
State of California
The Resources Agency
Department of Water Resources

**MATRIX OF LIFE HISTORY AND
HABITAT REQUIREMENTS FOR
FEATHER RIVER FISH SPECIES
SP-F3.2 TASK 2**

WHITE STURGEON

**Oroville Facilities Relicensing
FERC Project No. 2100**

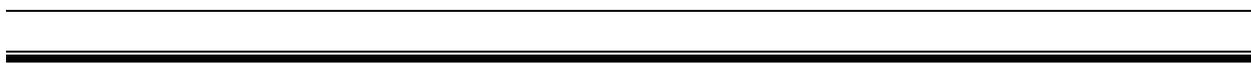


APRIL 2004

**ARNOLD
SCHWARZENEGGER**
Governor
State of California

MIKE CHRISMAN
Secretary for Resources
The Resources Agency

LESTER A. SNOW
Director
Department of Water
Resources



**State of California
The Resources Agency
Department of Water Resources**

**MATRIX OF LIFE HISTORY AND
HABITAT REQUIREMENTS FOR
FEATHER RIVER FISH SPECIES
SP-F3.2 TASK 2**

WHITE STURGEON

**Oroville Facilities Relicensing
FERC Project No. 2100**

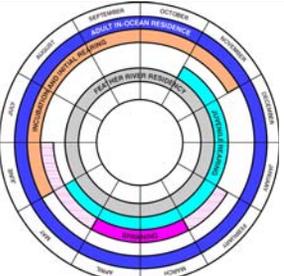
This report was prepared under the direction of

Terry J. Mills..... Environmental Program Manager I, DWR

by

Paul BratovichPrincipal/Fisheries Technical Lead, SWRI
David Olson..... Senior Environmental Scientist/Project Manager, SWRI
Adrian PittsAssociate Environmental Scientist/Author, SWRI
Meryka AtherstoneAssociate Environmental Planner/Author, SWRI
Allison NiggemyerAssociate Environmental Scientist/ Author, SWRI
Amanda O’Connell Environmental Planner/Author, SWRI
Karen Riggs Environmental Planner/Author, SWRI
Brian Ellrott..... Environmental Scientist/Author, SWRI

Matrix Of Life History and Habitat Requirements for Feather River Fish Species – White Sturgeon
Oroville Facilities P-2100 Relicensing

Element	Element Descriptor	General	Feather River specific
General			
common name (s)	English name (usually used by fishers and laypeople).	White sturgeon	
scientific name (s)	Latin name (referenced in scientific publications).	The scientific name of white sturgeon is <i>Acipenser transmontanus</i> (Moyle 2002).	
taxonomy (family)	Common name of the family to which they belong. Also indicate scientific family name.	White sturgeon belong to the <i>Acipenseridae</i> family (Moyle 2002).	
depiction	Illustration, drawing or photograph.		
range	Broad geographic distribution, specifying California distribution, as available.	<p>White sturgeon are reportedly restricted to Pacific coastal waters and river systems from Central California to Southern Alaska (Parsley et al. 1993).</p> <p>White sturgeon reportedly live in rivers from central California to southern Alaska and migrate among them via the Pacific ocean (CRI Staff 2002).</p> <p>In a Columbia River study, white sturgeon reportedly moved throughout the Columbia River system, from the Columbia River estuary to its headwaters (Brannon and Sutter 1992).</p> <p>White sturgeon are reportedly found in saltwater from Ensenada, Mexico, north to the Gulf of Alaska, but spawn only in large rivers from the Sacramento-San Joaquin river system northward. Landlocked populations of white sturgeon exist in the Columbia River basin above major dams (Moyle 2002).</p>	In California, white sturgeon are reportedly most abundant in the San Francisco Bay estuary. This population reportedly spawns mainly in the Sacramento and Feather rivers (Moyle 2002).
native or introduced	If introduced, indicate timing, location, and methods.	White sturgeon are native to California (Moyle 2002).	

Matrix Of Life History and Habitat Requirements for Feather River Fish Species – White Sturgeon
Oroville Facilities P-2100 Relicensing

Element	Element Descriptor	General	Feather River specific
ESA listing status	Following the categories according to California Code of Regulations and the Federal Register, indicate whether: SE = State-listed Endangered; ST =State-listed Threatened; FE = Federally listed Endangered; FT = Federally-listed Threatened; SCE = State Candidate (Endangered); SCT = State candidate (Threatened); FPE = Federally proposed (Endangered); FPT = Federally proposed (Threatened); FPD = Federally proposed (Delisting); the date of listing; or N = not listed.	White sturgeon are not a listed species (DFG 2002).	
species status	If native, whether: Extinct/extirpated; Threatened or Endangered; Special concern; Watch list; Stable or increasing. If introduced, whether: Extirpated (failed introduction); highly localized; Localized; Widespread and stable; Widespread and expanding.	White sturgeon are native to California and the current population size is reportedly abundant or increasing (Moyle 2002).	
economic or recreational value	Indicate whether target species sought for food or trophy. Whether desirable by recreational fishers, commercial fishers, or both.	<p>White sturgeon reportedly are an important recreational and commercial resource of the Pacific Northwest (Parsley et al. 1993).</p> <p>White sturgeon reportedly support valuable commercial and sport fisheries in Canada, Oregon, and Washington. In California, white sturgeon are taken in small numbers by the Native American fishery in the Klamath River, and support a major sport fishery in the San Francisco Bay estuary (Moyle 2002).</p> <p>White sturgeon are considered an excellent tasting fish, and their eggs are marketed as caviar. Historically, air bladders of sturgeon were made into isinglass, a transparent, almost pure gelatin used as an adhesive and a clarifying agent (Froese 2003).</p>	

Matrix Of Life History and Habitat Requirements for Feather River Fish Species – White Sturgeon
Oroville Facilities P-2100 Relicensing

Element	Element Descriptor	General	Feather River specific
warmwater or coldwater	Warmwater if suitable temperature range is similar to basses; coldwater if suitable temperature range is similar to salmonids.	White sturgeon are a coldwater fish (Moyle 2002).	
pelagic or littoral	Environment: Pelagic - living far from shore; Littoral - living near the shore.	White sturgeon reportedly spend most of their lives in the estuaries of large rivers, moving into freshwater to spawn, although a small number of white sturgeon reportedly make extensive movements in the ocean. White sturgeon are reportedly most abundant in the brackish portions of estuaries, but also utilize deeper sections of estuaries (Moyle 2002).	
bottom or water column distribution	Environment: bottom (benthic) or along water column.	White sturgeon are benthic fish. In estuaries, adult white sturgeon tend to concentrate in deep areas with soft substrates (Moyle 2002; Pacific States Marine Fisheries Commission 1996).	
lentic or lotic	Environment: Lentic - pertaining to stagnant water, or lake-like; Lotic - moving water, or river-like.	White sturgeon reportedly prefer low water velocity basins (Brannon and Sutter 1992).	
Adults			
life span	Approximate maximum age obtained.	White sturgeon reportedly may live 100 years or more (CRI Staff 2002; Parsley et al. 1993), but sturgeon longer than 6.6 ft (2 m) and older than 27 years are reportedly rare (Moyle 2002).	
adult length	Indicate: Length at which they first reproduce; average length and maximum length the fish can attain.	<p>White sturgeon reportedly can reach lengths of over 19.7 (6 m) (CRI Staff 2002; Moyle 2002; Parsley et al. 1993).</p> <p>Male white sturgeon are reportedly at least 10-12 years old and 29.5-41.3 inches (75-105 cm) FL before sexual maturity. Female white sturgeon reportedly do not mature until they are 12-16 years old and 37.4-53.1 inches (95-135 cm) FL (Moyle 2002).</p> <p>Female white sturgeon reportedly spawn at 15-20 years of age, and male white sturgeon reportedly spawn at approximately 12 years of age (CRI Staff 2002).</p> <p>In the San Francisco Bay estuary, young sturgeon reportedly reach 7.1-11.8 inches (18-30 cm) FL after the first year. By the 7th or 8th year, white sturgeon reportedly reach 40.2 inches (102 cm) FL. In subsequent years, growth rates slow and</p>	

Preliminary Information – Subject to Revision – For Collaborative Process Purposes Only

Matrix Of Life History and Habitat Requirements for Feather River Fish Species – White Sturgeon
Oroville Facilities P-2100 Relicensing

Element	Element Descriptor	General	Feather River specific
		white sturgeon reportedly grow 0.79-2.4 inches (2-6 cm) in length per year (Moyle 2002).	
adult weight	Indicate: Weight at which they first reproduce; average weight and maximum weight the fish can attain.	White sturgeon have been reported to weigh in excess of 1278.7 pounds (580 kg) (CRI Staff 2002; Parsley et al. 1993). The largest authentic record weight for white sturgeon was 1388.9 pounds (630 kg) (Moyle 2002). In California, the most recent record size white sturgeon is reportedly a 47-year-old female, 9.2 ft (2.8 m) TL, weighing 463 pounds (210 kg). In 1963, CDFG recorded a dead male white sturgeon reportedly measuring 9.5 ft (2.9 m) TL, weighing 496 pounds (225 kg), in Shasta Reservoir (aged at least 67 years) (Moyle 2002).	
physical morphology	General shape of the fish: elongated, fusiform, laterally compressed, etc.	White sturgeon have long, cylindrical bodies with large heads and mouths (Pacific States Marine Fisheries Commission 1996).	
coloration	Indicate color, and color changes, if any, during reproduction phase.	The ventral body surface is white, shading to gray- brown on the back above the lateral scutes (Moyle 2002). The dorsal color of white sturgeon is dark to light gray, pale olive, or gray-brown; its ventral color is white. The scutes of white sturgeon are lighter in color than the body, and fins are dusky to opaque gray (Pacific States Marine Fisheries Commission 1996).	
other physical adult descriptors	Unique physical features for easy identification.	The skeletons of white sturgeon are mainly comprised of cartilage. White sturgeon have thick skin and bony plates, called scutes instead of scales (CRI Staff 2002). White sturgeon have four barbels located on the ventral side of the head (Pacific States Marine Fisheries Commission 1996).	
adult food base	Indicate primary diet components.	White sturgeon reportedly feed on bottom-dwelling invertebrates, including crabs, clams, and shrimp. Fish become increasingly important in the diets of larger white sturgeon, especially herring, anchovy, striped bass, starry flounder, and smelt (Moyle 2002).	
adult feeding habits	Indicate whether plankton eater, algae eater, bottom feeder,	White sturgeon are reportedly primarily benthic feeders (Moyle 2002).	

Preliminary Information – Subject to Revision – For Collaborative Process Purposes Only

Matrix Of Life History and Habitat Requirements for Feather River Fish Species – White Sturgeon
Oroville Facilities P-2100 Relicensing

Element	Element Descriptor	General	Feather River specific
	piscivorous, active hunter, ambush predator, filter feeder. Night, day, dusk or dawn feeder.		
adult in-ocean residence time	For anadromous species, age when they migrate to the ocean and duration spent in the ocean before returning to freshwater to spawn.		
adult habitat characteristics in-ocean	For anadromous species, description of the ocean habitat utilized: whether along major current systems, gyres, pelagic (beyond continental shelves) and neritic (above continental shelves) zones, etc.		
Adult upstream migration (immigration)			
range of adult upstream migration timing	Time of year adults migrate upstream. If applicable, indicate for various runs.	In California, adult white sturgeon move upstream when they are ready to spawn. Spawning reportedly occurs between late February and early June (during winter and spring months). Upstream movements are apparently triggered by increases in flow (Moyle 2002). White sturgeon reportedly move upstream during the winter and spring months (Brannon and Sutter 1992).	
peak adult upstream migration timing	Time of year most adults migrate upstream. If applicable, indicate for various runs.	White sturgeon reportedly move into large rivers in the early spring (Pacific States Marine Fisheries Commission 1996).	
adult upstream migration water temperature tolerance	Range of water temperatures allowing survival. Indicate stressful or lethal levels.		
adult upstream migration water temperature preference	Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental.		

Matrix Of Life History and Habitat Requirements for Feather River Fish Species – White Sturgeon
Oroville Facilities P-2100 Relicensing

Element	Element Descriptor	General	Feather River specific
Adult holding (freshwater residence)			
water temperature tolerance for holding adults	Range of water temperatures allowing survival. Indicate stressful or lethal levels.		
water temperature preference for holding adults	Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental.		
water depth range for holding adults	Reported range of observed (minimum and maximum) water depth utilization.	Adult white sturgeon have reportedly been observed in waters 6.6-98.4 ft (2m-30m) in depth (Counihan et al. 1999). In the Columbia River, adult white sturgeon were reportedly observed in shallow water less than 23 ft (7m) deep (Parsley et al. 1993).	
water depth preference for holding adults	Reported range of most frequently observed water depth utilization.	In the Columbia River system, adult white sturgeon were reportedly observed at a mean water depth of 36.1 (11m) (Counihan et al. 1999). White sturgeon reportedly reside in shallow water during periods of high activity (summer) and in deep water during the winter (Brannon and Sutter 1992).	
substrate preference for holding adults	If bottom dwellers, indicate substrate: mud, sand, gravel, boulders, aquatic plant beds, etc. If gravel, indicate range or average size of gravel.	In Lake Roosevelt, white sturgeon reportedly were distributed most often over very fine sediment (Brannon and Sutter 1992).	
water velocity range for holding adults	Reported range of observed (minimum and maximum) water velocity utilization.	In the Columbia River, adult white sturgeon exceeding 6.6 ft (2 m) reportedly can negotiate water velocities of 13.1-19.7 ft/s (4-6 m/s), or approximately two to three times their body length per second (Parsley et al. 1993). In the Columbia River system, white sturgeon are reportedly found in water velocities of 0.3-6.6 ft/s (0.1-2.0 m/s) (Counihan et al. 1999).	
water velocity preference for holding adults	Reported range of most frequently observed water velocity utilization.	In the Columbia River system, the average water velocity utilized by white sturgeon reportedly is 2 ft/s (0.6 m/s) (Counihan et al. 1999).	

Preliminary Information – Subject to Revision – For Collaborative Process Purposes Only

Matrix Of Life History and Habitat Requirements for Feather River Fish Species – White Sturgeon
Oroville Facilities P-2100 Relicensing

Element	Element Descriptor	General	Feather River specific
other habitat characteristics for holding adults	General description of habitat (e.g. turbid or clear waters, lentic or lotic, presence of aquatic plant beds, debris, cover, etc.).	In the Columbia River system, white sturgeon reportedly utilized deep holes (Brannon and Sutter 1992). Adult white sturgeon reportedly utilized the interface between the Lake Roosevelt impoundment and the Columbia River (Brannon and Sutter 1992).	
timing range for adult holding	Time of year (earliest-latest) and duration of stay from upstream migration to spawning.		
timing peak for adult holding	Time of year when maximum number of adults are present before spawning.		
Spawning			
fecundity	Average or range in the number of eggs females lay in a spawning season.	Female white sturgeon reportedly can produce 300,000-4,000,000 eggs (CRI Staff 2002; Wang 1986). Female white sturgeon reportedly can produce from 100,000 to several million eggs (Pacific States Marine Fisheries Commission 1996). In the Sacramento River, fecundity of white sturgeon reportedly averages 2,555 eggs per lb (5,648 eggs per kg) of body weight. A typical female [4.9 ft (1.5 m) FL] reportedly contains 200,000 eggs (Moyle 2002).	
nest construction	Location and general description of nest -- substrates, aquatic plants, excavations, crevices, habitat types, etc.	White sturgeon are not nest builders (Pacific States Marine Fisheries Commission 1996).	
nest size	Size and average dimensions of the nest.		
spawning process	Indicate whether nest builder, broadcast spawner, or other.	White sturgeon are reportedly broadcast spawners (Pacific States Marine Fisheries Commission 1996).	
spawning substrate size/characteristics	Range of substrates used during spawning (e.g. mud, sand, gravel, boulders, beds of aquatic plants). Indicate presence of plant/wood debris, crevices at spawning sites. If gravel, indicate range of average size.	In the Columbia River, most white sturgeon eggs were reportedly observed over cobble and boulder substrates, although some eggs were also observed over sand, gravel and bedrock (Parsley et al. 1993). Generally, white sturgeon spawning occurs over deep gravel riffles or in deep holes with swift currents over rock bottoms	

Preliminary Information – Subject to Revision – For Collaborative Process Purposes Only

Matrix Of Life History and Habitat Requirements for Feather River Fish Species – White Sturgeon
Oroville Facilities P-2100 Relicensing

Element	Element Descriptor	General	Feather River specific
		(Moyle 2002).	
preferred spawning substrate	Indicate preferred spawning substrate (e.g. mud, sand, gravel, boulders, plant bed, etc).	<p>In the Columbia River, white sturgeon reportedly spawn over cobble in impoundments and over boulders in the lower river (Parsley et al. 1993).</p> <p>In spawning areas of the Sacramento River, white sturgeon reportedly utilize gravel substrates (Moyle 2002).</p> <p>White sturgeon reportedly spawn over rocky substrates (Pacific States Marine Fisheries Commission 1996).</p>	
water temperature tolerance for spawning	Range of water temperatures allowing survival. Indicate stressful or lethal levels.		
water temperature preference for spawning	Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation.	<p>Suitable water temperatures for white sturgeon spawning in California reportedly are 46.4°F-66.2°F (8°C-19°C); peak spawning reportedly occurs at water temperatures of approximately 57.2°F (14°C) (Moyle 2002).</p> <p>In the lower Columbia River, white sturgeon spawning reportedly was observed in water temperatures of 50°F-64.4°F (10°C-18°C). In the impoundments of the Columbia River, white sturgeon spawning was reportedly observed in water temperatures of 53.6°F-64.4°F (12°C-18°C). Most spawning reportedly occurs in water temperatures of approximately 57.2°F (14°C) in the river and associated impoundments (Parsley et al. 1993).</p> <p>In the Sacramento River, white sturgeon spawning reportedly occurred in water temperatures of 46°F-64°F (7.8°C-17.8°C). Maximum spawning reportedly occurred at approximately 58°F (14.4 °C) (Kohlhorst 1976).</p> <p>Suitable water temperatures for white sturgeon spawning reportedly are 53.6°F-59°F (12°C-15°C) (Wang 1986).</p> <p>The reported optimal water temperature for white sturgeon spawning is 55.9°F (13.3°C) (Gadomski et al. 2002).</p>	
water velocity range for	Minimum and maximum speed of water current the spawning fish can	In the lower Columbia River, white sturgeon spawning reportedly was observed at water column velocities of 3.3-9.2	

Preliminary Information – Subject to Revision – For Collaborative Process Purposes Only

Matrix Of Life History and Habitat Requirements for Feather River Fish Species – White Sturgeon
Oroville Facilities P-2100 Relicensing

Element	Element Descriptor	General	Feather River specific
spawning	tolerate.	<p>ft/s (1.0–2.8 m/s) and velocities near the substrate of 2-7.9 ft/s (0.60–2.40 m/s) (Parsley et al. 1993).</p> <p>In impoundments of the Columbia River, white sturgeon spawning reportedly was observed at water column velocities of 2.7-6.9 ft/s (0.81–2.1m/s) and velocities near the substrate of 1.7-5.3 ft/s (0.52–1.62 m/s) (Parsley et al. 1993).</p> <p>In the Columbia River, white sturgeon spawning reportedly occurs at water velocities of 2-7.9 ft/s (0.6-2.4m/s) (Moyle 2002).</p> <p>In the Sacramento River, there was no obvious flow threshold at which white sturgeon spawning occurred (Kohlhorst 1976).</p> <p>White sturgeon are reported to spawn in swift currents, near rapids (Pacific States Marine Fisheries Commission 1996).</p>	
water velocity preference for spawning	Preferred water current (flow velocity) during spawning.	<p>In the lower Columbia River, most white sturgeon spawning reportedly was observed at a water column velocity of 6.9 ft/s (2.1 m/s) and a velocity near the substrate of 4.6 ft/s (1.4 m/s) (Parsley et al. 1993).</p> <p>In impoundments of the Columbia River, most white sturgeon spawning was reportedly observed at water column velocity of 4.8 ft/s (1.46 m/s) and a velocity near the substrate of 3.4 ft/s (1.04 m/s) (Parsley et al. 1993).</p>	
water depth range for spawning	Reported range of observed (minimum and maximum) water depth utilization.	<p>In the lower Columbia River, white sturgeon spawning was reportedly observed at depths of 13.1-75.5 ft (4–23 m) (Parsley et al. 1993).</p> <p>In impoundments of the Columbia River, white sturgeon spawning was reportedly observed at depths of 13.1-78.7 ft (4–24 m) (Parsley et al. 1993).</p> <p>In the lower Sacramento River white sturgeon eggs were reportedly collected at a depth of 32.8 ft (10 m) (Wang 1986).</p>	
water depth preference for spawning	Reported range of most frequently observed water depth utilization.	In the lower Columbia River, most white sturgeon spawning was reportedly observed at depths of 19.7 ft (6 m) (Parsley et al. 1993).	

Preliminary Information – Subject to Revision – For Collaborative Process Purposes Only

Matrix Of Life History and Habitat Requirements for Feather River Fish Species – White Sturgeon
Oroville Facilities P-2100 Relicensing

Element	Element Descriptor	General	Feather River specific
		<p>In impoundments of the Columbia River, most white sturgeon spawning was reportedly observed at depths of 36.1 ft (11 m) (Parsley et al. 1993).</p>	
<p>range for spawning timing</p>	<p>Earliest and latest time of season or year in which spawning occurs.</p>	<p>In the Columbia River, white sturgeon spawning reportedly coincides with peak flows during spring and early summer (Parsley et al. 1993).</p> <p>Conditions favorable for white sturgeon spawning in the Columbia River reportedly occurred from April through July (Counihan et al. 1999).</p> <p>White sturgeon spawning in the Columbia River system reportedly occurs from April through July (Parsley et al. 1993).</p> <p>In the Sacramento River, white sturgeon spawning reportedly occurs from mid-February to late May (Kohlhorst 1976).</p> <p>White sturgeon spawner aggregations in Lake Roosevelt occurred from early spring to mid-summer (Brannon and Sutter 1992).</p> <p>In California, white sturgeon spawning reportedly occurs between late February and early June (Moyle 2002).</p> <p>In the Sacramento River, white sturgeon eggs reportedly were collected in April and May (Wang 1986).</p>	
<p>peak spawning timing</p>	<p>Time of year most fish start to spawn.</p>	<p>In the Sacramento River, white sturgeon spawning was reportedly most intense during March and April (Kohlhorst 1976).</p> <p>In the Columbia River system, reported optimal spawning conditions for white sturgeon reportedly occurred in mid-May (Gadomski et al. 2002)</p> <p>White sturgeon reportedly most commonly spawn from May through June (Pacific States Marine Fisheries Commission 1996).</p>	

Matrix Of Life History and Habitat Requirements for Feather River Fish Species – White Sturgeon
Oroville Facilities P-2100 Relicensing

Element	Element Descriptor	General	Feather River specific
spawning frequency (iteroparous/semelparous)	Semelparous - producing all offspring at one time, such as in most salmon. Usually these fish die after reproduction. Iteroparous - producing offspring in successive, e.g., annual or seasonal batches, as is the case in most fishes.	Male white sturgeon reportedly spawn every 1-2 years, but females wait 2-4 years between spawns (Moyle 2002). White sturgeon reportedly spawn every 4-11 years (Pacific States Marine Fisheries Commission 1996).	
Incubation/early development			
egg characteristics	Shape, size, color, in clusters or individuals, stickiness, and other physical attributes.	White sturgeon eggs reportedly are adhesive and stick to the substrate (Moyle 2002). White sturgeon eggs reportedly are spherical, oval or slightly irregular, slate gray in color, whitish in color at the pole, and 0.1-0.2 inches (3.3 mm-4.0 mm) in diameter (Wang 1986).	
water temperature tolerance for incubation	Range of water temperatures allowing survival. Indicate stressful or lethal levels.	Elevated mortality reportedly occurred among developing white sturgeon embryos incubated at 64.4°F (18°C), and complete mortality reportedly occurred in embryos incubated at 68°F (20°C). (Parsley et al. 1993).	
water temperature preference for incubation	Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation.	The median water temperature at which spawning occurred in the Columbia River [i.e., 57.2°F (14°C)] is reported as the optimal water temperature for white sturgeon egg development (Parsley et al. 1993).	
time required for incubation	Time duration from fertilization to hatching. Note: Indicate at which temperature range. Incubation time is temperature-dependent.	White sturgeon larvae reportedly hatch in 4-12 days, depending on water temperature. Eggs reportedly hatch in a little more than 4 days at 60.8°F (16°C) or in 8-12 days at 53.6°F (12°C) (Wang 1986). White sturgeon eggs reportedly can hatch in 4 days to 2 weeks depending on water temperature (Pacific States Marine Fisheries Commission 1996).	
size of newly hatched larvae	Average size of newly hatched larvae.	White sturgeon larvae reportedly are 0.3-0.8 inches (7.5 and 19.5 mm) in length (Kohlhorst 1976). In Sacramento-San Joaquin river, newly hatched larvae reportedly measure 0.4 inches (11.0 mm) in length (Wang 1986).	
time newly hatched larvae	Time of year of hatching, and duration between hatching and	White sturgeon larvae reportedly remain in gravel for 7-10 days (Moyle 2002).	

Preliminary Information – Subject to Revision – For Collaborative Process Purposes Only

Matrix Of Life History and Habitat Requirements for Feather River Fish Species – White Sturgeon
Oroville Facilities P-2100 Relicensing

Element	Element Descriptor	General	Feather River specific
remain in gravel	emergence from gravel.	Under laboratory conditions, white sturgeon larvae reportedly hatch in approximately 12 days (Parsley et al. 1993).	
other characteristics of larvae	Alevin -- early life history phase just after hatching (larva) when yolk-sac still present.	In a laboratory experiment, newly hatched white sturgeon larvae reportedly swam towards the surface and remained in the water column for a length of time that was inversely related to water velocity. The larvae reportedly then sought cover in or on the substrate and appeared to be photophobic. This "hiding" phase lasted until the yolk was absorbed, which reportedly occurred approximately 12 days after hatch (Parsley et al. 1993). White sturgeon larvae are initially pelagic; reportedly becoming demersal when pectoral fins are fully developed (Wang 1986). When yolk sacs are still present, white sturgeon larvae reportedly swim vertically and drift downstream towards the estuary. The yolk sac is reportedly absorbed in 7-10 days, and the larvae begin actively feeding from the bottom (Wang 1986).	
timing range for emergence	Time of year (earliest-latest) hatchlings (larvae and alevins) leave or emerge from the nesting/hatching (gravel) sites.	White sturgeon larvae reportedly emerge from gravel from June through November (Parsley et al. 1993).	
timing peak for emergence	Time of year most hatchlings emerge.		
size at emergence from gravel	Average size of hatchlings at time of emergence.		
Juvenile rearing			
general rearing habitat and strategies	General description of freshwater environment and rearing behavior.		
water temperature tolerance for juvenile rearing	Range of water temperatures allowing survival. Indicate stressful or lethal levels.		
water temperature preference for juvenile rearing	Range of suitable, preferred, or reported optimal water temperatures. Indicate whether	64.4°F (18°C) is reported as the preferred water temperature for rearing white sturgeon (Moyle 2002).	

Preliminary Information – Subject to Revision – For Collaborative Process Purposes Only

Matrix Of Life History and Habitat Requirements for Feather River Fish Species – White Sturgeon
Oroville Facilities P-2100 Relicensing

Element	Element Descriptor	General	Feather River specific
	literature, observational, or experimental derivation.		
water velocity ranges for rearing juveniles	Reported range of observed (minimum and maximum) water velocity utilization.	Juvenile white sturgeon in the Columbia River system (including impoundments) were reportedly collected in water column velocities and near-substrate velocities of 0.3-3.9 ft/s (0.1-1.2) and 0.2-2.6 ft/s (0.06-0.8 m/s), respectively (Parsley et al. 1993).	
water velocities preferred by rearing juveniles	Reported range of most frequently observed water velocity utilization.	Juvenile white sturgeon in the Columbia River system (including impoundments) were reportedly collected in median water column velocities and near-substrate velocities of 2.0-2.1 ft/s (0.61-0.65 m/s) and 1.2-2.0 ft/s (0.37-0.6 m/s), respectively (Parsley et al. 1993).	
water depth range for juvenile rearing	Reported range of observed (minimum and maximum) water depth utilization.	Juvenile white sturgeon in the Columbia River system (including impoundments) reportedly were collected in water depths of 6.6-190 feet (2-58 m) (Parsley et al. 1993).	
water depth preference for juvenile rearing	Reported range of most frequently observed water depth utilization.	Juvenile white sturgeon in the Columbia River system (including impoundments) reportedly were collected in median water depths of 52.5-62.3 feet (16-19 m) (Parsley et al. 1993). Juvenile white sturgeon were reportedly most often captured within the thalweg (deepest part of the river or stream channel) (Parsley et al. 1993).	
cover preferences for rearing juveniles	Type of cover for protection from predators used by rearing juveniles (e.g. crevices, submerged aquatic vegetation, overhanging vegetation, substrate cover, undercover bank, small woody debris, large woody debris).		
food base of juveniles	Indicate primary diet components. Also indicate the diet changes, if any, as growth occurs.	Young white sturgeon reportedly feed mostly on crustaceans, and as they grow their diet becomes more varied (Moyle 2002). Small white sturgeon reportedly feed mainly on chironomids, but also take small crustaceans, other insects, and mollusks (Froese 2003). Young white sturgeon reportedly feed on algae and aquatic insects (Pacific States Marine Fisheries Commission 1996).	

Preliminary Information – Subject to Revision – For Collaborative Process Purposes Only

Matrix Of Life History and Habitat Requirements for Feather River Fish Species – White Sturgeon
Oroville Facilities P-2100 Relicensing

Element	Element Descriptor	General	Feather River specific
		Juvenile white sturgeon reportedly feed on mysid shrimp, amphipods, small clams, polychaetes, and fish eggs (Wang 1986).	
feeding habits of rearing juveniles	Indicate whether plankton eater, algae eater, bottom feeder, piscivorous, active hunter, ambush predator, filter feeder. Night, day, dusk or dawn feeder. Also indicate change of feeding habits growth occurs.	Juvenile white sturgeon feeding is reportedly concentrated during the night (Wang 1986).	
predation of juveniles	Indicate which species prey on juveniles.	Channel catfish, northern pikeminnow, and prickly sculpin reportedly are predators of white sturgeon (Gadomski et al. 2002).	
timing range for juvenile rearing	Range of time of year (months) during which rearing occurs.		
timing peak for juvenile rearing	Time of year (months) during which most rearing occurs.		
Juvenile emigration			
time spent in fresh water prior to emigrating	Duration (in years and/or months) from emergence to emigration to the ocean.		
water temperature tolerances during emigration	Range of water temperatures allowing survival. Indicate stressful or lethal levels.		
water temperature preferences during emigration	Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation.		
emigration timing range	Time of year juveniles commence emigration and duration of emigration.		
emigration timing peak	Time of year most juveniles are emigrating.		
size range of juveniles during emigration	Minimum and maximum sizes (inches or mm) of emigrating juveniles. Indicate average size.		

Preliminary Information – Subject to Revision – For Collaborative Process Purposes Only

Matrix Of Life History and Habitat Requirements for Feather River Fish Species – White Sturgeon
Oroville Facilities P-2100 Relicensing

Element	Element Descriptor	General	Feather River specific
Other potential factors			
DO	Levels of dissolved oxygen in water expressed in mg/l tolerated by fish.		
pH	Alkalinity/acidity of water (expressed in pH) that fish can tolerate.		
turbidity	Indicate turbidity or state of water (e.g., clear water or presence of siltation or organic/inorganic matter in water) that fish can tolerate.		
factors contributing to mortality	e.g. fishing/angling mortality, drastic habitat alterations, unfavorable climatic changes, etc.	<p>In the San Francisco Bay estuary, white sturgeon spawning success reportedly varies from year to year such that the white sturgeon population tends to be dominated by a few strong year classes. Large year classes are reportedly associated with high outflows through the San Francisco Bay estuary in spring. This relationship may result from larval white sturgeon being moved quickly downstream to suitable rearing areas, where food is abundant and the probability of entrainment is low. Higher river flows also may stimulate larger numbers of sturgeon to spawn (Moyle 2002).</p> <p>In the Columbia River system, factors associated with the decline of white sturgeon populations reportedly include over-fishing and hydropower facility installation, which results in habitat alterations (Gadomski et al. 2002).</p> <p>Because of its long life span, white sturgeon tend to concentrate pollutants in their flesh. Bioaccumulation of PCBs and other contaminants reportedly inhibit sturgeon growth and decrease egg and larval survival (Pacific States Marine Fisheries Commission 1996).</p> <p>Dams negatively impact white sturgeon by creating landlocked populations and destroying spawning grounds by altering water flow (Pacific States Marine Fisheries Commission 1996).</p>	

References

- Brannon, E. and A. Sutter. 1992. Movements of White Sturgeon in Lake Roosevelt, Final Report 1988-1991. Project No. 89-44.
- Counihan, T. D., M. J. Parsley, D. G. Gallion, C. N. Frost, and M. N. Morgan. 1999. Report C *in* Effects of Mitigative Measures on Productivity of White Sturgeon Populations in the Columbia River Downstream from McNary Dam, and Determine the Status and Habitat Requirements of White Sturgeon Populations in the Columbia and Snake Rivers Upstream from McNary Dam, Annual Progress Report, April 1997-March 1998. Ward, D. L. (ed.), Portland, Oregon: Bonneville Power Administration, pp 94-129.
- CRI Staff. nd. Columbia River Investigations, White Sturgeon Mitigation and Restoration in the Columbia and Snake Rivers Upstream From Bonneville Dam. Available at <http://www.dfw.state.or.us>. Accessed on September 20, 2003.
- DFG. 2002. State and Federally Listed Endangered and Threatened Animals of California. California Natural Diversity Database. DFG, Habitat Conservation Division, Wildlife and Habitat Data Analysis Branch.
- Froese, R. nd. *Acipenser Transmontanus* - White Sturgeon. Available at www.fishbase.org. Accessed on August 11, 2003.
- Gadomski, D. M., M. J. Parsley, D. G. Gallion, and P. Kofoot. 2002. Report C *in* White Sturgeon Mitigation and Restoration in the Columbia and Snake Rivers Upstream from Bonneville Dam, Annual Progress Report 2001. Ward, D. L. (ed.), Portland, OR: Bonneville Power Administration, pp 48-113.
- Kohlhorst, D. W. 1976. Sturgeon Spawning in the Sacramento River in 1973, As Determined by Distribution of Larvae. California Fish and Game 62:33-40.
- Moyle, P. B. 2002. Inland Fishes of California. Berkeley: University of California Press.
- Pacific States Marine Fisheries Commission. nd. Anadromous Fish Life History Profiles. Available at http://www.psmfc.org/habitat/edu_anad_table.html. Accessed on January 16, 2003.
- Parsley, M. J., L. G. Beckman, and G. T. McCabe. 1993. Spawning and Rearing Habitat Use by White Sturgeons in the Columbia River Downstream From McNary Dam. Transactions of the American Fisheries Society 122:217-227.

Wang, J. C. S. 1986. Fishes of the Sacramento-San Joaquin Estuary and Adjacent Waters, California: A Guide to the Early Life Histories. IEP Technical Report No. 9. California Department of Water Resources, California Department of Fish and Game, U.S. Bureau of Reclamation, and U.S. Fish and Wildlife Service.