

**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**

**SPLITTAIL**

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



**APRIL 2004**

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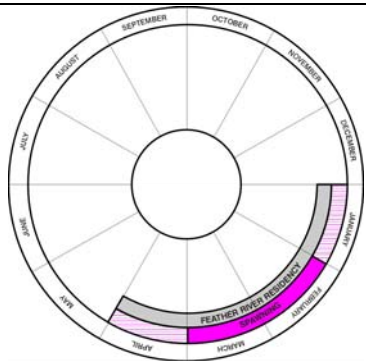
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Matrix Of Life History and Habitat Requirements for Feather River Fish Species - Splittail  
Oroville Facilities P-2100 Relicensing

| Element             | Element Descriptor  | General  | Feather River Specific   |
|---------------------|---|--|--|
| <b>General</b>      |   |  |  |
| Common name (s)     | English name (usually used by fishers and laypeople).                                 | Sacramento splittail   |  |
| Scientific name (s) | Latin name (referenced in scientific publications).                                   | The scientific name of Sacramento splittail is <i>Pogonichthys macrolepidotus</i> (Moyle 2002).<br><br>The Sacramento splittail is the only member of its genus; a second species, <i>P. ciscoides</i> , is now extinct (USFWS 1995b).   |  |
| Taxonomy (family)   | Common name of the family to which they belong. Also indicate scientific family name. | Sacramento splittail belong to the <i>Cyprinidae</i> (i.e., minnow) family (Moyle 2002).   |  |
| Depiction           | Illustration, drawing or photograph.  |    |    |
| Range               | Broad geographic distribution, specifying California distribution, as available.      | Sacramento splittail were historically found as far north as Redding, California, but are no longer found in this area (USFWS 1995b).<br><br>Sacramento splittail have been collected from the Merced River at Livingston and from the San Joaquin River at Fort Miller. There are reported catches from the southern San Francisco Bay and at the mouth of Coyote Creek in Santa Clara County, but recent surveys indicate that | In wet years, Sacramento splittail may migrate up the Sacramento River as far as the Red Bluff Diversion Dam and into the lower Feather and American rivers (Moyle 2002).<br><br>Sacramento splittail enter the lower reaches of the Feather River on occasion, and records indicate that they had been collected as far upstream as Oroville (USFWS 1995b). |

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|                      |  | <p>splittail are no longer present in these locations (USFWS 1995b).</p> <p>On the San Joaquin River, Sacramento splittail may be found as far as Salt Slough (Moyle 2002).</p> <p>In most years, Sacramento splittail are reportedly confined to the Delta, Suisun Bay, Suisun March, lower Napa River, and lower Petaluma River (Moyle 2002).</p> <p>Important Sacramento splittail spawning areas reportedly include Sutter and Yolo Bypasses on the Sacramento River and also the Tuolumne River (Moyle 2002).</p> <p>Except when spawning, Sacramento splittail reportedly are largely absent from the Sacramento River (USFWS 1995b).</p> | <p>Captures of larval Sacramento splittail indicate that an important spawning area may be in the Sacramento River between the mouths of the American and Feather rivers (USFWS 1995b).</p> |
| Native or introduced | If introduced, indicate timing, location, and methods.   | Sacramento splittail are endemic to California (Moyle 2002).  |   |
| 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. | <p>Sacramento splittail was listed as a threatened species (FT) in February 1999 by the U.S. Fish and Wildlife Service (Moyle 2002).</p> <p>On September 22, 2003, the U.S. Fish and Wildlife Service removed the Sacramento splittail from its list of threatened species (USFWS 2003).</p>  |   |

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| 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. | Sacramento splittail are native to California and their status is threatened (Moyle 2002).<br><br>On September 22, 2003, the U.S. Fish and Wildlife Service removed the Sacramento splittail from its list of threatened species (USFWS 2003).  |                        |
| Economic or recreational value      | Indicate whether target species sought for food or trophy. Whether desirable by recreational fishers, commercial fishers, or both.   | A small sport fishery reportedly exists for Sacramento splittail (Wang 1986).<br><br>Anglers fish for Sacramento splittail in order to use them as bait for striped bass (Moyle 2002).  |                        |
| Warmwater or coldwater              | Warmwater if suitable temperature range is similar to basses; coldwater if suitable temperature range is similar to salmonids.   | Sacramento splittail is a warmwater fish (Wang 1986).   |                        |
| Pelagic or littoral                 | Environment: Pelagic - living far from shore; Littoral - living near the shore.  | Sacramento splittail are reportedly entirely pelagic during the day (Sommer et al. 2002).   |                        |
| Bottom or water column distribution | Environment: bottom (benthic) or along water column.   | Within the Yolo Bypass, 51% of all splittail observations were made in benthic areas at night (Sommer et al. 2002).   |                        |
| Lentic or lotic                     | Environment: Lentic - pertaining to stagnant water, or lake-like; Lotic - moving water, or river-like.   | Sacramento splittail reportedly prefer slow-moving sections of rivers and sloughs (Young and Cech 1996).  |                        |
| <b>Adults</b>                       |  |   |                        |
| Life span                           | Approximate maximum age obtained.  | The reported life span of Sacramento splittail is 5 to 7 years, although larger fish may live to be 8 years old or older (Moyle 2002). The reported life span of the Sacramento splittail species is approximately five years (Caywood 1974).<br><br>The reported life span of Sacramento |                        |

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|              |  | <p>splittail is 5 to 7 years (Caywood 1974; Meng and Moyle 1995).</p> <p>Sacramento splittail commonly live to five years of age (Sommer et al. 1997).</p>   |                        |
| Adult length | Indicate: Length at which they first reproduce; average length and maximum length the fish can attain. | <p>Adult Sacramento splittail measure approximately 4.3 inches (110 millimeters) at the end of their first year, 6.7 inches (170 millimeters) at the end of their second year, 8.5 inches (215 millimeters) at the end of their third year, and grow about 1.4 inches per year (35 millimeters per year) thereafter. Sacramento splittail reportedly can reach over 15.7 inches (40 centimeters) in length (Moyle 2002).</p> <p>Males and females are often mature by the end of their second winter, with minimum lengths of 7.1 to 7.9 inches (180-200 mm) (Daniels and Moyle 1983); occasionally males may mature by the end of their first year and females by the end of their third year (USFWS 1995b).</p> <p>Sacramento splittail can reportedly reach over 11.8 inches (300 millimeters) in length (USFWS 1995b).</p> |                        |
| Adult weight | Indicate: Weight at which they first reproduce; average weight and maximum weight the fish can attain. | <p>Adult splittail were reported to weigh anywhere from 0.47 pounds (211 grams), as observed in Sherman Lake, California to 1.6 pounds (744 grams), as observed at Clifton Court Forebay, California (Feyrer 1998).</p> <p>Splittail adults collected from Suisun Marsh, California for a series of lab studies reportedly weighed 0.18 pounds</p>   |                        |

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|                                  |  | (80 grams) to 0.44 pounds (200 grams) (Young and Cech 1996).  |                        |
| Physical morphology              | General shape of the fish: elongated, fusiform, laterally compressed, etc. | <p>Sacramento splittail have an enlarged upper lobe of the tail, tiny barbells at the corners of the slightly subterminal mouth, a small head, and an elongated body (Moyle 2002).</p> <p>Sacramento splittail have pharyngeal teeth, which are hooked and have narrow grinding surfaces (USFWS 1995b).</p> <p>Adult Sacramento splittail reportedly develop a nuchal hump (USFWS 1995b).</p> |                        |
| Coloration                       | Indicate color, and color changes, if any, during reproduction phase.      | Sacramento splittail are silvery on their sides and become duller in color as they grow larger, and their back is usually dusky olive gray (Moyle 2002). During the breeding season, Sacramento splittail fins are tinged with red-orange and males become a darker color (Moyle 2002).   |                        |
| Other physical adult descriptors | Unique physical features for easy identification.                          | <p>Sacramento splittail have a distinctive tail (Moyle 2002).</p> <p>The upper lobe of the caudal fin on a Sacramento splittail is larger than the lower lobe (USFWS 1995b).</p>  |                        |
| Adult food base                  | Indicate primary diet components.  | <p>Sacramento splittail reportedly feed on bottom invertebrates in areas of low to moderate currents, and on earthworms in flooded areas (Moyle 2002).</p> <p>Detrital material reportedly makes up a high percentage of the stomach contents of Sacramento splittail (Moyle 2002).</p> <p>In the Suisun Marsh, Sacramento splittail reportedly forage extensively on opossum</p>             |                        |

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|   |   | <p>shrimp, benthic amphipods, and harpacticoid copepods. In the Delta, Sacramento splittail reportedly feed opportunistically on clams, crustaceans, insect larvae, and other invertebrates (Moyle 2002).</p> <p>Sacramento splittail reportedly feed extensively on opossum shrimp and detrital material, and feed opportunistically on earthworms, clams, insect larvae, and other invertebrates (USFWS 1995b).</p> |                        |
| Adult feeding habits                          | Indicate whether plankton eater, algae eater, bottom feeder, piscivorous, active hunter, ambush predator, filter feeder. Night, day, dusk or dawn feeder.   | <p>Sacramento splittail are diurnal feeders, with the most intense feeding occurring in the early morning (Moyle 2002).</p> <p>Sacramento splittail are benthic foragers (Meng and Moyle 1995).</p>   |                        |
| 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. |   |                        |
| <b>Adult upstream migration (immigration)</b> |   |   |                        |
| Range of adult upstream migration timing      | Time of year adults migrate upstream. If applicable, indicate for various runs.   | <p>Adult Sacramento splittail reportedly show gradual upstream movement during the winter and spring months to forage and spawn in flooded areas (Moyle 2002).</p> <p>Studies indicate that Sacramento splittail</p>  |                        |

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|   |   | <p>migrate upriver to spawn in freshwater from January through April (Meng and Moyle 1995).</p> <p>Adult Sacramento splittail reportedly undertake an annual upstream spawning migration from the estuary in late autumn and winter (Sommer et al. 1997).</p>   |                        |
| Peak adult upstream migration timing                  | Time of year most adults migrate upstream. If applicable, indicate for various runs.  | In 1998-99, four adult spawning migration pulses were indicated by peaks in upstream movements that reportedly occurred in mid-December, late January, early February, and late February (Garman and Baxter 1999 <i>in</i> Moyle et al. 2003).  |                        |
| 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. | Ripe splittail have been observed in association with cool temperatures (i.e., <15°C) (Moyle unpublished data <i>in</i> Moyle et al. 2003).   |                        |
| <b>Adult holding (freshwater residence)</b>           |   |   |                        |
| Water temperature tolerance for holding adults        | Range of water temperatures allowing survival. Indicate stressful or lethal levels.   | <p>Sacramento splittail are typically found in temperatures between 41°F and 75.2°F (5°C and 24°C). However, fish acclimated to higher temperatures [84.2°F to 91.4°F (29°C to 33°C)] reportedly can survive rapid changes in water temperature for short periods of time (Moyle 2002).</p> <p>In laboratory studies conducted at the University of California at Davis, mean critical thermal minima (CT<sub>min</sub>) and maxima (CT<sub>max</sub>) for age-2 fish was 44.6°F and 84.2°F (7.0°C and 29.0°C),</p> |                        |

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|   |  | <p>respectively (Young and Cech 1996).</p> <p>Female Sacramento splittail held in indoor tanks at constant temperatures of 18°C reportedly did not mature (Bailey et al. 2000 <i>in</i> Moyle et al. 2003).</p>  |                        |
| Water temperature preference for holding adults | Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental.                  | <p>Sacramento splittail are typically found in water temperatures between 41°F and 75.2°F (5°C and 24°C) (Moyle 2002).</p> <p>In laboratory studies conducted at the University of California at Davis, the final water temperature preference for age-2 fish was 66.2°F (19°C) (Young and Cech 1996).</p>         |                        |
| Water depth range for holding adults            | Reported range of observed (minimum and maximum) water depth utilization.  | Larger splittail adults in the Yolo Bypass tended to aggregate in the deeper areas of the wetland (Sommer et al. 2002).  |                        |
| Water depth preference for holding adults       | Reported range of most frequently observed water depth utilization.  | Field studies indicate that Sacramento splittail prefer a shallow water habitat of less than or approximately 22 feet (6.7 meters) (Meng and Moyle 1995).  |                        |
| 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. | <p>Shallow dead-end sloughs of the marsh lined with tules and reeds may provide rich feeding grounds and refuge from predators for Sacramento splittail (Meng and Moyle 1995).</p> <p>Flooded terrestrial habitat can provide abundant food for pre-spawning Sacramento splittail adults (Sommer et al. 1997).</p> |                        |
| Water velocity range for holding adults         | Reported range of observed (minimum and maximum) water velocity utilization.   | In laboratory studies, the range of velocities that Sacramento splittail holding adults were able to tolerate was reported as 30.5 to 91.3 cm/sec (Young and Cech 1996).   |                        |
| Water velocity preference                       | Reported range of most   |  |                        |

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| for holding adults                               | frequently observed water velocity utilization.   |   |                        |
| 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.). | <p>Sacramento splittail reportedly prefer low-salinity, shallow-water habitats (Meng and Moyle 1995).</p> <p>Sacramento splittail are primarily freshwater fish, but reportedly are tolerant of moderate salinities and can live in water with salinities of 10 to 18 parts per thousand (USFWS 1995b).</p> <p>Sacramento splittail tend to be most abundant where other native fishes are abundant as well (USFWS 1995b).</p>  |                        |
| Timing range for adult holding                   | Time of year (earliest-latest) and duration of stay from upstream migration to spawning.  | <p>Sacramento splittail may migrate upstream to spawn (Meng and Moyle 1995).</p> <p>Adult Sacramento splittail within the Sacramento-San Joaquin estuary were salvaged more often between January and April, than in later months (Meng and Moyle 1995).</p> <p>Adult Sacramento splittail sampling was reportedly conducted in Sutter Bypass and the main channels of the Sacramento, Feather, Cosumnes, and Mokelumne rivers during the months of March through May (Sommer et al. 1997).</p> |                        |
| Timing peak for adult holding                    | Time of year when maximum number of adults are present before spawning.   | <p>Sacramento splittail may migrate upstream to spawn (Meng and Moyle 1995).</p> <p>Survey samples taken at Chipps Island, California reported that most adult Sacramento splittail were present during</p>   |                        |

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|   |   | the months of May through June; adult peak abundance at the Suisun Marsh, California was reportedly during December through January (Sommer et al. 1997).  |                        |
| <b>Spawning</b>                         |   |  |                        |
| Fecundity                               | Average or range in the number of eggs females lay in a spawning season.  | <p>Sacramento splittail are reported to typically lay between 5,000 and 100,800 eggs (Wang 1986).</p> <p>The largest Sacramento splittail females reportedly can lay over 100,000 eggs (Moyle 2002).</p> <p>Of 20 sampled Sacramento splittail over 6.9 inches (175 millimeters) in length, fecundity ranged from 17,500 to 266,000 eggs (Daniels and Moyle 1983).</p> |                        |
| Nest construction                       | Location and general description of nest -- substrates, aquatic plants, excavations, crevices, habitat types, etc.  | Sacramento splittail reportedly construct spawning nests in shallow, weedy areas (Wang 1986).  |                        |
| Nest size                               | Size and average dimensions of the nest.  |  |                        |
| Spawning process                        | Indicate whether nest builder, broadcast spawner, or other.   | Fertilized Sacramento splittail eggs stick to submerged vegetation and debris until hatching (Moyle 2002).   |                        |
| 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. | <p>Sacramento splittail reportedly spawn in flooded river beds and in areas with submerged vegetation (Wang 1986).</p> <p>It is possible that Sacramento splittail spawn on vegetation (Daniels and Moyle 1983).</p> <p>Sacramento splittail reportedly spawn on submerged vegetation in flooded areas (USFWS 1995b).</p>  |                        |

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| Preferred spawning substrate              | Indicate preferred spawning substrate (e.g. mud, sand, gravel, boulders, plant bed, etc).  | <p>Sacramento splittail reportedly prefer to spawn in areas of flooded vegetation (Moyle 2002).</p> <p>Sacramento splittail reportedly prefer to spawn in areas having aquatic vegetation, in streams or river beds, and along banks (Caywood 1974).</p>   |                        |
| Water temperature tolerance for spawning  | Range of water temperatures allowing survival. Indicate stressful or lethal levels.  | <p>The onset of Sacramento splittail spawning reportedly is associated with increasing water temperatures of 57.2°F to 66.2°F (14°C to 19°C)] (Moyle 2002).</p> <p>Splittail within the Yolo Bypass floodplain, California reportedly spawn at a water temperature range of 51.8°F to 75.2°F (11°C to 24°C) (Sommer et al. 2002).</p>  |                        |
| Water temperature preference for spawning | Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation. | Sacramento splittail reportedly prefer to spawn in water temperatures ranging from 48.2°F to 68°F (9°C to 20°C) (Caywood 1974).  |                        |
| Water velocity range for spawning         | Minimum and maximum speed of water current the spawning fish can tolerate.   | <p>Successful reproduction of Sacramento splittail is reportedly strongly associated with high outflows preceding, during, and following spawning (USFWS 1995b).</p> <p>Under certain conditions, Sacramento splittail used the Suisun Marsh for spawning; high outflow in April 1995 coincided with their spawning time (Meng and Matern 2001).</p> <p>Species that spawn outside of the Suisun Marsh reportedly also benefit from intermediate to high flows (Meng and Matern 2001).</p> |                        |

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|  |   | Sacramento splittail catches were reportedly confined within the San Francisco Estuary mostly to 1995, a year when high flows peaked during their spawning season in March and April (Meng and Matern 2001).   |                        |
| Water velocity preference for spawning | Preferred water current (flow velocity) during spawning.                  | Spawning areas are characterized by the presence of flowing water, with low water temperature and water clarity (Moyle, unpublished data <i>in</i> (Moyle et al. 2003).  |                        |
| Water depth range for spawning         | Reported range of observed (minimum and maximum) water depth utilization. | Observations of Sacramento splittail spawning by Moyle et al. (2001) have reported spawning depths of less than 4.9 feet (1.5 meters) in the Cosumnes River floodplain; spawning reportedly occurred at depths of less than 6.6 feet (2 meters) in Sutter Bypass (USFWS 2003).<br><br>Sacramento splittail reportedly spawn on terrestrial vegetation and debris on floodplains that are inundated by spring high flows, typically at depths between 1.6 and 6.6 feet (0.5 and 2 meters) (Moyle 2002). |                        |
| Water depth preference for spawning    | Reported range of most frequently observed water depth utilization.       | Observations on the Cosumnes floodplain indicate that spawning fish move into open areas <1.5m deep that have dense growths of annual terrestrial plants (Moyle et al. 2003).  |                        |
| Range for spawning timing              | Earliest and latest time of season or year in which spawning occurs.      | Sacramento splittail spawning can occur anytime from late February to early July (Moyle 2002).<br><br>Sacramento splittail spawning reportedly occurs from late April to early May in the marsh (Daniels and Moyle 1983).<br><br>The onset of Sacramento splittail   |                        |

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|  |   | <p>spawning may be associated with increasing water temperature and day length, and reportedly occurs between early March and May in the upper Delta (USFWS 1995b).</p> <p>In the tidal freshwater and euryhaline habitats of the Sacramento-San Joaquin estuary, Sacramento splittail spawning reportedly occurs by late January and early February and continues through July (Wang 1986).</p> |                        |
| Peak spawning timing                         | Time of year most fish start to spawn.  | The most frequent Sacramento splittail spawning reportedly occurs in March and April (Moyle 2002).   |                        |
| Spawning frequency (iteroparous/semelparous) | <p>Semelparous - producing all offspring at one time, such as in most salmon. Usually these fish die after reproduction.</p> <p>Iteroparous - producing offspring in successive, e.g., annual or seasonal batches, as is the case in most fishes.</p> | <p>The Sacramento splittail reportedly is an opportunistic spawner (Wang 1986).</p> <p>The Sacramento splittail is an annual spawner (Daniels and Moyle 1983).</p> <p>Sacramento splittail are iteroparous (Moyle 2002).</p>   |                        |
| <b>Incubation/early development</b>          |   |  |                        |
| Egg characteristics                          | Shape, size, color, in clusters or individuals, stickiness, and other physical attributes.  | Mature Sacramento splittail eggs are spherical, measuring 0.05 to 0.06 inches (1.3 - 1.6 millimeter) in length (Wang 1986). The eggs are transparent, thick, and smooth, except at the adhering point (Wang 1986).   |                        |
| Water temperature tolerance for incubation   | Range of water temperatures allowing survival. Indicate stressful or lethal levels.   | In the Suisun Marsh temperatures ranged from 47.3°F – 82.4°F (8.5°C – 28°C) (Meng and Matern 2001).  |                        |
| Water temperature preference for incubation  | Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation.  | <p>In the Suisun Marsh temperatures averaged 54.9°F – 67.1°F (12.7°C – 19.5°C) (Meng and Matern 2001).</p> <p>The optimum temperature for age-0 wild</p>   |                        |

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|  |  | <p>splittail reportedly was 75.2°F (24°C) (Deng et al. 2002).</p> <p>At 18.5°C, eggs reportedly begin to hatch within 3-5 days after spawning (Bailey 1994 <i>in</i> Moyle et al. 2003).</p>  |                        |
| Time required for incubation               | Time duration from fertilization to hatching. Note: Indicate at which temperature range. Incubation time is temperature-dependent. | <p>The time required for egg incubation is 3 to 7 days, depending on the water temperature (Moyle 2002).</p> <p>Under laboratory conditions, eggs incubated in fresh water at 19°C reportedly start to hatch in about 96 hours (USFWS 1995a).</p>   |                        |
| Size of newly hatched larvae               | Average size of newly hatched larvae.  | <p>Newly hatched Sacramento splittail larvae are less than 0.3 inches (6.5 millimeters) in length (Wang 1986).</p> <p>Sacramento splittail larvae are 0.3 to 0.31 inches (7 to 8 millimeters) in length at the completion of the yolk-sac stage (Wang 1986).</p> <p>Larvae are 5.5-6.5 mm TL when they hatch, have a yolk sac, a non-functional mouth and no eye pigment (Wang 1986, 1995; Bailey et al. 2000 <i>in</i> Moyle et al. 2003).</p> |                        |
| Time newly hatched larvae remain in gravel | Time of year of hatching, and duration between hatching and emergence from gravel.   | <p>Sacramento splittail larvae reportedly remain in shallow, weedy areas close to the spawning sites for 10 to 14 days and move into deeper water as they mature and swimming ability increases (Wang 1986; Sommer et al. 1997 <i>in</i> USFWS 2003).</p> <p>Young of the year Sacramento splittail reportedly appeared in late May or early</p>  |                        |

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

| Element                         | Element Descriptor   | General   | Feather River Specific |
|---------------------------------|--|---|------------------------|
|                                 |  | <p>June and ranged from 22-40 mm SL (Daniels and Moyle 1983).</p> <p>Sacramento splittail feeding begins at 5-7 days post hatch (Bailey 1994 <i>in</i> Moyle et al. 2003), and by the time they reach 13-16 mm TL, they are recognizable as juveniles (Wang 1995 <i>in</i> Moyle et al. 2003).</p>  |                        |
| Other characteristics of larvae | Alevin -- early life history phase just after hatching (larva) when yolk-sac still present.                              | The Sacramento splittail yolk sac is elongated; enlarged in thoracic region, and slender in abdominal region (Wang 1986).   |                        |
| Timing range for emergence      | Time of year (earliest-latest) hatchlings (larvae and alevins) leave or emerge from the nesting/hatching (gravel) sites. | <p>After hatching, Sacramento splittail larvae reportedly remain in shallow, weedy areas until the water recedes, and then they migrate downstream with the river flow (Meng and Moyle 1995).</p> <p>Catches of Sacramento splittail larvae in Suisun Marsh were reportedly related to the timing and pattern of freshwater outflow during the spring (Meng and Matern 2001).</p> |                        |
| Timing peak for emergence       | Time of year most hatchlings emerge.   | The largest catches of Sacramento splittail larvae were in 1995, a wet year when outflow peaked during March and April (Meng and Matern 2001).  |                        |
| Size at emergence from gravel   | Average size of hatchlings at time of emergence.   | The initial body weight and total body length of splittail larvae under laboratory conditions reportedly were 2.6-3.6 mg and 8.7- 9.1 mm (0.87- 0.91 cm) respectively (Deng et al. 2002).   |                        |

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| Element   | Element Descriptor  | General  | Feather River Specific |
|---|---|--|------------------------|
| <b>Juvenile rearing</b>                           |   |  |                        |
| General rearing habitat and strategies            | General description of freshwater environment and rearing behavior.   | The youngest splittails (15-20 mm FL) studied in the Yolo Bypass were most abundant in the shallowest areas of the wetland with emergent vegetation, were associated with the lowest portion of the water column, and were largely benthic at night (Sommer et al. 2002).<br><br>Sacramento splittail rely on flooded vegetation for spawning, a habitat where their larvae and juveniles remain for weeks to months (Meng and Matern 2001).   |                        |
| Water temperature tolerance for juvenile rearing  | Range of water temperatures allowing survival. Indicate stressful or lethal levels.   | In a laboratory study on small age 0 to age 2 Sacramento splittail, the minimum water temperature tolerated was 44.1°F to 45.1°F (6.5°C to 7.3°C), while the maximum water temperature tolerated by juveniles was 68.9°F to 91.4°F (20.5°C–33.0°C), depending on the acclimated water temperature and age (Young and Cech 1996).   |                        |
| Water temperature preference for juvenile rearing | Range of suitable, preferred, or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation. | Lab studies conducted by Young and Cech (1986), show the preferred water temperature for small age 0 Sacramento splittail was 71.6°F to 75.2°F (22°C to 24°C), depending on acclimated water temperature. Preferred water temp for large age 0 fish was 69.8°F to 77°F (21°C to 25°C), depending on acclimated water temperature. For age 1 juveniles, the preferred water temperature was 66.2°F (19°C). YOY Sacramento splittail experienced optimal growth at 21°C, and juveniles and adults had optimal growth at 20°C. (Young and Cech 1996). |                        |
| Water velocity ranges for                         | Reported range of observed  | Intermediate flows positioned the mixing   |                        |

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| <b>Element</b>                                  | <b>Element Descriptor</b>  | <b>General</b>  | <b>Feather River Specific</b> |
|---|--|---|-------------------------------|
| rearing juveniles                               | (minimum and maximum) water velocity utilization.  | <p>zone in the Suisun Bay area and reportedly produced optimum rearing conditions for juvenile Sacramento splittail (Meng and Matern 2001).</p> <p>In laboratory studies conducted by Young and Cech (1996), the range of velocities that juvenile Sacramento splittail were able to tolerate were reported as 19.5 to 66.3 cm/sec.</p>                                 |                               |
| Water velocities preferred by rearing juveniles | Reported range of most frequently observed water velocity utilization.   |   |                               |
| Water depth range for juvenile rearing          | Reported range of observed (minimum and maximum) water depth utilization.  | <p>In dry years, native fishes are reportedly confined to the Sacramento River and similar channels that are deep (&gt; 5 m [16.4 ft]) and steep sided and have minimal shallow-water habitat or vegetation (Sommer et al. 2002).</p> <p>Juvenile splittail habitat use reportedly ranged from &lt;0.31 m during the day, to 0.61+ m at night (Sommer et al. 2002).</p> |                               |
| Water depth preference for juvenile rearing     | Reported range of most frequently observed water depth utilization.  | The data collected on juvenile splittail distribution within the Yolo Bypass suggests that floodplains and perhaps other shallow-water habitats are also important for the early life stages of splittail (Sommer et al. 2002).   |                               |
| 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). | <p>Juvenile Sacramento splittail reportedly prefer shallow-water habitat with emergent vegetation (i.e., tules and reeds) during rearing (Meng and Moyle 1995).</p> <p>Young splittail studied in the Yolo Bypass floodplain reportedly were most abundant in the shallowest areas of the wetland</p>   |                               |

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| Element                             | Element Descriptor  | General   | Feather River Specific |
|-------------------------------------|---|---|------------------------|
|                                     |   | with emergent vegetation (Sommer et al. 2002).  |                        |
| Food base of juveniles              | Indicate primary diet components. Also indicate the diet changes, if any, as growth occurs.   | The food base for juvenile Sacramento splittail is algae, pelecypods, and amphipods (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 Sacramento splittail are benthic foragers (USFWS 1995b).   |                        |
| Predation of juveniles              | Indicate which species prey on juveniles.   | Striped bass and other piscivorous fish prey on juvenile Sacramento splittail (Moyle 2002).<br><br>Large pikeminnow and striped bass reportedly prey on juvenile Sacramento splittail (Wang 1986).  |                        |
| Timing range for juvenile rearing   | Range of time of year (months) during which rearing occurs.   | Young Sacramento splittail rear in upstream areas for a few weeks to a year or more (Sommer et al. 1997).<br><br>Juvenile Sacramento splittail rearing was reported to occur during the months of May through August within the Sacramento-San Joaquin estuary (Meng and Moyle 1995).   |                        |
| Timing peak for juvenile rearing    | Time of year (months) during which most rearing occurs.   | Survey samples taken at Chipps Island, California reported that most juvenile Sacramento splittail were present during the months of May through June; juvenile peak abundance at the Suisun Marsh, California was reportedly during June through August (Sommer et al. 1997).<br><br>Most juveniles were reportedly collected at the State Water Project facilities during |                        |

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| Element   | Element Descriptor   | General  | Feather River Specific |
|---|--|--|------------------------|
|   |  | the months of May through July (Sommer et al. 1997).   |                        |
| <b>Juvenile emigration</b>                      |  |  |                        |
| Time spent in fresh water prior to emigrating   | Duration (in years and/or months) from emergence to emigration to the ocean.   | It is hypothesized that after hatching, Sacramento splittail larvae move downstream as they develop during the month of May (Caywood 1974).  |                        |
| 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  | Downstream movement of juvenile Sacramento splittail probably occurs between May and July (Meng and Moyle 1995).<br><br>Young-of-year (YOY) Sacramento splittail are reportedly caught in the South Delta pumping plants in the greatest numbers from April through August, presumably when moving downstream into the estuary (Moyle 2002). |                        |
| Emigration timing peak                          | Time of year most juveniles are emigrating.  | Large numbers of YOY Sacramento splittail are reportedly captured in screw traps in the Sutter and Yolo bypasses in May, with diminishing numbers in June (DFG, Region 2 unpublished data <i>in</i> Moyle et al. 2003).  |                        |
| Size range of juveniles during emigration       | Minimum and maximum sizes (inches or mm) of emigrating juveniles. Indicate average size.   | On the Cosumnes river juveniles have been observed leaving the floodplain at a size of 25-40 mm TL (Moyle, unpublished data <i>in</i> Moyle et al. 2003).  |                        |
| Factors associated with                         | Pulse flows, water temperature   | After hatching, larval Sacramento splittail  |                        |

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| Element                           | Element Descriptor   | General   | Feather River Specific  |
|-----------------------------------|--|---|---|
| emigration                        | changes, turbidity levels, photoperiod, etc.   | within the Sacramento-San Joaquin estuary are reported to remain in shallow weedy areas until the water recedes, and then they move into deeper water and migrate downstream with river flow (Meng and Moyle 1995).   |   |
| <b>Other potential factors</b>    |  |   |   |
| DO                                | Levels of dissolved oxygen in water expressed in mg/l tolerated by fish.   | All sizes of Sacramento splittail reportedly can survive in water having less than 1 milligram per liter of dissolved oxygen (Moyle 2002).<br><br>The tolerance levels of dissolved oxygen for Sacramento splittail are reportedly 0.6 to 1.3 mg/L for all age groups (Young and Cech 1996).  |   |
| PH                                | Alkalinity/acidity of water (expressed in pH) that fish can tolerate.  | Under laboratory conditions, pH for splittail larvae ranged from 8.0 to 8.2 (Deng et al. 2002).   |   |
| 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. | Juveniles are most abundant in shallow, turbid water (Young and Cech 1996 <i>in</i> Moyle et al. 2003).   |   |
| Factors contributing to mortality | e.g. fishing/angling mortality, drastic habitat alterations, unfavorable climatic changes, etc.  | In order of importance, factors contributing to the mortality of Sacramento splittail reportedly are: (1) reduction in valley floor habitats; (2) modification of spawning habitat; (3) changed estuarine hydraulics, especially reduced outflows; (4) climate variation; (5) toxic substances; (6) introduced species; and (7) exploitation (Moyle 2002).<br><br>Sacramento splittail have disappeared from much of their native range because dams, diversions, and agricultural development have eliminated or | Access to Sacramento splittail spawning areas or upstream habitat is now blocked by dams on large rivers such as Nimbus Dam on the American River and Oroville Dam on the Feather River (USFWS 1995b).<br><br>Reportedly, there is a consensus among Sacramento splittail anglers that the fishery has declined since the completion of Folsom and Oroville dams (USFWS 1995b). |

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|---------|--------------------|---|------------------------|
|         |                    | drastically altered much of the lowland habitat these fish once occupied (USFWS 1995b). |                        |

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