
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**

RIVER LAMPREY

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



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Governor
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Matrix Of Life History and Habitat Requirements for Feather River Fish Species – River Lamprey
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Element	Element Descriptor	General	Feather River Specific
General			
common name (s)	English name (usually used by fishers and laypeople).	River lamprey	
scientific name (s)	Latin name (referenced in scientific publications).	The scientific name of river lamprey is <i>Lampetra ayresi</i> (Moyle 2002).	
taxonomy (family)	Common name of the family to which they belong. Also indicate scientific family name.	River lamprey belong to the <i>Petromyzontidae</i> family (Moyle 2002). Lamprey are eel-like in form, but lack the jaws and paired fins of true fishes. Lamprey are distantly related to the long-extinct ostracoderms, among the earliest known vertebrates (Moyle 2002).	
depiction	Illustration, drawing or photograph.		
range	Broad geographic distribution, specifying California distribution, as available.	River lamprey are distributed from Juneau, Alaska to San Francisco Bay. British Columbia, where river lamprey are most abundant, is the center of the range. In California, most records are for the lower Sacramento-San Joaquin River system (Moyle 2002).	
native or introduced	If introduced, indicate timing, location, and methods.	River lamprey are native 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	River lamprey are not a federally or state listed species (DFG 2002).	

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	(Endangered); FPT = Federally proposed (Threatened); FPD = Federally proposed (Delisting); the date of listing; or N = not listed.		
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.	River lamprey is on the Watch List (Moyle 2002). Trends in California river lamprey populations are unknown, but are likely to have suffered a considerable decline due to the decline of suitable spawning and rearing habitat in the lower reaches of larger rivers. River lamprey are easily overlooked, so they may be more abundant than as indicated. There are few records on river lamprey in California (Moyle 2002).	
economic or recreational value	Indicate whether target species sought for food or trophy. Whether desirable by recreational fishers, commercial fishers, or both.		
warmwater or coldwater	Warmwater if suitable temperature range is similar to basses; coldwater if suitable temperature range is similar to salmonids.	River lamprey are considered a coldwater species (Beamish and Youson 1987).	
pelagic or littoral	Environment: Pelagic - living far from shore; Littoral - living near the shore.	“Pelagic” coloration of blue to black on the back and silver on sides and belly appears to be typical of actively feeding river lamprey (Bond et al. 1983).	
bottom or water column distribution	Environment: bottom (benthic) or along water column.	Adult river lampreys are free-swimming within the water column (Wang 1986).	
lentic or lotic	Environment: Lentic - pertaining to stagnant water, or lake-like; Lotic - moving water, or river-like.		
Adults			
life span	Approximate maximum age obtained.	The maximum age of river lamprey is reportedly 6 to 7 years (Moyle 2002).	

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		River lamprey mortality occurs approximately 2 years following the onset of metamorphosis, just after spawning. (Beamish 1980).	
adult length	Indicate: Length at which they first reproduce; average length and maximum length the fish can attain.	The average size of spawning river lamprey reportedly is 6.7 inches (17 cm) TL. The reported maximum length of river lamprey is approximately 12.2 inches (31 cm) TL (Moyle 2002). In British Columbia, adult river lamprey range in length from 4.7 to 9.4 inches (12-24 cm) (Beamish and Youson 1987).	
adult weight	Indicate: Weight at which they first reproduce; average weight and maximum weight the fish can attain.		
physical morphology	General shape of the fish: elongated, fusiform, laterally compressed, etc.	River lamprey are elongated and eel-like in appearance (Moyle 2002).	
coloration	Indicate color, and color changes, if any, during reproduction phase.	Adult river lamprey are dark on the back and sides and silvery to yellow ventrally (Moyle 2002).	
other physical adult descriptors	Unique physical features for easy identification.	The mouth of river lamprey is shaped like a disk-like funnel, with a lip (Wang 1986)	
adult food base	Indicate primary diet components.	River lamprey reportedly feed on a variety of fishes 3.9–11.8 inches (10-30 cm) TL, most commonly herring and salmon (Beamish and Youson 1987; Moyle 2002).	
adult feeding habits	Indicate whether plankton eater, algae eater, bottom feeder, piscivorous, active hunter, ambush predator, filter feeder. Night, day, dusk or dawn feeder.	River lamprey are piscivorous and predaceous. They attach to the back of host fish, above the lateral line, and feed on muscle tissue. Feeding may continue even after the death of the prey (Moyle 2002). More than one lamprey may feed on a single salmon. Predation by river lamprey is an important source of direct and indirect mortality to salmon and herring (Beamish and Youson 1987).	

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		River lamprey are considered more of a predator than a parasite because they feed by removing flesh from the host and killing them. Feeding continues after the death of the host (Beamish 1980; Beamish and Neville 1995).	
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.	<p>After a 9-month (in-river) metamorphosis, and acclimation at sea (in estuaries and salinity wedges of rivers and streams), river lamprey spend approximately 3 months in the ocean (Beamish and Youson 1987).</p> <p>River lamprey ammocoetes are likely to be from 3 to 5 years old when they begin the transformation into adults (Moyle 2002).</p> <p>River lamprey reportedly remain in saltwater from 3 to 4 months (in contrast to Pacific lamprey, which spend approximately 3.5 years in saltwater) (Beamish 1980; Moyle 2002).</p>	
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.	<p>Based on studies of river lamprey in British Columbia, adult upstream migration occurs in autumn. The range and more exact timing of upstream migration of adults is unknown (Moyle 2002).</p> <p>In British Columbia, river lamprey reportedly return to freshwater between September and May (Wang 1986).</p> <p>Some adult river lamprey reportedly return to freshwater as early as July (Beamish and Youson 1987).</p> <p>River lamprey reportedly return to freshwater between September and late winter (Beamish 1980).</p>	

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Element	Element Descriptor	General	Feather River Specific
peak adult upstream migration timing	Time of year most adults migrate upstream. If applicable, indicate for various runs.	River lampreys move into freshwater in early autumn in the Columbia River system (Bond et al. 1983).	
adult upstream migration water temperature tolerance	Range of water temperatures allowing survival. Indicate stressful or lethal levels.	Water temperature in the Yaquina Bay at times of capture of river lamprey reportedly ranged from 55.4°F to 69.8°F (13°C to 21°C) (Bond et al. 1983).	
adult upstream migration water temperature preference	Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental.		
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.	At night some river lamprey may move into water deeper than the depth of the purse seine (26 m to 33 m [85.3 ft to 108.3 ft]), or move inshore, but they reportedly seldom occur at depths greater than 50 m (164 ft) during the day or night (Beamish 1980).	
water depth preference for holding adults	Reported range of most frequently observed water depth utilization.	Most river lamprey were reportedly found at the 3m to 6m (9.8 ft to 19.7ft) depth range in the day samples (Beamish 1980).	
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.		
water velocity range for holding adults	Reported range of observed (minimum and maximum) water velocity utilization.		

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water velocity preference for holding adults	Reported range of most frequently observed water velocity utilization.	Catches of river lamprey during both the day and night sets reportedly appeared to be largest during periods of reduced velocities (Beamish and Youson 1987).	
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.).	The accumulation of river lamprey in the vicinity of major rivers and their distribution throughout the surface waters may indicate a preference for water of reduced salinities (Beamish 1980).	
timing range for adult holding	Time of year (earliest-latest) and duration of stay from upstream migration to spawning.	River lamprey reportedly remain in freshwater from autumn (when they enter freshwater) until the period of February through May, when spawning occurs (Moyle 2002). River lamprey reportedly hold in freshwater for up to 8 months, from the time they enter freshwater (September through late winter) until spawning (April through June) (Beamish 1980).	
timing peak for adult holding	Time of year when maximum number of adults are present before spawning.	River lamprey were reportedly most abundant in the surface waters in July and absent after September (Beamish 1980).	
Spawning			
fecundity	Average or range in the number of eggs females lay in a spawning season.	River lamprey fecundity estimates are limited. One female [6.9 inches (17.5 cm) TL] from Cache Creek contained approximately 37,300 eggs; another female [9.1 inches (23 cm TL)] contained approximately 11,400 eggs (Moyle 2002; Wang 1986).	
nest construction	Location and general description of nest -- substrates, aquatic plants, excavations, crevices, habitat types, etc.	In the laboratory, river lamprey constructed nests approximately (15 cm) in diameter in gravel (unknown gravel size class) (Beamish and Neville 1995).	
nest size	Size and average dimensions of the nest.	Prior to spawning, river lamprey reportedly construct nests approximately 15 cm (5.9 inches) in diameter (Beamish 1980).	
spawning process	Indicate whether nest builder, broadcast spawner, or other.	Prior to spawning, river lamprey reportedly construct nests in gravel by lifting rocks out of the nest area with the oral disk and by vigorous digging movements (Beamish 1980).	
spawning substrate size/characteristics	Range of substrates used during spawning (e.g. mud, sand,	River lamprey reportedly construct nests in rocks and gravel (Wang 1986).	

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Element	Element Descriptor	General	Feather River Specific
	gravel, boulders, beds of aquatic plants). Indicate presence of plant/wood debris, crevices at spawning sites. If gravel, indicate range of average size.	Adult river lamprey construct "... <i>saucer-shaped depressions</i> " in gravelly riffles (Moyle 2002).	
preferred spawning substrate	Indicate preferred spawning substrate (e.g. mud, sand, gravel, boulders, plant bed, etc).	Rocks and gravel are reportedly the preferred spawning substrates for river lamprey (Wang 1986).	
water temperature tolerance for spawning	Range of water temperatures allowing survival. Indicate stressful or lethal levels.	In a laboratory study, river lamprey spawned in holding tanks during May when the water temperature was 53.6°F (12°C) (Beamish and Neville 1995).	
water temperature preference for spawning	Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation.	River lamprey are reported to spawn at water temperatures of 55.4°F to 56.3°F (13.0°C–13.5°C) (Wang 1986).	
water velocity range for spawning	Minimum and maximum speed of water current the spawning fish can tolerate.	Adult river lamprey presumably need clean, gravelly riffles for spawning (DFG 2000).	
water velocity preference for spawning	Preferred water current (flow velocity) during spawning.		
water depth range for spawning	Reported range of observed (minimum and maximum) water depth utilization.		
water depth preference for spawning	Reported range of most frequently observed water depth utilization.		
range for spawning timing	Earliest and latest time of season or year in which spawning occurs.	River lamprey spawning reportedly occurs from February through May in British Columbia (Moyle 2002). River lamprey spawning reportedly occurs from April through May (Wang 1986). In British Columbia, river lamprey spawning reportedly occurs from April through June (Beamish 1980).	

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peak spawning timing	Time of year most fish start to spawn.	Peak river lamprey spawning reportedly occurs in May in British Columbia (Beamish 1980).	
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.	River lamprey reportedly are semelparous, and die after spawning (Moyle 2002).	
Incubation/ early development			
egg characteristics	Shape, size, color, in clusters or individuals, stickiness, and other physical attributes.	River lamprey eggs are reported to be 0.02 inches (0.7 mm) in diameter (Wang 1986).	
water temperature tolerance for incubation	Range of water temperatures allowing survival. Indicate stressful or lethal levels.		
water temperature preference for incubation	Range of suitable, preferred or reported optimal water temperatures. Indicate whether literature, observational, or experimental derivation.		
time required for incubation	Time duration from fertilization to hatching. Note: Indicate at which temperature range. Incubation time is temperature-dependent.		
size of newly hatched larvae	Average size of newly hatched larvae.		
time newly hatched larvae remain in gravel	Time of year of hatching, and duration between hatching and emergence from gravel.	Larval river lamprey reportedly spend several years buried in the soft bottom parts of streams and rivers predominately, feeding from small particles filtered from the water (Malmqvist 1986).	
other characteristics of larvae	Alevin -- early life history phase just after hatching (larva) when yolk-sac still present.		

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timing range for emergence	Time of year (earliest-latest) hatchlings (larvae and alevins) leave or emerge from the nesting/hatching (gravel) sites.		
timing peak for emergence	Time of year most hatchlings emerge.		
size at emergence from gravel	Average size of hatchlings at time of emergence.	<i>L. ayresi</i> ammocoetes reportedly ranged in length from 8 to 93 mm (0.8 to 9.3 cm), with an average length of 22.5 mm (2.25 cm) (Beamish and Youson 1987).	
Juvenile rearing			
general rearing habitat and strategies	General description of freshwater environment and rearing behavior.	River lamprey ammocoetes reportedly burrow into sandy or muddy substrates near the bank (Wang 1986).	
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 literature, observational, or experimental derivation.		
water velocity ranges for rearing juveniles	Reported range of observed (minimum and maximum) water velocity utilization.	River lamprey reportedly utilized water velocities that ranged from 1 to 5 cm/s to about 50 cm/s (Kainua and Valtonen 1980). Where river lamprey larvae were found in shallow water, the rate of flow was almost constantly below 10 cm/s (Kainua and Valtonen 1980).	
water velocities preferred by rearing juveniles	Reported range of most frequently observed water velocity utilization.	Small river lamprey larvae were reportedly proportionately more numerous in habitats where the flow was rapid (Kainua and Valtonen 1980).	
water depth range for juvenile rearing	Reported range of observed (minimum and maximum) water depth utilization.		
water depth preference for juvenile rearing	Reported range of most frequently observed water depth utilization.		

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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).	River lamprey ammocoetes reportedly burrow into sandy or muddy substrates near the bank (Wang 1986). River lamprey ammocoetes reportedly remain in silty backwaters and eddies (Moyle 2002).	
food base of juveniles	Indicate primary diet components. Also indicate the diet changes, if any, as growth occurs.	River lamprey ammocoetes reportedly feed on algae and microorganisms (Moyle 2002). River lamprey ammocoetes have no teeth, and feed on microscopic plants and animals (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.	River lamprey remove portions of flesh from their hosts (Beamish 1980).	
predation of juveniles	Indicate which species prey on juveniles.	At present there is little evidence of predation by other animals on river lamprey. As reported, river lamprey fed on other river lamprey in the laboratory and there is one report of a river lamprey being found in the throat of a lingcod (Vladygov and Follett 1958). In laboratory experiments, salmon fed on small adult western brook lamprey, so predation on river lamprey by other fishes may occur (Beamish 1980).	
timing range for juvenile rearing	Range of time of year (months) during which rearing occurs.	The river lamprey ammocoete life stage reportedly lasts from 3 to 5 years (Moyle 2002). The transformation from river lamprey ammocoete into adult reportedly begins when ammocoetes are approximately 4.7 inches TL (12 cm TL). Metamorphosis takes 9-10 months and begins during the summer (Moyle 2002). Metamorphosis from river lamprey ammocoetes to	

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		juveniles and young adults reportedly begins in July and is completed by April of the following year. (Beamish 1980; Beamish and Youson 1987).	
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.	<i>L. ayresi</i> reportedly takes approximately 9 months to complete metamorphosis and then goes to sea over the next 3 months. In some cases, it may be 12 months from the onset of metamorphosis until entry into the sea (Beamish and Youson 1987).	
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	<p>River lamprey reportedly congregate upriver from saltwater for 4 months as young adults and rapidly grow to 9.8–12.2 inches (25-31 cm) TL, and enter the ocean in late spring (Moyle 2002).</p> <p>River lamprey reportedly migrate to the ocean from May through July (Beamish 1980).</p> <p>Immature adult river lamprey reportedly enter saltwater from May through July and feed on herring and salmon, growing from 4.7 inches (12 cm), [0.07 ounces (2g)] to 9.8 inches (25 cm), [0.71 ounces (20g)] (Beamish 1980; Beamish and Youson 1987).</p>	
emigration timing peak	Time of year most juveniles are emigrating.	River lamprey salinity acclimation and feeding reportedly peaks in June (Beamish and Youson 1987).	
size range of juveniles during emigration	Minimum and maximum sizes (inches or mm) of emigrating juveniles. Indicate average size.	The reported mean length of immature adult river lamprey entering saltwater is 4.3 inches (11 cm) (Beamish 1980; Beamish and Youson 1987).	

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factors associated with emigration	Pulse flows, water temperature changes, turbidity levels, photoperiod, etc.	The metamorphosis from river lamprey ammocoete to adult is strongly correlated to river discharge. Delay of metamorphosis in autumn may be associated with declining river discharge. During the spring, when river discharge is at a maximum, the ability to osmoregulate is increased, and metamorphosis reportedly nears completion. River lamprey may have evolved in response to the discharge patterns of rivers (Beamish and Youson 1987).	
Other potential factors			
DO	Levels of dissolved oxygen in water expressed in mg/l tolerated by fish (lower limits)		
pH	Alkalinity/acidity of water (expressed in pH) that fish can tolerate		
turbidity	Indicate: level or 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.	Some river lamprey mortalities recorded probably are related to changes in osmoregulatory mechanisms (Beamish 1980).	

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