the summer. As mentioned above, physical habitat and marginal stream temperatures limit juvenile steelhead use between Cloverdale downstream to Monte Rio.

SCWA (2003) reports that riparian characteristics below Squaw Rock are patchy in nature, likely due to the high flows that create increased shear stress within the stream channel during the winter. Riparian habitat in this reach is less affected by anthropogenic factors, yet there appear to be remnant effects from the railroad grade that flanks the canyons' west side, and some riparian impacts from work conducted along U.S. Highway 101 on the east side of the canyon.

b. Current Condition of Habitat in Dry Creek

Dry Creek and its tributaries are generally accessible to salmonids. WSD is a complete barrier to migration and some small seasonal dams on tributaries may block migration. Flow in Dry Creek, augmented by WSD releases, is usually sufficiently deep to allow fish to easily pass most shallow areas. Water temperatures are generally sufficiently cool and suitable for salmonids; however, sometimes adult Chinook salmon immigrate as early as September. Because of a loss of riparian vegetation resulting in increased solar inputs to the stream, water temperature in the lower portion of Dry Creek in the late summer is not optimal for adult Chinook salmon. However, the majority of adult Chinook salmon migrate in October and November, a time with generally adequate water temperatures for adult Chinook salmon. Coho salmon and steelhead migrate later in the fall and winter; water temperatures in Dry Creek are adequate for immigration of adult coho salmon and steelhead. Instream habitat structure is limited in Dry Creek, which may limit cover for migrating adults to escape predators. Also, the limited instream habitat structure results in limited pools for adults to escape from high flows. Habitat conditions are sufficient for smolt emigration for all three species.

Dry Creek provides adequate depth and flow for salmonid spawning, but resting areas for adult fish are limited due to the absence of deep pools. This is exacerbated by a lack of LWD and boulders, which would increase habitat complexity. Pool/riffle habitat, which serves as prime spawning habitat for steelhead and salmon, is also limited. As described below in **B. Status of Listed Species within the Action Area,** lack of cover and complexity has not precluded relatively large numbers of Chinook salmon from spawning in Dry Creek.

The lack of LWD and boulders also increases potential for scour of stream bedload. This lack of instream habitat structure combined with reduced riparian habitat leads to increased stream bank erosion when subjected to high flows. Stream bank erosion on Dry Creek has caused increased delivery of fine sediment, negatively affecting the quality of spawning habitat. WSD blocks sediment from recruiting to lower Dry Creek; this has resulted in numerous sites of exposed bedrock along the creek (S. White, SCWA, personal communication, January 3, 2007). The availability of spawning habitat in Dry Creek is less for coho than for steelhead or Chinook salmon because coho salmon use smaller gravels for spawning than steelhead or Chinook salmon (Corps and SCWA 2004). These smaller gravels may be getting transported out of the upper reach of Dry Creek more readily due to the high flows in this creek (Corps and SCWA 2004). Coho salmon redds, which are constructed from November through January, are more subject to scour because they are subjected to a higher frequency of winter flow events. Higher flows, occurring in the latter part (January) of the spawning and incubation season, have the greatest potential to scour the most redds and incubating alevins (Corps and SCWA 2004). In an evaluation of potential scouring of salmonids redds conducted by the SCWA, coho salmon redds had the highest frequency of scour potential in Dry Creek. Water temperatures are good in Dry

Creek for incubation. However, in the lower portion of Dry Creek during the latter part of the spawning season (April and May) water temperatures are too warm for incubation, often exceeding 15° C. As previously mentioned in Tables 13 and 14, CHART has rated spawning habitat as good in Dry Creek for Chinook and steelhead. There is no rating of coho spawning habitat by CHART in Dry Creek; however, based on the conditions described above, we conclude that spawning habitat for coho salmon is in fair to good condition in Dry Creek.

Salmonid rearing habitat in Dry Creek is marginal. Chinook salmon have a limited rearing period in the action area – typically about two to four months (February through May) before emigrating to the ocean. Both coho salmon and steelhead have extended freshwater rearing life histories and would be expected to rear for one or more years before emigrating; therefore, juveniles of these species would need summer and winter rearing habitat. While temperatures in Dry Creek are generally favorable for salmonid rearing, other rearing habitat attributes are lacking or in poor condition. Riparian vegetation provides shade and a source for allochthonous inputs (food and woody debris) along much of the stream and its tributaries. However, the riparian vegetation has been encroached upon and the width of the riparian areas has diminished as vegetation was removed primarily to benefit agriculture. The reduction of riparian vegetation is particularly noticeable on the lower portions of tributaries and the lower two miles of Dry Creek.

Dry Creek is also lacking in riffles, cover, and instream structure that severely limits salmonid production (SEC 1996). The lack of these habitat elements result in limited areas where juveniles can find refuge from high water velocities and cover for escaping predators. This lack of cover also limits sites where there is deposition of loose gravels and cobbles which provide habitat for aquatic invertebrates – the preferred prey of juvenile salmonids (Corps and SCWA 2004). Also, flow management, bank stabilization, and blockage of sediment transport by WSD have lead to channel incision, channel straightening, and bank instability. These factors work in concert to leave the creek lacking in complex habitat such as back water eddies and pools, and the creek is disconnected from its flood plain. The low incidence of pools in the creek limits rearing habitat for coho salmon in particular, since they prefer pool habitat over riffle habitat.

The CHART concluded that rearing habitat for Chinook salmon and steelhead in Dry Creek was fair (Tables 13, 14); however, biologists from NMFS, the Corps, SCWA, CDFG, and Entrix conducted an analysis of aquatic habitat conditions in Dry Creek and determined that habitat conditions for steelhead rearing are poor in Dry Creek (see Appendix F of Corps and SCWA (2004)). The poor rearing conditions in Dry Creek are attributable to current operations at WSD. The SCWA's flow management continues to greatly influence the quality and quantity of PCEs of critical habitat for salmonids in the 14 mile segment of Dry Creek below WSD. During the past 15 years, SCWA has generally sustained releases from WSD of more than 110 cfs for many weeks or months during the summer. The interagency flow-habitat assessment study, which is also described in the *Effects of the Action* (Section VI.F), found a clear negative relationship between flow and availability of rearing habitat for juvenile salmonids. SCWA's operations that maintain elevated flows in Dry Creek result in very limited amounts of suitable and optimal quality habitats for salmonid rearing. These current velocities resulting from the flow releases exceed the tolerance of juvenile salmonids, thereby reducing habitat suitability. Poor winter rearing habitat conditions are exacerbated by the Corps' flood flow releases, which further limit

foraging opportunities for juvenile coho salmon and steelhead by increasing the duration of flows at which these juveniles must seek velocity cover.

c. Current Condition of Habitat in Zone 1A

This section describes the current condition of the PCEs of the salmonid habitat in the Zone 1A tributaries, including critical habitat for coho salmon. This section is divided into two parts, based on how SCWA manages these streams: constructed flood control channels and natural waterways. Most of the creeks in this zone are managed as both constructed flood control channels and natural waterways. The upper portions of the creeks are usually managed as natural waterways and the lower portions, found in the more urban areas, are typically constructed flood control channels. The first part of this section covers constructed flood control channels found in Santa Rosa Creek and the Rohnert Park-Cotati area. The second covers natural waterways which include the upper portions of the Santa Rosa Creek and Rohnert Park-Cotati area.

Zone 1A- constructed flood control channels. Instream salmonid habitat conditions within the constructed flood control channels are generally poor. These channels have been straightened and roughness elements (*e.g.*, LWD and boulders) have been removed to reduce turbulence and retention time of flows. Some channels are further modified by lining them with concrete or riprap and converting the channel shape to a trapezoid. Also, much of the woody vegetation has been removed from the stream banks, and the streams have been disconnected from their floodplains.

Migration habitat for juvenile and adult salmon and steelhead in the constructed flood control channels is degraded relative to historic conditions. Habitat complexity including reduced instream and riparian cover is especially lacking. Channel morphology has been simplified as well. Small lateral bars and in-channel vegetation, needed to create sinuosity of the channel and adequate depth for migration, are no longer evident in most of the flood control channels. This channel condition allows the stream flow to spread over the bottom width, reducing depth, and creating a laminar flow. This reduction of depth creates fish passage barriers for upstream migration when surface flow is relatively low. Many of the flood control channels have depths of only 2 to 3 inches. Adult salmon and steelhead generally require a minimum depth of 18 centimeters (7 inches) for upstream migration (Thompson 1972). As a result, adult migration opportunities are reduced from historic conditions and limited to periods when surface flow is higher and depth is adequate for passage. Also, during high water events, some adult or juvenile salmonids might become entrained in the unscreened diversion to Spring Lake, a SCWA flood control reservoir. Also, the SCWA has three inchannel flood control dams and reservoirs on Santa Rosa Creek tributaries; these facilities are complete barriers to migration. Migration opportunities for smolting salmonids in the flood control channels is fair, but opportunities for non-smolting juvenile salmonids is poor, primarily because of reduced summer and fall flows from water extraction, and reduced habitat complexity from flood control activities.

Most of the flood control channels have conditions unsuitable for spawning for salmon and steelhead; however, a small amount of suitable spawning habitat exists in a few flood control channels. The low-gradient straightened channels are subject to sediment deposition (Corps and

SCWA 2004). Flow through the low gradient (between 0.05 percent and 0.4 percent) areas of these channels does not have the energy necessary to mobilize the excess sedimentation found in these streams. Also, the lack of channel roughening elements such as LWD and instream vegetation reduces the amount of habitat complexity, and the ability of the stream to sort and retain appropriate gravels for spawning areas. The quality of spawning gravel is limited by high rates of gravel embeddedness or high levels of fine sediments. Urbanization and agriculture have added to the high sediment levels. The reduced amount of LWD, instream and riparian vegetation, and boulders leads to reduced amount of cover used by adult salmonids (Bisson *et al*. 1987; Bjornn and Reiser 1991).

Rearing conditions for salmonids are in poor condition in the flood control channels. The significant lack of channel roughening elements in the constructed flood control channels reduces cover and resting locations. This deficit in channel roughening elements has resulted in reduced pool habitats. According to Bisson and Bilby (1987), one of the most important functions of LWD in forming salmon habitat is the creation of rearing pools. Pool/riffle type habitat, necessary for successful salmonid rearing, is poorly developed due to the straightened channel, removal of riparian vegetation, bank stabilization activities, and sedimentation from urban and agricultural land uses. The lack of sinuosity in these channels inhibits the formation of pools. The limited amount of pools that do exist are relatively shallow. Pools, and especially deep pools, are important to salmonids for a variety of reasons, particularly for coho salmon[27]. Pools function as refugia for fish during floods and droughts (Sedell *et al*. 1990). The greater depth found in pools, compared to riffles, affords fish a better opportunity to escape from predators. Pools allow coexisting fish species and/or age classes to "stack" or occur in layers within the water column (Bisson *et al*. 1988). This divides territorial units which reduces density related competition. These limited resources are particularly troublesome for coho salmon, as they prefer pool habitat over riffles for rearing.

There is limited riparian vegetation near the channels, as most has been removed during flood control activities, though some urban and agricultural land uses have also reduced riparian vegetation. One contribution of riparian vegetation is to hold stream bank soils in place. Therefore, erosion of banks is more common in areas of reduced riparian vegetation. The bank erosion contributes fine sediments to the channels and fills in pools. The reduced riparian canopy results in higher stream temperatures. As described in the *Status of the Species* Section, higher water temperatures can negatively influence salmonid egg development, juvenile appetite and growth and can cause death when the temperatures are high enough. Because the channels are disconnected from their flood plains and much of the large woody riparian vegetation has been removed, complex instream habitat such as backwaters, eddies, and side channels are very minimal in the channels. These areas serve as summer and winter rearing areas for juvenile fish and provide critical refuge during floods (Moore and Gregory 1988*a*; Moore and Gregory 1988*b*; and Sedell *et al*. 1990, Moyle 2002, Quinn 2005).

Water quality is poor in many of the flood control channels. Urban runoff, including stormwater discharge, and agricultural runoff introduces toxins, nutrients, and fine sediment to these

[27] The historical presence of coho salmon on the Santa Rosa plain is unknown, but probable given their preference for rearing in off-channel habitat, which probably existed prior to creek channelization. Pools can also be particularly important for steelhead in California, serving as temperature refuges during the summer (Nielson 1994)

channels. These effects are most pronounced following early season or large rain storms. Other sources of toxins in the channels are herbicides applied directly to waterways to control invasive species of plants, such as water primrose (*Ludwigia* spp.) and cattail (*Typha* spp.); these chemicals are applied primarily in the spring and summer. Many of the flood control channels are dry in the summer or have shallow stagnant water. This is partially due to the low gradients that exist in these channels, increased sediment delivery to the channels, and water extractions. The poor summer flows, the loss of riparian vegetation, and the limited amount and depth of pool habitat increases summer water temperatures in these flood control channels. Levels of DO are reduced in the flood control channels, further reducing water quality.

Zone 1A natural waterways. In contrast to constructed flood control channels, natural waterways do not have the artificial trapezoid channel shape or the amount of bank stabilization structures. Sediment removal is not routinely performed in natural waterways, but occasionally sediment and debris removal is conducted in response to large storm events on an as needed basis (Corps and SCWA 2004). Many of the natural waterways were cleared of vegetation in the 1970s and 1980s, but this practice ended in 1987 (Corps and SCWA 2004).

The natural waterway portion of Santa Rosa Creek appears to be in fair condition for migration. Migration habitat in the natural waterway portions of the Rohnert Park-Cotati area is in poor to fair condition. There is usually sufficient flow during the steelhead migration period, however, there is not much instream cover or pools to provide refuge from high water velocity or cover from predators. Also, tributaries to Santa Rosa Creek have some permanent dams or grade control structures which diminish migration opportunities. The natural waterway portions of the Rohnert Park-Cotati area are in poor to fair condition, primarily because of loss of instream habitat. Tributaries throughout Zone 1A contain culverts and other impediments to passage of adult and juvenile salmonids – some of these objects are total barriers and others are partial barriers. Migration habitat for smolting salmonids is generally satisfactory, but opportunities for non-smolting juvenile salmonids is fair to poor, primarily because of reduced summer and fall flows from water extraction, and reduced habitat complexity from flood control activities.

Spawning habitat in the natural waterway portion of Santa Rosa Creek is in fair condition for salmonids. Sufficient spawning gravels are available; however, they are more embedded than in the middle section of the creek due to erosion from roads (CDFG 2006). Spawning habitat in the natural waterway portion of Santa Rosa Creek is also diminished due to nutrient loading in the stream from livestock and failing septic systems. Spawning habitat in the natural waterway portions of the Rohnert Park-Cotati area is in poor condition. These are low gradient streams with limited pool/riffle habitat and limited cover. Copeland Creek is an exception to this and has some potential habitat for steelhead (S. Chase, SCWA, personal communication, January 16, 2007). The upper portion of this creek runs through Fairfield/Osborne Preserve and is well shaded and in a fairly natural state. Two steelhead were found in this creek in the summer of 2006.

Rearing conditions in natural waterway portions of Santa Rosa Creek are in fairly good condition. There is adequate canopy cover in the form of mature, native riparian vegetation. The headwaters of Santa Rosa Creek are situated in Hood Mountain Regional Park where the stream is protected from most anthropogenic disturbances, though some recreation occurs in and

near the stream. All but two tributaries to Santa Rosa Creek (Fountain Grove Creek and Hood Mountain Creek) are managed, at least in part, as constructed flood control channels. Therefore, most of the rearing habitat in the tributaries to Santa Rosa Creek is degraded. Rearing habitat in the natural waterway sections of the Rohnert Park-Cotati area is in poor condition. Most of the natural waterway portions of the creeks dry in the summer or have warm water temperatures due to removal of riparian vegetation, limited canopy cover, and water extraction. Agricultural runoff also results in water quality impairments. Copeland Creek retains some fair rearing habitat in the summer. Between 1999 and 2003, SCWA restored portions of this stream by adding riparian vegetation to provide more canopy cover, and as a source of food and other allochthonous inputs.

d. Current Condition of Habitat in the Estuary

The Russian River estuary is a drowned river valley formed via erosion when sea level was lower during the early Pleistocene (Erskian and Lipps 1977). The bed of the estuary rises above mean sea level near Duncan's Mills, about five miles from the River's mouth. Ocean tides can influence water surface elevation in the river as far as 10 miles upstream near Monte Rio (Corps and SCWA 2004), and directly affect water elevation about five to seven miles upstream in the vicinity of Austin Creek (Erskian and Lipps 1977, Corps and SCWA 2004). Tides range approximately 6 feet and are diurnal (Erskian and Lipps 1977). Sediments are fluvial (gravels and cobbles), marine sands (Erskian and Lipps 1977), and fine silts and mud in some areas of the estuary (NMFS staff observations 2007). Several Russian River tributaries drain directly to the estuary, including Willow Creek, Freezeout Creek, Dutch Bill Creek, Austin Creek, and Sheephouse Creek (Figure 6).

Artificial breaching has created a mostly marine environment in the estuary in the summers. Forty three fish species have been identified in the estuary (including salmonids) during monitoring in the late 1990s and early 2000s (Corps and SCWA 2004). Most common were marine or estuarine species such as topsmelt (*Atherinops affinis*), starry flounder (Platichthys stellatus) and Pacific herring (Clupea pallasii) (SCWA 2004b). Macroinvertebrates such as opossum shrimp (*Neomysis mercedis*) , bay shrimp (*Crangon sp*.), Dungeness crab (*Cancer magister*), and amphipods (*Eogammarus confervicolus*) are also present (Corps and SCWA 2004). Pinnipeds found in the estuary and on its bar include harbor seals (*Phoca vitulina*), which are found year round; and sea lions (*Zalophus californianus*) and elephant seals (*Mirounga angustirostris*) are found less regularly (Corps and SCWA 2004).

Artificial breaching and high summer flows have had large impacts on salmonid habitat conditions. The following is a summary of these impacts, which are described in detail in the ***Effects of the Action*** (Section VI. G).

Salmonid migration habitat in the estuary is in relatively good condition. The estuary is usually open due to winter storms during the steelhead and coho migration period. During the spring months the estuary is usually open, which allows for salmonid smolt outmigration. In the fall, the estuary is often open[28], but it does close periodically. When it closes, it may breach naturally

[28] The estuary remains open during the summer and early fall due to a combination of artificial and natural breaching.

or require mechanical breaching to open. Breaching in the fall may provide attraction flows which could encourage more Chinook salmon to migrate upstream prior to fall and winter rains[29], which may expose some adults to impacts from recreational fishing and above optimal water temperatures. No physical impediments to migration such as dams, grade control structures, or culverts exist within the estuary. Summer water temperatures are generally adequate, as the result of the coastal climate.

The spawning PCE of critical habitat is not applicable to the estuary, as no Chinook salmon, coho salmon, or steelhead spawn within the estuary. Given the life history strategies of these three species, it is unlikely that any spawning occurred in the estuary historically.

The estuary provides suitable conditions for short-term rearing and transition to the marine environment for salmonid smolts. Early breaching events have not reduced habitat availability for smolts that arrive at the estuary during the late winter and spring months. The limited number of artificial breaches during the winter and early spring likely mimics natural estuary function when smolts utilize the estuary. Emigrating salmon smolts move through the estuary and into the marine environment when the estuary is in the open condition. If not, then emigrating smolts utilize the available estuarine habitat until the barrier beach is breached (naturally or artificially) when they are then able to migrate to the ocean. The current breaching regime may benefit smolting salmonids by allowing more frequent access to the marine environment in some years.

The juvenile steelhead rearing PCE of critical habitat is degraded in the estuary during the late spring, summer, and early fall by repeated mechanical breaching for flood control. Many estuaries in California convert to a productive freshwater lagoon following formation of a barrier beach. Following formation of a barrier beach the estuary slowly converts to freshwater; the process may take 1 month or more (Smith 1990). Until the conversion process has completed, stratification of the water by salinity occurs. Saltwater, being denser, is located at the bottom, while freshwater is found on top. Stratification can limit both the quantity and quality of freshwater steelhead habitat, relative to a freshwater lagoon. During the onset of stratified conditions, some habitat is present for YOY and 1+ juvenile steelhead in the shallow freshwater lens atop the estuary. These life stages are restricted by the highly saline and low DO conditions at the bottom of the estuary. Aquatic invertebrates, the prey base for juvenile steelhead, are often more diverse and abundant in a lagoon. When conversion of an estuary to a lagoon is complete, steelhead can have more abundant space and prey for survival.

[29] When the estuary closes, water surface elevation often rises prior to SCWA breaching. As the estuary drains, the outflow may encourage Chinook salmon to enter. NMFS compared the dates of estuary closure and breaching in the fall with Chinook salmon counts at Mirabel Dam. In some cases the salmon counts appear to rise shortly after the estuary is breached. However, NMFS found at least one year (2002) when over 1,000 Chinook salmon were counted at Mirabel (26-Sep.) prior to closure of the bar (30-Sep.) and the onset of fall breaching. Thus, breaching does not trigger large numbers of Chinook salmon to enter the estuary in all cases. Increase in numbers of Chinook salmon are also more generally correlated with increased flows in the Russian River which often start in late October or early to mid November.

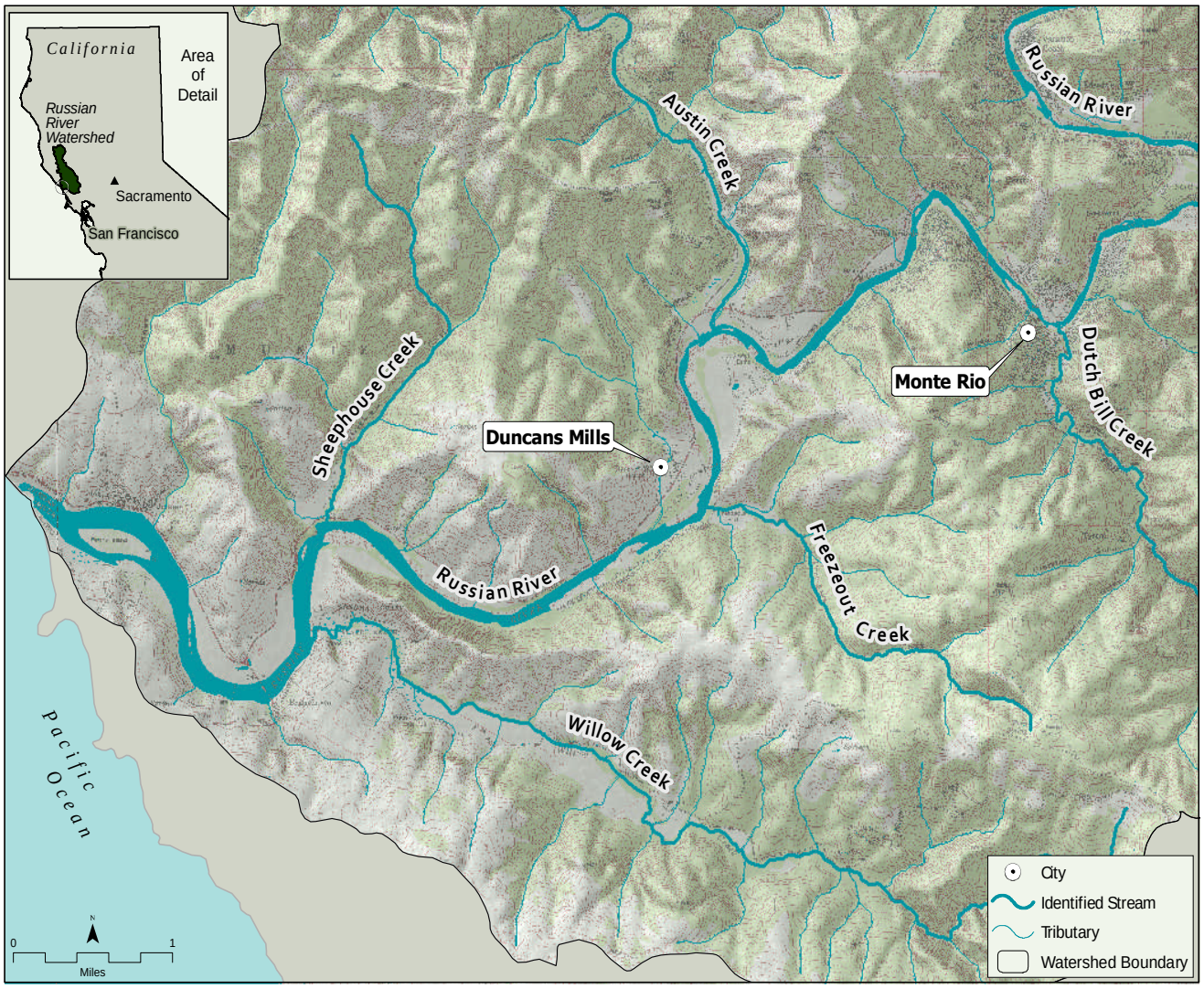

Figure 6. Russian River Estuary.

Although there is uncertainty regarding whether or not the estuary historically converted to a completely freshwater lagoon or remained stratified after bar closure, NMFS expects that given the high freshwater flows sent from WSD and/or CVD down the Russian River and into the estuary, conversion to a mostly freshwater lagoon, or stratification with a deep freshwater surface layer, is now likely if breaching did not occur. High river flows would eventually overtop the bar and entrain most of the salt water as they flowed out over the bar and over an ever shrinking salt water lens (a perched lagoon)[30]. Or, if flows were somewhat lower, equilibrium between inflow and outflow through the bar would establish and the freshwater would likely push most of the salt water through the bar and into the ocean.

The frequent artificial breaching of the barrier beach disrupts the conversion processes described above. Every time the barrier beach is mechanically breached, much of the limited existing freshwater lens (rearing habitat for younger juveniles) in the lower four miles of the estuary runs out into the ocean. Near the mouth of the estuary aquatic conditions (*e.g.*, salinity or temperature) are nearly marine. The extent of the upstream effect of these conditions depends upon tidal fluctuation and freshwater inflow from the Russian River main stem and estuary tributaries. Satisfactory freshwater rearing habitat may only be maintained consistently at the upstream end of the estuary and near tributary mouths, where freshwater inflow maintains low salinity conditions regardless of tidal action. The resulting high salinity and low DO at the bottom of the estuary during stratification likely limits food supply for juvenile salmonids rearing in the estuary. In lagoons north and south of the Russian River, temporary loss of estuarine invertebrates (salmonid prey base) was documented, or inferred from steelhead growth rates, each time estuaries closed and stratified (Smith 1990, Cannata 1998, Entrix 2004).[31] Also, as the smaller juvenile stages of steelhead are concentrated in the shallow freshwater lens of a temporarily stratified estuary, they are more susceptible to significant amounts of avian predation. Breaching may also lead to an increase in the amount of pinnipeds (steelhead predators) in the estuary, but increases in marine mammal predation appear to be minor.

Rearing habitat for juvenile steelhead in much of the estuary often remains heavily influenced by the marine environment for months, limiting the amount of YOY and 1 + juvenile steelhead that can successfully use the estuary, due to their low salinity tolerance (Described previously in the *Status of the Species* section). However, these habitat conditions do support larger steelhead juveniles some of which may be "half-pounders" (*i.e.*, post smolt/sub-adult steelhead juveniles that return early from the ocean to rear in river and streams before going out to sea to become spawning adults (Snyder 1925, Kesner and Barnhardt 1972, Fuller *et al.* 2008). Some steelhead in the estuary appear to be small sized mature male adults (Josh Fuller, NMFS, personal observation, 2008). During the twelve year period, 1996-2007, when the estuary closed in the spring, the estuary remained open after breaching for about 90 days on average during the late spring through early fall, ranging between about 44 and 144 days open.

The estuarine rearing habitat conditions for coho salmon are likely worse than for steelhead. High salinity concentrations probably limit habitat availability to the upper estuary below Austin Creek. As noted above, the Russian River estuary has relatively limited marshlands, which coho salmon may prefer as

[30] In early May of 2008, NMFS staff observed the initial stages of a perched lagoon at the mouth of the Russian River. Outflow was occurring southward over the bar until reaching the jetty, where the overflow channel took a sharp turn to the ocean. The freshwater lens appeared to be approximately 6-10 feet deep in the mid and lower portion of the estuary (NMFS unpublished data 2008).

[31] Estuarine invertebrates increased when the lagoons transitioned to fresh water (Entrix 2004).

estuarine rearing areas. Coho salmon have less tolerance for high water temperatures, which likely preclude their use of most of the upper estuary in the summer. Breaching the estuary limits water volume, potentially extending the duration of high water temperatures in the upper estuary.

3. Conservation Role of Specific Habitat Areas within the Action Area

We conducted more site specific analyses for the PCE of CCC coho salmon summer rearing habitat and the PCE of estuarine habitat for CCC steelhead to provide a link between effects of the action and how those effects may affect the role and function of critical habitat at the ESU and DPS scale. This section provides the context for understanding the significance of effects to these critical habitat elements, *i.e.*, how those effects may affect the functionality and ability of critical habitat to serve the intended conservation role for the species or retain the ability of the PCEs to be functionally established.

a. Coho Salmon Juvenile Rearing Habitat.

The Intrinsic Potential (IP) habitat model of historic coho salmon distribution developed by Agrawal *et al*. (2005) indicates that the historic (predevelopment) distribution of coho salmon in the Russian River watershed likely included 710 linear miles of stream habitat[32]. This does not include segments of the main stem which supported seasonal migrations, but were too warm to support juvenile rearing during summer months. This IP habitat model indicates that prior to development in the 18th century, coho salmon were likely distributed throughout most tributaries to the lower Russian River, including the Mark West Creek, Laguna de Santa Rosa, Santa Rosa Creek, Green Valley Creek, Dutchbill Creek, Hulbert Creek, Willow Creek and Austin Creek watersheds, as well as a variety of smaller watersheds tributary to the lower Russian River. CDFG records document coho salmon rearing in the Dry Creek, Mark West Creek and Maacama Creek watersheds as recently as the 1990's. Today the species is almost extirpated from the entire Russian River watershed as the result of the degradation of spawning and rearing habitat, and in the case of Willow Creek degradation of the migratory corridor.

To examine the effect of proposed project operations on the function and role of rearing habitat for coho salmon in main stem Dry Creek, and how these effects impact critical habitat in the Russian River, we estimated the amount of remaining summer rearing habitat for that species in the Russian River and calculated the percentage of that remaining habitat which is represented by Dry Creek. For this we defined the existing amount of summer rearing habitat based on current habitat suitability, water temperature information, and apparent summer rearing survival rates of captive bred coho salmon planted in several streams. We used several sources of information to determine habitat suitability, including: stream habitat typing data (CDFG 2006), the CDFG (2002*a*) definition of the minimum coho salmon distribution, coho captive broodstock monitoring data (UCCE 2007), and other miscellaneous sources of habitat and distribution information.

A principal step in defining the extent of summer rearing habitat for coho salmon was the subtraction of those areas where stream temperatures are, at present, likely to be too warm to support summer rearing of juveniles. We used temperature data primarily from the Russian River Interactive Information System (RRIIS) (Institute for Fisheries Resources 2002 and the Sotoyome Resource Conservation District (RCD) (Laurel Marcus and Associates 2004*a*, 2004*b*, 2004*c*). Where no other data was available, we used data

[32] The calculation of 710 linear miles is based on the intrinsic potential model computations with a water temperature mask eliminating stream segments where mean August air temperature is less than 20.5°C

from the CDFG (2002b) limiting factors analysis for the Russian River basin. Of the streams with continuous temperature data, most had data for at least one summer between 1998 and 2004. The RCD data were summarized into maximum weekly maximum temperatures (MWMT)[33] and we compared this to a threshold of 18˚C. Welsh *et al.* (2001) found that streams in the Mattole River watershed with MWMTs greater than 18˚C did not contain rearing juvenile coho salmon. This conclusion was supported within the CCC coho salmon ESU by Hines and Ambrose (2000). We therefore excluded those streams where temperature data exceeded an MWMT of 18˚C on the basis that they were too warm to provide viable summer rearing habitat. However, if current presence and/or survival data indicated coho salmon were present, or review of other field data indicated coho habitat was likely, we overrode the temperature criteria and included the reach as coho salmon habitat. We did not include areas that currently have unsuitable water temperatures, but that may support coho salmon as the result of future restoration efforts that create suitable temperatures for this species.

We found most of the qualifying summer rearing habitat to be in Mill Creek and its tributaries (Figure 7). Other coho salmon rearing habitats also occur in small portions of Austin Creek, Green Valley Creek, Dutch Bill Creek, Sheephouse Creek, Freezeout Creek, Redwood Creek, Willow Creek, and Hulbert Creek. It is worth noting that some of the segments that we included may have suitable water temperatures for juvenile coho salmon; however, they are currently not inhabited by coho because of habitat degradation such as blocked access (*e.g.*, Willow Creek and Redwood Creek) or impacts from water diversions, channelization, or sedimentation.

The main stem of Dry Creek below WSD is 14.1 miles long. Corps and SCWA (2004) modeled stream temperatures from releases at WSD and estimated median temperatures at the warmest time of year (July) to be 13.2˚C at the dam and 18.3˚C at the confluence with the Russian River. MWMT were not available for Dry Creek, so we concluded that a median temperature of 18.3˚C is likely in excess of the MWMT. However, the temperature gradient from the dam to the confluence was such that most of the stream would fall below the MWMT threshold. We therefore assumed, for the purposes of this analysis, the entire channel down to the Mill Creek confluence would qualify as suitable habitat based on stream temperature. However, we recognize that the quality of rearing habitat in Dry Creek is greatly limited by high velocities associated with high flow releases and limited instream cover.

Our rough estimate of the total number of stream miles of juvenile coho salmon summer rearing habitat in the Russian River is 85 miles, excluding Dry Creek. With Dry Creek there is approximately 98 miles of coho salmon rearing habitat remaining in the Russian River watershed. This remaining habitat is only 14% of the estimated original 710 miles of historic coho salmon habitat in the Russian River watershed. Any adverse effect on summer rearing habitat from flow releases in Dry Creek would therefore affect up to roughly 13 percent of the remaining rearing habitat as measured in river miles.

The actual contribution of Dry Creek as rearing habitat is likely under-represented by a linear analysis, given that Dry Creek is one of the widest streams under consideration . Because of its much greater width than other Russian River tributaries during summer, we factored channel widths in the analysis of available rearing habitat. Cross section data from the main stem of Dry Creek indicates an average wetted channel width of approximately 9.2 meters. Habitat typing data from CDFG (2002*c*) showed variable wetted channel widths for the other streams; therefore, we calculated the weighted average of the mean width of surveyed habitat units, and eliminated dry channel reaches to arrive at an overall wetted channel

[33] MWMT is the seven day moving average of the daily maximum temperature as recorded by in situ temperature data loggers.

area for summer habitat in tributaries. This calculation provided us with an average wetted area estimate of about 282,000 m^2 of wetted channel area in tributaries other than Dry Creek, and 181,800 m^2 of wetted channel area in Dry Creek[34]. Therefore, based on total wetted area, any adverse effect on summer rearing habitat from flow releases in Dry Creek could affect up to roughly 40 percent of the remaining coldwater rearing habitat for coho salmon in the Russian River.

Our results show that Dry Creek has the potential to support up to roughly 40 percent of the summer rearing habitat in the basin, by area. Our limiting factors analysis (described in the *Status of the Species*) indicates that summer rearing habitat is one of the primary factors limiting coho salmon production in the Coastal Diversity Stratum. Because summer rearing habitat is very likely limiting the Russian River coho salmon population, and because Dry Creek represents a significant portion of this habitat, ongoing flow releases from WSD during summer and early fall substantially diminish the function of a large portion of critical habitat to conserve the Russian River coho population, which is a major component of the species' Coastal Diversity Stratum.

[34]These numbers are rough approximations used for general comparisons of relative magnitude. The numbers are not intended to be precise calculations of the actual habitat areas available due to the assumptions and limited data for the calculations.

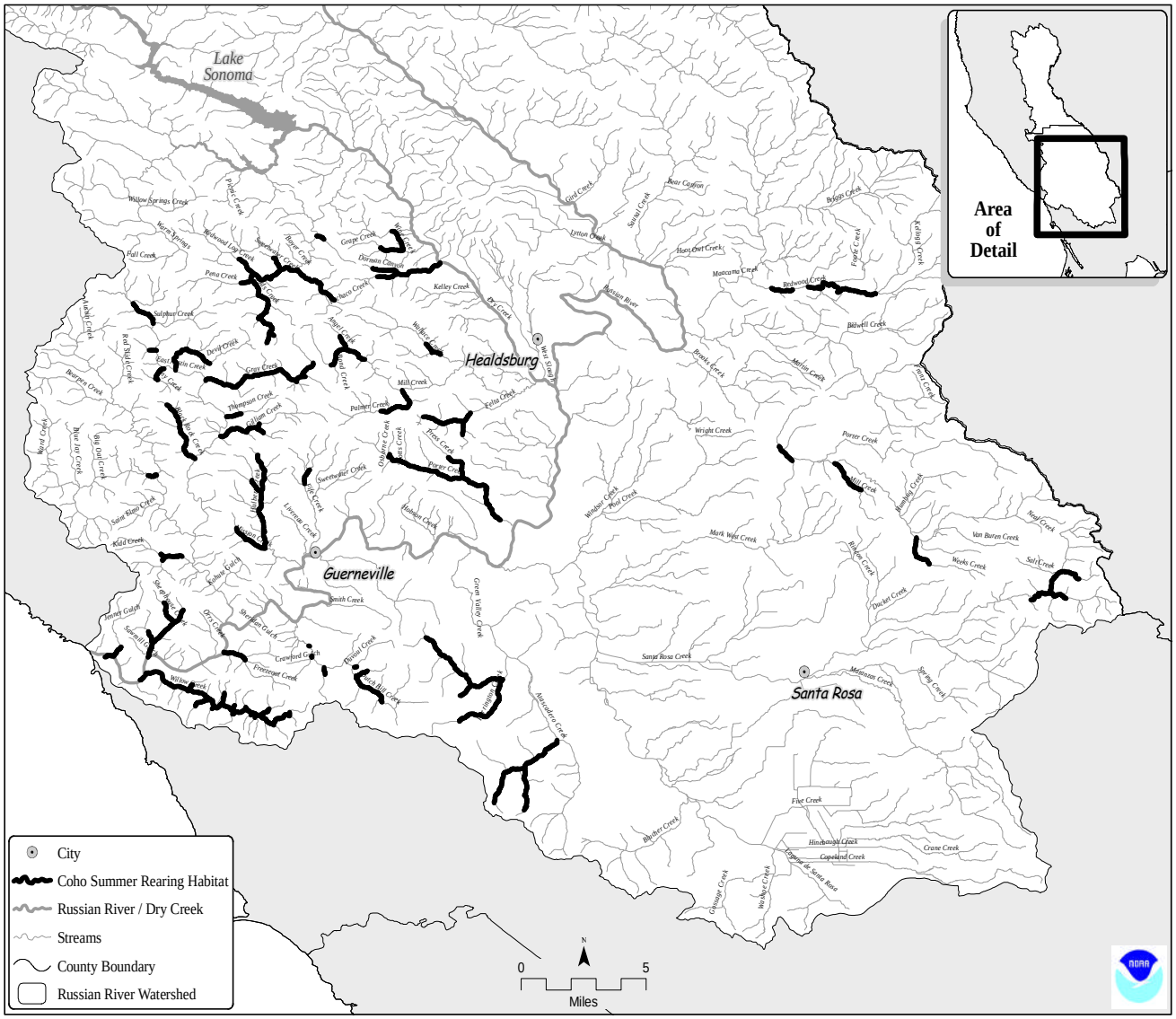

Figure 7. Estimated extent of juvenile coho salmon summer rearing habitat currently present in the Russian River, excluding Dry Creek.

b. Steelhead Estuarine Rearing Habitat.

As detailed in the Life History segment of the Status of the Species section (above), estuarine habitat is important to steelhead as rearing and migration habitat, and is influential in providing growth and survival opportunities as juveniles transition to the ocean phase of their life cycle. Bond (2006) found up to 48 percent of the juvenile steelhead population in Scott Creek had reared in the estuary and that they made up a disproportionate number (85 percent) of returning adults. It is likely that the Russian River estuary historically provided similar functions for steelhead in the basin, though its precise contribution to steelhead productivity in the basin is unknown. Current conditions are not conducive to successful rearing of large numbers of YOY and parr.

The estuary is also valuable in that it is perhaps the only habitat that must support every individual from each of nine populations of Russian River steelhead. With any other PCE of critical habitat, the species is distributed among different habitat patches. For example, while both the Austin Creek and Maacama Creek populations require summer rearing habitat, they may each experience very different habitat quality as a result of being in two different watersheds. Therefore, if something happens to the Maacama Creek habitat, the effect is limited to just that population. On the other hand, if habitat were degraded in the Russian River estuary, it would affect not only the Austin Creek and Maacama Creek populations, but all nine populations in the basin. The Russian River estuary is, in this way, inextricably linked to the recovery of all populations in the Russian River.

The specific habitat functions provided by the estuary include: successful passage of adult migrants upstream, successful passage of smolts migrating to the ocean, successful growth and smoltification of steelhead parr. The estuary must therefore be open to the ocean tides, or perched with enough overflow of the bar, during significant portions of the adult and smolt migration seasons, provide large areas of freshwater rearing space, as well as some areas of brackish and saltwater, and provide for an abundant and diverse invertebrate prey community as a food base for rearing juveniles.

B. Status of Listed Species within the Action Area

The purpose of this section is to: 1) provide a context for the effects analysis at the population scale, and 2) describe the current abundance, distribution, and condition of listed salmonids in the action area. By defining the status of salmonid populations associated with the action area, we are able to establish a link between project effects to individual fish (and/or their habitat) in the action area and a population response. This will, in turn, allow us to evaluate the risk of extinction at the ESU/DPS scale.

What follows is a description of the current condition of the species in the Russian River following the same four population viability metrics used to describe diversity strata in the previous section. Where possible, we describe each species' departure from historical condition and how they are likely to persist into the future.

Throughout this document, we use the historical population structure defined by Bjorkstedt *et al.* (2005) to define existing demographic units. A distinct population is defined as those individuals that spawn and rear in a single watershed that is tributary to the Pacific Ocean. Larger basins were further subdivided into multiple populations if sufficient physical, behavioral, or selective barriers to effective dispersal were evident.

1. Chinook Salmon

Bjorkstedt *et al.* (2005) conclude that a single population of Chinook salmon historically occupied the Russian River. This conclusion is based on the lack of evidence of substantially different selective environments. For example, spawning habitat is relatively contiguous throughout portions of the main stem river and Dry Creek. The spawning population is therefore likely to have been strongly influenced by dispersal from all areas within the basin. In addition, genetic analysis offers little support for the existence of separate populations.

Though there are conflicting reports, the high likelihood of suitable habitat under historical conditions offers strong evidence that a substantial population of fall-run Chinook salmon historically existed in the Russian River (Bjorkstedt *et al.* 2005; Moyle 2002). The historic size of the population remains mostly unknown (Chase *et al*. 2007). Some reports indicate Chinook salmon historically spawned in the upper drainage and were regularly harvested by local tribes in Coyote Valley prior to construction of CVD in 1959 (SEC 1996). However, no scientific observations of Chinook salmon exist in the Russian River prior to initial stocking efforts in the late 1880s. Stocking was performed sporadically through the latter half of the 20th Century, with poor adult returns during the most recent efforts (Chase *et al*. 2007).

SCWA has operated video cameras within the fish ladders at the Mirabel rubber dam in the middle reach of the Russian River for the last seven years. They estimated the Chinook salmon run size at about 1,500 in 2000 and 2001, and observed 5,474 in 2002, 6,103 in 2003, 4,788 in 2004, 2,572 in 2005, 3,410 in 2006, and 1,959 in 2007 (Chase 2005, www.scwa.ca.gov/ environment/ natural_resources/Chinook_salmon.php, SCWA 2008c). These data suggest a possible increase in adult escapement within the last several years. While a positive trend in abundance is an important indicator of viability, given the amount of historic habitat in the basin (548 stream miles, Bjorkstedt *et al.* 2005), it is not likely that the current population has reached a viable state. Smolt trapping just downstream of the Mirabel rubber dam has documented large numbers of Chinook salmon smolts heading downstream. For example, the annual catch in 2002 was 2,705 Chinook salmon smolts. In 2003 the catch was 6,255. A mark recapture study used in 2002 estimated trap efficiency at about 8 percent, resulting in an estimate of approximately 37,000 Chinook salmon smolts (± about 6,000) passing downstream to the Pacific Ocean (Chase 2004). In 2007, the catch was 7,713 smolts. Trap efficiency resulted in an estimate of 126,000 smolts (SCWA 2008d).

Genetic diversity is an important measure of viability as well. Genetic analysis of Russian River Chinook salmon suggests they are not closely related to either the nearby Eel River or Central Valley Chinook salmon, and likely evolved as part of a diverse group of native coastal populations (Hedgecock 2002). A history of hatchery stocking, however, has likely had some effect on genetic diversity (Bjorkstedt *et al.* 2006, Chase *et al.* 2007) (see detailed description in section V.C.8 below).

Although uncertainty regarding the species status warrants caution, there is no compelling evidence of a continued population decline in the Russian River for Chinook salmon, although the 2007 returns suggest caution in drawing this conclusion. The likelihood of the Russian River Chinook salmon's survival and recovery seems fair in light of these indicators. However, water diversions, the confinement of the river channel, limited riparian vegetation, and ongoing sedimentation from roads, agriculture, and other developments remain important unresolved threats to the success of the Russian River Chinook salmon.

The Russian River is the largest watershed in the CC Chinook Central Coastal Diversity Stratum and likely has the largest population. This population is also at the southern extent of the species range. Its extinction would therefore constitute a substantial range restriction, the loss of the largest population in the stratum, and probably the loss of a unique genetic component of the ESU. For these reasons, the survival and recovery of the Russian River population of CC Chinook is important to the conservation of the ESU as a whole.

In the action area, Chinook are known to spawn in the mainstem and Dry Creek, and utilize the estuary during their migrations to and from the Pacific Ocean. Observations of a few Chinook salmon in Santa

Rosa Creek (Part of Zone 1A) and Austin Creek have also been reported (David Manning, SCWA, personal communication, 2008). In the mainstem Russian River (from Riverfront Park in Healdsburg to just north of Ukiah), SCWA surveyed and documented relatively large numbers of Chinook salmon redds in the watershed from 2002 through 2006. In Dry Creek, redds were counted in 2003, 2004, and 2006, between the confluence with the Russian River and WSD. In 2003, 256 redds were observed, with 342 observed in 2004, and 201 observed in 2006 (SCWA 2007a). In the watershed as a whole, the total number of redds observed ranged from 1036 and 1157 in 2002 and 2003 respectively, to 603 in 2006. Most redds were located near Ukiah and in Dry Creek[35]. Many more migrating adults were counted at Mirabel Dam as described above. NMFS assumes that overlapping redds (superimposition), spawning occurring after survey work, spawning outside of the study areas, and the loss of some fish prior to spawning due to predation or illegal fishing are likely explanations for the small number of redds observed compared to adults counted.

A small number of Chinook juveniles and smolts have been documented in the estuary, as described in Section VI.G.2.e.

2. Coho Salmon

Bjorkstedt (2005) conclude that coho salmon existed as two populations in the Russian River; a large independent population in the lower basin, and a smaller ephemeral population that occupied tributaries in the northwest corner of the basin. The lower population represented what was historically the largest and most dominant source population in the ESU.

Information on the historic run size of coho salmon in the Russian River is limited. Late 19th and early 20th Century records are sparse, or non-specific as to species (Chase *et al*. 2007). They once occupied many tributaries throughout the basin, probably reared in backwater areas of the main stem, and were a major component of the fish community (Spence *et al.* 2005). They are now restricted to a few tributaries in the lower watershed (CDFG 2002), and rear only in isolated areas of suitable habitat (see preceding habitat analysis).

Various sampling methods were used to determine juvenile coho salmon presence/absence within several tributaries of the Russian River during the summers of 1992 through 2007 (Conrad and White 2006; M. Obedzinski, U.C.Davis Extension, personal communication, 2007). Both the abundance and distribution of juvenile coho salmon in the Russian River basin have declined precipitously in recent years (Conrad and White 2006). Since 2001, wild juvenile coho salmon presence has been confirmed by the RRCSCBP in only five of the 32 historic coho streams (referenced in Brown *et al.* 1994). Presence data has been collected during broodstock collection efforts and monitoring survey work and indicates that wild juvenile coho salmon were recently present in Green Valley Creek, Dutch Bill Creek, Mark West Creek, Redwood Creek (tributary to Maacama Creek) and Felta Creek (tributary in Dry Creek watershed) in low numbers, and were often only present in intermittent years. More recently, only three (Green Valley, Dutch Bill, and Felta creeks), of the 32 historic coho salmon streams within the Russian River (referenced in Brown *et al.* 1994) had confirmed wild juvenile coho salmon and only in intermittent years (Conrad and White 2006).

[35] The amount of redds in Dry Creek suggests that the lack of instream cover and complexity described may not be limiting for Chinook salmon spawning.

Three consecutive year classes of coho salmon were present in Green Valley Creek from 2001 through 2004, however, wild YOY coho salmon have not been detected in Green Valley Creek since 2004 (M. Obedzinski, U.C.Davis Extension, personal communication, 2007). Since YOY coho salmon have not been detected for three consecutive years, this may indicate that wild coho salmon have been extirpated from Green Valley Creek.

Genetic analyses of coho salmon sampled from Russian River tributaries are consistent with what would be expected for a population with such extremely reduced abundance. A review by Bjorkstedt (2005) found both strong departures from genetic equilibrium and evidence of recent, severe population bottlenecks. Historical hatchery practices may also have contributed to these results (described in section V.C.8 below). This evidence suggests an acute loss of genetic diversity for the Russian River coho salmon population.

The RRCSCBP was initiated in 2001 to reestablish self-sustaining runs of coho salmon in tributary streams within the Russian River Basin (Obedzinski *et al.* 2007). Under this program, offspring of wild captive-reared coho salmon are released as juveniles into tributaries within their historic range with the expectation that a portion of them will return to these areas as adults to naturally reproduce. These juveniles have been released into the following tributaries in the Russian River basin: Sheephouse Creek, Mill Creek, Palmer Creek, Ward Creek, Gray Creek, Gilliam Creek, Dutch Bill Creek, and Green Valley Creek (see Table 19 below).

The first returns of adult coho salmon were expected to return to release streams during the 2006/07 spawning season. Adult spawning survey efforts conducted by the RRCSCBP in the release streams during the 2006-07 spawning season only resulted in confirmation of one returning adult female coho salmon to Mill Creek. Although this program represents an important component of conservation and recovery efforts for Russian River coho salmon, the benefits of the program have not yet been realized.

Based on its decline in abundance, restricted and fragmented distribution, and lack of genetic diversity, the Russian River population of coho salmon is likely in an extinction vortex, where the population has been reduced to a point where demographic instability and inbreeding lead to further declines in numbers, which in turn, feedback into further declines towards extinction (Frankham *et al.* 2002). The Russian River population itself is in the middle of the CCC coho salmon ESU's range and inhabits a watershed that represents fully a third of the ESU by area. For these reasons, irrespective of the condition of the watershed, the Russian River has great potential to provide important geographic continuity, diversity, and habitat space for the species. The continued existence of CCC coho salmon in the Russian River is therefore significant to the survival and recovery of the entire ESU.

The few coho salmon that remain in the Russian River watershed use the Russian River mainstem and estuary primarily as a migration corridor. They are not present in the Zone 1A streams considered in this biological opinion. The estuary, mainstem Russian River, and Dry Creek are used by adult coho salmon migrants in the late fall and winter, and by smolting juveniles in the spring. Residence time in the estuary by smolting juveniles is likely short (see below in the *Effects of the Proposed Action* section). Very small numbers of YOY coho salmon may attempt to rear in the estuary for longer time periods. Some coho juveniles born in Dry Creek tributaries likely attempt to rear in Dry Creek but are unable to due to high flows and limited cover, as described in the *Effects of the Proposed Action* section.

3. Steelhead

The Russian River historically supported nine separate populations of steelhead in two diversity strata (see *Status of the Species* above). Austin Creek, Dutch Bill Creek, Green Valley Creek, Mark West Creek, Dry Creek, Maacama Creek, and Sausal Creek all represented distinct populations. The remaining tributaries were lumped into Upper and Lower Russian River populations respectively. In total, these populations represented one of the two most productive regions in the ESU (along with San Francisco Bay tributaries) (Bjorkstedt *et al.* 2005).

Situated at the northern extent of the CCC steelhead ESU's range, the Russian River was renowned as the third largest steelhead river in California during the first half of the 20th Century (SEC 1996). However, similar to coho salmon and Chinook salmon, historical and current data on run sizes are limited or non-existent. SEC (1996) reported historic Russian River catch estimates for steelhead: 15,000 for the 1936 sport catch, and 25,000 for the 1956/57 sport catch. These estimates are based on best professional judgment by a CDFG employee and, for the latter estimate, a sportswriter. Other estimates include one of 57,000 steelhead made in 1957 (SEC 1996). Assuming the characterization of the Russian River as the third largest steelhead stream in California in the mid 20th Century is reasonable, the estimates above are likely roughly accurate, indicating tens of thousands of steelhead inhabited the Russian River in the early and mid 20th Century. Since the mid 20th Century, Russian River steelhead populations have declined. Estimates based on best professional judgment infer a wild run of 1,700- 7,000 fish near the end of the 20th Century (McEwan 2001). Hatchery returns averaged 6,760 fish for the period 1992/93 to 2006/07, and ranged from 2,200 to 11,828 fish. The information available suggests that recent basin-wide abundance of wild steelhead has declined considerably from historic levels.

As described elsewhere in this document, the Russian River has received out of basin steelhead stock in large numbers and from a wide variety of sources as far back as the late 1800s (SEC 1996). Since 1982, fish have been collected from the CVFF and at WSD, and reared at the DCFH. Differentiation among steelhead within the Russian River basin has been substantially influenced by the widespread transfer of hatchery steelhead within the basin (Bjorkstedt *et al.* 2005). However, the degree to which this influence has resulted in degradation of genetic diversity within the basin is unclear.

Despite declines in abundance, steelhead remain widely distributed within the basin (NMFS 2005*b*). The primary exceptions to this are the barriers to anadromy caused by CVD and WSD. CVD has blocked approximately 21 percent of the historical habitat of the Upper Russian River population, and WSD has blocked approximately, 56 percent of the Dry Creek population's historical habitat (Spence 2006).

Certain aspects of the steelhead life history (detailed in the *Status of the Species* section) have afforded it greater resistance to extinction. For example, juveniles are able to tolerate a wider range of habitat conditions than most salmonids. This has allowed them to survive where others cannot (in very low numbers in portions of constructed flood control channels in Zone 1 A, for example). One apparent adaptive strategy however, appears to have created a challenge to their recovery. The habit of rearing in the estuary affords significant growth opportunities to that portion of the population which spends some or all of its time doing so, rather than in the stream environment (Bond 2006; Hayes *et al.*2006). The propensity for estuarine rearing appears to increase with populations in more southern latitudes and may be an adaptation to reduced instream growth opportunities in more arid regions where summer rearing habitat may be limited. Steelhead parr in the Russian River have been detected moving downstream

towards the estuary (Chase 2005; Katz *et al.*2006) in quantities sufficient to suggest that a significant portion of the Russian River populations attempt to rear there. Rearing conditions for YOY and parr in the estuary, however, are poor. This, in combination with degraded habitat upstream, is likely a major determinant in maintaining the current depressed population levels.

The Russian River populations of steelhead are important to the survival and recovery of CCC steelhead for several reasons. First, because they were historically among the primary source populations for the DPS, they presumably still have the potential to play that important role in supporting the survival and recovery of the DPS. Second, since the Russian River lies at the northern extent of the CCC steelhead range, it supports an important component of the species geographic distribution. And third, because the basin is so large, it supports a significant diversity of habitats, from wet coastal to arid interior environments, which potentially foster important diversity components for the species. The continued survival of Russian River steelhead is therefore integrally important to the overall survival and recovery of the CCC steelhead DPS.

The action area for this project is used by steelhead for migration (most of the action area), spawning (most of Dry Creek, some areas of the mainstem and Zone 1A, as well as many areas in other tributaries). For example, about 46 steelhead and 43 steelhead redds were observed in approximately 2 miles of Dry Creek in 1999 (NMFS unpublished data, 1999b)[36]. Juvenile steelhead rear throughout the Russian River basin. The density of rearing steelhead in particular areas is strongly influenced by the condition of rearing habitat.

Although aquatic habitat in the mainstem, Dry Creek, Zone 1A, and the estuary is in degraded condition for juvenile rearing, juvenile steelhead continue to inhabit these areas in low numbers. In the mainstem, SCWA surveyed juvenile steelhead abundance in distribution in the summer of 2001 from Ukiah downstream to Healdsburg. A total of 1,436 steelhead in 11.5 miles of total channel length surveyed, or 0.07 steelhead per yard, were observed. Densities ranged from a high of 0.2 steelhead per yard to as low as 0.03 steelhead per yard (SCWA 2003). The largest number of juvenile steelhead were found between Hopland and Cloverdale.

Downstream of Healdsburg, more limited sampling efforts show very low densities of juvenile steelhead in the mainstem during the summer, reflecting the highly degraded habitat conditions for summer rearing in this area of the the mainstem. For example, 5 steelhead were found in the 3 mile area inundated by the Wohler Pool in 2003 (SCWA 2004a). One juvenile steelhead was relocated from the fish ladder construction area for the Healdsburg summer dam (SCWA 2001b). In the estuary, seining efforts have documented low numbers of juvenile steelhead during the summer, as described in the *Effects of the Proposed Action* section.

In the action area portion of Zone 1 A, steelhead are still present in the Mark West Creek watershed including the Laguna de Santa Rosa, Copeland Creek, Brush Creek, Santa Rosa Creek, Paulin Creek, Windsor Creek, Blucher Creek, Crane Creek, and Matanzas Creek. Juvenile densities are very low in the constructed flood control channel portions of these creeks. Higher densities are found in natural waterway areas such as the Mark West Creek mainstem and portions of Santa Rosa Creek. For example, the constructed flood control channel reach in downtown Santa Rosa is dominated (numbers) by sculpin, with

[36] Dry Creek has not been surveyed for steelhead spawners and redds on a consistent basis. NMFS expects conditions in Dry Creek are good for steelhead spawning in many years.

steelhead densities ranging from 0.01 fish per square meter to 0.03 fish per square meter. Upstream of Spring Lake in the natural waterway portion of Santa Rosa Creek, juvenile steelhead were more numerous than other fish species with densities of 0.01 to 0.66 per square meter (SCWA 2002).

Most of the steelhead juveniles found in the constructed flood control channels are likely from spawning areas upstream in natural waterways. After emergence from spawning gravels, juvenile steelhead are known to move downstream disperse in streams seeking rearing areas. Some move downstream, as described above in the *Status of the Species* section. Those entering flood control channels are likely to encounter degraded baseline habitat conditions, and many of these fish will not survive, resulting in the low densities reported above.

C. Factors Affecting Listed Salmonids and Their Habitat within the Action Area

Threats to ESA-listed salmon and steelhead are numerous and varied. Among the most serious and ongoing threats to the survival of Russian River salmon populations in the action area are changes to natural hydrology, habitat degradation and habitat loss. Much of the Russian River watershed is affected by multiple human factors. Some of these anthropogenic factors are related to activities undertaken or authorized by the Corps or SCWA, but many factors are independent of the Corps or SCWA. Factors related to the Corps or SCWA projects which will be carried out into the future as part of the proposed action are discussed briefly in this section as it relates to current population and habitat conditions. We provide a more detailed analysis of those same factors in the Effects of the Action section of this document and relate the factors to likely future effects on species and critical habitat. Also, separately, we discuss factors not related to Corps or SCWA projects and naturally-occurring events, such as droughts or variation in ocean productivity, which affect salmonids and their habitat. The following discussion provides an overview of the types of activities and conditions that adversely affect salmon and steelhead populations and designated critical habitat in the Russian River watershed.

1. Coyote Valley Dam Operations

With the completion of CVD in 1959 on the East Fork of the Russian River access blocked up to 143 miles of salmonid spawning and rearing habitat (Corps 1982, Prolysts 1984, CDFG 2002). The habitat lost upstream of CVD was considered to be some of the highest quality habitat available for salmon and steelhead spawning and rearing (SEC 1996). Prolysts (1984) estimated annual steelhead productivity lost in the East Fork of the Russian River following placement of the CVD ranged from 2,213 to 7,685 adult fish and 51,465 to 178,721 wild, ocean-bound smolts (Prolysts 1984).

Construction of CVD also reduced sediment supply to the main stem Russian River. The SCWA estimates that the CVD has trapped about 21,000 tons of sediment per year from the 105 square mile watershed that drains to Lake Mendocino (Florsheim and Goodwin 1993). This reduction in sediment transport downstream of CVD contributes to channel incision and increases in erosion of stream banks in reaches below the dam as the river attempts to adjust to equilibrium (Corps 1997). The gravel retention by CVD coupled with sediment deficits from gravel extraction has caused channel incision in the main stem and tributaries of the Ukiah Valley.

Operation of CVD by the Corps since 1959 has provided flood protection for areas below the dam and supplies water for domestic and agricultural uses (Corps and SCWA 2004). The Corps's objective during

flood control operations is to prevent flows from the East Fork of the Russian River from contributing to flows that cause flooding in the Ukiah and Hopland areas to the extent possible (Corps and SCWA 2004). The Corps limits releases from CVD to prevent flooding at Hopland that can occur when flows exceed 8,000 cfs. Specific criteria for flood control for flood control operations are described in the CVD Water Control Manual (Corps 1998).

CVD affects the natural hydrology in the main stem river below the dam by reducing the peak flood discharge and storing runoff and then releasing the storage between storms (Florsheim and Goodwin 1993). Releases from the flood control pool typically extend the periods of high flows when they would otherwise be receding. A Corps study of the 1964 flood indicated that CVD reduced peak flows at Hopland by 29 percent, 14 miles downstream, reduced the flows at Cloverdale by 21 percent, 30 miles downstream, and 7 percent at Guerneville, 74 miles downstream (Corps and SCWA 2000*a*). Florsheim and Goodwin (1993) report that the duration of the flood flows for the 1964/65 flood and the 1986 floods were increased by 4 days in 1964/65, and 6 days in 1986.

CVD has less effect on more frequent flood events such as the 1.5 year event in the main stem Russian River. The dominant discharge for a 1.5 year event at Hopland was approximately 14,500 cfs in an unregulated condition and 9,500 cfs with flood control provided by CVD (Corps and SCWA 2000*a*). At Healdsburg, the effects of CVD winter flood flow regulation are negligible, with a flow for a 1.5 year event of about 25,000 cfs for the regulated and unregulated condition.

Corps and SCWA (2000*a*) identified four potential issues related to flood control operational effects on salmonid habitat conditions. These issues include the potential for flood releases to scour spawning gravels, potential to contribute to stream bank erosion, high and persistent turbidity levels in the main stem, and potential effects to channel forming/geomorphic flows that may affect salmonid habitat. In addition to these potential effects, Corps and SCWA (2000*a*) reviewed the effects that dam ramping rates (flow increases or decreases over time) may have on salmonids and their habitat, as well as the effects of annual and periodic inspections on listed species.

Scour impacts from CVD releases of 1,000 to 6,400 cfs may have sufficient stream power to mobilize streambed sediment that could result in scour of salmonid redds. The discharge that typically mobilizes the streambed is referred to as the dominant discharge and has a recurrence interval of 1.5 to 2 years on average (Mount 1995; Florsheim and Goodwin 1993). The dominant discharge that is likely to be sufficient to mobilize the streambed is approximately 4,200 cfs in the upper Russian River in the Ukiah Valley. In years when we expect natural channel forming flows to occur (wetter winters) CVD usually makes releases that contribute to a longer duration of channel forming flows due to prolonged post storm releases. CVD operations also decrease very large peak flood flows that may contribute to scour of salmonid redds on the upper Russian River. Although CVD increases the duration of flows that have the ability to mobilize the streambed, Chinook salmon and steelhead redds are typically constructed in areas of low mobility, and have a lower risk of being scoured to the depth of the egg pocket (May *et al.* 2007). The current channel conditions in the upper main stem such as incision, and dense riparian vegetation may have caused some increased probability of redd scour due to increased shear stress on the channel bed.

Bank erosion impacts due to flood operations of CVD were assessed by Entrix (Corps and SCWA 2004). The Entrix analysis, with hydrologic data provided by the Corps, was conducted based on an evaluation of the magnitude and frequency of stream flows above a threshold discharge identified as the

flow at which bank erosion is initiated. Initiation of bank erosion was found to occur at flows of 6,000 cfs at Hopland and 8,000 cfs at Cloverdale. Prolonged dam releases in the past have likely exacerbated bank sloughing due to channel incision and have resulting bank adjustments from Ukiah to Hopland.

Flood control ramping rates have been identified as a potential cause of stranding of juvenile salmonids, and can dewater salmonid redds if flow and stage elevations change rapidly. Between 1959 and 1998, the only restrictions to dam tenders at CVD were that releases could not change more than 1,000 cfs per hour to prevent bank sloughing in downstream reaches. In 1998, with the Federal listing of CCC coho salmon, the Corps and NMFS developed "interim ramping rates" to minimize effects to listed salmonids, until Section 7 consultation could address the effects from dam operations in the Russian River.

CVD has conducted pre-flood and periodic maintenance inspections since the early 1960s. These inspections occurred during the summer or fall and require flow cessation from the facility. Prior to 1998 these inspections were conducted with little regard to potential effects to aquatic resources downstream. Surveys from 1998 through 2004 have determined that adverse effects occur as a result of these inspections. Adverse effects occur with the minimization measures followed by the Corps that are set forth in NMFS biological opinions for these actions. Based on the results of these recent surveys of the three miles of the main stem below the confluence with the East Fork Russian River, NMFS concludes that many juvenile steelhead were likely impacted during the dam inspections that occurred from 1960 to 1998. Many juvenile steelhead residing in the upper three to four mile reach of the main stem where likely stranded, and may have perished. Currently the Corps follows strict ramp down procedures and other terms and conditions that minimize the take of listed species during these inspections.

From late spring through mid-fall, when precipitation and runoff are minimal, stream flow in the main stem Russian River is governed by releases from CVD and WSD. During this period, flow releases from CVD largely provide the surface flow in the main stem upstream from the confluence of Dry Creek at Healdsburg. From Healdsburg to the Russian River mouth at Jenner, main stem flow is the result of the combined releases of CVD and WSD. During the low flow season, releases from the two dams are operated under the management of SCWA for the purpose of water supply in accordance with SWRCB Decision 1610 (D1610). Under D1610, required minimum flows in both the upper and lower Russian River vary depending upon defined water supply condition (see Figure 1, and *Description of the Proposed Action* above).

Elevated summer flows have affected the following salmonid habitat PCEs in the main stem Russian River; 1) freshwater rearing habitat of steelhead and Chinook salmon, 2) estuarine rearing, 3) adult migratory habitat of Chinook salmon; and 4) spawning habitat of Chinook salmon. Past CVD summer flow operations have likely had little adverse effect spawning and migration of steelhead and coho salmon in the main stem Russian River due to timing of spawning of these species.

Under the constraints of D1610, flow management at CVD, creates stream discharges that provide limited amounts of rearing habitat for juvenile steelhead in the 34 mile segment between the dam and Cloverdale. During summer and fall, flow releases from this dam far exceed those that support optimal conditions for steelhead rearing. D-1610’s normal-water year minimum requirement of 185 cfs for April 1 through August 31 in the segment between the East Fork and Dry Creek necessitates the release of about 250 to 290 cfs from CVD. Such high flow releases are needed because a cumulative total of about 50 to 100 cfs is diverted from this segment each day by numerous municipal, residential, and agricultural interests.

These diversions eventually diminish the river's flow until it approaches the minimum requirement of 185 cfs at Healdsburg just upstream of the mouth of Dry Creek. The elevated flow conditions associated with these current operations create current velocities that limit the available rearing habitat for juvenile steelhead and juvenile Chinook salmon.

Main stem flow releases required to maintain requirements of D1610 also cause the coldwater pool in Lake Mendocino to become depleted by late August or early September, reducing the quality of rearing habitat in the upper main stem Russian River. As discussed in Section V.A.2, the segment downstream from Cloverdale does not support significant summer rearing habitat for steelhead because of relatively high water temperatures. Effects of high flows from CVD on salmonid habitat are described in more detail in the Effects Section VI.F of this opinion.

In contrast to the adverse affects to summer and fall rearing habitat, current flow management under D1610 provides good migration and spawning habitat conditions for adult Chinook salmon in the main stem Russian River. The elevated flows in the late summer and early fall ensure that the mouth of the river is open for migration of adult Chinook salmon. Flow releases also ensure abundant available spawning habitat for Chinook salmon in the fall.

Although releases from CVD provide some salmonid habitat in the upper Russian River, releases from this dam likely contribute high and persistent levels of turbidity to the main stem Russian River. The dam releases water from near the bottom of Lake Mendocino. Turbidity can remain high at the bottom of the lake after inflow and/or the lake's surface has cleared, mainly because of the depth of the lake, the small size of the sediment particles[37], turbidity currents[38], and releases from the bottom of the lake. Following rainstorms, NMFS staff conducting an overflight of the area observed turbid water being released from Lake Mendocino even though water entering the lake was clear (B. Cluer, NMFS, personal communication, February, 2007). Information from the mid-late 1960s also indicates the potential for persistent turbidity from CVD releases. Ritter and Brown (1971) found that the CVD increased the amount of time required for the East Branch of the Russian River to transport over half of its suspended sediment load by 2-3 times, lengthening the amount of time turbid water flows downstream into the main stem Russian River. The time needed to transport 90 percent of the sediment load increased by a factor of 10.

The potential duration of turbid water in releases from the CVD is a particular concern for both salmonids and their habitat. The longer sediment remains in downstream flows, the higher the likelihood suspended sediment will occur when flows are low in the main stem (between storms or after storms end in the late spring). Most salmonid adults and juveniles migrate during these times (adults between storms and juveniles in the spring), potentially increasing their exposure to turbidity from CVD releases. In addition, when suspended sediment occurs at lower flows, there is more opportunity for sediments to drop out of these slow and shallow flows and accumulate[39] throughout the channel, including in riffle and pool areas

[37] Storm flows entering Lake Mendocino have a high concentration of suspended sediment in the form of small clay particles. Because the clay particles are very small, they are slow to settle out of the water column and remain in the water column for protracted periods.

[38] Sediment laden water entering a lake can be denser (heavier) than lake water. If so, the denser sediment laden water moves toward the bottom of the lake. (Ritter and Brown 1971).

[39] As flows decrease, the river loses the power to transport sediment. The larger sized particles drop out first followed by smaller sized particles as flows continue to recede. When most sediment is transported at high flows, it is more likely to settle out at the edges of the channel where backwaters and eddies create low flow areas.

in the low flow channel. Turbidity from CVD may be causing delay harm to eggs and alevins, and limiting rearing opportunities by reducing feeding, displacing rearing juveniles downstream, reducing growth rates for rearing salmonids, and reducing their food supply.

Unfortunately, data are not available to accurately estimate the relative contribution of turbidity from CVD to the current turbidity and sediment loads in the Russian River. As described elsewhere in the *Environmental Baseline*, sedimentation and turbidity in the Russian River come from a variety of factors, including agriculture and development. Data on the relative amount of turbidity and sedimentation from each factor are lacking. Although the Russian River watershed was found to clear fairly rapidly after major storms in the mid-late 1960s (Ritter and Brown 1971), this may not always be the case today.

2. Warm Springs Dam Operations

Located 14 miles upstream from the mouth of Dry Creek, WSD blocks anadromous fish access to 50 to 105 miles (Cramer *et al*. 1995) of the Dry Creek watershed. The dam and its 381,000 acre foot (ac-ft) reservoir regulate year round stream flow in Dry Creek, providing substantially augmented stream flows during historic low flow periods and reducing the magnitude of high flows during winter storm events. The dam and its reservoir have also appreciably altered the dynamics of Dry Creek's sediment transport and the condition of the creek's riparian vegetation. Historically, lower Dry Creek was an intermittent stream, with isolated pool remaining in the summer. After the construction of WSD in 1983, Dry Creek became a perennial stream.

During the winter months WSD is operated for flood control, which reduces peak flood discharges in Dry Creek and the Russian River by storing runoff in Lake Sonoma (Corps and SCWA 2004). Prior to construction of WSD, flows of 5,000 cfs (channel forming flows, Corps and SCWA 2004) occurred in 60 percent of the years reviewed by NMFS. Since construction, flows exceeding 5,000 cfs only occur in about 14 percent of years. Lake Sonoma has a 130,000 ac-ft flood control capacity, which is sufficient to store watershed runoff from a 100-year, 6 day flood event. The Corps determines releases from the reservoir when lake elevation is above 451.1 mean sea level. Warm Springs flood operations are controlled by criteria set forth in the Warm Springs Dam Water Control Manual (Corps 1998). The Corps attempts to avoid flood releases from the dam that exceed 6,000 cfs, and to the extent possible manages releases to help limit flows on the Russian River at Guerneville to 35,000 cfs. Flow ramping rates for flood operations since 1998 have followed an interim ramping schedule agreed to by the Corps and NMFS.

WSD has altered the hydrologic regime and geomorphic conditions of Dry Creek. An example of the project's value in reducing peak flows is reported in EIP (1994), which compare the maximum pre-dam flood of 32,400 cfs in January 1963 with the maximum post dam peak flow in Dry Creek of 5,280 cfs. The floods of 1963 and 1986 on Dry Creek were of comparable size, which demonstrates that WSD can reduce peak flood by as much as 83 percent (EIP 1994 as cited in Corps and SCWA 2004). Similarly, a 1.5 year peak flow prior to dam construction was 11,000 cfs, and now is reduced to about 2,500 cfs in the post dam condition (Corps and SCWA 2004).

Even with the reduction to peak flow, releases from WSD may be sufficient to mobilize the streambed and impact salmonid spawning areas below the dam. In addition to potential redd scour, the Corps and SCWA (2004) evaluated the potential for these operations to initiate bank erosion, to decrease flushing flows that

are needed to maintain spawning habitat suitability, and the potential impacts that flow ramping releases may have on salmonids in Dry Creek.

Spawning gravel or redd scour potential was analyzed by Corps and SCWA (2004) for Dry Creek with respect to coho salmon, Chinook salmon, and steelhead trout. According to Corps and SCWA (2004), current flood operational releases provide for a balance between periodic mobilization of the streambed needed to flush spawning gravel, and the scour that can destroy salmonid embryos in redds. Although WSD flood releases that exceed 5,000 cfs may be sufficient to cause some scour of coho salmon and Chinook salmon redds, the overall frequency of flows that scour redds is decreased as a result of WSD operations. Scour flows that exceed 5,000 cfs occurred more often in Dry Creek before the dam was constructed, and occur at a reduced frequency since WSD has been in operation. Scour of steelhead redd sites are less likely to be affected because most of their redds are constructed later in the spawning season as compared to coho salmon and Chinook salmon.

In general, maintenance of channel geomorphic conditions which maintain sediment transport and flushing of fine sediments should occur about once every two or three years (Corps and SCWA 2004). Channel forming flows in Dry Creek are 7,000 cfs below Pena Creek and 5,000 cfs between Pena Creek and the WSD. These channel forming flows are achieved in Dry Creek about once every six years (Corps and SCWA 2000*a*). Analysis conducted as part of Corps/SCWA's BA indicates that flows below WSD may be insufficient to maintain geomorphic conditions. WSD flood releases that exceed 5,000 cfs have an effect on spawning gravel quality below the dam, but must be weighed against the effects of redd scour and loss of sediment transport due to the presence of the dam.

Bank erosion along Dry Creek below WSD is initiated at flows above 2,500 cfs. Bank erosion analysis conducted by Entrix indicates that the potential for flood releases that would initiate bank erosion is low for most years, but not in all years (Corps and SCWA 2000*a*). Flood releases are generally low during periods when natural flow accretion from Dry Creek and tributaries is above the 2,500 cfs threshold that initiates bank erosion. From 1983 to 1995, WSD flows exceed 2,500 cfs for three or more days only four times, or about 25 percent of the time during the flood season. When flows over 2500 cfs are released from WSD it is expected that they likely contribute to bank erosion along Dry Creek. Some adverse effects associated with bank erosion have likely occurred to salmonid spawning areas with localized increases in fine sediment that reduces embryo or alevin survival within redds. Some potential benefits associated with bank erosion may occur when organic debris enters the channel and provides improved rearing habitat conditions for juvenile salmonids.

Ramping of flow for flood control has the potential to adversely affect salmonids by stranding juvenile fish when large river stage elevation changes occur. NMFS has used the Washington Department of Fisheries ramping criteria (Hunter 1992) as an indicator for potential effects of ramping rates for operations such as WSD and CVD. Evaluation of stage-discharge data were analyzed by Corps and SCWA (2000a) for Warm Spring Dam releases of 250 cfs per hour, and 125 cfs per hour. Results for WSD ramping rates indicate that ramping rates of 250 and 125 cfs do not meet the Hunter Criteria of 0.32 feet per hour (ft/hr). Stage elevation changes in Dry Creek are about 0.5 ft/hr and data indicate that the stream reach closest to the dam are most susceptible to stage changes. Stream reaches further downstream from the dam (below Pena Creek) meet the criteria for juvenile salmonids. Potential effects to juvenile salmonids are most likely to occur from Pena Creek upstream to the outlet of WSD, a 1.5 mile reach. Prior to the interim ramping rates that were agreed to with NMFS in 1998, stranding likely occurred in the

reach below the dam due to less protective releases from the dam. The interim ramping rates that have been in place since 1998 have increased protection for juvenile salmonids, but analysis provided in Corps and SCWA (2000*a*) indicates that adverse effects in the form of stranding may be occurring between the outlet of WSD and Pena Creek.

Lake Sonoma is the principal water supply for much of Sonoma County's urban and residential population during the extended low flow season (*e.g.*, generally late May through October). SCWA obtains this water by releasing it at WSD where it flows down Dry Creek, enters the Russian River and then flows downstream to SCWA's principal diversion and treatment facilities located along the Russian River at Mirabel and Wohler. This system of transmitting water from Lake Sonoma to SCWA's diversion facilities on the Russian River via Dry Creek has greatly increased flow in Dry Creek during the summer months compared to conditions prior to construction of WSD. This change in flow regime for the 14 mile segment of Dry Creek below the dam has greatly altered habitats for steelhead, coho salmon, and Chinook salmon.

Before WSD was constructed, summer flows in Dry Creek were generally about 1 to 3 cfs during late summer; in several years, late summer flows below the confluence of Pena Creek were less than 1.0 cfs (published data for USGS gage No. 11465200). Summer flows in Dry Creek are markedly different today. SCWA operates WSD consistent with SWRCB D1610, which in normal years requires a continuous minimum flow of 80 cfs between WSD and the mouth of Dry Creek from May 1 to October 31. For dry years, D1610 requires a minimum flow of 25 cfs in Dry Creek between April 1 and October 31. D1610 stipulates the minimum flow to be maintained; however, the actual flow in Dry Creek during summer is dependent upon water demand (USACE and SCWA 2004). It can vary substantially with occasional releases as low as 25 cfs or as high as 180 cfs, but since 1995 it has been in the range of about 110 to about 130 cfs. However, during the past two years (2006 and 2007) the median monthly flow in Dry Creek during July through October has generally ranged between 97 and 105 cfs. Figure 8 depicts representative stream flows between July and October during the past fifteen years. Table 15 shows the median values for the average daily flow during summer months between 1992 and 2005

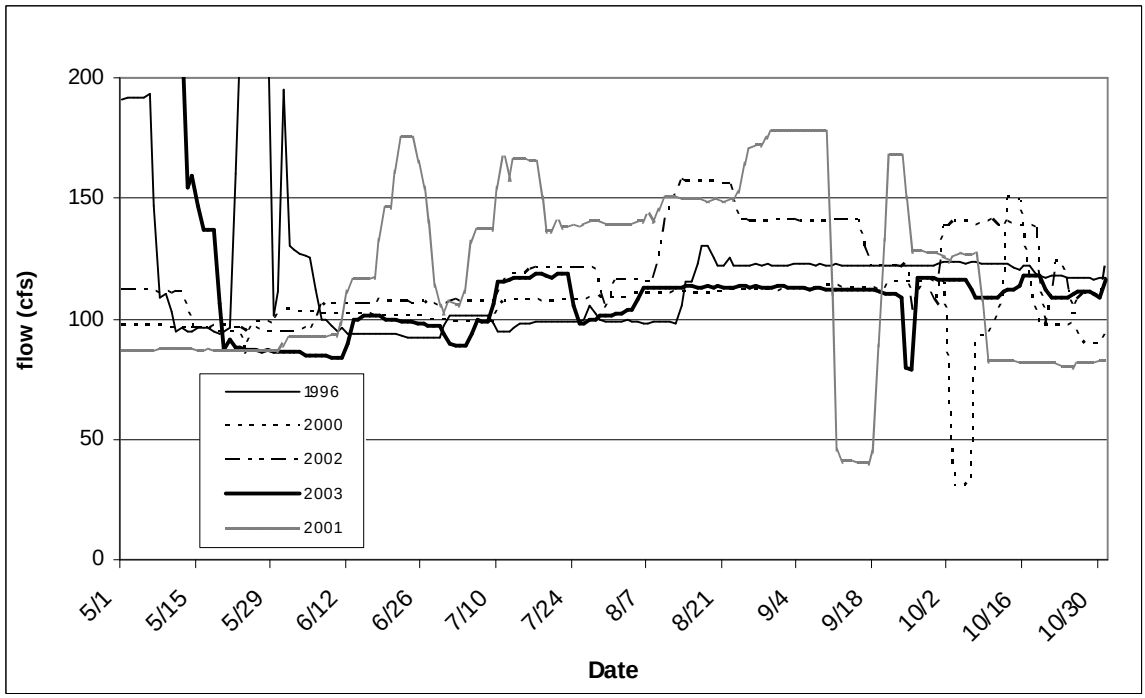

Figure 8. Representative water releases at Warm Springs Dam during summer months. Source: USGS Gage 11465000

The water released from Lake Sonoma is of a high quality that supports salmonid species. Corps and SCWA (2004) explain that the water released from WSD is managed for its use in the Don Clausen Fish Hatchery, where it is monitored for turbidity, suspended sediment concentrations, temperature, and dissolved oxygen. These water quality parameters are managed by mixing water from the low-flow tunnels that draw water from different levels of Lake Sonoma. Corps and SCWA (2004) report the results of flow and stream temperature modeling for Dry Creek for alternative water management scenarios. The Russian River Water Quality Model indicates that water released from WSD is cold and favorable for anadromous salmonids, and that temperatures remain cold along the 14 mile segment below the dam (Table 16). Temperature monitoring 500 feet below WSD (USGS Gage 11465000) between 1985 and

1993 document that the water released from Dry Creek is cold (Table 17). Dry Creek temperatures and the related requirements of steelhead and coho salmon were previously considered in Section V.A.2 above.

Table 15. Median value of the mean daily flow (cfs) in Dry Creek immediately below the WSD for each month during the low flow season 1992-2007. Source: USGS Gage 11465000

Water Year & succeeding October	June	July	August	September	October
1992	116	118	109	109	103
1993	104	128	133	116.5	99
1994	136	146	148	104	101
1995	90	92	100	97	97
1996	94	99	122	122	121
1997	97	154	152	103	96
1998	305	100	100	101	101
1999	92	94	102	108	108
2000	102	108	111	113	97
2001	115	139	149	128	82
2002	106	119	141	135	139
2003	97	105	113	112	111
2004	121	102	110	111	104
2005	135	114	116	106	111
2006	92	102	103	103	100
2007	123	97	97	102	--

Table 16. Estimated median temperatures (^{o}C) in Dry Creek under current demand levels for all water supply conditions combined (Source: Corps and SCWA 2004).

Station	June	July	August	September	October
Below WSD	13.2	13.2	13.1	13.1	12.9
Lower Dry Creek	17.8	18.3	17.9	16.8	15.1

Table 17. Monthly minimum and maximum water temperatures (°C) 500 feet below WSD during summer months 1985-1993 (data from USGS Gage 11465000).

	June		July		August		September	
Year	Min	Max	Min	Max	Min	Max	Min	Max
1985	10.0	11.5	10.5	11.0	10.0	11.0	10.0	10.5
1986	12.0	12.5	11.5	12.5	12.0	12.5	11.5	12.5
1987	13.5	15.5	12.0	16.5	12.0	14.0	14.0	16.0
1988	10.0	10.0	10.0	10.5	10.5	16.0	10.5	15.0
1989	11.0	11.5	11.5	12.0	10.0	12.5	10.0	12.0
1990	11.0	11.5	11.5	12.5	12.0	14.0	n/a	n/a
1991	11.0	16.0	11.0	11.5	11.0	11.5	10.0	12.0
1992	12.5	13.0	13.0	14.0	11.5	14.0	11.0	12.0
1993	n/a	n/a	11.5	12.0	12.0	13.0	12.5	13.5

Prior to the construction of WSD in 1983, Dry Creek contributed the most sediment of any Russian River tributary (Ritter and Brown 1971). Goudey *et al*. (2002) report that the gravel bed streams within the Dry Creek watershed are capable of transporting large amounts of sediment composed of Quaternary alluvium. Extraction of these high quantities of gravel began in the 1900s in the lower reaches of Dry Creek. This activity has caused considerable geomorphic changes in Dry Creek, particularly since 1940 when intensive gravel extraction was occurring along the Middle reach of the Russian River (Swanson 1992). Gravel continued to be extracted from Dry Creek until 1979 (Corps and SCWA 2004). Geomorphic changes were documented by the Corps 1987 that concluded that past gravel extraction operations on Dry Creek and the main stem Russian River had caused 10 feet of channel incision along 14 miles of Dry

Creek (Corps and SCWA 2004). This channel incision initiated lateral instability and bank erosion changing the channel width from 90 feet to over 450 feet in some areas in the 1970s (Corps 1987).

Since the completion of WSD in 1983 geomorphic and riparian channel adjustments in Dry Creek have continued. Gordon (2004) found that the dam starved the Dry Creek channel of sediment, causing channel incision and entrenchment that allowed vegetation to colonize the less frequently flood prone banks and bars. Mean bed elevation lowered 1.02 meters from 1987-2003 at the Yoakim Bridge (Gordon 2004). Historical aerial photographs show that on Dry Creek, below WSD, the riparian vegetation has extensively encroached, causing the channel to narrow, and likely fostering channel incision. This incision has resulted in bank erosion and widening of the channel in the lower portion of Dry Creek (USACE and SCWA 2004).

3. Hydroelectric Operations

Hydroelectric production at the WSDHF and the LMHPP is achieved through flow releases from Lake Sonoma and Lake Mendocino respectively. The reservoir release rate is not based on the needs for power production, but rather is coincident to the releases to meet flood control and water demands. Hydroelectric operations at these facilities have not changed stream flow; therefore, the effects that have been associated with flow from flood control and power production in terms of minimum flow (D1610) and water demands would encompass the flow bypassed through the hydroelectric facilities for power production. WSDHF turbines can operate at flows between 70 and 185 cfs, but Article 33 of the FERC license requires that discharge from WSD meets the following minimum flow for normal, or above normal water supply conditions:

- May 1 through October 31 - 80 cfs
- November 1 through December 31 - 105 cfs
- January 1 through April 30 - 75 cfs

Article 15 of the FERC license allows for modifications of the project operation for purposes fish and wildlife conservation as may be ordered by FERC upon its own motion or upon the recommendations of fish and wildlife agencies after opportunity for hearing. The FERC license for the LMPP does not have flow requirements; therefore, power output is determined by flows released for water supply or flood control purposes. Power at this facility can be generated at flows ranging from 50 to 400 cfs.

4. Water Diversion Facilities

The operation and maintenance of the inflatable rubber dam at Mirabel and the Mirabel and Wohler diversion facilities has adverse effects on salmonid habitat and salmonids. Because SCWA proposes to continue operation and maintenance as part of the proposed project, these effects are described in detail in the *Effects of the Action* section and summarized here.

The rubber dam creates an impoundment which may delay salmonid adults, juveniles and smolts during their downstream migrations. Adult delays are anticipated to be minimal, while delay of juveniles is more pronounced. The impoundment inundates approximately three miles of stream habitat, further degrading habitat complexity. Inflation and deflation of the dam, as well as gravel bar grading at the dam site, may strand juvenile salmonids on dry areas of the channel bottom when flows recede. Gravel bar grading also

further degrades habitat complexity and adds small amounts of turbidity to aquatic habitat when flows first return to graded areas. Impounding water with the inflatable dam results in a small temperature increase in the already warm water in the impoundment. Dissolved oxygen is only minimally affected.

The diversion intakes may entrain some juvenile salmonids, harming or killing them. The off-channel diversion ponds can trap salmonids if the river flood flows enter the ponds. SCWA has rescued Chinook salmon and steelhead stranded in the ponds. In addition, SCWA rescues fish stranded during dam inflation/deflation. To date, no salmonids have needed rescue during dam inflation/deflation.

SCWA's uses chemicals to keep vegetation in check at their facilities, make diverted water potable, and control corrosion in pipelines. These chemicals may enter aquatic habitat, although in most cases the risk of chemical entry is low. SCWA has multiple best management practices in place to keep chemicals out of aquatic habitat and minimize accidental spills should they occur.

5. Channel Maintenance

Following completion of CVD in 1959, the Corps designated the SCWA and the MCRRFCD as local agencies responsible for channel maintenance in the main stem Russian River. SCWA and the MCRRFCD use USACE Operation and Maintenance (O&M) manuals to direct procedures for conducting channel maintenance at the Federal sites in Mendocino (36 stream miles) and Sonoma (22 stream miles) counties. Channel improvement sites include bank stabilization sites built to control stream bank erosion after CVD was constructed. Gravel bar grading and vegetation maintenance have also been conducted to prevent bank erosion along the main stem river.

Past channel maintenance actions have contributed to a decrease in salmonid spawning and rearing habitat suitability in the Russian River. The past effects of channel maintenance have likely affected salmonid populations by reducing pool habitat, high flow refuge, shade canopy, and cover utilized by various life stages of salmonids (Corps and SCWA 2004).

The Corps expected channel changes in the Dry Creek with the building of WSD, and constructed bank stabilization at 15 sites from 1981 to 1989 (Corps and SCWA 2004). In 1981 the Corps constructed three grouted rock-type grade control structures to prevent effects of constructing WSD. Other channel projects constructed by the Corps and currently maintained by the SCWA include riprap bank sites, and flow deflection fences, sediment removal, vegetation removal, and removal of debris.

The SCWA maintains 33.6 miles of flood control channels in zone 1A (CDFG 2006). These channels are significantly altered waterways that have been widened and straightened to increase hydraulic capacity. Maintenance activities in these channels have included sediment removal, channel debris clearing, vegetation maintenance, and bank stabilization. LWD was historically removed when it threatened to create a flow blockage or cause erosion. This activity has resulted in the removal of large quantities of woody debris.

Bank stabilization activities have typically involved the implementation of structures such as riprap. Both Santa Rosa Creek and Matanzas Creek stabilization projects have included substantial use of concrete and riprap, while most of the other channels are earthen with limited use of riprap (SCWA 1997). Currently, riprap is only used as needed. Planting of native riparian vegetation is now used as much as possible, and

in some locations, is the only means used to stabilize the banks (J. Niehaus, SCWA, personal communication, November 2006).

Natural waterways are streams that have not been modified for flood control purposes by the SCWA. Historically, regular maintenance was performed with the objective of maximizing the hydraulic capacity without enlarging the waterways. In the 1970s to 1980s, vegetation was removed from the bottom of the streams with the use of heavy equipment and hand crews with chainsaws. The use of heavy equipment ended in 1987, and clearing continued to be performed using hand labor. Between 1958 and 1983 some of the natural waterways were stabilized and straightened (Corps and SCWA 2001). LWD was historically removed annually and resulted in the removal of large quantities of woody debris and other potential habitat structures (SCWA 1997). Currently, maintenance is only performed on an as needed basis, usually to protect adjacent property (Corps and SCWA 2004).

6. SCWA Reservoirs

There are four flood control reservoirs in Zone 1A and one diversion structure: Santa Rosa Creek Reservoir (Spring Lake), Brush Creek, Piner Creek (on Paulin Creek), Matanzas Reservoir, and Spring Creek Diversion. The reservoirs are all located on Santa Rosa Creek or its tributaries. These reservoirs were built in the late 1960s to reduce flooding in the Santa Rosa area. Santa Rosa Creek Reservoir, also known as Spring Lake, is located offstream. A diversion structure at the inlet allows low flows to bypass the reservoir into Santa Rosa Creek and higher flows to enter the reservoir. A stand pipe allows water to flow back into Santa Rosa Creek when flows in the reservoir get too high. A fish ladder and vortex weir, built in 1962, are located on Santa Rosa Creek at the Spring Lake Diversion to allow anadromous fish passage (Corps and SCWA 2004). Brush, Piner, and Matanzas Creek reservoirs are all located instream and do not have fish ladders, therefore they are migration barriers that block habitat to potential spawning and rearing areas above the reservoirs. Also, these reservoirs may affect changes to the natural stream hydrographs and change sediment delivery patterns. Matanzas Creek has approximately 74 percent of its watershed above the reservoir. Brush and Piner Creek have a much smaller percentage of their watershed above their reservoirs compared to Matanzas Creek.

7. Estuary Breaching

Breaching of the bar has likely occurred at frequencies and timing similar to present day for the last 3-4 decades. While settlers in the 1800s may have breached the estuary during some years, there is little information on breaching frequency prior to 1968. In addition, little, if any, information is available on the frequency and duration of bar closure in the summer prior to the Potter Valley Project and the subsequent elevation of summer Russian River flows. Although D1610 set summer base flow requirements in 1986, these changes in summer flows may not have had a large impact on the frequency of breaching. Information for the years 1968 through 1974 (RREITF 1994) appears to indicate frequencies and timing of breaching mostly similar to current practices[40]. SCWA took over breaching from the Sonoma County of Public Works in 1995 (SCWA 2004b). Public Works had responsibility for estuary breaching as early as the 1950s (RREITF 1994).

[40] During 1968-1974, breaching occurred in the fall of 6-7 years and in the spring of 2 years. Comparisons among the breaching data from different time periods to ascertain impacts of different summer river flow levels need to be treated with caution. Differences in rainfall patterns may have occurred during the different sets of breaching data. These differences likely influenced breaching timing and frequency.

The potential for conversion to a freshwater lagoon after bar closure in the spring has likely been disrupted by breaching for many decades. As described in section V.A.2.d above, breaching keeps the estuary open to ocean tides, resulting in a marine environment near the mouth and extending upstream, depending on tidal fluctuations (SCWA 2004b). When the tide is in, marine or brackish[41] conditions extend further into the estuary. Rearing habitat for juvenile steelhead in the estuary often remains heavily influenced by the marine environment for months, limiting the amount of YOY and 1 + juvenile steelhead that can use the estuary due to their low salinity tolerance.

Every time the estuary is mechanically breached, much of the limited freshwater rearing habitat created by bar closure in the lower four miles of the estuary runs out into the ocean. The estuary becomes subject to ocean tides, and freshwater conditions fluctuate in this area while it remains open. Freshwater rearing habitat may only be maintained consistently near tributary mouths, where freshwater flows from tributaries maintain low salinity conditions in small areas of the estuary regardless of tidal action.

8. Artificial Propagation and Supplementation of Salmonids

Releasing large numbers of hatchery fish can pose a threat to wild salmon and steelhead stocks through genetic impacts, competition for food and other resources, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production (Waples 1991). The genetic impacts of artificial propagation programs are primarily caused by the straying of hatchery fish and the subsequent hybridization of hatchery and wild fish. Artificial propagation threatens the genetic integrity, and diversity that protects overall productivity against changes in environment (61 FR 56138). The potential adverse impacts of artificial propagation programs are well documented (Waples 1991; National Research Council 1995; National Research Council 1996).

Hatchery and out-of-basin salmonid stocks have been planted into the Russian River basin for over a century, primarily for population supplementation and fishing enhancement purposes. Relocation of rescued fish and excess spawning stock at DCFH has also occurred. Table 18 provides a summary of documented fish releases; however, it may not be inclusive of all plants. For the hatchery programs at DCFH/CVFF, it appears that imported stock was necessary to initiate a run back to the hatchery, and then later, to supplement insufficient numbers for broodstock purposes for the coho salmon and Chinook salmon hatchery programs. Wild fish were incorporated opportunistically into the broodstock as well.

Table 18. Stock sources and number of salmonids, by species, released into the Russian River basin between 1911 and 1998.

Coho Salmon			**Steelhead**			**Chinook Salmon**		
Stock Source	**Number**	**%**	**Stock Source**	**Number**	**%**	**Stock Source**	**Number**	**%**
Russian River	752,372	32.5	Russian River	18,167,885	54.3	Russian River	542,478	6.2

[41] Brackish water has salinity roughly in-between ocean salt water and freshwater.

Alsea River	58,794	2.5	Eel River	5,009,156	15.0	Eel River	218,257	2.5
Eel River	25,112	1.1	Mad River	324,101	1.0	Klamath River	1,000,000	11.4
Klamath River	451,370	19.5	Prairie Creek	249,000	.7	Mad River	9,250	.1
Noyo River	613,056	26.5	San Lorenzo Creek	83,350	.25	Sacramento River	3,283,295	37.6
Soos Creek	8,420	.4	Scott Creek	433,458	1.3	Silver King Creek	70,000	.8
Unknown	403,340	17.4	Unknown	8,934,122	26.7	Unknown	2,265,292	26.9
n/a	n/a	n/a	Washougal	270,360	.8	Wisconsin	1,337,624	15.3
Total	2,312,464	100.0	Total	33,471,432	100.0	Total	8,726,196	100.0

Sources: CDFG (1996, 1997, and 1998), SEC (1996), and Corps and SCWA (2000b).

Coho Salmon. The DCFH coho salmon mitigation and enhancement program began in 1980 using Iron Gate Hatchery coho salmon broodstock the first 2 years, followed by stocks from the Noyo River (1984-91), Iron Gate Hatchery (Klamath River, 1986-88), Prairie Creek/Redwood Creek (1987-88), and Hollow Tree Creek (Eel River, 1987 and 1990). The remaining years of program releases came from the progeny of coho salmon adults returning to the hatchery weir. Out-of-basin coho salmon stocks have been planted into the Russian River watershed, from the early 1930's through 1998 (FishPro and Entrix 2000). Coho salmon stock sources include Alsea River, Oregon (1972), and Soos Creek, Washington (1978); Noyo River coho salmon were also planted heavily in the Russian River from 1981 to 1996 (Good *et al.* 2005). Average annual releases of coho salmon from the hatchery decreased from just over 123,000 in the 1987-1991 period to about 66,000 in the years between 1992 and 1996. Noyo River broodstock continued to constitute about 30 percent of the releases during the latter period. Production at the facility was ceased entirely in 1996, after failing to meet mitigation goals. Adult coho salmon returns (minus jacks) to DCFH averaged 254 coho salmon between 1991 and 1996. Following the cessation of releases, no more than four coho salmon were trapped at DCFH in subsequent years.

As discussed above, DCFH received coho salmon from the Klamath and Eel rivers (FishPro and Entrix 2000), and also continued to receive transfers from the Noyo River system throughout its program. The effect of the Noyo River coho salmon stock[42] on current Russian River coho salmon populations was not evident in Hedgecock *et al.* (2002) research on coho salmon genetic population structure in California.

[42] The Noyo River stock is part of the same CCC Coho salmon ESU as the Russian River stock.

However, in their microsatellite analysis using a different data set of populations and year-classes, and a greater number of genes, Garza and Gilbert-Horvath (2003) found Noyo River influence within the Lagunitas/Olema coho salmon population.

Russian River Coho Salmon Captive Broodstock Program. In 2001, the RRCSCBP was initiated at DCFH with wild juvenile coho salmon to prevent extinction of coho salmon in the Russian River basin, and to reestablish self-sustaining runs of coho salmon in tributary streams within the Russian River basin. The immediate purpose of this program is to increase the abundance of the Russian River coho salmon population by supplementing the wild spawning population. This is being accomplished through conservation of the remaining native Russian River coho salmon genome through genetic management that uses a spawning matrix that optimizes the genetic diversity of the progeny of the captive broodstock and out-planting juveniles into streams for rearing under natural selection pressure. Since the program's inception, a cumulative total of 146,216 juvenile coho salmon have been released into the following tributaries of the Russian River: Palmer, Mill, Gray, Gilliam, Ward, Dutch Bill, Green Valley, and Sheephouse creeks (Table 19).

The 2006/07 return season was the first year that returning adult coho salmon were expected to return. Since low numbers of juvenile coho salmon were released in 2004, only very low numbers were expected to return to the three initial release streams. In order to assess adult returns to two of the release streams, spawning surveys were conducted in Mill and Sheephouse creeks. There were no adult coho salmon and no redds observed in Sheephouse Creek. In Mill Creek, one live adult unspawned female coho salmon was observed, and a week later the carcass was retrieved. Based on the coded-wire tag in the carcass, this adult coho salmon was confirmed to be a fish released into Mill Creek in 2004 (M. Obedzinski, U.C.Davis Extension, personal communication, 2007). The lack of rain events and resulting lower flows during much of the 2006/07 upstream migration season were poor for coho salmon migration. Low flows in late December and January may have affected the number of adult coho salmon returning to the release streams and may have contributed to adult coho straying to streams near the release streams. Adult coho salmon were not detected during spawning surveys during the 2007/08 spawning survey. However, a possible coho salmon redd was observed in Mill Creek during

Table 19. Russian River Coho Salmon Captive Broodstock Program: number of juvenile coho salmon stocked by release location and season of release for all four release years. Data from RRCSCBP, U.C.-Davis Extension.

	Release Year: 2004 Brood Year: 2003		**Release Year: 2005 Brood Year: 2004**		**Release Year: 2006 Brood Year: 2005**		**Release Year: 2007 Brood Year: 2006**	
Release Location	***Spring***	***Fall***	***Spring***	***Fall***	***Spring***	***Fall***	***Spring***	***Fall***
Sheephouse Creek	0	952	7,024	1,070	2,911	978	3,004	0
Mill Creek	0	3,433	0	4,399	5,297	6,302	8,038	25,154
Palmer Creek	0	0	2,466	1,920	2,102	3,021	3,967	3,880
Ward Creek	0	1,775	0	4,356	5,690	0	0	0
Gray Creek	0	0	2,584	2,240	3,201	3,772	2,995	5,584
Gilliam Creek	0	0	0	0	0	0	0	2,709
Dutch Bill Creek	0	0	0	0	0	5,286	0	7,945
Green Valley Creek	0	0	0	0	0	4,278	0	7,883
Seasonal Totals	0	*6,160*	*12,074*	*13,985*	*19,201*	*23,637*	18,004	53,155
Yearly Totals	*2004 Total: 6,160*		*2005 Total: 26,059*		*2006 Total: 42,838*		*2007 Total: 71,159*	

RRCSCBP Juvenile Release Total: 146,216

the spawning surveys in 2006/07, and two wild YOY coho salmon were captured in the downstream migrant trap on Mill Creek during the spring of 2007 (M. Obedzinski, U.C.Davis Extension, personal communication, 2007). These data suggest that at least three adult coho salmon from the RRCSCBP returned to Mill Creek during the 2006/07 spawning season, and that two may have successfully spawned. The YOY coho salmon are being held at DCFH as captive broodstock, and genetic samples were taken, however the samples have not yet been analyzed to determine if they are in-fact progeny of RRCSCBP released coho salmon or progeny of wild coho salmon. Additionally, recent downstream migrant trapping data has shown more than 500 wild coho YOY in Felta Creek as of May 2008 (J. L. Conrad, PSMFC, personal communication, May 21, 2008). These data suggest coho of either hatchery or wild origin successfully spawned within the Felta Creek watershed during the winter of 2008. Further genetic analysis will specify the origin of these YOY and will provide further information for refining the RRCSCBP.

Because of the extremely low returns of coho salmon to the Russian River and the likelihood of inbreeding and depensatory processes that will further diminish the river's coho population (see Section IV), the RRCSCBP is essential for the survival and recovery of the Russian River coho salmon population. The hatchery component of the RRCSCBP is funded annually by the Corps and implemented by CDFG. However, the continuation of the genetic management of the broodstock, and the follow-up field monitoring and evaluation components of the project are not currently funded by the Corps. As described in Section III.B.5, the Corps had proposed continuation of the RRCSCBP with continuation of

genetic management and field monitoring for program evaluation. Yet, the continuation of these primary components of the RRCSCBP is uncertain due to lack of short-term and long-term funding. The necessary genetic analyses and the annual development of the genetic spawning matrix were previously funded by NMFS and CDFG; however, that funding ran out after the 2007/08 spawning season. Without use of a genetic spawning matrix, inbreeding may further threaten the fitness and genetic diversity of coho salmon produced and released by the program. The monitoring and evaluation component of the program is currently funded by CDFG through the Fishery Restoration Grant Program; however, future funding for this component is uncertain. Without monitoring and evaluation, the success of the program will be difficult to assess and the program cannot be adjusted accurately if program efforts are not as successful as anticipated. The genetic management and the monitoring and evaluation components of the RRCSCBP ensure the program is accomplishing the goals of preventing extirpation of coho salmon in the Russian River basin and reestablishing self-sustaining runs of coho salmon in tributary streams within the Russian River.

Chinook Salmon. The stocking of Chinook salmon in the Russian River basin first occurred in 1892 and continued sporadically, until the 1950s and 1960s when efforts became more concerted (Myers *et al.* 1998; Chase *et al.* 2005). The Chinook salmon hatchery program at the DCFH was started with out-of-basin stocks (Eel River, Wisconsin strain (Green River, Washington) and Silver King Creek), in addition to Russian River returns. This hatchery program ceased in 1997 due to low adult returns (Good *et al.* 2005), that failed to meet mitigation goals. The Russian River has received fall Chinook salmon transfers from a number of sources, including West Coast hatcheries in other ESUs, Sacramento River stocks (1881, and 1950s-1960s), Trinity River Iron Gate Hatchery (1975), Eel River (1981-1993), Feather River (1982-1994), Wisconsin (1982-1986), Mad River (1983), and Nimbus Hatchery (1990-1994) (Meyers *et al.* 1998).. Natural production of these stocks has been identified as "native" (Myers *et al.* 1998).

The current run of Chinook salmon in the Russian River stems from natural production, and likely evolved as part of a diverse group of native coastal populations (Hedgecock 2002). Genetic analyses have indicated separation between Eel River, Russian River, and Central Valley Chinook salmon populations A history of hatchery stocking, however, has likely had some effect on genetic diversity (Bjorkstedt *et al.* 2006; Chase *et al.* 2007)

Steelhead. There has been a long history of hatchery and rescued fish plants into Russian River tributaries or underutilized habitat, dating back to before 1900 (Corps and SCWA 2004). In the early 1900s, steelhead from Scott Creek (Santa Cruz County), were released throughout the Russian River basin. Significant numbers of steelhead from the Mad River Hatchery (Humboldt County) were released into the Russian River basin prior to the construction of the hatchery. Other reported historical plant sources (FishPro and Entrix 2000) include: Eel River (1972), Prairie Creek (1927), Mad River/Eel River hybrids (1974), San Lorenzo Creek (1973), Scott Creek (1911), and Washougal River, Washington (1981). In 1970, 1,170 steelhead fingerlings were transferred during a fish rescue operation from Dutch Bill Creek into Atascadero Creek, tributary to Green Valley Creek; and another 30,800 fingerlings from DCFH were planted into Atascadero Creek in 1984 (CDFG 2000).

Adult steelhead returning to both facilities are historically in excess of the broodstock needs for the Steelhead Mitigation Program (FishPro and Entrix 2000). Beginning in the 2000/2001 spawning season, CDFG was directed by NMFS to spawn only marked fish at DCFH and CVFF. Beginning in 2004, adult

hatchery steelhead from both facilities are no longer relocated above natural barriers in the Russian River to avoid compromising the genetic integrity of isolated resident trout stocks (based on results from Deiner (2004) discussed below). Adult *wild* steelhead that return to DCFH are relocated into Dry Creek, and adult *wild* steelhead that return to CVFF are relocated to the West Branch Russian River above Mumford Dam. Adult *hatchery* steelhead that return to DCFH that are not needed for broodstock are released into the main stem Russian River, upstream of the confluence with Dry Creek. Adult *hatchery* steelhead that return to CVFF that are not needed for broodstock are relocated to the Ukiah and Cloverdale reach of the main stem Russian River, and to tributaries to the upper Russian River including: Ackerman, Feliz, Orrs, Gibson, Doolan, Mill (tributary to Forsythe), Hensley, McClure, McNab, Morrrison, Parsons, Howell, Dooley, McDowell, Twining, and Walker creeks.

Despite historical releases of out-of-basin steelhead, there appears to be a significant amount of population structure remaining among California coastal steelhead stocks. Garza *et al.* (2004) examined multi-locus genetic data from 62 populations of steelhead in coastal California DPSs, and concluded that the population structure of steelhead in coastal California has been influenced primarily by migration. In addition, drift and local adaptation likely contribute to the differentiation between all populations in the study. Results from both Garza *et al.* (2004) and Deiner *et al.* (2007) suggest that the steelhead populations within the Russian River have not been dramatically altered by hatchery releases. Recent genetic information on Russian River steelhead indicates that there are no substantial genetic differences between wild and hatchery propagated steelhead in the basin, indicating a moderate gene flow among below-barrier anadromous sites (Deiner 2004; Diener *et al*. 2007).

9. Monitoring of DCFH/CVFF Hatchery Operations

The RRCSCBP has a monitoring and evaluation component, guided by the program's Monitoring and Evaluation Subcommittee. Data collected through the monitoring and evaluation component are used to adaptively manage various aspects of the program. Downstream migrant trapping occurs seasonally on selected release streams in order to monitor the number and emigration timing of coho salmon juveniles released by the RRCSCBP. The RRCSCBP evaluations include oversummer and overwinter survival and growth, and comparisons of survival and fish size/condition between spring and fall coho salmon releases. Incidental information is also collected on the number of emigrating steelhead smolts, species and size data on lamprey (*Lampetra* spp.) and counts of all other captured fish species. Tissue samples are taken from coho salmon and steelhead for genetic analysis. The RRCSCBP also monitors water flow, water temperature, and food availability of benthic macroinvertebrates in many of the release streams. Adult spawner surveys and adult trapping is also conducted in several of the release streams.

The CDFG has conducted habitat and biological surveys throughout the Russian River basin to gather information for habitat assessments, including a recent inventory on presence/absence of coho salmon. CDFG habitat assessments have provided guidance for choosing fish planting locations for the RRCSCBP.

Trout Unlimited, in cooperation with the SCWA and NMFS, is attempting to quantify the abundance of steelhead smolts produced by the Austin Creek watershed within the Russian River basin (Katz *et al.* 2006). Monitoring objectives include estimation of coho salmon, Chinook salmon, and steelhead smolt abundance, migration timing, and characterization of other demographics for these species. Fish are trapped by a rotary-screw trap, and counts are expanded from mark recaptures.

10. Main stem Russian River Channelization

Bank stabilization of the Russian River to secure property lines began as early as 1850. In the 1930s the Corps constructed levees along the riverbanks in the Cloverdale area to address flooding concerns. In the 1950s farmers commonly dumped brush, old tires, and wrecked car bodies into the river in an attempt to stabilize the banks in the Ukiah area (Chocholak 1992). These practices may have continued into the later part of the 20th Century.

To minimize anticipated changes in channel morphology following construction of CVD, the Corps constructed several channelization and stream bank stabilization projects along the main stem Russian River from 1956 through 1963 (Corps 1997). Project work included channel clearing, creation of pilot channels, bank protection works consisting of anchored steel jacks, flexible fence structures, wire mesh revetments, and impervious erosion check dams. These channel structures were located at 41 sites in Sonoma County in the Alexander Valley, and along a 15 mile reach of the Russian River in Mendocino County (Corps 1997).

Construction of levees has constrained the flows of the Russian River to a narrow channel. This has increased flood velocities and decreased sinuosity, causing channel degradation and loss of channel form diversity and habitat in the Russian River. Levees effectively remove the channel/floodplain interaction, destroying riparian cover and crucial low flow, back-channel habitat.

11. Agriculture

Agricultural activities have significantly altered the riparian and aquatic habitat in the Russian River watershed. Circuit Riders Productions, Inc. (2001) summarized the changes in the riparian corridor along the alluvial reaches of Mendocino County, and reaches of Alexander Valley, and the Middle Reach. Between 1940 and 2000, the Alexander Valley lost 41 percent and the Middle Reach lost 36 percent of the riparian vegetation along the river (Circuit Rider Productions 2001). During the same time period, Circuit Riders Productions (2001) reports that the loss of riparian vegetation in Mendocino County was 31 percent. By 1990, 92 percent of the riparian area of the Laguna de Santa Rosa was gone (David W. Smith Consulting 1990). In addition to these losses in native vegetation, there has been a substantial effect on the main stem Russian River from introduced species such as the giant reed (*Arundo donax*). This invasive plant is particularly troublesome because it suppresses the germination of seedlings, including native riparian species (Circuit Riders Productions 2001).

Much of the recent loss in riparian vegetation along the Russian River is due to its conversion to agricultural production, most recently vineyards. Vineyard development is believed to be increasing along the main stem Russian River and throughout the watershed in both Mendocino and Sonoma counties. For example, in Sonoma County, there are 56,000 acres of vineyard, with more than 13,000 acres planted in the late 1990s; a thirty percent increase (Chorneau 2001). This expansion has intensified pressure to encroach on riparian vegetation and, perhaps more significantly, has increased soil disturbance and erosion. The potential for erosion increases particularly as vineyards expand out of the valley floors and onto hill slopes (Dahlgren *et al*. 2001). Other common streamside activities related to agriculture are stream channelization and streambank stabilization.

Water diversions needed for agriculture have altered flow regimes in the Russian River and its tributaries. In addition to the two large reservoirs in the basin, numerous permanent and temporary water withdrawal facilities divert water and impede fish passage. The State Water Resources Control Board estimated 1,281 existing and unauthorized dams within Mendocino and Sonoma Counties holding back an estimated 29,663 acre-feet of water (Stetson Engineers 2007). The cumulative effects caused by dams and water diversions have likely led to the decline of salmonids within the Russian River. Impacts from water withdrawals and dams include localized dewatering of streams, migration barriers for multiple salmonid life stages, and depleted flows necessary for migration, spawning and rearing.

12. Urban Development

The majority of the human population in both Sonoma and Mendocino counties lives in the Russian River watershed, and profoundly affects salmonids and their habitats throughout the watershed. Construction of buildings, sidewalks, parking lots, and roads lead to an increase in the amount of impervious surfaces in the watershed. Impervious surfaces have dramatic affects on stream hydrology (reviewed in Calder 1993, Urbonas and Roesner 1993, and Brabec *et al*. 2002). Impervious surfaces prevent water from soaking into the ground. The volume and velocity of stormwater runoff is directly proportional to the amount of impervious surfaces. Increased stormwater volume and velocity cause increased stream bank erosion, sedimentation, and increased flooding (Florsheim and Goodwin 1993).

Urbanization also adds constraints to the stream channels such as roads, culverts, grade control structures, and bridges (Florsheim and Goodwin 1993). These constraints often create barriers to fish migration and unstable stream banks. Frequently, urbanization development leads to additional flood control measures when low-lying agricultural or natural areas are converted to urban uses (Florsheim and Goodwin 1993). Over the past few decades, the conversion of agricultural land to urban uses has occurred throughout much of the Russian River farming area, but is most common in the Zone 1A cities of Windsor, Santa Rosa, and Rohnert Park.

13. Instream Road Crossings

To provide access across streams during the dry season, there are at least five temporary gravel road crossings of the Russian River currently used: one near Asti (Washington School Road), three near Guerneville (Odd Fellows Road, Guernewood Park, and Vacation Beach), and one near the Dry Creek/Russian River confluence (Syar Industries crossing.) There are probably several other sites on the Russian River or its tributaries where vehicles simply ford the stream.

Although there is some overlap of late-emigrating juvenile salmonids or adult Chinook salmon migration timing, each of these five larger instream road crossings allow for surface stream flow. CDFG biologists report that summer road crossings have little or no effect on fish passage (CDFG 1991). Some direct effects to salmonids are expected with the construction and demolition of the instream road crossings. Some habitat is lost when the gravel roadbed is placed in the stream. Also, turbidity increases dramatically during both placement and removal of the gravel roadbed.

14. Small Dams

In addition to the WSD, CVD, and the SCWA's inflatable dam at Mirabel, there are numerous small dams within the Russian River watershed. Many of the reservoirs formed by these small dams are enduring, while many others are seasonal. These small dams are used to provide water supply (urban or agricultural), recreational use, or grade control, and some dams are derelict with no known purpose. Placement of various dams in the Russian River has occurred for more than 130 years.[43]

The permanent Willow County Water Diversion Dam spans the Russian River at RM 88 near Ukiah. The dam was formed by piling rocks and recycled concrete pieces across the channel, then covering that material with concrete. Fish passage parameters at this dam are unknown; however, given that no fish passage structures were incorporated during the construction of this dam, it is likely that this dam reduces passage opportunities for salmonids during some flows. Both Winzler and Kelly (1978) and CDFG (1991) conclude that this dam may negatively affect fish passage. Examples of other permanent dams within the watershed include a concrete grade control structure on Windsor Creek about 1 km upstream of Highway 101 and a derelict concrete dam of unknown purpose on Santa Rosa Creek near the intersection of Los Alamos Road and Melita Road; there are no fish passage structures at either of these dams.

There are three large seasonal dams routinely installed in the main stem Russian River during the summer to enhance recreation. Vacation Beach Dam is located at RM 12 and has a permanent 8-foot-tall concrete base with collapsible steel support beams for wooden flashboards. Johnson's Beach Dam is located at RM 14 and has an 8-foot-tall permanent concrete and steel pier structure with removable flashboards. Healdsburg War Memorial Beach Dam is located at RM 32 and is a 16.5-foot-tall concrete sill structure with removable flashboards and steel support beams. All of these summer recreational dams have fish ladders. The Vacation Beach Dam and Johnson's Beach Dam do not affect fish passage when the flashboards are not installed. The fish ladder at the Healdsburg War Memorial Beach Dam does not function when the flashboards are in use during the summer months. A fourth large seasonal dam, Del Rio Woods Dam, operated by the Del Rio Woods Recreation and Park District at RM 35, has not been installed since 2001.

The large recreational dams on the main stem Russian River will be installed on June 15th or later and removed by October 1st. This timing is outside of the anticipated migration of adult coho salmon and steelhead (Fukushima and Lesh 1998). Adult Chinook salmon may begin migrating in the Russian River as early as August, if conditions are appropriate, though the majority of adult Chinook salmon in the Russian River migrate October through December (Fukushima and Lesh 1998; Chase *et al*. 2005). Although there is some overlap of adult Chinook salmon migration timing, each of these large recreational dams has a fish ladder in place. Based on the results of video monitoring from 2000 through 2004, Chinook salmon appear to be successful in finding and ascending the fish ladders past the Mirabel Dam (Chase *et al*. 2004). Beyond the video monitoring, SCWA staff has conducted snorkel surveys near the entrances to the Mirabel Dam fish ladders and have not noted large numbers of adult Chinook salmon milling about at the fish ladder entrances. The large recreational dams are operated to avoid the majority of the emigration of salmonid smolts, though some smolts may still be emigrating from the Russian River though June (Fukushima and Lesh 1998). The small number of late-emigrating smolts may be delayed at the large recreational dams, but the delays are likely of short duration (Chase *et al*. 2004). The smaller

[43] August 12, 1869, edition of the *Russian River Flag*. Reference not seen – a purported excerpt was found at www.ourhealdsburg.com/history/transportation.htm

summer dams on the tributaries of the Russian River may preclude or delay migration of juvenile salmonids in summer (NMFS 2001).

15. Gravel Extraction

Gravel mining, along with reductions in sediment supply caused by CVD, and channelization efforts have resulted in bed elevation decreases in the main stem Russian River in Mendocino County. This bed lowering, or incision in the Ukiah Valley reach of the Russian River has reduced the elevation of the river's thalweg by 18 ft in some areas. This incision of the mainstem has in turn caused incision of tributary streams. Current channel conditions reported by Halligan (2004) indicate that the incised upper main stem channel has remained relatively stable in terms of elevation with little degradation or aggregation of the thalweg from 1996 to 2002. Peak flows observed by NMFS staff in December of 2006 caused some degradation in the upper main stem Russian River resulting in approximately two feet of downcutting along this reach.

Excessive extraction of instream gravels in Sonoma County has impacted three mining areas that include the Alexander Valley, and the Middle Reach. The Alexander reach, which is approximately 16 miles long, has experienced channel incision of up to 12 ft near the Geyserville Bridge (Florsheim and Goodwin 1993). The channel sinuosity in this reach has decreased due to instream mining, channelization, and agricultural activities.

The most current information for the Middle Reach indicates that replenishment of gravel exceeds extraction. County regulations, such as the Sonoma County Aggregate Resources Management Plan, and the Mendocino County Aggregate Resources Management Plan attempt to maintain extraction rates below annual replenishment rates. These regulations appear to be successful with a Middle Reach sediment recharge rate averaging 430,800 tons, and 183,000 tons proposed for harvest in this area of the Russian River (Entrix 2006).

Gravel extraction in the main stem Russian River has impacted salmonid habitat over time by altering the channel's natural geomorphology. Channel incision creates migration barriers at the mouths of tributaries and lowers the water table which in turn affects perennial stream flow. Impacts to spawning habitat are due to changes in sediment transport, and gravel quality that reduce the overall spawning habitat quality for salmonids attempting to utilize main stem habitat. Effects to riparian vegetation, pools and riffle sequences and gravel quality from gravel extraction limit rearing opportunities for juvenile salmonids. Large scale extraction of gravel is not expected to occur in the future with the current gravel management plan that exists in Sonoma County. Current gravel extraction practices are much improved with most operators following NMFS (2004) sediment removal guidelines which minimize impacts to salmonid habitat at a localized level. Improvements in gravel extraction methods in specific reaches of the main stem Russian River are likely to minimize effects to spawning habitat, and rearing habitat such as pool and riffle frequency, and riparian vegetation in the future.

16. Timber Harvest

Current timber harvest activities are conducted on a much smaller scale and are subject to California Department of Forestry regulations. The current trend is to convert timberland into vineyards, with significant increases in both Sonoma and Mendocino counties since 1990 (UC Hopland 2002). Between

1990 and 1997, 1,631 acres of dense hardwood forest, 278 acres of coniferous forest, 367 acres of shrubland, and 7,229 acres of oak grassland savanna were converted to vineyards in Sonoma County (Merenlender 2000). In Mendocino County there have also been a significant number of acres of native vegetation converted to vineyard acreage (UC Hopland 2000).

Past timber harvest actions are responsible for increasing sediment loads to streams by using streambeds for roads, increasing erosion from hillsides and stream banks. Increased delivery of sediment to streams is known to reduce spawning and rearing habitat quality, which may persist for many decades. Reductions in riparian forests associated with early timber harvest likely increased stream temperatures, reduced inputs of allochthonous and woody debris causing impacts to stream habitat quantity and quality.

The level of impact that timber harvest may have caused in the main stem Russian River is unclear. Transport of fine sediment and elevated water temperatures to the main stem channel likely had some impact on the Russian River in the past. Current timberland activities that impact the main stem Russian River are likely associated with localized harvest and the conversion of timberlands to vineyard production that can increase sediment transport and impact riparian areas in tributaries of the Russian River.

17. Fisheries Management

Angling regulations permit the daily harvest of two hatchery trout or two hatchery steelhead, in the Russian River main stem below the confluence of the East Branch Russian River all year. Only artificial lures with barbless hooks may be used from April 1 through October 31, and only barbless hooks may be used from November 1 through March 31. The main stem Russian River above the confluence of the East Branch Russian River and all other tributaries, and the area within 250 feet of the Healdsburg Memorial Dam, are closed to fishing all year (CDFG 2006). Santa Rosa Creek and Laguna de Santa Rosa, Sonoma County tributaries to the Russian River, have a summer catch-and-release fishery (Good *et al.* 2005). There is no legal harvest of coho salmon within the CCC coho salmon ESU; any coho salmon mortality due to angling would be due to incidental catch-and-release hooking mortality in other fisheries, accidental harvest related to errors in identification, or poaching. The CDFG Steelhead Fishing Report-Restoration Card has been in place since 1993, and has collected angling information to estimate harvest and releases of wild and hatchery steelhead throughout the state, since 1999. The most recent trout angling data from the Russian River reflects an increasing state-wide trend of re-releasing caught hatchery steelhead, complicating fishery management for the conservation of natural steelhead stocks (T. Jackson, CDFG, personal communication, January 24, 2007).

Hopkirk and Northen (1980) briefly describe some of the “rough fish” control measures undertaken in the Russian River watershed in the 1950s and 1960s. “Rough fish” is a term used to cluster non-exploited fish, and generally includes minnows, suckers, sculpins, and other less common groups not targeted by anglers. To minimize competition between game fish and rough fish, the CDFG applied rotenone, a potent ichthyocide, several times to the Russian River and to 118 miles of ten tributaries in the Upper Russian River watershed, Dry Creek watershed, and Zone 1A. Hopkirk and Northen (1980) do not describe any measures taken to protect salmonids during the rotenone applications, though certainly some must have been taken or they would have been killed with the rough fish. The rotenone treatments were largely ineffective at controlling rough fish populations, as within a couple years, the abundance of rough fish returned to pretreatment levels.

18. Water Diversions

Water diversion actions occur along most of the main stem Russian River and Dry Creek. Most diversions are associated with frost protection, heat control, or irrigation of vineyards or pear orchards. Most of the diversion facilities are equipped with self cleaning screens that meet NMFS screen criteria for protection against impingement and entrainment of salmonid fry (J. Bennet, Natural Resources Conservation Services, personal communication, April 2007).

Wells and other diversions have reduced available wetted habitat in some of the Zone 1A tributaries. Most of these Zone 1A diversions have occurred in rural upper Mark West Creek. A juvenile salmonid density monitoring study was conducted in the years 1993-2002 by Merritt Smith Consulting in a few Russian River tributaries. Summer diversion activities were found to contribute to the loss of rearing habitat in some areas.

19. Restoration Actions

Many instream and near-stream restoration activities have occurred throughout the Russian River watershed. Many of these activities were undertaken specifically to improve aquatic and riparian habitat to benefit salmonids. Examples of recent restoration activities include: 1) stabilizing stream banks, slides, roads, and gullies; 2) placing weirs and log structures in streams; 3) replaced instream road crossings and undersized culverts with appropriately sized culverts or bridges; 4) contoured stream banks to recreate or rehabilitate flood plains; 5) replacing riprap or other hardened surfaces using bioengineered techniques; 6) removing and replacing nonnative vegetation with native vegetation; 7) installing grazing excluders; and 8) improving fish passage at dams, such as the Healdsburg War Memorial Dam or Mumford Dam. These restorations projects were undertaken by the SCWA, or private landowners to fix chronic watershed problems that were degrading valuable habitat. Restoration objectives included: reduce erosion and minimize sediment delivery to streams, stabilize stream bed and grade, provide access to spawning and rearing habitat upstream by eliminating passage barriers, improve stream/floodplain connectivity, and provide cover and lower stream temperatures.

Nearly all instream and near stream restoration activities have environmental costs associated with their construction. Impacts included capture and relocation of fish, turbidity, or loss of riparian vegetation. However, those effects were generally small, localized, and of short duration. Long-term habitat impacts have been beneficial as salmonids have access to more spawning and rearing habitat, thereby facilitating recovery of salmonid populations. Also, restoration of hydrologic, geomorphic and sediment processes will lead to floodwater retention and water quality improvement further improving the value of salmonid habitat in the Russian River watershed. These changes are expected to improve spawning, rearing, or migration success of Russian River salmonids in future years.

20. Natural Events

Natural events such as droughts, landslides, floods, and other catastrophes have adversely affected steelhead and salmon populations throughout their evolutionary history. The effects of these events are now often exacerbated by anthropogenic changes to watersheds such as logging, road building, and water

diversion. These anthropogenic changes have limited the ability of these species to rebound from natural stochastic events and depressed populations to critically low levels.

Variability in ocean productivity has been shown to affect salmon production both positively and negatively. Beamish and Bouillion (1993) showed a strong correlation between North Pacific salmon production from 1925 to 1989 and their marine environment. Beamish *et al*. (1997) noted decadal-scale changes in the production of Fraser River sockeye salmon that they attributed to changes in the productivity of the marine environment. They (along with many others) also reported the dramatic change in marine conditions occurring in 1976/77, at the beginning of an El Niño event. El Niño conditions, which occur every 3 to 5 years, negatively affect ocean productivity. Johnson (1988) noted increased adult mortality and decreased average size for Oregon's Chinook and coho salmon during the strong 1982/83 El Niño. Although scientific understanding of the precise extent that ocean conditions have contributed to salmonid declines is limited, ocean conditions have likely affected populations throughout their evolutionary history.

Reduced marine derived nutrient (MDN) transport to watersheds is another consequence of the past century of decline in salmon abundance (Gresh *et al*. 2000). Salmon may play a critical role in the survival of their own species in that MDN (from adult salmon carcasses) has been shown to be vital for the growth of juvenile salmonids (Bilby *et al*. 1996, Bilby *et al*. 1998). The return of salmon to rivers makes a significant contribution to the flora and fauna of both terrestrial and riverine ecosystems (Gresh *et al*. 2000). Evidence of the role of MDN and energy in ecosystems infers this deficit may indicate an ecosystem failure that has contributed to the downward spiral of salmonid abundance (Bilby *et al*. 1996).

As described above in the ***Status of the Species and Critical Habitat*** section, the most relevant trend in global climate change is the warming of the atmosphere from increased greenhouse gas emissions. Global warming is likely to manifest itself differently in different regions. Impacts identified above for California include increase in the number of critically dry years (Cayan *et al.* 2006). Many of the threats already identified for these salmonid populations are related to a reduction in surface flow of tributary streams. Future climate change may therefore substantially increase risk to the species by exacerbating dry conditions. It is possible, but unlikely, that global climate change could affect the ability of SCWA and the Corps to operate the project for the next fifteen years as proposed: in a manner that mimics the previous fifteen years. NMFS does not expect that dramatic local impacts from global climate change will be realized within the next fifteen years. Progress is being made on forecasting decadal changes of surface temperature due to global climate change on global and large regional scales (Smith *et al*. 2007). However, predicting impacts on more local geographic areas remains elusive.

Marine mammal predation is not believed to be a major factor contributing to the decline of West Coast salmon and steelhead populations relative to the effects of fishing, habitat degradation, and hatchery practices. Predation may have substantial impacts in localized areas. Harbor seal (*Phoca vitulina*) and California sea lion (*Zalophus californianus*) numbers have increased along the Pacific Coast (NMFS 1999a). However, at the mouth of the Russian River, Hanson (1993) reported that the foraging behavior of California sea lions and harbor seals with respect to anadromous salmonids was minimal. Hanson (1993) also stated that predation on salmonids appeared to be coincidental with the salmonid migrations rather than dependent upon them.

VI. EFFECTS OF THE PROPOSED ACTION

We approached the effects analysis by first identifying the salmonid habitats, including PCEs of critical habitat, likely to be adversely affected by the proposed project. We then overlaid the analysis of effects to habitat onto an analysis of the effects to individual salmonids, including an examination of the extent to which individual fish are exposed to habitat changes and what their response is expected to be to such changes. We have organized the analysis around major project elements (flood control operations, channel maintenance, *etc*.).

In our effects analysis, we have used data and/or modeling efforts specific to the Russian River and the action area when such information is available. For example, in analyzing the impacts of D1610 stream flows on critical habitat and listed salmonids in Dry Creek and the main stem Russian River, we used the results of a 2001 flow-habitat assessment study conducted in these areas. Where data specific to the Russian River watershed and/or action area are unavailable, we have utilized information from other nearby river systems and more general information regarding aquatic habitat and salmonid responses to environmental perturbations. This information was then overlaid with the proposed project to produce reasoned conclusions regarding likely effects of the project on critical habitat and listed salmonids in the action area when added to the baseline.

The information described in this section (**VI. *Effects of the Proposed Action***) is used later in section **VIII. Integration and Synthesis.** That latter section assesses the ramifications of the effects of the proposed project in the action area on the role and function of critical habitat for species conservation and the likelihood of the survival and recovery of the species at the ESU or DPS scale.

A. Flood Control - Coyote Valley Dam Operations

1. Impacts to Habitat, Including Critical Habitat, in the Mainstem Russian River

CVD flood operations include both water storage and water releases. Water storage reduces the magnitude of flood peaks, while flood releases have the potential to scour the streambed, erode banks, increase turbidity, and may create dewatered channel conditions during ramp downs of flood releases. NMFS' analysis found adverse impacts to Chinook salmon spawning habitat from scour and bank erosion, and potential impacts to Chinook and steelhead spawning and rearing habitat from the release of turbid waters. Ramping of flows was found to create intermittent flow and/or dewatered conditions in rearing habitat used by both Chinook salmon and steelhead fry and juveniles during the winter and spring. Pre-flood and periodic inspections during the fall (September) are likely to cause dewatered channel conditions, adversely affecting rearing habitat for juvenile steelhead, as described below.

a. Streambed Scour

CVD flood control operations are designed to reduce the magnitude of flood peaks in the mainstem Russian River downstream of the confluence with the East Branch. Even though the CVD flood operations mute the peak flows, the magnitude of some flood releases from CVD may be sufficient to cause streambed scour that can adversely affect salmonid redd areas. To analyze the potential for streambed scour to affect salmonid spawning gravels in the mainstem Russian River, we evaluated an assessment by the Corps and SCWA (2000a), and our own field surveys of scour in the Russian River

main stem[44] downstream of the CVD. NMFS also reviewed CVD flow releases and mainstem Russian River flows that influence this area of the Russian River mainstem, and redd scour studies conducted on the Trinity River that evaluated flood operation releases below Lewiston Dam.

Channel forming flows, the dominant discharge known to mobilize the streambed, occur every one to two years (Kondolf and Williams 1999). In the Russian River near Ukiah the dominant discharge flow is estimated to be 4,200 cfs (Florsheim and Goodwin 1993). Further downstream at Hopland such flows are in the vicinity of 9,500 cfs (Corps and SCWA 2004). We reviewed hydrologic data and CVD flood release data to determine if CVD flood releases alone or in combination with main stem flows increase the frequency or duration of channel forming flows that may mobilize the streambed and affect salmonid redd sites in the mainstem Russian River downstream of CVD. To do this, we used the mean daily flows in the Russian River gauged directly above the confluence with the East Branch as a surrogate for flows occurring downstream of the confluence for approximately five miles. This location, the Ukiah Reach, is a major Chinook salmon and steelhead spawning area. Our comparison focused on whether CVD releases resulted in channel forming flows in the Ukiah Reach that would not have occurred due to flows entering this reach from the Russian River mainstem directly above the confluence with the East Branch.

This analytical approach ignores pre-dam conditions and the amount of flows coming from the East Branch in a "pristine" environmental setting (pre CVD and Potter Valley). While such information may be helpful in determining impacts at the population and ESU or DPS scale, it is not appropriate for the exposure and response analysis we report here. The Corps controls how flood releases occur at CVD, and critical habitat and salmonids are exposed to the results of those releases, regardless of historical conditions and what they may have experienced in a "pristine" environment.

Our results indicate in years when channel forming flows occur in the Ukiah Reach, the duration of these flows can be increased from December through March by CVD flood releases as shown in Table 20. Channel forming flows in this reach of the mainstem would have receded earlier had CVD releases not been made, or been made differently. During large storm events when the main stem Russian River reaches channel forming flows, CVD is releasing very low flow to minimize flooding in Ukiah and Hopland. Once the main stem flows begin to recede, CVD releases water that has been stored during winter storm events. These post storm flood releases of 1,000 to 6,400 cfs can by themselves or in combination with main stem flows reach or exceed channel forming discharges. CVD's extension of channel forming flows typically occurs in wet years. Longer durations of channel forming flows, such as occurred in 1998 and 2006, likely increase the potential for streambed scour during these events. However, CVD also reduces the magnitude of very large storms (those that raise Russian River flows far above channel forming thresholds), likely reducing the scour potential of those events.

Due to the paucity of site specific data for this area of the Russian River we used May *et al*. (2007) to gain understanding of the relationship among river discharge, bed mobility, and scour depths in areas used by spawning salmonids. May *et al*. (2007) evaluated high flow releases from Lewiston Dam on the Trinity River to determine the level of bed mobility that may scour Chinook salmon redds and impact redd viability.

[44] As described in the Environmental Baseline, no spawning habitat exists in the East Branch of the Russian River due to the CVD.

Given the streambed scour evaluation on the Trinity River, and that CVD increases the duration of channel forming discharges from December through March, we conclude that winter flood operations are likely to contribute to scour of salmonid spawning gravels during this time period. Because Chinook salmon spawn, and their eggs incubate during this time, the PCE of Chinook spawning habitat is likely to be adversely affected. Some steelhead spawning habitat may also be adversely affected. However, most steelhead use spawning gravels later in the year, when scour from flood operations is much less likely to occur.

Recent studies suggest that Chinook salmon are well adapted for reproductive success in flood prone river systems. May (2007) found that site selection preferences by Chinook salmon correspond to areas of the streambed that are least likely to become mobilized or be at risk for deep scour. Several studies cited by May *et al*. (2007) found that the average probability of Chinook salmon redd scour, defined as net scour greater than 30 cm in riffles, ranged from as little as 5 percent during annual floods to 20 percent for extreme, multi-century recurrence floods. For the Trinity River, May *et al*. (2007) found the probability of scour (>23 cm of depth) for Chinook salmon eggs is about seven percent when the streambed is fully mobile. Baseline channel conditions in the upper Russian River likely increase the potential for streambed scour in the upper Russian River during 1.5 to 2 year flood events. Channel incision, dense mature riparian vegetation, and the lack of complexity in the form of LWD or other roughness elements help to concentrate shear stress on the channel's streambed. Present channel conditions are likely to increase the potential for streambed scour due to the uniform distribution of shear stress along the channel bottom. Therefore, we expect that increased duration of channel forming flows caused by CVD are likely to cause slightly higher scour in riffles used by Chinook salmon for spawning than the five percent reported above for annual storm events. We estimate that scour of these riffles in the main stem below CVD may approach 10 percent. Scour as defined above diminishes the function of these areas as spawning PCEs until additional gravel is deposited during subsequent storms.

Table 20. Number of days CVD operations increase the duration of flows > 4,200 cfs in the Russian River mainstem below the confluence of the East Branch. The number of storms where CVD increased the duration of these flows is also shown.

Water Year	Number of Days flows in Ukiah Reach > 4,200 cfs without CVD	Number of Days CVD Extended the Duration of Flows in Ukiah Reach Over 4,200 cfs	Number of Storm Events CVD Extended the Duration of Flows Over 4,200 cfs
1994	None	None	None
1995	5	3	2
1996	None	2	2
1997	3	1	1
1998	1	14	5
1999	None	None	None
2000	None	1	1
2001	None	None	None
2002	None	None	None
2003	None	1	1
2004	1	2	2
2005	None	None	None
2006	3	8	2
2007	None	None	None
2008	1	None	None

b. Bank Erosion

CVD flood release flows of up to 6,400 cfs are likely to contribute flows that would initiate bank erosion along the main stem Russian River. Flows of 6,000 cfs or greater are needed to initiate bank erosion along the upper Russian River down to Hopland (Corps and SCWA 2004). When Russian River flows are elevated during storm events, CVD outflow is usually low, but during some winters with high rainfall, the CVD flood release contribution to flows at Hopland extends the duration of flows that can cause bank erosion. NMFS evaluated hydrologic data from CVD and for the Russian River, and found that CVD flood releases of 1,000 cfs and larger can, when added to mainstem flows, reach the bank erosion threshold of 6,000 cfs at Hopland. The additional duration of flows over the bank erosion threshold attributable to CVD releases is shown in Table 21.

CVD flood releases and storage operations are expected to result in small amounts of bank erosion. Large bank failures resulting from CVD releases are not expected because channel adjustments have occurred since the construction and operation of CVD. Bank erosion from CVD flood releases is expected to be minimal with input of sediment and riparian vegetation at few sites along the mainstem when bank erosion occurs.

Bank erosion contributed by CVD operations will likely reduce spawning habitat quality directly downstream of the bank erosion sites. Inputs of riparian vegetation are likely to increase the channel complexity for juvenile salmonids, yet will also reduce other parameters such as shade canopy. Some localized reduction in spawning habitat quality and spawning success is likely from the input of sand sized bank material to the streambed.

c. Flow Changes, Intermittent flows and Dewatering

As described in the Project Description, CVD operations incrementally ramp flows to accomplish flood control or release water supply to meet downstream flow requirements of D1610. Flow ramping rates for releases of 1,000 cfs or lower were modified in 1998 to minimize effects to listed salmonids in the Russian River. The USACE proposes to continue to use the interim ramping rates of 250 cfs/hr when flows are between 250 and 1,000 cfs, and 25 cfs/hr when flows are less than 250 cfs. When CVD releases flows of 1,000 cfs or greater the ramping rates are limited to not more than 1,000 cfs on the ramp down, and not more than 2,000 cfs when ramping up.

Flow ramping can cause intermittent surface flow, and at times may completely dewater portions of streams (Hunter 1992). Intermittent and dewatered areas are likely to be found in rivers with many side channels, potholes, and low gradient bars. Conversely, confined channels with steep banks have less potential for dewatered and intermittent areas.

CVD flow ramping impacts are likely to be most pronounced in the four mile stream segment below the confluence of the East Branch Russian River and main stem. In this reach, dewatered areas are most likely to occur in the spring when ramp down at 1,000 cfs per hour is conducted in conjunction with naturally receding flows. This reach has low gradient gravel bars with cobble substrates and backwater pools that are likely to become disconnected from the main channel and/or dewatered during ramping (Corps and SCWA 2004). The Corps and SCWA (2004) note that elevated storm runoff from the upper main stem may dampen this effect during late winter and spring, but that under some flow conditions, CVD ramp down of 1,000 cfs per hour may cause bar areas or off channel pools to become dewatered or disconnected from the main river channel from January through May.

Table 21. Number of days CVD operations increase the duration of flows > 6,000 cfs at Hopland. The number of storms where CVD increased the duration of these flows is also shown.

Water Year	# of Days > 6,000 cfs at Hopland without CVD	# of Days CVD Extended the Duration of Flows > 6,000 cfs at Hopland	# of Storm Events CVD Extended the Duration of Flows > 6,000 cfs
1994	None	None	None
1995	13	2	2
1996	2	2	2
1997	5	None	None
1998	10	16	5
1999	2	None	None
2000	1	None	None
2001	None	None	None
2002	1	None	None
2003	8	1	1
2004	7	4	3
2005	1	None	None
2006	9	6	3
2007	None	None	None
2008	3	None	None

Surveys of the East Branch Russian River and upper main stem Russian River by NMFS and USACE staff have determined that the potential for intermittent and dewatered areas in the East Branch is low due this segment's steep banks and lack of side-channels. These areas are only dewatered when flow is entirely stopped at the dam. Such conditions only occur during annual pre-flood and five-year periodic inspections.

Pre-flood and five-year periodic inspections are likely to have a more pronounced effect on the East Branch than the main stem because flow is stopped in a portion of the East Branch. As described in the *Project Description*, the Corps will reduce or shut-off stream flow from CVD to conduct inspection activities. Annual pre-flood and five-year periodic inspections will be conducted during the fall, usually in September to ensure CVD flood control facilities are operational for the upcoming winter storm season. The ramp down and complete shut-off of water from CVD for the inspection will create intermittent and/or dewatered conditions in some areas of salmonid rearing habitat in the East Branch and main stem downstream. The inspection takes a minimum of two hours to complete, at which time flows are restored.

NMFS and the Corps have worked to minimize impacts to habitat from the pre-flood and periodic inspections. In 2004, the Corps installed Remote Automated Gate Controllers (RAGC) that allow for releases in increments of about 10 cfs. The Corps and NMFS agreed in 2004 that a 25 cfs ramp down increment should be implemented to attempt to meet the Hunter (1992) criteria, which would minimize beaching and stranding of juvenile steelhead as flows are reduced. Observations conducted during the action in 2004 suggest that the 25 cfs ramp down rate may not achieve Hunter's stage elevation criteria of

not more than two inches per hour. However, a balance must be achieved between ramp down rates and maintaining flow downstream during the two-hour flow shutdown. Ramp down rates of less than 25 cfs would likely meet Hunter's protective criteria for stranding of steelhead juveniles. Unfortunately, less flow would be available within the stilling basin and downstream reaches due to the additional time required for the ramp down at lower rates. As a result, the USACE would be unable to maintain flows in the East Fork and main stem Russian River during the 2-hour flow shutdown. Based on monitoring of past pre-flood inspection flow ramp downs, NMFS and the USACE believe that a 25 cfs ramp down rate will adequately minimize the occurrence of intermittent and dewatered habitats near the dam while allowing for adequate flow from the stilling basin to the river, which maintains instream habitat for steelhead further downstream during the two-hour shutdown.

d. Turbidity - Coyote Valley Dam

Highly turbid flows from CVD releases are expected to affect the fine sediment deposition pattern in the river channel. The accelerated rate and extended duration of fine sediment from CVD releases during flood and water supply operations[45] causes fine sediment to settle on, and intrude into, the substrate of the low flow river channel degrading the habitat value of the normally clean gravel substrates of the low flow channel. When the bulk of the suspended sediment load is captured in reservoirs and released at lower flows as occurs with CVD, the result is degraded salmonid spawning rearing habitat (Everest 1969; Badgered et al. 1991). It also reduces the diversity of habitat for benthic invertebrates and may eliminate certain guilds of invertebrates from the food chain reducing food availability for juvenile salmonids

Data are not available to reliably estimate the magnitude of turbidity or the impacts to salmonid habitat. Impacts to habitat could include sustained levels of high turbidity and sedimentation of riffle and pool areas in the Russian River below the confluence with the East Branch. Given the current adult escapement (1,500 to 6,000) of Chinook salmon in the upper mainstem we assume that adverse affects to Chinook salmon spawning and rearing habitat is low to moderate. Impacts on steelhead rearing habitat in this area of the Russian River may be of more concern.

2. Impacts to Species

Flow releases for flood control are likely to result in scour of Chinook salmon redds downstream from CVD. Impacts to listed salmonids from bank erosion, such as entombment of eggs due to increased sediments, and effects to juvenile rearing habitat are also likely. Ramp downs for flood control and water supply occur in the late winter and spring and are most likely to affect salmonid fry and juveniles. Pre-flood/periodic inspections occur in the fall and are most likely to affect juvenile steelhead. These fall inspections should not affect juvenile Chinook salmon because they will have migrated downstream out of the affected area prior to the fall.

Chinook salmon redds have the most potential to be scoured by CVD flood releases. Construction of redds by adult Chinook salmon from October to mid-December makes them susceptible to CVD flood releases from December through February. Flood releases that contribute to flows of greater than 4,200 cfs in the upper five-miles (Ukiah Reach) are expected to cause mobilization of the streambed and adversely affect some Chinook redds. Based on the available information, NMFS estimates that 5 to 10

[45] Turbidity can result from both CVD flood control operations and CVD water supply releases. NMFS has placed the information on turbidity within the CVD Flood Control Operations section purely for editorial convenience.

percent of the Chinook redd areas in the upper main stem may be scoured by CVD flood releases. The estimate of five to ten percent is based on information for redd scour as reported in May et al. (2007) and baseline channel conditions in the upper Russian River.

To estimate the number of Chinook salmon redds that may be scoured by CVD flood operations we utilize site specific Chinook redd counts reported by SCWA (2005*a*). SCWA (2005*a*) reports that the Ukiah Reach of the main stem is an important spawning area for Chinook salmon, with redd densities ranging from 12 redds/mile in 2006 to 25 redds/mile in 2002. Based on these densities, 60 to 125 Chinook redds could be exposed to total or partial scouring in the upper five miles of the main stem Russian River. Based on our estimate of 5 to 10 percent of Chinook redds expected to be scoured, we expect that between 3 and 13 redds are likely to be scoured during each year that CVD extends the duration of 1 to 2 year flood events. Scour of Chinook salmon redds is expected to decrease survival of embryos and pre-emergent Chinook fry by physically dislodging embryos and pre-emergent fry from the protection of the redd during high flows. Chinook salmon redd scour is expected to occur when 1.5 to 2 year flood events occur in the upper main stem, or approximately seven to eight out of every fifteen years that CVD conducts flood control operations.

Few steelhead redds are expected to be impacted by CVD flood control releases due to the timing of steelhead redd construction. Most steelhead spawning in the Ukiah reach of the main stem occurs in March and April. Therefore, some redds that may be constructed in February and March could be affected by CVD flood releases, but the majority of steelhead redds constructed in the Russian River main stem are not likely to be affected by scour or bed mobilization from CVD flood operations occurring from December through March.

Bank erosion contributed by CVD operations may cause some reduction in survival of embryos and emergent fry in spawning areas that are directly affected downstream of bank erosion sites. These failures are expected to occur at few sites given the relatively dense riparian vegetation that exists along most of the upper main stem. Chinook salmon redds are likely to be affected because bank erosion is more likely to occur from late December through February when Chinook salmon redds are susceptible to sedimentation. Effects to Chinook redds are expected to be confined to short reaches below bank erosion sites.

Juvenile Chinook salmon and steelhead may benefit from bank failures along the upper main stem Russian River. These failures typically deliver vegetation in the form of small and large organic debris that improves winter habitat for salmonids, and is likely to improve rearing conditions for juvenile steelhead during the summer months.

Both CC Chinook salmon and CCC steelhead fry and juveniles have the potential to be stranded in isolated pools or beached in dewatered areas created during flood control flow ramp downs. Fry, which are more vulnerable than older juveniles, are poor swimmers and are known to inhabit shallow margins of rivers (Hunter 1992) where flow reductions are likely to have greater effects on aquatic habitat (these areas will drain down first). Ramping rates that result in river stage changes of one inch or less per hour are recommended by Hunter (1992) to protect steelhead fry, and two inches per hour or less to protect juveniles. Ramp down rates of 250 cfs/hr at CVD are expected to produce river stage changes of 6 inches/hr. These stage changes, and those from the larger ramp down rates greater than 250 cfs/hr to the maximum rate of 1,000 cfs/hr, are likely to strand fry and juveniles, although, as

described above, some dampening of stranding effects may occur due to late winter and spring storms. Stranded fry and juveniles are likely to experience higher rates of predation. Some fry and juveniles are likely to be stranded in disconnected pool areas that may not become reconnected depending on flow regime, ensuring the loss of these fish. A lesser number of fish are likely to become beached and perish due to asphyxiation.

The stranding or beaching that occurs in the upper main stem Russian River below the East Branch is not expected to affect all Chinook and steelhead fry and juveniles inhabiting this 4 mile stream reach. NMFS staff biologists have surveyed this area during the winter months (and during fall pre-flood inspections) and concluded that based on the number of low gradient bars and other cover that exist for Chinook salmon and steelhead fry and juveniles, only a small portion of the fry and juvenile population in this upper four miles may become stranded in isolated pools or beached by CVD flood control flow ramping actions.

The creation of intermittent and dewatered areas of the channel downstream of CVD during pre-flood/periodic inspections is expected to strand, but not injure or kill, juvenile steelhead along the East Fork Russian River and main stem Russian River when flow is ramped down. Surveys conducted by NMFS and Corps personnel during these inspections from 1998 to 2004 have documented juvenile steelhead stranded in disconnected pools. Past monitoring by NMFS staff has found that pools with stranded juvenile fish are reconnected with the wetted channel when flow is quickly restored during the ramp up phase of the action. No mortalities of stranded juvenile steelhead have been detected during any of the stream monitoring surveys conducted during fall pre-flood inspections. For example, increased predation by birds or other vertebrates on juvenile steelhead has not been observed during pre-flood surveys conducted by NMFS, SCWA, and the USACE from 1998-2004. These fall inspections should not affect juvenile Chinook salmon because they will have migrated downstream out of the impacted area prior to the fall. Coho salmon juveniles are not likely to be present in this area of the river.

The number of juvenile steelhead stranded is likely to vary based on channel conditions. From 2002 through 2004, observations by NMFS and USACE indicate that fewer than 20 juvenile steelhead were stranded in disconnected pools during pre-flood or periodic dam inspections. Observations by survey teams indicate that the build up of gravel bars has confined the wetted stream, thereby reducing the potential for fishes to become stranded in disconnected pools.

High turbidity concentrations can reduce dissolved oxygen in the water column; the settling and intrusion of fine sediments into the gravels in which salmonids deposit their eggs can reduce hyporheic flow. Reduced levels of DO in the water column will delay or impair development of eggs and alevins. Reduced hyporheic flow will reduce DO delivery to developing eggs and alevins and impair the removal of metabolic wastes from the egg pocket. Chinook salmon and steelhead redds located in the upper main stem from Ukiah to Hopland are likely to be most affected by turbid water released from CVD. Due to the lack of site specific turbidity data for the upper Russian River reductions in egg and alevin survival from elevated turbidity cannot be quantified at this time. However, we assume that reductions in embryo and

alevin life stages are likely low to moderate given the current high production of Chinook and steelhead fry in the upper mainstem Russian River[46].

Effects to juvenile Chinook salmon and steelhead are likely to result from reduction in prey availability and feeding ability caused by turbid waters (Newcomb and Macdonald 1991). These effects can lead to reductions in juvenile Chinook salmon and steelhead growth that may effect survival. Based on observations made by NMFS staff biologists over the last 10 years, and Ritter and Brown (1971), persistent turbidity levels from CVD are estimated to be of the magnitude that cause slight to significant impairment to juvenile salmonids. These impairment ratings are based on Newcombe (2003) which provides an assessment method for fish exposure in turbid waters. Again, we are lacking data to make specific conclusions regarding the response of juvenile salmonids to persistent elevated turbidity that results from CVD releases. As above, we assume that reductions in embryo and alevin lifestages are likely low to moderate given the current high production of Chinook salmon and steelhead fry in the upper mainstem Russian River.

B. Hydroelectric Facility at Coyote Valley Dam

1. Impacts to Habitat, Including Critical Habitat

a. Flow Impacts Downstream

The LMHPP turbines at CVD can generate power at flows between 50 and 400 cfs. The LMHPP diverts water from Lake Mendocino's main outlet tunnel through hydraulic turbines via a tainter gate. In January 2007, the City of Ukiah and the USACE retrofitted the hydraulic tainter gate at CVD. The tainter gate was tested and is currently in operation at CVD. Monitoring of river stage elevations in the upper main stem by NMFS staff biologists during the operation of the new tainter gate confirmed that shifting from flood to power mode has little effect on river stage downstream of the dam. These finding are consistent with a technical assistance letter that was provided to the City of Ukiah by NMFS on February 15, 2006. In that letter, we communicated to the City our conclusion that operation of the retrofitted tainter gate would have no effect on Chinook salmon, steelhead or designated critical habitat if operated in a manner consistent with the City of Ukiah's August 25, 2005 Operations Plan.

b. Gas Super Saturation

Water spilling through dams and turbines becomes pressurized and can entrain nitrogen gas bubbles at higher than normal levels. Juvenile and adult salmonids that are localized in shallow water habitats with supersaturated levels of nitrogen can develop gas bubble disease as the result of accumulated nitrogen gas bubbles in the bloodstream. Salmonid mortality from gas bubble disease has been observed in other river systems, such as the Columbia and Snake rivers, where large dams and hydroelectric facilities receive exceptionally high flows (NWFSC 2000). There have been no indications that water leaving the LMHPP is saturated with nitrogen at levels harmful to adult or

[46] Although information is limited, the best available is observations made by NMFS staff in May of 2000 of large numbers of steelhead fry in this area of the Russian River during Corps CVD inspection activities. NMFS assumes that if steelhead fry are abundant in this area of the mainstem, Chinook fry, which would be exposed to similar turbidity levels, are also abundant. However, because steelhead juveniles remain in rivers and streams during the summers, additional data needed to confirm impacts to steelhead juveniles are limited.

juvenile salmonids (Corps and SCWA 2004). This lack of super-saturation can be contributed in part from the weir structures and low gradient at the outflow pipe that slows water velocity and allows gas held in suspension to diffuse back into the atmosphere.

2. Impacts to Species

No impacts to listed species are anticipated because no adverse changes to their habitats are anticipated from the operation of the LMHPP. Entrainment in the turbines will not occur because listed salmonids are not present upstream of the LMHPP.

C. Flood Control - Warm Springs Dam Operations

1. Impacts to Habitat, Including Critical Habitat in Dry Creek

Similar to the analysis of CVD operations described above, flood management and annual pre-flood and five-year periodic inspections at WSD have the potential to reduce flood peaks, contribute to streambed scour and bank erosion, raise turbidity levels, and during ramp-downs for flood releases cause dewatering or disconnection of off channel areas in portions of the channel.

a. Streambed Scour

The Corps and SCWA (2000*a*) indicate that flood releases (1,000 to 6,000 cfs) from WSD during the winter and spring are sufficient in some years to cause scour of salmon and steelhead spawning gravels in Dry Creek. NMFS agrees with the Corps and SCWA (2004) that current flood operation releases provide for a balance between the periodic mobilization of the streambed needed to clean spawning gravel, and the scour that can destroy salmonid embryos in redds. WSD flood releases that exceed 5,000 cfs are likely to cause some scour of coho salmon and Chinook salmon redds. WSD operations are expected to cause an overall reduction in the frequency of flows that are sufficient to scour salmonid redds in Dry Creek.

As described in the Environmental Baseline, after the construction of WSD the frequency of channel forming flows in Dry Creek downstream was reduced by flood control operations at the dam. NMFS expects these impacts to continue for the fifteen year period of the proposed project. WSD flood operations reduce the potential for redd scour by muting peak flood events Due to the reduced sediment transport caused by the construction of WSD, sediment in the channel downstream of WSD has likely been reduced. The reduction in peak flows from the operation of WSD reduces the potential for degradation of the remaining sediment load downstream of the dam.

Our analysis indicates that even though WSD reduces scour potential in most years, continued operation of the project as proposed for the next fifteen years may contribute to scour of salmonid spawning sites downstream of the project. NMFS concludes that initiation of scour in Dry Creek by WSD flood releases is expected in years when very large flood releases are made, about once in every ten years. The relatively small sized gravel substrates that coho salmon prefer for spawning are more vulnerable to scour than gravels used by steelhead or Chinook salmon (Corps and SCWA 2004). Based on the Corps and SCWA (2000*a*) scour analysis, NMFS concludes that initiation of scour in Dry Creek by flood releases is likely to occur approximately twice every 15 years (once in ten years is 1.5 times in 15

years). When scour occurs, a portion of the spawning habitat for all three salmonid species approximately 3 miles downstream of the dam is likely to be lost. As above with CVD, NMFS expects approximately 5-10 percent of spawning habitat to be scoured to a depth greater than redd depth based on channel conditions and salmonid spawning habitat locations below WSD.

b. Bank Erosion

WSD flows of 1,000 to 6,000 cfs are likely to contribute flows that would initiate bank erosion in some years. Based on the analysis of hydrologic data and flows needed to initiate bank erosion by the Corp and SCWA (2000*a*), it appears that WSD flood operations are not a significant factor that contributes to bank erosion in Dry Creek in most years. Bank erosion initiates in Dry Creek at flow releases of 2,500 cfs or greater (Corps and SCWA 2004). During most winter storm events WSD reduces bank erosion potential by reducing releases that result in a reduction in flood peaks. Conversely, when tributary flow is low, flood releases of 1,000 cfs or greater can contribute to elevate flows to 2,500 cfs or greater and initiate bank erosion processes. NMFS' review of WSD releases indicates that the 2,500 cfs threshold initiates bank erosion about 8 times in 15 years. Therefore we expect that some bank erosion is occurring along Dry Creek due to the contribution of flood releases from WSD flood operations.

We expect bank erosion to occur in relatively small localized areas along Dry Creek. A relatively dense riparian zone along the stream banks, bank stabilization projects, and adjustments in the channel capacity since the construction of WSD reduce the potential for bank erosion along Dry Creek. Small bank erosion failures are likely to deliver sediment and organic debris to the channel affecting salmonid spawning and rearing habitat. Localized effects to spawning habitat or redds may occur when fine bank materials enter the channel affecting spawning quality by increasing the fine sediment component of spawning sites. Delivery of fine sediment to Dry Creek could also reduce intergravel flow, or entomb salmonid embryos or alevins at existing redd locations.

c. Reduction in Winter Habitat Quality

Unlike the flood flow analyses done for CVD (with scour and bank erosion thresholds), information is not available for WSD and Dry Creek that provides thresholds for winter flows that would affect winter habitat quality. Therefore our analysis is based on reasonable inference and the identification of limited winter refuge habitat in Dry Creek as described in the *Environmental Baseline*.

Our analysis indicates that although operation of WSD reduces flood peaks in Dry Creek and downstream in the Russian River, the subsequent release of flows reduces the quality of winter habitat in Dry Creek. This is because after flood peaks are stored behind the dam, water must be released in some years to provide storage space for additional flood peak flows from subsequent storms. Flood releases may range from 1,000 to 6,000 cfs. These releases, although smaller than the preceding flood peaks, are likely large enough to force salmonids to seek refuge to avoid being swept downstream into even higher flows in the Russian River. Salmonids are known to seek cover from high winter flows (see for example, Quinn 2005).

Currently, winter refuge habitat in Dry Creek is limited due to channelization and lack of boulders and LWD in the channel as described above in the *Environmental Baseline* section. These conditions provide few areas where listed salmonids can escape from high flows released during the winter. Flood

flow releases in Dry Creek as proposed confine listed salmonids to the small areas of winter refuge that remain. Juvenile salmonids must eat during the winter to survive, and cannot forage during high winter flows.

d. Intermittent Flows and Dewatering

NMFS examined the potential for flow ramp-downs associated with flood releases and inspections at WSD to adversely affect rearing habitat in the main stem of Dry Creek. The Corps proposes to continue to use the interim ramping rates of 250 cfs/hr when flows are between 250 and 1,000 cfs, and 25 cfs/hr when flows are less than 250 cfs. When CVD releases flows of 1,000 cfs or greater, the ramping rates are limited to not more than 1,000 cfs on the ramp down, and not more than 2,000 cfs when ramping up.

NMFS and Corps staff conducted surveys of Dry Creek during pre-flood inspections to determine if these operations have a high potential to cause intermittent flow and/or dewatering of Dry Creek during ramp downs. NMFS and the Corps concluded that these impacts will be limited due to the relatively steep banks and the general lack of side-channels or other areas where flows could become intermittent or scarce (Tom Daugherty, NMFS, personal communication, Feb 22, 2007).

2. Impacts to Species

Flood operations likely cause minor scouring of spawning habitat in Dry Creek below WSD. WSD reduces the scour potential in Dry Creek during flood operations, but may expose salmonid redds to some scour potential during large flood releases. Estimating the number of Chinook salmon, coho salmon, and steelhead redds that may be destroyed by scour is difficult because although Corps and SCWA (2000*a*) analyzed scour potential, the amount of spawning habitat was not quantified. A realistic worst-case-scenario approach would result in most redds being scoured, and salmonid eggs and alevins lost, in some, but not all years in the three mile long segment between the dam and Pena Creek. Based on May et al. (2007), we estimate that 5 to 10 % of the salmonid redds are likely to be scoured during WSD releases of 5,000 cfs or greater. In some years, climate conditions will preclude the need for flood control releases, in other years, climate conditions are likely to result in only a few flood control releases. Below Pena Creek, Warm Springs flood releases may contribute to scour potential, but given the wide range of flow conditions, the specific effects to salmonid redds are expected to be minimal and not detectable.

Bank erosion contributed by WSD operations may cause some reduction in survival of embryos and emergent fry in spawning areas that are directly affected downstream of bank erosion sites. These failures are expected to occur at few sites given the relatively dense riparian vegetation that exists along most of Dry Creek. Chinook and coho salmon redds have the highest likelihood of occurrence due to the timing of redd construction that makes their spawning sites more susceptible to sedimentation. Steelhead redds are less likely to be affected due to the timing of redd construction, but some spawning sites may be affected. Effects to salmonid redds are expected to be confined to short reaches below bank erosion sites at a limited number areas. Adverse effects to salmonid sites can be quite variable with minor intrusion of fine sediment to redds, or in cases redd location may be covered with bank material that entered the stream channel. In either case we expect a decrease in success of salmonid embryos or alevins at the affected sites.

Juvenile Chinook salmon and steelhead may benefit from bank failures along the upper main stem Dry Creek. These failures typically deliver vegetation in the form of small and large organic debris that improves winter habitat for both salmonids, but is likely to improve rearing conditions for juvenile steelhead during the summer months. Dry Creek in particular has been found to be lacking velocity refuge areas that would be increased with the introduction of organic debris.

Juvenile steelhead and coho salmon that are unable to utilize the limited velocity refuges available in Dry Creek during the winter will be swept downstream during WSD releases and likely perish. Those that are able to find winter refuge habitat will have their feeding opportunities limited by WSD flood releases. Reduction in feeding may impact their fitness.

Although the risk of intermittent flows and/or dewatered conditions is low during ramp downs, CC Chinook salmon, CCC coho salmon, and CCC steelhead fry and juveniles in Dry Creek are likely to be exposed to adverse effects during flow ramp down actions. As previously noted, Hunter (1992) recommends ramping rates of one inch or less per hour to protect steelhead fry and 2 inches per hour to protect juvenile salmonids.

Ramp down rates (both 250 cfs/hr and 125 cfs/hr) for the current operating releases produce river stage changes of 6 inches/hr in the first 1.5 miles below WSD (Corps and SCWA 2004). Ramp down rates between 250 and 1,000 cfs/hr are expected to produce river stage changes greater than 6 inches/hr and are likely to have greater impacts on salmonid fry and juveniles in Dry Creek. Although the Corps and SCWA did not survey stage changes in the 1.5 mile reach between Pena Creek and the point 1.5 miles below the dam, NMFS field observations indicate that similar channel conditions are present in this reach. The stage changes expected in these areas of Dry Creek (the first 3 miles downstream of the dam) are expected to result in fry and juvenile stranding during ramp-downs. Downstream from Pena Creek natural inflow from tributaries will likely dampen the effects of ramp-downs. Cross sections evaluated further downstream (greater than 3 miles) from WSD were generally able to meet the Hunter criteria (Corps and SCWA 2000*a*).

Chinook salmon, coho salmon, and steelhead juveniles are most likely to become stranded by proposed ramping operations between February and late June when discretionary ramping is most likely to occur. However as described above, the steep banks and lack of side channels in this three mile segment are generally not conducive to high stranding rates. Therefore, we expect that relatively low numbers of juvenile salmonids will be stranded in isolated pools or beached due to WSD flow ramping actions. Beached fish will die in less than ten minutes due to asphyxiation. Stranded fish are more likely to be eaten by predators, or harmed by poor habitat conditions in the relatively small pools they are confined to.

Annual Pre-flood and five-year periodic inspections at WSD are unlikely to strand or kill listed salmonids in Dry Creek because 1) these inspections are scheduled for September to avoid impacts to adult spawning and to allow juvenile fish time to grow to sizes that reduce their potential for stranding, and 2) the USACE will provide a continuous 25 cfs minimum bypass during the two hour inspection. See Project Description III. 5.*d* for additional information on WSD inspections.

D. Warm Springs Dam Hydroelectric Facility

1. Impacts to Habitat, Including Critical Habitat

a. Flow impacts downstream

Operation of the WSD Hydroelectric Facility (WSDHF) does not impact flows downstream in Dry Creek. Water used in the WSDHF is part of the water used for flood control and D1610 requirements. Some of this water is diverted through the WSDHF turbine before traveling downstream to meet these needs and uses.

b. Gas Super Saturation

There have been no indications that water leaving the WSDHF is supersaturated with nitrogen gas (Corps and SCWA 2004). Water tested at the inflow to the WSFF is at saturation level, meaning that the levels of nitrogen gas saturated in the water are at normal levels.

2. Impacts to Species

Operation of this facility does not impact critical habitat or listed salmonids. There is no potential for entrainment of listed salmonid species in the turbine because they are not present upstream of the dam.

E. Hatchery Operations

The release of hatchery steelhead could be considered an impact on the critical habitat of Chinook salmon, coho salmon, and wild steelhead because hatchery steelhead may compete for food, prey upon salmonids, or introduce disease in aquatic habitats. However, because the impacts to salmonids in the Russian River are caused directly by the hatchery fish, we have chosen not to break this section into habitat effects followed by species effects. Effects are discussed below for each element of the steelhead hatchery program.

The DCFH and CVFF were intended to serve as mitigation for the loss of salmonid spawning and rearing habitat blocked by the construction of WSD and CVD. Annual escapement goals of 1,100 adult coho salmon, 6,000 adult steelhead and 1,750 adult Chinook salmon in the Dry Creek drainage, and 4,000 adult steelhead in the upper Russian River drainage, were established to provide mitigation for losses resulting from construction and operation of WSD and CVD, and enhancement of the Russian River (Corps 1986b). The previous coho salmon and Chinook salmon hatchery programs both ended in the late 1990's as described in the Environmental Baseline Section, resulting in the Corps not being able to meet established mitigation goals.

a. Emergency Water Supply Line

The Russian River coho salmon population is threatened by a potential catastrophic loss of fishes in the DCFH as the result of a possible failure of its current water supply. An Emergency Water Supply Line

(EWSL) was constructed at the WSD as a back-up water supply line to provide bypass flow to the DCFH and to Dry Creek during annual or periodic inspections. However, the current EWSL at WSD has proven unreliable in providing the necessary bypass flows, since its construction in 1992, and it has not been able to provide an emergency water supply flow to the DCFH or Dry Creek when needed. The fish hatchery is crucial to the RRCSCBP, and an EWSL is necessary to prevent the catastrophic loss of three brood years of coho salmon broodstock, as well as to prevent the catastrophic loss of juvenile steelhead held each year at the hatchery. Catastrophic losses of steelhead have recently occurred at the CVFF due to problems with the EWSL at CVD, resulting in mortality of 104,400 juvenile steelhead at the CVFF in January 2006. The Corps has already made improvements to the EWSL at CVFF, but there is no commitment to improve the EWSL at DCFH, which is the center for hatchery operations for the RRCSCBP.

b. Russian River Coho Salmon Captive Broodstock Program

The RRCSCBP is authorized under an ESA section 10(a)(1)(A) enhancement permit issued to CDFG (Permit 1067, modification 3). Since the effects of the current RRCSCBP are already described in the September 2001 biological opinion concerning the permit issued for that program, the effects associated with the RRCSCBP are not described in this section. Instead, the effects of the RRCSCBP are described in the Environmental Baseline section of this biological opinion and are considered as part of our evaluation of the entire "effects of the action" (50 CFR 402.02) in the *Integration and Synthesis of Effects*.

c. Steelhead Mitigation Program

The Steelhead Mitigation Program is funded by the Corps and is implemented by CDFG. The steelhead produced at DCFH and CVFF have recently been included in the listed DPS. A draft Hatchery and Genetic Management Plan (HGMP) has been developed for this program, however, it is currently incomplete.

As noted in Section III, the Corps (and CDFG) have recently taken initial steps to begin transitioning the steelhead mitigation program from an isolated hatchery program to an integrated hatchery program, and they have incorporated operational changes that have been implemented due to revisions in CDFG policy and guidelines (Corps and SCWA 2004). During the 2007 spawning season, CDFG began incorporating unmarked wild steelhead into the spawning of steelhead at both DCFH and CVFF. However, for the programs to become fully integrated, additional wild steelhead would need to be obtained and incorporated into the annual spawning regime at both facilities.

Genetic Effects. Despite historical releases of out-of-basin steelhead, there appears to be a significant amount of population structure remaining among California coastal steelhead stocks. Garza *et al.* (2004) examined multi-locus genetic data from 62 populations of steelhead in coastal California DPSs, and concluded that the population structure of steelhead in coastal California has been influenced primarily by migration. In addition, drift and local adaptation likely contribute to the differentiation between all populations in the study. Results from both Garza *et al.* (2004) and Deiner *et al.* (2007) suggest that the steelhead populations within the Russian River have not been dramatically altered by hatchery releases. Recent genetic information on Russian River steelhead indicates that there are no substantial genetic differences between wild and hatchery propagated steelhead in the basin, indicating a moderate gene flow among below-barrier anadromous sites (Deiner 2004; Diener *et al*. 2007). Steelhead straying in the watershed may also be occurring as a response to artificial barriers and excess adult off-site releases. As a

result, gene flow is likely occurring between hatchery and wild steelhead. Previous genetic work by Deiner *et al.* (2007) indicated a lack of significant divergence of hatchery steelhead produced at both facilities from steelhead returning to DCFH and CVFF and naturally spawning steelhead throughout the basin. Genetic diversity was also similar, indicating a lack of substantial reduction of effective population size of hatchery steelhead.

Based on genetic and other information at the time, beginning in the 2000/01 spawning season, NMFS directed CDFG to not incorporate wild steelhead into the spawning of steelhead returning to DCFH and CVFF, and to only spawn hatchery (adipose fin-clipped) steelhead. However, current information on the genetics of steelhead indicate that there are no substantial genetic differences between wild and hatchery propagated steelhead within the Russian River basin (Deiner 2004; Deiner *et al.* 2006); therefore, the exclusion of wild steelhead from spawning is no longer recommended. Continued exclusion of wild steelhead from hatchery spawning stock could result in a divergent hatchery population with consequent loss of genetic diversity and increase in inbreeding. (C. Garza, NMFS Southwest Fisheries Science Center, personal communication, May 3, 2007). Therefore, the steelhead hatchery programs should be operated as integrated harvest programs[47].

In hatchery programs, inbreeding and hatchery/domestication selection can result in fish that are not only less fit, but also negatively influence naturally spawning populations through the exchange of migrants. This can occur by multiple mechanisms, including reduction of effective size through the Ryman-Laikre effect or through competitive interactions that result in overall loss of population fitness. Unfortunately, such effects can not be evaluated with the sort of population genetic structure study provided by Deiner *et al.* (2007), particularly since the lack of divergence could be largely due to straying of hatchery fish into the naturally spawning tributary populations. However, careful evaluation and mitigation of any potential detrimental effects of hatchery production on the ESA-listed CCC steelhead DPS can be achieved through genetic management of broodstock and consequent genetic monitoring.

Competition and predation. DCFH/CVFF hatchery steelhead may compete with wild steelhead as outplanted surplus hatchery adults, as straying hatchery adults that return to tributaries and the mainstem to spawn, or as out-migrating juveniles that compete for food and rearing habitat. Direct competition for food and space can result in displacement of wild fish into less preferred areas.

Adult hatchery steelhead that return from the ocean and stray into tributaries and relocated surplus adult hatchery steelhead may spawn in tributaries. Salmonid straying can be advantageous to long-term population sustainability by facilitating colonization of habitat and maintaining genetic diversity within small populations, and is inherent at some rate in natural populations (Hard et al. 1992). However, high rates of straying may have deleterious effects on native fish genomes and local adaptations, and lead to homogenization of populations with loss of diversity within and among populations (Williamson and May 2005, CDFG/NMFS 2001). Steelhead release strategies for DCFH and CVFF appear to reinforce homing to the facilities, as adult numbers have been sufficient or in excess of broodstock program needs. The incidence of straying hatchery steelhead has not been quantified for the Russian River basin, and would be compounded by the non-spawned adult hatchery steelhead that are planted into the mainstem Russian River and tributaries.

[47] Hatchery program in which artificially propagated fish are produced primarily for harvest and they are intended to spawn in the wild, and are fully reproductively integrated with a particular natural population.

Competition for spawning area and mates between hatchery and wild adult steelhead is anticipated to primarily occur in the tributaries, however, monitoring to determine the level of competition is lacking. The amount of competition is dependent upon the total number of steelhead present, number of ripe females, and the amount of available spawning habitat. Based on genetic results, hatchery steelhead and wild steelhead are spawning together which has resulted in an integrated population. Since release strategies for steelhead produced at DCFH and CVFF appear to reinforce adults returning the hatchery facilities, NMFS expects that only a low level of straying is occurring.

Adult hatchery steelhead that return to CVFF and are not needed for broodstock are relocated and released into tributaries to the upper Russian River including: Ackerman, Feliz, Orr, Gibson, Doolan, Mill (tributary to Forsythe), Hensley, McClure, McNab, Morrison, Parsons, Howell, Dooley, McDowell, Twining, and Walker creeks. These urban tributaries were selected by CDFG due to the present lack of wild steelhead, and the potential to re-establish steelhead in these tributaries. The potential competition between natural and hatchery steelhead in these urban tributaries is probably low, due to the present lack of wild steelhead in these streams.

The smolt release strategy is intended to minimize interactions with Russian River wild steelhead, Chinook salmon and coho salmon. Released hatchery steelhead are only expected to be in the watershed for a short amount of time, entering the estuary within a few weeks (Corps and SCWA 2004). However, DCFH/CVFF steelhead smolt releases and outmigration timing does overlap with emigration of wild steelhead, wild and hatchery coho salmon, and wild Chinook salmon smolts. Based on research conducted in Scott Creek, a small coastal stream, it was determined that hatchery steelhead smolts emigrated quickly with little interactions with wild salmonids (Hayes *et al.* 2004). DCFH steelhead smolts are transported and released into Dry Creek three miles downstream from the hatchery at Yoakim Bridge to facilitate outmigration. CVFF steelhead smolts leave the fish facility volitionally to enter the East Branch Russian River, which promotes natural transit behavior and has less impact on the carrying capacity (ISAB 1998). Since releases of hatchery steelhead smolts occur at or near each facility, competition between DCFH/CVFF steelhead and wild juvenile salmonids is likely concentrated downstream of WSD and CVD (*i.e.*, in Dry Creek and the main stem). There may be greater potential for competition from CVFF steelhead, since they are released higher in the basin and have to migrate longer distances than DCFH steelhead (Corps and SCWA 2004).

Hatchery steelhead smolts are larger than their wild counterparts, suggesting that predation by hatchery fish may occur on wild salmonid fry and fingerlings that are encountered during downstream migration, or during extended rearing. Although the effects are anticipated to be primarily in the mainstem Russian River and Dry Creek, there is a potential for hatchery smolts to prey on and compete with rearing wild juvenile steelhead and juvenile coho salmon in tributaries. Since the steelhead are released as smolts, and smolts typically emigrate downriver quickly, very few hatchery juvenile steelhead are anticipated to enter tributaries, minimizing the potential for predation and competition with wild steelhead and coho salmon.

Hatchery releases may also have an indirect effect on predation. Potential migratory behavioral interaction between hatchery and wild fish include a downstream schooling influence. This refers to the downstream sweeping of wild fish by large numbers of downstream migrant hatchery fish, known commonly as the “pied piper effect” (Weber and Fausch 2003). Large concentrations of migrating hatchery steelhead may attract predators (fish, birds, and seals) and consequently contribute indirectly to

predation of wild steelhead. This potential is greater for the DCFH releases since large numbers of smolts are released at a time; the potential is lower at the CVFF releases because steelhead are left to leave the facility on their own volition. Therefore, predation on wild and hatchery juvenile steelhead is most likely occurring at low levels primarily in Dry Creek, mainstem Russian River, and within the estuary, where DCFH steelhead smolts commingle with wild salmonids.

Disease transmission. Stress induced by crowding or injury, and the presence of pathogens, can easily induce outbreaks of fish disease in the hatchery setting (Wood 1979). Fish health is monitored by a CDFG Fish Health Center pathologist, following procedures adopted by the Fish and Game Commission (W. Cox, CDFG Senior Fish Pathologist, personal communication). Prophylactic and therapeutic treatments are carried under the conditions of National Pollutant Discharge Elimination System [NPDES] permits required by the State Water Quality Control Boards, and treated fish are not released before completion of depuration periods. Disease prevention is assisted by hatchery sanitation protocols and with quality fish nutrition. The DCFH steelhead program has previously had bouts of Coldwater Disease (causative agent *Flexibacter psychrophilus*), which is discouraged by disinfection of fertilized eggs, use of hatching jars to prevent water-borne transmission, and treatment of swim-up fry and juveniles with antibiotic Penicillin-G to combat occurrence. Bacterial kidney disease (BKD), (causative agent *Renibacterium salmoninarum*) has a low incidence of infection. As standard hatchery protocol, ovarian fluid is collected from one subset of 20 females from DCFH and one from CVFF, and screened for incidence of BKD to control for infection in the egg (FishPro 2004). BKD transmission can also occur horizontally, via a carrier or diseased fish in the water supply. There may be a risk of releasing BKD-infected excess hatchery steelhead adults, though it is believed that the BKD pathogen is widely present in wild salmonid stocks. Although measures are implemented to reduce the potential for disease within the hatchery, if an outbreak occurs the disease could have an impact on steelhead rearing in the hatchery. The decision to release diseased fish is made by the CDFG Fish Pathologist on a case by case basis (W. Cox, CDFG Senior Fish Pathologist, personal communication). Diseased steelhead may be released if the pathogen is found in receiving waters, or there is no risk of transmission such as in terminal waters or waters with no outlet, *etc.* If the release of diseased steelhead has the potential to spread the disease to wild steelhead, the pathologist will consider the destruction of the fish. These measures reduce the likelihood and potential of transmitting the disease to wild steelhead.

Increased angling effects. Recreational fishing is allowed by CDFG throughout the year on the Russian River mainstem and Dry Creek for hatchery steelhead as well as other species such as smallmouth bass, catfish (*Ictaluridae*) and shad (*Alosa sapidissima*). Fishing is prohibited in the tributaries. Most steelhead fishing occurs during late fall through early April when adult steelhead return from the ocean to spawn. Recreational fishing for hatchery steelhead undoubtedly causes take of listed salmonids, including the hatchery steelhead, wild steelhead, as well as Chinook salmon and possibly coho salmon. Absent approval of a Fishery Management and Evaluation Plan (FMEP) under rules promulgated pursuant to section 4(d) of the ESA, the capture of listed steelhead, including hatchery steelhead, or Chinook salmon in these fisheries is in violation of sections 4(d) and 9 of the ESA. Capture of coho salmon during recreational fishing is in violation of section 9 of the ESA absent exemption through section 7 or 10 of the ESA.

Adult hatchery steelhead that return to DCFH but are not needed for broodstock are relocated and released into the mainstem Russian River upstream from the mouth of Dry Creek. Adult hatchery steelhead that return to CVFF and are not needed for broodstock are relocated to the Ukiah and Cloverdale reach of the

mainstem Russian River. The adult release locations in the mainstem Russian River are intended to reduce the chances of the steelhead returning back to facilities and increase the recreational fishing opportunity within the main stem Russian River.

Relocation of excess DCFH and CVFF steelhead adults to favored angling sites may increase fishing effort on wild steelhead present in those areas. Angling pressure can affect wild and hatchery steelhead through capture, handling, incidental hooking injury, or mortality. CDFG's draft FMEP for CCC Steelhead (2001) proposes the upper limit of increased mortality due to sport fishing to be 2.5 percent in all populations, based on an estimated mortality rate of 5 percent on hooked fish (Schill and Scarpella 1997). Russian River harvest effort data collected from returned angler cards in 1999, 2001, and 2002, reported that wild steelhead comprised 46, 34, and 29 percent, respectively, of the total steelhead catch (FishPro 2004). The majority of wild fish were released (93 to 98 percent) and on average over half (41-65 percent) of the hatchery steelhead were also released. Injuries related to hook and line capture are influenced by hook size and type, bait or lure choice, and species behavior. Common hook and line injuries include damage to the skeletal structure of the mouth, injury to gills, and secondary infections. Fish may be additionally stressed from handling, especially if the fish is kept out of the water before it is released. Since the majority of wild steelhead are caught with barbless hooks and released upon capture, the main effect to wild steelhead is stress, injury, and some delayed mortality. According to Bendock and Alexandersdottir (1993), mortality resulting from hook and line capture and release averaged 7.5 percent with wound location and bleeding as primary factors associated with mortality, and most mortalities occurred within 72 hours of release. Mortality rates for wild steelhead or salmon caught in the Russian River are probably less than that reported by Bendock and Alexandersdottir, because those researchers reported mortality of Chinook salmon that 1) were apparently caught without barbless hook restrictions, and 2) incurred the stress of being caught and radiotagged. Although more monitoring is needed to better quantify the effects of fishing on wild salmonids, NMFS assumes that only a small percentage of the wild salmonids captured will result in mortality as a result of the increased fishing effort.

Effects to adult Chinook salmon. Adult Chinook salmon are sometimes trapped at DCFH and CVFF during broodstock collection of steelhead for the steelhead hatchery programs. Low numbers of adult Chinook salmon are trapped at DCFH and relocated to the Russian River annually. The average number of Chinook salmon encountered at DCFH for the last 10 years is approximately 99 adults, with a range of 2 to 306 adults. Adult Chinook salmon are trapped less frequently at CVFF and have only been encountered in 4 of the last 10 years, with an average of 3, and range of 0 to 23 adults. The primary effects to adult Chinook salmon trapped and relocated from both facilities are non-lethal and related to stress, minor injury associated with capture, handling, and transport to release sites in the Russian River.

F. Flow Management

The project will continue to manage WSD and CVD for purposes of water supply during the low flow season (roughly late May through October) in a manner similar to recent historic project operations. These operations heavily regulate the flow in the main stem Russian River and the lower 14 miles of Dry Creek. Russian River flows are also influenced by reservoir operations at Lake Pillsbury and the associated diversions of water from the Eel River to the Russian River via the Potter Valley Project (PVP). Operations at CVD and WSD moderate peak flows in the Russian River and Dry Creek during high runoff events in winter, and together with the diversions at the PVP, they substantially augment flows during the low flow season. Although the inter-basin transfer of water at the PVP is not under the control of Corps

or SCWA, most of the water diverted to the Russian River at PVP passes through Lake Mendocino and is subject to control (*i.e.*, storage and release) by operations at CVD.

The project must make water supply releases from Lake Sonoma and Lake Mendocino in accordance with minimum flow criteria established in 1986 by Decision 1610 (D1610) of the SWRCB. Section III.B.1 of this opinion reviews those minimum flow criteria. Although D1610 provides minimum flow standards for the main stem Russian River and the lower 14 miles of Dry Creek, it does not provide standards for an upper limit to the amount of stream flow that may be discharged down these rivers. SCWA's use of the Russian River and Dry Creek as conduits for transmitting water supply from Lake Sonoma and Lane Mendocino during the low flow season has resulted in stream flows that are often more than 40 cfs higher than minimum flows under D1610, which are, in turn, much higher than either natural conditions or flows providing substantial, good quality habitat.

1. Flow-Habitat Assessment Study

Between 1999 and late 2001, SCWA, the Corps, and NMFS discussed alternative methods for assessing the effects of summertime flow releases from WSD and CVD on downstream salmonid habitats. In a letter dated February 7, 2000 to the Corps, NMFS recommended that the assessments be done using additional field measurements and habitat simulation (modeling) followed by a flow demonstration study involving observations by an interagency study team. Habitat modeling to address instream flow needs for fishes is often accomplished using the Instream Flow Incremental Methodology (IFIM) (Bovee 1982). In a letter dated January 2, 2001 to the Corps, NMFS specifically recommended that the IFIM be employed to address habitat flow relations in stream segments affected by project water releases. However, SCWA declined to use this highly quantitative method for addressing this issue. Instead the SCWA, DFG, Corps, and NMFS collaborated in a Demonstration Flow Assessment study to examine the effects of the artificially elevated summer flows on salmonids in the upper Russian River and Dry Creek (Annear *et al* 2004; Railsback and Kadvany 2008). That study, which was conducted in fall 2001, provides the best available information for evaluating the impacts of flow management at the two major Russian River dams on rearing habitats for salmonids. It also provides the best data for evaluating alternatives for minimizing those impacts. The study, which is reported as Appendix F of Corps and SCWA (2004), indicates that the current operations (*i.e.*, water releases) at WSD and CVD between late spring and early fall create excessively high current velocities that limit the amounts of rearing habitat for coho salmon, Chinook salmon, and steelhead in the upper Russian River and Dry Creek. The study found that these river segments support much more rearing habitat for salmonids when summer releases from the dams are lower. To understand the effects of flow management at the two dams and possible alternatives for minimizing impacts to salmonids, it is necessary to review the results of the interagency flow-habitat study.

The 2001 flow-habitat study employed a panel of fishery biologists with expertise in salmonid habitat assessment. The expert panel rated the quality and quantity of rearing habitats for salmonid species at nine study sites in Dry Creek below WSD and 13 study sites in the upper Russian River between the mouth of the East Branch and the city of Cloverdale. Each study site was approximately 200 to 300 ft in length and spanned the width of the wetted channel. At each study site, a panel of at least eight biologists estimated the percentages of the wetted surface area having 1) *suitable* and 2) *optimal* quality habitat for *fry* and older *juvenile* stages of the three salmonid species. Each of the study sites was rated at three separate flows. Sites in Dry Creek were evaluated after flows stabilized following releases of 47, 90, and

130 cfs from WSD; sites in the upper Russian River were evaluated at flows following releases of approximately 125, 190, and 275 cfs from CVD. Comparison of the percentages of available habitat at alternative flows was facilitated by the fact that the surface area of each study site did not change appreciably between study flows. This was so because the study flows were all higher than "natural" late-summer conditions and wetted width increased minimally across the range of study flows.

The study's panel of biologists reached consensus on the estimated amount of suitable and optimal habitat that was available at each of the study sites in Dry Creek and the upper Russian River. For Dry Creek, the lowest flow (47 cfs) generally provided greater amounts of habitat for each of the evaluation species life stages (Table 22). The suitability of habitat was strongly influenced by depth and velocity conditions provided by each flow; instream cover and velocity refuges were also important factors affecting habitat value. Specific habitat criteria are identified in the interagency flow-habitat assessment. Specifically, the flow-habitat study results show the following for Dry Creek:

a. Steelhead rearing in Dry Creek

- Of the three study flows, the lowest (47 cfs) provided the greatest amount of *suitable* and *optimal* habitat for both the fry and juvenile stages of steelhead.

- Eight of the nine study sites had substantially more *suitable* habitat for steelhead fry at 47 cfs than at 90 cfs or 130 cfs.

- Seven of nine study sites had substantially less *suitable* habitat for juvenile steelhead at 130 cfs than at a flow of 90 cfs or 47 cfs. Of the remaining two sites, only one site had the highest amount of *suitable* juvenile habitat at 130 cfs, and at the other site available *suitable* habitat for juvenile steelhead was about equal at all three study flows.

- As flows increased, the decrease in available steelhead habitat was significant. At several study sites the amount of *suitable* habitat for steelhead fry declined from more than 60% of the total wetted area to less than 25% of the wetted area when flow rose from 47 to 130 cfs. At several sites the area of *optimal* habitat for fry and juvenile stages of steelhead declined from more than 25% of the total channel area to less than 10% of the channel area as flow rose from 47 to 130 cfs. In this assessment, sites rated as having less than 10% suitable or optimal habitat often had very little or no habitat for that life stage.

b. Coho salmon rearing habitat in Dry Creek

- *Suitable* and *optimal* quality habitats for coho salmon fry were more available at 47 cfs than at the higher flows. However, even at 47 cfs rearing habitat for coho salmon was limited because of the general lack of deep pools and instream cover (*e.g.* large woody debris) that provide shelter from predators and refuge from high current velocities.

- The lowest flow, 47 cfs, provided the greatest amount of *optimal* habitat for coho fry: at 47 cfs, two sites provided *optimal* fry habitat in 10-25% of the wetted channel area; whereas at both 90 and 130 cfs, only one site provided 10-25% *optimal* habitat for fry.

- The greatest amount of *suitable* habitat for juvenile coho was observed at 47 cfs at which three sites were rated 10-25% and one site was rated as having 25-40% of its wetted area providing *suitable* juvenile coho habitat. At 90 cfs only two sites were rated 10-25% and one site was rated 25-40%; at 130 cfs only two sites were rated 10-25%, and no sites were rated 25-40%.

- Flows of 47 and 90 cfs appear to provide equal amounts of *optimal* habitat for juvenile coho, and these lower two flows provide more optimal habitat than 130 cfs. Only one site had more than 10% *optimal* juvenile habitat at 47 and 90 cfs; however, no sites had more than 10% *optimal* juvenile habitat when flow was 130 cfs.

c. Chinook salmon rearing habitat in Dry Creek

- Flows of 47 and 90 cfs provided approximately similar amounts of *suitable* and *optimal* habitats for the fry and juvenile stages of Chinook salmon; whereas a flow of 130 cfs provided substantially less *suitable* and *optimal* rearing habitat for Chinook salmon than 47 or 90 cfs.

- At three of nine study sites more than 40% of the stream channel provided *suitable* habitat for Chinook fry when flow was 90 cfs or less; whereas no study sites had more than 40% of their channel area providing *suitable* fry habitat when flow was 130 cfs.

- Five out of nine study sites had more than 10% of the channel area providing *optimal* habitat for Chinook fry when flow was 90 cfs or less; whereas at 130 cfs, only one study site had more than 10% of the channel area providing *optimal* fry habitat.

For the upper Russian River, the assessment team did not rate habitats for coho salmon because the relatively warm summer water temperatures in this segment preclude this area as coho rearing habitat. Similar to Dry Creek, the lowest study flow (in this case a release of 125 cfs from CVD) generally provided greater amounts of rearing habitat for steelhead and Chinook salmon. Specifically, the flow-habitat study results (Table 23) show the following for the upper Russian River:

a. Steelhead rearing habitat in the main stem

- The amount of available habitats for juvenile stages of steelhead (*i.e.*, fry and juvenile) declined substantially as releases at CVD increased above 125 cfs, the lowest of the three study flows.

- Eleven of 13 study sites had substantially more *suitable* habitat for steelhead fry at dam releases of 125 cfs than at 190 cfs or 275 cfs.

- At 8 of 13 sites, the greatest amount of *optimal* habitat for steelhead fry occurred at CVD releases of 125 cfs; 10 of 13 had the greatest amount of *optimal* fry habitat at either 125 cfs or 190 cfs (or both);

none of the 13 study sites had the highest amount of *optimal* fry habitat at releases of 275 cfs, although 3 sites had equal amounts of *optimal* habitat for steelhead fry at all three study flows.

- Eight of the 13 sites had the highest amount of *suitable* habitat for steelhead juveniles at releases of 125 or 190 cfs; only 2 sites had higher amounts of *suitable* juvenile steelhead habitat at 190 cfs.

- Seven of the 13 sites had the highest amount of *optimal* habitat for juvenile steelhead at releases of 125 or 190 cfs (or both); only 1 study site had higher amounts of *optimal* habitat for juvenile steelhead at the release of 275 cfs.

b. Chinook salmon rearing habitat in the main stem

- Of the three study flows, the greatest amounts of habitat for the fry and juvenile stages of Chinook salmon occurred at the lowest CVD release of 125 cfs.

- Ten of the 13 study sites had substantially more *suitable* habitat for Chinook salmon fry at dam releases of 125 cfs than at 190 cfs or 275 cfs; 7 out of 13 sites had the highest amount of *optimal* fry habitat at a release of 125 cfs; All thirteen study sites had higher amounts of *optimal* fry habitat at either 125 or 190 cfs than at 275 cfs.

- Eight of 13 study sites had more suitable habitat for juvenile Chinook salmon at 125 cfs than at the two higher flows; only 1 study site had higher amounts of suitable habitat for juvenile Chinook salmon at the release of 275 cfs.

- Nine of the 13 sites had the highest amount of *optimal* habitat for juvenile Chinook salmon at releases of 125 or 190 cfs (or both); no study sites had higher amounts of *optimal* habitat for juvenile steelhead at the release of 275 cfs.

Table 22. The percentage of wetted area of nine study sites in Dry Creek having suitable and optimal habitats for the fry and juvenile stages of Chinook salmon, coho salmon, and steelhead trout.

Life Stage	Habitat Quality	Flow (cfs)	Study Site								
			1	2	3	4	5	6	7	8	9
Chinook fry	Suitable	47	40-60	10-25	10-25	<10	>80	10-25	10-25	40-60	<10
		90	40-60	10-25	10-25	<10	40-60	25-40	10-25	40-60	<10
		130	25-40	10-25	<10	<10	25-40	10-25	<10	10-25	<10
	Optimal	47	25-40	<10	<10	<10	60-80	10-25	<10	25-40	<10
		90	25-40	<10	<10	<10	40-60	10-25	10-25	10-25	<10
		130	<10	<10	<10	<10	<10	<10	<10	10-25	<10
Chinook Juvenile	Suitable	47	25-40	10-25	10-25	<10	40-60	25-40	10-25	40-60	10-
		90	>80	10-25	10-25	<10	40-60	25-40	25-40	40-60	<10
		130	25-40	<10	<10	<10	25-40	<10	10-25	10-25	<10
	Optimal	47	<10	<10	10-25	<10	25-40	10-25	<10	40-60	<10
		90	60-80	<10	10-25	<10	25-40	10-25	10-25	10-25	<10
		130	10-25	<10	<10	<10	10-25	<10	<10	10-25	<10
Coho fry	Suitable	47	10-25	<10	<10	<10	10-25	<10	10-25	25-40	<10
		90	<10	<10	<10	<10	25-40	<10	10-25	10-25	<10
		130	10-25	10-25	<10	<10	10-25	<10	<10	10-25	<10
	Optimal	47	<10	<10	<10	<10	10-25	<10	<10	10-25	<10
		90	<10	<10	<10	<10	10-25	<10	<10	<10	<10
		130	10-25	<10	<10	<10	<10	<10	<10	<10	<10
Coho Juvenile	Suitable	47	10-25	10-25	<10	<10	10-25	<10	<10	25-40	<10
		90	10-25	<10	<10	<10	25-40	<10	10-25	<10	<10
		130	10-25	<10	<10	<10	10-25	<10	<10	<10	<10
	Optimal	47	<10	<10	<10	<10	<10	<10	<10	10-25	<10
		90	<10	<10	<10	<10	10-25	<10	<10	<10	<10
		130	<10	<10	<10	<10	<10	<10	<10	<10	<10

Table 22 continued.

Life Stage	Habitat Quality	Flow (cfs)	1	2	3	4	5	6	7	8	9
Steelhead fry	Suitable	47	60-80	25-40	40-60	10-25	>80	60-80	25-40	60-80	10-25
		90	60-80	10-25	25-40	<10	10-25	25-40	10-25	40-60	<10
		130	60-80	10-25	<10	<10	10-25	10-25	<10	10-25	<10
	Optimal	47	10-25	10-25	25-40	<10	40-60	60-80	10-25	40-60	<10
		90	60-80	<10	10-25	<10	10-25	10-25	10-25	10-25	<10
		130	25-40	<10	<10	<10	<10	<10	<10	10-25	<10
Steelhead Juvenile	Suitable	47	10-25	40-60	40-60	25-40	40-60	40-60	10-25	40-60	10-25
		90	25-40	25-40	25-40	<10	40-60	25-40	10-25	40-60	10-25
		130	40-60	10-25	10-25	<10	25-40	<10	10-25	25-40	<10
	Optimal	47	<10	40-60	25-40	10-25	10-25	25-40	<10	25-40	<10
		90	10-25	10-25	10-25	<10	25-40	10-25	10-25	25-40	<10
		130	10-25	<10	<10	<10	10-25	<10	<10	10-25	<10

Table 23. The percentage of wetted area of 13 study sites in the upper Russian River having suitable and optimal habitats for the fry and juvenile stages of Chinook salmon and steelhead trout.

Lifestage	Habitat Quality	Flow (cfs)	Study Site 1	2	3	4	5	6	7	8	9	10	11	12	13
Chinook fry	Suitable	125	25-40	10-25	<10	60-80	40-60	10-25	25-40	25-40	25-40	25-40	25-40	25-40	25-40
		190	10-25	10-25	<10	25-40	10-25	<10	<10	10-25	10-25	10-25	<10	10-25	10-25
		275	<10	<10	<10	10-25	10-25	<10	40-60	10-25	10-25	<10	<10	<10	10-25
	Optimal	125	25-40	<10	<10	10-25	25-40	<10	<10	10-25	10-25	10-25	10-25	10-25	25-40
		190	<10	10-25	<10	<10	10-25	<10	<10	<10	10-25	10-25	<10	<10	<10
		275	<10	<10	<10	<10	10-25	<10	<10	<10	<10	<10	<10	<10	10-25
Chinook juvenile	Suitable	125	40-60	10-25	10-25	40-60	25-40	<10	10-25	10-25	10-25	40-60	25-40	10-25	40-60
		190	10-25	25-40	<10	40-60	10-25	<10	10-25	10-25	<10	10-25	10-25	<10	25-40
		275	10-25	<10	<10	25-40	10-25	<10	40-60	10-25	<10	10-25	<10	<10	10-25
	Optimal	125	25-40	10-25	<10	<10	25-40	<10	<10	10-25	10-25	40-60	25-40	<10	25-40
		190	10-25	10-25	<10	10-25	10-25	<10	10-25	10-25	<10	10-25	<10	<10	10-25
		275	<10	<10	<10	10-25	10-25	<10	<10	<10	<10	<10	<10	<10	10-25
Steelhead fry	Suitable	125	25-40	<10	10-25	25-40	40-60	10-25	10-25	25-40	25-40	25-40	25-40	25-40	25-40
		190	10-25	10-25	<10	10-25	25-40	<10	<10	10-25	10-25	10-25	<10	10-25	10-25
		275	<10	<10	<10	10-25	10-25	<10	40-60	10-25	10-25	<10	<10	<10	10-25
	Optimal	125	25-40	<10	10-25	<10	25-40	<10	10-25	10-25	10-25	25-40	25-40	10-25	10-25
		190	<10	10-25	<10	<10	10-25	<10	<10	<10	10-25	10-25	<10	<10	10-25
		275	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	10-25
Steelhead juvenile	Suitable	125	40-60	10-25	10-25	10-25	40-60	10-25	10-25	10-25	40-60	60-80	60-80	10-25	25-40
		190	25-40	25-40	<10	10-25	25-40	<10	10-25	10-25	<10	25-40	25-40	10-25	25-40
		275	10-25	10-25	10-25	25-40	10-25	<10	40-60	10-25	<10	10-25	10-25	<10	25-40
	Optimal	125	10-25	<10	<10	<10	25-40	<10	<10	10-25	25-40	40-60	40-60	<10	10-25
		190	10-25	10-25	<10	<10	10-25	<10	10-25	10-25	<10	25-40	10-25	<10	10-25
		275	10-25	<10	<10	10-25	10-25	<10	<10	<10	<10	<10	<10	<10	10-25

We approached the assessment of the effects of flow management between late spring through mid-fall by first identifying the stream flows that result from project operations. We then examined the effects of those stream flows on the quality of habitats for listed salmonids. The interagency flow-habitat study and water temperature data and modeling (Corps and SCWA 2004) provided the basis for that habitat analysis. Finally we considered the effects that project altered habitats would have on individual salmonids and relevant salmonid populations. The following sections separately address the effects of flow management by SCWA on salmonids in Dry Creek and the main stem Russian River.

2. Dry Creek - Effects on Habitat, including Critical Habitat

SCWA proposes to manage Lake Sonoma water supply through releases at WSD in a manner similar to recent past practices. This plan will continue to affect the following PCEs of critical habitat in Dry Creek: 1) juvenile rearing for all three listed salmonids, 2) adult migratory habitat of Chinook salmon, and 3) spawning of Chinook salmon. The migration and spawning habitats of steelhead should not be affected by SCWA flow management, because adult steelhead migrate and spawn during the winter months and early spring when WSD is managed by the Corps for flood control and SCWA diversions for water supply are satisfied by natural flow in the Russian River. Likewise, migration and spawning habitat for coho salmon in Dry Creek will likely not be affected by releases for water supply because this species typically spawns from November through January, when flows are naturally elevated and under the control of the Corps for flood protection. The absence of observations of coho salmon at the monitoring station at the seasonal Mirabel rubber dam (SCWA 2005*b*) suggests that, unlike other salmonid species, adult coho salmon do not ascend the Russian River to Dry Creek until at least after seasonal rains increase flows in the Russian River and the Mirabel dam is deflated.

SCWA's proposed flow management will continue to greatly influence the quality and quantity of PCEs of critical habitat for the rearing of steelhead, Chinook salmon, and coho salmon in the 14 mile segment of Dry Creek below WSD. The minimum flow requirements for Dry Creek under D1610 will have little bearing on the actual flows released from WSD from late spring through October. During this period, releases from WSD are highly dependent on water supply demand. Although minimum flow requirements under D1610 are less during dry years, water supply demand from Lake Sonoma is anticipated to be higher during dry years (Corps and SCWA 2004), and thus flows in Dry Creek would likely be higher during dry years. During the past fifteen years, WSD has generally sustained releases of more than 110 cfs for many weeks or months during the summer (see baseline section V.C.2). During the relatively dry years of 2001 and 2002, the median monthly flow released from WSD frequently exceeded 125 cfs during July, August, and September, and during that time flows in excess of 140 cfs were sustained for many weeks (Table 15). The interagency flow-habitat assessment study, described above, found a clear negative relationship between flow and availability of rearing habitat for juvenile salmonids. Much of Dry Creek provides optimal quality rearing habitat for steelhead at a dam release of 47 cfs; whereas at 130 cfs optimal quality habitats for rearing steelhead are nearly absent. The observed flow of 90 cfs provided intermediate amounts of rearing habitat for this species. The principal factor governing the flow-habitat relationship for steelhead rearing habitat is the current velocities that increase with flow and eventually exceed the tolerance of age 0+ and 1+ steelhead. SCWA's plan to maintain status quo operations at WSD will provide very limited

amounts of suitable and optimal quality habitats for rearing steelhead and minimal amounts of rearing habitat for coho and Chinook salmon.

In contrast to the effects on rearing habitat, the proposal to manage Dry Creek flows in a manner similar to recent operations will likely provide good quality conditions and PCEs of critical habitat for adult migration and spawning of Chinook salmon in Dry Creek. Annual monitoring by SCWA documented a substantial annual run of Chinook salmon in the Russian River that precedes the onset of naturally elevated flows associated with seasonal rains. Video monitoring at the Mirabel rubber dam documented that Chinook salmon annually begin to ascend the Russian River in late August or early September (SCWA 2005*b*). The peak of this run, which numbers 1,000 to 6,000 adult fish, occurs in late October or early November before river flows are naturally augmented by seasonal precipitation and runoff. A substantial component of this Chinook run enters Dry Creek. Late summer and early fall flow releases from WSD provide favorable depths and velocities for the migration of adult salmon in Dry Creek up to WSD, and they provide ample, good quality spawning habitats for Chinook salmon in Dry Creek. The predominant water temperatures in upper Dry Creek during October and November are highly suitable (12-13°C) for Chinook salmon spawning (data from USGS gage 11465000). The Corps and SCWA (2004) report that under existing operations, average water temperatures in lower Dry Creek during October and November are 15.1 and 13.1°C, respectively. Given that the run peaks in late October or early November in the lower river, most Chinook salmon likely spawn during mid to late November when water temperatures are in the vicinity of 12 to 14°C , well below the reported upper temperature limit of 16°C at which Chinook salmon eggs experience 50% mortality (Alderdice and Velsen 1978).

3. Dry Creek - Effects on Anadromous Salmonids

Steelhead, coho salmon, and Chinook salmon all spawn in Dry Creek. Corps and SCWA (2004) report that flow conditions and temperatures are very stable in Dry Creek and suitable for spawning and incubation of these species regardless of the water supply condition. Observations by NMFS staff of numerous adult steelhead and Chinook salmon in Dry Creek during the respective spawning seasons support these findings (T. Daugherty, NMFS, personal communication, 2007). Likewise, the annual return of several thousand adult hatchery steelhead[48] to the Warm Springs Fish Hatchery at the base of WSD confirm that passage conditions for adult salmonids are favorable under historic flow management practices (Corps and SCWA 2004).

Although conditions will be favorable for spawning and migrations of both adults and smolt stages, growth and survival of juvenile salmonids will be minimal in Dry Creek because suitable and optimal quality habitats will be very limited. Upon hatching and emerging from their gravel nests, salmonid fry are weak swimmers that aggregate in shallow, low velocity areas (<10 cm/sec) along stream margins (Chapman and Bjornn 1969; Everest and Chapman 1972; Bjornn and Reiser 1991). As they grow, juvenile steelhead and Chinook salmon occupy deeper and swifter habitats (Everest and Chapman 1972; Bjornn and Reiser 1991); coho fry and juveniles occupy deeper habitats often associated with heavy instream cover (Quinn 2005). Salmonid fry that emerge from the gravels of Dry Creek will encounter limited suitable quality habitats in

[48] Return of adult hatchery steelhead and coho that are stocked in Dry Creek as hatchery reared smolts.

which to rear. In most streams that support steelhead and salmon, intraspecific and interspecific competition for limited preferred areas cause the downstream displacement of many juvenile salmonids (Chapman 1966; Quinn 2005). Because rearing habitat is very limited in Dry Creek, most fry that originate from in-river spawning will be displaced into the lower main stem Russian River where predators abound and average summer water temperatures, which typically exceed 23°C, are unsuitable for juvenile salmonids. Very few or none of the young-of-year steelhead or coho salmon that are displaced downstream out of Dry Creek during summer are likely to survive.

The proposed flow management plan for Dry Creek will also greatly reduce the potential value of Dry Creek as habitat for young-of-year and yearling steelhead and coho salmon that emigrate out of the tributaries of Dry Creek. Small seasonal streams provide spawning habitats for steelhead; however, as flows subside and disappear during summer months, fry that are not stranded are displaced downstream where they may find suitable rearing habitats (Erman and Leidy 1975; Erman and Hawthorne 1976). Perennial tributaries, such as Wine Creek, Pena Creek, Crane Creek, and Mill Creek, provide limited rearing habitat, and large numbers of juvenile steelhead and possibly juvenile coho salmon will emigrate downstream in search of suitable habitat. Under the proposed flow management plan for WSD, very few juvenile steelhead and coho salmon originating in tributaries of Dry Creek that emigrate to Dry Creek will find suitable habitat. Most will be displaced downstream into the lower Russian River over the course of the summer. Survival of these individuals will be minimal.

NMFS recognizes that stream-dwelling salmonid species are adapted to survive in variable flow regimes that include episodes with high flows providing limited habitat for juvenile fish (Bjornn and Reiser 1991; Tetzlaff *et al*. 2005; Scruton *et al*. 2003). Salmonids are adapted to variable flows in temperate climates with year-round rainfall, and they persist below hydropeaking hydroelectric power dams that periodically release high flows for a few hours (Heggenes 1988; Pert and Erman 1994; Bunt *et al.* 1999). Salmonids respond to periodic high flow events by seeking limited velocity refugia in pools and other sheltered areas (Heggenes 1988; Bunt *et al*. 1999). However, prolonged high flows with durations that substantially exceed typical, natural, rainfall-runoff events, confine rearing salmonids to limited sheltering microhabitats (pools, and other velocity refugia) for extended periods, thereby reducing the availability of suitable habitats where these fish are able to forage.[49] Such conditions will compress areas of suitable habitat for prolonged periods, with likely adverse effects on individual growth rates and the stream's carrying capacity for juvenile salmonids.

High flow events can have other adverse ecological effects that affect salmonids. For example, Flodmark *et al*. (2006) suggest that short-term pulses of high flow from hydropeaking operations may have only limited effects on salmonid growth and behavior, but that artificial flow fluctuations may have significant impacts to riverine benthic communities. Poff *et al*. (1997) argue that rivers should be managed to incorporate natural flow variability with five components of a natural flow regime (*i.e*., the natural magnitude, frequency, duration, timing, and rate of change). Given the Mediterranean climate in central, coastal California and the near absence of rainfall-runoff events in the Dry Creek Valley between late May and early October, it may be that any sudden increase in flow during summer months is unnatural, with consequences to Dry

[49] That reduction in suitable habitat was documented in the interagency habitat-flow study.

Creek's benthic community. However, short term pulses of high flow (*e.g.*, 120 to 150 cfs with natural recession limbs) for only one or two days per month may simulate natural run-off events similar to those in more northerly or eastern streams that support salmonids. Infrequent, modest changes that simulate natural runoff events would probably not cause significant displacement of salmonids, although the effects of short term increases of summer flow on the benthic community are uncertain. Yet such consideration of the effects of short term increases in summer flow in Dry Creek is probably moot, given that recent historic and proposed operations entail prolonged releases of flow exceeding 100 cfs for several weeks or more during summer months.

It is not possible to provide a precise estimate of the numbers of juvenile steelhead and coho salmon that will be lost as a result of the high sustained flows in Dry Creek, because of the complexities of salmonid behavior and the paucity of salmonid population data specific to Dry Creek. However, as described in Section V.A.3.c, Dry Creek has an average width of about 9.2 meters when flows range from about 45 to 90 cfs; therefore the 14 mile segment of Dry Creek below WSD has a wetted channel area of approximately 205,000 m^2. Average density of juvenile steelhead in good quality rearing habitat in coastal California streams is approximately 0.5 to 1.5 fish/m^2 (Lau 1984; Harvey and Nakamoto 1996; Smith 2007; NMFS unpublished data). The interagency flow habitat assessment study indicates that rearing habitats are very good for steelhead at flows in the vicinity of 45 cfs (*e.g.*, 60 to 80 percent of several study sites provided suitable rearing habitat for steelhead fry and roughly half the channel provided suitable rearing habitat for age 1+ juveniles), and it shows that the quality and quantity of rearing habitat is greatly diminished at flows of 130 cfs. If we assume that steelhead production in Dry Creek would approximate that seen in other good quality steelhead rearing habitats (*i.e.*, 0.5 to 1.5 fish/m^2), then the segment of Dry Creek below WSD has the potential to rear about 100,000 to 300,000 juvenile steelhead. The precise production of steelhead in Dry Creek under current flow management with sustained flows over 100 cfs for many weeks is not known. However given that almost all of the flow-habitat study sites had less than 25 percent suitable habitat for steelhead fry at 130 cfs and many provided less than 10 percent suitable habitat, it is reasonable to assume that flows of 130 cfs reduce available rearing habitat for steelhead fry to one-quarter or less. Non-quantitative observations during the flow-habitat study indicate that sustained flows higher than 130 cfs further diminish available rearing habitat for steelhead. Given that 1) Dry Creek supports substantial runs of adult CCC steelhead that were outplanted as hatchery smolts, 2) spawning habitat for this species is relatively abundant in Dry Creek 3) CCC steelhead successfully spawn in all of the major tributaries, 4) steelhead routinely migrate downstream from tributaries in response to intraspecific competition (Chapman 1966; Quinn 2005) and reduced summer flow (Erman and Leidy 1975; Erman and Hawthorne 1976), and 5) downstream migration of juvenile steelhead has been routinely documented in Mill Creek, a tributary of Dry Creek (RRCSCBP monitoring data), it is reasonable to assume that juvenile steelhead produced in Dry Creek and dropdowns of juveniles from this stream's tributaries would populate most or all of the suitable habitat in Dry Creek, if flows were in the vicinity of 45 cfs. With such changes, Dry Creek would quickly support production of about 100,000 to 300,000 juvenile steelhead. Based on an estimated reduction of about 75%, the proposed project's flow regime would reduce that production to roughly 25,000 to 75,000 juvenile steelhead (or fewer with sustained flows exceeding 130 cfs between spring and early fall).

With respect to coho salmon, the proposed summer flows and ongoing channel maintenance in Dry Creek will probably not directly cause the immediate loss of many tens of thousands of juvenile fish, because the numbers of adult coho salmon that return to the Dry Creek watershed are currently extremely low. For example, during the winter of 2007/2008 less than five adult coho salmon were documented returning to all RRCSCBP streams in the Russian River watershed. Nevertheless, some juvenile coho probably do enter Dry Creek, where rearing habitat for this species is poor due to high flows and limited velocity refugia and other forms of shelter. In 2006, monitoring efforts for the RRCSCBP captured 311 age 0+ coho salmon as they migrated downstream in lower Mill Creek. Many of those fish likely moved downstream into Dry Creek. Although it is not known with certainty that adult coho salmon routinely spawn in Dry Creek and its tributaries, we do know that wild smolts have been recently captured in Mill Creek (RRCSCBP monitoring data), that coho salmon were documented in the Wine/Grape Creek system during 1998 (DFG unpublished data), and that other adult salmonids spawn in Dry Creek. Given that coho salmon spawn in riffle habitats similar to steelhead and Chinook (with minor differences in gravel size and current velocity), it is likely that a few adult coho do continue to spawn in the Dry Creek watershed in some or all years. Given the uncertainty of the actual numbers of adult coho that might spawn in this watershed, we assume a conservatively low estimate that three adult female coho salmon are able to successfully spawn in the mainstem Dry Creek each year and that an additional three adult female coho do successfully spawn in one of the several tributaries entering Dry Creek downstream of WSD. The result of such a modest return to the Dry Creek watershed would result in the production of an estimated 1800 juvenile coho salmon produced through natural spawning in Dry Creek and an additional 180 juvenile coho that enter Dry Creek as the result of emigration from Dry Creek tributaries that support natural spawning of this species (Table 24). The near absence of rearing habitats for juvenile coho salmon due to the degradation of habitat through ongoing channel maintenance and sustained high flows greatly limits the survival of the few coho fry that are produced in Dry Creek or emigrate into it. Given the near absence of coho salmon in the watershed, the very limited low velocity refugia with abundant cover, and the paucity of population data, we assume that 90% of juvenile coho salmon produced in Dry Creek are prematurely displaced downstream into the Russian River or other inhospitable habitats. Moreover, the continuation of these conditions prohibits growth of the Dry Creek subpopulation of coho, despite the stream's highly favorable water temperatures for this species.

Table 24. Estimated average number of coho salmon reproduced and stocked annually in Dry Creek and its tributaries, and the estimated number of juvenile coho salmon displaced from Dry Creek as the result of ongoing habitat degradation due to project operations (channel maintenance and flow releases).

Stream	**No. adult females successfully spawning**	**Egg production (2000/female)** [1]	**Egg to fry survival (assume 30%)**[1]	**Fry and juveniles entering Dry Creek during first spring & summer**	**Estimated Fry and Juveniles displaced downstream from Dry Creek**
Dry Creek	3	6000	1800	1800	1539 (90%)
Dry Creek tribs (wild)	3	6000	1800	252 (14%)[2]	226 (90%)
Dry Creek tribs (stock)	--	--	--	1200[2]	1080 (90%)
Totals:	6	12,000	3600	3252	2845

[1]Sandercock (1991)
[2]RRCSBSP unpublished data

The loss of juvenile coho salmon and steelhead that are displaced from Dry Creek to the lower river will affect the numbers of returning adults to the river. Elevated river temperatures, the presence of predatory species, and lack of suitable habitat are likely to reduce the survival of juvenile salmonids displaced to the Russian River. However, the effects of downstream displacement of juvenile Chinook salmon due to dam operations is less clear given that 1) this population migrates to the marine environment during the first spring such that individuals avoid exposure to high summer water temperatures in the lower river, 2) our review of the status of CC Chinook salmon indicates that the Central Coast diversity stratum, in which the Russian River is the principal watershed, supports a relatively abundant population of Chinook salmon that has exhibited positive growth rate despite ongoing operations at the dam and the lower coastwide returns during fall 2007, 3) our analysis found that the rearing PCE for the Central Coast diversity stratum does not appear to be limiting the Russian River population, and 4) in the Russian River, the freshwater rearing of Chinook salmon takes place largely during the late winter and early spring when stream flows are relatively high and largely determined by unregulated inflow from the river's tributaries.

4. Russian River Main Stem - Effects on Habitat, including Critical Habitat

To understand the effects of SCWA's flow management at WSD and CVD on main stem flows during summer and early fall, we began by examining USGS stream gauge records for the upper and lower Russian River before and after construction of the dams and after implementation of D1610. Table 25 shows the median daily flow in the Russian River at Hopland for the period July 1 through September 30 during representative years before and after construction of CVD. None of the years included in Table 25 represent periods with natural, unregulated flow, because

they all occurred after the construction of the PVP with its interbasin transfer of water from the Eel River, which has been ongoing since 1908. USGS records show that during the period 1947 to 1958, late summer diversions at Potter Valley into the Russian River generally ranged from about 200 to 300 cfs; whereas prior to the construction of Lake Pillsbury in 1922, diversions at the PVP in late summer were typically less than 50 cfs. USGS data also show that prior to the completion of Lake Pillsbury, Russian River flow immediately below the mouth of the East Fork at Ukiah was also usually less than about 50 cfs in July and less than 25 cfs in August and September.

Table 25 shows that in the 12 years immediately prior to the filling of Lake Mendocino in November 1958, median flow at Hopland for the period July 1 through September 30 generally ranged from about 110 to 225 cfs. After construction of Lake Mendocino but before adoption of D1610, summer flows increased in the upper Russian River, with median flows during the period July through September generally ranging from about 230 to 325 at Hopland. In many years the median flow at this location was over 250 cfs. After adoption of D1610 in 1986, median flow at Hopland during the three summer months was reduced and generally in the range of about 160 to 225 cfs. During this latter period, the lowest median summer flows at Hopland were 130 and 142 cfs, which occurred during the relatively dry years of 1988 and 2002, respectively.

Table 25. Median daily flow (cfs) in the Russian River during summer months (July 1-September 30) at the USGS Gage (No. 11462500) at Hopland during representative years before and after construction and storage at Lake Mendocino.

	Years Prior to Lake Mendocino					
Year:	**1947**	**1948**	**1949**	**1950**	**1951**	**1952**
Median daily flow[1]:	105	168	129	116	129	224
Year:	**1953**	**1954**	**1955**	**1956**	**1957**	**1958**
Median daily flow:	249	183	183	189	174	197
	Years with Lake Mendocino Storage, PRE-D1610					
Year:	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**
Median daily flow:	244	237	280	243	260	253
Year:	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**
Median daily flow:	250	248	264	327	247	229
	Years with Lake Mendocino Storage, after adoption of D1610					
Year:	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**
Median daily flow:	130	234	190	173	215	223
Year:	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Median daily flow:	162	208	227	208	221	259
Year:	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Median daily flow:	228	142	180	214	204	209

[1]Median daily flow is the median value of the mean daily flow during the period July 1-Sept 30 for that year.

At Guerneville, median flow during the period July 1 through September 30 was generally in the range of about 110 to 225 cfs prior to the construction of Lake Mendocino and Lake Sonoma (Table 26). In some years such as 1947, the median flow during the summer months was as low as 82 cfs. After the construction of the two major reservoirs, but before adoption of D1610, median flow for the period July 1 through September 30 was generally in the range of 170 to 250 cfs. Now with D1610, median flow over the three summer months is generally in the range of about 150 to 200 cfs in normal years. Under SWRCB procedures for designating dry years, flows were lowered such that the median flow at Guerneville for the three summer months was 113 and 120 cfs during 2001 and 2004, respectively.

Table 26. Median daily flow (cfs) in the Russian River during summer months (July 1-September 30) at the USGS Gage (No. 11467000) at Guerneville during representative years before and after construction and storage at Lake Sonoma and Lake Mendocino.

	Years Prior to Lake Mendocino and Lake Sonoma					
Year:	**1947**	**1948**	**1949**	**1950**	**1951**	**1952**
Median daily flow[1]:	82	158	109	110	131	224
Year:	**1953**	**1954**	**1955**	**1956**	**1957**	**1958**
Median daily flow:	253	152	157	165	150	193
	Years with Lake Mendocino Storage, Pre-Lake Sonoma and Pre-D1610					
Year:	**1965**	**1966**	**1967**	**1968**	**1969**	**1970**
Median daily flow:	227	179	252	177	191	187
Year:	**1971**	**1972**	**1973**	**1974**	**1975**	**1976**
Median daily flow:	174	173	201	248	186	141
	Years with Lake Sonoma and Lake Mendocino Storage, after adoption of D1610					
Year:	**1988**	**1989**	**1990**	**1991**	**1992**	**1993**
Median daily flow:	146	191	163	141	187	224
Year:	**1994**	**1995**	**1996**	**1997**	**1998**	**1999**
Median daily flow:	139	205	187	181	265	204
Year:	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
Median daily flow:	187	113	149	208	120	191

Although the diversions at Potter Valley substantially augmented flows in the Russian River prior to the construction of CVD and WSD, SCWA is able to regulate the release of inflow from the Potter Valley project through storage and controlled releases from Lake Mendocino. The ability of SCWA to manage inflow from the Potter Valley diversion is demonstrated by SCWA's low flow proposal described by Corps and SCWA (2004). That plan calls for substantial reduction in main stem flows both in the upper and lower main stem. For example, SCWA's low flow proposal planned to reduce minimum flow requirements at Healdsburg and Guerneville to 50 and 35 cfs, respectively, during summer months in normal water years.

For the project considered in this opinion, SCWA proposes to manage the water supplies in Lake Mendocino and Lake Sonoma in a manner similar to recent past practices. This plan will continue to affect the following PCEs of critical habitat in the main stem Russian River: 1) freshwater rearing of steelhead and Chinook salmon, 2) estuarine rearing, 3) adult migratory habitat of Chinook salmon, and 4) spawning habitat of Chinook salmon. PCEs for migration and spawning of steelhead should not be affected by SCWA flow management, because adult steelhead migrate and spawn during the winter months and early spring when CVD and WSD are

managed by the Corps for flood control and SCWA diversions for water supply are satisfied by natural flow in the Russian River. Likewise, PCEs of critical habitat for the migration and spawning of coho salmon in the main stem will likely not be affected by releases for water supply because this species typically migrates and spawns from November through January, when flows are naturally elevated and under the control of the Corps for flood protection. The absence of observations of coho salmon at the continuously monitored fish ladder at the seasonal Mirabel rubber dam (SCWA 2005*b*) suggests that, unlike other salmonid species, adult coho salmon do not ascend the Russian River until at least after seasonal rains increase flows in the Russian River and the Mirabel dam is deflated. The main stem Russian River does not support rearing habitat for coho salmon during summer months because its water temperatures far exceed suitable temperatures for coho salmon (Corps and SCWA 2004).

SCWA's proposed management of water supply will likely have little adverse affect on the quality of rearing habitats for salmonids in the Russian River main stem between Cloverdale and Monte Rio, because in that segment, summer water temperatures typically exceed thermal tolerances of rearing salmonids (Corps and SCWA 2004). Thus this segment provides both minimal amounts and marginal quality rearing habitats for these species.

SCWA's proposed flow management will continue to influence the quality of PCEs of critical habitat for rearing of steelhead and Chinook salmon in the 34 mile segment of the upper Russian River between Cloverdale and CVD. Whether these influences are benign or adverse partly depends on the water year type as classified by D1610. During the past fifteen years SCWA has usually sustained releases from CVD of more than 250 cfs for many weeks or months during the summer (see baseline section V.C.1). Each of these were normal water years, except for 2001, a dry year, when median monthly flows during July, August and September ranged from 184 to 199 cfs. The interagency flow-habitat assessment study, described above, found a clear negative relationship between flow and availability of rearing habitat for steelhead and Chinook salmon in the upper Russian River. Much of this segment provides suitable quality rearing habitat for steelhead and Chinook salmon at a release of 125 cfs from CVD; whereas the highest observed study flow (275 cfs) creates conditions providing substantially lower amounts of rearing habitats for these species (Table 23). This was especially true for the fry stage.

The principal factor governing this flow-habitat relationship for rearing steelhead and Chinook salmon is the current velocities that increase with flow and eventually exceed the tolerances of these juvenile life stages. SCWA's plan to maintain status quo operations at CVD during the low flow season will likely provide less suitable and optimal quality habitats for rearing steelhead and Chinook salmon, especially during "normal years", compared to the amounts that would be available with lower flow releases. High flows associated with operations during normal water years will create high current velocities that will limit available habitat. During dry years and critically dry years, SCWA is able to reduce releases from CVD relative to normal years, as the result of D1610 provisions. Reductions in flow would reduce in-channel velocities that limit habitat quality. However, past operations during a dry year (2001) suggest that despite the reduction of the minimum flow requirement at Healdsburg from 185 cfs (the normal year minimum) to 75 cfs in dry years, CVD continues to release close to 200 cfs during dry water years - a reduction of about 50 to 75 cfs from typical releases in normal years.

Waters released from Lake Mendocino are relatively cold during summer months. However, as the cold water pool becomes depleted, the waters released from the CVD become warmer as the summer progresses. Under current practices, median monthly water temperatures immediately downstream from CVD were 12.7, 15.1, and 19.4°C in July, August and September, respectively (data from USGS Gage 11462000). Summer water temperatures remain suitable for steelhead rearing as far downstream as Cloverdale, where average daily water temperatures are in the vicinity of 20°C in late August and September (Corps and SCWA 2004).

In contrast to the effects on rearing habitat, the proposal to manage main stem flows in a manner similar to recent operations will likely provide good quality conditions and habitats for the adult migration and spawning of Chinook salmon. During late summer and early fall, in compliance with D1610, project releases from CVD and WSD provide depths and velocities in the main stem that facilitate the upstream migration of adult Chinook salmon to CVD and the West Branch Russian River. The artificially high flows in the lower Russian River also ensure that the mouth of the river is open, thereby allowing the annual entry of fall run Chinook salmon during the late summer and early fall. Proposed flow releases from CVD will also provide abundant, good quality spawning habitats for Chinook salmon in the upper main stem during October and early November, the period when most adult Chinook move upstream past the Mirabel rubber dam (SCWA 2005*b*). The predominant water temperature in the upper Russian River during November (14°C) is suitable for Chinook salmon spawning (Healy 1991).

5. Russian River Main Stem - Effects on Anadromous Salmonids

The principal anadromous salmonid life stages to be affected by SCWA's proposed water supply management plan for the Russian River main stem are the adult migratory and spawning stages of Chinook salmon and rearing juvenile steelhead. As stated above, the SCWA flow management plan should have little effect on steelhead and coho salmon migrations or spawning because these life stages occur during late fall and winter when flow operations are managed for flood operations and main stem stream flows are largely determined by precipitation and natural runoff. We have considered the possibility that the artificially high flows sustained in the lower river during fall months due to releases from Lake Mendocino may have some potential to affect adult coho, if returning adult fish enter the Russian River before winter rains elevate flows in the river's tributaries where most spawning habitat occurs. Any adults that might be prematurely attracted into the Russian River by the artificially high flows in the lower river during early to mid fall would be exposed to detrimentally high temperatures in the main stem. However, we believe that the incidence of such occurrences will likely be very limited and of minor consequence to the coho population given that 1) CCC coho salmon historically enter rivers, migrate and spawn during December and January after water temperatures have declined, 2) Sandercock (1991) reports that adult coho salmon mill about the mouths of rivers until both water temperatures and flow are suitable for upstream migration, 3) adult coho have not been documented in the lower main stem during six years of continuous video monitoring at the Mirabel Dam, 4) we are unaware of any reported stranded adult coho in the main stem during early to mid fall, and 5) CCC coho salmon runs in the Russian River were relatively robust prior to 1960, yet artificially high flows during fall months have been ongoing in the lower river since completion of Lake Pillsbury in 1922.

Under SCWA's proposed flow management plan, in most years the mouth of the Russian River will be open on most days in September and October. These are months when the river mouth and estuary were probably closed prior to the construction of Lake Pillsbury and Lake Mendocino. The following section describes the effects of flow management on the estuary, including salmonid use of that estuary. However, in addition to those considerations, the artificially elevated flows in the Russian River will continue to provide conditions that promote adult Chinook salmon access to the lower river. As a result, this species will very likely continue to commence its annual run during late summer or early fall, with run peaks sometime in late October or early November. The elevated flows produced by releases at CVD will continue to create substantial amounts of spawning habitat that will contribute to the production of Chinook salmon smolts. SCWA (2005*b*) estimated that during the peak of the downstream run in 2004 (mid April through late May), 90,000 wild Chinook salmon smolts passed the Mirabel rubber dam. Based on trap data, numbers of Chinook smolts were likely comparable or higher in 2002 and 2003 (SCWA 2005*b*). Probably most of these fish originated from adults spawning in the upper main stem Russian River. Under the proposed flow management plan, this level of production will likely continue.

With the proposed flow management plan, the upper main stem Russian River will continue to support some production of juvenile steelhead and Chinook salmon. SCWA (2003) reported observing relatively low numbers of steelhead in the approximately 20.5 mile segment between the mouth of the East Fork and Hopland. They found higher densities of juvenile steelhead in the 13.0 mile "Canyon Reach" between Hopland and Cloverdale. At the time of that study, releases from CVD were usually between 230 and 270 cfs and flows at Hopland were about 165 to 190 cfs. The interagency flow habitat assessment study and water temperature modeling suggest that the quality and quantity of habitat for rearing steelhead is substantially better when releases are in the vicinity of 125 cfs and flow at Hopland is about 90 cfs.[50] Under the proposed flow management plan, steelhead fry that emerge from the gravels of the main stem Russian River will encounter limited suitable habitats in which to rear. As described above for Dry Creek, juvenile steelhead will compete for the limited preferred areas as they grow, with many individuals being displaced to marginal or unsuitable habitats where survival will be much reduced.

The proposed flow management plan will also limit the potential quantity and quality of the upper main stem as critical habitat for young-of-year and yearling steelhead that emigrate out of the river's tributaries in Mendocino County. Small seasonal streams provide spawning habitats for steelhead; however, as surface flows subside and disappear during summer months some fry will be displaced downstream where they must find suitable rearing habitats (Erman and Leidy 1975; Erman and Hawthorne 1976). Perennial tributaries, such as Mill Creek, Sulfur Creek, Forsythe Creek, Ackerman Creek, and McNab Creek also provide limited rearing habitat, and large numbers of juvenile steelhead will likely emigrate downstream in search of suitable habitat. Under the proposed flow management plan for CVD, many juvenile steelhead originating in tributaries of the upper main stem will be displaced downstream into the Russian River over the

[50] The discrepancy in the difference in flow between CVD and Hopland during the two studies is due to the higher total diversion of water from the main stem during the steelhead survey in August and early September 2002. The flow-habitat assessment study was conducted in late September 2001 when agricultural water demands are less.

course of the summer. Survival of these individuals will be low, due to limited availability of suitable rearing habitats in the main stem.

Juvenile Chinook salmon typically migrate towards the ocean within months of their hatching and emergence from the gravel. The peak of the juvenile Chinook salmon out-migration is usually in late April or early May (SCWA 2005*a*), and almost all individuals that successfully make it to the estuary do so by late June. SCWA's proposed flow management operations will probably have only a modest effect on juvenile Chinook salmon during February, March and April because stream flows in the upper main stem during these months are heavily influenced by natural inflow from numerous tributaries. For example, between 1987 (the year D1610 was first implemented) and 2005, the median flow in April 500 ft downstream from CVD (USGS station 11462000) was 207 cfs; whereas median flow in April at Hopland and Healdsburg during those years was 360 and 664 cfs, respectively. The flow management plan will have a greater effect on juvenile Chinook salmon rearing in the main stem during May when releases from CVD largely determine stream flows. For example between 1987 and 2005, the median flow immediately below CVD in May was 191 cfs; whereas median flow at Hopland in May was 230 cfs during this same period of years. Similar to the flow-related impacts to juvenile steelhead, production of juvenile Chinook salmon would likely be higher if flows in the upper main stem were reduced from recent historic levels (*i.e.*, releases of approximately 230 to 275 cfs at CVD) to releases in the vicinity of about 125 to 175 cfs.

However, as discussed for Dry Creek, effects of downstream displacement of juvenile Chinook salmon due to dam operations is less clear given that 1) the species migrates to the marine environment during the first spring thereby avoiding exposure to high summer water temperatures in the lower river, 2) the ESU's Central Coast diversity stratum supports a relatively abundant population, despite ongoing operations at the dam, 3) the rearing PCE for the Central Coast diversity stratum does not appear to be limiting the Russian River population, and 4) for this population, freshwater rearing takes place largely during the late winter and early spring when stream flows are relatively high and largely determined by unregulated inflow from the river's tributaries.

G. Estuary Management

The analysis described below incorporates and supersedes the previous analysis reported in the May 20, 2005, biological opinion on breaching the bar at the mouth of the Russian River. Since that analysis, NMFS has acquired additional information on the frequency of breaching, as well as reports and data on estuarine conditions and salmonids in the Russian River estuary and other estuaries and lagoons in California. In addition, D1610 summer flows, which influence the frequency of SCWA's breaching estuary, are included as part of the proposed project analyzed in this consultation.

Information on the Russian River estuary, including the impacts of breaching on habitat and salmonids, remains limited. Studies of fish species and water quality in the estuary in the early 1990s were conducted in the first 5.5 miles of the estuary. In the late 1990s the same issues were studied in the lower three miles of the estuary (MSC, 1997 through 2000). More recent work (SCWA 2005a, 2006) included observations near the river's mouth and in the seven miles

upstream to Austin Creek. Most recently, SCWA has used acoustic tags to track small numbers of large juvenile steelhead in the estuary (SCWA 2006a). Where data are lacking, NMFS has made reasonable assumptions based on professional knowledge of salmonids and their habitat needs from the scientific literature, and best professional judgment.

NMFS cannot precisely predict the amount and timing of future SCWA breaching actions because surface water elevations in the estuary and storm conditions are variable throughout the winter, spring, and fall months.[51] In order to analyze the impacts of the proposed estuary breaching, NMFS assumes that breaching during the next fifteen years would occur at roughly the same frequency and times as in the recent past. Information on recent breaching indicates breaching actions as proposed by SCWA would typically be conducted mostly in the spring and fall, as shown in Table 27 below.

1. Effects on Habitat, Including Critical Habitat

a. Migration

Breaching changes the amount of time the estuary is open to ocean tides. As described above in the *Environmental Baseline* section, the Corps and SCWA's proposal to continue breaching the Russian River estuary bar as they have in the recent past will result in the estuary being open to ocean tides: 1) earlier in the fall of most years, 2) during nearly all summers, and 3) more often during the spring.

The primary impact on the migration PCE of critical habitat for all three salmonids species will be to increase its availability. Adult salmonids intending to migrate upstream in the late summer or fall are less likely to find their way blocked by a closed bar at the mouth of the Russian River. If breaching did not occur, the high flows in the mainstem during the fall would likely overtop the bar within 2-3 weeks of bar closure, opening the migration route. Similarly, smolts outmigrating in the spring will have more opportunity to enter the open ocean when they arrive in the estuary. Keeping the estuary open in the summer affects the rearing PCE of critical habitat for listed salmonids; this impact will be discussed in *b. Estuarine Rearing* below.

Breaching likely increases the number of pinnipeds in the estuary, but the amount of increase in predation on salmonid adults appears discountable. Harbor seals (*Phoca vitulina)* have been documented foraging in the surf zone outside of the Russian River estuary and inside the estuary (RREITF 1994). RREITF (1994) reports that more harbor seals are in and near the estuary when it is open, based on seal haul-out numbers. Observations during a five-year monitoring period showed that the number of pinnipeds quickly increased once the sandbar was artificially breached. Few, if any, adult salmonid remains have been found in seal scat (Hanson 1993). Most predation is assumed to occur to smolts and juveniles. The amount of predation on smolts and juveniles is described below in subsection VI.G.2, Effects on Species.

[51] In wet years, stream flow to the estuary remains high into June. In dry years, stream flow may recede to D1610 regulated flows by April 1st.

b. Estuarine Rearing

Coastal estuaries of California can have complex water quality dynamics during the extended period of seasonal low flows. In many rivers, the absence of rainfall during summer and early fall generally sets up conditions favoring the formation of highly productive freshwater lagoons. Keeping the estuary open to the ocean tides by breaching will severely restrict the quantity of rearing habitat for salmonid juveniles seeking productive freshwater conditions. A freshwater lens will not be able to persist and a freshwater lagoon will have no chance of forming. This loss of freshwater habitat likely limits the carrying capacity of the estuary for juvenile salmonid rearing. In addition, every time the estuary is breached, it will be cycled through adverse changes in water quality for salmonid rearing. Pinniped predation on salmonids may also increase.

When the sandbar at the mouth of the estuary closes, river flows from upstream accumulate over the remaining denser salt water in the estuary, forming a thick freshwater lens at the surface. Breaching the bar removes this accumulation of freshwater by allowing it to flow to the ocean. Because breaching usually occurs within 10 days[52] of bar closure, newly formed freshwater lenses are unlikely to be more than one to three meters deep before they are lost. Once the freshwater lens is lost, the estuary cannot become a freshwater lagoon. Conversion to freshwater by gradual deepening of the freshwater lens (and the eventual passage of denser salt water through the sand bar to the ocean) appears to require one month or longer in other California streams (Smith 1990). The formation of a perched lagoon is also prevented by breaching. In this process (described above in the *Historical Conditions* section of the ***Environmental Baseline***), freshwater inflow raises the estuary's surface water elevation until the bar is overtopped. Freshwater running out to the ocean over the bar entrains and eventually removes most of the salt water in the lagoon. With the bar intact, ocean tides cannot refill the estuary with salt water.

Without conversion to a freshwater lagoon, food production for young (YOY and parr) juvenile steelhead[53] may be limited. Conversely, Smith (1990) found that the diversity and quantity of salmonid foods were high after closed lagoons converted to freshwater. In addition to euryhaline (tolerant of a wide range of salinities) species of amphipods present under a wide range of estuarine conditions, freshwater insects and other invertebrates also become abundant when lagoons convert to freshwater (Smith 1990). NMFS recognizes that forage base in the vicinity of the estuary is dependent on both water quality dynamics (*e.g.*, salinity, DO, temperature, nutrients) as well as suitable, stable substrates, and that sedimentation of substrates in freshwater lagoons may limit aquatic productivity.

In addition to the potential for reduced food production, salinities in much of the estuary are beyond the tolerable range for smaller age classes of non-smolting juvenile steelhead when the

[52] From 1996 to 2000, the estuary closed 42 times and was breached 40 times within 10 days after it closed. NMFS assumes this timing of breaching actions will continue.

[53] NMFS focuses on juvenile (non-smolting) steelhead habitat in this section because impacts to steelhead habitat are of greater magnitude than impacts to juvenile habitat for coho salmon or Chinook salmon.

estuary is open during the late spring, summer, and fall[54] (as described in the *Status of the Species*). In addition, seasonal cycles of breaching followed by closures contribute to periodic episodes of low DO in the deeper salt water layers that may turn to anoxic or near anoxic conditions. Because the estuary is breached relatively quickly, low DO at depth likely persists until the bar is opened. Whereas if the estuary were managed as a closed or perched lagoon with sufficient inflow, the lower Russian River could form a productive freshwater lagoon with suitable water quality to sustain large numbers of young juvenile steelhead during the summer and fall.

NMFS review of recent SCWA data on water quality in the estuary (SCWA 2004b, and 2005a, 2006a, 2006b, 2008e) indicates that when the estuary is open, the most upstream portion of the estuary near Austin Creek[55] (about 1 mile of the upper estuary) is the only portion where some freshwater habitat is maintained throughout the summer. Salinity in this area remains at zero to a depth of 2 meters and possibly deeper, depending upon tidal fluctuation[56]. The middle portion of the estuary (1 to five miles from the mouth) is most subject to fluctuation in salinities throughout the water column due to ocean tides (SCWA 2004b). Here, salinities are often as high as 30 ppt. Salinities near the mouth (1st mile of the estuary) are mostly similar to ocean salinities (SCWA 2004b, 2008e). Salinities only fluctuate at the surface in the lower portion of the estuary based on tidal action (SCWA 2006a, 2008e). For example, near the mouth, salinities are about 30ppt[57], except near the top of the water column (approximately 1 meter from the surface), where they fluctuate between about 1 ppt and 33 ppt (SCWA 2006a, 2008e).

When the bar is open, DO also fluctuates based on tidal action in the estuary. DO is reported to be approximately 7 -10 ppm in the surface layers, and varies, on average, from 4 to 9 ppm in bottom areas of estuary pools (SCWA 2004b, 2006a, 2008e). Short excursions to 0 ppm or near 0 can occur, mostly in deep pools (SCWA 2006a, 2008e). Similar to salinity above, DO at pools in the vicinity of Austin Creek did not go as low as 4 ppm; instead, DO ranged from 6 to 11 ppm. Near Freezout Creek, about 1 mile downstream from Austin Creek, DO at depth usually ranged from 7 -10 ppm. However, brief excursions to lower than 1 ppm occurred in 2006 (SCWA 2008e). Estuary temperature during bar-open conditions ranged from about 11°C to 15.5^{o}C in late summer and early fall in pools where it was measured during 2003 (SCWA 2004b). During the same time period and conditions in 2005, temperatures in the lower estuary ranged from

[54] NMFS is not further analyzing breaching impacts to rearing habitat during the winter because: 1) breaching in the winter is very limited in frequency, and 2) winter breaching is more likely to mimic natural habitat conditions. Breaching occurs mainly in the spring and fall, although occasionally SCWA has breached the estuary in the summer, and more rarely, in the winter (Table 23). If the estuary does close during the winter, winter storms are likely to reopen the bar before a freshwater lagoon can form.

[55] Recently, SCWA has decided to redefine the extent of the estuary to exclude the mouth of Austin Creek (SCWA 2008a), due to their failure to detect seawater or brackish water in this area. NMFS has chosen to continue to include the area of the Russian River at the mouth of Austin Creek as part of the Russian River estuary in this biological opinion. NMFS does this to include data that show more abundant small age classes of juvenile steelhead in freshwater conditions.

[56] In the estuary breaching opinion (May 20, 2005) NMFS indicated that: "Salinities were <5 ppt throughout the water column in the upstream areas of the estuary". This statement was in error, and should have read "salinities *averaged* less than 5 ppt in the upper 2 miles of the estuary". The data available indicate that although the upper 2 miles average less than 5 ppt, excursions to salinities of about 20 ppt can occur outside of the area immediately adjacent to Austin Creek.

[57] Ocean salinity is 35 ppt.

about 12.5 ^{o}C at the bottom to 20 ^{o}C at the surface (SCWA 2006a, 2006b). In 2006, temperatures during open bar conditions ranged from highs of over 25 ^{o}C for short periods to lows of 16 ^{o}C at the surface (SCWA 2008e), depending on time of year (high temperatures were in late July, low temperatures were in early October). At mid and bottom depths, temperatures ranged from 10 ^{o}C to 18 ^{o}C during roughly the same time periods (SCWA 2008e). Interestingly, the highest surface temperatures appear correlated with the lowest temperatures at depth at many locations.

When the bar at the mouth of the estuary closes, water quality for salmonids quickly degrades. Salinity, DO and temperature changes can begin within 24 hours (SCWA 2006a, 2006b). During these events, tidal action ceases and salinity, DO and temperature can change dramatically. A freshwater lens begins to form at the surface, starting at the mouth and then extending approximately 4 miles upstream. During one bar closure in 2003, salinity at the surface varied from 1 to 5 ppt in the lower four miles of the estuary, and was 0 ppt from 4 to 7 miles upstream of the mouth (SCWA 2004b). Similar values were obtained in 2005 (SCWA 2006). Salinity in the deeper layers of the estuary ranged from 25 to 30 ppt (SCWA 2001a). Recent data (SCWA 2008e) indicates that the estuary may become more saline at depth in upper areas of the estuary (near Freezout Creek) when the bar closes. After sandbar formation, saline bottom waters in estuaries often initially become anoxic because of a lack of mixing (Smith 1990). Based on the salinity and water quality data available, this is likely what occurs in many of the deeper pool areas of the Russian River estuary. When the bar closes, DO concentrations near the surface remain similar to those found when the estuary is open (7 to 10 parts per million (ppm)). In deeper pools, DO typically drops to less than 5 ppm (SCWA 2001a, SCWA 2006a, 2008e). These hyper-saline and low DO conditions limit salmonid juvenile rearing habitat to the upper 1 to 3 meters of the estuary in most cases.

Low DO and hyper-saline conditions that occur in the bottom layers of the estuary when it closes are also likely to initially reduce the availability of food for rearing juvenile salmonids in the estuary. In lagoons north and south of the Russian River, temporary loss of estuarine invertebrates (salmonid food) was documented (or inferred by steelhead growth rates) each time lagoons closed (Corps and SCWA 2004; Cannata 1998; Smith 1990).[58] Reduced steelhead growth has been documented in stratified California coastal lagoons, both north and south of the Russian River (Corps and SCWA 2004; Smith 1990). In the Navarro River, a California coastal lagoon/estuary north of the Russian River, the closure of the sandbar appeared to result in a temporary reduction in steelhead growth and/or caused movement to middle and upper lagoon areas where habitat conditions were better (lower salinity). Although the lagoon did not convert to freshwater, as freshwater accumulated growth rates rebounded and appeared to slightly exceed growth rates prior to lagoon formation (Cannata 1998).

[58] Estuarine invertebrates increased when the lagoons transitioned to fresh water.

Table 27. Breaching of the Russian River Estuary, 1996-2007. Number of times breached by year and month, including breaches by SCWA, natural breaches (denoted by [#]), and breaches conducted by private individuals without a Corps permit, denoted by (#). Data from Corps and SCWA 2004, SCWA 2002-2004, SCWA 2006-2008).

	YEAR											
MONTH	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
January						1						
February												1,[1]
March		1										
April		[1]				2			[1]			3
May		1, [1]			1	3			1			
June		2		1	1		1	[1]				
July	1			1								
August	(2)	1							[1]			
September	1, (1)	2	4	1	1					1		
October	1	1	3	2	2	2	[1]	2	(1)	1	[1]	[1]
November	[1]	1	1	1, [1]	4	[1]	3		(2)	2	[3]	2
December					2		1	1			[1]	[1],1
Totals	7	11	8	7	11	9	6	4	6	4	4	10
SCWA	3	9	8	6	11	8	5	3	1	4	0	7
breached/ open*	6/1/96	6/26/97	6/1/98	7/1/99	6/21/00	6/1/01	6/4/02	6/12/03	8/6/04	6/1/05	6/01/06	6/01/07
Closed	6/29/96	8/9/97	8/26/98	9/17/99	8/28/00	9/25/01	9/30/02	10/8/03	10/10/04	9/16/05	10/23/06	10/22/07
Total days open in summer	28	44	86	78	68	116	118	118	65	107	145	144

*June 1 used if estuary was open in the spring- numbers are meant to reflect the approximate total number of days the estuary was open continuously in the summer

Although temperatures may increase in the summer and late fall when the bar is closed, the temperatures observed remained within tolerable limits for juvenile steelhead[59] during the short closure periods (1-3 weeks) for which data are available. Bar-closed temperatures at depth and at the surface appear to increase in most cases in comparison to temperatures at the same depths and location during bar-open conditions (SCWA 2004b, 2006a, 2008e). Bar-closed water surface temperatures monitored in the estuary by SCWA in 2003 varied between 16.5^{o}C and 18°C (SCWA 2004b). In 2005, surface water temperatures during bar closure varied between 19.4 ^{o}C and 23.9 ^{o}C (SCWA 2006a)[60]. These higher temperatures can be tolerated by steelhead if food supplies are abundant and the highest temperatures are not constant (Spina 2007). For example, although steelhead showed lower growth in 1997 in the Navarro Lagoon when temperatures at the surface and depth exceeded 24°C for 2-3 weeks (Canata 1998), steelhead numbers at the end of the summer in 1997 were roughly equivalent to numbers in 1996 when temperatures were lower.

Whenever the bar is breached, the freshwater surface layer (1 to 3 meters in depth) of the lower four miles of the estuary will run into the ocean as the elevation of the estuary's surface decreases. Breaching typically occurs when the estuary reaches a depth of 7 feet or greater. After breaching, the water surface elevation of the estuary is typically 2 feet. Tidal action returns salinity, DO, and temperature to conditions found in the open estuary.

Multiple breaching events cycle the Russian River estuary through episodes of poor water quality. Multiple breaching is common and is expected to continue through the next fifteen years as part of the proposed project. The estuary is likely to be breached by SCWA twice as often in the fall than the spring. During the years 1996-2007 the estuary was breached by SCWA an average of about two times from January through July and about four times from August through December.

2. Effect on Species

a. Chinook Adult Migrants.

Breaching in the late summer and fall as proposed is likely to benefit some early migrating adult Chinook salmon in the Russian River, although early migrants (August and September) may be more vulnerable to sport fishing. Opening the bar during the late summer and fall allows adult Chinook salmon additional opportunities to access the Russian River, although the estuary is often open to the ocean in August and September, likely due to spring breaching combined with ocean conditions and high summer flows. During October and November, the bar often closes, but high river flows would likely reopen the bar in a few weeks as described above in the ***Environmental Baseline***). Currently, thousands of Chinook salmon enter the Russian river in October and November, when breaching by SCWA is most active[61] (25).

[59] Juvenile coho salmon and Chinook salmon are discussed below.
[60] In 2006, the bar did not close during the hottest months of the year and temperatures were lower (SCWA 2008e).
[61] NMFS doubts that breaching the bar is the only factor responsible for the recent increase in Chinook salmon numbers based on the available data. As reported in the *Environmental Baseline*, the number of Chinook salmon spawners in the Russian River, and the number of Chinook migrating upstream has increased during the monitoring

Early arriving (August - September) adult Chinook salmon may be more susceptible to sport fishing anglers due to the extended period of time that they spend in the river. NMFS staff have observed members of the public hooking and releasing adult Chinook salmon throughout the Russian River, even though recreational angling for this species is prohibited by Federal law (67 FR 1116). Most of these fish are likely those that have entered the system early and are thus more easily targeted by sport anglers because late summer and fall flows are lower and less turbid than flows after winter rains begin. During the months of August and September for the years 2000 to 2005, adult Chinook salmon counts at the Mirabel monitoring site ranged from approximately 15 to over 1,000 adult salmon (SCWA 2006*b*). The number of Chinook salmon that are caught by in-river sport anglers during August and September is not known. However, the Joint Chinook Technical Committee of the Pacific Salmon Commission estimates a 12% mortality of adult Chinook salmon caught in hook-and-release recreational fisheries (CTC 1997).

The number of anglers catching Chinook salmon during late summer and early fall has likely been reduced by recent Sonoma County law enforcement efforts (Press Democrat 2006).

b. Coho Salmon Adult Migrants

Breaching as proposed may harm early coho salmon adult migrants by allowing them access to the Russian River watershed when conditions are poor for tributary migration and spawning. CCC coho salmon are most likely to enter freshwater streams to spawn after fall or winter rain storms breach bars at estuary mouths. The bulk of coho salmon migrants enter rivers in California in November and December (SCWA 2005b). On more northern rivers in California with estuaries that are open to the ocean most or all of the year, SONCC coho salmon may enter in early October[62] (CDFG 2002). Maintaining the Russian River estuary open to the ocean by breaching for the last several decades may have allowed some CCC coho salmon migrants to adopt earlier river entry behavior.

Coho salmon migrants in the Russian River in early fall may arrive before enough flow is available for migration and spawning in certain tributary streams known to presently, or historically, support coho salmon. For example, the mouth of Austin Creek is often dry in the late summer and early fall. The dry condition is likely the result of aggradation of the stream bed at the mouth caused by gravel mining and timber harvest in the Austin Creek watershed (D. Hines, NMFS, personal communication, 2006).

c. Steelhead Adult Migrants.

Early steelhead migrants (October) may experience impacts from the proposed breaching somewhat similar to the impacts NMFS expects for early coho salmon migrants. However, the

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period (the last five years) (SCWA 2005b). Breaching the estuary's bar has occurred at roughly the same frequency as proposed for several decades and cannot be solely responsible for the recent increase in upstream migrants.

[62] Coho salmon are known to enter the Klamath and Eel Rivers in October. In the Klamath, they may begin entering in early September (CDFG 2002).

proportion of early steelhead unable to find spawning areas is likely lower than for coho salmon, as steelhead migrate later in the fall and winter and often spawn in river mainstems. From 2000 to 2004, no more than nine steelhead were counted migrating in the Russian River in October (SCWA 2005b)[63]. These few steelhead would likely be able to spawn in the mainstem and Dry Creek, which contain flows all year. The bulk of steelhead migration and spawning is January to March, when the estuary would naturally be open in most years.

Late steelhead migrants and spawners returning to the ocean may benefit if breaching actions are concurrent with their arrival at the mouth of the Russian River. Steelhead may migrate as late as April in some years (Busby *et al.* 1996). The estuary can close as early as April, as evidenced by SCWA breaching in April or March in four years during 1996-2007. Spring breaching in these years may allow late steelhead migrants, if present, to avoid delay in their spawning run in the Russian River. As above, high summer flows would eventually overtop the bar and provide access. Unlike salmon, a small portion of steelhead can survive spawning. These fish return to the ocean and can spawn in subsequent years. Breaching in March, April, or May could assist these fish in avoiding delay in returning to the ocean[64]. Breaching in these months occurred in five years from 1996-2007.

d. Smolts

Breaching the estuary in the spring and early summer is unlikely to adversely affect salmonid smolts of each species and may benefit them by allowing greater access to the marine environment. Most of the potential benefit would accrue to smolts that are migrating downstream later in the spring (May and June), when breaching is most likely to occur (as shown in Table 27 above). Winter breaching is rare, and when it occurs, is likely to mimic natural environmental conditions to which smolts of all three species of salmonids are adapted. Because Chinook salmon smolts can use estuaries for extended periods of time, NMFS focused the analysis below on them.

Although their ocean-type life history suggests Chinook salmon can use estuaries for extended periods of time to rear (Busby *et al.* 1997), the information available indicates their use of the Russian River estuary is limited (RREITF 1994, SCWA 2001a). To date, the monitoring work done by RREITF during 1992 and 1993, MSC from 1996 to 2000, and SCWA in 2003, 2004, and 2005 shows that only very few juvenile Chinook in the Russian River estuary maintain residency through much of the summer (SCWA 2004a, SCWA 2001a, RREITF 1994, SCWA 2005a). For example, 106 were captured via seining in 2005, with most captures occurring prior to the end of June (SCWA 2006a).

The short residence time for Chinook salmon in the Russian River estuary may be attributed to the size of these juvenile fish upon entering the estuary. According to Healy (1991), in general, Chinook salmon fry remain in the estuarine nursery areas until they are 70 mm fork length, and

[63] No coho salmon were observed in the Mirabel fish ladders during this period. However, the dam is upstream of several tributaries where coho salmon are likely to spawn, such as Austin Creek. These coho would not encounter the dam on their spawning migration.

[64] Steelhead spawning can occur as late as May (Busby 1996).

then disperse into nearby marine areas. Juvenile Chinook salmon passing the Mirabel site in the Russian River (River Mile 21.5) averaged 74 mm by the third week of April, and averaged 105 mm by the last week of June (SCWA 2004a). Nine juvenile Chinook found in early June by RREITF (1994) in the estuary averaged 114 mm in length, which suggests they were of sufficient size to enter the marine environment.

More recent data confirms the large size of Chinook salmon in the estuary, but also suggests that more may rear through part of the summer than indicated by previous studies. About 340 juvenile Chinook salmon were captured in the estuary in 2007 (Fuller 2008b). Nearly all captures occurred between May and July, only 11 Chinook salmon were caught in August. NMFS' inspection of the data indicates that the size of Chinook salmon caught appeared to increase each month (average size roughly 85 mm in May, 91 mm in June, 106mm in July, and 117 mm in August). This may indicate Chinook rearing in the estuary until the end of August, after which no captures occurred.

Breaches in the late winter or early spring may be of more concern due to the smaller size of Chinook salmon juveniles that may be present. These breaches are few, only two occurred prior to April during the twelve year period described above. In the winter and early spring of most years, the estuary would likely be open to the ocean, and downstream Chinook salmon migrants would likely have evolved and adapted to such conditions[65].

The increased numbers of seals as a result of estuary breaching (described above in 1. Effects on Habitat, Including Critical Habitat, a. *Migration*) appears to increase the number of smolts and juvenile salmonids that are eaten by seals, although the overall predation rate remains low. Each time the estuary is breached, pinniped haul-out attendance increases from about 15 to about 95 seals (Mortensen 1996). However, Hanson (1993) reports that juvenile/smolt salmonid remains found in seal scat on the sandbar at the mouth increase in frequency when the mouth is closed.

e. Pre-smolt Juvenile Salmonids

As noted above, the information available indicates breaching actions as proposed by SCWA would typically be conducted mostly in the spring and fall (25). Steelhead juveniles are most likely to be rearing in the estuary for extended periods during this time, and are the main focus below. Some coho salmon juveniles may also attempt to rear in the estuary for long time periods as described above in the *Status of the Species* section, and impacts on these coho salmon are also described below, along with potential impacts to Chinook salmon juveniles. There may be some increased predation on juvenile salmonids by harbor seals; this information is discussed above in *d. Smolts*

Steelhead. SCWA's proposed systematic breaching of the estuarine bar reduces the estuary's carrying capacity for juvenile steelhead. Large numbers of steelhead juveniles (YOY and parr) have been documented moving downstream toward the estuary. However, few juveniles have been found in the lagoon, and those that are found are either large juveniles (half-pounders) that

[65] A sudden breach which caused the surface water layer to quickly leave the estuary is likely similar to high stream flows on outgoing tides. NMFS expects downstream migrants, regardless of size, to be adapted to these conditions which would be similar to winter or spring storms breaching the bar at the mouth of the river.

are more tolerant of brackish and ocean salinities in the lower estuary, or mostly concentrated in the upstream area of the estuary, closer to Austin Creek, where the water has very little to no salt content (See description below). This suggests that few young juveniles moving downstream can survive in the estuary to become smolts or half-pounders. When the estuary is breached repeatedly to keep it open, the few juveniles in the estuary of all age classes likely experience additional degradation of water quality, a reduction in available habitat, and loss of food productivity.

Data from screw traps in the Russian River and Austin Creek show large numbers of juvenile steelhead (YOY and parr) moving downstream. In 2003 and in 2004, approximately 1,200 YOY juvenile steelhead and a few parr were caught in SCWA screw traps in the Russian River just downstream of Mirabel Dam (SCWA 2004a, SCWA 2005b). Trap efficiency for smolts was just below 10 percent. Trap efficiency for YOY and parr was likely higher (these smaller juveniles are more easily captured). Nevertheless, these numbers indicate that thousands of juvenile steelhead move downstream towards the estuary. The screw trap used in lower Austin Creek caught approximately 1,900 YOY or parr in 2005. In 2006, the same trap caught 881 YOY and 386 parr (Katz *et al.* 2006).

Several years of estuarine sampling have failed to document large numbers of YOY or parr rearing in the estuary. MSC studies in 1996, 1997, 1998, 1999, and 2000 captured fewer than 80 juvenile steelhead each year (MSC 1997, 1998, 2000, SCWA 2001a). Most of the juveniles captured were smolts. Recent SCWA studies documented somewhat higher numbers of juveniles in the estuary. In 2005, SCWA captured 438 steelhead (SCWA 2006b). In 2004, the number of steelhead captured was similar, 462 (SCWA 2005*a*). SCWA's sampling effort was greater than MSC's, which likely accounts for the larger number of steelhead captured by SCWA. In both years, the number of steelhead caught dwindled by the end of the summer (SCWA 2006*b*).

Many of the steelhead juveniles found in the estuary are found near tributary mouths, where salinities are low. Seventy six of the 103 steelhead captured in beach seines by MSC were captured near the mouth of Sheephouse or Willow Creek. More recently, in 2004 and 2005, SCWA made approximately 90 percent of their juvenile steelhead captures near the mouths of creeks (SCWA 2005a, 2006b). Most, approximately 400,were captured at the most upstream area of the estuary, near the mouth of Austin Creek where average salinity is zero (SCWA 2005*a*, 2006*b*).

Examination of other estuaries on the California Coast indicated much larger numbers of steelhead in estuaries that close during the summer. The Mattole and Navarro River lagoons, and Pescadero, San Gregorio, and Waddell Creek lagoons all had summer estimates of several thousand or over ten thousand juvenile steelhead[66]. The number of steelhead caught in these

[66] Regardless of the number of seine hauls in each estuary, catch per unit of effort (CPE - a seine pull in this case) was higher in these estuaries. For example, CPE for steelhead in the Russian River estuary was less than 2 in 2005 for all sites except the mouth of Austin Creek, where CPE was about 12 during the late spring and early summer (SCWA 2006*a*, 2006b). In the Navarro River estuary, CPE ranged from about 3.44 to 10.23, with CPE at most sites about 7 (Cannata 1998). Seine mesh sizes in other estuaries were equal or larger than mesh sizes used in the Russian River.

lagoons remained high throughout the summer and fall (Cannata 1998, Zedonis 1992, Smith 1990). Conversely, the Big River and Albion River estuaries do not close during the summer. These estuaries have very limited freshwater juvenile steelhead habitat. NMFS could find no recent juvenile steelhead population estimates for the Albion, Big River, or the Russian River estuaries. This may be because steelhead densities are too low in these estuaries to conduct population estimates via marking and recapture.

There is uncertainty regarding the capture efficiency of seining efforts in the Russian River estuary. SCWA has indicated that seine efficiency in the Russian River estuary is limited due to submerged structures and frequent depths over 3 m (SCWA 2008a). However, the Navarro River estuary is fairly large, has depths over 3 meters, and likely has submerged structures. Seining in the latter estuary captured far more steelhead, and because methods were similar, comparison of capture data from these two estuaries suggests that steelhead numbers in the Russian River estuary are low compared to estuaries that close to tidal influence during the summer or fall. If the Russian River estuary was as productive as closed estuaries on the coast, in NMFS's judgment the catch of steelhead would be much larger than current numbers reported, even in consideration of the potential for improvements to seining methodology.

Moreover, in the Russian River, Big River, and the Albion River estuaries, marine fish species such as surf perch are numerically dominant, reflecting the marine salt water environments of these estuaries during the summers (Maahs and Cannata 1998, SCWA 2006*a*, SONAR 2001). In the Navarro, and other estuaries that close and become lagoons, juvenile steelhead are the most numerous species, or one of the most numerous (Zedonis 1992, Cannata 1998, Smith 1990).

Salinity plays an important role in the distribution or number of juvenile steelhead even when open estuaries support thousands of these fish. Prior to closure of its bar in 1996 and 1997, juvenile steelhead in the Navarro River estuary were distributed by size, with the smallest juveniles (YOY) residing in the most upstream areas of the estuary that are mostly freshwater (Cannata 1998). The Garcia River, which also remains open to the ocean, contains numerous steelhead juveniles in the late spring and early summer. However, as river flows decline and salinity levels in the estuary increase throughout the summer, steelhead numbers in the estuary were observed to plummet while the numbers of some salt water fish species increased (Higgins 1995).

Recent unpublished data (Fuller, 2008b) show small numbers of juvenile steelhead in various areas of the Russian River estuary. Most of the smaller steelhead juveniles captured in 2007 (< 90 mm in fork length) were found in Freezeout Pool, an area about 1 mile downstream of Austin Creek that is often mostly freshwater (SCWA 2004b, 2006a). Larger steelhead (> 150 mm fork length) often congregated in an area Between Patty Rock to Sheephouse Creek according to 2005 and 2006 acoustic tag data (Fuller, 2008a). Salt concentration in this area at the surface fluctuate between near freshwater conditions and ocean salinity, depending on tides and whether or not the estuary is open or closed to the ocean (SCWA 2006a). At mid depths, salinities are similar to seawater unless the estuary closes. Once closed, salinities at mid depths appear to slowly decline during periods of closure. Bottom salinities remained at or near seawater during 2005 water quality sampling, regardless of bar condition (SCWA 2006a).

Repeated late spring through early fall breaching proposed by SCWA is likely to limit rearing opportunities and habitat quality for juveniles in the estuary as described above. NMFS estimates breaching (June through October) by SCWA is likely to occur between two and seven times per year, based on the breaching frequency for the period 1996-2005. The few small juveniles that reside within the estuary downstream of Austin Creek throughout the summer and fall will likely be limited to the upper area of the estuary near Austin Creek and areas near tributary mouths, where salinities are lower.

Steelhead rearing in these areas are likely to be adversely affected by a further decrease in the availability of habitat space and food supply each time the layer of freshwater is reduced during repeated fall breaching. After breaching, salmonid food production is likely disrupted by anoxic and near anoxic conditions at depth in the estuary as described above. These impacts have been found in other estuaries/lagoons. Smith (1990) found that juvenile steelhead growth rates were very good when the Waddell Creek lagoon converts to freshwater, as opposed to greatly reduced fish size during 1986 when the lagoon was breached several times. Juvenile salmonid growth rates in estuaries are usually greater than those in tributaries (Thorpe 1994). Other estuaries on the California coast that close and are not mechanically breached appear to provide increased juvenile steelhead growth during the summer (Cannata 1998, Smith 1990, Zedonis 1992, Bond 2006).

Limited growth rate data for juvenile steelhead in the Russian River estuary suggest that this area may provide good growing conditions for larger juvenile steelhead that are able to utilize the estuary, although growth data are scant. Surveys conducted by MSC in 1998 showed that juvenile steelhead residing in the Russian River estuary had similar growth rates compared to steelhead reared in tributaries (MSC 1999), suggesting that rearing in the breached estuary provided no benefit over rearing in a tributary stream. More recent data indicates that the estuary appears to provide good growth conditions for a small number of large juveniles, age class 2+ to 3+, sometimes termed half-pounders (David Manning, SCWA, personal communication, April 19, 2007). Preliminary information from other recent work shows substantial growth of steelhead (all age classes) in the estuary during 2006 and 2007, although the sample size is relatively small (Fuller, 2008).

NMFS concludes that under the proposed breaching, most of the thousands of YOY and parr steelhead moving downstream toward the estuary will: 1) perish soon after entry into the estuary due to the lack of large areas of productive freshwater rearing habitat or 2) attempt to leave the poor habitat conditions in the estuary and migrate back upstream to reach tributary rearing habitats. However, low quality habitat predominates in much of the Russian River main stem from Cloverdale to Monte Rio during the summers due to high water temperatures as described above in Section **VI.F. *Flow Management.*** In addition, low flows in the tributaries during late spring and summer will greatly limit the availability of habitat for juvenile steelhead seeking refuge from adverse conditions in the lower mainstem and estuary. Juveniles that avoid the estuary after moving downstream will not easily find high quality rearing habitat and are likely to perish or have their survival chances reduced due to poor water quality. Juveniles that reach the estuary are likely to be subject to repeated degradation of water quality and food supply via multiple breachings in the fall and spring. However, a small number of juveniles survive in the Russian River estuary during the summer and fall, and may be growing at substantial rates.

The reduction in estuarine carrying capacity and loss of juvenile steelhead that move downstream to rear in the estuary is likely to impact a large portion of juvenile steelhead in the Russian River. Data from other rivers in California confirm that juvenile migration downstream to rear in lagoons is a normal part of the life history strategy for a substantial amount of steelhead juveniles in watersheds. For example, Shapovalov and Taft (1954) found as many as 38 percent of steelhead juveniles (YOY to 4+) moved downstream to rear in the Waddell Creek lagoon for a year prior to entering the ocean. More recently, Smith (1990) observed thousands of juvenile steelhead rearing in the summer in small freshwater lagoons south of San Francisco. As many as 17,000 juvenile steelhead were estimated to be rearing in the fall in Pescadero Lagoon, with over 2,000 estimated rearing in Waddell Creek lagoon. In the Navarro River, approximately 9,000 steelhead were estimated to be rearing in the lagoon in 1997 (Cannata 1998). In Scott Creek, Bond (2006) found as many as 48 percent of the downstream migrants reared in the estuary before going to sea.

This loss of juvenile steelhead in the Russian River watershed may be magnified due to the importance of estuarine rearing for juvenile steelhead ocean survival. Bond (2006) reports that the extra growth that juveniles obtain rearing in the estuary before heading to the sea as smolts dramatically increased their chances of return to Scott Creek as adult steelhead spawners. Bond's review of data and conclusions from other river systems on the Pacific coast indicates that the size of steelhead entering the ocean is an important factor in their ocean survival. Steelhead smolts smaller than 150 mm generally have a poor chance of ocean survival. Juveniles that reared in the Scott Creek lagoon quickly increased in size by the end of the summer, with most juveniles growing larger than 150 mm. Juvenile smolts heading downstream from Scott Creek were often smaller than 150 mm. These fish did not rear in the estuary. Juveniles that did rear in the estuary comprised between 8 and 48 percent of the juvenile population for Scott Creek. These same juveniles made up 85 percent of the returning adult population (Bond 2006).

Coho salmon. Impacts to coho salmon smolts that may rear in the estuary are likely to be far less severe than impacts to juvenile steelhead. If coho salmon smolts use the Russian River estuary for rearing, residence times are likely shorter than for juvenile steelhead, as described above in the *Status of the Species* section. Shorter residence times would expose these juveniles to the spring breaching, which is more likely to mimic natural high flow breaches from spring rains than the breaching proposed for the fall.

Coho salmon have only recently been observed in the estuary. Estuarine fish surveys done in 1992-1993, 1996-2000, and 2003-2005 failed to detect coho salmon (RREITF 1994, MSC 1996-2000, SCWA 2003, 2004, 2005). This lack of detection could be the result of the very low numbers of coho salmon in the Russian River watershed, and/or that juveniles and smolts have low residency times. The low numbers of coho salmon currently in the Russian River have prompted NMFS, CDFG, and the Corps to cooperatively manage the RRCSCBP, which we have described previously in this opinion (66 FR 23833). Recent work in 2007 detected about 16 Captive Broodstock Program coho salmon in the estuary in the spring (May 14- June 7). These fish were smolting (losing parr marks, becoming silver in color) (Josh Fuller, NMFS, personal communication, 2008).

NMFS believes it likely that very small numbers of YOY coho salmon migrate downstream to the Russian River estuary in the spring and attempt to rear through the summer in some years. As described above in the *Status of the Species* section, YOY coho salmon are known to utilize estuaries for rearing and have been found in other estuaries in California. Small numbers of YOY coho have been observed in migrant traps in the Sheephouse Creek watershed, a stream that drains directly to the Russian River estuary.

In the Russian River estuary, YOY coho salmon would need to find low salinity and low temperature areas to survive. Under current management, when the bar is open, temperatures, salinities, or both, are usually too high for coho salmon to successfully rear. For example, temperatures in the upper estuary can exceed 20 ^{o}C due to the high temperatures of river inflows, and salinities in the lower estuary are nearly equivalent to seawater. When the estuary becomes closed during periods of high river temperatures, estuary temperatures can increase from those seen when the bar is open. If the bar closed in the spring, temperatures in the upper estuary would be significantly cooler and salinity in the lower estuary considerably lower, with both being within the suitable range for coho rearing. How long into the summer rearing period, and to what areal extent a suitable colder temperature regime would remain in the estuary would depend on the strength of temperature stratification of flows (lower flows=stronger stratification), and on the extent of cold tributary and groundwater inflows.

Repeated breaching to keep the estuary open to ocean tides potentially diminishes or perhaps, in some years, eliminates any areas where coho salmon can rear in the estuary. NMFS expects that breaching likely results in the loss of any YOY coho salmon in the estuary due to habitat reduction or elimination. NMFS cannot precisely determine the number of coho salmon that may be lost, but expects it is dependent on brood year success and any particular year's hydrology and summer stream conditions, which could cause any number of coho YOY to either be flushed down to, or migrate to the estuary and attempt to rear. However, we expect the number will be relatively few based on the relatively small number of coho salmon spawning in the watershed.

Chinook salmon. Breaching is unlikely to have much impact on juvenile Chinook salmon when they pass through the estuary during the spring and early summer months, as described above. Based on past breaching history, multiple breachings may occur during the spring (Table 26) but only one or two breaches are likely to occur during the summer months. Monitoring data suggests that few Chinook juveniles reside in the estuary beyond July, and those in the estuary in spring and early summer are likely large enough to survive in the marine environment, which suggests they may be more resilient to the adverse changes in water quality that occur when the estuary is breached and then closes again.

H. Channel Maintenance - Main Stem and Dry Creek

1. Effects on Habitat, Including Critical Habitat, in the Main Stem Russian River

SCWA and the MCRRFCD propose to continue bank protection, including repair or replacement of riprap, gravel bar grading, and vegetation maintenance on the main stem

Russian River. As described in the *Description of the Proposed Action*, SCWA will maintain a 22-mile reach from river mile 41 near the confluence of Maacama Creek upstream along the Russian River to river mile 63 just north of Cloverdale. In addition, SCWA will, if necessary, repair failing banks at Mirabel and Riverfront Park. MCRRFCD will conduct channel maintenance actions in Mendocino County, a 36-mile reach of the main stem Russian River from the county line north of Cloverdale upstream along the river north to the town of Calpella. The MCRRFCD also is responsible for any channel maintenance actions in the East Branch Russian below CVD downstream to the confluence with the Russian River, a one mile reach (B.Spazek, MCRRFCD, personal communication 2007). No more than four maintenance sites are proposed for work in each county during the summer months. A year's work will be limited to no more than 2,000 feet in each county, and total work for the next fifteen years will be limited to 15,000 feet in each county.

Migration habitat in the mainstem appears to be in moderate condition for all three salmonid species, as described above in the *Environmental Baseline* section. Winter flows are usually adequate for passage, and enough pools and other cover exist to allow migrants to rest and hide from predators. Spawning habitat is in generally good or moderate condition for Chinook salmon, while most steelhead spawning habitat is in moderate or poor condition. Coho salmon are not expected to spawn in the mainstem due to their life history preference for spawning in smaller streams. Rearing habitat for all three species varies depending upon location, but is in generally poor condition downstream of Cloverdale due to high water temperatures. In addition, high water levels negatively impact rearing habitat in much of the mainstem.

The SCWA and MCRRFCD have proposed minimization measures as described in the *Project Description*. These minimization measures are likely to lessen the impact of channel maintenance on salmonid habitat. For example, a 25 foot vegetative buffer strip will be left on graded gravel bars to filter sediment and help maintain habitat complexity. However, in some cases, this vegetative strip may be mowed.

Gravel bar grading is expected to reduce channel sinuosity and development of pools at the affected stream sites. Loss of pools and habitat complexity is likely to reduce suitability for migration of salmonid adults and smolts, and habitat availability for juvenile salmonids throughout the year. Juvenile rearing habitat suitability during the summer and winter may be affected through the loss of hydraulic diversity at the various channel maintenance sites (Corps and SCWA 2004). Bar grading at these sites will not be conducted in the wetted channel. However, spawning habitat may be adversely affected when rains and elevated river flows transport fine sediment from disturbed gravel bars (Corps and SCWA 2004). Delivery of fine grained sands is known to decrease spawning habitat quality and have the potential to reduce survival of incubating salmonid eggs.

Vegetation maintenance is proposed to occur at many of the gravel bar grading locations. In addition, vegetation removal is proposed at some sites for bank erosion control along the main stem channel. Corps and SCWA (2004) state that this removal of vegetation in large swaths (250-400 feet wide) along the main stem is likely to have adverse affects to salmonid habitat in the main stem Russian River. As noted in the ***Description of the Proposed Action,*** MCRRFCD will also remove obstacles including LWD that spans the channel. The

combination of gravel bar grading and vegetation maintenance is likely to further reduce the habitat complexity at the channel maintenance sites. The loss of complexity at these sites will make them less suitable for juvenile salmonids during the winter as refuge areas. Changes in the wetted portion of the channel as a response to vegetation and gravel bar grading may reduce the potential for summer rearing by juvenile steelhead, and reduce habitat for Chinook salmon and steelhead as they migrate to and from the ocean.

During any given year, the extent of impacts from channel maintenance will be limited. Corps and SCWA (2004) reports that channel maintenance actions conducted in the past generally occur at sites 10 to 300 feet in length. Given the length of channel maintenance sites in the past and the maximum length that such activities may occur (2,000 ft in each county), the length of river affected by these actions is expected to range between 600 and 4,000 ft each year. Sites that are affected by channel maintenance activities will likely have impairment of habitat conditions for one or more years until stream dynamics restore natural habitat functions to baseline conditions.

Work done by property owners on channel improvement sites covered under Public Law (PL) 84-99 will be included in the total length limits described above by SCWA if SCWA is able to ensure that property owners follow the BMPs described in the BA for this project. As described in the *Project Description* twenty one channel improvement sites associated with the CVD Project exist on the main stem Russian River from river mile 42.2 upstream to RM 61.3. USACE inspections conducted in 2000 report that most of the sites are currently stable and are unlikely to require work in the next fifteen years (Corps and SCWA 2004). Work at PL 84-99 sites may include vegetation removal and installation or repair of riprap. In some cases, a portion of the channel may need to be dewatered to effect the repair. Based on the type of bank protection repairs likely, NMFS anticipates no more than 750 lineal feet of the Russian River will need temporary diversion or dewatering during the next fifteen years to facilitate repairs.

2. Effects to Species in the Main Stem

Information is not available to allow NMFS to precisely determine the numbers of each species that will be adversely affected by channel maintenance activities in the main stem Russian River. However, NMFS has used the lineal extent of habitat affected, the likely habitat changes, the overall quality of habitat in the main stem, and available fish survey data in the Russian River to determine that small numbers of juvenile steelhead will be injured or killed, as described below.

No more than 30,000 lineal feet of the main stem Russian River will be affected by channel maintenance activities in the next fifteen years. No more than 1,000 to 2,000 feet (1-2 bars) will be graded each year in each county[67]. The loss of habitat complexity at the maintenance sites will make the habitat less suitable for adult, smolt, and juvenile Chinook salmon during the winter and spring months, but the extent of the affected sites is limited and is not expected to affect the survival of individual fish as they migrate up or downstream. Enough suitable habitat is expected to be available upstream and downstream of the channel maintenance sites

[67] As described above, each county may work as much as 2,000 feet of mainstem channel per year, but may not exceed 15,000 feet in ten years.

to allow Chinook salmon adults, smolts and juveniles to rest, feed, or find cover as they migrate.

Although there may be an increase in the amount of fine sediments in the channel resulting from transport of fine sediment from disturbed gravel bars during winter storms, this increase is unlikely to affect migrating salmonids or eggs and alevins in the gravel. Analysis done in the Alexander Valley reach of the Russian River indicated fine sediments from gravel mining are limited and minor, with small impacts to eggs or alevins (NMFS 2003b). Because the amount of gravel skimming proposed is smaller than the amount occurring in the Alexander Valley, NMFS expects the impacts to survival chances of eggs or alevins will be minimal.

Loss of habitat complexity at channel maintenance sites has the potential to affect juvenile steelhead rearing during the summer and winter. The limited number of sites affected by maintenance actions is not expected to reach a level that would adversely affect juvenile steelhead rearing during the winter, nor would it likely affect adult and smolt migrations. As above, enough suitable habitat will remain to provide adequate food, rest, and cover in the winter and spring. Reduction in summer habitat suitability in up to 2,000 (and in some years 4,000) feet of stream each year is unlikely to impact large numbers of juvenile steelhead because few juvenile steelhead inhabit the mainstem of the Russian River during the summers, due mainly to high flow releases and high water temperatures, as described above in the *Environmental Baseline and Effects of the Action* sections. Some juvenile steelhead that cannot find suitable habitat in channel maintenance areas due to lack of complexity may find other suitable habitats nearby. Others may be lost to predation as they seek better areas of cover.

NMFS used the steelhead density information in SCWA's Upper Russian River Steelhead Distribution Study (2003) to calculate an average density of juvenile steelhead in the Russian River mainstem from Healdsburg to just upstream of Ukiah (approximately 66 miles). This area matches nearly all of the mainstem affected by channel maintenance activities, and NMFS assumes that steelhead densities from this study provide a rough approximation of the number of steelhead that would be present in any given summer during the next fifteen years under the proposed project[68].

SCWA observed a total of 1,436 steelhead in 11.5 miles of surveyed channel, or 0.07 steelhead per yard. Densities ranged from a high of 0.2 steelhead per yard to as low as 0.03 steelhead per yard. Using 0.07 steelhead per yard, NMFS expects that as many as 50 to 100 juvenile steelhead in the mainstem of the Russian River could perish each year due to the loss of suitable habitats in as much as 2,000 to 4,000 feet of channel (roughly 670 to 1,300 yards) each year from channel maintenance activities. The number of juvenile steelhead lost is likely to be far lower because: 1) some steelhead will be able to find suitable rearing habitats adjacent to those lost to channel maintenance activities, and 2) NMFS does not anticipate that

[68] Steelhead densities at Mirabel and Riverfront Park are anticipated to be similar or lower. For example, 1 juvenile steelhead was captured and relocated when the Healdsburg Dam fish ladder was constructed at Riverfront Park (SCWA 2001b). In the winter, juvenile (non-smolting) steelhead densities are likely to be lower as steelhead head upstream in the fall to find cover from high winter flows.

4,000 feet, or even 2,000 feet of channel maintenance will occur in all project years, based on previous sizes of projects reported.

At PL-84-99 sites, dewatering of worksites may need to occur. NMFS assumes that no more than 750 feet of mainstem channel will need to be dewatered in the next fifteen years as described above. NMFS has used the highest steelhead densities described above to estimate that as many as 50 juvenile steelhead may need to be relocated from this area. As many as 3% of these relocated fish may be injured or killed during relocation efforts, based on the results of similar past projects. Use of the highest densities reported likely over-estimates the number of steelhead that will need to be relocated.

3. Effects to Habitat, Including Critical Habitat, in Dry Creek

As described in the *Project Description*, SCWA, via Corps authorization, maintains 15 federal bank stabilization sites in Dry Creek which have a total lineal extent of approximately one mile. These include: anchored steel jacks, flexible fence training structures, wire mesh and gravel revetments, pervious erosion check dams, rock bank, board fencing, erosion control sills, and concrete weirs. Some of these structures only require inspections while others may require maintenance such as bank repair or structure maintenance/repair.

Repair of these 15 bank stabilization sites can involve heavy equipment working along the banks of Dry Creek. As described in the *Project Description*, excavators or dump trucks may be used to place earth or rock. Bulldozers may be used to change the shape of channel banks. Dewatering of adjacent stream reaches will not occur, and equipment operating from stream banks may conduct activities in flowing water, such as digging toe trenches and placing riprap. Bank stabilization repair activities will occur from June 15 to October 31.

Salmonid habitat, including critical habitat, may be adversely affected due to bank stabilization work in these areas. Vegetative cover over and in the stream is likely to be reduced or eliminated, undercut banks are likely to be eliminated, and parts of mechanical equipment (excavator buckets) will temporarily enter aquatic habitat. These areas, and areas directly downstream, will experience temporary increases in turbidity levels and increases in sedimentation during and after bank stabilization work. Localized changes in channel hydraulics are also likely.

The main effects to migration habitat are limited vegetation removal and maintenance of riprap at some of the bank stabilization sites. Vegetation removal and riprap reduce the amount of vegetative cover available for adult salmonids to use as velocity refuges and to hide from predators during spawning migrations. Removal of undercut banks also reduces the amount of cover and velocity refuge available for migrating adults.

Spawning habitat will experience similar cover loss. In addition, vegetation loss will likely reduce the sediment filtration capacity where vegetation removal occurs. This, combined with ground disturbance in maintenance areas, may cause localized sedimentation of spawning gravels. Increased fine sediments in spawning gravels reduce the quality of the substrate for incubating eggs by decreasing the amount of dissolved oxygen available to them. The barrier

used to prevent downstream turbidity and sedimentation may increase these impacts in localized areas adjacent to the bank repair sites.

Channel maintenance is likely to adversely affect rearing habitat in several ways. Vegetation removal and bank hardening is likely to reduce or eliminate the recruitment of large woody debris (LWD) to Dry Creek. The loss of complexity at these sites is likely to reduce cover from predators and velocity refuges from winter flows, and, over time, is expected to adversely affect winter and summer rearing habitat as bank protection work continues during the next fifteen years. The removal of undercut banks will also eliminate habitat that provides hiding cover and velocity refuges. Instream cover needed by steelhead for velocity refuge and concealment from predators is already limited in the mainstem of Dry creek. Implementation of the proposed project will help to maintain these conditions, and may exacerbate them if cover is removed during maintenance activities. NMFS notes, however, that some of the bank protection methods themselves (jacks, for example) can provide cover and velocity refuge, and may ameliorate the loss of vegetation and undercut banks to some extent at some of the bank protection sites.

Additional sediment entry to Dry Creek is likely to settle in pools, making them shallower, and eliminating aquatic insects that juvenile salmonids feed upon. Additionally, the use of hard-armoring techniques such as riprap can prevent the establishment of a native riparian corridor over the long term. This in turn affects rearing habitat by reducing canopy cover and increasing water temperatures for summer rearing. A reduction in canopy cover is likely to have the largest habitat impact in the lower section of Dry Creek where canopy cover is currently sparse.

Overall, managing the system of bank stabilization sites on Dry Creek is likely to continue to maintain reduced habitat suitability conditions for juvenile salmon and steelhead in portions of Dry Creek. The upper three miles of Dry Creek have a high number of stabilization sites that inhibit the function and development of optimal habitat. The middle and lower reaches of Dry Creek have a lower density of stabilization sites, and therefore, maintenance of these sites is less likely to affect the overall condition of habitat for juvenile salmonids in those stream segments.

4. Effects to Species in Dry Creek

Information is not available to allow NMFS to precisely determine the numbers of each species that will be adversely affected by channel maintenance activities in Dry Creek[69]. NMFS has used the lineal extent of habitat affected (5,800 ft), the likely habitat changes and direct effects, and overall quality of habitat in Dry Creek to determine that small numbers of each species at specific life history stages will be injured or killed, as described below. The actual extent of effects is likely to be smaller, as many sites do not need maintenance on a yearly basis.

Adult Chinook salmon and steelhead will likely be adversely affected if they encounter spawning habitat that has been degraded as described above. For example, they may be lost to predators if pools or cover are degraded. NMFS believes the number of adults adversely affected will be low because: 1) the number and size of bank protection sites in Dry Creek (approximately 1 mile total, 600 feet per year) is limited compared to the 12 miles of known spawning habitat in Dry Creek (SCWA 2004c, SCWA 2007a), and 2) although some aspects of spawning habitats are

[69] For example, there are no recent juvenile density estimates for the mainstem of Dry Creek.

already limited in Dry Creek, the relatively large numbers of Chinook salmon and steelhead that have been observed spawning this stream indicate that much of the mainstem of Dry Creek is suitable for spawning, regardless of the limited amount of instream cover for spawners.

Due to the abundance of Chinook and steelhead spawners in Dry Creek (as noted in the *Environmental Baseline* section), the limited extent of channel maintenance work during the next fifteen years, and the apparent availability of suitable spawning sites throughout Dry Creek, NMFS anticipates roughly no more than 2 Chinook salmon and steelhead adult spawners are likely to be unable to find appropriate cover in Dry Creek for spawning per year due to channel maintenance activities. These fish are likely to be lost to predators before they are able to spawn.

NMFS does not expect that many eggs and alevins of Chinook salmon or steelhead will be adversely affected by work at bank stabilization sites in Dry Creek. The size of bank stabilization sites is limited and females of both species clean gravels prior to spawning. Impacts to steelhead eggs and alevins are not likely because this species spawns in late winter and spring, when high seasonal flows in Dry Creek will help clean fine sediments from spawning gravels. A few Chinook redds may be adversely affected. NMFS expects no more than 2 Chinook redds per year could have the survival of their eggs and alevins reduced. This estimate is probably high because work in any given year may or may not contribute sediment to Dry Creek.

Direct disturbance of flowing water by construction equipment may injure or kill juvenile steelhead at the bank protection sites. Some juveniles at the sites are likely to seek refuge in undercut banks or near other areas that will be disturbed or eliminated by heavy equipment. These fish may be injured or killed during bank protection repair operations. SCWA's placement of barriers to prevent sediment and turbidity downstream of the repair sites may exacerbate injury to juvenile steelhead that remain at the sites by concentrating turbidity in the construction areas.

Juvenile steelhead are likely to be adversely affected by the loss of channel complexity at these sites once construction activities are completed. Juvenile steelhead in the lower section of Dry Creek are more likely to be adversely affected because habitat conditions in this area are less suitable due to more limited sheltering cover and shade. Steelhead attempting to rear in some of these sites are likely to be exposed to higher rates of predation and higher water temperatures that may be injurious.

NMFS believes that the number of juvenile steelhead adversely affected by these activities will be limited, because 1) the sites comprise only a relatively small portion of rearing habitat in Dry Creek, and SCWA will only operate yearly on 10% of the total lineal extent of the sites (roughly 600 feet per year), 2) not all sites or work at sites eliminate rearing habitat, 3) not all juvenile steelhead will remain at sites where work is conducted in flowing water, and 4) few juvenile steelhead are likely to be present in Dry Creek due to the high summer water velocities, as described above. Steelhead juveniles forced to move because of habitat loss from bank stabilization may not be able to find cover from high flows and other resources they need to survive in Dry Creek.

As previously described, juvenile Chinook salmon rear in fresh water for a very brief period, usually two to four months (February through May) before emigrating to the ocean (Corps and SCWA 2004). Some Chinook salmon smolts may still be emigrating from the system in June; however, most of these fish will already have passed downstream into the ocean by the time channel maintenance takes place (Corps and SCWA 2004). Therefore, effects to juvenile Chinook salmon from channel maintenance activities are not likely.

Coho salmon have not been observed in the mainstem of Dry Creek since the 1990s; however, there is little current information on the distribution of salmonids, especially juvenile stages, in Dry Creek. As described above, NMFS expects few coho salmon are present in Dry Creek during the summer due to high stream flows and lack of velocity cover. Impacts to coho salmon due to channel maintenance in Dry Creek would likely be similar to those described for steelhead.

I. Channel Maintenance - Zone 1A Constructed and Natural Waterways

The following section describes the effects of SCWAs channel maintenance activities to the PCE's of habitat, including critical habitat, and salmonids in the Zone 1A tributary area. Similar to the *Environmental Baseline* section on this area, this section is divided into two parts: constructed flood control channels and natural waterways. The first part of this section covers constructed flood control channels found in Santa Rosa Creek and the Rohnert Park-Cotati area. The second part of the section covers natural waterways which include the upper portions of the Santa Rosa Creek and Rohnert Park-Cotati area.

1. Effects to Habitat, including Critical Habitat in Constructed Flood Control Channels

SCWA conducts sediment removal, LWD removal, vegetation maintenance/removal, and bank stabilization activities in Zone 1A constructed flood control channels (Figure 3, Tables 28 and 29). These activities are conducted between June 15 and October 31, when most flood control channels are dry. The frequencies, locations, and magnitudes of these activities vary, as described briefly below.

Sediment removal activities can occur throughout constructed flood control channels in the Zone 1A tributaries, however, sediment removal is conducted primarily in the Rohnert Park-Cotati area. Sediment removal is conducted on an as-needed basis. Some of the constructed flood control channels require annual sediment removal, some require sediment removal approximately every 5 to 10 years, and some have never required sediment removal.

Some creeks may not experience sediment removal during the next fifteen years. One exception to this is Copeland Creek (Rohnert Park-Cotati), where sediment removal occurs fairly frequently, about every one to three years (Table 28). In 1997, 100 percent of this constructed flood control channel was cleaned; however, in 2000, only 17 percent (2000 feet) was cleaned. Santa Rosa Creek, the Laguna de Santa Rosa, and Windsor Creek are also likely to experience sediment removal during the next fifteen years. The frequency of work needed in these channels can change from year to year depending on land-use practices that potentially alter sediment

supply conditions. The other channels in Tables 28 and 29 are unlikely to experience sediment removal during the project time period.

In addition, SCWA will also remove sediment at road crossings (in and adjacent to culverts, for example) and at culvert outfalls. SCWA anticipates no more than three sediment removal actions at road crossings and outfalls annually in constructed flood control channels in the following areas or watersheds: Laguna de Santa Rosa, Santa Rosa Creek, Copeland Creek, and Windsor Creek. As noted in the project description, work will occur in the summers when these channels are dry.

Woody debris removal in flood control channels is very limited due to the flashy nature of these channels; they are able to pass even large trees fairly efficiently. SCWA estimates an average of half a dozen pieces of LWD are removed annually from flood control channels. They are removed from the top of the bank with a winch, cut up and transported away.

The lineal extent of vegetation removal will occur as described in Table 28 and Table 29. There are three different levels of vegetation maintenance/removal in the constructed flood control channels: original design, intermediate and mature. Approximately 75 percent of the vegetation is removed with the original design method, leaving only vegetation near the top of the bankfull channel and vegetation set back from the top of the bank. This type of vegetation maintenance occurs in Paulin, Piner, Santa Rosa, Brush, Crane, Laguna de Santa Rosa Creek, Rinconada, Copeland and Todd Creek. The intermediate and mature methods occur on other channels and do not have much affect on habitat or species because very little vegetation is removed with these methods.

Bank stabilization projects have been infrequent and will likely continue to be infrequent during the next fifteen years. These projects may occur in any constructed flood control channel in the Zone 1A area.

Overall, SCWA's channel maintenance actions, when added to the poor baseline conditions found in the creek reaches classified as "Constructed Flood Control Channels", prevent habitat conditions in these channels from improving. In the portions of these creeks characterized as "Constructed Flood Control Channels" flows have been channelized and much of the banks have been hardened with rock and concrete. Sediment and vegetation would build up in these areas during the next fifteen years without SCWA's proposed maintenance activities, and would provide some improvement to salmonid habitat. However, because channelization and bank hardening has disrupted salmonid habitat forming processes in these areas, habitat conditions would not improve dramatically if SCWA's maintenance activities did not occur.

Table 28. Frequency and extent of sediment and vegetation removal in Zone 1A constructed flood control channels in the Rohnert

Constructed flood control channel name	Total constructed channel length (ft)	% channel worked for sediment	Frequency of Work Sediment	Comments	% stream worked for vegetation	Frequency of work vegetation	Recent steelhead Presence (2006)
Laguna de Santa Rosa	24,200	10%	5-10yrs	Last cleaned in 1992/93	25-50%	annually	X
Coleman	3,300		1-5yrs	Last cleaned in 1997			
Copeland	19,250	17%	1-3yrs	Last cleaned in 2000	25-50%	annually	X
Copeland South Fork	4,000	100%	10-20yrs	Last cleaned 1986/87			
Cotati	1,000	100%	5-10yrs	Not cleaned in last 5yrs			
Crane	800	100%	5-10yrs	Last cleaned in 1991/92			
Five	6,600	100%	5-10yrs	Last cleaned in 2000	25-50%	1-5yrs	
Gossage	7,700	90%	5-10yrs	Last cleaned 1989/98			
Hinebaugh	13,200	25%	1-5yrs	1989/95/99 3 separate reaches of approx. 1,000 feet			
Hunter Lane	6,600	100%	5-10yrs	Last cleaned 2000	<25%	annually	
Spivok	1,600		5-10yrs	Not cleaned in last 5 yrs	<25%	annually	
Washoe	1,600	100%	5-10yrs	Not cleaned in last 5 yrs	<25%	annually	
Wilfred	22,000	100%	5-10yrs	Last cleaned 1989/95			
Starr	2,500	100%	10-20yrs	Last cleaned 1985/86	25-50%	annually	

Park/Cotati area.

a. Migration Habitat

Sediment removal activities may limit migration opportunities for salmonids, especially during low flow winter conditions. Sediment removal eliminates small lateral bars, which in turn, reduces the sinuosity of the channel. This loss of sinuosity creates a laminar flow and reduces the depth of the channel, resulting in fish passage barriers for adult upstream migration in these tributaries during low flow winter conditions. Most steelhead migrate as flows recede after winter storms; however, due to the degraded habitat described above, their migration opportunities during these times will be more limited. Steelhead generally require a minimum depth of about seven inches for upstream migration (Thompson 1972) and many of these streams have less than ½ foot of depth when extended periods of low rainfall occur during the fall and winter (Corps and SCWA 2004). Therefore, sediment removal may exacerbate this problem, limiting migration to periods when flows are higher and depth is adequate for passage. In stream segments where a thalweg is not re-established over the winter, smolt outmigration may be affected in the spring as well. Sediment removal at road crossings may improve migration conditions, depending upon the amount of sediment in the crossing and the impact of the crossing on migration habitat regardless of sediment build-up.

The loss of vegetation along channel banks and in stream channels due to vegetation maintenance, sediment removal, bank stabilization, and LWD removal affects migration habitat by decreasing hiding cover for both adults and juveniles during migration. LWD and vegetation removal also reduces the amount of velocity refuges available for adults during their migration.

b. Spawning Habitat

Sediment removal reduces the potential for spawning areas to develop by simplifying the channel. As above, NMFS notes that 20th Century channelization practices have straightened constructed flood control channels and dramatically reduced the ability of these channels to form spawning habitat. Sediment removal reduces channel complexity and sinuosity, thereby preventing the natural formation of pool/riffle habitat. The downstream end of pools or the head of riffles is the location of most spawning habitat. Without these features, the formation and extent of spawning habitat is compromised. Spawning salmonids also need pools for velocity refuges during high flows.

Vegetation removal, including removal from bank stabilization, will likely result in increased sedimentation in these channels. Vegetation along stream banks traps fine sediments as they are washed toward streams during rainstorms. Removing vegetation along channel banks increases the amount of fine sediments entering stream channels. Increased sedimentation reduces the quality of spawning gravels for incubating eggs by decreasing the amount of dissolved oxygen available to them.

Vegetation and LWD removal affects spawning salmonids by exposing them to predation and disturbance. Overhanging and submerged vegetation provides hiding cover (protection from predators) and disturbance for adult salmonids during the spawning season (Bisson *et al*. 1987 and Bjornn and Reiser 1991). LWD provides velocity refuges needed by adult spawners during

high flows. As described in the baseline, there is already a limited amount of cover such as instream vegetation and LWD in all the flood control channels. In some locations rip-rap is needed to help stabilize the banks. When this occurs vegetation is obstructed from growing in these locations. The use of rip-rap also reduces recruitment of spawning gravel for salmonids (USFWS 2004).

c. Rearing habitat

Sediment removal activities also have the potential to adversely affect rearing habitat for salmonids. Similar to migration and spawning habitat, sediment removal activities can affect rearing habitat by eliminating small lateral bars, and associated in-channel vegetation needed to create the small amounts of sinuosity possible in these channels. This loss of a sinuous, narrow channel and of lateral bars also reduces the formation of pool/riffle habitat. Loss of pool habitat and cover from sediment removal (and LWD removal and vegetation management - see below) is a particular concern for coho salmon critical habitat, because coho salmon juveniles prefer deep, dark pools for rearing.

SCWA intends to reestablish sinuosity in some of the low-flow channels following sediment removal activities. This activity occurred in one section of Copeland Creek. However, unless this is done every time sediment is removed, the effects described above will likely continue at each sediment removal site. In some areas, reestablishing sinuosity will not be possible due to channel constraints from hardened banks and nearby public or private buildings.

The removal of living vegetation and LWD results in a reduction in cover needed by juvenile salmonids for protection from predators as well as a reduction in foraging sites.
Living vegetation and LWD create complex lateral habitats such as backwaters, eddies, and side channels. These areas serve as rearing areas for juvenile fish and provide critical refuge during floods (Gregory *et al.* 1991). LWD also adds to habitat complexity by scouring pools with woody debris for cover. Habitat complexity and cover are already severely lacking in these flood control channels and the removal of living vegetation and LWD only exacerbates this problem. Vegetation removal results in reduced shade, which can increase water temperatures beyond juvenile tolerances. High water temperatures are a particular concern for coho salmon, which have a lower tolerance for high temperatures compared to steelhead. Reduced riparian vegetation has also resulted in numerous sites with decreasing bank stability, which increases the potential for erosion and sedimentation. These sites then contribute fine sediments to the channels which fill in rearing pools, making them shallower.

The reduction of LWD and living vegetation also reduces invertebrates in the channel by limiting their food source or substrate in which they live. Similarly, by disturbing the bed and banks of streams, sediment removal may bury aquatic insects that juvenile salmonids feed on. These aquatic insects are an important component of the diet of juvenile salmonids.

Most of the impacts described above for rearing habitat are most likely to occur in channels where the “original design” method for vegetation maintenance is used, and in those creeks where most sediment removal is likely to occur. SCWA does intend to use bioengineering

techniques whenever feasible, which will reduce the impacts of LWD, sediment and vegetation removal on salmonid habitat.

Herbicide applications on service roads and in channels are unlikely to have adverse effects on salmonid habitat. SCWA will use Aquamaster®, a glyphosate herbicide approved by EPA for aquatic use in channels and on service roads. Agri-Dex®, a surfactant, will be added to the herbicide when road application occurs. NMFS has approved both in the past for channel maintenance and weed control due to their limited impacts on primary constituent elements of listed salmonid critical habitat (NMFS 2003a).

2. Effects on Species From Activities in Constructed Flood Control Channels

Steelhead are likely to be present in the constructed flood control reaches of Laguna de Santa Rosa, Copeland Creek, Brush Creek, Paulin Creek, and Santa Rosa Creek, where they have been observed as recently as 2006 (Chase 2008). Steelhead may also be present in the other channels indicated in Table 2 in the *Description of the Proposed Action*. Chinook adults and smolts have been documented migrating in a portion of Santa Rosa Creek (David Manning, SCWA, personal communication, March 25, 2008). Based on their life history, CC Chinook salmon are not likely to be present in the summer months; they migrate to the ocean by May or June. Therefore, direct impacts on rearing Chinook salmon from the implementation of maintenance activities are of limited concern. The best available information on the distribution and abundance of CCC coho salmon indicate that they are not likely to rear or migrate through the constructed flood control channels of the Zone 1A tributary area, and thus are not likely to be present. Coho salmon have not been observed in the flood control channels since 1994 (when they were observed in Santa Rosa Creek) and then only a few were observed. Coho salmon are thus likely extirpated from these areas and are not considered further in this section.

Specific information on the numbers of Chinook salmon and steelhead present in these creeks is limited or unavailable. NMFS used the limited fish survey information available, the frequency of channel maintenance activities (Tables 28 and 29), the lineal extent of channels affected, and the types of adverse effects to habitat to determine that small numbers of listed salmonids are likely to be adversely affected, as described in the text below.

Salmonids migrating through the creeks listed above may be delayed by the channel conditions resulting from maintenance in constructed flood control channels, and they may experience additional risk of predation. Some steelhead and Chinook adults and smolts may not survive their journeys through these areas. Some adults that do survive may experience reduced spawning success due to the additional energy cost of migrating through degraded habitat. Migrating Chinook salmon may be more affected than steelhead by the impacts to migration habitat described above. Chinook salmon migrate upstream in the Russian River in the late summer and fall when flows and water depth are already low, making passage difficult and leaving Chinook salmon more exposed to predation. The additional loss of channel sinuosity and vegetative cover due to channel maintenance activities are likely to exacerbate these conditions as described above.

NMFS believes only a small portion of the salmonids migrating in these creeks will fail to survive migration through these areas because the barriers to migration created by low flows will be limited in duration based on flow and channel conditions. During other times, flows will be high enough to allow migrating salmonids access to resting and hiding cover at the edges of channel beds (trees, large woody debris, etc.) for listed salmonids to migrate[70]. When flows are low and migration is difficult or delayed, the lack of cover in these areas will expose the fish to predation. These effects are most likely to occur in Copeland Creek, the Laguna de Santa Rosa, and Santa Rosa Creek as a result of the proposed project due to the expected frequency and lineal extent of sediment removal work in these channels in the next fifteen years. Sediment removal is not anticipated to occur in most other constructed flood control channels that contain steelhead, and it will affect only a small portion of habitat one time in the next fifteen years in Windsor Creek. Sediment removal at road crossings may improve migration success through some areas of these channels.

As noted above, suitable spawning sites are likely to be limited in these creeks as the result of both 20th Century channelization and ongoing maintenance activities. Adult steelhead and Chinook salmon are likely to expend energy moving up or downstream to find better spawning habitats. Again, the limited amount of instream and overstream cover from vegetation and LWD in these streams will expose these spawners to predation. If spawning occurs, egg survival is likely to be low due to increased fine sediments in spawning gravels. While spawning sites are improbable in the constructed flood control channels, it is likely that spawners would move upstream to better spawning sites likely present in the natural waterway portions of many of these streams. This is contingent, however, on their ability to migrate successfully to these locations, which is likely to be problematic when winter flows between storms drop to low levels.

Vegetation removal activities are likely to adversely affect juvenile steelhead, particularly when the original design method of vegetation removal occurs (removal of approximately 75% vegetation or more). This type of vegetation maintenance occurs in creeks where steelhead were recently observed: Paulin, Santa Rosa, Brush, Laguna de Santa Rosa, and Copeland creeks. Vegetation removal occurs in each of these creeks annually. The portion of the stream where vegetation is removed can be up to 25 percent of the constructed waterway area, with the exception of Copeland Creek and the Laguna de Santa Rosa where 25 to 50 percent of the designated constructed waterways are subject to vegetation removal. Adverse effects to rearing steelhead juveniles are most likely to occur in these creeks due to the extensive amount of vegetation removed and the associated effects to steelhead habitat (*e.g.*, loss of shade and cover). These activities are likely to result in the injury or death of some juvenile steelhead in some years.

Herbicide application in these channels is unlikely to adversely affect salmonids because SCWA is using glyphosate herbicides and surfactants in diluted amounts. The LC50 for glyphosate is 38 parts per million (ppm) for a 96 hour exposure for rainbow trout and 930 ppm for *Daphnia magna* (water flea) (CADPR 1998), so it would take a very heavy application to cause detectable effects. Two studies of the acute lethality of the surfactant Agri-dex reveal a LC50 range from

[70] See, for example, photo documentation of channel conditions in the constructed flood control portion of Copeland Creek (Entrix 2002).

271 to >1000 ppm (SERA 1997; Smith *et al*. 2004). Even the lower end of this range is highly unlikely to be encountered in a waterbody under any conditions other than a product spill.

NMFS estimates (with concurrence from SCWA 2008f) that sediment removal is likely to occur three times in the Laguna de Santa Rosa, six times in Copeland Creek, once in Windsor Creek, and three times in Santa Rosa Creek in the next fifteen years, based on the frequencies provided in Table 28 and 29. Habitat disturbance from sediment removal will be limited to 2,400 feet in the Laguna de Santa Rosa, 3,270 feet in Copeland Creek, 500 feet in Windsor Creek each time sediment removal activities occur. In Santa Rosa Creek, a total of 4,000 feet of sediment will be removed three times during the next fifteen years. In addition, approximately 500 cubic yards of sediment will be removed annually from the diversion channel near the vortex tube and v-sill at the Spring Lake diversion structure (SCWA 2008b).

Because the constructed flood control channel portions of these creeks provide limited baseline summer rearing habitat for steelhead, few juvenile steelhead are likely to experience direct impacts. For example, in Copeland Creek, juvenile densities ranged from 0.06 steelhead per linear foot of stream to 0.01 steelhead per foot, depending on location and when steelhead were present (Entrix 2002)[71]. Juvenile steelhead will be relocated if they are occupying sediment removal sites (see below). Overall, most of these adverse effects to steelhead juveniles are most likely to occur in Copeland Creek, Santa Rosa Creek, and Laguna de Santa Rosa Creek due to the combined impacts of both sediment and vegetation removal in the constructed flood control channel portions of these creeks.

SCWA's channel maintenance program for the constructed flood control channels in the Zone 1A tributaries contributes to ensuring that degraded habitat conditions are likely to persist for the next fifteen years. However, NMFS notes that these channels run through and around housing developments, and under/along roadways. Without SCWA's channel maintenance activities, it is unlikely habitat conditions, and impacts to listed species, would dramatically improve in the next fifteen years.

While SCWA will make efforts to contain sediment, it is possible that some sediment may enter the channel during channel maintenance activities taking place along stream banks, thereby temporarily increasing the turbidity of the water. Steelhead juveniles are "sight feeders" and excessive turbidity in the water can reduce their ability to feed (Corps and SCWA 2004). Based the limited amount of sediment that may enter stream channels, and the short duration of increased turbidity associated with this action NMFS does not expect adverse effects to steelhead juveniles from activities on dry stream banks.

If channel maintenance activities occur in wetted channels and salmonids are found to be present, SCWA will relocate salmonids from the project reach and install barriers to exclude fish from the area during channel maintenance work. For example, the sediment removal at the Spring Lake Diversion Structure requires dewatering and fish relocation[72]. Nearly all salmonids

[71] NMFS notes that the density of juvenile steelhead in Copeland Creek flood control channel is generally lower that in the mainstem Russian River.

[72] Barriers and fish rescues are unlikely in most of the constructed flood control channels because steelhead have not been found at sediment removal sites (S. White, SCWA, personal communication, 2004).

present are expected to be juvenile steelhead. There is a small chance that Chinook salmon adults or juveniles would be present. It is possible that not all salmonids will be relocated; if so these fish would experience direct injury or mortality from maintenance equipment. Temporary relocation or displacement of salmonids may cause injury or death to salmonids by subjecting them to stress, increased competition, or predation. Based on information from other relocation efforts, NMFS expects injury and mortalities will be limited to 3% of those salmonids that are relocated. The low densities of steelhead in these channels indicate that few, if any, will need relocation.

Overall, direct effects to steelhead (or Chinook salmon) from relocation due to in channel work are likely to be limited to areas where vegetation removal, LWD removal, bank stabilization, and sediment removal occur and disturb aquatic habitat. Most of the in-channel work is sediment removal, and most sediment removal occurs in the Rohnert Park-Cotati area. Few, if any, rearing juvenile Chinook salmon are likely to experience adverse effects because channel maintenance activities will occur in the summer months and early fall when Chinook juveniles have already emigrated to the ocean. Few, if any, Chinook adults are likely to be present. There is a small chance early migrants will enter these creeks in the late summer; however NMFS expects this occurrence to be negligible because of low flows and elevated water temperatures in the creeks during late summer. The direct adverse effects described above are most likely to occur to juvenile steelhead in Copeland Creek, the Laguna de Santa Rosa, Santa Rosa Creek and Windsor Creek due to the higher frequency of sediment removal activities described above. These fish are unlikely to experience direct adverse effects from sediment removal at road crossings or outfalls because this work will be done when stream channels are dry.

Table 29. Frequency and extent of sediment and vegetation removal in Zone 1A constructed flood control channels in the Santa Rosa area.

Constructed flood control channel name	Total constructed channel length (ft)	% channel worked for sediment	Frequency of Work Sediment	Comments	% stream worked for vegetation	Frequency of work vegetation	Steelhead Presence
Brush	12,100		>20 yrs	Self cleaning	<25%	annually	X
Oakmont	6,600		>10 yrs	No sediment removal	<25%	1-5 yrs	X
Paulin	15,400		>20yrs	Self cleaning	<25%	annually	X
Piner	12,000	50%	>10yrs	Last cleaned in 1989			X
Santa Rosa	48,400		>20yrs	Self cleaning	25%	annually	X
Todd	15,400	40%	5-10 yrs	Not cleaned in last 5 yrs	25-50%	annually	
Austin	5000		>20 yrs	Self cleaning	<50%	annually	X
Colgan	19,250	50%	5-10yrs	Last cleaned in 2000		annually	
College	4,400		>20yrs	Self cleaning	25-50%	annually	
Forestview	3,850		>20yrs	Self cleaning	75-100%	annually	
Indian	1,650	100%	>10yrs	Last cleaned in 1999	<25%	annually	
Kawana Springs	2,200	100%	10-20yrs	1988/89	<25%	annually	
Lornadell	1,200	100%	5-10yrs	Last cleaned 1987/88	<25%	1-5 yrs	
Matanzas	2,500	100%	>10yrs	Last cleaned 1988/89			X
Peterson	8,800		>20yrs	Self cleaning	50-75%	annually	X
Roseland	23,000		5-10yrs	Not cleaned in last 5yrs	25-50%	annually	
Russell	3,800	100%	5-10yrs	Last cleaned 1989/97	50-75%	annually	
Sierra	1,600		>20yrs	Hydraulic only/ no sediment removal	<25%	annually	X
Steele	12,000	20%	10-20yrs	Last cleaned in 2003	25-50%	annually	
Wendell	6,100	50%	50-10yrs	Not cleaned in last 5yrs	50-75%	annually	
Windsor	5,000	50%	5-10yrs	Not cleaned in last 5yrs			X

3. Effects to Habitat in Natural Waterways

Migration, spawning, and rearing habitat for steelhead and Chinook salmon is likely to be minimally affected by channel maintenance activities in the natural waterway portions of streams in the Zone 1A area. As described above in ***IV. Description of the Proposed Action***, channel maintenance activities will not occur in natural waterways used by coho salmon. Maintenance does not occur in these sections of the streams as regularly as it does in the constructed flood control channels. However, where such activities are implemented to restore channel hydraulic capacity, the effects to salmonids from vegetation, LWD, and sediment removal activities, as well as from bank stabilization in natural waterways, are similar to those described above for the constructed flood control channels. There are a few minor differences and these are described below.

a. Sediment Removal and Bank Stabilization

Sediment removal and bank stabilization activities have the potential to affect rearing habitat in natural waterways. However, SCWA does not perform routine sediment removal activities in natural waterways. When sediment removal and bank stabilization does occur it is typically conducted at discrete, selected sites. Based on past activities, SCWA estimates that sediment removal activities occur about once every 10 years in natural waterways. This is about the same frequency as sediment removal activities in some of the constructed flood control channels. While the frequency is about the same, the extent or size of sediment removal is limited in natural waterways to small areas associated with downed trees, therefore, effects to steelhead rearing habitat are much more limited during the next fifteen years than in the constructed flood control channels. In addition, guidelines for incorporating bio-engineering, revegetation, and fish habitat elements into bank stabilization work should help reduce impacts from sediment removal and bank stabilization activities in these streams. Sediment removal and bank stabilization will be conducted during the summer and fall months when flow is minimal. If flow is present in the channel, it is diverted by using an earthen coffer dam, pea gravel or by using a clean bypass. If salmonids are likely present, fish relocations will be conducted. Work is performed using backhoes, excavators, and dump trucks. Unlike the flood control channels, access roads may not be available for work needed in natural waterways. NMFS assumes that in some cases access roads will be needed for equipment to enter the channel and remove sediment. The creation of such roads will likely increase the potential for sediment and turbidity to enter channels, as well as removing canopy cover. SCWA will employ upslope sediment control measures such as silt fences which will reduce sediment inputs.

b. Vegetation and Debris Removal

Current vegetation removal practices in natural waterways require retention of a shade canopy over stream channels and underbrush removal. It is estimated that no more than 25 percent of the in-channel vegetation would be removed at any given site. The length of vegetation removed is limited to small projects, usually 300 to 600 feet in length. SCWA anticipates no more than three vegetation removal actions in each natural waterway per year (SCWA 2008b). Vegetation removal in constructed flood control channels is not limited in length and some of the sites have 75 percent or more of the vegetation removed, therefore, compared to the constructed flood

control channels, affects to steelhead habitat due to vegetation removal are expected to be lower in natural waterways. Though individual projects in natural waterways may have limited impacts to habitat, the sum of several projects may have a larger net effect. This is especially true for creeks with important spawning and rearing habitat such as the natural waterway portion of Santa Rosa Creek.

Natural waterways that potentially support summer rearing within or upstream of sites where vegetation and debris removal activities are likely to occur will experience a reduction in rearing habitat quality. Vegetation and debris removal impact the habitat by reducing cover in and along the channel edge, by reducing habitat complexity, by increasing water temperatures, and by decreasing bank stability which increases the potential for erosion and sedimentation. The reduction of vegetation and debris also affects aquatic insects in the channel by limiting their food source or substrate in which they live. These aquatic insects are part of the food chain which support salmonids.

Herbicides may be used in natural waterways, although road spraying will not occur adjacent to these areas. The effects are expected to be negligible for critical habitat as described above for the constructed flood control channels.

4. Effects to Species in Natural Waterways

Information is not available to allow NMFS to precisely determine the numbers of each species that will be adversely affected by channel maintenance activities in Natural Waterways. NMFS has used the lineal extent of habitat affected, the likely frequency of projects, the habitat changes described above, likely direct effects, and overall quality of habitat in Natural Waterways to determine that small numbers of each species at specific life history stages will be injured or killed, as described below.

SCWA's sediment removal activities will only occur one to two times in each natural waterway during the next fifteen years, and that removal activities will affect 50 lineal feet or less of aquatic habitat in each waterway. Vegetation removal activities will be limited to no longer than 600 feet with no more than 25% of the vegetation removed from no more than three sites per year in each natural waterway.

In most of the natural waterways, only steelhead adults and smolts are expected to be present. Chinook adults and smolts have not been documented in any of the tributaries of the Rohnert Park-Cotati area to date, however, they have recently been found in Santa Rosa Creek. Based on their life history, there is only a small chance that Chinook salmon adults or juveniles could be present. Therefore, effects to species in the natural waterways are not as much of a concern for Chinook salmon as it is for steelhead. As noted in the project description, SCWA will not conduct channel maintenance activities in creeks inhabited by coho salmon. Similar to the constructed flood control channels, herbicides used by SCWA in natural waterways are unlikely to adversely affect listed salmonids because the concentrations used are small.

Effects to steelhead and Chinook salmon during all life stages from channel maintenance activities are similar to the effects described above for salmonids in the constructed flood control

channels. However, according to the Corps and SCWA (2004), maintenance activities generally occur in smaller areas than in constructed flood control channels. In addition, the limits to vegetation maintenance and sediment removal activities described above reduce impacts to the habitat and thus to the species. The natural waterways are characterized by fairly good habitat with adequate canopy and instream cover, cooler water temperatures, and adequate foraging sites. Assuming that the frequencies and magnitude of all maintenance activities in natural waterways are low, only low numbers of steelhead, Chinook or coho salmon are likely to be adversely affected by adverse changes to habitat in these streams.

Overall, direct effects to steelhead or Chinook salmon juveniles from in channel work in natural waterways are likely to be limited to areas with increased potential for flooding due to reduced hydraulic capacity. These maintenance activities are expected to be infrequent, as described above, but may adversely affect juvenile steelhead or Chinook salmon due to direct disturbance of aquatic habitat and fish relocation. Adverse affects to juvenile Chinook salmon are probably few since the channel maintenance activities will occur in the summer months and early fall when most Chinook juveniles have already emigrated to the ocean. Migrating salmonids are not likely to be adversely affected due to the small sizes of sediment removal sites and the relative abundance of hiding and resting cover in natural waterways.

The only coho salmon found in Zone 1A were in the Mark West Creek mainstem in 2002. They are not likely to be in other natural waterways in Zone 1A, nor are they likely to inhabit streams above constructed flood control channels in Zone 1A[73]. In Zone 1A, steelhead are known to inhabit many tributaries in the Mark West Creek watershed, including Copeland Creek, Laguna de Santa Rosa, Austin Creek, Brush Creek, Mtanzas Creek, Oakmont Creek, Paulin Creek, Peterson Creek, Piner Creek Rinconada Creek, Santa Rosa Creek, Sierra Park Creek, the Mark West Creek mainstem, and Windsor Creek (Table 1). In creeks where natural waterways maintenance activities disturb aquatic habitat when listed salmonids are present, SCWA will relocate listed salmonids (juvenile steelhead and perhaps Chinook salmon).

NMFS anticipates that nearly all salmonids will be relocated once per year from areas of 50 lineal feet or less in those creek's natural waterways described directly above. Because these waterways contain better habitat conditions than constructed flood control channels, larger numbers of juvenile steelhead will need to be relocated. Nevertheless, because the areas of fish relocation are small compared to the extent of natural channels in these creeks, the juvenile salmonids relocated are likely only a small percentage of the juvenile steelhead rearing in these creeks. Relocation is likely to result in injury or death to three percent of fish transported and released away from sediment removal work sites. A smaller percentage of listed salmonids are likely to remain in the work areas (those that avoid relocation efforts) and die during dewatering and other construction activities.

[73] Coho salmon may inhabit some tributaries of Mark West Creek upstream of the locations where they were found in the Mark West Creek mainstem in 2002. They are unlikely to be found in tributaries of the Laguna de Santa Rosa, or Windsor Creek (due to this creek's high temperatures and poor habitat conditions).

J. Central Sonoma Watershed Project Flood Control Reservoirs

These reservoirs operate passively, *i.e.*, they were constructed to require no operational activity. Maintenance activities at these reservoirs are, in most cases, unlikely to adversely affect salmonid habitat or salmonids. Sediments and vegetation are removed from the reservoirs periodically. Because no flow passes downstream of the reservoirs during these activities, habitat accessible to salmonids downstream is not impacted.

Spring Lake is drained for maintenance work approximately once every 12 years. SCWA does not anticipate draining the lake during the next fifteen years (SCWA 2008b).

K. Urbanization

Continued operation of the Dams to provide water downstream to SCWA diversion facilities will likely facilitate continued growth and development in Sonoma County and Marin County. As described above in the Environmental Baseline, urbanization can adversely affect salmonids and their habitats by increasing: 1) water withdrawal from streams, 2) stormwater runoff frequency and magnitude, 3) sediment, turbidity, and toxic chemicals in streams, 4) loss of riparian habitat, and 5) loss of stream channel complexity.

NMFS does not expect that the growth facilitated by the operation of the proposed project for the next fifteen years will have major impacts on listed salmonids or their critical habitats. Growth has slowed in both counties due to recent economic conditions and both counties have general plans that focus growth to areas already urbanized (Sonoma County 1998, Sonoma County 2005, Marin County 2007). For example, only 5 percent of undeveloped land (84 percent of the county) in Marin County is available for development. Adverse impacts to stream and riparian habitats in the next fifteen years related to growth are expected to be confined to small areas of the Russian River watershed and Marin County.

L. Interrelated and Interdependent Activities

1. Diversion Facilities

Generally, the SCWA proposes to continue to operate and maintain the diversion facilities at Mirabel and Wohler as done in the recent past. These activities have the potential to adversely affect salmonid habitat and salmonids. For example, the diversion will change instream flow patterns and may delay migrating salmonids. The effects that are likely to occur for the fifteen year duration of the proposed project are described below.

a. Effects to Habitat, Including Critical Habitat

Inflation and deflation of the dam decrease the river stage above and below the dam, creating the potential for fish stranding upstream and downstream of the dam. As the dam is deflated, water levels decline upstream of the dam. Flow recession occurs from the dam to approximately 3.2 stream miles upstream. Flow fluctuations due to inflation/deflation occur on average only 3 times per year. When the dam is inflated, it begins to impound water and flow is reduced

downstream. Water spills over the dam until it is about two-thirds inflated, then most of the flow passes through the ladders and associated bypass pipelines. Inflating the dam will also change the water level downstream until stable flows through the ladders and associated bypass pipelines are established.

Before the dam is raised, it is sometimes necessary to remove gravel that has accumulated on top of the dam and in the fish ladders as the result of bed movement during winter. The stream channel is also graded at this time to promote water infiltration to the subsurface water extraction facilities. These activities are likely to remove habitat complexity, increase sediment input to the river, and create conditions that could strand juvenile salmonids. Simplification of habitat through the removal of bar vegetation and larger cobbles is likely to reduce the suitability of juvenile steelhead habitat that could be utilized during the winter to escape high flows. Gravel grading at Mirabel also causes turbidity levels to increase in downstream reaches of the Russian River. During this process, SCWA constructs a berm to separate the river from the grading area. After grading the gravel bar, the berm is removed and turbid water is released downstream into the Russian River. SCWA monitoring of these action found turbidity levels of 37.6 Nephelometric units (NTU) for two hours that subsequently declined to 7.3 NTUs after three and a half hours. Scraping and removal of gravel at the Mirabel Bar is to an elevation below the low-flow water surface. A two percent slope is left to reduce the potential for disconnection of surface water that could cause juvenile stranding.

The infiltration ponds, which are isolated from the Russian River by levees, occasionally flood during storm events. During flooding events salmonids (and potential predators) may be trapped in the ponds as water levels recede. The infiltration ponds at Mirabel are less likely to flood during storm events than the ponds at Wohler. Both sets of ponds are predicted to overtop only during December through March.

Water diversion intakes at Wohler and Mirabel are screened to prevent fish entrainment. However, the screens at Wohler do not meet NMFS screening criteria. The screens at Mirabel only meet NMFS screening criteria for juvenile salmonids, but not fry. The currents created by operation of these diversions are likely to overcome the swimming ability of some salmonid juveniles and fry, with potential for their impingement on the diversion screens.

As described in the ***IV. Description of the Proposed Action***, SCWA will replace the rotary drum fish screens at Mirabel to meet NMFS criteria for screen openings. Replacement will entail temporary diversion of the Russian River around the site using coffer dams. SCWA anticipates it will require 5 to 7 years to design and construct this project element in coordination with NMFS.

We have also considered the effects of the inflatable dam on water quality. The SCWA monitored the DO of the Wohler Pool in 1999 and found that DO levels ranged from 6.7 mg/l to 9.0 mg/l – slightly lower than DO levels at the upstream control site. Initial distress symptoms for salmonids occurred at DO levels of 6.0 mg/l – 7.0 mg/l (Barnhart 1986, Hassler 1987, Bjornn and Reiser 1991). Low dissolved oxygen levels can negatively affect metabolic function, swimming, and overall survival of salmonids. Small temperature increases above natural warming occur in the Wohler Pool impoundment (upstream of the dam). This would be most

critical during summer months. However, summer water temperatures upstream of the impounded area are naturally high, and it is likely that poor rearing conditions may occur in this part of the main stem during the hottest part of the summer, whether Wohler Pool is there or not. Increases in stream temperature are a significant concern for salmon and steelhead, as stream temperature affects their metabolism, behavior, and survival rate (Bjornn and Reiser 1991). Many streams in California are already at or near high temperature thresholds identified in the literature for salmon and steelhead. Artificial structures that exacerbate stream warming can turn good quality habitat into marginal habitat, and turn marginal habitats into poor habitats.

The aquatic habitat at the inflatable dam site does not provide good quality rearing habitat for salmonids, as described in the *Environmental Baseline.* When the dam is inflated, a 3-mile long pond like environment will be created in the Russian River. Pond conditions are likely to diminish the value of this reach as salmonid habitat, by: 1) preventing the establishment of emergent riparian vegetation, 2) reducing the ability of the river to cool at night (in the pond), and 3) improving habitat conditions for known salmonid predators (pikeminnow and smallmouth bass). Pools and riffles will also be inundated with inflation of the dam, further reducing habitat complexity.

The SCWA Diversion Facility uses a variety of chemicals for its water transmission system. Herbicides are used to control vegetation along access roads, anti-corrosion chemicals are used in the facilities piping, and chlorine (0.6 parts per million) is used to disinfect diverted water. Because of SCWA best management practices for chemical storage and use, such as storage of all such chemicals at least 250 feet from water, and de-chlorination prior to discharges, the risk of entry of these chemicals into salmonid habitat during normal operations is negligible. Accidental spills do have the potential to introduce chlorinated water to streams in the watershed. SCWA has added de-chlorination baskets and alerts to each of 17 valves that could result in a spill of chlorinated water via valve failure. In addition, chlorine storage buildings are equipped with leak detection alarm systems that alert SCWA's operation and maintenance center.

b. Effects to Species

Salmonids may become stranded when inflation and deflation of the inflatable dam change river stage levels at the site as described above. The rate of change in the river stage in these areas depends on the rate the dam is raised or lowered. Rapid changes can dewater habitat occupied by juvenile and adult salmonids. Mortality may result if fish become desiccated or suffocate when trapped in isolated pools. Trapped fish may be at a higher risk from predation. Vulnerability to stranding appears to be size dependant, with juvenile salmonids more vulnerable to stranding than adults.

Although salmonid stranding during dam inflation and deflation has not been documented, SCWA staff noted stranding of warmwater fish species in 2003. NMFS concludes that stranding of salmonids is possible, especially when the dam is inflated or deflated in the late spring when YOY steelhead juveniles are present. However, based on the information available (and described below), NMFS expects few juvenile steelhead would be adversely affected, no more than five. Chinook salmon juveniles are likely to be larger, better swimmers capable of avoiding dewatered areas. Similarly, coho salmon smolts (if any are present) are unlikely to be impacted.

Gravel bar grading will continue at a two percent slope to reduce the potential for disconnection of surface water that could cause juvenile stranding. In addition, SCWA proposes to relocate juvenile steelhead to avoid stranding them in areas that may become disconnected from main channel flows. Although no fish were captured during fish relocation activities in 1999, low numbers of steelhead have been found in this reach of the Russian River by boat electrofishing surveys (Corps and SCWA 2004). For example, five steelhead were found in the area inundated by the Wohler Pool in 2003 (SCWA 2004a). Densities of juvenile steelhead are likely limited in this reach during summer months because of high summer temperatures. We estimate that, based on similar relocation activities reviewed by NMFS, approximately 3% of juvenile steelhead present at the site are likely to be injured or killed during relocation efforts.

Increased turbidity caused by gravel grading at the diversion sites is not expected to reach a level or duration that will adversely affect juvenile steelhead because of the short duration (three to four hours) and low levels of turbidity associated with this activity. Short duration exposure of turbidity levels caused by channel maintenance actions is likely to reduce feeding, or habitat preference for a short period of time with juvenile fish resuming normal behavior and preferred habitat within a few hours. Decreased habitat complexity caused by grading may prevent some juvenile steelhead from finding suitable rearing areas near the dam site.

Flood flows that overtop the infiltration ponds are likely to trap salmonids in the ponds when flows recede. SCWA has captured Chinook salmon from the Mirabel infiltration ponds, and both Chinook salmon and steelhead from the Wohler infiltration ponds. As floodwaters recede, fish stranded in these ponds will perish without intervention. After each flooding event, the SCWA rescues fish from drying portions of the ponds using standard fish capture techniques. Those fish are then transported and released in the Russian River. Based on the reported number of Chinook salmon and steelhead rescued from Mirabel ponds and the relative number of Chinook salmon spawning in the mainstem above Mirabel (Corps and SCWA 2004), NMFS anticipates no more than 150 juvenile Chinook salmon will need to be rescued and relocated per year. Similarly, NMFS anticipates no more than 150 juvenile steelhead and 5 adult steelhead will need to be rescued and relocated per year. Fish relocation activities pose a risk of injury or mortality to rearing juvenile salmonids. Any fish collecting gear, whether passive (Hubert 1983, Hubert 1996) or active (Hayes 1983, Hayes *et al.* 1996) has some associated risk to fish, including stress, disease transmission, injury, or death. As described above, we estimate that only 3% of relocated fish are likely to be injured or killed during relocation.

Both fry and juvenile salmonids may become impinged on the fish screens at Wohler; whereas because of better screening only fry may become impinged at Mirabel. Fish held on screens by diversion flows are likely to be injured or killed depending on the strength of the flow through the screens. The most common injury is scale loss, which can put fish at risk for disease. Higher flows can cause greater body injury or mortality. Screw traps downstream of Mirabel have documented steelhead juveniles in the area during spring. NMFS cannot accurately estimate the number of steelhead juveniles that could become impinged, but expects the number will be relatively small compared to the size of the juvenile steelhead population migrating downstream. The flow into the diversions is limited and is likely to only attract juvenile steelhead swimming downstream along the bank where the diversions are located. Juveniles swimming in the main

current and near the opposite bank are unlikely to be adversely affected. Impingement is likely to occur for the next fifteen years at Wohler, and occur for the next five to seven years at Mirabel, until these fish screens are replaced.

Although most project details are not available for replacing the drum fish screens at Mirabel to avoid entrainment of steelhead fry, the information available indicates that diversion of the Russian River will be needed. Diversion to dewater the work area is likely to strand any juvenile salmonids present. Based on the project's timing, NMFS expects only juvenile steelhead are likely to be present. Fish survey information from this area of the Russian River indicates juvenile steelhead densities are low. NMFS assumes SCWA will relocate any juvenile steelhead present in the dewatered area. Based on juvenile density information for this area, NMFS expects fewer than five juvenile steelhead will need to be relocated.

Adults delayed by the inflatable dam are not expected to be harmed or prevented from spawning. Since adult steelhead migrate later than either coho salmon or Chinook salmon and the dam will be deflated during most or all of the steelhead run, there should be minimal delay of steelhead. SCWA has concluded that when the ladders are functioning, adult salmonids can locate and pass the fish ladders successfully (Corps and SCWA 2004). The creation of a notch in the dam's crest is likely to reduce delays of smolts that encounter the 3.2 mile long impoundment created by the dam. Analysis of fish passage in the Columbia River found that juvenile salmonids are attracted to surface-oriented spillways for passage (Christensen and Wielick 1995). SCWA has tested this approach at the inflatable dam and has found it effective in reducing smolt delay by about half Median delay is now about 2.4 hours, mean delay is 12.8 hours (Manning *et al.* 2005). Although delay is reduced with the notch, any delay may expose salmonid smolts to increased rates of predation. Yet, the precise amount of additional predation cannot be determined based on available information. NMFS does not expect that increase in predation of juvenile and smolting salmonids is having a large impact on salmonid numbers because the delay is short

Salmonid smolts may experience higher rates of predation in this area in the spring when the dam is inflated if salmonid predators congregate in the pool or just downstream of flow over the notched dam. NMFS assumes that the overall impact of this predation on Chinook is limited due to the relatively large run documented in the Russian River. The overall impact on steelhead may be similar. NMFS is concerned that predation rates on coho salmon smolts in this area may be high. However, coho salmon smolt numbers are likely low and predators may be targeting more abundant prey (Chinook salmon and steelhead)

The dissolved oxygen levels found in the impoundment are within acceptable ranges for salmonids. The small temperature increases documented in the Wohler pool in summers may put any juvenile steelhead in this area under increased physiological stress. However, summer water temperatures in this segment of the Russian River are naturally high and are unsuitable for extended residence by steelhead, with or without the pool.

Inundation of three miles of the main stem by the Wohler pool may further reduce rearing opportunities in this area of the main stem, increasing the chance that some juvenile steelhead may not survive their attempts to rear in this area. Based on the small amount of juvenile steelhead likely to be present, NMFS expects few juvenile steelhead will be adversely affected.

2. Wastewater Treatment

Project operations for purposes of water supply result in the diversion of approximately 65,000 acre-feet of water from the Russian River (Corps and SCWA 2004). A substantial portion of this water supply is consumed, eliminated as waste, treated as wastewater, and ultimately discharged back into the Russian River watershed or San Pablo Bay as treated effluent. Corps and SCWA (2004) state that eleven wastewater treatment plants (WWTPs) serve SCWA's primary and secondary water contractors, including contractors who divert water under SCWA's water rights. NMFS has reviewed the project BA's analysis (see Section 7.2 in Corps and SCWA 2004) of the effects of these WWTPs on listed salmonids in the Russian River watershed and in streams entering San Pablo Bay, and we agree that the expected risk to salmonids due to operations at these facilities is generally low.

Members of the Subregional Reclamation System (an association that does not include SCWA) are working to resolve existing water quality issues related to discharges from the SRSWRS to the Laguna de Santa Rosa. Their current options are to either improve the quality of treated effluent or move the point of discharge. The movement of the point of discharge will likely require future federal consultation with NMFS concerning the effects to federally listed salmonids.

a. Impacts to Habitat, including Critical Habitat

Wastewater discharges are controlled and scheduled under the established policies of the Water Quality Control Plan for the North Coast (NCRWQCB 1993). Water treated to the secondary level or better (as described in the *Environmental Baseline*) is discharged back into Jones Creek, Dutch Bill Creek, Mark West Creek, and the Laguna de Santa Rosa tributaries of the Russian River. While discharge schedules vary between treatment facilities, the WWTP generally limit their discharges to months with relatively high seasonal flows. None of the facilities discharge to tributaries of the Russian River between May 15 and October 1; some commence discharges beginning in November, some end discharges April 30. Under the permits filed with NCRWQCB, the identified treatment plants can only discharge at 1% of the current flow rate, with the exception of the Santa Rosa Subregional Wastewater Reclamation System (SRSWRS), which has a discharge allowance of 5% of ambient flow.

NMFS is not aware of contaminant issues associated with any of the WWTP discharges, with the exception of the SRSWRS. This latter facility is known to exceed standards for nutrient concentrations, which can cause low DO concentrations and algal blooms that can adversely affect stream pH in the Laguna de Santa Rosa. This stream is also listed under Section 303(d) of the Clean Water Act for having high levels of ammonium and low DO due to non-point source nutrient inputs from agriculture. Discharges that contribute to diminishing concentrations of DO in the Laguna de Santa Rosa potentially diminish the value of this stream as a migratory corridor for steelhead.

b. Effects to Species

Migratory impacts to steelhead would most likely occur during years in which stream flows are relatively low during April and May when steelhead smolts and presmolts emigrate from tributaries of the Laguna de Santa Rosa towards the ocean. Steelhead smolts and juveniles that are prevented from migration during low flow years may be forced to reside in unsuitable habitat in upstream areas of the Laguna. Upstream migration to cooler tributary areas may be possible for some juvenile steelhead, but those that do not migrate upstream may not survive due to low DO or lethal temperatures conditions during the summer months.

VII. CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

NMFS staff maintain regular contacts with local state agency staff, local governments and private individuals and organizations within the action area. For example, NMFS staff have been meeting with private property owners to develop habitat improvement plans for some areas of the Russian River watershed. These projects will likely require separate section 7 consultation. NMFS has also tracked local issues such as proposed local riparian regulations in Sonoma County. Based on this information and these resources, NMFS does not believe, other than the impacts of ongoing actions such as agriculture, forestry, and urbanization that have been described and analyzed in the *Environmental Baseline*, additional cumulative effects are reasonably certain to occur in the action area during the next fifteen years. NMFS expects the impacts of the ongoing actions during the next fifteen years to be similar to the present day impacts on listed salmonids and PCEs of critical habitat identified in the *Environmental Baseline*.

VIII. INTEGRATION AND SYNTHESIS OF EFFECTS

In this biological opinion, we analyzed the effects to threatened and endangered salmonid species and critical habitat of 1) ongoing operations and maintenance of the flood control and water supply projects at CVD and WSD, 2) operations associated with the Corps' Don Claussen Fish Hatchery facility at WSD and the CVD fish rearing facility and associated angling for those hatchery fish, 3) stream channel maintenance activities in the Russian River, Dry Creek, and a group of streams (Zone 1A) in the vicinity of Santa Rosa and Rohnert Park, 4) maintenance of water levels in the Russian River estuary for the prevention of flooding, 5) operation of the hydroelectric facilities at WSD and CVD, and 6) other actions that are interrelated and/or interdependent with the above actions. The Action Area for this project includes the East Branch and main stem Russian River downstream from CVD to the Pacific Ocean, the 14.1 mile section of Dry Creek below WSD, the Zone 1A streams affected by channel maintenance activities, and other streams that both support Federally listed salmonids and are affected by physical maintenance of SCWA's water transmission system (*e.g.*, pipelines). In analyzing the impacts of the hatcheries, it was necessary for us to consider the effects on all streams accessible by steelhead in the Russian River watershed, because of the potential effects of straying hatchery fish. Our analysis concerns the effects of continued operations of the project in a manner similar to recent historic practices for an additional fifteen year period.

Our assessment has considered the effects of the project on three species known to reside in the project area: CCC steelhead, CCC coho salmon, and CC Chinook salmon and their critical habitats. For each species and their critical habitat, it is necessary to analyze the impacts of the project in the context of the environmental baseline. This baseline is the environmental conditions that have resulted from past, current and ongoing actions that significantly altered the quality and quantity of the species' habitat. Thus, we must evaluate the project's impacts on the survival and recovery of the species by adding the effects of the project to the existing baseline condition of the species and their habitats. Because salmonid species require distinct freshwater habitats at different life stages, we have considered potential project effects to each of the major life stages occurring in the riverine environment: adult migrations, adult spawning, egg incubation, fry stages, juvenile rearing, and juvenile outmigration to the ocean.

The effects analysis considered the effects of the proposed action on the species' habitats, including critical habitat, and individual fish and fish populations in the action area. Here, we assess the impact of these effects on the function and role of of critical habitat and the survival and recovery of listed species at the ESU and DPS scale. In evaluating the effect of the project on the function and role of critical habitat, we identified four primary constituent elements (PCEs) of designated critical habitat for the three listed salmonid species. These PCEs are freshwater migration corridors, freshwater spawning habitat, freshwater rearing habitat, and estuarine rearing habitat. Where appropriate, we have differentiated adult migration and smolt migration to better describe anticipated effects of project operations on the freshwater migration PCE. Analysis of impacts to listed species was done primarily by evaluating how project effects on habitat would likely affect the survivorship of each life stage in the species life cycle and the effect of these changes to sub-populations, the Russian River basin in total, and each salmon species' ESU and the CCC steelhead DPS. We considered changes in abundance, population growth rate, spatial distribution, and genetic and ecological diversity.

Below, we first examine whether, with implementation of the proposed action, critical habitat would remain functional to serve the intended conservation role of the species (or retain the current ability for the primary PCE's to be functionally established), and then we address the effects of the proposed action on the likelihood of the survival and recovery of listed species.

A. Critical Habitat

The proposed project will adversely affect designated critical habitat as the result of flow management at WSD and CVD, stream channel maintenance activities, and water level management in the river's estuary. The following assessment first examines the effects and implications of proposed flow management actions on critical habitat for each species. We then discuss the effects of estuarine water level management and the implications of channel maintenance activities on critical habitat for each species. We also consider the effects to critical habitat of the hydroelectric project operations and water diversions by SCWA. After discussing the effects of these distinct project activities on critical habitat, we consider the significance of the combined effects of these activities, baseline conditions, and cumulative effects on the function and role of critical habitats for the three listed species.

1. Flow Management Effects on Critical Habitat

We have found that the amount and quality of critical habitat in the main stem Russian River and Dry Creek is highly dependent on the levels of flow released from CVD and WSD. Proposed flood protection and water supply management operations enhance some PCEs, but others are substantially degraded.

The adverse impacts of the project's proposed flow management plan on critical habitat are partly due to SCWA's requirement to maintain the minimum flows stipulated in D1610. This state mandate requires SCWA to manage releases at CVD so that except during dry water years, 185 cfs is maintained at Healdsburg between April 1 and August 31 and 150 cfs is maintained from September 1 through December 31. Given the extensive water demands and diversions along the 65 river miles between CVD and Healdsburg, SCWA needs to release about 250 to 300 cfs from CVD to achieve the 185 cfs minimum requirement at Healdsburg. Likewise, D1610's minimum flow requirement of 125 cfs at Guerneville during summer, except for dry years, causes artificially elevated inflow to the Russian River estuary that causes the need for periodic breaching of the sandbar at the rivers mouth. That breaching results in impacts to estuarine dynamics and the loss of freshwater lagoon habitats important for rearing steelhead. The minimum flows required under D1610 hamper efforts to recover CCC steelhead and CCC coho salmon. With respect to Dry Creek, the D1610 minimum flow requirement of 80 cfs is at a level that creates extensive high current velocities that limits the availability of rearing habitat for coho salmon and steelhead. These flows hamper efforts to recover these species. However, unlike the main stem, flow releases from WSD are determined by both the requirements of D1610 and water demand that often exceeds D1610's 80 cfs minimum requirement for summer months.

a. Chinook salmon

We conclude that the management of flows released from CVD and WSD has substantially affected PCEs of critical habitat for Chinook salmon. However, those effects are either largely beneficial or of minor adverse consequence to the current condition of these PCEs. Elevated flows during September and October appear to increase the quality of migration corridors for Chinook salmon in both the Russian River main stem and Dry Creek. SCWA's adherence to D1610 flow requirements for November and early December ensure that stream depths and current velocities support the formation of ample suitable habitat for the spawning and egg incubation of Chinook salmon. During winter, flow management is likely not problematic for Chinook salmon because flood operations help to reduce deleteriously high flows associated with storm events. Winter stream flows in the main stem and Dry Creek are also largely dependent on inflow from unregulated tributaries. Flood operations in response to major runoff events result in releases as high as 5,500 cfs at WSD and 4,000 cfs at CVD, with resulting scouring of substrates in potential Chinook salmon spawning habitats in the approximately three mile segment immediately downstream of WSD and in the five mile segment of the upper main stem Russian River below CVD. However, during times of potential flooding, the Corps' operations actually limit the magnitude of high flows, especially at sites below the confluence of major tributaries such as below Pena Creek on Dry Creek and below the confluence of the Russian River mainstem and the East Branch. Reduction of flows during potential flood events appears to mitigate the adverse affects of high flows on Chinook salmon spawning substrates, and it likely helps to mitigate the erosion of stream banks thereby limiting impacts to both spawning and rearing habitats. Although most flood peaks are reduced by CVD and WSD, existing and proposed flood releases will contribute to channel forming flows at a frequency that maintains geomorphic conditions in downstream reaches. These channel forming flows are periodically needed to transport sediment, and flush fine sediment from spawning areas. Flow releases during late fall and winter should provide relatively good quality habitat for incubating Chinook salmon eggs, although in some years flood operations between November and late February will likely destroy a small number of incubating Chinook salmon eggs or alevins when high flow releases scour gravel substrates in the upper main stem Russian River below CVD and in the three mile segment immediately downstream from WSD. The management of flows at WSD and CVD during spring will likely provide only limited amounts of rearing habitat for juvenile Chinook salmon in Dry Creek and the Ukiah Valley segment of the Russian River, because the project's artificially high flows create widespread high current velocities that exceed the tolerance of rearing juveniles. However, the significance of this effect of flow management on rearing Chinook salmon is unclear because this population migrates to the marine environment during their first spring when stream flows are naturally high and largely determined by unregulated inflow from the river's tributaries and because the rearing PCE for the Central Coastal diversity stratum does not appear to be limiting the Russian River population of CC Chinook salmon.

b. Steelhead

We find that flow management of Lake Mendocino and Lake Sonoma primarily affects CCC steelhead critical habitat by limiting the value of the PCEs of freshwater and estuarine rearing habitats. The project's flow management has little adverse affect on the adult migration corridor

and spawning site PCEs, because this species migrates and spawns during winter and early spring when flows in the main stem and Dry Creek are generally high and largely dependent on inflow from unregulated tributaries. The project's flood management operations during winter months generally help to reduce deleteriously high flows associated with storm events that contribute to redd scour, fish stranding on banks and flood plains, and downstream displacement of fishes. We conclude that flows during winter and spring are conducive to successful steelhead spawning and egg incubation. Eggs of steelhead that successfully spawn in the gravels of the main stem or Dry Creek are likely to successfully hatch in areas where gravels are not embedded with excessive fines due to sedimentation.

In contrast to the limited effects on habitat for migratory and spawning stages, the project's proposed flow management at WSD and CVD during late spring, summer and fall has a clear effect on the availability of rearing habitat for steelhead in the 14.1 mile segment of Dry Creek, in the 34 miles of the upper Russian River immediately below CVD, and in the river's estuary. Although dam construction, channel maintenance, and land use activities have all affected the natural morphology and habitat conditions in Dry Creek, the magnitude of flow releases from WSD has the greatest influence on the ultimate value of Dry Creek as critical habitat for rearing steelhead and the extent to which Dry Creek is able to support production of that species. Existing data for Dry Creek suggest that the proposed sustained summer flows of about 100 to 150 cfs create widespread high current velocities that exceed tolerances of rearing juvenile steelhead. The relationship between stream flow in Dry Creek and available rearing habitat for steelhead is generally inversely related between flows of about 50 cfs and 175 cfs, with decreasing quantity and quality of habitat as flow increases. Consequently, under the proposed flow operations, only a very small portion of Dry Creek will be optimal quality rearing habitat for steelhead, much of the creek will not be functional rearing habitat. Likewise, proposed operations at CVD during seasonal low flows substantially affect the amount of critical habitat for rearing steelhead in the upper Russian River. As in Dry Creek, habitat-discharge relations in the upper mainstem are inversely related. Despite the fact that summer water temperatures are suitable for steelhead in 34 miles of the upper Russian River, at current and proposed flow levels of more than 250 cfs at Ukiah, the amount and quality of steelhead rearing habitat is very limited in this segment during the low flow season of normal water years. In diminishing the quality and quantity of existing steelhead rearing habitat in approximately 14 miles of Dry Creek and 34 miles in the upper Russian River, the project will appreciably reduce the ability of the critical habitat PCE for juvenile rearing in these areas to be functional and serve the intended conservation role for this species. As discussed later, the significance of this becomes apparent when the overall status of critical habitat for this species in the Russian River and the DPS is considered.

Because of the complex relationship between flow management and estuarine water level management, we discuss the effects of project flows on estuarine rearing habitat separately in Section VIII.A.2, below.

c. *Coho salmon*

We find that the proposed flow management at CVD will probably have little adverse effect on coho salmon critical habitat because of the timing of this species' migrations and the distribution

of juvenile coho salmon habitat. This species primarily migrates and spawns during early winter (December and January) when flows in the main stem are generally high and largely dependent on inflow from unregulated tributaries. Therefore, proposed flow management at CVD will probably have little influence on conditions (*e.g.*, stream depths and velocities) for upstream passage of adult coho salmon during their winter migrations. We also find that proposed operations at CVD will have little influence on the PCE of spawning critical habitat for CCC coho salmon, given that the Russian River population of this species typically spawns in Russian River tributaries. Similar to Chinook salmon and steelhead, any coho that may spawn in the main stem will likely encounter flow levels conducive to spawning and successful egg incubation, except in areas immediately below CVD during flood control operations (see Chinook salmon discussion above). Regulation of flow from Lake Mendocino during spring months will provide suitable conditions for the out-migration of coho salmon smolts. Flow releases from Lake Mendocino during summer and early fall will likely have minimal effects on PCE of rearing critical habitat for coho salmon, because summer water temperatures in the main stem Russian River below this reservoir are unsuitable for rearing juvenile coho salmon during most of the summer.

Proposed operations at WSD will likely have only minor adverse effects on PCEs of critical habitat for adult migrating and spawning coho salmon. However, it will have a substantial adverse affect on the PCE of rearing critical habitat for coho salmon in Dry Creek.

The project's proposed flow management will have little adverse effect on the adult migration and spawning stages of coho, because this species migrates and spawns during winter (primarily December and January), when flow in Dry Creek is largely dependent on natural inflow from unregulated tributaries and releases from WSD are generally suitable for salmon spawning except during flood operations. The project's flood management operations during winter months generally help to reduce deleteriously high flows associated with storm events that contribute to redd scour, fish stranding, and downstream displacement of fishes. Thus we conclude that proposed flow management at WSD during winter will generally be conducive to successful coho salmon spawning and egg incubation. Similar to the other salmonid species, the eggs of coho salmon that may successfully spawn in the gravels of Dry Creek are likely to successfully hatch in areas where gravels are not embedded with excessive fines due to sedimentation.

The project's proposed flow management at WSD between late spring and mid-fall will have a detrimental effect on the value of the PCE of rearing critical habitat for coho salmon for reasons similar to those described above for steelhead. Many factors influence the ability of Dry Creek to function as critical habitat for rearing salmonids (*e.g.*, stream gradient, channel morphology, quality of substrate, availability of cover, water quality, depths, *etc*.); however, the ultimate value and proper functioning of Dry Creek as critical habitat for rearing coho and the extent to which Dry Creek is able to support production of coho is heavily influenced by the level of flow released from WSD. Existing data suggest that the proposed sustained summer flows of about 100 to 150 cfs create widespread high current velocities that support negligible levels of suitable habitat for rearing juvenile coho salmon. Similar to rearing habitat for steelhead, the relationship between stream flow and available rearing habitat for coho salmon is generally inversely related. However, rearing juvenile coho salmon are even more dependent on low velocity habitats than

steelhead (Hartman 1965; Sheppard and Johnson 1985). With the implementation of the proposed project and status quo flow releases from WSD, the PCE of critical habitat for rearing juvenile coho would not function to serve the intended conservation role for coho salmon in the mainstem of Dry Creek. The significance of this becomes apparent when the overall status of the PCE of freshwater rearing critical habitat for coho salmon in the Russian River and the ESU is considered.

Rearing habitat for coho salmon is very limited in the Russian River basin. Recovery of CCC coho salmon in the Russian River will very likely be dependent on the protection, restoration, and enhancement of limited available rearing habitats for this species. Coldwater releases from the bottom and middle strata of Lake Sonoma have created a unique, large stream of coldwater with water temperatures near optimal for juvenile coho salmon, a species that needs especially cold water to survive. Although these releases are made at temperatures conducive to coho rearing, water velocities in Dry Creek are generally too high for coho juveniles to find much in the way of useable rearing habitat in Dry Creek. NMFS estimates that the project's proposed flows will appreciably diminish the quality and quantity of existing coho rearing habitat in approximately 13 miles[74] of Dry Creek and thereby reduce the amount of the highly limited critical rearing habitat needed to sustain the Russian River coho salmon population.

It might be argued that the effects of the summer flow releases at WSD do not adversely modify critical habitat for steelhead and coho salmon or jeopardize the species because prior to the construction of the dam, the affected segment of Dry Creek had very limited rearing habitat due to naturally low summer flows (<1cfs) and following dam construction the relatively high regulated flows simply continued this condition of limited habitat in Dry Creek. Such an argument is based on the premise that maintaining a status quo of very limited critical habitat is all that is necessary to avoid a jeopardy or adverse modification finding. However, such an argument fails to recognize the need for the Action Agency to insure that the action is not likely to jeopardize listed species or result in destruction or adverse modification of critical habitat. The argument that constraining available rearing habitat for coho salmon and steelhead is acceptable because pre-development conditions in Dry Creek had limited rearing habitat does not address the fact that WSD and its related water supply functions have created a 14 mile long and approximately 30 ft wide segment of river with optimal coldwater temperatures and good quality substrates for juvenile coho salmon and steelhead. Abundant coldwater habitat (<18°C) was not present in this segment during summer months prior to the dam's construction, and now the elevated project releases very likely cause and facilitate the downstream displacement and subsequent mortality of significant numbers of juvenile steelhead and coho salmon (hatched in Dry Creek and emigrants from tributaries) that would otherwise occupy Dry Creek if flows were lower. It also does not recognize that summer rearing habitats for coho salmon are now very greatly limited in the Russian River watershed due to diverse public and private sector activities including the construction of WSD that blocked fish movements, road construction, channel maintenance, local timber harvests, agriculture, and both residential and urban development (including public regulatory and financial support). The coho salmon population in the Russian River has declined precipitously since construction of WSD in response to the reduction in the quantity and quality of rearing and spawning habitats throughout the watershed, and the

[74] the precise length is dependent on summer temperature-flow relations.

population will likely become extinct like the adjacent Walker Creek and Salmon Creek coho populations unless coldwater habitats for this species are restored or created. The Russian River coho salmon population is so low that maintenance of status quo conditions threaten the population through depensatory processes (*e.g.*, inability of few individuals to find mates) and inbreeding. By continuing to degrade a large portion of the existing coldwater habitat that some remaining coho salmon very likely attempt to use, the project helps insure the extirpation of coho salmon in the Russian River watershed, with deleterious consequences for the species. Likewise, the above development activities have significantly depressed numbers of steelhead in the watershed, and deeper coldwater rearing habitats for age 1+ juvenile steelhead are now limited in the watershed. The continuation of degraded conditions in the mainstem of Dry Creek is likely to limit the viability of the Dry Creek steelhead population by precluding a large portion of rearing juveniles from completing the species' life history cycle.

Opting for a "status quo condition" of very limited habitat in Dry Creek similar to pre-dam conditions also does not address the need to avoid diminishing the value of critical habitat needed for the conservation (*i.e.*, recovery) of the species. In this case, rearing habitat is extremely limited for coho salmon and substantially reduced for steelhead in the Russian River watershed. Under the proposed releases from WSD, the PCE of critical habitat for rearing steelhead and coho salmon would not be functional in Dry Creek. Maintaining the degradation of a large portion of the remaining rearing habitat will severely hinder the ability of coho salmon and steelhead to increase their numbers, distribution, and reproduction in the Russian River watershed, appreciably reducing the likelihood that these populations can be recovered.

2. <u>Estuarine Management Effects on Critical Habitat</u>

Proposed project operations will likely have significant effects on the PCE of estuarine critical habitat for each salmonid species because flow management at WSD and CVD will create high inflows to the estuary during the low flow season and the sandbar breaching activities at the mouth will significantly affect water quality in the lowermost segment of the river. The combination of artificially high flows entering the estuary during summer months and the proposed plan for breaching the estuary mouth is likely to result in the loss of productive freshwater rearing habitat at the mouth of the Russian River. This habitat is lost because the Russian River estuary will not remain closed long enough to form a freshwater lagoon during the low flow season in most years.

We conclude that effects on estuarine critical habitat for coho and Chinook will have minor consequences on the value of estuarine habitat for these species, because at the southern end of their ranges (e.g., the Russian River), juvenile coho and Chinook salmon generally do not reside in estuaries for extended periods, and their populations do not appear to be dependent on extended rearing in estuarine or freshwater lagoon habitats. However, the disruption in the formation of a closed lagoon will perpetuate the loss of habitat for an important life history component of steelhead in the Russian River watershed. The trapping of thousands of YOY steelhead in the Russian River near the Mirabel Rubber Dam and in lower Austin Creek demonstrates that large numbers of juvenile steelhead migrate downstream towards the estuary every year. The continued cycling of the estuary as an open and closed system from late spring through early fall will perpetuate dynamic water quality conditions that include episodes of

depleted oxygen levels and relatively high salinity that is not conducive for the survival and growth of young-of-year and age 1+ steelhead. Under recent historic practices, most young steelhead are unlikely to survive in the estuary.

Information from other estuaries and lagoons indicates that steelhead juveniles that rear in lagoons are a substantial portion of returning adult spawners. Conservation of the Russian River steelhead population is likely to depend, in part, upon an estuary that can support large numbers of rearing juveniles (tens of thousands) with good growth rates that promote better chances of their returning from the ocean as adult steelhead migrants. As described in the Status of the Species, the Russian River watershed is a key component of the CCC steelhead DPS. It is unlikely the DPS can be conserved without a successful conservation of Russian River steelhead populations.

3. Flood Channel Maintenance Effects on Critical Habitat

With respect to the project's proposed flood management maintenance activities in the main stem Russian River, Dry Creek, and the flood channels and natural waterways within SCWA's Management Zone 1A, we conclude that the proposed practices will not appreciably degrade the value of critical habitat for listed salmonid species in the main stem and Zone 1A. However, the anticipated erosion control practices along the banks of Dry Creek are likely to degrade PCEs of critical habitat for the rearing, spawning and migration of all three listed salmonid species. The proposed gravel bar grading in the river's main stem will be done in a manner that may increase sedimentation and degrade the quality of pool habitat along the river's thalweg (*i.e.*, deepest part of the channel). Vegetation maintenance at these main stem sites will reduce the availability of velocity refuges for fish during high flow events. The extent of channel maintenance activities on the main stem will be confined to not more than 4000 feet of river during any one year, and the activities will be implemented with a series of measures to minimize adverse effects to aquatic habitats. Channel maintenance activities in Zone 1A will largely concern stream segments not known to support coho salmon and not listed as critical habitat for either steelhead or Chinook salmon. Most of the work done in Zone 1A will consist of channel maintenance activities in flood control channels in segments of urban streams that are already heavily channelized and that provide either no or, at best, marginal quality habitats for listed species. Channel Maintenance activities in both flood control channels and in natural waterways in Zone 1A will be limited to activities during summer low flow conditions and limited to situations that pose a significant and demonstrated flood potential during upcoming seasonal storms. In Dry Creek, channel maintenance will consist largely of the maintenance of existing structures, vegetation removal, and possible placement of rip-rap at points of bank erosion. The placement of rip-rap will contribute to armoring the stream bank to the detriment of native riparian vegetation, with resulting degradation of areas providing velocity refuge during high flow events. Placement of rip-rap along the banks of Dry Creek will also contribute to simplifying the stream's channel morphology, with losses of complex pool and riffle sequences, and it will likely reduce the riparian forest canopy that shades Dry Creek during hot summer months.

4. Water Diversion Facility and Hydroelectric Project Effects on Critical Habitat

We find that operations of the water diversion facility at Mirabel and Wohler and the maintenance of the offstream water transmission facilities (*i.e.*, piping) for the water transmission system have minimal effects on critical habitat for listed salmonid species. The current waste water discharges that occur as the result of water diversions associated with the project have minimal adverse effects on critical habitat for listed salmonid species, although high nutrient levels pose some potential adverse affect on steelhead in the Laguna de Santa Rosa, a stream that was not designated as critical habitat. We also conclude that the hydroelectric operations at CVD and WSD are not likely to adversely affect critical habitat for salmonids because they will not determine the stream flows released from the project, but rather they generate electricity based on releases of water for other purposes. The quality of water discharged by the hydroelectric facilities is suitable for salmonids.

5. Summary of Project Effects on Critical Habitat

The above analysis identifies several ways in which the proposed project operations will affect the quality and quantity of PCEs of critical habitat for coho salmon, Chinook salmon, and steelhead. Because adult fall run CC Chinook salmon primarily migrate to spawning habitats during mid to late fall and the resulting progeny migrate downstream to the ocean during the following spring, flow management at WSD and CVD does not have significant adverse consequences for this species. Migrations of adult Chinook salmon appear to actually benefit from the elevated regulated flows during fall months, and rearing juveniles do not contend with the artificially high summer flows that limit available rearing habitat for the other Federally listed salmonid species. Although channel maintenance activities will likely have some adverse effect on spawning and rearing habitats for Chinook salmon, these effects will probably be minor because each year, channel maintenance will affect only a small portion (1.5 miles) of the 94 mile long main stem Russian River. This 94 mile segment effectively supports rearing habitat for juvenile Chinook salmon along its entire length and spawning habitat at riffles along the approximately 58 mile segment upstream from Healdsburg. Ongoing channel maintenance activities in Dry Creek will likely diminish available rearing habitat for Chinook salmon; however, the extent of habitat loss for rearing Chinook salmon in Dry Creek due to ongoing channel maintenance activities is likely minor given the availability of rearing habitat for this species throughout the main stem Russian River. We conclude that, if the proposed project is implemented, critical habitat for Chinook salmon would remain functional to serve the intended conservation role for this species.

In contrast to Chinook salmon, the proposed project will likely have significant adverse effects on the critical habitat of steelhead and coho salmon. With these effects, critical habitat for steelhead and coho salmon would not be functional to serve the intended conservation role for these species. Proposed flow releases from WSD and CVD during the approximately six-month long, low flow season will create excessively high current velocities that will greatly limit the value of 14 miles of Dry Creek and 34 miles of the upper Russian River as rearing habitat for steelhead. Flow management at the project's reservoirs and breaching of the estuary's bar will also adversely affect the value of steelhead rearing habitat in and near the vicinity of the estuary. Flow releases from WSD during summer and fall months will be so high that available habitat

for rearing juvenile coho will be minimal. Proposed continued channel maintenance activities in Dry Creek will contribute to armoring the stream banks, reducing velocity refuge areas for fishes during high flows, and simplifying stream channel morphology with potential degradation of both summer and winter rearing habitats for steelhead and coho salmon. The significance of these impacts to critical habitat for rearing steelhead and coho salmon becomes apparent when the status of critical habitat for these species is considered.

Our review of the status of populations of CCC steelhead in the Russian River indicate that freshwater rearing habitat is one of the two primary PCEs of critical habitat that are most degraded in the Interior and North Coastal Diversity Strata. The entire Interior stratum and a major portion of the North Coastal stratum are within the Russian River watershed. In these areas, degradation of steelhead rearing habitat is due to channel modifications, chronic deposition of fine sediments, and intensive diversions of surface flow in tributaries. The successful recovery of populations of steelhead within the Interior and North Coastal Diversity strata will depend upon the restoration of good quality freshwater rearing habitats, including ecologically diverse habitats such as freshwater lagoons and deep main stem habitats for older age 1+ and 2+ fish. Recovery of these diversity strata will, in turn, substantially improve the chances for the recovery of the CCC steelhead DPS. However, as proposed, the project's flow management plan (*i.e.*, conformance with D1610, water supply releases, and water level management in the estuary) will hamper efforts to recover this species by degrading and, in some cases, eliminating important freshwater rearing habitats in the upper mainstem Russian River, the river's estuary, and in Dry Creek.

Likewise, the availability of rearing habitat for coho salmon has been greatly reduced in the Russian River watershed and elsewhere as the result of numerous developmental activities. Coho salmon require especially cold water in which to rear, and developmental activities have undoubtedly limited the availability of such coldwater habitats. As discussed in the Effects Section, approximately 13 miles of Dry Creek provide temperatures that sustain rearing coho salmon; however, high flow releases from WSD during summer and fall months greatly limit the value of the PCE of critical habitat for rearing coho salmon. The proposed project operations appreciably degrade the value of critical habitat for CCC coho salmon. Successful recovery of this species will very likely require protection, restoration, and enhancement of existing rearing habitats for this species. Given that the Russian River is the largest watershed occupied by CCC coho salmon and that it is centrally located in this ESU, it is unlikely that the CCC coho can be recovered without a successful restoration of coho salmon runs in the Russian River.

B. Species

The proposed project has the potential to affect one or more of the following salmonid population viability criteria: population abundance, population growth rate (*i.e.*, productivity over the entire life cycle), spatial structure, and diversity. The following discussion separately addresses the effects of the project on these criteria for each of the three listed salmonid species that occur in the action area. From that analysis we are able to assess the project's risk to the likelihood of the survival and recovery of the species.

1. Project Effects on Chinook Salmon Survival and Recovery

Based on our analysis of the project's effects on critical habitat for Chinook salmon and the species' increasing population trend, we conclude that the proposed project will not adversely affect the abundance and population growth rate of Chinook salmon in the Russian River. The population has experienced generally positive growth over the past ten years and we reason that the likelihood of the Russian River Chinook salmon population's persistence is high. The project and interrelated or interdependent activities will likely injure or kill some individual Chinook salmon. For example, the water intakes at Wohler diversion facility do not meet NMFS screening criteria, and therefore some juvenile Chinook salmon are likely to be either impinged on the diversion screen or entrained through the screen into the diversion intake. It is also possible that a few juvenile Chinook salmon may be stranded when the Mirabel inflatable dam is deflated or when flood flows trap fish in the project's infiltration ponds. Likewise, sedimentation of gravels caused by project channel maintenance for flood protection in the main stem may annually cause some loss of good quality spawning habitat, with resulting loss of incubating eggs or alevins. We anticipate that these losses to Chinook salmon will be relatively minor to the population and not adversely affect the population's growth rate because they likely concern only a very small portion of the total egg, alevin, and juveniles produced in the river. The Russian River Chinook salmon population has maintained a positive growth rate despite these ongoing losses and continuing them for fifteen more years should not appreciably reduce the species chances for survival or recovery.

We also do not expect the project to adversely affect the spatial structure or genetic diversity of the Russian River population of Chinook salmon during the fifteen year life of the project, given that the project does not cause significant adverse effects to the species habitat, and the project will maintain the same conditions that have supported the recent growth of the Chinook salmon population. We have no reason to expect that the project will cause additional impediments that might further limit the species distribution or appreciably affect the ecological or genetic diversity of this population of Chinook salmon.

2. Project Effects on Steelhead Survival and Recovery

With respect to steelhead, we do not anticipate that the project will appreciably decrease the abundance of steelhead populations in the Russian River watershed relative to recent population abundances, because summertime flows in the main stem, Dry Creek and the river's estuary have been artificially elevated for decades and the proposed operations will result in flows that approximate those historic conditions. Many tributaries of the Russian River that are unaffected by the proposed project will continue to provide functioning, albeit degraded, steelhead rearing habitat, and several thousand wild steelhead will continue to annually return to spawn in the Russian River watershed during the fifteen year life of the project. The Don Claussen Fish Hatchery will also continue to contribute to the abundance of steelhead in the watershed through the production and stocking of hatchery fish that are genetically similar to wild stock and are listed as part of this DPS themselves. Despite the fact that the proposed project will probably not reduce the abundance of steelhead relative to recent historic numbers, the project will adversely affect the functionality of the PCE of freshwater rearing habitat for steelhead in 34 miles of the upper Russian River, 14 miles of Dry Creek, and the river's estuary, with resulting mortality of

juvenile fish (as described in the Effects Section). As a result, production of juvenile steelhead will be low in these potentially productive, major areas of the watershed. Because of the degradation of the critical rearing habitat and the fact that steelhead rearing habitat is limited in the Russian River watershed, we conclude that the project plays a substantial role in maintaining Russian River steelhead populations in abundances that are dramatically reduced from those found in the early and mid 1900s.

All of the populations of steelhead in the Russian River have exhibited negative growth rates over the past several decades as the result of diverse impacts to their environment. The project's flow management plan influences the growth rates of these populations because it directly affects both the available rearing habitat and potential production of steelhead in Dry Creek, the upper Russian River, and the lower river near, and in, the estuary. Each of these populations is adversely affected by the ongoing degradation of rearing habitat for juvenile steelhead due to the elevated inflows to the estuary and ongoing water level management practices in the river's estuary. The Dry Creek population, which was the largest potentially independent steelhead population occupying a single Russian River tributary, has experienced a significant negative trend over the past 25 years as the result of the construction of WSD, summer flow releases from that dam, and channel modifications in Dry Creek that combined have resulted in poor survival and growth of juvenile steelhead. Yet despite the migratory barrier presented by WSD, the Dry Creek watershed below that dam continues to be large enough to support a potentially independent population of steelhead (Spence *et al*. 2008). Any future flow management plan for the waters stored in Lake Mendocino and Lake Sonoma will affect growth rates in this population and other steelhead populations in the Russian River watershed. As proposed, the flow management plan will perpetuate status quo flows that strongly influence habitat suitability while the steelhead populations in the watershed experience negative growth trends due to other diverse developmental activities throughout the watershed. Elevated inflows to the estuary, the upper mainstem, and Dry Creek during the low flow season, and channel maintenance activities will continue to suppress populations of steelhead in the basin and not contribute to recovery; instead populations of steelhead will likely continue to decline through degradation of habitats stemming from status quo project operations and diverse non-project related activities. Alternative flow regimes in the Russian River and Dry Creek during summer and early fall have the potential to promote recovery by increasing steelhead abundance and population growth rates.

The proposed project will also maintain longstanding conditions that constrain the ecological diversity of the steelhead populations. As discussed in Baseline Section V.B.3, steelhead populations have diverse life history strategies, and in California, a significant component of many steelhead populations rear in productive freshwater lagoons. Indeed, juvenile production in freshwater lagoons can account for a large portion of the adults that return from the ocean to California streams. The proposed flow management plan and estuarine water level management will adversely affect the ecological diversity of steelhead populations in the Russian River watershed by continuing to suppress this component of the steelhead population's life history strategy.

We do not expect the project to cause any further adverse change in the existing spatial distribution of steelhead in the Russian River because the proposed project operations have been

ongoing in this form for many years, and any reductions in the spatial distribution of the species due to ongoing operations have very likely already occurred and will remain as a result of continued operations for the next fifteen years. We also note that steelhead remain widespread, albeit in low numbers, in the project area including the main stem, Dry Creek below WSD, and the river's estuary. We do not expect the project will cause additional impediments that might further limit the species distribution of steelhead.

With respect to the steelhead hatchery program at DCFH and the CVFF, the Steelhead Mitigation Program is currently a mitigation hatchery program, mitigating for salmonid habitat and production losses above Warm Springs and Coyote Dams. Although there is a potential to use these hatchery steelhead for recovery purposes, the program is currently only a mitigation program. The steelhead hatchery program does not offset losses of steelhead downstream from WSD. The primary objective of the ESA is the conservation of species in their natural ecosystems. The ESA mandates the restoration of threatened and endangered species in their natural habitats to a level at which they can sustain themselves without further legal protection (NMFS 1992). For Pacific salmonids, the ESA's focus is therefore on natural populations, the progeny of naturally spawning fish, and the ecosystems upon which they depend (NMFS 1992). Therefore, hatchery produced fish can not be relied upon to minimize or offset project impacts in the Russian River basin. The costs and benefits of the steelhead hatchery program can not be precisely determined, given the incidental capture of wild steelhead in the sportfishery for hatchery steelhead, the absence of a Fishery Management and Evaluation Plan for that sportfishery, and the fact that the hatchery fish are a part of the CCC steelhead DPS. However, it is known that there are no substantial genetic differences between wild and hatchery propagated steelhead in the basin, and therefore, continued exclusion of wild steelhead from hatchery spawning stock could result in a divergent hatchery population with reduced genetic diversity and increased inbreeding. The stocking of hatchery smolts may have some adverse effects to wild populations through their predation or competition with wild fish. We believe those effects are relatively minor, because hatchery fish are stocked only into Dry Creek and the East Branch (near the confluence with the upper main stem Russian River) when they are in a migratory stage and not acclimated to survival in the wild, and most migrate within a few weeks to the ocean. The hatchery program also promotes a fishery for marked adult hatchery fish in the mainstem Russian River. That fishery results in the capture (with barbless hooks) and release of wild steelhead, coho salmon, and Chinook salmon.

3. Project Effects on Coho Salmon Survival and Recovery

Almost all of the current production of coho salmon in the Russian River watershed is sustained either by artificial production and planting of wild stock coho salmon via the RRCSCBP or by remnant natural spawning in a few stream segments that are not within the action area. Because of the extremely small size of the Russian River coho salmon population and other coho populations in the coastal diversity stratum, the RRCSCBP will likely remain an essential factor in maintaining the abundance, spatial distribution, and genetic diversity of coho salmon in the river's tributaries until sufficient good quality habitats are restored or established. However, the efficacy of this program and prospects for achieving a viable population of coho salmon in the Russian River is threatened by the absence of an emergency water supply line for the DCFH and by the absence of funding commitment for the genetics management and field monitoring

components of the RRCSCBP. Spawning of wild adult fish likely occurs in only a few Russian River tributaries, including probably Dry Creek.

We anticipate that the proposed project's flow regime will probably not directly reduce the abundance of wild spawned coho salmon in the Russian River watershed relative to their recent abundance, because wild spawned coho fry will be exposed to the same adverse conditions and experience the same rates of mortality as other year classes of coho in recent previous years. However, the project's flow releases from WSD will perpetuate for an additional 15 years, conditions that adversely affect the functionality of critical habitat for rearing coho salmon in about 13 miles of Dry Creek and the river's estuary. Juvenile coho that originate from adult spawning in Dry Creek or that emigrate from tributaries to Dry Creek are likely to be displaced downstream into the main stem Russian River because available rearing habitat is limited by elevated summer flow and ongoing channel maintenance. We anticipate that most age 0+ juvenile coho salmon that are displaced downstream from Dry Creek will die as the result of predation or adverse conditions (*e.g*., elevated temperatures in the mainstem, or high salinity in the estuary). This anticipated continued loss of juvenile coho salmon due to high flow releases will reduce the abundance of the Russian River coho salmon population, which has exhibited a precipitous decline over the past several decades and is currently at a critically low level. As discussed above, this population is so low that maintenance of status quo conditions threatens the population through depensatory processes and inbreeding. Given that flows in Dry Creek and inflows to the estuary strongly influence the survival and abundance of juvenile coho in the Russian River watershed, any future flow management plan for the waters stored in Lake Sonoma will affect growth rates in this population. The project's flow management plan influences the spatial structure of the coho salmon population because, as proposed, it virtually precludes Dry Creek as useable rearing habitat for the production of juvenile coho salmon in Dry Creek. In the Russian River watershed, remnant runs of coho are largely confined to tributaries entering the lower river (*e.g*., Green Valley Creek and Dutchbill Creek). Coho salmon returns to the Dry Creek watershed are almost exclusively limited to fishes stocked in Mill Creek by the wild broodstock hatchery program.

The Russian River coho salmon population has declined to very low numbers. As such, the genetic diversity of the population is vulnerable to ecological depensatory processes that increase the risk of the population becoming extirpated. Depensatory processes include the inability of potential mates to find one another, and increased predation rates when predators are unsatiated. Discussing this issue McElhany *et al*. (2000) state, "Environmental variation can cause small populations to go extinct when chance events reduce survival and fecundity to low levels for an extended time. The genetic processes that may affect small populations include diversity loss, inbreeding depression, and the accumulation of deleterious mutations." In maintaining ongoing operations that constrain growth of the population, the project is contributing to the population's vulnerability to ecological and genetic processes that are likely reducing the genetic diversity of the river's coho salmon population. Given the central location of the Russian River in the range of CCC coho and that the watershed represents a third of the ESU by area, the survival and recovery of CCC coho salmon will likely depend on a substantial positive trend in the growth rate and abundance of coho salmon in the Russian River.

4. Summary of Project Effects on Species Survival and Recovery

In summary, we conclude that the proposed project operations are not likely to appreciably reduce the likelihood of CC Chinook salmon survival and recovery in the Russian River. We make this conclusion because the project is unlikely to reduce the abundance of spawners, the growth rate, spatial structure, or genetic diversity of the Russian River population of Chinook salmon. We base this finding on the following facts: 1) the population has experienced a generally positive growth over the past ten years, 2) the project does not cause significant adverse effects to the species habitat, and, 3) the project will maintain the same conditions that have supported the recent growth of the Chinook salmon population. However, we also conclude that, unlike the situation for Chinook salmon, the proposed project will likely have substantial adverse effects on both the coho salmon population and several steelhead populations in the Russian River watershed. The proposed flow management plan for CVD and WSD, the water level management plan for the river's estuary, and the ongoing channel maintenance activities in Dry Creek substantially influence the abundance, growth rate, and spatial structure of populations of steelhead and coho salmon in the Russian River. We find that the proposed project adversely affects these fundamental factors governing the viability of these salmonid populations. As proposed, the flow management plan will perpetuate status quo flows that strongly influence habitat suitability while the steelhead populations in the watershed experience negative growth trends due to other diverse developmental activities throughout the watershed. Elevated inflows to the estuary, the upper mainstem, and Dry Creek during the low flow season, and channel maintenance activities will continue to suppress populations of steelhead in the basin and not contribute to recovery; instead populations of steelhead will likely continue to decline through degradation of habitats stemming from status quo project operations and diverse non-project related activities. Alternative flow regimes in the Russian River and Dry Creek during summer and early fall have the strong potential to promote recovery by increasing steelhead abundance and population growth rates. Given that the Russian River supports nine steelhead populations, including one functionally independent population and six potentially independent steelhead populations, and that the river's populations span two of the five diversity strata within the CCC steelhead, the survival and recovery of this DPS will likely depend on successful efforts to increase the abundance, spatial structure, diversity, and growth rates of Russian River steelhead populations. Likewise, given the central location of the Russian River in the range of CCC coho and that the watershed represents a third of the ESU by area, the survival and recovery of CCC coho salmon will likely depend on a substantial positive trend in the growth rate and abundance of coho salmon in the Russian River. The coho population is appreciably affected by the continued loss of juvenile coho that are likely displaced from Dry Creek due to high summer flows that limit habitat availability and by the continued channel maintenance practices that prohibit natural channel processes that create suitable rearing habitats for the species. Given that the coho salmon population is so low, water level management of the river's estuary also poses some risk to the species.

IX. CONCLUSIONS

After reviewing the best available scientific and commercial data, the current status of the species, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS biological opinion that the continued operations of CVD and WSD for a fifteen year period in a manner similar to recent historic practices together with SCWA's proposed ongoing water diversions from the Russian River and its proposed stream channel maintenance activities, estuary management, and hydroelectric project operations at CVD and WSD are not likely to jeopardize the continued existence of threatened CC Chinook Salmon. However, we find that the continued operations of CVD and WSD in a manner similar to recent historic practices together with proposed Dry Creek channel maintenance activities and estuary management are likely to jeopardize the continued existence of threatened CCC steelhead and endangered CCC coho salmon.

After reviewing the best available scientific and commercial data, the current status of the critical habitat, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS biological opinion that the continued operations of CVD and WSD for a fifteen year period in a manner similar to recent historic practices together with SCWA's proposed stream channel maintenance activities and estuary management are likely to adversely modify critical habitat for CCC coho salmon and CCC steelhead. It is NMFS opinion that the proposed project is not likely to adversely modify critical habitat for CC Chinook salmon.

X. REASONABLE AND PRUDENT ALTERNATIVE

Regulations (50 CFR § 402.02) implementing section 7 of the Act define reasonable and prudent alternatives as alternative actions, identified during formal consultation, that: (1) can be implemented in a manner consistent with the intended purpose of the action; (2) can be implemented consistent with the scope of the agency's legal authority and jurisdiction; (3) are economically and technologically feasible; and (4) would, NMFS believes, avoid the likelihood of jeopardizing the continued existence of listed species or the destruction or adverse modification of critical habitat.

This biological opinion has found that the proposed Russian River Project jeopardizes the survival and recovery of CCC steelhead and CCC coho salmon, and that aspects of the project adversely modify the critical habitat for both of these species. We find that the proposed project will have a significant adverse effect on the PCE of summer rearing habitat for steelhead in 1) the Russian River estuary, 2) the East Branch and mainstem segment between CVD and Cloverdale, and 3) the segment of Dry Creek downstream of WSD. Project operations affect the survival of steelhead in these three areas, thereby perpetuating negative population growth trends and maintaining longstanding conditions that constrain the ecological diversity of steelhead populations. The proposed project's major adverse effect on coho salmon stems from the elevated summer flows in Dry Creek and the ongoing maintenance of one mile of channel that ruin the value of Dry Creek as rearing habitat for coho salmon, despite the highly unusual, long stream segment (9 miles) with optimal temperatures for rearing coho salmon. The progeny of any coho salmon that might spawn in Dry Creek or juvenile coho that emigrate from tributaries (*e.g*., Mill Creek, Wine Creek, Pena Creek) into Dry Creek will likely be displaced downstream with low chances for survival. We also found that the proposed project will diminish coho production or adversely modify this species' critical habitat in the estuary, but it will not do so in the upper mainstem Russian River, because water temperatures in the latter area exceed tolerance limits of coho salmon, regardless of the proposed project.

To avoid the likelihood of jeopardy to the species and adverse modification of critical habitat, NMFS has collaborated with the Corps and SCWA in developing a Reasonable and Prudent Alternative (RPA) for this project that is consistent with the intended purpose of the action, can be implemented consistent with the legal authority and jurisdictions of the Corps and SCWA, is economically and technologically feasible, and would avoid the likelihood of jeopardizing the continued existence of listed species or the destruction or adverse modification of critical habitat. This RPA involves implementation of the project as described in Section III of this biological opinion, with eight modifications and additional actions as described in Section X.A of this opinion. All eight modifications and additional actions must be implemented as part of one RPA. In summary, new or modified actions that will be part of the Russian River Water Supply and Flood Control Project will include:

1. SCWA will petition the SWRCB to change minimum bypass flows identified in D1610 for the mainstem Russian River and Dry Creek. SCWA will also complete all necessary environmental documentation and other activities within its jurisdiction to promote changes to D1610 minimum flow standards as identified in Section X.A.1.

2. SCWA will collaborate with NMFS and modify their estuary water level management in order to reduce marine influence (*i.e.*, high salinity and tidal inflow) in the estuary during the summer and promote a higher water surface elevation in the estuary for purposes of enhancing the quality of rearing habitat for age 0+ and 1+ steelhead. SCWA will monitor the response of water quality, invertebrate production, and salmonids in and near the estuary to water surface elevation management in the estuary-lagoon system.
3. The Corps and SCWA will implement and monitor on-the-ground enhancements of rearing habitat that will avoid adverse modification of critical habitat and appreciably increase the survival of juvenile salmonids in Dry Creek during both summer and winter months. To do this, SCWA and the Corps will enhance the quality and quantity of pool habitat along the 14 mile segment of Dry Creek and install boulder clusters to improve rearing habitat for steelhead and coho salmon in Dry Creek. These enhancements, which will ameliorate habitat conditions adversely affected by high summer flow releases, will be distributed at several locations along Dry Creek and the timing of their installation will be staggered to begin by Year 5 and be completed by Year 12. Because the initial design, permitting, and construction of this work will take up to five years to complete, SCWA will also restore or otherwise enhance rearing habitat for salmonids in tributaries that enter Dry Creek downstream of WSD or other Russian River tributaries supporting coho salmon and steelhead by the end of Year 3 covered by this opinion.
4. SCWA will investigate the feasibility of constructing a pipeline to deliver water from Lake Sonoma to the mainstem of the Russian River in order to reduce the adverse effects of relatively high flow releases from WSD on rearing habitat for coho salmon and steelhead. An assessment of bypass pipeline alternatives will enable SCWA to identify the best method to ensure water deliveries while meeting salmonid habitat needs in Dry Creek in the unlikely event that habitat enhancement efforts in Dry Creek are unsuccessful in supporting successful growth and survival of juvenile steelhead and coho salmon.
5. The Corps will strengthen the Russian River Coho Salmon Captive Broodstock Program (RRCSCBP) by conducting needed 1) annual genetics analysis and 2) annual monitoring of the distribution and survival of stocked juvenile salmon and the subsequent return of adult coho to the Russian River.
6. SCWA will implement expansion of the RRCSCBP to include the annual rearing and stocking of 10,000 coho smolts genetically managed via the wild coho broodstock program.
7. The Corps will install a new back-up water supply pipeline to the Warm Springs Hatchery, and complete construction of additional rearing facilities for the coho salmon broodstock program.
8. Consistent with recent historic monitoring efforts, SCWA will annually monitor the upstream migration of adult salmonids at the Mirabel Dam between late August and late fall, and they will annually monitor downstream migration of juvenile salmonids past the Mirabel Dam during spring and early summer for 15 years.

The following section describes the purpose, objective, methods and schedule of each project modification and new element of the Russian River Water Supply and Flood Control Project.

A. Project Modifications and New Project Elements of the Reasonable and Prudent Alternative

1. Pursue Changes to D1610 Flows

Purpose:
As described in this opinion, the proposed continuation of elevated flows in Dry Creek, the mainstem Russian River, and the estuary is likely to negatively affect the ability of salmon and steelhead populations to survive and recover in the Russian River watershed. High water velocities associated with the project's artificially elevated summer flows and stream channelization greatly limit the quantity and quality of juvenile salmon and steelhead rearing habitat in Dry Creek and the upper Russian River. Relatively high discharge also disrupts the normal processes of lagoon formation in the Russian River estuary, thereby exacerbating the potential for flooding of low-lying properties, and increasing the frequency of mechanical sandbar breaching.

SCWA's water right to operate the Russian River Project is permitted by SWRCB Decision 1610 (D1610). Changes to the D1610 flow minimum requirements will enable alternative flow management scenarios that would increase available rearing habitat in Dry Creek and the upper Russian River, and it would provide a lower, closer to natural inflow to the estuary between late spring and early fall, thereby enhancing the potential for maintaining a seasonal, freshwater lagoon that would likely support increased production of juvenile steelhead and salmon.

Objective:
Changing the minimum flow requirements mandated under D1610 will require an action by the SWRCB. The Corps and SCWA do not have the authority to change these minimum flow requirements; however, SCWA does have the ability to petition the SWRCB to change minimum flow requirements identified in D1610, and it has the ability to complete needed environmental and engineering documentation to support the petition to change flow requirements specified in D1610. The objective of this RPA element is to require all activities within the authority of the SCWA and the Corps to change minimum instream flow requirements in the Russian River and Dry Creek via the water rights petitioning process of the SWRCB. D1610 specifies that further fisheries investigations should be done in the Russian River and that such studies may assist in refining minimum instream flows. The SWRCB maintained jurisdiction to amend the Agency's water right permits if fisheries studies demonstrated that a flow schedule different from that outlined in D1610 would be beneficial. As described in the preceding biological opinion, data indicate that proposed Corps and SCWA operations maintain minimum instream flows that are excessive and limit conservation of listed salmonids. Reducing minimum flows mandated by D1610 could substantially augment usable rearing habitats for older (age 1+ and late summer age 0+) juvenile coho salmon and steelhead. Such modifications would likely favorably affect salmonid population growth rates and beneficially affect spatial structure of the populations.

Methods and Schedule:

Changing D1610 will require a Petition to Change D1610 minimum flow requirement to the SWRCB, Public Notice of this Petition, completion of a multiyear EIR for compliance with California Environmental Quality Act (CEQA), and a hearing process before the SWRCB. This

process will require 6 to 8 years to complete. Before completing this process, SCWA will be obligated to maintain minimum flows stipulated under D1610 with resulting impacts to listed salmonids for up to eight years, unless temporary relief is provided. Temporary variance from D1610 is possible. Therefore, SCWA will seek both long term and interim changes to minimum flow requirements stipulated by D1610.

Permanent Changes to D1610

SCWA will begin the process of changing minimum instream flows by submitting a petition to change D1610 to the SWRCB within one year of the date of issuance of this final Biological Opinion. That petition will request that the SWRCB change stream flow requirements for the Russian River Basin such that minimum stream flows at certain locations will be reduced in the mainstem Russian River and Dry Creek between late spring and early fall during normal and dry water years as defined by water year criteria specified in D1610. Requested revised minimum flow criteria will promote goals of enhancing salmonid rearing habitat in the upper Russian River mainstem, the lower river in the vicinity of the estuary, and Dry Creek downstream of WSD. The revised minimum flows should promote water conservation and seek to limit effects on in-stream river recreation. Observations during the 2001 interagency flow-habitat study and during the 2007 low flow season, when flows at the Guerneville gage ranged from about 60 to 100 cfs, indicate that the following changes may achieve these goals:

During Normal Years:

1. Reduce the minimum flow requirement between the mouth of Dry Creek and the mouth of the Russian River from 125 cfs to 70 cfs.
2. Reduce the minimum flow requirement in the Russian River from the East Fork to Dry Creek from 185 cfs to 125 cfs between June 1 and August 31; and from 150 cfs to 125 cfs between September 1 and October 31.
3. Reduce the minimum flow requirement in Dry Creek from Warm Springs Dam to the Russian River from 80 cfs to 40 cfs from May 1 to October 31.

During Dry Years:

1. Reduce the minimum flow requirement between the mouth of Dry Creek and the mouth of the Russian River from 85 cfs to 70 cfs.

The rationale for these suggested changes in minimum flow requirements is as follows:

As explained in Sections V.A.1 and VI.G.1b of this biological opinion, estuarine hydraulics and estuarine water quality dynamics are dependent on the magnitude of freshwater inflow, sediment supply, and wave action that promotes formation of a barrier beach (commonly referred to as a sandbar) at the river's mouth. Artificially high inflows during summer months interfere with normal processes that discharge river flow through or over the barrier beach to the ocean. Corps and SCWA (2004) estimate that predevelopment mainstem flows to the estuary often dropped to 25 cfs or less, and that prior to the Potter Valley Project, the estuary likely remained closed to the ocean for weeks or months at a time. The D1610 minimum requirement of 125 cfs at Guerneville during normal water years is much higher than the unregulated conditions that existed prior to construction of Lake Pillsbury and Lake Mendocino. Because the dynamics of

lagoon formation are dependent on several variables, including freshwater inflow, wave conditions, the quantity and quality of available sediment supply, and underlying geologic structure at the river's mouth, it is not possible to specify any one single inflow requirement that will promote lagoon formation. However, a lower flow requirement would promote long-term closure of the lagoon (*i.e*., a barrier beach across the mouth that isolates the lagoon from the ocean) or maintenance of a perched lagoon in which the river flows over the barrier beach, increasing lagoon depths and disconnecting the estuary from the ocean (eliminating the influx of saltwater) except for occasional wave overwash. A new minimum flow requirement of approximately 70 cfs at Guerneville would reduce the minimum flow requirement at Guerneville by 44%. Because SCWA maintains a 10 to 15 cfs buffer to avoid non-compliance of the minimum standard, a 70 cfs requirement would likely result in an inflow of about 80 to 85 cfs to the estuary. In the considerably smaller Carmel River estuary, a perched freshwater lagoon was maintained in 2005 at an inflow of about 60 to 70 cfs, and the Carmel River lagoon would likely accommodate higher inflows if the outlet stream over the barrier beach was moved to the northern side of the river's mouth (J. McKeon, NMFS, personal communication 2007). Informal observations and reports concerning recreational boating in the lower Russian River during summer 2007 indicate that flows of 80 to 100 cfs accommodate recreational canoeing and kayaking. Thus a minimum flow requirement of 70 cfs at Guerneville, with a 10 to 15 cfs buffer would appreciably enhance the prospects for achieving a closed or perched lagoon that would likely enhance salmonid estuarine rearing habitat, while conserving water and minimizing impacts to other river resources.

Reduction of the minimum flow requirement at the Healdsburg gage during normal years would enhance the quantity and quality of rearing habitat for steelhead in the river between the mouth of the East Fork and Cloverdale, the segment that typically supports suitable summer water temperatures for rearing juvenile steelhead. The 2001 flow-habitat assessment indicated that flows of about 125 cfs provided considerably more rearing habitat for steelhead in this segment than higher flows (190 and 275 cfs). In order for SCWA to comply with D1610 and maintain flows of 185 cfs between the East Fork and the mouth of Dry Creek, it is necessary for them to release approximately 250 to 300 cfs at CVD during summer months. Reducing this minimum requirement to 125 cfs would ensure that adequate flow is provided in the segment between the East Fork and Cloverdale (as documented in the 2001 flow habitat assessment). Moreover, it would likely enhance the quantity and quality of steelhead rearing habitat throughout this segment, while conserving the coldwater pool in Lake Mendocino. Conservation of that coldwater pool would increase the likelihood that waters released from that reservoir would remain suitably cool for rearing steelhead throughout the summer. It would also help ensure that sufficient flow could be released to facilitate upstream migration of fall run Chinook salmon.

Reduction of the minimum flow requirement for Dry Creek below WSD would allow SCWA to release lower flows at WSD during summer months. The 2001 flow-habitat assessment indicated that flows of about 50 cfs provided more rearing habitat for steelhead and coho salmon in this segment than higher flows (90 and 130 cfs).

In pursuing CEQA/NEPA compliance, SCWA may find alternative minimum flow requirements that meet the goals of restoring functional salmonid rearing habitat in Dry Creek, the upper

mainstem, and the estuary, thereby increasing population abundance and growth rates, while promoting water conservation and limiting adverse effects on other in-stream resources.

Within 6 months after the SWRCB's public notice that SCWA has petitioned for a change to terms and conditions of D1610, SCWA will begin the CEQA/NEPA process by issuing a Notice of Preparation/Notice of Intent. The SCWA's Board of Directors shall certify a final CEQA/NEPA document within four (4) years of filing the petition to change D1610. This would be five years after the issuance of this biological opinion. Upon filing the petition to change D1610, SCWA will conduct outreach with the support of NMFS staff to affected parties in the Russian River watershed. The SWRCB will very likely complete required staff review, public hearings, and issue an order to change flows following a one to two year period (seven to eight years after the issuance of this biological opinion).

The change of minimum required stream flows in the Russian River mainstem and Dry Creek is an essential RPA element for avoiding jeopardizing the continued existence of CCC steelhead and CCC coho salmon. Although the establishment and change of stream flow requirements is done under the authority of the SWRCB and not the SCWA nor the Corps, the likelihood that such changes can and will be accomplished within an eight year time frame is near certain because:

1. D1610 provides SWRCB with "*jurisdiction to amend SCWA's permit if a fishery study is conducted which shows that a different flow schedule would be better, or if further evidence otherwise becomes available which may affect the minimum flows*".
2. This biological opinion and referenced studies and reports strongly support reducing minimum stream flow requirements to protect and recover several important fish species in the Russian River and Dry Creek.
3. The fish species benefited by reductions in required minimum flows are both commercially important and listed under the Federal ESA. One of the species, coho salmon, is listed under CESA.
4. Throughout California, water supply is highly limited during summer and early fall. The Russian River is the only river in California where regulated flows that greatly exceed historic, unregulated levels are discharged to the Pacific Ocean during summer and early fall. Therefore, municipalities and other water supply interests will very likely support changes that help to avoid jeopardizing listed salmonids and at the same time reduce the amount of water that must be allowed to reach the Pacific Ocean.
5. This RPA element seeks to conserve the value of critical habitat for rearing steelhead and coho salmon in Dry Creek, the upper mainstem, and the estuary, while at the same time promoting water conservation and limiting adverse effects on other in-stream resources. Therefore, with few exceptions, the public-at-large will very likely support such changes.
6. During summer 2007 when stream flows were in the vicinity of 80 to 100 cfs, depths and velocities in shallow riffles were lower than when flows are between 140 and 180 cfs (more typical, recent summer flows in the lower Russian River). Nevertheless, during summer 2007, observations by NMFS staff indicate that recreational canoeing and kayaking was feasible and viable throughout the lower river (W. Hearn, NMFS, personal communication). Effects of the lowered minimum flows in 2007 on recreational boating were negligible in the several miles of river impounded by county summer dams (*i.e.*,

Vacation Beach dam, Johnson Beach dam, and the SCWA dam at Mirabel). Therefore, although recreational boating may be affected by reduced summer flows, the effect is likely minor and insufficient to cause SWRCB to reject a change in the minimum flow requirements currently stipulated by D1610.

7. SCWA has maintained vertical arrays of continuously recording water quality meters at several sites in the Russian River estuary since 2004. A multi-year comparison of dissolved oxygen and water temperature in the freshwater portion of the water column at two sites showed no differences that were attributable to the quantity of freshwater inflow (river discharge) to the estuary. For example, despite flows in the vicinity of 80 to 100 cfs during summer 2007, peak surface water temperatures at the middle estuary water quality monitoring site were lower than in 2006, a year with normal discharge (J.Church, SCWA, personal communication, July 2008).
8. In response to limited winter rainfall, dwindling water supply in Lake Mendocino, and anticipated impacts to fisheries, the SWRCB temporarily lowered minimum flows in the Russian River during summer months in 2004 and 2007. The SWRCB's support of lowered minimum flow requirements during these years demonstrates that agency's openness and willingness to modify D1610 flow requirements when provided defensible, supporting technical information.

In summary, with documented benefits to both fisheries and water supply from decreased minimum stream flow requirements in the Russian River, and the absence of significant water quality impacts of reduced flow requirements during 2004 and 2007, and past support of SWRCB in temporarily modifying (reducing) stream flow requirements in 2004 and 2007, it is highly likely that the SWRCB will act favorably towards SCWA's petition to reduce summer flow requirements in the Russian River and Dry Creek to address adverse effects of flow releases identified in this opinion. The SWRCB will have authority to change D1610 flow requirements following issuance of CEQA documentation and a public hearing process. We anticipate this will be accomplished between 2014 and 2016.

Temporary Urgency Changes

To help restore freshwater habitats for listed salmon and steelhead in the Russian River estuary, SCWA will pursue interim relief from D1610 minimum flow requirements by petitioning the SWRCB for changes to D1610 beginning in 2010 and for each year prior to the permanent change to D1610. These petitions will request that minimum bypass flows of 70 cfs be implemented at the USGS gage at the Hacienda Bridge between May 1 and October 15, with the understanding that for compliance purposes SCWA will typically maintain about 85 cfs at the Hacienda gage. For purposes of enhancing steelhead rearing habitats between the East Branch and Hopland, these petitions will request a minimum bypass flow of 125 cfs at the Healdsburg gage between May 1 and October 15. NMFS will support SCWA's petitions for these changes to D1610 in presentations before the SWRCB. Given the reservation of authority in D1610 and the fact that this BO constitutes substantial new information on fisheries in the Russian River that was not available to the SWRCB at the time D1610 was issued, and that the changes of flows outlined in this RPA are necessary to avoid jeopardizing the continued existence of the listed species, NMFS expects that the temporary urgency change petitions will be approved by the SWRCB on an expedited basis.

Reporting and Review:
Copies of the petitions to change D1610 submitted to the SWRCB will be sent to the NMFS Santa Rosa office. NMFS will be included on the mailing list for all public notices and documents related to the CEQA/NEPA compliance process. NMFS will be updated on the progress of this element of the RPA during Section 7 progress meetings and as public notices and documents are issued related to the petitions to change D1610 and the associated CEQA/NEPA process. NMFS acknowledges that unforeseen issues may arise during the water rights and CEQA/NEPA processes. The aforementioned schedule may be modified in consultation with NMFS based on proceedings for the petition to the SWRCB and the related CEQA/NEPA processes.

2. Alterations to Estuary Management

As described in this opinion, the proposed project is likely to result in Russian River estuarine conditions that negatively affect the ability of steelhead to recover in the Russian River watershed by limiting the number and life history stages of steelhead that can successfully rear in the estuary during spring, summer and early fall months. The biological opinion describes two main project elements that will likely cause these conditions, sandbar (*i.e.*, barrier beach) management at the estuary's mouth, and elevated inflows to the estuary from dam releases upstream.

Elevated inflows are addressed in RPA Element 1 above. This second RPA element is intended to modify barrier beach management to reduce its adverse effects on juvenile steelhead numbers and life history stages that rear in the estuary. This element also includes provisions for monitoring the response of water quality, invertebrate production, and salmonids in the estuary to the management of water surface elevations in the estuary-lagoon system.

Brackish/freshwater lagoons and sloughs elsewhere in California and the west coast are used extensively by emigrating smolts and rearing juvenile steelhead and Chinook salmon, as well as coho salmon smolts. A significantly deeper and stable brackish/freshwater estuary is likely more similar to the historic rearing environment for Russian River salmonids than conditions induced by frequent breaching and conversion to a marine environment. Adaptive management of the barrier beach, estuarine water levels, and outflow at the river's mouth is a reasonable and prudent approach to achieving flood protection and fish habitat goals. To achieve these goals it will be necessary to monitor biological productivity, water quality and physical processes in response to changes in management actions that control estuarine water levels.

2.1 Alternative Strategy and Approaches for Management of Estuarine Water Surface Elevations

Purpose:
As stated in Section VIII.A.2, proposed sandbar breaching activities at the mouth will significantly affect habitat conditions in the lowermost segment of the Russian River. When ocean waves build up a sandbar across the river's mouth, the Russian River estuary forms a lagoon that is hydraulically isolated from the marine environment, except for occasional wave

overwash. Freshwater inflow causes this lagoon to slowly gain in volume and depth. Similar to historic practices, the proposed breaching activities will cause the lagoon to return to a tidal system reconnected to the ocean and have a nearly marine salinity of >28 parts per thousand as far upstream as the mouth of Sheephouse Creek. These practices cause the estuary to become very shallow and subject to water quality dynamics that are neither natural nor optimal for the survival of large numbers of small, juvenile steelhead. The purpose of this element of the RPA is to enhance the quality of the Russian River estuary as rearing habitat for young-of-year and age 1+ juvenile salmonids.

Objectives:
SCWA will manage water surface elevations in the Russian River estuary by conserving beach sands and encouraging formation of a more extensive beach complex capable of forming an elongated and elevated outlet channel during the low flow season (approximately mid-May through mid-October) that will 1) maintain the estuary's water surface above the high tide line and 2) avoid flooding.

Estuary water level management targets will be:
1) A daily minimum water surface elevation of 3.2 feet during 70 % of the year. Absent river flood flows and the historic mechanical breaching practices, NMFS expects cross shore transport of sand by wave action will be sufficient to maintain the bar at this elevation.
2) An average daily water surface elevation of at least 7 feet from May 15 to October 15. NMFS expects the barrier beach to be this high or higher when the estuary closes in the spring, as a natural function of wave action and sand transport typical of spring and summer.
3) NMFS expects the lagoon will be breached open to ocean tides starting after October 15th if the estuary is perched or closed. Steelhead juveniles are expected to be large enough by mid-October to withstand salt water conditions.

These targets may be initially difficult to meet because NMFS expects past management has depleted sand supply to the north end of the beach, decreasing the width and elevation of the barrier beach. At first, this condition will constrain outlet channel length, elevation and stability. Over time NMFS expects RPA implementation will result in greater beach width and elevation, allowing formation of a more stable outlet channel capable of effectively maintaining the minimum water surface elevation targets.

Actions:
To achieve these objectives, SCWA will manage flood risk and estuary water surface elevation by adaptively managing the barrier beach and flood risk as follows:

2.1.1. <u>Adaptive Management of the Outlet Channel</u>

1a) Within six months of the issuance of this biological opinion, SCWA, with support from NMFS, shall conduct public outreach and education on the need to reduce estuarine impacts by avoiding mechanical breaching to the greatest extent possible.

1b) In coordination with NMFS, CDFG, and the Corps, SCWA will annually prepare barrier beach outlet channel design plans. Each year after coordinating with the agencies, SCWA will

provide a draft plan to NMFS, CDFG, and the Corps by April 1st for their review and input. The initial plan will entail the design of a lagoon outlet channel cut diagonally to the northwest. Sediment transport equations shall be used by SCWA as channel design criteria to minimize channel scour at the anticipated rate of Russian River discharge. This general channel design will be used instead of traditional mechanical breaching whenever the barrier beach closes and it is safe for personnel and equipment to work on the barrier beach.

1c) Alternate methods may include 1) use of a channel cut to the south if prolonged south west swells occur, and 2) use of the current jetty as a channel grade control structure (as described below) for maintaining water surface elevations up to 7-9 feet NGVD.

1d) If attempts to avert flooding using action 1b or 1c above fail to prevent a continued rise in the estuary's water surface level, flooding is imminent, and ocean conditions are such that repeated attempts to adaptively manage the estuary's water surface level described in 1b or 1c are not safely feasible, mechanical breaching may be used to breach the estuary as necessary to avoid flooding.

1e) If the barrier beach has not closed and the estuary's water surface level is not being maintained at >3.2 feet NGVD by June 15 of each year when river inflows should have receded to about 150 cfs, SCWA shall consult with NMFS and CDFG to consider the feasibility of changing the outlet location from the center of the beach to a longer more northerly outlet as described in 1b), and filling in the center outlet channel with sand from the beach. The change in channel configuration would likely need to be carried out at slack tide and may not be feasible under all hydraulic conditions in the outlet channel. Based on the feasibility of closing the sandbar mouth during the summer months and managing the estuary as a closed or perched estuary, SCWA will implement these changes.

NMFS, CDFG, and the Corps will be invited to observe implementation of the revised outlet channel design plan. An approximately one week notice will be provided.

Subsequent to the results of implementation, if needed, SCWA will revise the channel design plan in consultation with NMFS, CDFG, and the Corps. Adaptive estuarine water level and barrier beach management plans will be provided to NMFS, CDFG, and the Corps for their review, input, and approval by no later than April 1st in each year covered by this biological opinion.

2.1.2. Investigation of Jetty Impacts on Permeability and Lagoon Formation and Evaluation of Jetty removal

2a) If adaptive management of the outlet channel as identified in items 1b, 1c, and 1e above is not able to reliably achieve the targeted annual and seasonal estuary management water surface elevations by the end of 2010, SCWA will draft a study plan for analyzing the effects and role of the Russian River jetty at Jenner on beach permeability, seasonal sand storage and transport, seasonal flood risk, and seasonal water surface elevations in the Russian River estuary. That study will also evaluate alternatives for achieving targeted estuarine management water surface elevations via jetty removal, partial removal of the jetty, jetty notching, and potential use of the

jetty as a tool in maintaining the estuary water surface elevations described above. SCWA will consult with California State Parks, public trustee and manager of the beach at Jenner. If efforts identified in 1b, 1c, and 1e above are unable to achieve the estuary water surface elevation management targets, the study plan for the jetty will be submitted for NMFS and CDFG review and approval no later than June 30, 2011. SCWA will then conduct that study for which a report will be completed and submitted to NMFS and CDFG by no later than December 30, 2012.

2b) If the Jetty compromises the formation of a closed barrier beach in the spring and summer, and removal of the jetty does not appreciably increase flood risk, the Corps shall design a plan for removal of the jetty and fund its implementation.

2.1.3. Flood Risk Reduction

Because of the likely degradation of the barrier beach resulting from decades of mechanical breaching, and the effect of the jetty on beach permeability and barrier bar formation, it may be difficult to reliably achieve raised water surface elevation targets based on items 1b, 1c, and 1e above. Should those actions be unsuccessful in meeting estuarine water surface elevation goals, SCWA will evaluate, in coordination with NMFS and other appropriate public agencies, the feasibility of actions to avoid or mitigate damages to structures in the town of Jenner and low-lying properties along the estuary that are currently threatened with flooding and prolonged inundation when the barrier beach closes and the estuary's water surface elevation rises above 9 feet. Such actions may include, but are not limited to, elevating structures to avoid flooding or inundation. Because raising public and private structures to avoid flooding damage associated with restoration of natural estuarine function may have no realistic reversibility, the following actions for this RPA element shall not be implemented unless all three conditions described in 3c below are met.

a) SCWA shall develop a list of structures, properties, and infrastructure that would be subject to flooding/inundation as the result of sandbar formation and if the estuary were allowed to naturally breach. A completed list will be submitted to NMFS and CDFG within 18 months of the issuance of this biological opinion.

b) SCWA, shall identify possible funding mechanisms to provide grants or loans to property owners to avoid or mitigate damages to structures (by raising the structures or otherwise) that are commonly threatened by flooding when the estuary closes. For example, SCWA shall work with appropriate public and non-profit private agencies to identify, and if possible, obtain, funding assistance for avoidance and mitigation efforts.

c) If: 1) adaptive management of the outlet channel as identified in items 1b, 1c, and 1e above is not able to reliably achieve the targeted annual and seasonal estuary management water surface elevations by the end of 2013; 2) estuary monitoring indicates that freshwater or oligohaline (low salinity brackish) habitats, or temporary closure of the estuary provides substantial benefit to rearing juvenile steelhead similar to other closed lagoons on the California Coast; and 3) monitoring indicates no adverse impacts to other populations of Russian River salmonids are occurring from raised lagoon water surface levels; SCWA, in coordination with NMFS and other appropriate public and nonprofit agencies, shall, not later than May 1, 2014, attempt to negotiate

agreements with property owners to avoid or mitigate potential damages to the structures identified in 3a from flooding, either by elevating the structures or other methods. Such agreements will include identification of funding sources and initial schedule for initiation and completion of avoidance and mitigation work.

SCWA may, alternatively, pursue other actions that will result in the mitigation or avoidance of flood damage to the structures identified in 3a.

d) SCWA shall continue to implement the RPA's adaptive barrier beach management strategy until avoidance or mitigation measures are complete.

e) Not later than October 1, 2014, SCWA will provide quarterly reports to NMFS and CDFG describing progress toward: 1) developing funding mechanisms for avoidance and mitigation activities for flood prone structures in Jenner and 2) negotiating agreements with property owners, or 3) implementing other flood mitigation measures.

Monitoring/Reporting:
In addition to the monitoring and reporting requirements described above:

SCWA shall conduct and record during the year, on a monthly basis, or as determined necessary by NMFS, DFG, SCWA, and the Corps, surveys of the beach topography and outlet channel (including bar elevation). Additionally, SCWA shall place a time lapse video camera at a strategic location to record the interaction of waves, tides and the river mouth. This information will be used to determine the potential for flooding, analyze effects of marine and riverine sediment transport on beach morphology, and to aid in developing estuary and barrier beach adaptive management strategies. SCWA shall provide this information to NMFS, CDFG, and the Corps on a quarterly basis or as requested.

2.2 Monitoring Estuarine Water Quality

Changes in sandbar management are expected to alter water quality in the Russian River estuary by minimizing tidal influence and creating a brackish/freshwater lagoon environment during much of the year. Changing water quality dynamics should enhance the quality of juvenile salmonid rearing habitat in the estuary. Summer water quality in the Russian River estuary was monitored from 1996 to 2000 and from 2005 to 2006 (Merritt Smith 1997, 1998, 1999, and 2000; Sonoma County Water Agency and Merritt Smith Consulting 2001; Martini-Lamb et al. 2006 and 2007 *in preparation*). As part of this RPA, SCWA will 1) continue monitoring salinity, water temperature, dissolved oxygen, and pH during spring, summer, and fall months in the Russian River estuary, and 2) evaluate changes in these parameters as a result of adaptive sandbar management.

Methods:
Water quality monitoring methods are detailed in Martini-Lamb *et al*. (2006 and 2007 *in preparation*). Estuary water quality will be monitored during the spring, summer, and fall using multi-parameter, continuously-recording YSI 6600 water quality meters (sondes).

Sondes will be deployed at multiple stations in the lower, middle, and upper reaches of the estuary as shown on Figure 1 of Martini-Lamb et al. (2007). An additional station will be added in the upper reach between Sheephouse and Freezeout creeks. Stations in the deepest locations will consist of a concrete anchor attached to a steel cable suspended from the surface by a large buoy and an array of sondes. Sondes in the array will be attached to the cable and record water quality conditions at near bottom, mid-depth, and the surface (within 1 meter) of the water column. Some stations that are in more shallow locations may consist of one or two sondes, depending on water depth, that are cabled to the bank. Each station will be located in the deepest part of the channel to capture the fullest water quality vertical profile. The placement of sondes vertically at each station will also track anoxic events and determine if salinity or temperature stratification is present. Calibration will occur every three weeks and data will be downloaded and sondes cleaned during each event.

Sondes will collect hourly water temperature (degrees Celsius), D.O. (milligrams per liter), salinity (parts per thousand), pH, and specific conductance (mho). Monitoring these variables will show how water quality changes with sandbar conditions and how this may affect salmonid habitat in the estuary.

Sampling Frequency and Duration:
Deployment will occur once river flows and turbidity have declined to safe levels (mid-April to early May in most years). Sondes will be retrieved prior to the onset of winter rains (by early November in most years). Water quality will be annually monitored for the first 10 years of this project. Following review of the results of water quality monitoring in the first ten years of the project, the Corps, CDFG, and NMFS will evaluate with input from SCWA the need for additional water quality monitoring during the remaining years of the project. If determined to be necessary because of uncertainty regarding the effectiveness of estuarine water level management in minimizing impacts to listed salmonids, SCWA will conduct additional water quality monitoring.

Reporting and Review:
Water quality data will be summarized in annual reports. These data, along with the summaries, will be forwarded in a report to NMFS and CDFG within nine (9) months of each year's cessation of sampling. SCWA will provide NMFS and CDFG with the collected provisional raw water quality data quarterly or as real time data if the latter is available (*e.g*., estuary water elevation data).

The aforementioned research and monitoring program can be adapted in consultation with NMFS and CDFG pending results of the new sandbar management strategy (RPA 2.1). Adaptation can include changes in sampling frequency, design, and any other changes deemed necessary, including ending sampling prior to 2018 if the purpose and objectives of water quality sampling have been met. Any changes to the water quality sampling program will be forwarded to NMFS and CDFG for review and approval if appropriate.

2.3 Invertebrate Monitoring in the Estuary

Densities of steelhead appear to be low in the Russian River estuary, a condition that is likely due to reduced water quality (*e.g.*, elevated salinity and other water quality dynamics) as well as diminished production of invertebrates that are typically the forage base of juvenile salmonids. Invertebrates are good indicators of ecosystem productivity as their life cycles are closely linked to changes in water and habitat quality (Simenstad *et al*. 1991). Epibenthic invertebrates (primarily crustaceans and insects) are particularly important prey resources for salmon rearing in estuaries (Robinson 1993, Levings 1994). Efforts to enhance production of juvenile steelhead in the Russian River estuary via alterations of summer inflow and water level management practices will likely affect both water quality and invertebrate production in the estuary. It is important that the effects of adaptively managing estuarine water levels on aquatic biota be monitored in order to document improved conditions and avoid any adverse effects. At present, there is a paucity of information concerning invertebrate production in the Russian River estuary.

SCWA will monitor the effects of alternative water level management scenarios and resulting changes in depths and water quality (primarily salinity, dissolved oxygen concentration, temperature, and pH) on the productivity of invertebrates that would likely serve as the principal forage base of juvenile salmonids in the Russian River estuary. Specifically, SCWA will determine the temporal and spatial distribution, composition (species richness and diversity), and relative abundance of potential prey items for juvenile salmonids in the Russian River estuary, and evaluate invertebrate community response to changes in sandbar management strategies, inflow, estuarine water circulation patterns (stratification), and water quality. The monitoring of invertebrate productivity in the estuary will focus primarily on epibenthic and benthic marine and aquatic Arthropods within the classes Crustacea and Insecta, the primary invertebrate taxa that serve as prey for juvenile salmonids. The monitoring effort will involve systematic sampling and analysis of zooplankton, epibenthic, and benthic invertebrate species.

Methods for monitoring invertebrates:
For previous monitoring efforts, the SCWA divided the estuary into three reaches based on water quality (primarily salinity) patterns. The 6-km upper reach extends from Brown's Gulch (11.5 km from the river's mouth) to the confluence of Sheephouse Creek, the middle reach extends 4 km from Sheephouse Creek to the upstream end of Penny Island, and the lower 1.5-km reach extends to the mouth of the Russian River (Martini-Lamb et al. 2006 and 2007). These reaches are used to describe the study stations for the monitoring of invertebrates to be conducted in support of the new approach for managing estuarine water surface elevations.

The composition of invertebrate communities is directly related to habitat conditions within the estuary. Therefore, bathymetric maps that identify vegetated, unvegetated, coarse, fine (sand, silt), and mud substrates in the estuary will be developed prior to sampling. Habitats should be designated according to Cowardin *et al*. (1979) and include vascular plants and benthic algae assemblages. The final invertebrate sampling design will be based on the results of bathymetric maps, water quality sampling information, and estuarine bar condition. SCWA is encouraged to design the invertebrate monitoring program with the assistance of well qualified aquatic invertebrate researchers.

The bathymetry of the Russian River estuary is relatively complex and will likely require several sampling methodologies to adequately evaluate epibenthic and benthic assemblages occurring at various depths. Methods that may be employed include: nets, sleds, Ekman grabs, core borings, suction pump, artificial substrates, and quadrats. Systematic sampling will be conducted at a variety of sites, including three depth ranges along at least one cross-sectional transect in the downstream most reach, and three depth ranges along two transects in each of the upper and middle reaches. Thus, replicate sampling will occur at a minimum of five (5) longitudinal sites spaced approximately evenly along the lowermost 12 kilometers of the river. At a minimum the sampling design will include the spatial and temporal replication described in Table 30.

To further assess changes in invertebrate productivity relative to changes in sandbar condition and water quality, the SCWA will also monitor zooplankton. Zooplankton will be sampled by plankton tow or with a vertical profiling pump (Simenstad *et al*. 1991, Laprise and Dodson 1994) along transects throughout the estuary. Samples will be collected at a variety of sites, including at least one transect in the lower reach and at least two transects in each of the upper and middle

Table 30. Minimum spatial and temporal sampling effort for the annual monitoring of epibenthic and benthic invertebrates in the Russian River estuary during the months of May through October. Replicate samples will be collected at three distances (depth ranges) from shore.

Reach	Lower			Middle						Upper					
Month	M J J A S O			M J J A S O			M J J A S O			M J J A S O			M J J A S O		
Transect	1			2			3			4			5		
Distance from Shore (m)	0-15	15-30	30-45	0-15	15-30	30-45	0-15	15-30	30-45	0-15	15-30	30-45	0-15	15-30	30-45
Depth (m)	0-1	1-3	3+	0-1	1-3	3+	0-1	1-3	3+	0-1	1-3	3+	0-1	1-3	3+
Number Samples	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Total Monthly	9			9			9			9			9		
Total samples May-October	54			54			54			54			54		

reaches (Table 31). Assigning transects throughout the estuary should address the issue of patchy distribution exhibited by zooplankton in response to tidal and freshwater circulation. Zooplankton exhibit daily vertical movements through the water column in response to changes in salinity and light (Day *et al.* 1989; Simenstad *et al*. 1991), therefore samples will be collected at multiple depths at approximately the same time of day. A minimum sampling design should include the spatial and temporal replication shown in Table 31.

The monthly zooplankton monitoring strategy will be augmented once annually by post sandbar closure sampling 7 and 14 days after formation of a stable bar (Table 32). This post-closure sampling strategy will capture the effects of rapid changes in water quality on estuarine biota. The unpredictable nature of sandbar formation and persistence necessitate an adaptive sampling component to fill potential data gaps missed by monthly monitoring.

Water temperature, salinity, and dissolved oxygen levels will be recorded at each transect or sampling location during each sampling event at all depths sampled. A secchi disk will be used to measure turbidity. For zooplankton tows between the bottom and surface, water quality will be sampled near the bottom, mid-depth, and within 1 meter of the surface.

Table 31. Minimum spatial and temporal sampling effort for the annual monitoring of zooplankton in the Russian River estuary during the months of May through October. Tows at a mid channel station from the maximum depth to the surface are replicated three times at each transect.

Reach	Lower	Middle		Upper	
Month	M J J A S O	M J J A S O	M J J A S O	M J J A S O	M J J A S O
Transect	1	2	3	4	5
Distance from Shore (m)	Mid Channel	Mid Channel	Mid Channel	Mid Channel	Mid Channel
Depth (m)	Max to Surface	Max to Surface	Max to Surface	Max to Surface	Max to Surface
Number tows	3	3	3	3	3
Total Monthly	3	3	3	3	3
Total Annual	18	18	18	18	18

Samples will be collected and preserved for laboratory analysis using standard techniques. For each sample collected, organisms will be sorted and identified to the lowest practical taxonomic level, and for the Class Insecta identified to at least the family level using binocular dissecting microscopes as necessary. For each epibenthic and benthic sample, the following data will be determined:

1) Total abundance (number per unit area or volume) of each invertebrate taxa in each sample.
2) Diversity (utilizing the Shannon Weiner index or comparable metric)
3) EPT index
4) combined total abundance of individuals within the Order Amphipoda

For each zooplankton sample, total abundance of each taxa will be determined.

Table 32. A zooplankton sampling strategy for the Russian River estuary to capture changes in productivity 7 and 14 days after a sandbar closure event.

Reach	Lower						Middle												Upper											
Days Post Closure	7			14			7						14						7						14					
Transect No.	1			1			2			2			3			3			4			4			5			5		
Distance from Shore (m)	Mid Channel						Mid Channel						Mid Channel						Mid Channel						Mid Channel					
Depth (m)	Max to Surface						Max to Surface						Max to Surface						Max to Surface						Max to Surface					
Number Tows	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Total Closure	3			3			3			3			3			3			3			3			3			3		
Total Annual	6						12												12											

The SCWA will also provide a qualitative description of salmonid diet in the estuary. Gastric lavage will be used to evacuate the stomach contents of live steelhead from a variety of size classes (Light *et al*. 1983). Gut contents will be sampled approximately monthly as fish are captured using techniques identified in element 2.4, below. Measures of seasonal diet may include frequency of taxa occurrence and percent composition by number (Bowen 1996).

Bathymetric sampling will be completed prior to 2010 and invertebrates will be sampled from 2010 through 2019. The SCWA will monitor these parameters monthly between May and October (epibenthic and benthic invertebrates and zooplankton) and immediately after lagoon formation (zooplankton) when the sandbar is closed or "perched".

Reporting and Review:
Invertebrate monitoring data will be summarized and evaluated in annual reports. Successful evaluation of invertebrate communities in the estuary is dependent upon methodologies that will be affected by experimental manipulation of the sandbar (*e.g*., changes in water depths and flooded habitats). The aforementioned invertebrate monitoring program can be adapted in consultation with NMFS and CDFG pending results of the adaptive sandbar management strategy. Adaptation can include changes in sampling frequency, design, and any other changes deemed necessary, including ending sampling prior to 2019 if the purpose and objectives of invertebrate sampling have been met. Any changes to the invertebrate sampling program must be approved by NMFS and CDFG. Following review of ten years of results of estuarine invertebrate monitoring for the project, the Corps, CDFG, and NMFS will evaluate, with input from SCWA, the need for additional invertebrate monitoring during the remaining years of the project. If determined to be necessary because of uncertainty regarding the effectiveness of estuarine water level management in minimizing impacts to listed salmonids, SCWA will conduct additional invertebrate monitoring.

2.4 Monitoring of salmonids in the Estuary

As previously stated, changes in sandbar management that create a brackish/freshwater lagoon environment for prolonged periods during summer should enhance juvenile salmonid rearing habitat. A freshwater or perched lagoon environment will have measurably different water quality characteristics (both spatially and temporally) than the estuary under the current management regime. As part of this RPA, SCWA will 1) evaluate seasonal use of the Russian River estuary by juvenile salmonids and 2) study fish response to alternative breaching strategies and resulting changes in water quality.

Methods:
SCWA's Russian Estuary Monitoring Plan, initiated in 2005, has collected information on juvenile salmonid distribution, relative abundance, residence time, and habitat characteristics from early summer to late fall. For this RPA, SCWA will focus and expand these efforts to monitor the response of young-of-the-year steelhead with: 1) monthly beach seining at sites throughout the estuary, 2) fyke net trapping in the upper reach of the estuary, and 3) implantation of passive integrated transponder (PIT) tags.

The primary metric of fish abundance will be mean catch-per-unit-effort (CPUE) defined as the number of juvenile steelhead captured per seine net haul (Hubert and Fabrizio 2007). Net setting techniques recommended in Hahn *et al*. (2007) will be employed at fixed sites in discrete strata sampled repeatedly over time. Annual beach seining surveys will be performed monthly from May to October at 25 sites in each of two (upper and lower) estuary reaches for a total effort of 50 seine hauls per month or 300 total seine hauls per year. An analysis of SCWA's estuary seining data from 2005 to 2007 indicates that this level of sampling intensity is powerful enough to detect a two-fold change in fish abundance (100% difference) between sampling periods (months) and reaches (upper and lower). Should habitat conditions change markedly at the fixed sites over time as a result estuary management, the sampling scheme may need to incorporate adaptively selected sites. Sampling sites (and any changes to the sampling scheme) must be approved by NMFS and CDFG.

Fyke style trap nets in the upper estuary will provide information about the timing of downstream movements of juvenile fish, relative abundance, and the size/age structure of the population (O'Neal 2007). The primary objective of the trap operation is to capture young-of-the-year fish as they enter the estuary. SCWA surveys have identified a likely trapping location 10.5 km above the river mouth in the town of Duncans Mills upstream of the Moscow Road Bridge. SCWA will operate one or two fyke nets with wings. The precise location, number of fyke nets, and type of fyke net will be determined through consultation and with the approval of NMFS and CDFG. The annual period of trap operation is dependent on flow and water stage in the estuary but will generally extend from spring to mid-summer. The efficiency of trap nets will be tested using mark and recapture techniques (Bjorkstedt 2005).

All steelhead greater than 75 mm FL captured in fyke nets or seines will be implanted with PIT tags. Captured fish will be wanded to look for pit tags. The recapture of tagged fish may yield information about estuarine residence time, growth, and survival. Length and weight of all fish will be recording during initial and subsequent recapture. A handheld PIT tag reader must be carried by all field crews. Lengths and weights of fish will be recorded for fish captured at each seining station and fyke net or subsampled as appropriate.

Sampling Frequency and Duration:
Seining surveys will occur monthly from 2009 to 2018 between late spring and fall when river flow, measured at the USGS Hacienda Bridge Gaging Station in Guerneville, is below 300 cfs (typically May to October). Fyke net trapping will occur annually from 2009 to 2018. The initiation of fyke net trapping will also correspond to lower stream flow in spring. The trap net near the head of the estuary in the vicinity of Duncans Mills will be operated from spring (April) until catches decline to near zero (assumed to be in late July).

Reporting and Review:
Data will be summarized in annual reports. These data, along with summaries will be forwarded in a report to NMFS and CDFG within nine (9) months of each year's cessation of sampling. The aforementioned research and monitoring program can be adapted in consultation with NMFS and CDFG pending results of the new sandbar management strategy (RPA 2.1). Following review of the results of fish sampling in the estuary during the first ten years of the project, the Corps, CDFG, and NMFS will evaluate, with input from SCWA, the need for

additional fish sampling in the estuary during the remaining years of the project. If determined to be necessary, SCWA will conduct additional fish sampling in the estuary.

3. Dry Creek Habitat Enhancements

As currently managed, Dry Creek is a critical component of SCWA's Project. The lower 14 miles of the creek conveys flow from the water supply pool in Lake Sonoma to satisfy municipal water demands in Sonoma and Marin counties. Yet, the Dry Creek watershed is also one of the few Russian River tributaries supporting populations of steelhead, coho salmon, and Chinook salmon. DCFH, located at the base of WSD, annually releases about 300,000 yearling steelhead into Dry Creek. The RRCSCBP has released native Russian River origin juvenile coho salmon into one of Dry Creek's tributaries since 2004. Monitoring associated with this Broodstock Program has also detected multiple year-classes of wild (non-program origin) coho salmon in the Mill Creek watershed, a tributary of Dry Creek. Other monitoring has documented extensive use of Dry Creek by spawning Chinook salmon and steelhead. The release of cold hypolimnetic water from Lake Sonoma into Dry Creek provides potentially valuable, abundant rearing habitat for listed salmonid species. However, current (and anticipated future) water releases to Dry Creek in the summer and fall create high water velocities in Dry Creek that severely limit the quantity and quality of salmonid rearing habitat in Dry Creek, regardless of water temperature. Limited rearing habitat hinders the conservation of CCC coho salmon and CCC steelhead, as previously described in this biological opinion. High current velocities, extensive channel incision, and bank erosion limit both the quantity and quality of Dry Creek's winter and summer rearing habitats for juvenile steelhead and coho salmon.

There are probably only three basic approaches to minimizing adverse effects of high summer flow releases on rearing habitat for coho salmon and steelhead: 1) water releases from WSD could be reduced, 2) Dry Creek's channel could be modified to accommodate a higher flow that sustains good quality habitat, or 3) high flow releases could be bypassed around Dry Creek via a pipeline. Immediate substantial reductions in the flows released from WSD during summer would very significantly impact water supply in Sonoma County and Marin County, because Lake Sonoma is the principal municipal water supply for much of Sonoma County and northern Marin County and Dry Creek is an integral part of the county's water transmission system. Therefore, remediation of impacts of high flow releases on salmonid rearing habitat and listed species along 14 miles of Dry Creek would likely require either a major bypass pipeline or substantial alterations in the morphology and structure of the Dry Creek stream channel. Major alterations of the Dry Creek channel would likely need to not only address effects of current levels of flow releases, but also accommodate potential increased flow releases that may result from SCWA's pending application to the SWRCB for additional rights for water held in Lake Sonoma. Channel alterations would require numerous landowner agreements and possibly require acquisition of riparian lands by SCWA. To be implemented, a bypass pipeline would require comprehensive analysis of feasible alternatives, engineering design, considerable efforts for environmental permitting, funding initiatives, and construction. Based on previous analysis by SCWA and NMFS, a major pipeline cannot likely be completed until year 14 or 15 of the 15 year period covered by this biological opinion. For that reason, the bypass pipeline alternative is problematic; under a pipeline option, 14 miles of Dry Creek would remain adversely modified

for an extended time, the entire life of the 15 year project. Therefore, the best approach for addressing the effects of high flow releases at WSD on salmonid rearing habitat is to implement and monitor on-the-ground enhancements of rearing habitat that will avoid adverse modification of critical habitat and appreciably increase the survival of juvenile salmonids in Dry Creek during both summer and winter months.

Although it is reasonably certain that reaches of the Dry Creek channel can be modified to create conditions conducive to the production of steelhead and coho salmon, given the complexity of major habitat enhancements and influences of uncontrollable factors such as major flood events, it will be important to monitor both physical and biological responses to the habitat enhancement structures. In addition, to ensure that adverse modification of critical habitat in Dry Creek is avoided, it would be appropriate to conduct feasibility analysis, conceptual design, preliminary environmental impact assessment, and costing of a Dry Creek bypass pipeline to be implemented if monitoring determined that habitat enhancements to Dry Creek are unsuccessful in generating substantial good quality rearing habitat for coho salmon and steelhead.

This element of the RPA contains two separate actions: 3.1) the enhancement of coho and steelhead rearing habitat along reaches of Dry Creek and its tributaries and 3.2) feasibility and preliminary environmental assessments of a Dry Creek bypass pipeline

3.1 Enhancement of Salmonid Rearing Habitat in the Dry Creek Watershed

The Corps and SCWA will substantially enhance the quantity and quality of rearing habitat for juvenile steelhead and coho salmon in the 14 mile segment of Dry Creek downstream of WSD. To do this, SCWA will enhance low flow season, pool-riffle habitat along the 14 mile segment and install additional large boulder clusters to provide velocity refuges and habitat for juvenile steelhead and coho salmon. The Corps will enhance winter habitat at points along the margins of Dry Creek. As discussed below, these enhancements will be distributed at several locations along Dry Creek and the timing of their installation will be staggered to begin by Year 5 and be completed by Year 12. Because the initial design, permitting, and construction of this work will take up to five years to complete, SCWA will restore or otherwise enhance rearing habitat for salmonids in tributaries that enter Dry Creek downstream of WSD or in other Russian River tributaries supporting coho salmon and steelhead by the end of Year 3 covered by this opinion.

3.1.1 Enhancement of Salmonid Rearing Habitats in Dry Creek

The enhancement of Dry Creek will convert sections of stream containing marginal or poor quality salmonid rearing habitat due to high current velocities and minimal instream cover (*e.g.*, absence of large woody debris) to near optimal quality habitats so that, when WSD releases are 110 to 175 cfs, at least six miles of Dry Creek contains excellent quality habitats for rearing coho salmon and the remaining reaches are enhanced with large boulder clusters, as described by Flosi *et al*. (1998). Flows of 110 to 175 cfs represent the range of high summer flows in Dry Creek during the past decade (USGS gage 11465000) that have been shown to adversely affect summer rearing habitat for coho salmon and steelhead (see Section VI.F). The habitat enhancement project will create both winter and summer rearing habitats for juvenile steelhead and coho salmon, with an emphasis on improving habitats for the survival of juvenile coho salmon.

Enhancement of Summer Rearing Habitat

Depth, velocity and cover preferences of rearing coho salmon during the low flow season are well documented. Beecher *et al.* (2002) state that juvenile coho salmon in western Washington streams in summer showed greatest preference for depths ranging from 0.46 to 1.2 meters, similar to the depths used by introduced coho salmon in New York (Sheppard and Johnson 1985), and juvenile coho in central California (Shapovalov and Taft 1954), experimental stream channels on Vancouver Island (Ruggles 1966), western Washington (Lonzarich and Quinn 1995), and Alaska (Bugert *et al*. 1991). Beecher *et al*. (2002) also provide velocity preference information for juvenile coho salmon:

> *"The greatest preference for velocity in summer in this study was 3-6 cm/s* [0.1-0.2 ft/s], *similar to values found in other studies of juvenile coho salmon (Ruggles 1966; Bovee 1978; Sheppard and Johnson 1985; Bisson et al. 1988; Murphy et al.1989; Dolloff and Reeves 1990; Bugert et al. 1991; Shirvell 1994; Peters 1996). Puckett and Dill (1985) calculated the stationary swimming speed of territorial juvenile coho salmon, based on tailbeat frequency, at just under 10 cm/s. Slow water velocity is related to juvenile coho salmon distribution (Murphy et al. 1989), holding capacity (Ruggles 1966), and habitat use (Bisson et al. 1988; Peters 1996).*

Good quality juvenile coho salmon habitat also contains substantial instream structure such as large woody debris and log jams and low overhanging vegetation that provide cover, velocity refugia, and sources of invertebrate production (Sandercock 1991; Giannico 2000). Juvenile coho also need abundant complex instream structures and sidepool alcoves that provide ample velocity refugia during the high flows of winter (Bustard and Narver 1975; Nichelson *et al.* 1992). Raleigh *et al*. (1984) states that high quality pools for juvenile and adult rainbow trout and steelhead during the late growing season, low flow period have more than 30% of the pool bottom obscured due to depth, surface turbulence, or the presence of structures such as logs, debris piles, boulders, or overhanging banks and vegetation. McMahon (1983) reports that juvenile coho salmon prefer streams with about one-third to two-thirds pool habitat (*i.e.*, McMahon rates streams with 33 to 67 percent pools as having Habitat Suitability Index values of 80% or higher). McMahon (1983) also provides the results of Nicholson and others, who found that during the low flow season in Oregon, good quality pools for coho salmon are 10 to 80 m^3 or 50 to 250 m^2. Conditions providing a combination of depths ranging from 2 to 4 ft, mean column velocities of 0.1 to 0.2 ft/s, ample large woody debris, and sidepool alcoves providing high quality shelter during both low and high flow events also support rearing steelhead (Raleigh *et al*. 1984; Bjornn and Reiser 1991).

The reduction of impacts from high current velocities during the low flow season (June through October) will be accomplished by modifying the Dry Creek channel so that, at flow releases of 110 to 175 cfs, six miles of Dry Creek is contoured to create six miles of high quality riffle and pool habitat for coho salmon with a pool:riffle ratio ranging between 1:2 and 2:1, with all pools providing good quality depth, velocity, cover, and size during the low flow season, using the above described criteria. The riffle: pool habitat enhancements will not be concentrated in a contiguous six miles of stream, but rather will be distributed across eight or more sites including

sites in the upper, middle, and lower portions of Dry Creek. Dry Creek contains a few existing pools (probably with inadequate cover) that may be incorporated into the six miles of riffle:pool enhancements if they can be upgraded to meet the depth, velocity, and cover criteria when flow releases from WSD range from 110 to 175 cfs. In addition, to these channel modifications, a minimum of 20 large boulder clusters will be installed in locations outside of the six miles of stream that are modified to form excellent quality riffle:pool sequences for production of steelhead and coho salmon. As described by Flosi *et al*. (1998), boulder clusters create velocity refuges for resting migrating spawners and rearing habitat for juvenile salmonids. Boulder clusters provide a relatively inexpensive means to create additional velocity refuges for rearing salmonids, especially steelhead that are less dependent on deep pools with abundant cover than juvenile coho salmon (Hartman 1965; Sheppard and Johnson 1985; Bisson *et al*. 1988).

The creation and enhancement of at least six miles of modified channel with high quality pool-riffle sequences with a minimum 1:2 pool-riffle ratio will ensure the creation or enhancement of at least 2.0 miles of high quality pool habitat in Dry Creek. Riffle habitats adjacent to the enhancement zones will also become useable by fishes that periodically leave pools or velocity refuges to forage in higher velocity riffle-run habitats. SCWA will monitor physical habitat conditions and the abundance and microhabitat use of each habitat enhancement site both prior to construction and for at least five years after construction.

SCWA will enhance salmonid rearing habitat in Dry Creek using a five phase approach to construction:

1. two years of conceptual project design and planning;

2. two years for project review, permitting, and pre-monitoring;

3. two years of initial construction of at least one mile of modified stream channel providing excellent quality coho summer rearing habitat with a pool-riffle ratio ranging between 1:2 and 2:1, plus installation of 10 boulder clusters in reaches not otherwise enhanced;

4. two years of construction (years 8 and 9 covered by this opinion) of an additional two miles of modified stream channel providing excellent quality coho summer rearing habitat with a pool-riffle ratio ranging between 1:2 and 2:1, plus the installation of ten additional large boulder clusters in reaches not otherwise enhanced; and

5. two years of construction (years 11 and 12 covered by the opinion) of an additional three miles of modified stream channel providing excellent quality coho summer rearing habitat with a pool-riffle ratio ranging between 1:2 and 2:1.

Table 33. Schedule for the design, construction and monitoring of enhanced salmonid habitats in Dry Creek in response to high seasonal flow releases from WSD.

Year:	'09	'10	'11	'12	'13	'14	'15	'16	'17	'18	'19	'20	'21	'22	'23
Phase:	I		II		III			IV			V		VI		
Engineering Design	Conceptual Design		Permitting & final design: 1st pool:rifflemile		Permitting & final design: 2nd & 3rd pool:riffle mile			Permitting & final design: pool:riffle miles 4-6							
Engineering Construction					Construct 1st mile			Construct miles 2 &3			Construct miles 4,5,6				
Design evaluation & Adaptive Mgmt						Evaluate mile 1 work & boulder clusters			Evaluate miles 2 &3 & boulder clusters			Evaluate enhanced miles 4, 5, and 6			
Monitoring:		Premonitoring			Pre and Post-monitoring						Pre and Post-monitoring				

With support from qualified habitat restoration specialists, SCWA will conceptually design habitat enhancement projects after considering alternative potential sites, availability of potential access, physical constraints, and costs and benefits for alternative designs. The designs will also consider the likely biological potential (quantity and quality of summer and winter rearing habitat) of alternative enhancement designs for individual sites. The project design for the habitat enhancement projects will include geomorphic, hydraulic, biologic, and engineering analyses. Conceptual designs will consider a variety of restoration techniques such as log or rock weirs, deflectors, log jams, constructed alcoves, side channels, backwaters, and dam pools that have successfully increased the quantity and quality of summer and winter rearing habitat for coho and steelhead (Cederholm *et al.* 1997; Solazzi *et al*. 2000; Roni and Quinn 2001; Roni *et al*. 2005).

From this analysis and design, habitat enhancement options will be generated focusing on appropriate life stages and the goal of species recovery. Working with local land owners, DFG, and NMFS, SCWA will prioritize options for implementation.

It is anticipated that the conceptual design of at least eight projects that enhance six miles of Dry Creek with high quality riffle-pool habitats for coho salmon plus approximate locations and design of the additional 10 boulder clusters will be completed in 24 months. Upon completion of the conceptual design of this habitat enhancement work, SCWA will provide copies of the designs and their descriptions to NMFS and DFG for review and approval. During years 3 and 4 of the period covered by this opinion, SCWA will conduct final design, obtain necessary permitting for the project, conduct pre-project monitoring at treatment and control sites, and select a construction contractor. Physical habitat monitoring will include habitat mapping and documentation of depth, velocity, and cover conditions along a series of cross-sectional transects within each habitat enhancement site. Biological monitoring techniques could include downstream migrant trapping, PIT tagging to evaluate movement, snorkel surveys and

electrofishing. A plan for physical and biological monitoring protocol will be prepared and submitted to NMFS and CDFG for review and approval. The first mile of habitat enhancement work and ten additional boulder clusters will be constructed by the end of Year 6. During construction, if project implementation requires the dewatering of aquatic habitat, SCWA will relocate any fish, including listed salmonids, from areas to be dewatered. Relocated fish will be placed in appropriate aquatic habitat upstream or downstream of enhancement sites. Following construction of Phase III enhancement sites (one mile), SCWA will conduct post-construction monitoring at Phase III treatment and control sites for five consecutive years. Post-construction monitoring will evaluate project implementation (construction), effectiveness (physical habitat response), and validation (biological response) as described below.

In Phase III, SCWA will also design and permit enhancement projects (modification of habitat in another 2 miles of stream) that will be constructed during Phase IV (Years 8 and 9 covered by the opinion). Projects to be constructed during Phase V (Years 11 and 12 covered by the opinion) will be designed and permitted during Phase IV. Upon completion of the conceptual design of habitat enhancement work to be done in Phases IV and V, SCWA will provide copies of the designs and their descriptions to NMFS and DFG for review and approval for construction. As described for Phase III construction, if construction during Phase IV and V requires the dewatering of aquatic habitat, SCWA will relocate any fish, including listed salmonids, from areas to be dewatered. Relocated fish will be placed in appropriate aquatic habitat upstream or downstream of enhancement sites.

Prior to construction of Phase III, IV, and V enhancement projects, SCWA will develop and submit to NMFS and CDFG for review and approval, a post-construction adaptive management, monitoring, and evaluation plan that will identify project goals, objectives, and success criteria.

The goal of the plan will be to monitor the populations and the habitat they live in (*i.e.*, coho salmon and steelhead in Dry Creek and the enhanced tributaries associated with the RPA) over multiple years (pre- and post-restoration and enhancement) to detect change from the treatment conditions and distinguish between background noise or non-treatment variables. Pre-project monitoring would collect multiple years of data before habitat restoration and enhancement efforts are applied at treatment sites in Dry Creek, and post-restoration/enhancement monitoring would encompass the adjustment phase of the stream habitat and fish populations to the work and subsequent changes to the conditions of the habitat and population. Reference control sites will be identified and monitored such that background noise and confounding variables can be evaluated and treatment reaches compared to the new conditions of the stream and habitat.

Objectives should be clearly identified (*e.g.*, improve habitat conditions, lengthen freshwater residency, increased over-summer/winter survival, increased macroinvertebrate productivity, with measurable attributes (*e.g.*, increased depth,/cover)).

Success criteria should be based on expected physical and biological responses of each objective (*e.g.*, improved rearing habitat, longer residency, successful rearing, successful spawning, *etc.*). Success criteria will also identify post-project treatment measures which will be initiated if the expected target criteria are not met.

Following construction of Phase III, IV and V enhancement projects, SCWA will implement a NMFS and CDFG approved post-construction adaptive management, monitoring and evaluation plan. SCWA will conduct for five consecutive years post-construction monitoring that will measure the projects ability to meet satisfactory physical and biological response criteria at each treatment and control site. Following the protocols of CDFG (2003) and Duffy (2005) and in consultation with NMFS and DFG, that post-construction monitoring will include:

1. implementation monitoring to determine if the habitat enhancement/restoration was done according to the approved design,
2. effectiveness monitoring to determine if the restoration is having the intended effect on physical habitat quality, and
3. validation monitoring to assess whether the habitat enhancement/restoration work is achieving the intended objective (i.e., creating habitat that is inhabited by listed salmonids and appreciably improves the production and survival of rearing steelhead and coho salmon in Dry Creek).

Based on the results of annual post-construction monitoring, SCWA, at the discretion of NMFS and CDFG, will re-visit engineering techniques and approaches for addressing minimization of effects of high flow releases from WSD on rearing salmonids. If deemed necessary by NMFS and CDFG, SCWA, at the direction of NMFS and CDFG, will appropriately modify the habitat enhancement sites or implement alternative enhancement projects. The monitoring in the year following Phase IV construction (*i.e*., during Year 10) will be a key milestone for evaluating the efficacy of the habitat enhancement program for Dry Creek. In Year 10, SCWA, in consultation with NMFS and DFG, will evaluate the success of the habitat enhancements conducted in Phase III and IV prior to undertaking major efforts scheduled for Phase V.

Enhancement of Winter Rearing Habitat

Juvenile steelhead and coho salmon utilize markedly different habitats during winter and summer (Bustard and Narver 1975; Quinn 2005). During the high flows of winter, coho salmon typically seek off-channel habitats in low velocity areas with substantial cover (Tschaplinski and Hartman 1983). Quinn (2005) states that during winter, salmon (particularly coho salmon) move from inhospitable main channel areas to flooded wetlands, beaver ponds, tributaries, and a variety of off-channel habitats. Bell (2001) documented increased fidelity and survival of winter rearing juvenile coho salmon in alcoves and backwaters in a Northern California stream. Others have documented increased densities of coho salmon in side-channel pools (Bjornn and Reiser 1991).

The 14 mile segment of Dry Creek below WSD lacks natural sinuosity, backwaters, and natural floodplains as the result of stream channelization processes. These conditions have appreciably reduced the availability of potential winter rearing habitat for coho salmon. Ongoing channel maintenance in Dry Creek helps to maintain these conditions. As a result, over-wintering coho are likely displaced by high flows associated with flood control releases.

To address this problem, the Corps will assist SCWA in the design of the eight summer habitat enhancement sites described above, so that each of these sites will include winter habitat for coho salmon. The design for salmonid winter habitat enhancements will be integrated with the summer habitat enhancement projects to be reviewed by NMFS and DFG. The Corps will be

responsible for implementing channel modifications that insure the presence of low velocity refugia with instream cover adequate to protect coho salmon during flow releases of 2500 to 6000 cfs. To promote the longevity of the enhanced winter habitats, banks will be stabilized using bioengineered approaches.

3.1.2 Enhancement of Salmonid Rearing Habitats in Tributaries to Dry Creek and the Russian River

Because of the endangered status of coho salmon and because enhancements of Dry Creek habitats will likely not be constructed until five years after completion of the biological opinion, it is important that SCWA take actions to promote the survival and recovery of coho salmon in the Dry Creek watershed prior to year 5 of the project. NMFS, DFG, and SCWA have identified several projects that would benefit the survival of coho salmon in tributaries of Dry Creek and the Russian River that have significant potential coho salmon rearing habitat. These projects include:

1. Crane Creek Fish Passage Access Project

NMFS (2007) found that the extreme lower portion of Reach 1 on Crane Creek is severely incised due to previous gravel mining and channelization activities in Dry Creek. The most severe evidence of down-cutting is in the downstream-most 100 yards of the stream up to the point of a head-cut that presents a partial or complete barrier to salmonids depending on flows, species, and life stage. SCWA will improve fish passage conditions for multiple species and life stages of salmonids with the lower section of Crane Creek. Structure type and anchoring technique, if needed, will be identified and must be reviewed at higher flows. The design for this work must be reviewed for approval by NMFS and the DFG Fish Habitat Specialist. There are 2 landowners within this reach, and they both granted NMFS access in 2007. This reach is a complete upstream migration barrier for juvenile coho salmon and steelhead, and it is partial migratory barrier for adult salmonids. Removal of this barrier would improve passage conditions for adult coho salmon and steelhead by a 25% improvement factor[75] (B. Coey, DFG, personal communication) and restore access to approximately 4021 m^2 spawning and rearing habitat. Estimated cost for this work is $10,000.

2. Crane Creek In-stream Habitat Improvement Project

NMFS (2007) found pool frequency is high within Crane Creek and includes a moderate to high number of pools with adequate depth; however, pool shelter is low in reaches 1 and 2. Some areas within this reach are incised and highly erosive and would benefit greatly from additional bio-engineering bank stabilization techniques, increased riparian setbacks, streambed toe stabilization, large woody debris (LWD)/ boulder structures and native re-vegetation. A typical project to restore in-stream habitat conditions within Crane Creek may include the installation of LWD and boulder structures (*e.g.*, plunge weirs, boulder and log weirs, digger logs, cover structures, *etc.*) on a ***reach level***. Installation of at least 25 complex LWD and boulder structures within a 4000 ft section of Crane Creek would enhance approximately 645 m^2 of tributary rearing habitat for coho salmon and steelhead. DFG estimates that this project would require a 50% improvement factor for the enhanced stream

[75] The amount of time that adult salmonids would be able to successfully pass upstream would be increased by 25%.

habitat, *i.e.*, increase the numbers of salmonids in restored reaches by 50% (B.Coey, DFG, personal communication). Additional habitat improvement projects including bio-engineered bank stabilization techniques, increased riparian setbacks, streambed toe stabilization, and native revegetation may substitute the LWD project mentioned above, but must contain an equal improvement value of 50%. Structure type, anchoring techniques, and habitat improvement factors will need to be identified and then reviewed for approval by NMFS and the DFG Fish Habitat Specialist. The section that contains the lowest shelter values begins 4300 ft from the confluence of Dry Creek and extends upstream for an additional 4000 ft. There are three landowners within this segment, and they all granted NMFS access to assess stream habitat conditions in 2007. The estimated Cost for this work is about $75,000 to $100,000.

3. Grape Creek Fish Passage Enhancement Project

NMFS (2007) identified artificial structures that are passage barriers for one or more life stages of anadromous salmonids within the Grape Creek Watershed. Taylor *et al*. (2003) prioritized 78 stream crossings that should be addressed to improve fish passage in the Sonoma County portion of the Russian River Basin. The West Dry Creek Road crossing was ranked 14 as a high priority for removal. Some of the grade control structures installed to address fish passage at this crossing may also impede fish passage at moderately low flows. Coho salmon already are able to pass through this culvert at certain flow levels; however, changes in the hydraulics within the culvert could extend the amount of time that the culvert is passable, increase the likelihood that coho would successfully migrate past this road crossing, and potentially increase the number of adult coho salmon and steelhead that might spawn in this stream. To successfully implement this project, SCWA will utilize designs currently being developed under contract with DFG to implement fish passage improvements via complete removal (natural channel bottom) or retro-fit (*i.e.*, curbing and baffles) within the existing county culvert. The grade control structure immediately downstream of the culvert will be adjusted to match the new channels modified elevation to allow fish passage for all life stages of salmonids. Designs shall meet DFG/NOAA criteria and be approved by NMFS and DFG prior to construction. Implementation of significant enhancements of fish passage opportunity at the existing county culvert and the grade control structures immediately downstream of this culvert would increase opportunities for coho salmon to access approximately 1977 m^2 of spawning and rearing habitat. DFG estimates that this project would approximately double the opportunity for migrating adult salmon and steelhead to ascend Grape Creek (B.Coey, DFG, personal communication). Estimated cost would be dependent on the method used to enhance passage opportunity and range from about $50,000 to about $300,000. Provision of an arched culvert with a natural channel bottom would likely provide the greatest improvement in passage opportunity for this important salmonid stream and would be the more expensive alternative.

4. Grape Creek In-stream Habitat Improvement Project

NMFS (2007) found low pool shelter ratings throughout all reaches in Grape Creek and recommended the installation of cover structures in existing pools to promote recovery of coho salmon and steelhead. The quality and quantity of spawning and rearing habitat in this stream can be increased through the implementation of habitat improvement projects including bio-engineered bank stabilization techniques, increased riparian setbacks,

streambed toe stabilization, log and boulder structures (*e.g.*, plunge weirs, boulder and log weirs, digger logs, cover structures) and native re-vegetation on a ***reach level***. SCWA will enhance spawning and rearing habitat conditions by a 50% improvement factor in 730 m^2 of Grape Creek (this will likely require enhancements in roughly 2000 linear feet of stream) Structure type, anchoring techniques and habitat improvement factors specific to each site will need to be identified, reviewed and approved by NMFS and the DFG Fish Habitat Specialist. The section that contains the lowest shelter values begins 5600 ft from the confluence of Dry Creek and extends upstream for 1000 ft; the second section for this project begins 9800 ft from the confluence of Dry Creek and extends upstream for 1000 ft. There are three landowners bordering the lower section and three landowners bordering the upper section. Estimated cost for this effort is $75,000 to $100,000.

5. Wine Creek In-stream Habitat Improvement Project

NMFS (2007) assessed habitat conditions on Wine Creek, a tributary of Grape Creek, and found low pool shelter ratings and low pool to riffle ratios in the lowermost five reaches. In the fall of 2007, twelve log and boulder weir structures were installed to provide velocity refuge, cover, and deeper pools for spawning salmonids, and to trap and sort suitable spawning gravels throughout the first portion Reach 1. Further improvements of the riparian zone in Reach 1 could address bank erosion, reduce sediment inputs, lower stream temperatures, buffer urban and agricultural runoff, and complete habitat improvements in Reach 1. Additional work is also needed in the upstream reaches to alleviate the low shelter ratings and low pool to riffle ratios.

To improve the quality of salmonid habitats in Wine Creek, SCWA will improve the riparian zone in Reach 1 by utilizing bio-technical approaches to treat bank erosion and enhance low canopy areas by planting and (maintaining newly planted) native, overstory tree species. In addition, SCWA will restore upstream reaches through the installation of 12 LWD and boulder structures (*i.e.*, plunge weirs, boulder and log weirs, digger logs, cover structures). Those installed instream structures will be placed in Wine Creek along the 2500 ft long segment immediately upstream from a point 2900 ft above the confluence with Grape Creek (*i.e.*, DFG reaches 2, 3, and 4). Structure type and anchoring technique for each structure will need to be identified and then reviewed and approved by NMFS and the DFG Fish Habitat Specialist. There are 6 landowners within this section, and they all granted access to NMFS in 2007. We estimate that this project will enhance carrying capacity by about 25% in about 390 m^2 of habitat (B.Coey, DFG, personal communication) in Wine Creek and cost approximately $50,000 to $75,000.

6. Wallace Creek Fish Passage Enhancement Project-

NMFS identified artificial structures that are passage barriers for one or more life stages of anadromous salmonids within the Wallace Creek Watershed. Taylor *et al.* (2003) prioritized 78 stream crossings that should be addressed to improve fish passage in the Sonoma County portion of the Russian River Basin. The Wallace Creek Rd/Mill Creek Rd crossing was ranked as a high priority for removal. Adult salmonids are likely already able to pass through this culvert at certain flow levels; however, changes in the hydraulics within the culvert could extend the amount of time that the culvert is passable, increase the likelihood that coho would successfully migrate past this road crossing, and potentially increase the

number of adults that might spawn in this stream. Remediation would enhance passage opportunity for adult coho salmon and steelhead by a 50% improvement factor, thereby likely increasing the potential production of these species in about 5990 m^2 of stream (B.Coey, DFG, personal communication). SCWA will utilize designs currently being developed under contract with DFG to implement fish passage improvement via complete removal (natural channel bottom) or retro-fit (*i.e.*, curbing and baffles) within the existing county culvert . Designs shall meet DFG/NOAA criteria and be approved by DFG Fish Passage Engineers prior to construction. Estimated cost would be dependent on the method used to enhance passage opportunity and range from about $75,000 to about $300,000. Provision of an arched culvert with a natural channel bottom would likely provide the greatest improvement in passage opportunity for this important salmonid stream and would be the more expensive alternative.

7. Purrington Creek Fish Passage Enhancement Project

The DFG has identified artificial structures that are passage barriers for one or more life stages of anadromous salmonids within the Purrington Creek watershed. One of the Sonoma County road crossing culverts on Purrington Creek has been identified as a partial barrier to adult and juvenile coho salmon and steelhead. SCWA will utilize designs currently being developed under contract with DFG to implement fish passage improvement via complete removal (*i.e.*, natural channel bottom) or retro-fit (e.g. curbing, baffles) within the existing county culvert. Designs shall meet DFG/NOAA criteria and be approved by DFG Fish Passage Engineers prior to construction. Remediation would enhance passage opportunity for adult coho salmon and steelhead by a 50% improvement factor, thereby likely increasing the potential production of these species in about 2650 m^2 of stream (B.Coey, DFG, personal communication). Estimated cost would be dependent on the method used to enhance passage opportunity and range from about $75,000 to about $300,000. Provision of an arched culvert with a natural channel bottom would likely provide the greatest improvement in passage opportunity for this important salmonid stream and would be the more expensive alternative.

8. Willow Creek Fish Passage Enhancement Project

Willow Creek is a tributary to the lower Russian River that once supported an abundant sub-population of coho salmon. The creek continues to support significant potential spawning rearing habitat; however, access to that habitat is blocked by impassable road culverts and a shallow braided channel that passes through forested wetland. DFG has identified artificial structures that are passage barriers for one or more life stages of anadromous salmonids within the Willow Creek Watershed. A Sonoma County road crossing culvert has been identified as a complete barrier to salmonids and a partial barrier to bedload associated with impacted watershed conditions. DFG has funded road improvement projects on private and public roads to reduce non-point source sediment and non-profit entities have implemented improvements to point-source sediment sources. The California State Parks and Stewards of the Coast and Redwoods, a non-governmental environmental organization, have funded the engineering design and completion of the CEQA document for the improvement of fish passage opportunity at the "2nd Bridge" on Willow Creek. The 80% engineering design is scheduled for completion by May 2008; CEQA documentation is scheduled for completion by September 2008. The project will likely be able to be constructed during 2008; however, the remaining engineering design and project construction will need funding. SCWA will

support this fish passage enhancement project by State Parks by funding $100,000 of the construction costs. This project will help restore adult coho salmon and steelhead access to 9480 m^2 of spawning and rearing habitat for these species. The passage project will improve passage for adult salmonids by a 50% improvement factor (B.Coey, DFG, personal communication).

9. Mill Creek Fish Passage Improvement

In Mill Creek, tributary to Dry Creek, a significant barrier (a recently undermined flashboard dam on private property) exists midway in the watershed which is a partial barrier to migration for adult and juvenile coho and steelhead. SCWA will seek landowner permission to design and implement a step pool fishway through the crossing footprint which stabilizes the stream channel, and provides passage to pristine upstream habitat. Remediation would enhance passage opportunity for adult coho salmon and steelhead by a 50% improvement factor, thereby likely increasing the potential production of these species in about 23,760 m^2 of stream (B.Coey, DFG, personal communication). The estimated cost of this highly important project is $100,000 to $200,000.

10. Redwood Creek Fish Passage Improvement Design-

Redwood Creek, tributary to Maacama Creek, is a documented coho stream in the Knights Valley area of the Russian River watershed. A significant barrier (a recently undermined Arizona concrete crossing) exists midway in the watershed which is a complete barrier to migration for adult and juvenile coho and steelhead. SCWA will design and implement a step pool fishway through the crossing footprint which stabilizes the stream channel, and provides passage to pristine upstream habitat. Remediation would enhance passage opportunity for adult coho salmon and steelhead by a 50% improvement factor, thereby increasing the potential production of these species in about 3950 m^2 of stream (B.Coey, DFG, personal communication). The estimated cost of this project is $200,000 to $300,000.

If project implementation requires the dewatering of aquatic habitat, SCWA will relocate any fish, including listed salmonids, from areas to be dewatered. Relocated fish will be placed in appropriate aquatic habitat upstream or downstream of enhancement sites. Implementation of some of these projects would involve enhancement of stream habitat on private lands, others involve activities on public lands (*e.g.*, public road crossings). SCWA will attempt to gain access and permission to complete the above projects on private lands; however, at a minimum SCWA will implement at least five of the above projects on Dry Creek tributaries by end of year 3 of the 15 year period covered by this biological opinion. Any combination of five (5) stream habitat enhancement projects and/or fish passage improvement projects will provide habitat or access to habitat with resulting increases in the survival of juvenile steelhead and coho salmon until those individuals reach the downstream migratory (smolt) stage.

Prior to constructing the five or more habitat enhancement projects or fish passage improvement projects in Russian River tributaries, SCWA will develop and submit to NMFS and CDFG for review and approval, a post-construction adaptive management, monitoring, and evaluation plan for these projects. The monitoring and evaluation plans for these projects will identify goals, and objectives, and success criteria using protocol similar to that described above for the Dry Creek habitat enhancements. Similar to the post-construction monitoring for Dry Creek habitat

enhancements, tributary restoration project monitoring will include implementation monitoring, effectiveness monitoring, and validation monitoring. SCWA will implement the habitat restoration projects in the tributaries of Dry Creek and the Russian River after their project design plans and monitoring plans are reviewed and approved by NMFS and CDFG. NMFS and CDFG will be consulted throughout the planning and implementation process and a written report will accompany the completion of each project phase for the habitat restoration projects within the Dry Creek and Russian River tributaries.

3.2 Dry Creek Bypass Pipeline Feasibility Study

SCWA will investigate the feasibility of constructing a pipeline to deliver water from Lake Sonoma to the mainstem of the Russian River in order to reduce the adverse effects of relatively high flow releases from WSD on rearing habitat for coho salmon and steelhead. A pipeline from Lake Sonoma to the Russian River would eliminate the need to maintain flows in Dry Creek at levels that preclude abundant juvenile salmonid rearing in 14 miles of this stream. As part of this assessment, SCWA will examine the routing options and associated infrastructure needs for construction and operation of a pipeline from Warm Springs Dam to the Russian River outside of the Dry Creek watershed. The objective of this task is an alternatives analysis for two or three possible routes and their associated costs. An assessment of bypass pipeline alternatives will enable SCWA to identify the best method to ensure water deliveries while meeting salmonid habitat needs in Dry Creek in the unlikely event that habitat enhancement efforts described in 3.1 above are unsuccessful in supporting successful growth and survival of juvenile steelhead and coho salmon and protecting the function and role of critical habitat. The assessment of a Dry Creek bypass pipeline will also consider potential impacts to listed salmonids that may occur during construction of such a project.

In its assessment of alternative Dry Creek bypass pipelines, SCWA will employ standard engineering and economic assessment practices. The study will include conceptual design and costing of alternative raw water pipelines, appurtenances, and inlet/outlet structures, including a new inlet structure at Lake Sonoma. The pipeline would be designed to enable SCWA to bypass its water supply releases past Dry Creek, with the exception of an approximately 35 to 50 cfs flow that would be released from WSD directly to Dry Creek. Study of potential hydroelectric generation facilities may be included. The study will also include analyses of the effects of elevated flow levels on listed salmonids and their habitats in the Russian River in the vicinity of potential outlet structures and downstream of the anticipated discharge locations.

SCWA will initiate the Dry Creek bypass pipeline study during fall 2008 and complete the study no later than December 2010. SCWA will transmit the results of the completed report for this study to NMFS.

As part of the environmental review process (*i.e.*, CEQA documentation) for the permanent changes to D1610, SCWA will provide a preliminary environmental analysis of alternative Dry Creek bypass pipeline routes. That analysis shall describe, at a minimum, the potential geological, hydrologic, botanical, fish, and wildlife effects of alternative pipeline scenarios that might occur as the result of changes in Dry Creek minimum flow requirements.

4. Coho Broodstock Program Enhancements

4.1 Coho Broodstock Program Monitoring and Genetic Analysis

Initiated in 2001, the Russian River Coho Salmon Captive Broodstock Program (RRCSCBP) was established to: 1) prevent extirpation of Russian River coho salmon; 2) preserve genetic, ecological, and behavioral attributes of Russian River coho salmon while minimizing potential effects to other stocks and species; and 3) build a naturally-sustaining coho salmon population (Corps and SCWA 2004). Annual spawning of the captive broodstock is currently conducted by adhering to a genetic spawning matrix to maximize genetic diversity of the coho salmon produced, and to minimize adverse effects to the genetic composition of the Russian River coho salmon. The RRCSCBP includes a monitoring and evaluation component that provides information on juvenile coho salmon release strategies, over-summer survival, over-winter survival, and adult coho salmon returns. The Corps and SCWA (2004) state,

> *"The proposed project for coho salmon is a continuation of the coho salmon captive broodstock integrated recovery program to be extended as necessary beyond the current expiration of 2007."*
>
> *"State-of-the-art genetic analyses will be conducted for all fish used in the program, and the results of the analysis will be used to dictate the combinations of mature coho salmon to use in the spawning process."*
>
> *"Monitoring and evaluation of critical areas will be conducted to ensure that the coho salmon integrated recovery program is operating in a successful manner."*

However, the continuation of the genetic management, and the monitoring and evaluation components are uncertain due to the lack of committed long-term funding. These components of the RRCSCBP ensure the program is accomplishing the goal of preventing coho salmon extirpation in the Russian River. Without monitoring and evaluation, the success of the program will be difficult to judge and the program cannot be adjusted accurately if program efforts are not as successful as anticipated. Without use of a genetic spawning matrix, inbreeding may further threaten the fitness of fish released by the program.

Given the central importance of the RRCSCBP in efforts to avoid extirpation of CCC coho salmon in the Russian River watershed, the Corps will conduct annual genetics analysis and the monitoring and evaluation components of the RRCSCBP at levels consistent with recent historic funding levels for these activities, with adjustments for inflation. Recent NOAA and DFG funding for these activities has been approximately $250,000 for annual monitoring and evaluation and $50,000 for annual genetics analysis of the coho broodstock program.
With this effort, the Corps will ensure that:

1. state-of-the-art genetic analyses will be conducted annually for all coho salmon in the program, and the results of the analyses (genetic matrix) will be used to dictate the combinations of mature coho salmon to use in the spawning process.

2. Genetic assessments of both the naturally-spawning and hatchery-reared components will be conducted over time, to determine the loss or increase of genetic variation in each component.

3. Monitoring and evaluation of the RRCSCBP will be conducted to evaluate the effectiveness and performance of program. This will include monitoring of juvenile and adult coho salmon in multiple release streams to assess survival of the juveniles released, adult returns, spawning success, and to determine if there is an increase in abundance of natural production of coho salmon in these streams.

4. The RRCSCBP will be adaptively managed based on information gathered from the monitoring and evaluation component.

Annual genetic and spawning information, and information from each year's monitoring and evaluation component will be included in the annual report submitted for the section 10 permit that authorizes the RRCSCBP.

4.*2 Warm Springs Dam Emergency Water Supply Line*

The Emergency Water Supply Line (EWSL) was constructed at the WSD to provide bypass flow to the DCFH and to Dry Creek during annual or periodic inspections. The current EWSL at Warm Springs Dam has proven unreliable in providing the necessary bypass flows, since its construction in 1992, and it has not been able to provide an emergency water supply flow to the fish facility or Dry Creek when needed. The fish hatchery is crucial to the RRCSCBP, and an EWSL is necessary to prevent the catastrophic loss of three brood years of coho salmon broodstock held each year at the hatchery. The hatchery requires flows of 35 to 50 cfs for its current operations, and modifications to the hatchery would require additional water (up to 75 cfs total), which is not available through the existing pipeline and backup supply.

As part of the RPA for this project, the Corps will construct a new EWSL to ensure that water flow to the DCFH does not fail. A new EWSL would also have the potential to provide bypass flows to Dry Creek during pre-flood and periodic inspections and during-repairs. The system must be designed to provide a minimum of between 60 cfs and 75 cfs, to the fish hatchery that can also be used as a bypass flow to Dry Creek during inspections and repairs to the outlet works.

The Corps will complete a feasibility level report before initiating construction of a flow bypass system at Warm Springs Dam by 2010. The flow bypass system will be completed by 2012. The Corps will provide NMFS with at least annual updates on the progress, plans, and funding of the new EWSL until implementation.

4.3 Coho salmon broodstock smolt program

The RRCSBSP involves the stocking of juvenile age 0+ coho salmon into coho salmon rearing habitat in several Russian River tributaries. In its infancy, the program has, to date, successfully reared and planted two year classes of juvenile coho that have reached an age sufficient to yield returning adult spawners. However, the numbers of stocked juveniles have been relatively low in the early years of this program, and adult returns appear to be very low (less than 5

documented adult coho salmon per year, M. Obedzinski, U.C.Davis Extension, personal communication).

In order to avoid reducing the likelihood of both survival and recovery of Russian River stock coho salmon until adverse effects of high summer and fall flow releases from WSD are remedied in Year 12 of the period covered by this opinion (see RPA element 3.1 above), the Corps and SCWA will expand the RRCSBSP to include a smolt stocking program that would complement the planting of wild-stock, juvenile coho salmon. Funding for this effort will be provided to DFG to facilitate the rearing of smolt stage coho salmon beginning one year after issuance of this final biological opinion. The annual production of 10,000 smolt stage coho salmon at the WSD hatchery and their release in Dry Creek at WSD would likely yield the annual return of approximately 100 adult Russian River stock coho salmon to the WSD hatchery (assuming a 1% marine survival) for spawning and production of a succeeding generation. This will help ensure that enough adult coho salmon are available to continue the captive broodstock program. The RRCSBSP is managed by the DFG under contract to the Corps. Expansion of that program to include smolt rearing will require one additional seasonal technician, additional fish feed and supplies, additional rearing facilities, and additional genetic analysis of returning adult coho salmon. The genetic analysis of returning adult coho salmon is needed to avoid inbreeding of siblings and ensure the genetic integrity and diversity of Russian River stock coho salmon. The genetic analysis will be performed annually prior to the spawning of the adult coho that return to the WSD Hatchery.

Following review of the results of post-construction monitoring outlined in section 3.1.1 and 3.1.2 of this RPA in the first twelve years of the project, the Corps, CDFG, and NMFS will evaluate, with input from SCWA, the need for additional funding of the coho broodstock smolt program during the remaining years of this project (Years 13-15). If determined to be necessary because of uncertainty regarding SCWA's ability to attain satisfactory success criteria described in section 3.1.1 and 3.1.2. of the RPA, SCWA will fund the coho broodstock program throughout the term of the project covered by opinion.

5. Annual Monitoring of Salmonid Migration in the Russian River at Mirabel/Wohler and Dry Creek

The inflatable rubber dam at Mirabel, is a critical component of SCWA's water supply infrastructure during the low-flow season (April to November). Previous upstream and downstream fish passage monitoring at Mirabel/Wholer have revealed previously unknown population trends including annual abundance of both juvenile and adult migrants and migration timings (Chase et al. 2007). Continuation of the program will provide important support for the efforts to recover steelhead, Chinook salmon, and coho salmon in north-central California. Gauging the success of these efforts through life cycle monitoring will allow adaptive management of future restoration projects.

As part of this RPA, SCWA will 1) monitor juvenile outmigration using rotary screw traps at the Mirabel Dam site, 2) monitor adult escapement using underwater video at Mirabel Dam fish ladders, 3) monitor juvenile outmigration using a rotary screw trap in the lower reach of Dry Creek, and 4) monitor juvenile coho and steelhead abundance at multiple sites in Dry Creek.

Methods:
The primary objectives of rotary screw trapping at Mirabel are: 1) young-of-the-year Chinook salmon population estimates, 2) total counts and timing of juvenile steelhead and coho salmon, 3) characterization of size and age of captures, and 4) PIT tagging of juvenile steelhead for subsequent monitoring. Two rotary screwtraps (1.4-m- and 2.5-m-diameter) will be operated annually 50 m below the Mirabel Dam site during spring (April to July). When river flow allows, the traps will operate 24 hours per day, 7 days per week, and will be checked once daily. Up to 50 age 0+ Chinook salmon greater than 60 mm FL will be marked daily and released upstream of the trap site to determine catch efficiency for population estimates. All other fish will be released immediately downstream. A subsample of captured Chinook salmon, coho salmon, and steelhead will be weighed and measured. All coho salmon will be checked for marks and tags applied by the Captive Broodstock Program. All wild steelhead greater then 75 mm FL will be PIT tagged. Trapping methods are described further in Chase *et al*. (2005).

The primary objective of adult escapement monitoring is to provide annual counts of Chinook salmon passing through ladders at Mirabel Dam. The Dam is operated during the majority of the Chinook salmon immigration period. Some overlap with early returning steelhead and coho salmon is also possible. Video counts are not population estimates and should only be considered escapement minimums. Denil-style fish ladders on both sides of Mirabel Dam are equipped with underwater digital cameras that continuously record passing fish. The system only operates when the Dam is inflated. Time lapse images are stored electronically and reviewed immediately by trained technicians who identify species and record time of passage. Video counting methods are described further in Chase *et al*. (2005).

Despite its potential significance for coho salmon and steelhead recovery in the Russian River watershed, little is known about juvenile salmonid abundance in the mainstem of Dry Creek. Annually, SCWA will operate a 1.5-m- diameter rotary screwtrap in lower Dry Creek near the city of Healdsburg in the vicinity of the West Side Road Bridge. Trapping will commence in spring (April) and continue through summer (September). General methods will follow trapping procedures previously described for the Mirabel Dam site with the following additions and exceptions: 1) mark and recapture population estimates will be generated for juvenile coho salmon and wild steelhead, 2) continuous operation of the trap may be suspended during times when Don Clausen Fish Hatchery releases large numbers of yearling steelhead, and 3) the period of trap operation may vary pending the results of an initial two year pilot study (2009-2010).

During the initial pilot study period, SCWA will augment the screw trapping station with small trapnets or other field sampling efforts designed to capture fry at multiple sites in mainstem Dry Creek. Fry trapping will be conducted during spring and will primarily: 1) identify stream reaches utilized by spawning coho salmon and steelhead and 2) investigate timing and patterns of fish movement among reaches.

To further investigate abundance and habitat use in Dry Creek SCWA will implement an annual juvenile steelhead and coho salmon rearing survey. The primary objective of the survey is an index of juvenile abundance at multiple sites during late summer. High summer discharge from WSD creates depth, turbidity, and water velocity conditions in Dry Creek that are not conducive

to standard juvenile sampling methods such as snorkeling and electrofishing. However, annual maintenance inspections at Warm Springs Dam require greatly reduced flow releases and present an opportunity to collect juvenile abundance data using standard techniques. Inspections typically occur in late September. During the inspection period, SCWA relinquishes control of dam releases to USACE for up to 4 days. Typical flow rates in Dry Creek during this period range from 25 to 50 cfs. During the inspection period SCWA and USACE will slowly ramp down flow on day 1, maintain a consistent discharge of 25-50 cfs on days 2 and 3, and slowly ramp flows up to normal discharge on day 4. On days 2 and 3 of the inspection period, SCWA will implement a juvenile abundance survey at multiple sites along 22 km of mainstem Dry Creek from the Russian River confluence upstream to Warm Springs Dam. The number, location, and length of sampling reaches may be constrained by property ownership, field crew access, or habitat characteristics. Specific sampling protocols using snorkeling and electrofishing must be tested to ensure abundance data provide an index that allows spatial (site to site) and temporal (year to year) comparisons. Possible sampling schemes could include depletion-removal electrofishing, mark-recapture electrofishing, single pass electrofishing, multiple pass snorkel counts, or a two-phase approach using snorkel counts validated by habitat specific population estimates derived from electrofishing. During a two-year pilot study (2009-2010), SCWA will evaluate these sampling approaches at eight separate 100 m-long reaches spaced approximately 3 km apart along the 22 km-long mainstem length of Dry Creek. This intensive effort will require a field crew of 15 individuals and total roughly 300 person-hours. After this initial study period, SCWA will sample fixed sites annually for the period of this biological opinion.

Sampling Frequency and Duration

Safe installation and operation of the traps at Mirabel Dam is dependent on river flow. Since 2000, the date of median cumulative catch for juvenile Chinook salmon and natural origin steelhead smolts has occurred during the first week of May. If river flow is conducive to safe and efficient operation, the Agency will attempt to install the trap annually after April 1 and operate continuously until catches decline in late June from 2009 to 2023.

Since 2000, less than one percent of observed adult Chinook salmon have passed the Dam site before September 1. Peak immigration typically occurs from October 15 to November 15. SCWA will operate the video counting system at Mirabel Dam annually from September 1 until high-flow or low water demand necessitates deflation of the dam in late fall from 2009-2023.

Installation date and operation of the screw trap in Dry Creek depends on flow and releases of steelhead smolts from Don Clausen Hatchery. Annually, SCWA will attempt to install the Dry Creek trap by April 15 and operate it until catches decline to near zero in late summer (September 1) from 2009-2018. SCWA will also operate fry traps from May 1 to July 1 during a two-year pilot study 2009-2010.

SCWA will conduct annual (2009-2023) juvenile abundance surveys on the mainstem of Dry Creek in conjunction with USACE Warm Springs Dam inspections. Dam inspections typically occur in September.

Reporting and Review
Because trapping and juvenile survey methods are untested in Dry Creek, SCWA will convene annual review meetings during the pilot study period with NMFS and CDFG before the sampling season begins in February 2009 and 2010. All data collected at Mirabel/Wohler and Dry Creek will be summarized in annual reports. These data, along with summaries will be forwarded to NMFS and CDFG within nine (9) months of each year's cessation of sampling. The aforementioned research and monitoring program can be adapted in consultation with NMFS and CDFG pending the results of the two-year pilot study.

6. *Funding Assurances for Purposes of Consistency Determination for CESA*[76]

SCWA shall provide security (Security), in a form and an amount to be approved by DFG, to cover all costs of monitoring and management of the Russian River estuary, and for monitoring, management and construction of habitat enhancement projects in Dry Creek, and the tributaries to Dry Creek, as specified in Sections [X 2.1.1], [X 2.2-2.4,], [X 3.1.1 and 3.1.2] and Section [X 4.3] (coho broodstock smolt program) of this Biological Opinion.

SCWA shall provide Security in three stages: (1) Stage 1 shall cover years 1-6 (2009-2013) and shall be provided to DFG prior to receiving take authorization for coho salmon from DFG (i.e., prior to issuance of a consistency determination); (2) Stage 2 shall cover years 7-9 (2014-2016) and shall be provided to DFG no later than January 1, 2013; and (3) Stage 3 shall cover years 10-15 (2017-2022) and shall be provided to DFG no later than January 1, 2016. Table 34 sets forth the monitoring, management, and construction activities included in each of the three Security-funding stages.

SCWA shall obtain DFG approval of the amount of the Security and language of the Security, which shall be consistent with this provision. The Security shall allow DFG to draw on the principal sum if DFG, at its sole discretion and in compliance with the provisions of the Security, determines that SCWA has failed to fully implement the required management, monitoring, and enhancement activities for that stage.

[76] This subsection has been added to help ensure that the RPA will be implemented consistent with the California Endangered Species Act.

Table 34. Monitoring, management, and construction activities included in each of the three stages of Security-funding.

Activity	Stage 1 Year 1-6 (2009-2013)	Stage 2 Year 7-9 (2014-2016)	Stage 3 Year 10-15 (2017-2022)
2.1.1 b) Annual design plans	All		
2.1.1 Adaptive Management	All		
2.2 Water Quality Monitoring	Year 1-6	Year 7-9	Year 10+[77]
2.3 Invertebrate Monitoring	Year 1-6	Year 7-9	Year 10+[77]
2.4 Fish Monitoring	Year 1-6	Year 7-9	Year 10+[77]
3.1.1 Dry Creek Enhancements	Group 1[78] planning, permitting, pre-monitoring, construction, and monitoring Group 2[79] planning, pre-monitoring, and permitting	Group 2 construction and monitoring Group 3[80] planning, pre-monitoring, and permitting	Group 3 construction and monitoring
3.1.2 Dry Creek Tributary Enhancements	All planning, pre-monitoring, permitting, construction, and monitoring	monitoring	Monitoring[77]
4.3 RRCBSP	Year 1-6	Year 7-9	Year 10-12 Year 13-15[77]

[77] Estuarine water quality, invertebrate, and fish monitoring for Stage 3 and coho smolt production in Years 13-15 shall be conducted if it is determined to be necessary pursuant to the terms of the Section X (Reasonable and Prudent Alternatives) of this Opinion.

[78] Group 1: at least 1 mile of modified stream channel providing excellent quality coho summer rearing habitat with a pool-riffle ratio between 1:2 and 2:1 and installation of 10 boulder clusters in reaches not otherwise enhanced.

[79] Group 2: additional 2 miles of modified stream channel providing excellent quality coho summer rearing habitat with a pool-riffle ratio between 1:2 and 2:1 and installation of 10 boulder clusters in reaches not otherwise enhanced.

[80] Group 3: additional 3 miles of modified stream channel providing excellent quality coho summer rearing habitat with a pool-riffle ratio between 1:2 and 2:1.

B. Effects of the RPA on CC Chinook salmon, CCC steelhead, and CCC coho salmon

The purpose of the Russian River Water Supply and Flood Control project is to control flooding within the watershed, to supply water to users within and outside of the watershed, and generate hydroelectric power. NMFS has concluded that the proposed actions described in Section III of this biological opinion operated in conjunction with the actions identified in Section X.A (*i.e.*, pursuit of changes to D1610, modifying management of estuarine water levels, habitat modifications to minimize adverse effects of high flow releases from WSD, further support for the RRCSCBP, and fish monitoring) constitute a reasonable and prudent alternative (RPA) to the proposed action that will achieve the project's purposes, avoid jeopardy to listed species and avoid the destruction or adverse modification of critical habitat.

The RPA actions identified in Section X.A include several distinct components. Each component in Section X.A must be implemented to ensure compliance with the RPA, to avoid jeopardizing CCC coho salmon and CCC steelhead, and to avoid adverse modification of designated critical habitat for these species.

1. Effects of the RPA on Steelhead Survival and Recovery

NMFS has analyzed the effects of the RPA (*i.e.*, the original project described in Section III as modified with the new elements described in section X.A) on CCC steelhead. This was done by examining the effects of the RPA when added to the species' baseline condition. This analysis is largely based on an evaluation of how habitat changes due to the project would likely affect survivorship of each life stage in the species' life cycle and the effect of these changes to populations of steelhead in the Russian River and to steelhead at the DPS scale.

As previously discussed in this opinion, the populations of steelhead in the Russian River have exhibited negative growth rates over the past several decades as the result of diverse impacts to the environment. Urban, residential, and agricultural developments, timber harvest, road construction, water supply and flood control management activities have had a collective adverse affect on the quality and quantity of steelhead spawning, rearing, and migratory habitats. Among these impacts to the species are the adverse effects of high flow releases from WSD and CVD on steelhead rearing habitat in 34 miles of the upper Russian River, the river's estuary, and 14 miles of Dry Creek. Artificially high inflows and SCWA's management of water levels in the estuary have diminished the quality and quantity of estuarine rearing habitat that has likely value for all populations of steelhead in the Russian River watershed. Notwithstanding these impacts, many tributaries to the Russian River that are unaffected by the project have continued to provide functioning, albeit degraded, steelhead spawning and rearing habitat (*e.g.*, NMFS 2007), and an estimated 1700 to 7000 wild steelhead have continued to annually return to spawn in the Russian River watershed (McEwan 2001). The DCFH has contributed to the abundance of steelhead in the watershed through the annual production and stocking of approximately 500,000 hatchery-reared steelhead smolts that are genetically similar to wild stock and are listed as part of the CCC steelhead DPS themselves. During the past five years, this smolt stocking program has resulted in an average annual combined total return of about 9,400 adult steelhead to the WSD hatchery and CVD fish facilities (DFG records for DCFH and CVFF).

When added to baseline conditions, the project as modified by the RPA will likely increase the abundance of returning wild spawned steelhead because:

1. Estuary water levels will be managed in the spring and summer to promote greater depths and lower salinity in the downstream most reaches of the Russian River. Such improvements will likely enhance the survival rate of small steelhead (<120 mm) that enter the estuary during spring and summer months. These changes, which will potentially benefit all populations of steelhead in the watershed, should enhance survival of juvenile steelhead as early as Year 1 of the 15 year project period. Increased juvenile survival in the estuary will promote increased production of steelhead smolts in the following year; this in turn will likely increase the numbers of returning adults 3 to 5 years after improvements in estuarine rearing habitat are achieved. Breaching after October 15 is anticipated to have discountable impacts on rearing steelhead because juvenile steelhead in the estuary will have grown to sufficient size by early fall to tolerate a highly saline estuary.

2. SCWA will enhance opportunities for adult steelhead to migrate past manmade barriers (*e.g.*, partially passable culverts) and/or improve the quality of rearing habitat in stream segments where survival is limited due insufficient pool depths, pool shelter, velocity refuge, or other factors limiting survival. Enhancement of passage opportunity will increase the likely numbers of adult steelhead that will spawn upstream of partial barriers. Implementation of five passage projects identified in Section X.A.3.2 (*i.e.*, removal of partial barriers on Grape, Wallace, Purrington, Crane, and Mill Creeks) will increase the duration of time that adult steelhead will be able to access approximately 47,000 m^2 of stream habitat, thereby increasing the likelihood that sufficient numbers of adult spawners can access these segments and maximize the production potential (*i.e.*, carrying capacity) above the former passage barriers. Likewise, the habitat restoration projects (*e.g.*, on Crane Creek, Grape Creek, and Wine Creek) will likely increase the potential numbers of juvenile steelhead that can rear within a unit area of these enhanced stream segments. For example, the three restoration projects identified on Crane, Grape, and Wine Creek have the potential to substantially enhance the quality of habitat in about 1800 m^2 of stream. Given the current degraded nature of these stream segments and that streams with good quality steelhead habitat support approximately 0.5 to 1.5 juvenile steelhead per m^2 **(**Lau 1984; Harvey and Nakamoto 1996; Smith 2007; NMFS unpublished data**)**, those enhancements would likely promote survival of roughly 800 wild juvenile steelhead (based on 25-50% improvement of habitat). Such efforts will provide benefits as early as Year 3 of the 15 year project period.

3. The creation of near-optimal quality, pool-riffle habitat distributed along at least six miles of Dry Creek and additional boulder clusters will afford rearing juvenile steelhead with much needed velocity refugia and greatly enhance the quality of both summer and winter rearing habitat for steelhead in Dry Creek. This effort will provide substantial benefits by the end of Year 5 and continue to improve rearing habitat through Year 12 of this 15 year project. Assuming that the six miles of new pool-riffle habitat averages 10 meters in width (a likely conservative, low estimate), at least 96,560 m^2 of high quality pool-riffle habitat will be created and interspersed over eight or more sites along Dry Creek. As described in Section VI.F.3, average density of juvenile steelhead in good quality rearing

habitat in coastal California streams is approximately 0.5 to 1.5 fish/m^2. Therefore, the six miles of enhanced pool-riffle habitat could yield the production of roughly 50,000 to 150,000 juvenile steelhead.

In addition, 20 large boulder clusters will create habitats for rearing juvenile steelhead in other areas of Dry Creek beyond the six miles of enhanced pool-riffle habitats. The production of juvenile steelhead that might occur as the result of the placement of boulder clusters is difficult to quantify. Raleigh *et al*. (1984) report that juvenile steelhead prefer streams with pool-riffle ratios of at least 1:4 (*i.e*., Raleigh et al. rate streams having ratios between 1:4 and 4:1 with Habitat Suitability Index values of 80% or higher). It seems reasonable that the footprint of each large boulder cluster and its associated pool and low velocity water will be at least 50 to 100 m^2. Assuming that the pool and velocity refuge provided by each boulder cluster is associated with four parts riffle habitat (*i.e*., a 50 m^2 pool formed by boulder clusters in association with 200 m^2 riffle habitat provides 250 m^2 of habitat), 20 boulder clusters should enhance 5,000 to 10,000 m^2 of steelhead rearing habitat. At 0.5 to 1.5 juvenile fish/m^2, this would provide for the additional production of 2500 to 15,000 juvenile steelhead.

4. Reduction of flows via changes in D1610 will promote enhancements in the quality of rearing habitat in the 34 mile segment between CVD and Cloverdale. Reducing the minimum flow requirement at Healdsburg from 185 to 125 cfs would enable SCWA and the Corps to reduce releases at CVD by 60 cfs throughout the summer. Such a change would reduce releases at CVD from about 230 cfs to about 190 cfs, and given the ongoing diversions in the mainstem, would reduce flows to about 160 to 200 cfs near Hopland and to approximately 145 to 180 cfs at Cloverdale (based on historic USGS Russian River gage records and an assumed linear reduction of flow between Hopland and Healdsburg). The interagency flow habitat study of the upper mainstem found that reducing summer releases at CVD from 275 to 190 cfs *increased* the availability of suitable juvenile steelhead rearing habitat at six of thirteen study sites, but *decreased* the quantity of suitable habitat at three sites[81] – a net benefit (Table 35). Moreover, this level of summer flow reduction appears to provide even greater gains in the abundance of optimal quality juvenile steelhead habitat (five sites were improved, and only one site had less optimal quality juvenile steelhead habitat). This reduction in summer flow releases would also conserve the coldwater pool in Lake Mendocino, thereby promoting the release of coldwater throughout the summer and early fall, rather than exhausting the coldwater pool during late summer**.** We estimate that SWRCB's minimum flow requirements under D1610 can be changed within a 6 to 8 year period. Petitions for interim changes to D1610 (*e.g*., annual Temporary Urgency Changes) will provide benefits to steelhead and possible coho rearing habitat in the estuary between Year 2 covered by this opinion and the permanent change to D1610.

Improved rearing habitats in the estuary, upper mainstem, Dry Creek and various tributaries will likely increase the survival of pre-smolt stages of steelhead that will in turn increase the production of steelhead smolts that enter the ocean. The resulting increase in smolt production should have a positive effect on the numbers of wild adult steelhead returning to the Russian

[81] Table 20 shows that the magnitude of the decrease at three sites is not outweighed by the gains at the other sites.

River. However, the exact increase in numbers of returning adults cannot be identified with great precision given that the survival of juvenile steelhead is dependent on many factors (*e.g.*, the timing and intensity of annual rainfall, stream flows, and oceanic conditions that affect marine survival of outmigrating smolts).

Table 35. Effects of reducing flow releases from 275 cfs at CVD on steelhead habitat at 13 study sites in the upper mainstem Russian River. Data from the Interagency Flow Habitat Study (Corps and SCWA 2004).

Life stage	Habitat Quality	Change in Flow Release (cfs)	Number of Sites		
			No change in Available Habitat	Habitat Gain	Habitat Loss
Steelhead Juvenile	Suitable	275 to 190	4	6	3
	Optimal	275 to 190	7	5	1
Steelhead Fry	Suitable	275 to 190	7	5	1
	Optimal	275 to 190	9	4	0
Steelhead Juvenile	Suitable	275 to 125	4	7	2
	Optimal	275 to 125	7	5	1
Steelhead Fry	Suitable	275 to 125	1	11	1
	Optimal	275 to 125	4	9	0

Nevertheless, the numbers of returning adults are a function of the numbers of out-migrating smolts, whether of wild or hatchery origin. Quinn (2005), who reviewed 215 published and unpublished studies of stage-specific survival rates for different species of salmon and steelhead, acknowledges wide ranges in the rate of smolt-to-adult survival, and he reports that average smolt-to-adult survival of steelhead is about 13%. A half century ago, intensive monitoring of steelhead in Waddell Creek (Santa Cruz County, CA) showed that age-2 smolts had an approximately 6% marine survival (Shapovalov and Taft 1954). Increased numbers of smolts produced as the result of implementation of this project's RPA will likely result in more steelhead returning to the Russian River than occurred under baseline conditions (*i.e.*, the effects of the RPA on steelhead abundance is a net increase in abundance, and hence growth in the river's steelhead populations).

In Section VIII, we found that the original project proposed by the Corps and SCWA constrained the ecological diversity of steelhead, because the high summer inflows and water level management practices in the estuary substantially reduce the quality of estuarine rearing habitat for YOY steelhead. With the RPA, water levels will be managed in a manner that should provide enhanced, good quality estuarine rearing habitat. Thus the project will not constrain the ecological diversity of steelhead.

We found that the original project would not likely cause any further adverse change in the spatial distribution of steelhead, and the RPA will also not adversely affect the spatial distribution of steelhead. The RPA's provision for the completion of at least five (5) tributary restoration projects may allow steelhead access to previously blocked habitats, depending upon the tributary restoration projects chosen (*i.e.*, the species spatial distribution would not be

enhanced if SCWA selected five channel habitat restoration projects in reaches already accessible to steelhead and coho salmon).

With implementation of the RPA there will continue to be some mortality or other forms of take of juvenile steelhead as the result of ongoing channel maintenance, flood control operations, stream flow changes associated with annual pre-flood and periodic dam inspections at CVD, deployment of the inflatable dam at Mirabel, entrainment of fishes into infiltration ponds at the Mirabel/Wholer diversion facilities during high flows, flow releases from WSD during the low flow period (June through October) prior to the completion of the planned habitat enhancements, and flow releases from CVD in years before D1610 flow requirements are changed. We have considered the effects of these various project elements in Section VI of this opinion. These impacts of the project operations have been generally ongoing at least since water storage commenced at WSD in October 1983 and D1610 was adopted in 1986. During the first five years of the project as defined by the RPA, loss of CCC steelhead due to the release of elevated flows in Dry Creek during the low flow season will be the same as recent years; however, it will be less in subsequent years because of planned habitat enhancements in Dry Creek. In addition to those effects of flood control and water supply operations, SCWA's seasonal monitoring of salmon and steelhead via the trapping and live release of a small percentage of juvenile salmonids migrating past the Mirabel dam and their monitoring of fishes in the estuary via seining have been ongoing for nine and five years, respectively. Some limited injury or mortality of juvenile steelhead may also occur as the result of RPA habitat enhancement work in the tributaries and in Dry Creek. SCWA will relocate juvenile steelhead from aquatic habitat in work sites. As described above in the biological opinion, NMFS anticipates injury and mortality to be limited to 3% of juvenile steelhead found at these sites. The injury and mortality associated with these project operations when combined with the benefits of the new project elements incorporated into the RPA (as described in Section X.A), is unlikely to reduce the likelihood of steelhead survival or recovery, but as discussed below, will likely increase chances for the species survival and recovery.

With the baseline annual return of several thousand wild and hatchery reared CCC steelhead to the Russian River, the consistent, albeit relatively low, return of adult CCC steelhead to other watersheds (*e.g.*, Napa River, Sonoma Creek, Salmon Creek, Lagunitas Creek, *etc.*), and the RPA's enhancement of tributary, upper mainstem and estuarine habitats in Years 2 through 4, it is highly unlikely that this species will become significantly reduced in abundance during the project's first five years prior to the habitat enhancements in Dry Creek. Given that the RPA will likely increase the recent historic abundance of steelhead populations in the Russian River beginning with enhancements of passage opportunity and rearing habitat in Dry Creek or Russian River tributaries during Years 1 to 3, enhancements of estuarine habitat beginning in Year 2, and substantial enhancement of rearing habitat in Dry Creek beginning in Year 5, followed by additional, major enhancements of steelhead rearing habitat in Dry Creek during Years 6, 8, 9, 11, and 12, the RPA will likely promote a positive trend in the growth rate of these populations. In addition, the RPA will not adversely affect the spatial diversity, ecological diversity, or genetic diversity of this species. For those reasons, we find that the RPA will not reduce appreciably the likelihood of the survival of CCC steelhead. The RPA will likely enhance many miles of rearing habitat for the potentially independent steelhead population in the Dry Creek watershed, and it will likely enhance estuarine rearing habitat that would benefit all

functionally independent, potentially independent, and dependent populations of steelhead in the Russian River watershed. These enhancements of habitat will likely increase the abundance and population growth rates of steelhead in the Russian River watershed. For those reasons, we find that the RPA will not reduce appreciably the likelihood of the recovery of CCC steelhead.

Incidental to its role of avoiding jeopardy of CCC steelhead, the RPA will help conserve CCC steelhead as this species responds to climate change. The genus *Oncorhynchus* has populated coastal streams of western North America since the Pliocene epoch two million years ago (Healey 1991). Over that period *Oncorhynchus* has persisted despite considerable variation in North America's climate, which has included several episodes of glaciation followed by global warming. As discussed in Section IV, Status of the Species, the recent warming of the earth's atmosphere will undoubtedly have some effects on both freshwater and marine ecosystems. The effects of global warming on the complex dynamics of coastal California marine ecosystems are uncertain and any adverse effects will likely be difficult to mitigate given their oceanographic scale. However, freshwater habitats of steelhead can be conserved and restored so that the survival of wild juvenile steelhead and the survival of post-spawned adult steelhead can be maximized. Given that ocean survival and adult returns are generally a small percentage of the numbers of outmigrating smolts, the production and conservation of large numbers of smolts in freshwater habitats should yield more returning adults than scenarios with much lower production of outmigrating smolts. The coldwater riverine habitats of the upper Russian River and Dry Creek produced by the RPA will create large quantities of coldwater rearing and spawning habitats of substantial value to steelhead. That abundant coldwater habitat will provide important refugia for steelhead populations that may become impacted by losses of summer rearing habitat due to climate driven droughts. Likewise the RPA's focus on restoring natural functioning conditions in the estuary will likely increase the abundance of steelhead smolts entering the ocean. Beyond the need to enhance freshwater steelhead production, the ability of CCC steelhead to respond successfully to climate change effects on both freshwater and marine ecosystems will be partly determined by their continued ability to adapt to changing conditions. To do that, the species and its populations will need to draw upon their inherent, natural genetic variation (Wapples *et al*. 2001; Crozier and Zabel 2006; Beechie *et al*. 2006). For that society will need to protect habitats that accommodate genetically diverse populations (e.g., protect both early running and late running individuals during the adult and juvenile migrations, protect the diverse timings and ages at which individual steelhead first spawn, and protect both anadromous and non-anadromous populations).

2. Effects of the RPA on Steelhead Critical Habitat

The new RPA actions will avoid adverse modification of designated critical habitat for steelhead, because:

1. Water levels in the estuary will now be managed to enhance the quality of the estuary as rearing habitat for steelhead in the spring and summer. Reduction of mainstem flows and a new water level management program that promotes natural closure of the lagoon or formation of a perched lagoon will likely yield conditions more similar to those that were present before the construction of WSD, CVD, and PVD, which created the need for water level management in the estuary. As described in Section

VI.G.1.b, recent historic management has contributed to elevated salinity levels, shallow depths, and localized reductions in the concentration of dissolved oxygen in the estuary. These management practices and resulting changes in water quality and depths have degraded the quality of critical habitat in the estuary. The RPA will ameliorate those adverse effects of the project by providing greater depths, reduced salinity, and localized higher dissolved oxygen concentrations. The enhanced depths may also yield cooler temperatures near the bottom of the estuary, conditions favored by steelhead.

2. The upper mainstem Russian River will have lower flows from mid-spring through early fall. This will enhance the quality of critical rearing habitat for steelhead. As explained in Section VI.F.4, water management under D-1610 has degraded critical rearing habitat for steelhead because the elevated summer flows released at CVD create excessive current velocities that limit the amount of rearing habitat for juvenile stages. Reducing the minimum flow requirement for the segment between the East Fork and Healdsburg by 60 cfs will promote lower releases in the vicinity of about 190 to 230 cfs. Tables 23 and 33 show that reducing summer releases at CVD from about 275 to 190 cfs (an 85 cfs reduction) will substantially enhance the value of the PCE of critical rearing habitat at several representative study sites in the upper mainstem. The proposed reduction of 60 cfs in summer releases has not been precisely studied; however, the interagency flow-habitat assessment suggests that appreciable gains in habitat are possible with lower summer releases in the vicinity of 190 to 230 cfs relative to the recent historic summer releases, which have generally been about 250 to 290 cfs. In addition, as noted above, lower summer releases at CVD will promote conservation of the coldwater hypolimnion in Lake Mendocino, which will increase the likelihood that water temperatures will remain good to excellent for steelhead throughout the summer. During average or above average water years, summer water temperatures near Cloverdale have historically been in the vicinity of about 20°C, which is higher than optimal for steelhead. During "below-normal water years", Lake Mendocino's hypolimnion has become severely depleted by historic water releases to the Russian River.
3. The impacts of high summer flow releases from WSD on the PCE of critical habitat for steelhead rearing in Dry Creek will be remedied by substantially enhancing the quantity and quality of rearing habitat for juvenile steelhead in the 14 mile segment downstream of WSD when flows range from about 110 to 175 cfs. To do this SCWA will create near-optimal quality, pool-riffle rearing habitat in six miles of Dry Creek for that range of flows. These enhancements will be distributed at eight separate sites and include improvements in the upper, middle and lower portions of Dry Creek. In addition, SCWA will install 20 boulder clusters that will provide velocity refuge and create rearing habitat in those areas that will not be engineered to provide near-optimal quality, pool-riffle sequences. The Corps will also work with SCWA to enhance winter habitat refuges at points along the margins of Dry Creek. The flood protection functions of WSD and the stabilization of banks through bioengineered approaches will promote the long-term stability of the habitat enhancements.

As described in section X.B.1, the construction of six miles of near optimal quality pool-riffle habitat in Dry Creek will create roughly 96,500 m^2 of high quality rearing habitat for steelhead.

As also described in the above section, the installation of 20 large boulder clusters in other stream reaches not subjected to major pool-riffle enhancements will provide velocity refuges and create roughly an additional 5000 to 10,000 m^2 of rearing habitat for juvenile steelhead at diverse locations throughout the remaining eight miles of Dry Creek affected by flow releases from WSD.

The plan for habitat enhancement will substantially improve rearing habitat throughout the 14 mile segment of stream and appreciably increase Dry Creek's carrying capacity for juvenile steelhead over that present during recent historic operations. The plan for five years of post-construction monitoring and adaptive management of all habitat enhancement sites will help ensure that the RPA creates good quality rearing habitat at each of the 28 habitat enhancement sites (8 major, pool-riffle enhancement zones plus 20 large boulder clusters), thereby avoiding adverse modification of rearing habitat in Dry Creek. We recognize that the science and application of stream habitat restoration and enhancement is highly complex and subject to the unpredictable influences of geology, hydrology (*e.g.*, floods), and biology. Therefore, despite the high likelihood that the implementation of the habitat enhancement plan will avoid adverse modification of critical habitat, we remain cautious and require engineering analysis, conceptual design, environmental impact assessment, and costing of a Dry Creek bypass pipeline for SCWA to convey its water supply from Lake Sonoma. A pipeline will be constructed in the unlikely event that it is found that unforeseeable, physical factors confound efforts to ameliorate the adverse affects of high summer and winter flow releases via modifications of the Dry Creek channel. A bypass pipeline would facilitate the reduction of summer flows, with resulting increases in available salmonid rearing habitat as described in Section VI.F.

3. Effects of the RPA on Coho Survival and Recovery

NMFS analyzed the effects of the RPA on CCC coho salmon in a manner similar to that which was done above for steelhead. The effects of the RPA were evaluated as conditions that will be added to the species' baseline condition. Much of this evaluation involves analysis of how habitat changes due to the project would likely affect survivorship of each life stage in the species' life cycle and the effect of those changes to the coho salmon population in the Russian River and to the CCC coho salmon ESU.

As previously discussed in the Environmental Baseline, the Russian River's coho salmon population is likely in an extinction vortex. The population has declined precipitously as the result of habitat degradation. The numbers of coho in the Russian River watershed are now so low that demographic instability and inbreeding threaten to cause further declines. Urban, residential, and agricultural developments, timber harvest, road construction, water supply and flood control management activities have had a collective adverse affect on the quality and quantity of coho salmon spawning, rearing, and migratory habitats in this watershed. Among these impacts to the species are the adverse effects of stream channelization and high flow releases from WSD on coho salmon rearing habitat in about nine miles of Dry Creek. SCWA's management of water levels in the estuary may also have diminished the quality and quantity of estuarine rearing habitat for the species. As previously discussed, most of the current production of coho salmon in the Russian River watershed is likely sustained by the RRCSCBP. However, this program is in its infancy, and to date, adult returns appear to be very low. In addition to that

program, low levels of natural reproduction produce returns of a few adult fish to a few streams that are not in the project area (*e.g.*, Green Valley Creek and Dutchbill Creek).

The project as modified by the RPA, when added to baseline conditions, will likely enhance the abundance, population growth rate, spatial distribution, and diversity of returning wild coho salmon. These population viability metrics will be enhanced because:

1. A new reservoir of genetically healthy and compatible, juvenile coho salmon will be reared at the WSD hatchery so that at least 10,000 smolts will be annually released into Dry Creek. This program of stocking genetically healthy and compatible hatchery smolts that have wild broodstock ancestry will compliment the wild broodstock fry and juvenile stocking program. The hatchery smolts will not require one year of rearing in Russian River tributaries and therefore will not be vulnerable to the high mortalities associated with droughts, water diversions, sedimentation and other threats to stream-rearing juvenile fish. We estimate that 10,000 smolts will have a return rate of about 1 to 3% (Sandercock 1991; DFG data for hatchery returns) and thus this new element of the program will help ensure that the RRCSCBP continues to have about 100 to 300 adult Russian River stock coho to breed each year. Given the very low abundance of the Russian River coho salmon population, and the potential for inbreeding depression and depensatory processes (*e.g.*, inbreeding and inability for adults to find mates), it is important that the RRCSCBP augment numbers of coho until such times as habitat is restored to several tributaries in the watershed and the abundance of natural spawning wild coho salmon is sufficient to avoid such threats to the population.

2. SCWA will enhance opportunities for adult coho salmon to migrate past manmade barriers (*e.g.*, partially passable culverts) and/or improve the quality of rearing habitat in stream segments where survival is limited due insufficient pool depths, pool shelter, velocity refuge, or other factors limiting survival. Enhancement of passage opportunity will increase the likely numbers of adult coho salmon that will spawn upstream of partial barriers. Implementation of five passage projects identified in Section X.A.3.2 (*i.e.*, removal of partial barriers on Grape, Wallace, Purrington, Crane, and Mill Creeks) will increase the duration of time that adult coho salmon will be able to access approximately 47,000 m^2 of stream habitat, thereby increasing the likelihood that sufficient numbers of adult spawners can access these segments and maximize the production potential (*i.e.*, carrying capacity) above the former passage barriers. Likewise, the habitat restoration projects (*e.g.*, on Crane Creek, Grape Creek, and Wine Creek) will likely increase the potential numbers of juvenile coho salmon that can rear within a unit area of these enhanced stream segments. For example, the three restoration projects identified on Crane, Grape, and Wine Creek have the potential to substantially enhance the quality of habitat in about 1800 m^2 of stream. Given the current degraded nature of these three stream segments and that streams with good quality coho salmon habitat support approximately 0.3 juvenile coho salmon per m^2 (Brakensiek 2002; Del Real *et al*. 2008; DFG unpublished data), those enhancements would likely promote the additional survival of roughly 240 wild juvenile coho salmon (based on 25-50% improvement of habitat). Computation of

additional production associated with passage enhancements is dependent on the numbers of additional spawners that are able to access the 47,000 m^2 above the partial barriers. Passage improvements and rearing habitat enhancements will provide benefits by Year 3 of the 15 year project period.

3. The creation of high quality pool-riffle habitat along at least six miles of Dry Creek and additional habitats created by large boulder clusters will afford rearing juvenile coho salmon with much needed velocity refugia and greatly enhance the quality of both summer and winter rearing habitat for coho salmon in Dry Creek. This effort will provide substantial benefits by the end of Year 5 and continue to improve coho rearing habitat through Year 12 of this 15 year project. Assuming that the six miles of new pool-riffle habitat is at least 10 meters in width (a likely conservative, low estimate), at least 96,560 m^2 of high quality pool-riffle habitat will be created and interspersed over eight or more sites along Dry Creek. As noted above, average density of juvenile coho in good quality habitat is approximately 0.3 fish/m^2. Therefore, the six miles of enhanced pool-riffle habitat could yield the production of roughly 30,000 juvenile coho salmon.

   In addition, 20 large boulder clusters will create habitats for rearing juvenile coho salmon in other areas of Dry Creek beyond the six miles of enhanced pool-riffle habitats. The production of juvenile coho salmon that might occur as the result of the placement of large boulder clusters is difficult to quantify. McMahon (1983) reports that juvenile coho salmon prefer streams with about one-third to two-thirds pool habitat (*i.e*., McMahon rates streams with 33 to 67 percent pools as having Habitat Suitability Index values of 80% or higher). As described above for steelhead, it seems reasonable that the footprint of each large boulder cluster and its associated pools and low velocity water will be at least 50 to 100 m^2. Assuming that the pool and velocity refuge provided by each boulder cluster is associated with two parts riffle habitat, then 20 boulder clusters should enhance 3000 to 6000 m^2 of juvenile coho salmon habitat. At 0.3 juvenile fish/m^2, this would provide for the additional production of 900 to 1800 juvenile coho salmon in Dry Creek.

4. Estuary water levels will be managed to promote greater depths and lower salinity in the downstream most reaches of the Russian River. Such improvements will likely enhance the survival rate of small coho salmon (<120 mm) that enter the estuary during spring and summer months. These changes may enhance survival of juvenile coho salmon as early as Year 1 of the 15 year project period. Reduction of flows via changes in D1610 will also promote enhancements in the quality of rearing habitat in the Russian River estuary. We estimate that SWRCB's minimum flow requirements under D1610 can be changed within a 6 to 8 year period. Petitions for interim changes to D1610 (e.g.,annual Temporary Urgency Changes) will provide benefits to possible coho rearing habitat in the estuary between Year 2 covered by this opinion and the permanent change to D1610. Increased juvenile survival in the estuary will promote increased production of coho salmon smolts in the following year; this in turn will likely increase the numbers of returning adults two to three years after improvements in estuarine rearing habitat are achieved. Fall breaching (after October

15) is unlikely to have adverse effects on coho salmon rearing in the estuary. As described in the biological opinion, coho salmon are expected to migrate upstream out of estuaries in the fall. In addition, by October 15 juveniles are likely to have grown to sufficient size to tolerate salt water conditions.

5. The RRCSCBP will have secure funding for genetics management of the wild broodstock and for monitoring of stocked juvenile fishes planted in Russian River tributary streams. Proper genetics management and knowledge of the survival, abundance, distribution, and migration timing of program fishes is essential for the long-term success of the RRCSCBP in reestablishing natural coho salmon populations within the Russian River basin. In addition, the installation of an EWSL will help ensure that the wild coho captive broodstock program is not threatened by catastrophic losses due to a water supply failure.

Improved rearing habitats in the estuary, Dry Creek, and various tributaries will likely increase the survival of pre-smolt stages of coho salmon that will, in turn, increase the production of coho smolts that enter the ocean. The resulting increase in smolt production should have a positive effect on the numbers of wild adult coho salmon returning to the Russian River. However, the exact increase in numbers of returning adults cannot be identified with great precision given that the survival of juvenile coho salmon is dependent on many factors (*e.g.*, the timing and intensity of annual rainfall, stream flows, and oceanic conditions that affect marine survival of outmigrating smolts).

Nevertheless, the numbers of returning adults are a function of the numbers of out-migrating smolts, whether of wild or hatchery origin. Sandercock (1991) suggests that smolt to adult survival of coho salmon is generally about 3 to 5%, although higher and lower returns are reported. Increased numbers of smolts produced as the result of implementation of this project's RPA will likely result in more coho salmon returning to the Russian River than would return under the original proposed project (*i.e.*, the effects of the RPA on coho abundance is a net increase in abundance). Increased production of coho salmon in habitats improved by the RPA will help offset losses caused by depensatory processes and inbreeding associated with the extremely low population numbers of Russian River coho salmon. Furthermore, given the near extirpation of the species in this watershed, the RPA has good potential to reverse the negative trend in population growth to a positive trend.

In Section VIII, we found that the original project proposed by the Corps and SCWA constrained the genetic and ecological diversity of coho salmon, because it maintains a status quo that inhibits growth of a population so low that depensatory mechanisms threaten the population's genetic diversity. With the restoration of habitats in Dry Creek's mainstem and tributaries, improvements in estuarine water level management, the annual stocking of 10,000 genetically compatible coho salmon smolts, and assurances of ongoing genetic management and population monitoring within the RRCSCBP, the RPA should improve population growth and decrease risks associated with reduced genetic and ecological diversity.

We also found that the original project would likely adversely affect the spatial distribution of coho salmon, because it virtually precludes Dry Creek as useable rearing habitat for this species. The RPA will promote expansion of the spatial distribution of coho salmon because it will

substantially enhance the suitability of both Dry Creek and its tributaries as rearing habitat for coho. In addition the RPA funding support for genetics management, an emergency water supply pipeline at Warm Springs Hatchery, and population monitoring in the field for the RRCSCBP will enable cooperating agencies to rear and plant genetically healthy and compatible Russian River-stock coho into streams where Russian River coho have been extirpated.

With implementation of the RPA there will continue to be some mortality or other forms of take of juvenile coho salmon as the result of ongoing channel maintenance in the mainstem, flood control operations at WSD, deployment of the inflatable dam at Mirabel, entrainment of fishes into infiltration ponds at the Mirabel/Wholer diversion facilities during high flows, and flow releases from WSD during the low flow period (June through October) prior to full implementation of the Dry Creek habitat enhancements in 2020. We have considered the effects of these various project elements in Section VI of this opinion. These impacts of the project operations have been generally ongoing at least since water storage commenced at WSD in October 1983 and D1610 was adopted in 1986. Loss of CCC coho salmon due to the release of elevated flows in Dry Creek during the low flow season will be similar to that in recent years during the first five years of the RPA; however, it will be less in subsequent years because of planned habitat enhancements in Dry Creek. In addition to those effects of flood control and water supply operations, SCWA's seasonal monitoring of salmon and steelhead via the trapping and live release of a small percentage of juvenile salmonids migrating past the Mirabel dam and SCWA's monitoring of fishes in the estuary via seining have been ongoing for nine and five years, respectively. Some limited injury or mortality of juvenile coho salmon may also occur as the result of RPA habitat enhancement work in the tributaries and in Dry Creek. SCWA will relocate juvenile coho salmon from aquatic habitat in work sites. As described above in the biological opinion, NMFS anticipates injury and mortality to be limited to 3% of juvenile salmonids found at these sites. Because we anticipate substantially greater numbers of coho salmon in the system as the result of the RPA, the actual loss of individual juvenile coho salmon will probably be greater than that under recent operations. However, the loss or mortality of some coho salmon due to implementation of the RPA when combined with the increased survival of other individuals due to new project elements in the RPA (as described in Section X.A), will likely substantially improve population growth and abundance and decrease diversity risks to the Russian River coho salmon population.

Given that the RPA will likely increase the abundance of the coho salmon population in the Russian River beginning in Year 1 with estuarine habitat enhancements and annual stocking of 10,000 genetically compatible smolts, and the enhancement of passage opportunity and rearing habitats in tributaries by end of Year 3, the major enhancements of rearing habitat in Dry Creek between Years 5 and 12, the RPA will likely promote a positive trend in the growth rate of the Russian River coho salmon population. In addition, the annual funding of the genetics management and field monitoring for the RRCSCBP and the replacement of the emergency water supply line for the Warm Springs Hatchery will help ensure the viability of the RRCSCBP for the duration of the Project. With support for genetic analysis, field monitoring of stocked program fish, the implementation of a smolt stocking component, provision of an emergency back-up water supply line, and substantial habitat enhancements in Dry Creek and its tributaries, it is likely that Russian River stock coho will not be extirpated during the 15 year Project. Indeed, it is unlikely that the RPA will appreciably reduce the numbers of coho in the watershed,

but rather it will likely increase the abundance of the Russian River coho salmon population, and enhance its habitats in both the Dry Creek watershed and estuary. The RPA should also not adversely affect the spatial diversity, ecological diversity, or genetic diversity of this species. For those reasons, we find that the RPA will not jeopardize the survival of CCC coho salmon. Beyond not jeopardizing the species, these enhancements of habitat and the stocking of smolts from the RRCSCBP will likely increase the abundance and population growth rates of coho salmon in the Russian River watershed. Therefore, we find that the RPA will not reduce appreciably the likelihood of the recovery of CCC coho salmon. In addition, for the reasons described above for steelhead, the RPA will likely also help the Russian River coho salmon population respond to climate change.

4. Effects of the RPA on Coho Salmon Critical Habitat

The new RPA actions will avoid adverse modification of designated critical habitat for coho salmon, because:

1. The adverse modification of critical rearing habitat due to high summer flow releases from WSD will be remedied by substantially enhancing the quantity and quality of rearing habitat for juvenile coho salmon in the 14 mile segment downstream of WSD when flows range from about 110 to 175 cfs. To do this SCWA will create near-optimal quality, pool-riffle rearing habitat in six miles of Dry Creek for that range of flows. These enhancements will be distributed at eight separate sites and include improvements in the upper, middle and lower portions of Dry Creek. In addition, SCWA will install 20 boulder clusters that will provide velocity refuge and create rearing habitat in those areas that will not be engineered to provide near-optimal quality, pool-riffle sequences. The Corps will also work with SCWA to enhance winter habitat refuges for coho salmon at points along the margins of Dry Creek. The flood protection functions of WSD and the stabilization of banks through bioengineered approaches will promote the long-term stability of the habitat enhancements.

2. Water levels in the estuary will be managed to enhance the quality of the estuary as rearing habitat for coho salmon and steelhead. Reduction of mainstem flows and a new water level management program that promotes natural closure of the lagoon or formation of a perched lagoon will likely yield conditions more similar to those that were present before the construction of WSD, CVD, and PVD, which created the need for water level management in the estuary. The RPA will provide greater depths, reduced salinity, localized higher dissolved oxygen concentrations, and it may yield cooler temperatures near the bottom of the estuary, conditions favored by coho salmon.

As described in Section X.B.3, the construction of six miles of near-optimal quality pool-riffle habitat in Dry Creek will create roughly 96,500 m^2 of high quality rearing habitat for coho salmon. As also described in the above section, the installation of 20 large boulder clusters in stream reaches not benefited by major pool-riffle enhancements will provide velocity refuges and create roughly an additional 3000 to 6000 m^2 of rearing habitat for coho salmon at diverse locations throughout the remaining eight miles of Dry Creek affected by flow releases from WSD.

The plan for habitat enhancements will substantially improve coho salmon rearing habitat throughout the 14 mile segment of stream and appreciably increase Dry Creek's carrying capacity for juvenile coho salmon over that present during recent historic operations. The plan for five years of post-construction monitoring and adaptive management of all habitat enhancement sites will help ensure that the RPA creates good quality rearing habitat at each of the 28 habitat enhancement sites (8 major, pool-riffle enhancement zones plus 20 large boulder clusters), thereby avoiding adverse modification of coho salmon rearing habitat in Dry Creek. As stated under the discussion of steelhead habitat enhancements, we recognize that the science and application of stream habitat restoration and enhancement is highly complex and subject to the unpredictable influences of geology, hydrology (*e.g*., floods), and biology. Therefore, despite the high likelihood that implementation of the habitat enhancement plan will avoid adverse modification of critical habitat, we remain cautious and require engineering analysis, conceptual design, environmental impact assessment, and costing of a Dry Creek bypass pipeline for SCWA to convey its water supply from Lake Sonoma. A pipeline will be constructed in the unlikely event that it is found that unforeseeable, physical factors confound efforts to ameliorate the adverse affects of high summer and winter flow releases via modifications of the Dry Creek channel. A bypass pipeline would facilitate the reduction of summer flows, with resulting increases in available salmonid rearing habitat as described in Section VI.F.

5. Effects of the RPA on Chinook salmon survival and recovery

NMFS has analyzed the effects of the RPA on CC Chinook salmon. This was done similar to what was done above for steelhead and coho salmon. As previously discussed in this opinion, the population of Chinook salmon in the Russian River appears to be at least stable, and may be increasing, although the reduced 2007 returns warrant caution. Water diversions, the confinement of the river channel, limited riparian vegetation, and ongoing sedimentation from roads, agriculture, and other developments remain important unresolved threats to the success of the Russian River Chinook salmon.

When added to the baseline, the RPA will initially have only limited impacts on the abundance of Chinook salmon, and is unlikely to affect the species growth rate, distribution, or diversity. As the RPA's various new project components are implemented over time, Chinook salmon juvenile abundance, and perhaps the species' growth rate, are anticipated to increase because:

1. Losses to Chinook salmon resulting from the original project elements will be relatively minor as described above in the biological opinion. These losses are unlikely to adversely affect the population's growth rate because they likely affect only a very small portion of the total egg, alevin, and juveniles produced in the river.
2. The new elements of the RPA are unlikely to adversely affect large numbers of Chinook salmon. The perched lagoon created by adaptive sandbar management at the mouth of the Russian River is anticipated to allow migrating adults and smolts to enter and exit the watershed via the overflow channel. There may be some increase in predation on Chinook salmon entering or exiting the lagoon due to the relatively confined space provided by the overflow channel. NMFS expects that most smolts will be migrating during high spring flows prior to closure of the bar in most years, and losses to the population will be relatively minor. Similarly, most adults migrate from mid October

through early winter, and NMFS anticipates the bar will be open to ocean tides in most years due to high flows and/or breaching.

3. The RPA's eventual reduction in the mainstem Russian River and enhancement of low velocity refuge habitat in Dry Creek are anticipated to be beneficial to fry and juvenile Chinook salmon, as described in Tables 22 and 23 in the preceding biological opinion. Thus, survival of the fry and juvenile components of the population should increase, and for the reasons described above for steelhead, the RPA will probably also help the Russian River Chinook salmon population respond to climate change.

6. Effects of the RPA on Chinook salmon Critical Habitat

The RPA will avoid adverse modification of designated critical habitat for Chinook salmon, because:

1. The migratory corridor PCE of critical habitat for adult Chinook salmon appears to be enhanced by the elevated regulated flows that will begin annually on October 15. Under the RPA, the Russian River mainstem will not serve as a migratory corridor for upstream migrating adult Chinook salmon between late August and mid-October (as has occurred under D1610). However, functional migratory habitats for adult CC Chinook salmon at this time are not essential to population viability in the Russian River, given that numbers of fishes entering the river prior to October 1 is minimal, early migrants into the river are exposed to prolonged angling pressure and high water temperatures, early migrants in the Russian River have been generally unable to access spawning habitats until after October 15, and high water temperatures in the mainstem Russian River and major tributaries during late August and September preclude early spawning and successful egg incubation of Chinook salmon.
2. Because they migrate to the ocean in the spring of their first year, rearing juvenile Chinook salmon do not contend with the artificially high summer flows that limit available rearing habitat for the other Federally listed salmonid species. Although channel maintenance activities under the RPA will likely have some adverse effect on spawning and rearing habitats for Chinook salmon, these effects will likely be minor because each year, channel maintenance will affect only a small portion (less than 1 mile) of the 94 mile long main stem Russian River, which effectively supports rearing habitat for juvenile Chinook salmon along its entire length and spawning habitat at riffles along the approximately 58 mile segment upstream from Healdsburg. The extent of habitat loss for rearing Chinook salmon in Dry Creek due to the RPA's channel maintenance activities is minor, confined to small, fixed locations, and further discountable given the availability of rearing habitat for this species in the main stem Russian River.
3. Changes to migration habitat in the Russian River estuary are unlikely to impair egress from, or entrance to, the Russian River. Predation from marine mammals may increase due to the relatively confined space of the outflow channel when compared to a tidal channel. However, as described in Section V, predation from marine mammals in the estuary is expected to have only minor effects on salmonid population abundance.
4. Changes in the value of estuarine habitat for juveniles transitioning to the marine environment are anticipated to be minor because: 1) in many years the perched lagoon will not be created until after the bulk of Chinook salmon smolts have entered the ocean, and 2) as described above in the biological opinion, most juveniles are expected to be

ready (based on size) to enter the ocean when they arrive at the estuary, reducing their need for transitioning habitat. Furthermore, the timing of the closure or partial closure will approximate the natural closure of the estuary that occurred prior to the development of water projects in the Russian River.

XI. INCIDENTAL TAKE STATEMENT

Section 9 of the ESA and Federal regulation pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by NMFS as an act which actually kills or injures fish or wildlife. Such an act may include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not the purpose of the agency action is not considered to be prohibited taking under the ESA provided that such taking is in compliance with the terms and conditions of this incidental take statement.

The measures described below are nondiscretionary, and must be undertaken by the Corps and SCWA for the exemption in section 7(o)(2) to apply. The Corps and SCWA have a continuing duty to regulate the activity covered by this incidental take statement. If the Corps or SCWA: (1) fail to assume and implement the terms and conditions, or (2) fail to require any permittee to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to any permit, grant document, or contract, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps and SCWA must report the progress of the action and its impact on the species to NMFS as specified in the incidental take statement (50 CFR §402.14(i)(3)).

This incidental take statement is applicable to all activities related to the Corps and SCWA Russian River Flow Management Project pursuant to the RPA described in this opinion. Unless modified, this incidental take statement does not cover activities that are not described and assessed within this opinion.

A. Amount or Extent of Take

Certain RPA elements are unlikely to result in take:

- Pursuit of lower D1610 Minimum Flows
- Project Scoping and Preliminary Design of a Water Delivery Pipeline

These elements include planning, design, and public scoping involving no disturbance of listed salmonids or their habitats.

The remaining RPA elements (the original proposed projects and modifications described above in section X.) are anticipated to result in take. As described in the preceding biological opinion and RPA, the number taken is likely to be small in many instances. The precise number of salmonids that are likely to be taken by the Project cannot always be accurately quantified because salmonids: (1) are relatively small (especially as eggs, alevins, and juveniles); (2) live in aquatic environments where visibility is often low, hiding cover often available, and predators

feed; (3) migrate long distances in short periods of time during some life history stages; and (4) naturally fluctuate in number between years due to short term environmental variation and other factors. In cases where NMFS cannot specify a quantity of individuals that are expected to be incidentally taken by the action, incidental take must be quantified using a surrogate as an extent. Thus, NMFS has used habitat impacts as a surrogate for numbers of salmonids expected to be incidentally taken. Habitat impacts are a reasonable surrogate as we have identified habitat impacts and demonstrated their link to incidental take of listed salmonids in the biological opinion and RPA.

The following quantification of incidental take is based on implementation of the proposed action as modified by the elements of the RPA. NMFS anticipates the following take from the combination of proposed action and RPA project elements:

1. Water Supply releases from WSD and CVD

a. Dry Creek

In our analysis of the effects of the originally proposed project (Section VI.F), we estimated that the mainstem Dry Creek channel had the potential to support 90,000 to 270,000 juvenile steelhead if summer releases were maintained at about 45 cfs. We estimated that approximately 75% of that potential production is lost as the result of sustained high releases in the range of 120 to 130 cfs during the summer period. Losses are even higher when flows are sustained at even higher levels. In that analysis of the originally proposed project, we also found that, because the coho salmon population in the Russian River is so low, the numbers of coho that are likely killed as the result of high summer flows in Dry Creek is in the vicinity of about 2,800 juvenile fish. However, because of the need to establish enforceable, measureable levels of anticipated take, NMFS will not use these numbers in describing the amount of anticipated take in this incidental take statement. The use of discrete numbers of individual fish for the incidental take statement is problematic because: 1) they are rough estimates used in the biological opinion to make relative comparisons, 2) monitoring of juvenile coho salmon and steelhead swept downstream is precluded by the difficulty in observing (or capturing all) these small fish in their habitat, 3) take levels will vary depending upon water year type and the flows released from WSD, and 4) fish loss is expected to diminish over time as interim channel improvements are installed, creating areas where juvenile fish can escape high velocity flows.

Instead, NMFS will use both WSD flow release data and anticipated enhancements to Dry Creek described in the RPA as surrogates for estimating numbers of fish killed, and as a means to identify if implementation of the action and RPA is exceeding levels of anticipated take. In this opinion, we found that large numbers of salmonids are likely adversely affected by the proposed "status quo" summer flow releases at WSD. As the RPA is implemented, channel improvements are scheduled to be placed in the mainstem of Dry Creek starting in year five[82]. Given that salmonid rearing habitat degrades steadily as flow rises above 90 cfs, it is prudent and reasonable to not augment releases beyond recent levels (past fifteen years) until the RPA's Dry Creek habitat enhancement measures are fully constructed and shown to provide good quality steelhead and coho salmon rearing habitat. Under the RPA, flow releases during summer months are

[82] The first set of channel improvements in the mainstem are not scheduled to be fully installed until year six.

expected to be similar to operations that have occurred during the past fifteen years. As the channel improvements described in the RPA occur, the amount of incidental take will decrease, starting in year five and culminating in year 13 when incidental take from WSD flow releases is expected to become discountable.

To that end, NMFS will use the monthly median flow released from WSD during the months of June, July, August, September and October of the next fifteen years as one of the surrogates for numbers of fish lost due to high velocity summer flows. Given that water supply releases under the RPA will be similar to those practiced during the past fifteen years, NMFS analyzed those flow releases in the biological opinion and assumes the next fifteen years of WSD releases would be similar to the past fifteen years. We used the flow levels we analyzed in Dry Creek (47, 90, and 130 cfs) as references for relative impact and examined the frequency distribution of flows during the previous fifteen years (Table 15). We used this frequency distribution as part of the basis for describing anticipated take. Based on the median monthly summer flow releases for water years 1993 through 2006[83], NMFS expects that the anticipated numbers of juvenile salmonids swept downstream into inhospitable conditions would be exceeded if during the next twelve years (the time prior to the completion of Dry Creek habitat enhancements affording good habitat conditions for WSD releases of 110 to 175 cfs):

- Monthly median flow immediately below WSD[84] during low flow months (June, July, August, September, and October) exceeds 160 cfs in more than one month of the total 60 low flow months (five months per year for 12 years) covered by the first 12 years of this opinion, and
- Monthly median flow immediately below WSD during low flow months (June, July, August, September, and October) exceeds 140 cfs in more than 5 months of the total 60 low flow months (five months per year for 12 years) covered by the first 12 years of this opinion, and
- Monthly median flow immediately below WSD during low flow months (June, July, August, September, and October) exceeds 120 cfs in more than 16 months of the total 60 low flow months (five months per year for 12 years) covered by the first 12 years of this opinion, and
- Monthly median flow immediately below WSD during low flow months (June, July, August, September, and October) exceeds 105 cfs in more than 34 months of the total 60 low flow months (five months per year for 12 years) covered by the first 12 years of this opinion.
- Monthly median flow immediately below WSD during low flow months (June, July, August, September, and October) exceeds 175 cfs during Years 13-15 covered by this opinion (assuming that the habitat enhancements described in the RPA and below are implemented and shown to be effective and support good production of juvenile steelhead and coho salmon by end of Year 12).

[83] We were unable to use data for water year 2007 because October 2007 is part of Water year 2008, which is provisional and not available at this time

[84] Monthly median flows will be determined using provisional data from USGS Gage 11465000 located immediately downstream of the outlet structure complimented with other provisional discharge data for WSD.

These values represent a frequency distribution for monthly median flows that is equivalent to the preceding fifteen years of monthly medians for the months indicated. We assume that consistent with the RPA, SCWA will enhance habitat in Dry Creek by end of year 12 covered by this opinion such that releases of 110 to 175 cfs will not be deleterious to salmonids in Dry Creek. If habitat enhancements are not implemented or monitoring indicates that the habitat enhancements are not effective, then take of listed steelhead and coho salmon may be exceeded.

In addition to limitations on flow, the anticipated numbers of juvenile salmonids swept downstream into inhospitable conditions would be exceeded if:

- By the end of Year 3 the Corps and SCWA have not completed five of the ten habitat restoration projects within Russian River or Dry Creek tributaries as identified in the RPA, Section X.A.3.1.2.

- By the end of Year 6 the Corps and SCWA have not created and enhanced at least one mile of the mainstem of Dry Creek with high quality pool-riffle sequences with a pool-riffle ratio ranging from 1:2 to 2:1 and with pools having the following characteristics:
  Size - 10 to 80 m^3 or 50 to 250 m^2
  Depth - ranges from 2 to 4 feet
  Substantial areas with mean column velocities of 0.1 to 0.2 ft/s
  Cover - more than 30% of the pool bottom obscured due to depth, surface turbulence, or presence of structures such as logs, debris piles, boulders, or overhanging banks and vegetation
  Placement- enhanced stream channel distributed at a minimum of two (2) different locations

- By the end of Year 6 the Corps and SCWA have not placed 10 boulder clusters in the mainstem of Dry Creek as described by Flosi *et al*. (1998).

- By the end of Year 9 the Corps and SCWA have not created and enhanced at least three (3) miles of the mainstem of Dry Creek with high quality pool-riffle sequences with a pool-riffle ratio ranging from 1:2 to 2:1 and with pools having the following characteristics:
  Size - 10 to 80 m^3 or 50 to 250 m^2
  Depth - ranges from 2 to 4 feet
  Substantial areas with mean column velocities of 0.1 to 0.2 ft/s
  Cover - more than 30% of the pool bottom obscured due to depth, surface turbulence, or presence of structures such as logs, debris piles, boulders, or overhanging banks and vegetation
  Placement- enhanced stream channel distributed at a minimum of four (4) different locations

- By the end of Year 9 the Corps and SCWA have not placed 20 boulder clusters in the mainstem of Dry Creek as described by Flosi et al. (1998).

- By the end of Year 12 the Corps and SCWA have not created and enhanced at least six (6) miles of the mainstem of Dry Creek with high quality pool-riffle sequences with a pool-riffle ratio ranging from 1:2 to 2:1 and with pools having the following characteristics:

  Size - 10 to 80 m^3 or 50 to 250 m^2
  Depth - ranges from 2 to 4 feet
  Substantial areas with mean column velocities of 0.1 to 0.2 ft/s
  Cover - more than 30% of the pool bottom obscured due to depth, surface turbulence, or presence of structures such as logs, debris piles, oulders, or overhanging banks and vegetation
  Placement- enhanced stream channel distributed at a minimum of eight (8) different locations

b. Mainstem Russian River

Similarly, NMFS has used a frequency distribution of monthly medians of the daily mean flow in the mainstem during the previous fifteen years as a surrogate for anticipated take of listed salmonids in the mainstem due to high summer flow releases during the next fifteen years. However, criteria for anticipated take associated with high flow releases from CVD is more complicated because: 1) June and October are months when flow in the mainstem can be heavily influenced by natural events (spring runoff in June and reduction in evapotranspiration in October), 2) summer releases from CVD and minimum flows at Healdsburg are highly dependent on water year type, and 3) the RPA calls for changes in minimum flow requirements for the Russian River so that releases from CVD can be reduced. Therefore, our estimate of the number of listed salmonids we anticipate swept downstream and killed due to high summer flow releases from CVD is focused only on the months of July, August, and September and it considers water year type and whether SWRCB minimum flow requirements are changed. Based on the last fifteen years of record, NMFS expects that incidental take may be exceeded during, July, August, or September if:

<u>Prior to any modification of flow requirements stipulated in D1610</u>

In normal water years:

- Monthly median flow immediately below CVD[85] during low flow months (July, August, and September) exceeds 335 cfs in more than one month of the total 45 low flow months (three months per year for fifteen years) covered by this opinion, and
- Monthly median flow immediately below CVD during low flow months (July, August, and September) exceeds 300 cfs in more than 10% of the total number of low flow months in normal water years occurring over the fifteen years covered by this opinion, and

[85] Montly median flow will be determined by USGS gauge 11462000, which is located immediately downstream of CVD. NMFS recognizes that SCWA and the Corps operate CVD using instantaneous provisional discharge data at CVD. Final corrected USGS data are not computed until months after releases are made. SCWA and the Corps will make best efforts to achieve flow objectives utilizing real-time (provisional) discharge data from both USGS 11462000 and the Corps data for CVD.

- Monthly median flow immediately below CVD during low flow months (July, August, and September) exceeds 260 cfs in more than 50% of the total number of low flow months in normal water years occurring over the 15 years covered by this opinion.

In Dry water years:

- Monthly median flow immediately below CVD during low flow months (July, August, and September) exceeds 230 cfs in more than one month for all low flow months occurring in dry water years over the 15 years covered by this opinion, and
- Monthly median flow immediately below CVD during low flow months (July, August, and September) exceeds 200 cfs in more than 50% of the total number of low flow months in dry water years occurring over the 15 years covered by this opinion.

<u>After modification of flow requirements stipulated in D1610</u>
(We assume minimum flow requirements between the East Fork and Healdsburg can be reduced by at least 60 cfs in normal water years)

Normal water years:

- Monthly median flow immediately below CVD during low flow months (July, August, and September) exceeds 275 cfs in more than one month of the total 45 low flow months (three months per year for ten years) covered by this opinion, and
- Monthly median flow immediately below CVD during low flow months (July, August, and September) exceeds 240 cfs in more than 10% of the total number of low flow months in normal water years occurring over the 15 years covered by this opinion, and
- Monthly median flow immediately below CVD during low flow months (July, August, and September) exceeds 200 cfs in more than 50% of the total number of low flow months in normal water years occurring over the 15 years covered by this opinion.

Dry water years:

- Monthly median flow immediately below CVD during low flow months (July, August, and September) exceeds 230 cfs in more than one month for all low flow months occurring in dry water years over the 15 years covered by this opinion, and
- Monthly median flow immediately below CVD during low flow months (July, August, and September) exceeds 200 cfs in more than 50% of the total number of low flow months in dry water years occurring over the 15 years covered by this opinion.

2. <u>Adaptive Estuarine Breaching</u>

NMFS expects that adaptive management of the sand bar at the mouth of the estuary will improve habitat conditions during the spring and summer for juvenile steelhead and potentially for juvenile coho salmon, while avoiding adverse impacts to Chinook salmonids and other life history stages of steelhead and coho salmon, as described above in the RPA. However, in some conditions (high ocean swells, for example) it may not be feasible to create an outflow channel to

the north before flooding is imminent. In such cases, SCWA would need to breach the estuary in the spring or summer (May 15 to October 15)[86] as they have previously, allowing a deep channel to form roughly perpendicular to the bar. Such breaching would expose biota in the estuary to large amounts of salt water transported by tidal action. NMFS anticipates this will occur with limited frequency during the initial years of RPA implementation because SCWA will closely monitor conditions at the sandbar and maintain an adequate overflow channel. Experience gained with the alternative breaching strategies during the first few years is expected to ensure that subsequent overflow channels will work properly.

If it is necessary for the estuary to be breached in the spring or summer as it has been breached in the past, conditions are created that likely: 1) sweep small juvenile steelhead (and possibly juvenile coho salmon) out to sea before they are ready for the ocean environment, 2) increase salt levels in the estuary to amounts beyond the tolerance levels of YOY steelhead, 3) expose juvenile steelhead (and possibly juvenile coho salmon) to greater levels of predation as the freshwater lens at the top of the estuary shrinks, and 4) set up conditions for subsequent closure of the bar and temporary adverse changes to water quality as described in the biological opinion. Most of the small juvenile salmonids exposed to these conditions will die.

NMFS cannot accurately estimate the number of juvenile steelhead impacted by this type of breaching. The number may have considerable range, depending upon the timing of YOY downstream migration and when the estuary closes in the spring. Therefore, NMFS will use the number of times the estuary may be breached as a surrogate for the numbers of juvenile steelhead and coho salmon taken as described above. We estimate that SCWA will need to artificially breach the lagoon using methods that do not create a perched lagoon twice per year between May 15 and October 15 during the first three years covered by this opinion, and once per year between May 15 and October 15 during years 4-15 covered by this opinion. We assume that experience gained during years 1-3 and remediative steps associated with modification of the jetty or other flood management options will improve the proficiency of SCWA at maintaining a closed or perched lagoon. If the estuary is breached using methods that create a deep channel through the bar more than the number of times indicated above, or biological monitoring indicates periods of adverse water quality throughout the estuary longer than 3-4 weeks[87], then incidental take may be exceeded. As described in the preceding biological opinion, NMFS anticipates 3-4 weeks of adverse water quality conditions after the sandbar closes at the mouth of the estuary. A longer period of adverse water quality conditions may indicate that the formation of a closed lagoon or the creation of a perched lagoon by adaptive bar management has resulted in unanticipated water quality degradation.

Only small amounts of incidental take are anticipated for Chinook salmon migrants because, 1) these fish are anticipated to be able to enter and exit the estuary through the overflow channel that will be constructed, 2) the estuary will be fully open to ocean tides prior to the bulk of Chinook adult migration (mid-October through mid-November), and 3) most juvenile Chinook

[86] As described in the preceding biological opinion, breaching during the fall, winter, and early spring is unlikely to have adverse effects on listed salmonids.

[87] For example, dramatic reductions in invertebrate prey items, or temperatures over 23°C throughout the water column, or dissolved oxygen levels near zero throughout the water column for longer than 3-4 weeks likely indicate adverse conditions beyond those anticipated in the RPA.

salmon enter the estuary large enough to tolerate salt water. Similarly, most coho salmon in the estuary are expected to move into the ocean prior to the summer and are not likely to be adversely affected by adaptive management or a limited number of spring or summer breaching events. Those that remain are expected to leave the estuary and move upstream prior to fall breaching. As described in the biological opinion, there may be a very small number of coho salmon YOY in the estuary when it is breached. Some of these fish would likely be harmed or killed during breaching.

NMFS assumes that if partial or complete removal of the jetty in the bar at the mouth of the Russian River occurs, construction equipment will not operate in flowing water. NMFS anticipates no take of listed salmonids from jetty modification or removal. Take from using the jetty as a tool in maintaining the estuary's water surface elevation as described in the RPA is assumed to be similar to the take described above for creating the outlet at the north end of the estuary's bar.

3. Flood Control at WSD and CVD

a. WSD

In the preceding biological opinion, NMFS anticipated take of fry and juvenile stages of Chinook salmon, coho salmon, and steelhead in the first three miles of Dry Creek downstream from WSD. Changes in river stage during flood control ramping are likely to strand these species' life history stages between February and late June during the next fifteen years, exposing them to higher rates of predation. However, we anticipate that the numbers of stranded fish will be low, because of steep channel banks and lack of side channels in this area of Dry Creek.

Take of juvenile salmonids during flood control ramping at WSD is difficult to quantify for the reasons described above. NMFS has used change in river stage (estimated by the Corps (2008))[88] as a surrogate for the number of fish stranded. If flood control ramping produces a stage change greater than 1 foot per hour when releases are 3,000 cfs or less, or a stage change of greater than ½ foot per hour when ramping rates are over 3,000 cfs, anticipated take due to stranding may be exceeded.

As described in the preceding biological opinion, scour at WSD is likely to result in loss of 5-10% of salmonid redds in a three-mile reach below the dam, during years when releases are 5,000 cfs or greater. Detection of lost redds will be difficult because: 1) redds are created by salmonids in complex aquatic environments where they can be missed by observers, 2) redds can be obscured by high flow events without being destroyed, leading to incorrect counts of redds lost. Therefore, to monitor this anticipated take, NMFS will use flow release rates as a surrogate for redd loss. As described in the preceding biological opinion, NMFS estimates releases from WSD will be 5,000 cfs or greater twice during the next fifteen years (see Section VI.c.1). If releases of 5,000 cfs or greater occur more often, incidental take may be exceeded.

Small, localized loss of salmonid embryos and fry from sedimentation due to bank erosion is expected during some years. In the preceding biological opinion, NMFS determined that the

[88] Email from Chris Eng, Corps, to Eric Shott and Tom Daugherty, NMFS, February 7, 2008.

number of embryos and fry lost was likely to be small due to the limited extent of bank erosion sites. NMFS will use the frequency of WSD flow releases that are likely to produce bank erosion as a surrogate for numbers of fish taken. Bank erosion occurs when releases are 2,500 cfs or greater. NMFS estimates releases will be 2,500 cfs or greater during 8 of the next 15 years. If these releases occur with greater frequency, anticipated take may be exceeded.

b. CVD

NMFS anticipates take of juvenile steelhead and Chinook salmon due to stranding downstream of CVD in both the East Branch of the Russian River and in four miles of the Russian River mainstem downstream of the East Branch. As described in the biological opinion, stranding is more likely in the mainstem due to channel configuration. As above, the amount of fish lost is difficult to quantify. NMFS has used change in river stage as a surrogate for the number of fish stranded. If flood control ramping produces a stage change greater than 1.2 feet per hour (Corps 2008)[89], anticipated take due to stranding may be exceeded.

Scour due to flood control flow releases is expected to destroy between 3 and 13 Chinook salmon redds during eight out of the next fifteen years. Fewer steelhead redds will be lost. Due to the difficulty in observing redd loss downstream of the dam, NMFS will use the expected number of days that CVD increases the duration of scour events during the next fifteen years (as described above in the *preceding biological opinion*) as a surrogate for the number of redds lost downstream in the upper five miles of the Russian River. Our effects analysis assumes that flow releases associated with flood operations will be similar to that observed during the past fifteen years.

During the next fifteen years, NMFS anticipates years when CVD operations will extend the duration of flows over 4,200 cfs (scour events) in the upper Russian River beyond the number of days such exceedance would occur based on Russian River flows alone. Based on the analysis of these scour events in the biological opinion, NMFS anticipates that CVD will extend the duration of scour events for a total of 32 days during 16 storm events over the course of the 15 year period covered by this biological opinion. Incidental take may be exceeded if:

- CVD extends the duration of scour events by more than 32 days or during more than 16 storm events during the next fifteen years; or
- CVD in any one year extends the duration of scour events on more than 5 storms in one year; or
- CVD in any one year extends the duration of scour events by more than 14 days in one year.

Small, localized loss of salmonid embryos and fry from sedimentation due to bank erosion is expected during some years. Flows of 6,000 cfs or greater are needed to initiate bank erosion along the upper Russian River down to Hopland. Chinook salmon redds are the most likely affected given their spawning timing. There are five known bank erosion areas that continue to cause some sedimentation on an annual basis (Pat Ford, consultant for MCRRFCD, personal

[89] Email from Chris Eng, Corps to Tom Daugherty and Eric Shott, NMFS, January 31, 2008.

communication, 2008). Steelhead and Chinook redds located directly downstream of these five locations could be affected.

Similar to the issue of redd scour, it is difficult to detect redd loss from sedimentation downstream of the dam. Therefore, NMFS will use the number of days CVD is expected to extend the duration of flows greater than 6,000 cfs at Hopland (other than what would occur based on Russian River flows alone) as a surrogate for the number of redds lost downstream of CVD due to bank erosion. Based on the continuation of operations practiced during the past fifteen years, CVD releases are expected to result in an additional 31 days[90] of flow > 6,000 cfs at Hopland during the next 15 years. Therefore, incidental take may be exceeded if:

- CVD releases contribute to more than 31days of flows > 6,000 cfs at Hopland over the course of the next fifteen years, or
- CVD releases in any one year contribute to more than 16 days of flows > 6,000 cfs at Hopland; or
- CVD releases in any one year contribute to flows > 6,000 cfs at Hopland) during more than 5 storms.

This portion of anticipated take is based on ramping operations for flood control. Anticipated take from preflood/periodic inspections is described below. Changes in river stage resulting from releases from WSD or CVD in pursuit of other purposes, such as hydropower generation testing, were not analyzed by NMFS and may result in take of listed salmonids .

4. <u>Preflood/periodic inspections at CVD</u>

a. CVD

At Coyote Valley Dam, annual preflood and /periodic inspections (every five-years) are anticipated to strand no more than 20 juvenile steelhead during inspections each year.

b. WSD

NMFS does not anticipate take associated with Preflood/periodic inspections at WSD conducted in late August or September.

5. <u>Turbidity Releases from CVD</u>

Turbidity releases from CVD are anticipated to result in minor reductions in Chinook salmon and steelhead egg, alevin, fry, and juvenile survival in the upper Russian River mainstem below the confluence with the East Branch. These reductions may occur via entombment of eggs and alevins, and loss of prey for fry and juveniles due to high elevated turbidity. Information is not available to specifically quantify take that may be associated with turbidity releases from CVD nor is information available to quantify an extent of this take using a surrogate such as the

[90] Without CVD releases, flows at Hopland would likely be less than 6,000 cfs, as described in the preceding biological opinion.

magnitude or timing of the releases. In the preceding biological opinion, NMFS has assumed that the overall effect of turbidity on salmonid populations (juvenile Chinook salmon and steelhead) in the mainstem of the Russian River is low to moderate, given the relatively high production of Chinook salmon fry in the upper mainstem Russian River. Below, in the Terms and Conditions, NMFS is requiring turbidity monitoring to more precisely determine the level of impact that turbid releases from CVD have on listed salmonids.

6. Hatchery Operations

Operation of the steelhead hatchery program as mitigation for the construction and operation of CVD results in several different types of take. For example, both adult steelhead and adult Chinook salmon return to the hatchery and are subsequently captured and collected. Some of the captured adult steelhead are spawned and the remainder are transported and released into nearby streams. All of the captured adult Chinook salmon are transported and released back into the Russian River. As indicated in Section VI.E, immediate mortality of adult Chinook salmon is likely negligible; however, the collection and transport causes stress and minor injury to the adult fish. The progeny of the spawned steelhead are held in captivity for rearing, and then transported and released into streams. The types of take and numbers of steelhead affected by the hatchery program are described as follows:

1. Of the adult steelhead that are captured at the hatchery and rearing facilities each year, at least 180 female steelhead are collected and held for spawning at DCFH and at least 120 females are collected at CVFF. Up to three times as many steelhead males are also collected and spawned. Surplus adult steelhead that return to the facilities are outplanted to the Russian River watershed as described below in number 7.

2. Hatchery operations annually collect approximately 900,000 steelhead eggs at DCFH and about 600,000 eggs at the CVFF (B.Wilson, DFG, personal communication July 2008). Hatchery operations then rear (hold in captivity) about 600,000 steelhead eggs at DCFH and about 320,000 steelhead eggs at CVFF. Individuals are reared to the smolt life history stage.

3. Steelhead fry reared at CVFF are transported to DCFH where they are then reared in separate tanks from those containing progeny of adults that returned to the DCFH. Upon reaching the yearling smolt stage, the CVFF fish (approximately 40,000 pounds of fish) are then transported back to CVFF in three separate lots in late January/early February and March. Following that second transfer, they undergo 4 to 6 weeks of additional rearing, acclimation, and imprinting to home waters before they are released to the East Branch of the Russian River (as described in 5 below).

4. Before their release, all steelhead produced at both facilities are marked with an adipose fin clip.

5. Up to 300,000 DCFH steelhead smolts are transported three miles downstream from the hatchery and released into Dry Creek. During late winter and early spring, up to 200,000 CVFF steelhead smolt are allowed to volitionally leave the CVFF and swim downstream.

6. Up to 500 adult Chinook salmon can be annually trapped and relocated during the collection of adult steelhead broodstock at DCFH and CVFF, with not more than 2 percent mortality. As discussed in the **Effects of the Proposed Action** section, mortality of Chinook salmon during trapping and transport at both facilities occurs infrequently, and in most years, all Chinook salmon are trapped and relocated without mortality. The primary effects to adult Chinook salmon trapped and relocated from both facilities are non-lethal and associated with their capture, handling, and transport. The adult Chinook salmon that are trapped and relocated, should be able to successfully spawn and contribute to subsequent generations.

7. The amount of straying by returning adult hatchery steelhead is expected to be below levels (or in locations) that would cause deleterious effects on wild fish genomes and local adaptations. Competition between hatchery steelhead and wild salmonids is anticipated to be very low, because the number of strays is expected to be low. Although predation by smolt-sized hatchery fish may occur on wild salmonid fry and fingerlings, the potential magnitude of this take is low because the hatchery smolts are expected to migrate from the watershed within a few days to a few weeks and thus contact between wild fish and hatchery smolts will be limited and the release of smolts typically occurs in late winter prior to the emergence of most steelhead fry, which typically emerge between late March and late May.

Release of non-spawned adult hatchery steelhead (surplus returns to the hatchery) into the Russian River is expected to be below levels (or in locations) that would cause deleterious effects on wild fish genomes and local adaptations. Competition between hatchery steelhead and wild salmonids is anticipated to be very low, because adult hatchery steelhead are released into streams currently lacking wild steelhead. Although predation by hatchery fish may occur on wild salmonid fry and fingerlings, the potential is low, and most likely occurs (if at all) in Dry Creek, the mainstem Russian River, and within the estuary.

Adult hatchery steelhead that return to DCFH but are not needed for broodstock are released into the main stem Russian River, upstream of the confluence with Dry Creek. Adult hatchery steelhead that return to CVFF that are not needed for broodstock are relocated to the Ukiah and Cloverdale reach of the main stem Russian River, and to tributaries to the upper Russian River including: Ackerman, Feliz, Orr, Gibson, Doolan, Mill (tributary to Forsythe), Hensley, McClure, McNab, Morrison, Parsons, Howell, Dooley, McDowell, Twining, and Walker creeks.

NMFS cannot precisely estimate the amount of wild salmonids affected by competition with hatchery fish, hatchery fish predation, or disease transmission that result from straying or release of surplus fish. However, as described in the preceding opinion, the number is likely to be small. NMFS will use the average number of hatchery steelhead that returned during the last ten years, the maximum that have returned, the numbers released (by sex), and the current release sites, as a surrogate for estimating take. For example, we assume that the amount of straying is proportional to the number of returns to the hatchery. Larger numbers of steelhead returning would indicate larger amounts of straying. If returns or releases are greater than the numbers provided below, or releases occur in different streams than those described in the biological opinion, incidental take may be exceeded:

Hatchery returns average 6,700 fish for the next fifteen years, and range no higher than 12,000 fish.

Creeks where surplus adult steelhead are released (and maximum numbers of steelhead, and maximum numbers of females released) (CDFG 2008):

Stream or Location	**Maximum Number Released**	**Maximum Number of Females**
Orr Creek (below barrier only)	45	15
Gibson Creek	30	10
Doolan Creek	30	10
Mill Creek tributary to Forsythe	45	15
Hensley Creek	45	15
Mill/McClure Creeks	30	10
McNab Creek	15	5
Morrison Creek	45	15
Parsons Creek	30	10
Howell Creek	15	5
Dooley/McDowell Creeks	45	15
Walker Creek	45	15
Akerman Creek	45	15
Fleiz Creek	45	15
Twining Creek	30	10
West Fork Russian River above Mumford Dam and the Russian River near the confluence with Forsythe Creek	450	150
Ukiah Reach* and Cloverdale Reach* of the Russian River mainstem (sportfishing enhancement)	No Limit	No Limit

*Hatchery returns are used as a surrogate for incidental take for these release sites.

In subsection **C. Reasonable and Prudent Measures and Terms and Conditions** of this Incidental Take Statement, Reasonable and Prudent Measure 7, Term and Condition B.(1) requires the Corps and CDFG to incorporate wild steelhead returns to the hatchery into the spawning matrix. This will result in a small number of additional outplants of steelhead hatchery returns to the reaches of the Russian River described above. NMFS anticipates no more than 10 additional surplus adult returns will be outplanted each year.

7. Channel Maintenance Activities in Mainstem, Dry Creek, and Zone 1 A

a. Mainstem

As described above in the biological opinion, NMFS estimates that SCWA and MCRRFCD channel maintenance activities will result in the death of small numbers of juvenile steelhead relative to the number of juveniles in the mainstem each year for the next fifteen years in the Russian River mainstem. Because these losses are the indirect result of habitat degradation (loss of habitat complexity such as hiding and thermal cover) and subsequent increase in predation, the precise number of juvenile steelhead deaths will be difficult to determine. For example, direct observation of all predation events in this type of riverine environment is impossible due to limited in-water visibility. In addition, it is impracticable to monitor, all the time, everywhere juvenile steelhead may be present. Therefore, NMFS will use the location and amount of habitat disturbed every year as a surrogate for the low numbers of juvenile steelhead killed. Incidental take may be exceeded if more than 15,000 feet of mainstem Russian river channel is disturbed by maintenance activities in either Sonoma or Mendocino County over the course of the next fifteen years. No more than 2,000 feet of mainstem channel is expected to be disturbed in any given year. Incidental take may be exceeded if channel maintenance work occurs outside of the 22 mile reach between river mile 41 and 63, the 36 mile reach from the Mendocino County line north, or outside of the Mirabel and Riverfront Park Areas. Incidental take is anticipated to be low because apart from bank areas and adjacent channel bed or gravel bars disturbed by maintenance work, the surrounding channel areas will remain undisturbed. In addition, if channel maintenance activities leave habitat in a condition that is likely to result in take of other salmonid life stages, take is likely to be exceeded. For example, if migration barriers are created for any salmonid life history stage as a result of channel maintenance activities, incidental take is likely to be exceeded.

Some sites may need dewatering as described in the biological opinion. A small number of steelhead may need to be relocated from dewatered areas (<40 fish). Some steelhead may avoid relocation efforts, and the precise number of steelhead at dewatering sites will be difficult to determine. Therefore, as above, NMFS will use the total anticipated length of dewatering during the next fifteen years as a surrogate for numbers of fish. NMFS anticipates no more than 750 linear feet of the mainstem Russian River will need to be dewatered during the next fifteen years and most juvenile steelhead in these areas will be relocated successfully. No more than 3% of these fish will be injured or killed during relocation.

b. Dry Creek

NMFS estimates that channel maintenance activities in Dry Creek will result in the direct mortality or injury of small numbers of juvenile steelhead and coho salmon. The precise numbers likely killed or injured cannot be easily calculated due to the limited fish distribution and density information available, and the difficulty in observing these small aquatic organisms in the wild. NMFS has inferred small losses relative to the size of the expected juvenile population in Dry Creek due to the small area disturbed by channel maintenance activities. Therefore, NMFS will use the amount of habitat expected to be disturbed in Dry Creek during the next fifteen years as a surrogate for juvenile steelhead and coho salmon killed or injured

indirectly due to habitat destruction. A total of 600 linear feet of Dry Creek channel is likely to be disturbed each year for the next fifteen years. Incidental take may be exceeded if more than 600 feet of Dry Creek mainstem is disturbed by maintenance activities during the next fifteen years. Incidental take is anticipated to be low not only because few steelhead, and fewer coho salmon are likely to inhabit the Dry Creek mainstem in the summer, but also because apart from bank areas and adjacent channel bed disturbed by maintenance work, the surrounding channel areas will remain undisturbed. In addition, if channel maintenance activities leave habitat in a condition that is likely to result in take of other salmonid life stages, take is likely to be exceeded. For example, if migration barriers for any salmonid life history stage are created as a result of channel maintenance activities, incidental take is likely to be exceeded.

NMFS also anticipates small losses of adult Chinook salmon, steelhead, and coho salmon migrants and spawners due to loss of habitat (cover and resting pools) in Dry Creek. Although NMFS was able to estimate that roughly two Chinook and steelhead spawners may be lost each year, the chance of finding a dead or dying fish after a predation incident is extremely low. Therefore NMFS will use the amount of habitat disturbed (600 feet per year) as a surrogate for numbers of fish.

Sediment from channel maintenance activities is likely to result in the loss of not more than 2 Chinook redds per year. As above, NMFS will use the amount of habitat disturbed per year (600 feet) as a surrogate for the number of redds lost. NMFS expects that sediments from channel maintenance activities will be dispersed downstream following winter storms and will not accumulate over time near channel maintenance sites.

c. Constructed Channels - Zone 1A

Juvenile steelhead. NMFS estimates that sediment and vegetation removal activities in constructed flood control channels of Zone 1A will result in the loss of small numbers of juvenile steelhead. The precise numbers likely lost cannot be easily calculated due to the limited fish distribution and density information available, and the difficulty in observing these small aquatic organisms in the wild. As described in the preceding biological opinion, NMFS has inferred small losses due to the current poor condition of these channels to support rearing steelhead. For example, in Copeland Creek, juvenile steelhead densities ranged from 0.06 steelhead per foot to 0.01 steelhead per foot and many portions of the channel are dry in the summer.

Because the precise number of steelhead juveniles attempting to rear in these channels is unknown, NMFS will use the amount of habitat expected to be disturbed in the Laguna de Santa Rosa, Copeland Creek, Windsor Creek, and Santa Rosa Creek during the next fifteen years as a surrogate for juvenile steelhead killed or injured indirectly due to habitat destruction. NMFS expects the following lengths of these creeks to have habitat complexity (pools, instream wood, shade, etc.) degraded or destroyed during the next fifteen years at the following frequencies:

- Laguna de Santa Rosa - 2,400 feet of sediment removal three times during the next fifteen years, and 12,000 feet of vegetation removal annually;
- Copeland Creek - 3,270 feet of sediment removal six times during the next fifteen years, and 9,625 feet of vegetation removed annually;

- Windsor Creek - 500 feet of sediment removal two times during the next fifteen years, and the annual removal of 3,000 feet of vegetation during the next fifteen years;
- Santa Rosa Creek - 4,000 feet three times during the next fifteen years, and 12,100 feet of vegetation removal annually.

In addition, if flowing water is present, SCWA will relocate juvenile steelhead present in the channel lengths described above. Most juvenile steelhead are expected to be captured and relocated during channel maintenance activities. Some will remain and will be killed during dewatering. Three percent of the juvenile steelhead present are expected to be injured or killed during relocation and dewatering. As described in the biological opinion, the number of steelhead injured or killed is anticipated to be small.

Migrating salmonids. As above, NMFS is unable to calculate precise numbers of migrating salmonids (steelhead and Chinook salmon) that will be unable to migrate upstream to spawn due to channel maintenance activities in constructed flood control channels. NMFS anticipates this number will be very small based on the analysis in the preceding biological opinion. Anticipated take levels may be exceeded if the extent or frequency of channel maintenance activities are increased beyond what is described above in this incidental take statement. In addition, NMFS assumes that large trees, large woody debris, large rocks, etc. at the edges of channels will not be removed by SCWA during sediment or vegetation removal activities. Should these elements of resting and hiding cover (at higher flows) be removed, anticipated take may be exceeded. If physical barriers to salmonid migration such as concrete sills, gravel berms, or road crossings are installed in these channels during channel maintenance activities, and remain during smolt or adult migration seasons, take may be exceeded. Such barriers could further reduce salmonid migration opportunities in these channels beyond the anticipated reductions from sediment removal activities. If sediment removal at road crossings and culvert outfalls leaves depressions which trap migrating adult or juvenile steelhead as flows recede, anticipated take will be exceeded.

d. Natural Waterways Zone 1A

NMFS anticipates that fish relocation will occur once in each natural waterway in Zone 1A (excluding the Mark West Creek watershed upstream of the mouth of the Leguna de Santa Rosa) during the next fifteen years and juvenile steelhead will be relocated from no more than 50 lineal feet of channel at any one site. Three percent of juvenile steelhead are expected to be injured or killed during fish relocation activities when sediment removal work is conducted. A smaller percent (1%) are expected to avoid relocation and die during sediment removal.

In natural waterways, a small number of juvenile steelhead will likely be unable to find cover due to vegetation removal and experience higher rates of predation. It is possible that a smaller number of juvenile Chinook salmon will suffer a similar fate. Because of the difficulty in documenting salmonid loss to predators, NMFS will use the limited amount of in-channel vegetation removal as a surrogate for the anticipated take. No more than 25 percent of the in-channel vegetation will be removed at any given site, and sites are anticipated to be less than 600 feet in length. Vegetation removal is anticipated on no more than three sites per natural waterway per year. NMFS anticipates no vegetation above top-of-bank will be removed.

8. Water Diversions Including Maintenance

Inflation and deflation of the inflatable dam is likely to strand a limited number of juvenile steelhead when the dam is inflated or deflated in the late spring. NMFS anticipates no more than five juvenile steelhead will become stranded each time the inflatable dam is installed or removed. SCWA will relocate stranded steelhead, and NMFS expects it unlikely that more than 3%, or one juvenile steelhead, will be injured during each year's relocation efforts.

Similarly, very few steelhead (five or less) will be lost each year when habitat conditions are degraded by the creation of the Wohler pool. Because finding dead fish before they are eaten by predators or scavengers will be difficult in the pool environment, NMFS will base the number of fish lost each year on the size of the impoundment created, 3.2 miles. If a larger area is impounded, more juvenile steelhead may be injured or killed.

Small numbers of fry and juvenile salmonids are likely to become impinged on the fish screens at Wohler; small numbers of salmonid fry may become impinged on the fish screens at Mirabel. As described in the preceding biological opinion, NMFS cannot precisely determine the number of fish impinged, but expects this number to be modest because the flow into these diversions is a small portion of the river flow during periods of juvenile migration and likely to attract few juveniles swimming downstream. Impingement is likely to occur for the next fifteen years at Wohler, and for the next five to seven years at Mirabel, until these fish screens are replaced.

Flood flows can overtop the infiltration ponds, stranding listed salmonids in the ponds. When flood flows recede, NMFS anticipates no more than 20 juvenile Chinook salmon will need to be rescued and relocated per year at the Wohler and Mirabel infiltration ponds. Similarly, NMFS anticipates no more than 150 juvenile steelhead and one steelhead adult will need to be rescued and relocated per year. NMFS anticipates no more than 3% will be injured or killed during relocation efforts.

9. Salmonid Monitoring

a. Mainstem at Mirabel/Wohler

As part of the RPA, SCWA will monitor adult, smolt, and juvenile salmon and steelhead migrants at the Mirabel Dam site as described above in the RPA. Table 36 shows the amounts and types of take that NMFS anticipates will occur from this fish monitoring at Mirabel/Wohler.

b. Estuarine Monitoring

Under RPA element , SCWA and the Corps will adaptively manage the estuary's bar to create a brackish/freshwater lagoon environment for prolonged periods during the late spring, summer, and early fall. SCWA will monitor salmonids in the estuary (RPA section 2.4) during these time periods to evaluate the number and condition of juvenile salmonids that migrate to the estuary.

Table 37 shows the amounts and types of take that NMFS anticipates will occur from this monitoring of fish in the vicinity of the estuary.

c. Dry Creek Fish Monitoring

Under RPA element 5, SCWA will implement an annual juvenile steelhead and coho salmon rearing survey. Specific sampling protocols may include depletion-removal electrofishing, mark-recapture electrofishing, single pass electrofishing, multiple pass snorkel counts, or a two-phase approach using snorkel counts validated by habitat specific population estimates derived from electrofishing. Table 38 shows the amounts and types of take that NMFS anticipates will occur from this fish monitoring in the Dry Creek watershed.

Table 36. Anticipated annual take of listed salmonids due to fish monitoring by SCWA in the vicinity of the Mirabel/Wholer Inflatable Dam.

Species/life stage	**Take cause**	**No. of Fish**	**Take Type**	**% major injury and mortality**
Chinook salmon adults	Observe (video in fish ladders)	10,000	Observed in fish ladder	none
Chinook salmon juveniles	Capture, observe, handle, anesthetize, fin clip, release (screw trap)	30,000 (Fin clip 6,000)	Stress, minor and major injury, unintentional mortalities	3%
Steelhead adults	Observe (video in fish ladders)	10,000	Observed in fish ladder	none
Steelhead juveniles (wild or hatchery)	Observe (video in fish ladders)	2,000	Observed in fish ladder	none
Steelhead juveniles (wild)	Capture, anethetize observe, handle, fin clip, mark, tag, release (screw trap)	20,000 (fin clip or mark 2,000) (PIT tag 1000)	Stress, minor and major injury, unintentional mortalities	3%
Steelhead juveniles (hatchery)	Capture, anethetize observe, handle, fin clip, mark, tag, release (screw trap)	20,000 (fin clip 2,000) (PIT tag 500)	Stress, minor and major injury, unintentional mortalities	3%
Coho salmon adults (wild or RRCSCBP)	Observe (video in fish ladders)	1,000	Observed in fish ladder	none
Coho salmon juveniles (RRCSCBP)	Capture, anesthetize, handle, release, fin clip, mark (screw trap)	5,000 (Fin clip or mark 500)	Stress, minor and major injury, unintentional mortalities	2%

Table 37. Anticipated annual take of listed salmonids resulting from fish monitoring by SCWA in the lower Russian River and estuary downstream from Monte Rio.

Species/life stage	**Take cause**	**No. of Fish**	**Take Type**	**% major injury and mortality**
Juvenile CCC coho salmon (wild or RRCSCBP)	Capture (seine or fyke net), Anesthetize, Handle, Fin Clip, Mark, Release	2,600	Unintentional mortalities	2 percent
		Fin clip or mark		
		500 RRCSCBP		3 percent
		100 wild		
Juvenile CC Chinook salmon	Capture (seine or fyke net).	5,000	Unintentional mortalities	2 percent
	Anesthetize, Handle, Fin Clip, Mark, Release	Fin clip or mark		3 percent
		200		
Juvenile CCC steelhead (wild or hatchery)	Capture (seine or fyke net), Anesthetize, Handle, Fin Clip, Mark, PIT tag, Release	3,500	Unintentional mortalities	2 percent
		Fin clip or mark		
		2,000		
		PIT tag 1000 fish >70 mm		3 percent

Table 38. Anticipated take of listed salmonids resulting from fish monitoring by SCWA in Dry Creek.

Species/life stage	**Take cause**	**No. of Fish**	**Take Type**	**% major injury and mortality**
Juvenile CCC coho salmon (wild or RRCSCBP)	Capture(backpack electrofishing, rotary screw trap, pipe-trap or fyke-net trap), Anesthetize, Handle, Fin Clip, Mark, Release	750 RRCSCBP 500 Wild 250	Unintentional mortalities	2 percent
Juvenile CCC coho salmon (wild or RRCSCBP)	Capture (rotary screw trap, pipe-trap, or fyke-net trap), Anesthetize, Handle, Release	7,500 RRCSCBP 5,000 Wild 2,500	Unintentional mortalities	2 percent
CCC coho salmon (wild or RRCSCBP)	Observe (spawner surveys, snorkel)	75 Redds, 150 adults,	Walking in stream	none
CCC coho salmon (wild or RRCSCBP)	Carcass	150 100 RRCSCBP 50 wild	Walking in stream	none
CC Chinook juvenile salmon	Capture, Anesthetize, Handle, Fin Clip, Mark, Release	Fin Clip or Mark 3,000	Unintentional mortalities	3 percent

10. Dry Creek Habitat Enhancements

Under RPA element 3, SCWA will undertake a series of habitat enhancements in the Dry Creek watershed, including the mainstem of Dry Creek. The first enhancements will occur in several tributaries to Dry Creek within three years of issuance of this biological opinion. SCWA will choose and implement five projects from the list of ten provided in the RPA. The second enhancement effort will focus on the mainstem of Dry Creek where at least six miles of Dry Creek downstream from WSD will be enhanced to provide excellent quality summer rearing habitat for coho salmon and steelhead, and the remaining reaches of Dry Creek below WSD will be enhanced as rearing habitat through the installation of large boulder clusters. The RPA stipulates a phased schedule of construction for the Dry Creek enhancements beginning in Year 5.

The RPA directs SCWA to relocate any listed salmonids from construction sites when implementation of a particular project requires work in aquatic habitat. Due to the lack of information on salmonid densities at the project sites, NMFS cannot precisely determine the number of salmonids that will need relocation. However, based on: 1) the degraded habitat conditions in the project areas, 2) the limited extent of dewatering needed to implement these projects, and 3) the summertime work windows provided by the RPA, NMFS anticipates that only relatively small numbers of listed juvenile salmonids will need to be relocated.

Because NMFS cannot precisely determine the number of listed juvenile salmonids that will need relocation, NMFS will use the extent of work area dewatering as a surrogate for take due to capture (relocation). NMFS anticipates that no more than 200 feet of streambed will need to be dewatered for each of the five tributary enhancement projects SCWA chooses to implement within three years of the issuance of this biological opinion. In the mainstem of Dry Creek, NMFS anticipates no more than a total of 2000 feet of Dry Creek will need to be dewatered for purposes of habitat enhancement constructjon during any one year of the project. NMFS anticipates most juvenile steelhead will be captured and relocated during channel maintenance activities. Some will remain and will be killed during dewatering. Three percent of the juvenile steelhead present at the project sites are expected to be injured or killed during relocation and dewatering.

SCWA will install 20 large boulder clusters in the mainstem of Dry Creek, and in some cases, SCWA may choose stream enhancement projects in Dry Creek tributaries where LWD or boulders are dropped or hauled into aquatic habitat. Very small numbers of listed juvenile salmonids may be injured or killed during these activities if LWD or boulders are placed on top of their hiding places in streams. NMFS cannot precisely calculate the number of juvenile salmonids that may be injured or killed but expects the number will be smaller than the amount relocated from dewatered areas for other projects due to degraded aquatic habitat in the enhancement areas and corresponding sparse density of listed salmonids.

NMFS will use the number of structures provided in the RPA for each project as a surrogate for numbers of fish taken:

Crane Creek: 25 structures (LWD or boulders)
Grape Creek: 15 structures (LWD or boulders)
Wine Creek: 12 structures (LWD or boulders)
Dry Creek: 20 structures (large boulder clusters)

NMFS assumes care will be taken when LWD and boulder structures are installed. Anticipated take may be exceeded if structures are dragged more than 10 yards across or along stream beds in flowing or standing water, or if heavy equipment drives through flowing or standing water within stream banks to reach enhancement sites. Such activities may crush listed salmonids not present at the structure placement site. Similarly, digging in stream beds or stream banks with heavy equipment without relocated listed salmonids would also exceed anticipated take.

B. Effect of Take

As described above, NMFS has determined that the anticipated take for the Reasonable and Prudent Alternative is not likely to jeopardize the continued existence of CCC coho salmon, CCC steelhead, and CC Chinook salmon.

C. Reasonable and Prudent Measures and Terms and Conditions

The following RPA elements were developed by the Corps, SCWA, and NMFS and are unlikely to result in take. No RPMs are provided for these elements:

- Pursuit of lower D1610 Minimum Flows
- Project Scoping and Preliminary Design of a Water Delivery Pipeline for the Mainstem of Dry Creek

The remaining elements of the RPA may result in incidental take, including those elements that remain unchanged from the original project description. NMFS believes that the following reasonable and prudent measures (RPMs) are necessary and appropriate to minimize the likelihood of take of Central California Coast Steelhead, Central California Coast Coho Salmon, and California Coastal Chinook Salmon resulting from the Reasonable and Prudent Alternative.

In order to be exempt from the prohibitions of section 9 of the ESA, the Corps, the SCWA, and their designees must comply with the following terms and conditions, which implement the reasonable and prudent measures described below and outline necessary reporting/monitoring. These terms and conditions are nondiscretionary.

RPM 1: Undertake measures to ensure that harm and mortality to listed salmonids from adaptive management of the bar at the mouth of the Russian River are low.

Purpose:
Although adaptive management of the estuary's bar is anticipated to be beneficial, there are instances where adverse water quality conditions may occur if the bar must be breached as it has in the past to avoid flooding. The purpose of this RPM is to more precisely determine the extent

of low DO outflow from the Willow Creek Marsh should SCWA need to breach the bar when the estuary's surface water level is 8 feet above mean sea level or greater.

Objective:
Monitor dissolved oxygen levels in the outflow from Willow Creek Marsh and, if low DO is observed, monitor the impact of low DO outflow from the marsh on DO levels in the estuary.

Terms and Conditions:

A. If the estuary is breached when water surface elevation is 8 feet or more above mean sea level, SCWA will monitor DO levels in the lower portion of Willow Creek Marsh for 2 hours prior to breaching and for 48 hours after breaching, taking one measurement ever hour until nightfall, and resuming hourly measurements at daybreak. If DO levels are observed to decline, SCWA shall also monitor DO levels in the estuary near Willow Creek hourly for 72 hours as described above.

B. NMFS and CDFG shall be provided with a report of DO measurements and raw data within 3 months of monitoring.

RPM 2: Undertake measures to ensure that harm and mortality to listed salmonids from pre-flood/periodic maintenance at CVD are low.

Purpose:
This RPM is focused on minimizing and avoiding the stranding of juvenile steelhead during annual pre-flood and five year periodic inspections at CVD. Annual pre-flood and five-year periodic inspections require the Corps to halt flow from CVD for a period of two hours to inspect the dam conduit. During this time, the cessation of flow into the East Fork Russian River strands juvenile steelhead in the East Fork and mainstem Russian River. Currently there is no bypass capability that provides flow to the East Fork Russian River during inspections or repairs at CVD.

Objective:
Install a flow bypass system at CVD to minimize and avoid harm and mortality to juvenile steelhead during inspections and repairs at the dam.

Terms and Conditions:

A. The Corps will initiate a study within two years and complete a feasibility level report before initiating construction of a bypass system at Coyote Valley Dam by October 1, 2011. The bypass system will be completed by October 1, 2013.

B. The bypass system shall consist of the following: The Corps shall install pumps and bypass facilities (pipes, channel) to provide bypass flows of 50 cubic feet per second (cfs) into the East Fork Russian River during inspections and repairs at Coyote Valley Dam. In addition, a 15 cfs diversion to the fish hatchery should also be investigated that would provide bypass flows to the fish facility, if needed.

C. The Corps will provide NMFS with annual updates on the progress, plans, and funding of the flow bypass system.

D. During the interim years prior to the completion of the bypass system, the Corps shall implement the following measures to minimize and avoid take of listed steelhead in the East Fork and mainstem Russian River:

1. Flows from CVD will ramp up at no greater than 100 cfs/hour in order to prevent juvenile fish from being displaced from preferred habitats.

2. The Corps will have NMFS approved personnel conduct fish monitoring and relocation efforts on the day of the pre-flood inspection on the East Fork of the Russian River below Coyote Valley Dam (one mile reach) and below the East Fork and mainstem Russian River confluence downstream to the Perkins Street Bridge (three mile reach).

3. During the monitoring surveys on the East Fork Russian River and Russian River, the Corps shall document any instances of salmonid stranding, including mortalities. Any mortalities shall be identified to species, age class (length in mm), and enumerated. The date, time, location (mapped), photos, and habitat type shall be documented for all salmonid impacts.

4. A report, including all Corps activities, fish monitoring and relocation results, including fish mortalities, stream temperature and flow monitoring results shall be prepared and submitted to the following location by January 15, of each year following the pre-flood or periodic inspection:

NMFS
Santa Rosa Area Office Supervisor, Protected Resources Division
Southwest Region
National Marine Fisheries Service
777 Sonoma Avenue, Room 325
Santa Rosa, California 95404

RPM 3: Undertake measures to ensure that harm and mortality to listed salmonids from ramping procedures at CVD are low.

Purpose:
This RPM is focused on developing the information necessary to determine if ramping procedures at Coyote Valley Dam can be modified to minimize and avoid adverse impacts to listed salmonids, and making modifications to ramping procedures, if possible. As described in the biological opinion, ramp down of flood releases can strand juvenile salmonids on gravel bar surfaces or off-channel habitats by reducing river stage elevation too quickly for juvenile salmonids to follow the receding river elevation. Juvenile salmonids that are stranded in off-

channel habitat or in cobble substrates are subject to increased mortality. Stranding of juvenile salmonids is expected to be most problematic in the mainstem Russian River below the East Fork Russian River downstream approximately four miles. This reach is particularly susceptible to stranding due to the presence of alternate gravel bars and off-channel high flow habitats that are utilized by juvenile salmonids.

Objective:
Adjust ramping rates at Coyote Valley Dam if analysis of cross sectional survey information indicates stranding can be further minimized or avoided while maintaining flood control.

Terms and Conditions:

A. The Corps will complete development of the study plan within one year and provide it to NMFS for approval within a 60 day period.

B. As part of the study plan, the Corps will conduct a cross section survey, suitable for the development of a hydraulic model of the Russian River from Coyote Valley Dam to Perkins Street Bridge. The survey shall include specific gravel bars and off-channel habitats along the four-mile reach of the Russian River most susceptible to stranding impacts.

C. The Corps will complete the field survey of the Russian River from CVD to Perkins Street Bridge within two years and provide the study data and results to NMFS within 2 months of study completion.

D. As part of the study plan, the Corps will use the field data from the survey and perform a hydraulic analysis using HEC-RAS to determine the range of flows that occur when gravel bars and off-channel habitat are dewatered.

E. The Corps will use this flow range to investigate potential alternative ramp down criteria of flood control releases to try and minimize juvenile salmonid stranding at key locations, as determined in D.

F. Based on the results of the study, the Corps will adjust ramping rates at CVD to further minimize or avoid stranding within two years of study completion, if study results indicate that such adjustments will allow flood control to be maintained. The Corps will report any adjustments to NMFS prior to their implementation.

RPM4: Undertake measures to assist NMFS in determining the amount of take resulting from turbidity releases at CVD.

Purpose:
This RPM is focused on developing the information necessary to more precisely determine the impact of turbidity from CVD on salmonid growth and survival to emergence, and appropriately acting on that information. The preceding biological opinion identifies Coyote Valley Dam as a major contributor to sustained turbidity in the Russian River. The sustained level of turbidity is

expected to adversely affect the growth and survival of steelhead and Chinook salmon incubating eggs and alevins within Russian River gravels. However, the precise magnitude of impact, while expected to be low, is currently unknown. In order to better determine the magnitude of adverse effects that may result from turbidity associated with releases from Coyote Valley Dam and Warm Springs Dam, the Corps shall conduct turbidity monitoring at most of the existing stream flow gauges currently operated by the U.S. Geological Survey Water Resources Division (USGS). Based on this information, the Corps shall also develop and begin implementation of a plan to avoid and minimize these impacts.

Objectives:
Install turbidity monitoring meters at existing USGS gages, and conduct a bathymetric survey of Lake mendocino to more accurately determine the magnitude of adverse effects to salmonids caused by Corps dam releases in Dry Creek and the Russian River and develop and implement a plan to minimize incidental take.

Terms and Conditions:

A. The Corps shall conduct a bathymetric survey of Lake Mendocino to determine the level of siltation and if dredging is a reasonable alternative to reduce turbidity levels.

B. The Corps will conduct the bathymetric survey of Lake Mendocino within two years.

C. The Corps shall install turbidity meters at existing USGS gauging stations (non low-flow gages). In addition to the existing turbidity monitoring currently conducted on the mainstem *Russian River at Hopland (11462500)*, *Digger Bend* (11463980), and *Guerneville* (11467000), turbidity monitoring will be conducted at the following stream gauges:

- USGS Gauge 11461000 on mainstem Russian River (West Fork)
- USGS Gauge 11461500 East Fork Russian River above Coyote Valley Dam
- USGS Gauge 11462000 East Fork Russian River below Coyote Valley Dam
- USGS Gauge 11463000 Russian River at Cloverdale
- USGS Gauge 11465000 Dry Creek below Warm Springs Dam

D. The Corps shall contract with the USGS to have turbidity monitoring equipment installed and functioning at the sites listed above by October 1, 2009.

E. The Corps shall contract with the USGS to maintain and publish turbidity data using USGS guidelines for a period of ten years and provide annual reporting of the analysis of the data to NMFS. NMFS expects that ten years, while shorter than the project duration analyzed in the preceding biological opinion, will provide enough data on different conditions (water year types) to estimate the impact of turbidity releases from CVD.

F. The Corps shall report to the NMFS by October 1, 2009on the progress of the turbidity monitoring contracts with USGS and overall progress of the monitoring effort.

G. The Corps shall analyze the turbidity data to determine if flood control operations contribute to an increase in turbidity that adversely affect rearing and spawning habitat on the mainstem Russian River between Coyote Valley Dam and Cloverdale and monitor the turbidity that Warm Springs Dam contributes to Dry Creek.

H. The Corps shall report the results of their analysis to NMFS for review and approval. The Corps shall provide NMFS with the turbidity data and results on an annual basis. Turbidity data collected each winter and spring will be provided no later than August 15 of the same year.

I. If turbidity data confirm that adverse effects to listed salmonids are likely to occur as described in the preceding biological opinion, or indicate effects are worse than anticipated, the Corps shall provide a draft plan to minimize and avoid these effects to NMFS for review no later than July 1, 2013.

J. If turbidity from CVD or WSD is adversely affecting listed salmonids as described above, the Corps shall complete and begin implementation of a plan to minimize and avoid these adverse effects by no later than January 1, 2014.

RPM 5: Undertake measures to ensure that harm and mortality to listed salmonids resulting from Dry Creek and tributary habitat enhancements and channel maintenance activities in the mainstem Russian River, Dry Creek, and Zone 1A, are low.

Purpose:
The purpose of the following terms and conditions are to provide additional measures to reduce take of listed salmonids from direct losses due to in-channel construction and fish relocation, and indirect harm and mortality due to reduction in habitat complexity from removal of sediment, thermal cover, and hiding cover. The proposed channel maintenance and enhancement activities are likely to result in injury and mortalities to listed salmonids due to construction equipment working in flowing water in some areas, fish relocation, and, in-channel maintenance areas, reductions in hiding cover and thermal cover in some of these waters. In Zone 1A constructed channels, migration opportunities will be more limited, resulting in loss of a small number of salmonid migrants.

Objective:
Reduce harm and mortality to listed salmonids from crushing by construction equipment, relocation efforts, and loss of habitat elements important to salmonid survival.

Terms and Conditions:

A. The Corps, SCWA, or MCRRFCD shall isolate work areas located in aquatic habitat from the flowing stream and relocate listed salmonids prior to proceeding with in-channel work for flood control maintenance or habitat enhancment:

(1) The Corps, SCWA, MCRRFCD or their designees shall retain a qualified biologist with expertise in the areas of anadromous salmonid biology, including the handling, collecting, and relocating salmonids, salmonid/habitat relationships, and biological monitoring of salmonids. The Corps, SCWA, or MCRRFCD shall ensure that all biologists working on their projects are qualified to conduct fish collections in a manner that minimizes all potential risks to ESA-listed salmonids. Electrofishing, if used, shall be performed by a qualified biologist and conducted according to NMFS Guidelines for Electrofishing Waters Containing Salmonids Listed under the Endangered Species Act, June 2000.

(2) The biologist shall be on site during all dewatering events to capture, handle, and safely relocate ESA-listed salmonids. The biologist shall notify NMFS biologist Tom Daugherty at 707-468-4057 or Tom.Daugherty@noaa.gov one week prior to capture activities in order to provide an opportunity for NMFS staff to observe the activities.

(3) ESA-listed fish shall be handled with extreme care and kept in water to the maximum extent possible during rescue activities. All captured fish shall be kept in cool, shaded, aerated water protected from excessive noise, jostling, or overcrowding any time they are not in the stream, and fish shall not be removed from this water except when released. To avoid predation, the biologist shall have at least two containers and segregate young-of-year fish from larger age-classes and other potential aquatic predators. Captured salmonids will be relocated, as soon as possible, to a suitable instream location in which suitable habitat conditions are present to allow for adequate survival of transported fish and fish already present.

(4) If any salmonids are found dead or injured, the biologist shall contact NMFS biologist Tom Daugherty by phone immediately at (707) 468-4057 or the NMFS Santa Rosa Area Office at TTY 866-327-8877 (enter number 707-578-8555). The purpose of the contact is to review the activities resulting in take and to determine if additional protective measures are required. All salmonid mortalities shall be retained, placed in an appropriately-sized sealable plastic bag, labeled with the date and location of collection, fork length, and be frozen as soon as possible. Frozen samples shall be retained by the biologist until specific instructions are provided by NMFS. The biologist may not transfer biological samples to anyone other than the NMFS Santa Rosa Area Office without obtaining prior written approval from the NMFS Santa Rosa Area Office, Supervisor of the Protected Resources Division. Any such transfer will be subject to such conditions as NMFS deems appropriate.

(5) The Corps, SCWA, and MCRRFCD shall allow any NMFS employee(s) or any other person(s) designated by NMFS, to accompany field personnel to visit the project site during activities described in this opinion.

B. At all channel maintenance sites in Dry Creek, the mainstem, and Zone 1A, and at all instream enhancement sites in the Dry Creek watershed: the Corps, SCWA, or MCRRFCD shall:

(1) Check construction equipment used within the creek channel each day prior to work within the creek channel (top of bank to top of bank) and, if necessary, take action to prevent fluid leaks. If leaks occur during work in the channel (top of bank to top of bank), the Corps, SCWA, MCRRFCD or their designee will contain the spill and remove the affected soils.

(2) Ensure that if coffer dams are used to isolate work areas, fill material for cofferdams will be fully confined with the use of plastic sheeting, sheetpiles, sandbags, or with other non-porous containment methods, such that sediment does not come in contact with stream flow or in direct contact with the natural streambed. All loose fill material for cofferdams shall be completely removed from the channel by October 31. Alternatively, clean gravel or clean crushed stone may be used without plastic sheeting, sandbags, etc. to separate worksites from aquatic habitat.

(3) Ensure that all pumps used to divert live stream flow, outside the dewatered work area[91], will be screened and maintained throughout the construction period to comply with NMFS' and CDFG's Fish Screening Criteria for Anadromous Salmonids. See: http://swr.ucsd.edu/ hcd/fishscrn.pdf.

(4) Ensure that coffer dams are constructed as close as practicable to the size of the work area. If coffer dams are across the channel such that they impound the channels flow, flows shall be diverted through a suitably-sized pipe from upstream of the upstream coffer dam and discharged downstream of the downstream coffer dam. Coffer dams and the stream diversion system shall remain in place and functional throughout the construction period. Normal flows shall be restored to the affected stream immediately upon completion of work at that location.

(5) Ensure that once construction is completed, all project introduced material (pipe, gravel, cofferdam, etc.) is removed, leaving the creek as it was before construction (except for the channel maintenance work). Excess materials will be disposed of at an approved disposal site.

C. For all channel maintenance and instream enhancement construction activities described in the preceding biological opinion and RPA, the Corps, SCWA, or MCRRFCD shall provide NMFS and DFG reports by February 15 of the year following construction. The report shall be submitted to NMFS Santa Rosa Area Office, Attention: Supervisor of Protected Resources Division, 777 Sonoma Avenue, Room 325, Santa Rosa, California, 95404 6528. The report will be submitted to the Regional Manager for

[91] Pumps used in the area to be dewatered must be screened as described until salmonids are relocated.

CDFG Region 3, headquartered in Yountville, CA. The report shall contain, at a minimum, the following information:

(1) Construction related activities -- The report shall include the dates construction began and was completed; a discussion of any unanticipated effects or unanticipated levels of effects on salmonids, a description of any and all measures taken to minimize those unanticipated effects and a statement as to whether or not the unanticipated effects had any affect on ESA-listed fish; the number of salmonids killed or injured during the project action; and photographs taken before, during, and after the activity from photo reference points.

(2) Fish Relocation -- If fish relocation was necessary, the report shall include a description of the location from which fish were removed and the release site including photographs; the date and time of the relocation effort; a description of the equipment and methods used to collect, hold, and transport salmonids; if an electrofisher was used for fish collection, a copy of the logbook must be included; the number of fish relocated by species; the number of fish injured or killed by species and a brief narrative of the circumstances surrounding ESA-listed fish injuries or mortalities; and a description of any problems which may have arisen during the relocation activities and a statement as to whether or not the activities had any unforeseen effects.

D. The Corps, SCWA, or MCRRFCD shall implement the following measures to reduce the impacts of channel maintenance on habitat complexity at their respective channel maintenance sites:

(1) Because the project description provided to NMFS does not provide specific work windows for Dry Creek and Natural Waterway bank stabilization, all work within the stream/riparian corridor in Dry Creek and in Natural waterways shall be confined to the period June 15 to October 15. Revegetation work is not confined to this time period.

(2) No phase of the project may be started if that phase and its associated erosion control measures cannot be completed prior to the onset of a storm event if that construction phase may cause the introduction of sediments into the stream. Seventy-two (72) hour weather forecasts from the National Weather Service shall be consulted prior to start up of any phase of the project that may result in sediment run-off to the stream.

(4) Vehicles may be driven on the dry stream/lake bed to traverse the distance to the work site from the access point and in the immediate vicinity (within 50 feet) of the work area, and only as necessary to accomplish authorized work.

(5) All exposed/disturbed areas on upper stream banks or adjacent uplands within the project site shall be stabilized. Erosion measures such as silt fences, straw hale bales, gravel or rock lined ditches, water check bars, and broadcasted straw shall be used wherever silt laden water has the potential to leave the work site.

(6) Erosion control measures shall ensure that run-off from steep, erodable upland surfaces will be diverted into stable areas with little erosion potential or contained behind erosion control structures.

(7) All new riprap shall be planted with willows or other native tree species, spaced appropriately to provide improved thermal cover for listed salmonids.

(8) No grouted riprap shall be installed at channel maintenance sites to avoid complete loss of hiding cover in riprap areas.

(9) Bioengineering techniques shall be incorporated into all bank protection projects to reduce the amount of riprap used and provide better hiding and thermal cover for listed salmonids.

(10) LWD in the mainstem shall not be disturbed unless it spans the mainstem and is causing bank erosion. LWD that spans and causes bank erosion can be cut and cabled to the banks.

(11) When grading gravel bars in the mainstem, a buffer of at least 25 feet or 10 percent of the maximum bar width, whichever is greater, shall be maintained along the edge of the low flow channel, whether vegetation is present or not.

(12) In the mainstem, gravel bar vegetation removal shall only occur outside of a 25 foot buffer zone next to the low-flow channel. On banks and levees, vegetation removal shall only occur on the upper portion of the bank outside of 25 foot buffer zone next to the channel. Vegetation within the buffers shall not be disturbed, unless it is non-native (non-native vegetation may be removed).

(13) At sediment removal sites in Zone 1(A), SCWA shall construct a low flow channel to provide enhanced migration habitat through sediment removal areas.

Sediment removal project designs will be transmitted to NMFS and CDFG 60 days prior to implementation for approval. NMFS and CDFG shall respond within 30 days with either project approval, or a list of changes needed.

The low flow channel shall be monitored at least two times in-between large storms during the winter period to assess its function as a migration corridor and impact on stream stability.

RPM 6: Undertake measures to ensure that harm and mortality to listed salmonids from diversion operations, maintenance, and fish screen replacement at Wohler and Mirabel are low.

Purpose:
The purpose of the following terms and conditions are to provide additional measures to reduce take of listed salmonids from direct losses due to inflation and deflation of the rubber dam at Wohler, entrapment of salmonids in water infiltration ponds, and installation of new fish screens at Mirabel. These activities are expected to result in entrapment, injury, and loss of salmonids as described above. Injury and loss due to stranding and entrapment can be minimized by rescuing

fish from areas that become dewatered or from which fish cannot escape (infiltration ponds). Adverse effects to salmonids during fish screen replacement can be minimized by isolating the work space from flowing water and relocating salmonids out of the work area. Additionally, the infiltration ponds on the east side of the Russian River can be modified or decommissioned without disrupting water supplies.

Objectives:
1) Rescue any salmonids stranded during Wohler Dam inflation and deflation, and entrapped in infiltration ponds, 2) Provide NMFS with new fish screen design at Mirabel and complete construction within 5 years of issuance of the biological opinion, and 3) Decommission or modify infiltration ponds that are no longer needed to prevent salmonid entrapment.

Terms and Conditions:

A. SCWA shall monitor the Russian River upstream and downstream of the impoundment during inflation and deflation of the rubber dam and rescue any salmonids that become stranded, relocating them to appropriate nearby riverine habitats. SCWA shall also rescue any listed salmonids that become stranded in the infiltration ponds after flood flows overtop the ponds.

(1). SCWA shall follow the protocols (1-5) for fish rescue and relocation described above in RPM 5, Term and Condition A.

B. SCWA shall complete design of the new fish screen at Mirabel within three years of the issuance of this biological opinion, and replace the fish screen within three years after completion of the design.

(1) During the design phase, SCWA shall work with NMFS fish passage engineers at the NMFS Santa Rosa Area Office and with CDFG engineers to ensure the design meets NMFS and CDFG specifications for avoiding impingement or stranding of listed salmonids.

(2) Within one year of the completion of the design phase, SCWA shall provide NMFS and CDFG a complete project description, including project timing, scope, and the extent of disturbance to the bed and banks of the Russian River.

(3) Upon receiving written approval from NMFS and CDFG for the design and project description, SCWA shall replace the screens at Mirabel within two years.

(4) SCWA shall isolate the workspace from flowing water and follow the protocols (1-5) for fish rescue and relocation described above in RPM 5, Term and Condition A.

C. Within three years of the issuance of this biological opinion, SCWA shall decommission or modify the infiltration ponds on the East side of the Russian River at the Mirabel/Wohler facility to prevent fish entrapment in these ponds during flood events.

(1) SCWA shall provide NMFS with a complete project description of infiltration pond decommissioning or modification within one year of the issuance of this biological opinion.

(2) The project description shall include project timing, scope, and the expected condition of the infiltration ponds and their inlets following decommissioning or modification.

(3) Upon receipt of written approval from NMFS and CDFG for the project, SCWA shall decommission or modify the east side infiltration ponds within two years.

RPM 7: The Corps (and CDFG) shall operate the DCFH and CVFF steelhead programs in a manner that minimizes adverse genetic effects to steelhead within the Russian River and within the CCC steelhead DPS.

Purpose:
The purpose of the following terms and conditions are to implement measures to avoid adverse genetic effects to hatchery and wild steelhead from the operation of the DCFH and CVFF steelhead programs. As described in the preceding biological opinion, these programs currently exclude wild steelhead from the hatchery spawning stock. Because current information on the genetics of steelhead indicate that there are no substantial genetic differences between wild and hatchery propagated steelhead within the Russian River basin, continued exclusion of wild steelhead from hatchery spawning stock could result in a divergent hatchery population with consequent loss of genetic diversity and increase in inbreeding. To minimize the potential for adverse genetic effects, yearly genetic analysis and monitoring of spawning stock, and incorporation of wild fish into spawning stock, is needed.

Objective:
Ensure that annual genetic management occurs and in-season spawning matrixes linked to genetic monitoring are used where appropriate. Incorporate wild steelhead into the spawning stock of both programs. Obtain an HGMP under ESA 4(d) for the steelhead programs.

Terms and Conditions:

A. For the next 15 years, the Corps will conduct genetic management and genetic assessment of the DCFH and CVFF steelhead programs. Estimated annual cost for that program is $125,000.

(1) The Corps shall ensure that genetic analysis needed to develop the in-season spawning matrix for DCFH and for the annual genetic monitoring of all steelhead spawned at DCFH and CVFF is conducted in coordination with and to the standards of NMFS Southwest Fisheries Science Center. Data from the annual genetic monitoring of the steelhead program will be used to determine the need for the continuation of in-season genetic management of steelhead spawning conducted at DCFH, and will be used to determine if in-season genetic management of spawning should be implemented at the

CVFF. Estimated annual cost of the genetic management of the steelhead program is $125,000.

(2) The Corps shall ensure that CDFG is staffed to implement the in-season genetic management of steelhead spawning at DCFH. Estimated annual cost for that staffing is $50,000.

B. The Corps (and CDFG) shall operate the DCFH and CVFF programs as integrated harvest programs to minimize adverse genetic impacts associated with each program.

(1) Begin incorporating all wild steelhead that return to each facility into the spawning program annually to begin transitioning from isolated to integrated hatchery programs.

C. The Corps shall work with NMFS and CDFG to update the draft HGMP and submit the updated plan to NMFS for approval.

(1) The updated Hatchery and Genetic Management Plan shall incorporate the measures described above and other necessary measures to minimize adverse genetic effects to steelhead.
(2) The updated HGMP shall be submitted to NMFS by October 1, 2009. If the HGMP is not approved by NMFS, the Corps and CDFG shall update it to address NMFS' concerns and re-submit it for NMFS approval within one year.
(3) Once approved by NMFS, the Corps (and CDFG) shall operate the steelhead hatchery programs consistent with the approved HGMP to ensure that adverse effects to CCC steelhead associated with the steelhead hatchery programs are minimized.

RPM 8: SCWA shall undertake measures to ensure that injury and mortality to listed salmonids resulting from fish monitoring at Mirabel diversion dam, in the estuary, and in Dry Creek are low.

Purpose:
The purpose of the following terms and conditions is to reduce injury and mortalities to listed salmonids resulting from monitoring efforts at Mirabel dam, in the estuary, and in Dry Creek. Listed salmonids may be injured or killed if held in traps, nets, or out of water for too long, if handled without care, or if exposed to predatory fish in holding containers.

Objective:
Reduced injury and mortalities from capture, release, and marking related to operation of screw traps, and seining and fyke netting in the estuary.

Terms and Conditions:

A. The downstream migrant traps (rotary screw trap) shall be checked every morning of operation at a minimum. Additionally, periods of peak migration, high flows, and/or debris

levels during storm periods may require the traps to be checked more frequently to minimize associated mortality. Salmonids in the traps will be released after measurements and PIT tag implantation, as appropriate. All other fish will be released as soon as possible.

B. Fyke-net traps shall be checked at lease twice per 24 hour period (or more frequently as conditions warrant) to remove captured fish and debris. Any salmonids found in the fyke nets will be released after measurements and PIT tag implantation, as appropriate by species and life history stage. All other fish will be released as soon as possible. Photographs of the downstream migrant fyke-net trap are required and must be submitted to NMFS within 2 days of operating the trap.

C. All ESA-listed juvenile salmonids captured within the estuary/lagoon will be held in holding buckets or livewells filled with debris-free clean water and equipped with battery powered aerators before and after handling. In addition to holding buckets and livewells, ESA-listed salmonids captured within the stream are also permitted to be held in live cars, which allow water flow-through with stream ambient oxygen and temperature levels. All listed salmonids will be allowed to recover fully before being released back into the water at or close to the location from which they were taken. Water temperatures must be documented within both the sampling and fish holding areas. All precautions will be taken by the researchers to prevent overcrowding in live cars, livewells, and holding buckets and any other excessive stressing of detained fish. Fish should not be detained for more than the minimum time required to collect the necessary data.

D. ESA-listed salmonids shall be handled with extreme care and kept in water to the maximum extent possible during sampling and processing procedures. When using gear that captures a mix of species, ESA-listed salmonids shall be processed first and be released as soon as possible after being captured to minimize the duration of handling stress.

E. When using anesthesia (MS-222 or Alka-Seltzer®), extreme care shall be taken to use the minimum amount of substance necessary to immobilize juvenile ESA-listed salmonids for handling and sampling procedures. It is the responsibility of the researcher to determine when anesthesia is necessary for handling and sampling juvenile ESA-listed salmonids.

F. In the event that debris (rocks, logs, abundant vegetation, etc,) are trapped within the beach seine, researchers will remove debris before fish are centralized in the net to prevent harm. Researchers will select the smallest mesh-size seine or dip-net that is appropriate to achieve sampling objectives while reducing the probability that smaller fish will become gilled in the net.

G. ESA-listed salmonids shall not be handled if stream temperatures at the capture site exceed 70 degrees Fahrenheit. Under these conditions, fish shall only be identified and counted.

H. Fin-clips that are collected from juvenile ESA-listed salmonids, as well as any tissues that are collected from juvenile ESA-listed salmonids that are unintentionally killed

during research activities, shall be made available to NMFS upon request.

XII. CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the ESA directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information.

1. The Corps could fund the annual collection of adult steelhead trout in tributaries of the Russian River within Mendocino County and in tributaries of Dry Creek in Sonoma County for purposes of including wild adult steelhead in the pool of steelhead spawned at CVFF and the DCFH. Inclusion of wild adult steelhead into the hatchery program would promote an integrated hatchery program which would help avoid adverse genetic affects of the mating of wild steelhead with stray hatchery fish.

2. The Corps could expand the DCFH to enable it to support a captive coho salmon broodstock program that would help recover coho salmon in watersheds near and adjacent to the Russian River (*e.g.*, Salmon Creek, Gualala River, Walker Creek, and the Garcia River).

XIII. REINITIATION NOTICE

This concludes formal consultation on the water supply, flood control, and channel maintenance operations conducted by the Corps and Sonoma County Water Agency, and Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) the identified action is subsequently modified in a manner that causes an effect to listed species or critical habitat that was not considered in the biological opinion; or (4) a new species is listed or critical habitat designated that may be affected by the identified action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

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Enclosure 2

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSERVATION RECOMMENDATIONS

PROJECT ACTION: Water supply, flood control operations, and channel maintenance conducted by the U.S. Army Corps of Engineers, the Sonoma County Water Agency, and Mendocino County Russian River Flood Control and Water Conservation Improvement District in the Russian River watershed.

CONSULTATION CONDUCTED BY: National Marine Fisheries Service, Southwest Region

ADMINISTRATIVE RECORD NUMBER: 151422SWR2000SR150

PUBLIC CONSULTATION TRACKING SYSTEM NUMBER: F/SWR/2006/07316

I. STATUTORY AND REGULATORY INFORMATION

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), as amended by the Sustainable Fisheries Act of 1996, establishes a national program to manage and conserve the fisheries of the United States through the development of Federal Fishery Management Plans (FMPs), and Federal regulation of domestic fisheries under those FMPs, within the 200-mile U.S. Exclusive Economic Zone (16 U.S.C. §1801 *et seq*). To ensure habitat considerations receive increased attention for the conservation and management of fishery resources, the amended Magnuson-Stevens Act required each existing, and any new, FMP to "describe and identify essential fish habitat for the fishery based on the guidelines established by the Secretary under section 1855(b)(1)(A) of this title, minimize to the extent practicable adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitat." (16 U.S.C. §1853(a)(7)). Essential Fish Habitat (EFH) is defined in the Magnuson-Stevens Act as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" (16 U.S.C. §1802(10)). The components of this definition are interpreted at 50 C.F.R. §600.10 as follows: "Waters" include aquatic areas

and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem; and "spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle.

Pursuant to the Magnuson-Stevens Act, each Federal agency is mandated to consult with NOAA's National Marine Fisheries Service (NMFS) (as delegated by the Secretary of Commerce) with respect to any action authorized, funded, or undertaken, or proposed to be, by such agency that may adversely affect any EFH under this Act (16 U.S.C. §1855(b)(2)). The Magnuson-Stevens Act further mandates that where NMFS receives information from a Fishery Management Council or Federal or state agency or determines from other sources that an action authorized, funded, or undertaken, or proposed to be, by any Federal or state agency would adversely effect any EFH identified under this Act, NMFS has an obligation to recommend to such agency measures that can be taken by such agency to conserve EFH (16 U.S.C. §1855(4)(A)). The term "adverse effect" is interpreted at 50 C.F.R. §600.810(a) as any impact that reduces quality and/or quantity of EFH and may include direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of, or injury to, benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce quantity and/or quality of EFH. In addition, adverse effects to EFH may result from actions occurring within EFH or outside EFH and may include site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions.

II. BACKGROUND AND CONSULTATION HISTORY

The San Francisco District of the US Army Corps of Engineers (Corps), the Sonoma County Water Agency (SCWA), and the Mendocino County Russian River Flood Control and Water Conservation Improvement District (MCRRFCD) have owned, maintained, or operated facilities for flood control, water supply, and hydroelectric power generation for many years in the Russian River watershed in Sonoma and Mendocino counties, California. Since December 31, 1997, NMFS, the Corps, the SCWA, and the MCRRFCD have engaged in preconsultation technical assistance to evaluate the potential risk from the Corps, SCWA, and MCRRFCD facilities and operations to species under the jurisdiction of NMFS. On May 4, 2006, the Corps submitted a letter to NMFS requesting consultation on the Corps, SCWA, and MCRRFCD facilities and operations. Please read the *Consultation History* section of the preceding biological opinion for a complete consultation history for this proposed action. A complete administrative record of this consultation is on file at the NMFS, 777 Sonoma Avenue, Room 325, Santa Rosa, California 95404.

A. Proposed Action

The Russian River Water Supply and Flood Control Project (Project) includes operation of several dams and appurtenant facilities in the Russian River watershed. Together, the facilities are operated to control flooding within the watershed, to supply water to users within and outside

the watershed, and to generate hydroelectric power. The altered flow regimes caused by the Project change the natural hydrology of the Russian River, its tributaries, and estuary. Artificial breaching of the barrier beach at the mouth of the Russian River is often required to prevent flooding of buildings adjacent to the estuary. In addition, the Project includes the operation of two fish hatchery facilities and channel maintenance activities. The duration of the Project is 15 years. Please read section III of the preceding biological opinion for a complete description of the proposed action.

B. Action Area

For purposes of this EFH consultation, the action area is the entire Russian River watershed in Sonoma and Mendocino counties, California. Most of the direct and indirect effects of the proposed project occur in: 1) the East Branch Russian River below Coyote Valley Dam and the main stem Russian River from the confluence of the East Branch Russian River to the mouth of the Russian River at Jenner (including the Russian River Estuary), 2) Dry Creek, a major Russian River tributary, downstream of Warm Springs Dam, and 3) the Laguna de Santa Rosa and its tributaries. However, some effects to EFH are expected in other portions of the Russian River watershed from interrelated activities, such as wastewater discharge.

The proposed Project occurs within EFH for various Federally-managed fish species within Pacific Salmon Fishery Management Plan (FMP), the Coastal Pelagics FMP, and the Pacific Groundfish FMP.[92] Table 1 lists the FMP-managed species observed in the Russian River. The Russian River basin contains habitat necessary to Pacific salmon for spawning, breeding, and feeding or growth while rearing. Pacific salmon use the Russian River, its tributaries, and its estuary. Species managed under the Coastal Pelagics and Pacific Groundfish FMPs use the Russian River estuary primarily for juvenile rearing, though some species may use the area for spawning as well. In addition, the Project occurs within areas designated as Habitat Areas of Particular Concern (HAPC) for species managed under the Pacific Groundfish FMP. HAPC are described in the regulations as subsets of EFH which are rare, particularly susceptible to human-induced degradation, especially ecologically important, or located in an environmentally stressed area. Designated HAPC are not afforded any additional regulatory protection under Magnuson-Stevens Act; however, Federal projects with potential adverse impacts to HAPC will be more carefully scrutinized during the consultation process. As defined in the Pacific Groundfish FMP, the Russian River watershed contains estuary habitat – a habitat designated as a HAPC. Estuaries are important elements of Pacific Groundfish EFH, as estuaries provide prey items, foraging areas, habitat complexity, nursery areas, and refugia. Estuaries provide the same vital elements for species managed under the Pacific Salmon and Coastal Pelagic FMPs, as well as many other fish species.

III. EFFECTS OF THE PROPOSED ACTION

[92] Definitions for Essential Fish Habitat are found at: http://www.pcouncil.org/salmon/salfmp/a14.html [for salmonids], http://swr.nmfs.noaa.gov/hcd/cpsefh.PDF [for coastal pelagic species], and http://swr.nmfs.noaa.gov/hcd/grndfsh.pdf [for groundfish species.]

Based on information from various sources, NMFS concludes that Project, as proposed, would adversely affect EFH for various Federally-managed species within the Pacific Salmon FMP, the Coastal Pelagics FMP, and the Pacific Groundfish FMP. The preceding biological opinion fully discusses NMFS' analysis of the Project and its effects on Russian River habitat. Following is a summary of the effects that NMFS believes are associated with the Project.

NMFS inferred historical estuarine habitat conditions by combining information on current conditions with scant historical information about river flow and bar closures. Given the information available, NMFS expects that prior to dams and diversions in the Russian River watershed, the estuary was likely open to the ocean for several months between late fall and early spring in nearly all years, and then closed to the ocean during the late spring through the early fall of most years. NMFS expects that the Russian River estuary likely converted to a freshwater lagoon in many years after bar closure, as seen in other California systems (Smith 1990). Conversion to a freshwater lagoon occurs following creation of a barrier beach across the mouth of the stream or river. Freshwater from upstream continues to enter the estuary and builds up on top of the salt water layer, gradually forcing the salt water layer to seep back into the ocean through the barrier beach. The estuary may also have remained stratified in some years.

Because of unnaturally high Russian River surface flow associated with the Project, the estuary surface elevation is higher than normal and can lead to flooding of low lying areas near Jenner. The SCWA breaches the barrier beach to evacuate the estuary thereby reducing surface elevation and flooding risk. The SCWA uses a bulldozer, or some other type of heavy equipment, to breach the barrier beach at the mouth of the Russian River. The breaching schedule for the Russian River system varies from year to year depending on the frequency of the creation of the barrier beach at the river mouth. Periodic breaching of the barrier beach is likely to occur from 4 to 11 times per year, based on data from past breaching events (Corps and SCWA 2004, SCWA 2002-2004, SCWA 2006-2008). Breaching can occur during any season of the year, though most frequently occur in the spring and fall. From 1996 through 2007, most breaches of the barrier beach occurred between May and November, though breaching did occur in all other months (breaching occurred in one February from 1996-2007, for example).

Conversion to a freshwater lagoon is dependent upon the date of initial closure and freshwater inflow to the estuary. Smith (1990) found that it took at least one month for a freshwater lagoon to form; however, sometimes, closed estuaries remained stratified with heavier salt water on the bottom. During the summer and fall, artificial breaching of the barrier beach on the Russian River occurs, on average, every three weeks (Corps and SCWA 2004). Water quality surveys conducted for or by the SCWA show that the Russian River estuary remains stratified following recreation of the barrier beach and conversion to a freshwater lagoon has not been observed. However, the Russian River barrier beach is probably breached too frequently to observe the conversion. When a closed estuary stratifies, lower portions of the water column (highly saline water) are not mixed and they develop very low dissolved oxygen conditions which can create adverse habitat conditions for most fish. Fish managed under the Pacific Salmon, Coastal Pelegic, and Pacific Groundfish FMPs can be subject to these harmful conditions. As noted in the biological opinion, steelhead can do well in some stratified lagoons, depending upon overall water quality and food productivity.

Additional effects to Pacific Salmon EFH occur upstream of the estuary in the main stem and tributaries of the Russian River. We have found that the amount and quality of salmonid migration, spawning and freshwater rearing habitat in the Russian River and its tributaries is degraded compared to historical conditions. The preceding biological opinion describes how Project-related water management and flood control activities have resulted in adverse changes in physical habitat (*i.e.*, depths, velocities and salinity), habitat simplification, and loss of riparian vegetation.

1. Pacific Salmon

Potential impacts to coho salmon (*Oncorhynchus kisutch*) and Chinook salmon (*O. tshawytscha*) habitat due to the proposed action have been described in the preceding biological opinion. Pink salmon (*O. gorbuscha*) are observed in the Russian River sporadically; however, that species was not included in the preceding biological opinion as that species is not listed as threatened or endangered under the Endangered Species Act of 1973, as amended. NMFS expects that pink salmon will use the estuary similarly to Chinook salmon, as adult and smolt migration times and estuarine residences times are similar between the two species (Healey 1991, Heard 1991). In summary, adverse effects of the proposed action on Pacific salmon EFH may occur from estuary breaching, water delivery activities, and flood control activities leading to decreased water quality, loss of habitat complexity, and increased turbidity. The direct result of these threats is that the function of EFH may be eliminated, diminished, or disrupted. Migration, spawning, and rearing of Pacific salmon are negatively affected by these degraded freshwater and estuarine conditions.

2. Coastal Pelagics and Pacific Groundfish

Currently the Project causes the estuary to open, through artificial breaching, at unnatural times and durations. Following breaching events, the abundance and diversity of marine and estuarine fish increases, and following recreation of the barrier beach the abundance and diversity of marine and estuarine fish decreases over time (SCWA 2005). Following the artificial breaching events of the Project, estuarine water quality becomes so poor that many fish are likely to perish. When water quality conditions degrade in the closed estuary, perhaps some highly mobile euryhaline species may be able to find refuge in some areas of the estuary, but stenohaline marine fish or poorly mobile species are likely to perish. Therefore, the Russian River estuary may become a population sink for species managed under the Coastal Pelagics or Pacific Groundfish FMP. Managing the estuary to have a historic breaching regime would reduce the number of times that species managed under the Coastal Pelagics and Pacific Groundfish FMPs are entrained into the Russian River estuary.

IV. EFH CONSERVATION RECOMMENDATIONS

As described in the above effects analysis, NMFS has determined that the proposed action would adversely affect EFH for various Federally-managed fish species within the Pacific Salmon FMP, the Coastal Pelagics FMP, and the Pacific Groundfish FMP. Therefore, pursuant to section 305(b)(4)(A) of the Magnuson-Stevens Act, NMFS offers the following EFH

conservation recommendations to avoid, minimize, mitigate, or otherwise offset the adverse effects to EFH. NMFS provides seven EFH conservation recommendations for this proposed project. These EFH recommendations are consistent with, and otherwise support, certain elements of the Reasonable and Prudent Alternative described above in section X. of the preceding biological opinion.

1) To improve conditions of Pacific Salmon, Coastal Pelagic, and Pacific Groundfish EFH, NMFS recommends that the Russian River estuary be managed to mimic natural breaching patterns. This strategy would improve rearing habitat for Pacific salmonids and would reduce the likelihood that the estuary becomes an environmental sink for species managed under the Coastal Pelagic of Pacific Groundfish FMPs. Also, to reduce the impacts to Russian River estuarine water quality, the Corps and the SCWA should consult with NMFS to develop and implement breaching protocols that reduce impacts to Pacific Salmon, Pacific Groundfish, and Coastal Pelagic EFH within the Russian River estuary.

2) The Corps and SCWA should consult with NMFS to develop and implement a study plan which seeks to better understand the potential impacts to EFH associated with the current jetty at the mouth of the Russian River estuary. At a minimum, the study plan should consider the effect the current jetty has on estuarine water current dynamics, estuary water surface elevation, water transport through the barrier beach, estuarine water quality, and sediment transport.

3) The Corps and SCWA should consult with NMFS to develop and implement a study plan which seeks to better understand the limnology of Lake Mendocino. At a minimum, the study plan should consider the effect that current operation of Coyote Valley Dam has on hydrology and sediment delivery to the East Branch Russian River, fine sediment transport dynamics through the Russian River system (including the estuary), and the effect that turbidity has on relevant water quality parameters in the East Branch and main stem Russian River (including the estuary). The study should allow for appropriate comparison with Ritter and Brown's (1971) study on the turbidity and suspended-sediment transport in the Russian River Basin.

4) The Corps, SCWA, and MCRRFCD should assess the potential to restore main stem and tributary salmonid habitat related to flood control operations. Currently aquatic and riparian habitat complexity is highly reduced in many areas impacted by Corps and SCWA flood control activities; this results in degraded Pacific Salmon EFH. By modifying current flood control practices, the Corps and SCWA can greatly improve habitat conditions, stream function, and floodplain connectivity.

5) To mitigate for any and all remaining effects to EFH, the Corps, SCWA, and MCRRFCD should work with NMFS to develop and implement restoration projects within the Russian River watershed or adjoining coastal watersheds.

V. STATUTORY RESPONSE REQUIREMENT

Please be advised that regulations at section 305(b)(4)(B) of the Magnuson-Stevens Act and 50 CFR 600.920(k) require your office to provide a written response to this letter within 30 days of its receipt and at least 10 days prior to final approval of the action. A preliminary response is acceptable if final action cannot be completed within 30 days. Your final response must include a description of measures to be required to avoid, mitigate, or offset the adverse impacts of the activity. If your response is inconsistent with our EFH conservation recommendations, you must provide an explanation of the reasons for not implementing those recommendations. The reasons must include the scientific justification for any disagreements over the anticipated effects of the proposed action and the measures needed to avoid, minimize, mitigate, or offset such effects.

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TAdN Arundo Eradication and Coordination Program

Eradication Planning Packet Checklist

All of the following is required before commencing project-funded eradication work.
Please send all completed electronic forms and documents to: Mark Newhouser
EXCEPT send all Field Data to Kasey Allen: kasey@sonomaecologycenter.og.

__ **Project Description**
(Refer to section 2.1, "Project Description," in Sub-RA Agreement for more detailed guidelines. Also see Sample Eradication Plan-Sonoma Creek for an example of a Project Description.)

- Organization description, including:
  - Organization/agency mission or mandate
  - Years of experience implementing ecological restoration, including invasive plant abatement projects.
  - Summary of the number and types of restoration and invasive plant abatement projects implemented.
  - Brief description of who (i.e., staff, contractors, volunteers) will be implementing your abatement work and their level of awareness regarding protecting sensitive resources
- Project history/background (including past work, funding, and support, cooperating groups)
- Proposed eradication plan summary (project rationale, location, extent of infestation, land-use, characteristics of area's vegetation and wildlife)
- Proposed project goals and schedule
- Indicate if planning on using passive or active revegetation. If the latter, describe restoration plan (template provided).

__ **Eradication Methods Form**

__ **Budget (template provided)**

__ **Human Resources Information Form**

Field Data

__ Aerial or topo map showing points of Arundo infestations
(Note: Although not a part of your Eradication Planning Packet, a weed occurrence and weed assessment, and area survey using WIMS must be conducted and photo documentation taken before begining any eradication work.)

Necessary Permits/Permissions

__ Copies of federal, state, and local permits
__Copies of signed landowner access agreements (sample provided), or a signed letter stating you already have access to the lands where eradication work is to occur
__Copies of any signed contracts with eradication contractors (as soon as available), or letter stating that work will be performed without subcontractors, or a letter stating when subcontracts are expected to be established
__Copy of your certificate of insurance, or letter providing proof of self-insurance

All forms and sample documents are available in electronic format at the TAdN website: http://teamarundo.org/eradproject/planning_packet.html.

Data collection in the field will entail the use of a PDA, GPS, and digital camera. All data will be entered into the WIMS database, transferred to the Arundo Program Data Coordinator, and entered into a central database. Database description and instructions can be found at: http://teamarundo.org/survey.

TAdN Arundo Eradication Program

Eradication Methods

Method	Best Use	Timing	Tools	Permits	Advantages	Disadvantages
Cut Only	On small patches when immediate action is needed and/or when there is great concern about herbicide use.	Anytime. Best in late summer/early fall when plant energy is transferred to roots.	Loppers or power brush cutter (steel-blade weed whacker).	Fire permit if burning cane debris.	Less disturbance of soil and surrounding vegetation. No herbicide used. Can use volunteers and simple tools.	Least effective. Cane resprouts from roots and requires ongoing maintenance.
Root Removal	For exposed or overhanging root wads, small infestations.	Dry season, to avoid soil loss.	Loppers, pick and shovel. Backhoe for very deep roots.	Fire permit if burning debris. Permit(s) to work in channel with backhoe.	No herbicide used. Can use volunteers. Low disturbance of other vegetation.	Moderate to significant soil disturbance.
Spray Only	Small stands of pure Arundo, before canes are full height, located away from water.	When plant is green. Best in late summer/early fall when plant energy is transferred to roots.	Glyphosate-based herbicide appropriate for foliar application. Sprayer with directional nozzle.	County Ag Commission permit for pesticide application by non-landowner.	Low soil disturbance. Short duration of labor each season.	Takes 3-5 years of annual herbicide applications. Risk from drift to non-target plants. Licensed applicator needed if non-landowner applies herbicide.
Cut, Resprout and Spray	Pure stands. Large infestations	Cut in spring to summer. Spray regrowth in late summer/early fall when plant energy is transferred to roots.	Loppers or power brush cutter (steel-blade weed whacker). Glyphosate-based herbicide appropriate for foliar application. Sprayer with directional nozzle.	County Ag Commission permit for pesticide application by non-landowner.	Low soil disturbance. Less risk of non-target herbicide drift than when spraying full-grown canes. Can use volunteers for cutting cane.	Takes 3-5 years of annual herbicide applications. Risk from drift to non-target plants. Licensed applicator needed if non-landowner applies herbicide.
Cut Stump	Appropriate for most situations including Arundo mixed with native vegetation.	Anytime during growing season. Best in late summer/early fall when plant energy is transferred to roots.	Loppers. Full-strength glyphosate-based herbicide. Wand or paintbrush applicator.	Fire permit if burning debris. County Ag Commission permit for pesticide application by non-landowner.	Low soil disturbance. Highest success rate. Low risk of non-target herbicide drift. Can use volunteers for cutting cane. Volunteers can work near applicator. Less use of herbicide, therefore lower cost.	Requires handling full-strength application of glyphosate-based herbicide.
Tarping (under development)						
Grazing (under development)						

Note: Various methods may be combined to optimize benefits at a given site. For example, a higher mechanical cut may be used first, followed by cut stump treatment to maximize absorption. This method could be followed by a regrowth period and spraying the regrowth.

TAdN Arundo Eradication Program

Restoration/Revegetation Plan Guidelines

The Restoration/Revegetation Plan contains a written plan, timeline, and budget.

Choosing Revegetation Methods

You must first decide upon the most appropriate revegetation method for your site(s). There are two approaches that can be used to restore the area to a more stable, desirable state: *passive revegetation* and *active revegetation.* You may use active in one place (e.g. high on banks) and passive in another (e.g. lower on the same banks).

Passive revegetation means replanting by natural processes. Nature itself becomes the restoration agent! This method requires the least effort and expertise to restore native riparian vegetation. Wind, rain, and high stream flows generally will carry seeds, plants, and sediment downstream, where they will settle on the lower stream banks naturally. This process is periodic and may take several years. Passive revegetation is unintrusive and fewer disturbances may result in less erosion. It also ensures the introduction of local genetic stock, including *both* native and exotic plants. If exotic pest plants dominate adjacent areas, the eradication site is at risk of being repopulated by these invasive non-native plants.

Passive revegetation is most appropriate when:

- There are established native plants that provide seeds and propagules, either on-site or upstream.
- Few non-native plants inhabit the site or exist upstream of the site
- The site does not contain a lot of disturbed, unvegetated sunny ground that could act as a magnet for non-native pest plants.
- The soils are stable and at low risk of erosion.
- The site tends to flood each year, allowing nearby native plant material to settle and become established.

If these conditions exist, then attempting active revegetation may be a waste of time and resources.

Active revegetation means planting by hand. It usually involves installing and maintaining an irrigation system, and following a weed management schedule. It is often needed to revegetate the higher, drier areas adjacent to streams that may not be affected by frequent flooding. It is generally recommended that you postpone active revegetation until you have the most invasive pest plants under control, since it may be difficult to avoid harming desirable plants during follow-up herbicide treatments. Adequate control can take more than one season.

Active revegetation is most appropriate when:

- The site is located downstream from or near invasive plant species that rapidly invade sites (such as broom, thistle, mustard, and hemlock). In such cases, prompt revegetation with natives may be necessary to prevent invasion of your site.
- The soil or stream bank is unstable and at high risk of erosion.

- A landowner strongly desires a privacy screen or is worried about bank erosion following pest plant removal.

When an eradication site is on an unstable bank or a vulnerable site, revegetation alone may not provide adequate soil or bank stabilization. Soil retention materials and stabilizing structures may be needed to adequately prevent erosion and bank failure. In such cases, materials such as erosion control fabrics and engineered structures should be considered before engaging in invasive plant removal. Your Restoration/Revegetation Plan should include both proposed bank stabilization and revegetation proposals, if needed. For structural changes, consult with a professional. Some sources to consider consulting with are private engineering firms, government agencies, Resource Conservation Districts, and landscape architects.

Restoration of native plant communities is an art and science unto itself. In planning active revegetation, it is best to err on the side of caution and remember that work on your site will likely have impacts downstream. Choose the simplest project that will still satisfy your goals. We strongly encourage the use of locally grown native stock. Seek advice from experienced professionals before you act, keeping in mind that people knowledgeable about native plants or stream dynamics are not necessarily experts in revegetation, or visa versa. As a general rule, plant most species in the fall and early winter to take advantage of winter rains and ensure survival. Plants will need irrigation for the first one or two years.

Elements of the Plan

The following elements should be a part of your Restoration/Revegetation plan:

1) Project Goals and Timeline

Briefly describe what you want to accomplish—the desired long-term outcomes of your plan. Goals should be general, easily understood, and flexible enough to adapt to changing situations. For example, to maximize fish and wildlife habitat, your long-term goals could include eventually shading the stream, stabilizing the ground surface with native plants (not annual grasses), and providing a multi-leveled structure of vegetation from small shrubs to tall trees.

Also prepare a timeline with detailed tasks laid out by months or quarters. A spreadsheet is probably the simplest way to accomplish this.

2) Existing Conditions

Briefly describe the area(s) that will be restored, including existing vegetation (native and non-native), wildlife, soil, topography, drainage, rainfall and flow regimen adjacent land uses and ownership, and any other relevant factors. Describe any known future plans for the site or adjoining lands. Describe any site conditions that may constrain the revegetation work, including protections for sensitive species. You can learn what listed species are in the area(s) by using database searches, such as the Natural Diversity Database. A qualified biologist should conduct a search for these species.

3) Permitting

If the streambed or bank requires alteration, recontouring, or significant removal of vegetation, a Stream Bank Alternation Agreement (Section 1600) is required from the California Department of Fish and Game. If streambed alteration work is done below the plane of ordinary high-water, a permit is required from the U.S. Army Corps of Engineers.

You will need to determine if you have sensitive species habitat on your site(s). Since existing agency records are usually incomplete, the most accurate method is to have a qualified expert such as a botanist conduct a field survey. Sources of existing information include the Department of Fish and Game, State Parks Department, the California Natural Diversity Database, and the CalFlora website. You can also consult with the U.S. Fish and Wildlife Service. Your eradication plan must use the best possible methods to avoid disturbing wildlife habitat or mitigate any disturbance it is likely to cause.

It is your responsibility to obtain all necessary permits. Even beneficial projects often require extensive permitting. Allow time and an adequate budget for the permitting process.

4) Site Preparation

Often, pest plant debris will be removed in the course of eradication. If plant debris remains in the revegetation areas, it should be secure on the banks and not pose a threat of flooding or property damage. In some cases, it can be used for mulching new plantings or erosion control.

Other debris, including trash, concrete slag, or other man-made materials should be removed to facilitate revegetation.

5) Planting Plan

Develop a list of desired plant species and a planting design. Let experts you work with know you want to use *only* native species! Choose fast-growing natives that can flourish on your site. For example, for a privacy screen at the water's edge, use willow pole plantings (*Salix* species). These are easy to establish in moist soils and grow rapidly. For the same effect on a high bank, try coyote bush (*Baccharis pilularis*). Don't plant expensive or labor-intensive species near the waterline, since they may be washed out in their first winter.

If you plan to do your own propagating, research the proper timing and techniques for the plant species you will be using, the number of plants, source of stock, and genetic origin. Also consider plant spacing and density, mulching, and other post-planting work. If you plan on contracting out this work, be sure you discuss these issues with the contractor.

Revegetation plan drawing(s) should include plant locations, grading, irrigation system (if used), access routes, protective measures such as fencing and signage, etc.

6) **Maintenance**

Plan for maintenance, including pest and erosion control, weeding, replanting, irrigation (if

needed), and fencing and signage (if needed).

7) **Monitoring and Success Criteria**

List criteria you will use to evaluate the success of your plan. Derive these criteria directly from your revegetation goals (Section 1). Examples might include the % survival of various categories of planted vegetation (i.e., trees, shrubs, etc.), % cover (invasive problem species, tree canopy, bare ground, understory shrubs, groundcover, etc.), use of revegetated areas by wildlife, birds, etc. Include plans to photodocument the results. Describe long-term (10-year) monitoring and how you intend to fund it.

8) Responsibilities

List the people who will design, manage, and implement your plan, including specialists such as hydrologists, biologists, botanists, erosion control specialists, landscape architects, and contractors. Describe what each person will do and their affiliation. This information will help other groups plan new revegetation efforts.

9) Cost Analysis

Revegetation costs are extremely variable depending on the needs of the site, the intensity of planting, size of the area planted, and the labor source. You will want to budget for the following types of activities/needs: site preparation (labor and equipment), maintenance and monitoring, materials, and overhead/administration.

10) Appendix

Attach any additional revegetation information and/or plan drawings.

Additional Resources

- Local chapter or state office of the California Native Plant Society.
- Nurseries specializing in local native species.
- Yellow pages listings for Environmental, Conservation, and Ecological Organizations, or Environmental and Ecological Services.
- Society for Ecological Restoration, California Chapter (SERCAL), at www.sercal.org or SERCAL, 915 L Street #C104, Sacramento CA 95814, 805-634-9228.
- Local restoration or mitigation consultants and biologists.

TAdN Arundo Eradication and Coordination Program

Restoration/Revegetation Plan

(To complete, refer to Restoration/Revegetation Plan Guidelines. The Guidelines and an example of a completed restoration plan are available at: http://teamarundo.org/eradproject/planning_packet.html.)

Watershed:

Organization Name:

Project Goals:

List each goal as simply and clearly as possible. A short sentence for each should suffice.

Goal #1:

Goal #2:

Goal #3:

Goal #4:

Timeline:

Revegetation Methods: ☐ Passive ☐ Active ☐ Passive *and* Active

Target Date or Time Period	Revegetation Tasks

Existing Conditions:

Permitting:

Site Preparation:

Planting Plan:

Below, list which revegetation activities will be occurring at each Arundo clump (waypoint). You may also group clumps that are to receive the same revegetation method. Revegetation methods are determined by the size of the clump, position on bank, the presence or absence of erosion, and the presence or absence of non-native weeds.

Clump # (Waypoint)	Passive Revegetation	Upland Shrubs and Trees	Grasses & Sedges	Willow Sprig Planting	Willow Blanket	Willow Revetment

List the plants you expect to use in your revegetation plan.

Common Name	Scientific Name	Source	Planting Area	Timing

Maintenance Plan:

Monitoring and Success Criteria:

Responsibilities:

If possible, list below the people who will assist in the design, management, and implementation of your plan (i.e., specialists such as hydrologists, biologists, landscape architects, contractors, etc.) This information will be valuable in helping new projects locate qualified specialists for their Arundo eradication work.

Type of Specialist	Name	Address	Phone

Cost Analysis: Use the Revegetation Budget Form to organize your budget costs and include with your Revegetation Plan.)