State of California
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Department of Water Resources

REDD DEWATERING AND JUVENILE STEELHEAD AND CHINOOK SALMON STRANDING IN THE LOWER FEATHER RIVER, 2002-2003

Interim Report
SP-F10, Task 3C

Oroville Facilities Relicensing
FERC Project No. 2100

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SUMMARY

Since 2001, DWR has been conducting a redd dewatering and juvenile stranding study on Chinook salmon and steelhead in the Lower Feather River. The objectives of the study are to determine the number of redds dewatered by reductions in flow; identify potential ponding areas; determine the relative abundance of stranded salmonids; and determine the biological significance of stranding / redd dewatering losses to the existing population of salmonids in the river. The following report summarizes activities from 2002/2003 sampling season. Only 14 dewatered redds were discovered, as compared to an estimated 23,308 female spawning Chinook. Empirical observations and historical aerial photos have led to the identification of over 30 areas that have potential to strand juvenile salmonids. Sampling of these areas revealed that relatively few juvenile salmon and steelhead become isolated. Furthermore, the proportion of stranded salmonids represent a very small percentage (<< 1%) of the estimated number of emigrants. The major flow fluctuation occurred in late February, which probably reduced the potential stranding impact to rearing salmonids. The peak of emigration for Chinook salmon occurred several weeks prior to this event. Also, over 75% of steelhead early rearing takes place in the LFC suggesting that flow fluctuations in early spring have a very limited potential impact on juvenile steelhead in the HFC.

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1.0 INTRODUCTION

In March 2000 the National Marine Fisheries Service (NMFS) issued a Biological Opinion (NMFS 2000) for the California State Water Project (SWP), which required the Department of Water Resources (DWR) to develop a monitoring program to determine the extent of juvenile steelhead and spring-run Chinook salmon stranding and redd dewatering resulting from SWP operations on the Feather River. In response, DWR proposed a study plan consisting of two major components: aerial and ground surveys to locate spawning riffles and potential stranding areas and biological observations to estimate the incidence of juvenile stranding and redd dewatering. Results from the monitoring program are to serve as a basis for establishing long-term ramping rate criteria to minimize the potential for stranding juvenile salmonids.

The objectives for the first year of this study were: 1) to survey spawning sites to determine the number of redds dewatered by reductions in flow; 2) to identify potential ponding areas using historical data, aerial photos and ground surveys; 3) to sample established ponds to determine the relative abundance of stranded salmonids; and 4) to determine the biological significance of stranding / redd dewatering losses to the existing population of salmonids in the river.

In the second year of study, we have maintained similar objectives, however, the scope has expanded to include the section of the Feather River between Honcut Creek and the confluence with the Sacramento River. The following is an interim report summarizing activities from October 2002 to May 2003.

2.0 METHODS

2.1 Study Area

The Feather River drainage is located within the Central Valley of California, draining an extensive area of the western slope of the Sierra Nevada (Figure 2.1-1). The Feather River is of low gradient from the Oroville-Thermalito Complex downstream to the confluence with the Sacramento River. Oroville Dam and Thermalito Diversion Dam regulate flow into the lower Feather River below the reservoir. Under normal operations, the majority of the Feather River flow is diverted at Thermalito Diversion Dam into the Power Canal and Thermalito Forebay. The remainder of the flow, typically 600 cfs, flows through the historical river channel, the low flow channel (LFC). Water released from the Forebay is used to generate power before discharge into Thermalito Afterbay. Excluding local diversions and occasional pumpback operations, the water is returned to the Feather River through Thermalito Afterbay Outlet, then flows southward through the valley to the confluence with the Sacramento River at Verona.

DWR has been conducting fisheries research on the upper 25 miles of the lower Feather River for nearly seven years. This portion of the river consists of the LFC, which extends from the Fish Barrier Dam to the Thermalito Afterbay Outlet, and the high flow channel (HFC), which extends from the Outlet to Honcut Creek (Figure 2.1-2). The reaches differ in channel morphology, flow characteristics and salmonid abundance. Most salmon spawning and juvenile rearing is in the LFC (Sommer et al. 2001).

Since flows in the LFC remain constant year-round, stranding or redd dewatering would occur mainly during flood events. Another exception could occur during summer, if flows were manipulated to meet temperature criteria promulgated by NMFS.

The HFC is more complex and flow is more variable, which would increase the risk of redd dewatering and juvenile stranding. Redd dewatering is not expected because, to date, there is no evidence that steelhead or spring-run salmon spawn in the HFC. However, a significant amount of rearing occurs, so juvenile stranding is possible. Thus, field efforts were concentrated in the HFC.

2.2 Redd Dewatering

In the Feather River, Chinook salmon spawn from September through December and steelhead spawn from December through March. During this period, major spawning riffles in the HFC were visited after each reduction in flow. Measurements included river mile, flow and the number of exposed redds.

Redds were considered dewatered if the water surface elevation had dropped below bed elevation.

The incidence of redd dewatering was compared with the estimated number of salmon redds from the 2002 spawning season to determine redd losses as a proportion of the total in the river.

2.3 Juvenile Stranding

Previous studies suggest there are very few juvenile salmon and steelhead rearing in the river through the summer (DWR 2003); therefore stranding surveys are conducted from late Fall to late early summer. Based on the timing of flow fluctuations in 2002/2003, standing data presented here are the results from surveys in January and March 2003.

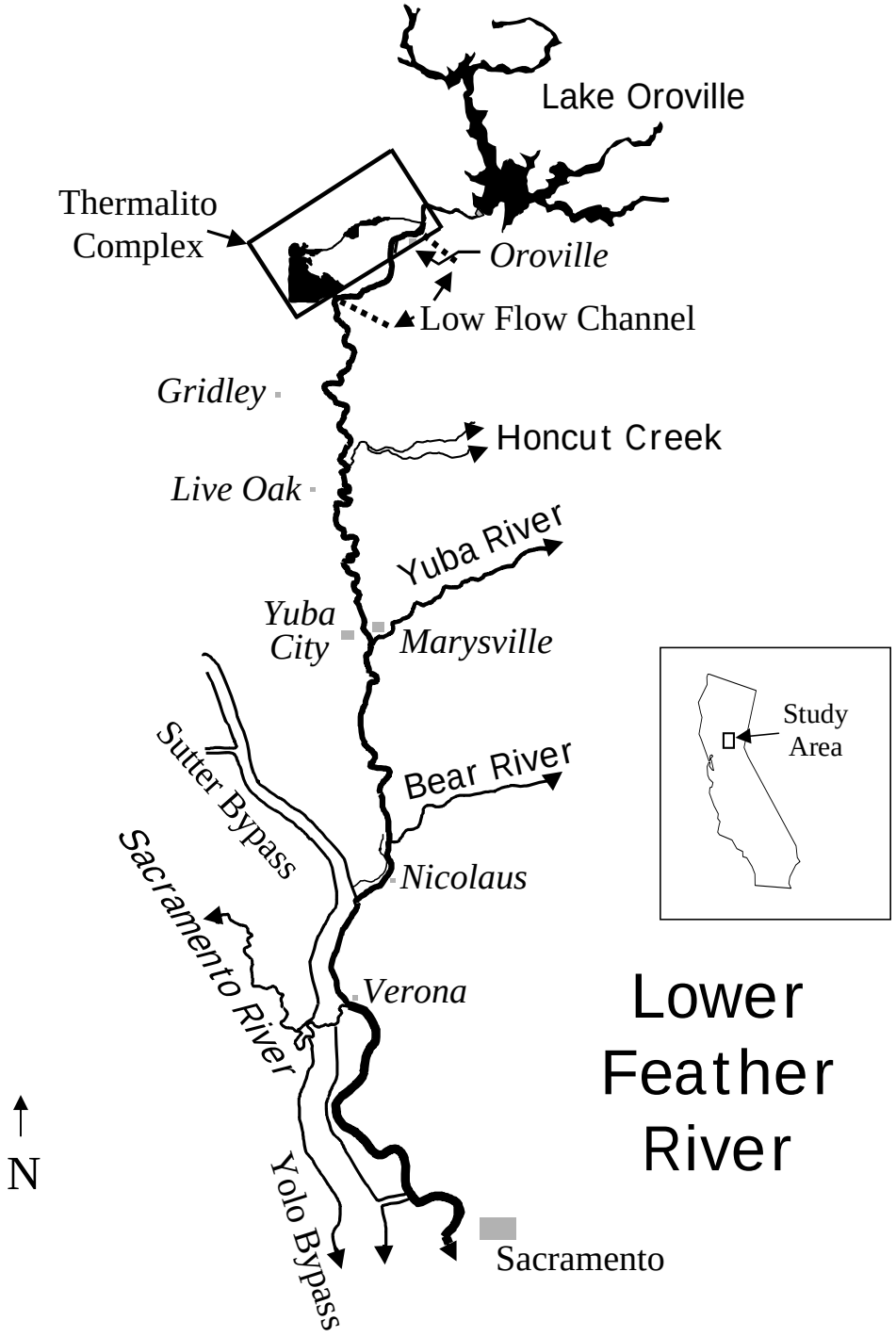
Most stranding areas were identified in the previous study year (DWR 2002). However, searches for new stranding areas were completed for flow ranges not previously observed. Physical measurements recorded for each pond included river mile, river flow, average depth and total surface area.

In 2003, the sample area was expanded to include identification of ponded areas between Honcut Creek and the confluence with the Sacramento. Boating can be difficult and dangerous in this section of the river; therefore an aerial survey was scheduled to locate stranding areas. Additionally, historical aerial photos were examined to identify potential stranding areas. This season, isolated ponds downstream of Honcut Creek were not sampled for stranded fish.

Once ponding occurred, a sub-set of ponds from the Thermalito Afterbay Outlet downstream to Honcut Creek was sampled by beach seine or snorkeling. Fish were identified and enumerated by species. The fork length (FL) of each species from snorkel surveys was estimated visually. Fish captured by beach seine were measured for up to 50 salmon and steelhead (and up to 20 individuals for non-salmonids). Run identification was based on a daily length table (Greene 1992) for Central Valley Chinook salmon. The proportion of spring run sized fish in the sub-sample was used to estimate the number of spring run sized salmon in the total catch.

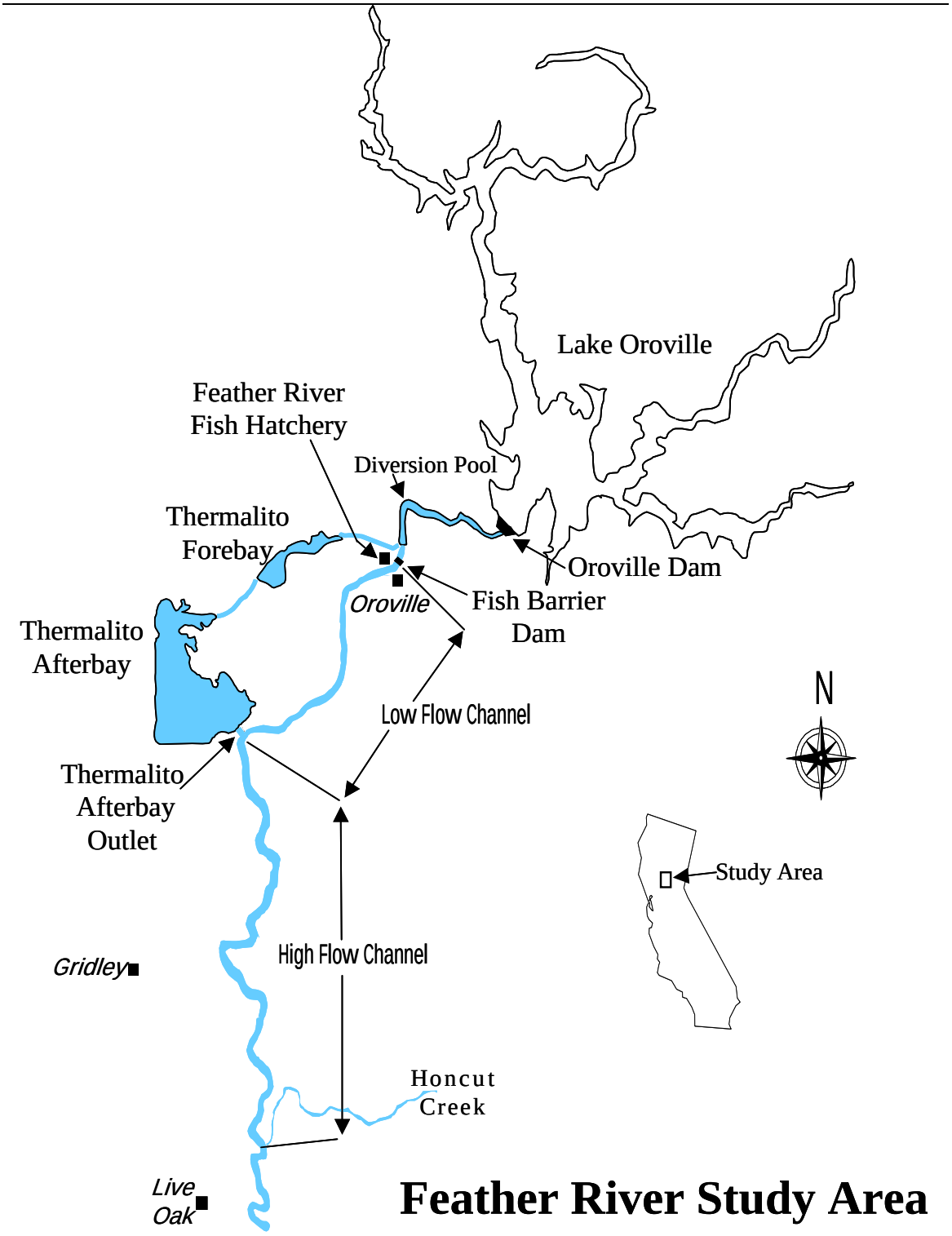
Fish density (number of fish per area swept) was used to estimate species abundance for the entire pond. Mean fish density across all ponds was computed and multiplied by the total ponded area to estimate the number of salmon and steelhead stranded in the study area.

The incidence of stranding was compared with emigration estimates from rotary screw trap operations (DWR unpublished data) to determine the stranding losses relative to the population of juvenile spring-run salmon in the river.



Source: DWR 2002

Figure 2.1-1. Map of the Lower Feather River.



Source: DWR 2002

Figure 2.1-2. Map of the Feather River Study Area.

3.0 RESULTS

There were two major flow reductions in the HFC of the Feather River from January to May 2003 (Figure 3.0-1). In the HFC, flows ranged between 1050 and 8000 cfs. Releases to the LFC remained at 600 cfs for the same period. However, for two days in late August LFC flow was temporarily increased to 1800 cfs as part of manipulations necessary for instream flow studies.

3.1 Redd Dewatering

A total of 14 dewatered salmon redds were identified (Table 3.1-1). Dewatered redds resulted from two decreases in flow, the first in mid-October (2750 to 2000 cfs) and the second in mid-January (2000 to 1750 cfs). All dewatered redds were in the HFC. The water operation in October led to the dewatering of 6 redds, while 8 redds were dewatered in January.

Since the flow fluctuation in the LFC was in August, we did not search for dewatered redds. Chinook salmon and steelhead in the Feather River do not spawn in August.

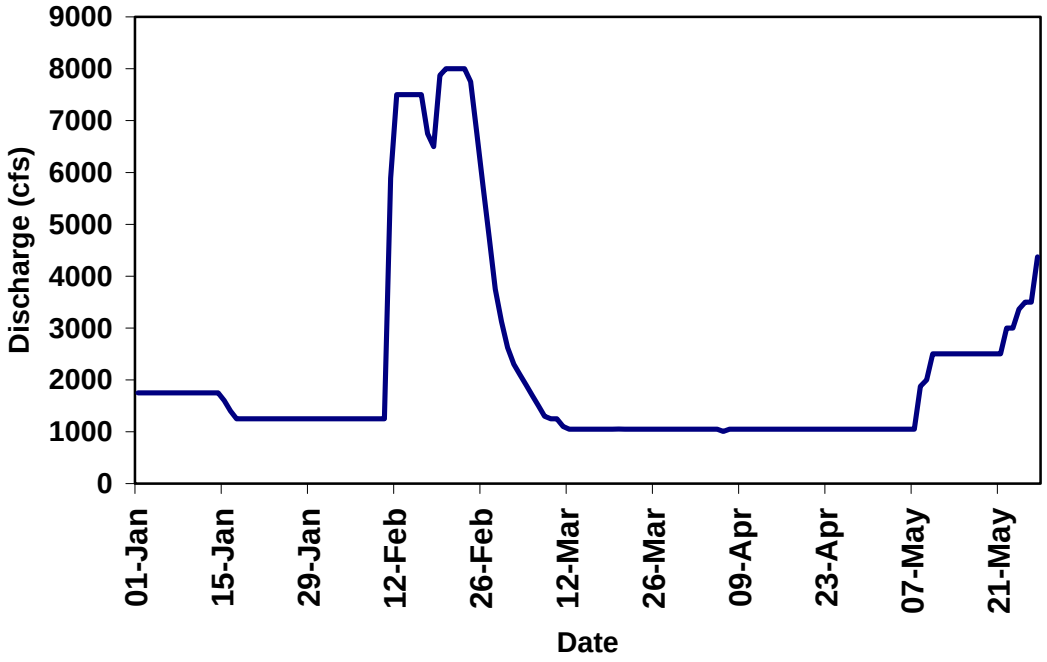
Table 3.1-1. Location, River Mile, and number of dewatered redds during flow reductions in October 2002 and January 2003.

Location	River Mile (RM)	Number of Dewatered Redds	
		October 2002	January 2003
G95	57.3	0	1
Hour Riffle	56.3	2	5
Keister Riffle	55.0	0	1
Big Riffle	54.0	1	0
Big Bar	53.4	0	2
McFarland Riffle	52.3	0	2

3.2 Juvenile Stranding

A minor flow fluctuation in January isolated a few shallow ponds, but only one Chinook salmon (47 mm FL) was found. Data from this survey was not used for the estimate of total number of salmon stranded. In February total discharge reached 8000 cfs, the river inundated 18 of the 19 sites above Honcut Creek, which were identified as potential stranding areas (DWR 2002); Seventeen of those sites are included here. An estimated total of 60,601 m^2 of isolated surface area was created (Table 3.2-1). Isolated areas were sampled from March 2 to March 8 with a combination of beach seining and snorkeling (see DWR 2002, for a detailed discussion of methods). A total of 21,529 fall run sized Chinook, 8 spring run sized Chinook, and 1 steelhead juveniles were sampled. The expanded total for fall run sized Chinook is 47,474. Expanded totals for spring run sized salmon and steelhead were not completed.

Examination of historical aerial photos revealed 17 other areas below Honcut Creek, susceptible to isolation (RM 2 – 43). An aerial survey of the Lower Feather River (Fish Barrier Dam to the confluence with the Sacramento River) completed on March 18, identified 2 of the 17 isolated areas. Ponded areas were located at Shanghai Bench (RM 25) and at RM 35.



Source: CDEC 2003.

Figure 3.0-1. Feather River discharge below the Thermalito Afterbay Outlet, January through May 2003.

In August, discharge to the LFC was increased to 1800 cfs and subsequently dropped to 600 cfs. This flow fluctuation created a shallow pond around Gateway Riffle (RM 59.8). A visual survey showed there were no fish in the pond. The pond was dry within 24 hours.

Table 3.2-1. Estimated pond surface area of isolated basins in 2003.

Location	River Bank	River Mile	Pond Area (m^2)
Thermalito Bar	L	59.0	520
G95 South Island (1)		57.2	216
G95 South Island (2)		56.9	190
Upper Hour Island		56.3	735
Lower Hour Island		56.1	1,530
Hour Bars	L	55.9	4,700
Goose Riffle	L	54.8	153
Big Bar	R	53.4	1,800*
Upper Macfarland	R	52.6	784
Lower Macfarland	R	52.4	6,746*
Gridley Side Channel (1)	L	49.5	384
Gridley Side Channel (2)	L	49.5	1,922
Gridley Riffle	R	49.2	13,296*
Shallow Riffle	R	47.0	312
Herringer Side Channel (1)	R	46.5	518
Herringer Side Channel (2)	R	46.5	16,109
Herringer Riffle	L	45.2	10,686*

** Estimated range based on historical aerial photos.*

Juvenile fall-run salmon, pikeminnow, and hardhead were the most abundant species sampled (Table 3.2-2). Other species collected include largemouth bass, Sacramento sucker, and wagasaki. A total of 21,529 fall run sized Chinook, 8 spring run sized Chinook, and 1 steelhead juveniles were sampled. Additionally, five hatchery planted, age 1+ steelhead were observed in the Herringer riffle pond. The only piscivorous species collected were largemouth bass, hatchery steelhead and pikeminnow.

Table 3.2-2. Fish species collected by beach seine and snorkel surveys in 2003.

Species	Number collected	
	Beach Seine	Snorkel
fall-run sized Chinook salmon	9,802	11,727
Sacramento pikeminnow / Hardhead	29	1,150
largemouth bass	0	10
spring-run sized Chinook salmon	2	6
Sacramento sucker	2	5
steelhead (hatchery)	0	5
wakasagi	2	0
Lepomis spp. (sunfish)	0	2
steelhead (wild)	1	0

Fall-run sized Chinook salmon ranged from 35 to 44 mm FL while spring-run sized salmon were between 66 and 68 mm FL. The Age-0 steelhead was estimated at 25 mm FL and the Age-1+ steelhead ranged from 175-225 mm FL. The expanded total for fall run sized Chinook was 47,474. Expanded totals for spring run sized salmon and steelhead were not calculated due to their extremely low abundance.

The estimated emigration estimate between November 2002 and May 2003 for fall run sized Chinook salmon was 8,072,964. Thus, substantially less than one-half percent of fall run were isolated and potentially lost.

4.0 DISCUSSION

4.1 Redd Dewatering

Fourteen Chinook salmon redds were dewatered as a result of flow reductions, but it is impossible to know if the redds were from spring-run or fall-run salmon. To put losses due to dewatering in the context of the total population, we can use the escapement estimate for the Feather River. The 2002 carcass survey estimated the salmon run at 83,259 salmon. An estimated 34% of these fish were considered spawned (DWR, unpublished data). With the conservative assumption that each female spawned only once, a loss of 14 redds is 0.005% of the estimated total. The loss of redds due to dewatering during the 2002/2003 spawning period does not appear to be a significant impact on salmon egg production in the Feather River.

4.2 Juvenile Stranding

Nearly all stranding areas upstream of Honcut Creek were inundated this season. The high number of stranded areas occurred because flow below the Thermalito-Afterbay Outlet reached 8000 cfs. This is the highest flow observed in the Feather River, since the beginning of the survey in Fall 2001. Of the 17 potential stranding areas identified downstream of Honcut Creek only 2 were isolated at 1050 cfs. However, flow in downstream reaches of the Feather River is strongly influenced by tributaries like Honcut Creek, the Bear River and the Yuba River. The additional water input from these tributaries may have reduced the potential for stranding. Conversely, the outflow from these tributaries may create stranding events even when DWR is not manipulating Feather River flows.

Upstream of Honcut Creek, the impact of stranding on Chinook salmon and steelhead populations appears to be very small when compared to the number of emigrants from the Feather River. The major HFC flow change occurred in late February, which probably reduced the potential impact to rearing salmonids. The peak of emigration for Chinook salmon occurred weeks prior to this event. Also, the fact that over 75% of steelhead spawning and early rearing is thought to be in the LFC suggests that at this time of year there is a very limited potential impact on juvenile steelhead (DWR 2003). However, since areas below Honcut Creek were not sampled for stranded fish, our estimate of stranded fish is not representative of the entire Feather River; and likely underestimates the total impact of stranding on salmonids in the lower Feather River. In subsequent surveys, sampling in reaches below Honcut Creek, may improve our estimate of stranding for the whole river; and possibly our ability to assess stranding as an impact to Feather River salmonid populations.

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