TECHNICAL NOTES

U.S. DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE
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BIOLOGY TECHNICAL NOTE NO. 51

Pacific Lamprey and NRCS: Conservation, Management and Guidelines for Instream and Riparian Activities

This Technical Note is divided into two parts: Part I *Conservation and Management of Habitats for Pacific lamprey (Entosphenus tridentatus)* and Part II *Pacific Lamprey Protection Guidelines for USDA Natural Resources Conservation Service Instream and Riparian Activities.* These two documents should be used in conjunction with one another during NRCS conservation planning in areas where Pacific lampreys may occur.

Part I. Conservation and Management of Habitats for Pacific lamprey (*Entosphenus tridentatus):*

1. Introduction to Pacific Lamprey Conservation and Biology.

Pacific lamprey are an ancient and highly specialized fish that spend most of their life in freshwater, save for a relatively brief time as adults when they feed in the ocean. They historically inhabited coastal rivers of the western US, and those rivers draining into the Pacific Ocean, from Japan and the Aleutian Islands south to Baja California, including the Sacramento-San Joaquin, Eel, Trinity, Klamath, Umpqua, Columbia, Umatilla, Methow, Clearwater, Selway, Chehalis, and Skagit Rivers. Current surveys and anecdotal accounts indicate lamprey populations have dramatically declined or been extirpated in many of the former habitats provided in these rivers and tributaries. Pacific lamprey populations have declined throughout their range in California, Oregon, Washington and Idaho with the most precipitous documented declines in the upper Columbia, Snake and North Umpqua River basins. Currently, on the west side of the Cascades, Pacific lamprey are known to utilize many if not all streams and rivers with migratory access to and from Puget Sound in Washington, the Columbia River in Washington and Oregon, the Klamath , Umpqua and Rogue River in Oregon, and the Eel River in California. East of the Cascades, Washington Department of Fish and Wildlife (WDFW) has documented lamprey spawning redds near White Salmon. In other areas of Central Washington, WDFW has found Pacific lamprey redds in the Wenatchee River and tributaries, the Methow River and tributaries, the Tucannon River, and the Walla Walla River. Nez Perce tribal biologists have completed re-introductions of the species in Asotin Creek. Idaho Department of Fish and Game has documented lamprey ammocoetes and/or adults in the following Salmon River Basin tributaries: Salmon River downstream of the South Fork, Clearwater River, Middle Fork Clearwater River, South Fork Clearwater River, Red River, Lochsa River and Selway River. It should be recognized that lamprey may be present in numerous other streams and rivers, even though presence of the species has not been recorded.

Pacific lamprey, called eels by many, have been harvested for millennia by people of the Yurok, Karuk, Wiyot, Kalapuya, Umpqua, Molalla, Rogue River, Shasta, Yakama, Umatilla, Nez Perce, Warm Springs, and other Tribes. These fish are thus ecologically and culturally significant to many people. Because Pacific lamprey, like salmon, are anadromous, their contribution to Pacific Northwest ecosystems includes the transport and cycling of marine-derived nutrients far inland from Pacific shores. The Pacific lamprey is a tribal trust species and thus is protected under tribal treaty and other rights. The US Fish and Wildlife Service (USFWS) coordinates with tribes on a government-to-government basis in efforts to protect these tribal trust resources and their associated habitats. The developing Pacific Lamprey Conservation Initiative (PLCI) is the USFWS's strategy to improve Pacific lamprey populations by coordinating conservation efforts among states, tribes, Federal agencies, and other involved parties. This effort is meant to facilitate actions to address threats, restore habitat, increase knowledge of Pacific lamprey, and improve their distribution and abundance throughout their known range. The primary product of the PLCI is the development of a range wide Conservation Plan. The USFWS, some state fish and wildlife agencies, and other federal partners, including NRCS, have increased their focus on Pacific lamprey due to the recognition that populations are in decline. Conservation status of Pacific lamprey varies by state, as follows: Oregon-*Sensitive*, Washington-*Priority*, Idaho-*Endangered*, California-*no special status*, Alaska-*Commercial*. Federally, it is a Species of Concern. Columbia River Basin Tribes (Nez Perce, Umatilla, Yakama, and Warm Springs) have drafted a Pacific lamprey restoration plan, and consider the species abundance and distribution to be "declining precipitously" (CRITFC 2008). Collaboration between the USFWS, numerous tribes, the USFS, the NRCS, BLM, and state agencies in OR, WA, ID, and CA has generated a number of documents providing information on the current population status of Pacific lamprey throughout the West, as well as management considerations to improve lamprey survival. This Technical Note summarizes information derived from available reports and scientific publications to provide NRCS field office personnel with a synthesis of information relevant to the conservation of Pacific lamprey in streams and rivers adjacent to or within working landscapes. Readers are cautioned that our knowledge of Pacific lamprey biology is limited compared to that of salmon and trout. The ***Pacific Lamprey Protection Guidelines*** appended to this document provide specific management actions to protect this species during project implementation, based on current knowledge.

2. Pacific lamprey life history.

Pacific lamprey are anadromous native fish. They spend a good part of their lives as larvae and freshwater juveniles, and several years as adults at sea, returning to streams and rivers to spawn once, and die. During spawning in the spring, mating pairs dig a depression in the stream bottom, forming a redd where they deposit and fertilize eggs (Figure 1). Redds are generally about 1.5 feet by 1.5 feet in area (Figure 2).

Figure 1 – Spawning adult Pacific lamprey

Figure 2 – Completed redd

Eggs incubate for 11-30 days, depending on the water temperature, prior to hatching. Hatched embryos remain in the gravel for up to one more month as gill slits develop. They emerge from redds as drifting larvae called ammocoetes (Figures 3, 5). Ammocoetes passively move downstream with the currents, eventually burrowing in slow water pockets of fine silts (Figure 4) where they ingest algae, diatoms, and detritus by filter-feeding from their mouths. They move downstream to multiple rearing sites of increasing substrate sizes as they grow over a period of 3 to 8 years.

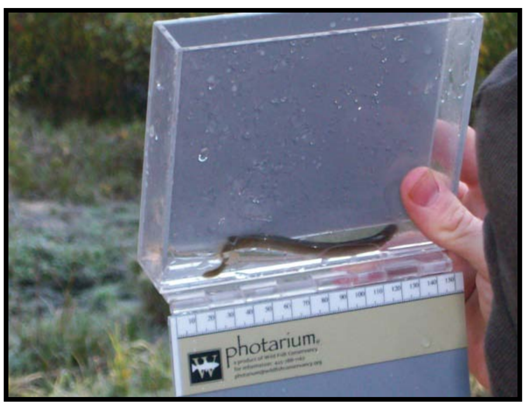

Figure 3. Larval lamprey (Ammocoete)

Figure 4. Ammocoete rearing habitat

Figure 5. Enlargement of photo of Pacific lamprey ammocoete. Note gill slits on side of head and lack of eyes. *Photo taken by Brett Blundon.*

Figure 6. Lamprey macropthalmia

After several years, ammocoetes transform to macropthalmia with eyes, sharp teeth arranged in an oral disc, and a silvery color (Figure 6), usually during the summer and early fall. The juvenile macropthalmia migrate to the ocean from late fall to early summer, and then spend 1-4 years as adults feeding as external parasites on marine fish and mammals to which they attach with their oral disc. There is no evidence that lamprey imperil their hosts. Pacific lamprey spend only about ¼ of their lives in the ocean, where they grow to lengths ranging from about 16 – 27 inches (Figure 7). Adult Pacific lamprey migrate to streams and rivers during the spring, to mature and spawn, generally after about one year.

Figure 7. Adult Pacific lamprey returning to freshwater (Willamette Falls). *Photo taken by Ben Clemens, Oregon State University*.

3. Pacific Lamprey Habitat Requirements.

Watershed-scale habitat requirements. Stream and river reaches that have relatively stable flow conditions or flows that mimic the "natural" flow regime will better support all life history stages of Pacific lamprey. In addition, a mix of deep pools with good hiding cover (such as boulders and large wood), low velocity rearing areas with fine sand or silt, and silt-free cobble areas upstream of rearing areas, all combined with summer temperatures that rarely or never exceed 68 degrees Fahrenheit will provide good habitat conditions for all life stages.

Spawning habitat requirements. Spawning occurs in medium-sized rivers and smaller tributary streams, from February to September, depending on latitude. Egg incubation can last up to one month after deposition in colder waters. Pacific lamprey dig nests or "redds" of around 2 square feet in gravels and cobbles ranging in size from 1 to 3.5 inches in diameter. Redds are constructed in the downstream ends of pools and slow water areas (e.g. runs or glides), where water is flowing over gravel and cobble ("tail outs") as well as low- gradient riffles. Redd depths range from 7 inches to 3.5 feet. As with salmon spawning areas, well-oxygenated water flowing through relatively clean substrates is critical to egg survival.

Ammocoete habitat requirements. Drifting lamprey ammocoetes emerging from redds are carried by currents into backwaters, alcoves, sloughs, or pocket pools. Once they reach slow water, they burrow into fine sand and/or silty depositional areas covered with a "frosting" of detritus. These habitats provide opportunities for filter-feeding, and are most common in un-channelized streams with complex channel morphology and seasonal floodplain wetlands and backwater areas. Ammocoetes are particularly vulnerable to irrigation diversions and therefore designs of diversions or water withdrawal must provide lamprey protection features such as site location and fish screens. For diversions that are not screened, ammocoetes trapped in ditches will perish when ditches are drained. Land managers are therefore encouraged to “rescue” ammocoetes in these sites and transplant them to permanent water habitats at the close of the irrigation season.

Macrothalmia habitat requirements. Macrothalmia begin their downstream migration in late summer-early fall, when rains increase stream flow. Downstream migration is passive, in that the fish are carried by the current to mainstem rivers and eventually the sea. Resting habitat providing cover and low flows are essential as well as unimpeded flows and passage facilities enroute to the ocean.

Adult Upstream Migration Habitat . At present, there is no evidence that lamprey return or “home” to their natal stream or river. Adults do migrate to freshwater from the ocean and then take up to a year to become sexually mature. Water temperatures greater than 68^{o} F have been found to reduce adult growth and disrupt timing of sexual maturation (Clemens et al. 2009). During this time they require deep pools with good cover for hiding from predators. While lamprey are able to “climb” up obstacles using their oral disc as a suction cup, successful passage over dams and/or through culverts is dependent on the surface of the facility being wet with velocities of less than 6 feet/second. Moreover, evidence suggests that Pacific lamprey lose their willingness to negotiate multiple challenging obstacles, such as the dams on the Columbia River. Unfortunately, design features that are helpful to upstream migrating salmon are dissimilar to those needed by Pacific lamprey. Studies to determine lamprey passage design criteria for dams of all sizes are in progress. Available research indicates that hydraulic conditions and the density of passage barriers between the ocean and spawning sites are important for successful migrations of lamprey. Upon reaching suitable habitat, spawning of mature adults occurs when water is 50^{o} to 60^{o} F.

4. Threats to Pacific lamprey and habitat considerations in working landscapes. A summary of potential threats to Pacific lamprey in working landscapes, as well as guidance for mitigating these threats is provided in the Appendix: *Pacific Lamprey Protection Guidelines*, prepared on contract by Chuti Fiedler (USFS) with oversight by FWS and NRCS biologists. In summary, lamprey may be harmed by actions that alter or degrade those elements of stream corridors that contribute to stream habitat connectivity and complexity. These elements include natural flow regimes, intact floodplain features, good water quality, adequate water quantity, diverse and “clean” stream substrates, and intact riparian vegetation. Streams where lamprey are likely to occur should be evaluated using the NRCS Stream Visual Assessment Protocol, Version 2 prior to project planning and implementation. Stream reaches with overall SVAP2 scores of 5.0, while meeting Quality Criteria for stream habitat, are not likely to be of high enough quality to sustain Pacific lamprey spawning and rearing. Field personnel working with landowners managing such stream reaches should encourage stream restoration actions to improve habitat for Pacific lamprey. In addition, project planning and approval on ***all*** properties where Pacific lamprey are expected to occur should consider the need to: (1) provide or restore adult lamprey passage upstream and downstream of the site; (2) protect or restore spawning and rearing habitat and associated stream channel complexity; (3) protect or restore water quality and quantity and (4) protect all life stages from entrainment in pumps or irrigation diversions.

The following table provides a list of NRCS Conservation Practice Standards that when implemented have the potential to affect Pacific lamprey habitat. For each practice, if its implementation has the potential to impact one of the key habitat components critical for Pacific lamprey, that feature is identified in column 2 in red font. If the potential threat/impact is addressed by implementation of the practice, OR is addressed in the standard’s criteria and considerations, this is designated by blue font. Use of this table, in conjunction with the Pacific Lamprey Protection Guidelines (PLPGs) will help state and field office planners assist landowners with conservation and management of Pacific lamprey habitats throughout its range.

Table. Conservation Practices that potentially pose a threat or address threats to Pacific lamprey.

National Conservation Practice Standard	Threat potential/ Threat Addressed	Standard Criteria Address Threat? Yes	No	Standard Considerations Address Threat? Yes	No	Refer to PLPGs Yes	No
Access Road	Water quality	X		X			X
Channel Stabilization	Habitat complexity	X		X			X
Clearing and Snagging	Habitat complexity	X		X			X
Critical Area Planting	Habitat complexity		X		X	X2	
Dam, Diversion	Migration		X		X	X1	
Dam	Migration		X		X	X1	
Dike	Habitat complexity		X		X	X1,2	
Fish and Wildlife Structure	Entrainment	X		X			X
Fish Passage	Migration	X		X			X
Grade Stabilization Structure	Migration		X		X		
Hedgerow	Water quality	X		X			X
Integrated Pest Mgmt	Water quality	X		X			X
Irrigation System	Water quantity/ quality, Entrainment, Migration		X		X	X3 X1	
Irrigation Canals or Lateral	Water quantity/ quality, Entrainment, migration		X		X	X3 X1	
Irrigation Field Ditch	Entrainment	X			X	X1	
Irrigation Water Mgmt	Water quantity	X		X			
Open Channel	Migration	X			X	X1	
Pipeline	Water quantity	X			X	X3	
Pumping Plant	Entrainment	X			X	X1	
Riparian Herbaceous Cover	Water quality	X		X			X
Riparian Forest Buffer	Water quality, Habitat complexity	X		X			X
Shallow Water Management/Wildlife	Habitat complexity, migration	X		X			X
Spring Development	Water quantity	X		X			X
Stream Habitat Improvement and Mgmt.	Habitat complexity, Water quality, quantity	X		X			X
Stream bank and Shoreline Protection	Habitat complexity, Water quality	X		X			X
Structure for Water Control	Entrainment		X		X	X1	
Subsurface Drain	Water quantity		X		X	X3	
Surface Drainage	Water quantity		X		X	X3	
Tree and Shrub Establishment	Water quality	X		X			X
Watering Facility	Water quality	X			X	X3	
Wetland WL Habitat Mgt.	Habitat complexity, migration	X		X		X1, X1	
Wetland Enhancement	Habitat complexity, migration	X		X			X
Wetland Restoration	Habitat complexity, migration	X		X			X

Note: if the Standard does not address a threat to Pacific lamprey either in the Standard's Criteria or Considerations (designated by an X in the table), refer to the Pacific Lamprey Protection Guidelines (PLPGs) in the Appendix to mitigate threats to water quality or quantity, migration, or habitat complexity. Numbers adjacent to an "X" in far right column refer to the specific Best Management Practices in the PLPGs that may be used to mitigate the particular threat.

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Appendix: Pacific Lamprey Protection Guidelines for USDA Natural Resources Conservation Service Instream and Riparian Activities. July 2010 (Attached)

Part II.

Pacific Lamprey Protection Guidelines

for

USDA Natural Resources Conservation Service Instream and Riparian Activities

July 2010

Introduction

The Pacific lamprey (*Entosphenus tridentatus*, previously *Lampetra tridentata*) is an ancient and native species that has suffered widespread decline throughout the Columbia Basin and the Northwest coast, from California to Alaska (Close et al. 1995; BioAnalysts Inc 2000, Kostow 2002). These declines parallel those of Pacific salmonids, perhaps because the two groups share similar distribution, as well as anadromous life histories. Lampreys are not recognized as a sport or game fish species, thus relatively little attention has been given to its population status. The largely nocturnal lamprey has been poorly studied in comparison to the much more economically-valuable salmon. Historically widely distributed from Mexico north along the Pacific Rim to Japan, they are culturally important to indigenous people throughout their range (Close et al. 2002; CRITFC 2008). Their distribution is thought to have been at least as widespread as salmon and steelhead. As with salmon, the sheer abundance of this species during their spawning and juvenile migration stages likely plays a vital role in the ecosystem as food for mammals, fish and birds, as well as for marine nutrient cycling and storage to oligotrophic headwaters of freshwater stream systems. Pacific lamprey are a key indicator of the ecological health of the Columbia Basin and appear to be a choice food for avian, marine mammal and fish predators, and at times may be preferred over salmon smolts (Beamish 1980; Close et al. 1995). The species has played a vital part in the ecosystem for hundreds of millions of years. One of three lamprey species in the Columbia River Basin, the Pacific lamprey is the most important to local tribes (Close et al. 2002).

Like other lamprey species throughout the world, the Pacific lamprey's decline in abundance is linked primarily to habitat alterations from human causes (Renaud, 1997). Lampreys are vulnerable to habitat losses due to reduced river flows, water diversions, dredging, streambed scouring, channelization, inadequate protection of stream side vegetation, chemical pollution, and impeded upstream passage due to dams and poorly designed road culverts (Luzier et al. 2009). Severe declines in salmon abundance may also be influential in the lamprey decline because salmon are one of their primary food resources (Wydoski and Whitney 2003). Lamprey access to much of the historic spawning and freshwater rearing habitat has been blocked by main-stem and tributary dams and other channel spanning obstacles. Other factors include overall degradation of aquatic habitat and water quality, as well as past applications of fish eradication chemicals.

Conservation interest in Pacific lampreys has grown in recent years, with increasing attention from native tribes, government agencies, and other interest groups. In 2003, four lamprey species were petitioned for listing under the Endangered Species Act: the Pacific, western brook, Kern brook, and river lamprey. For the Pacific lamprey, the U.S. Fish and Wildlife Service (USFWS) review of the petition indicated a likely decline in abundance and distribution throughout California, Oregon, Washington, and Idaho, and the existence of both long-term and proximate threats to this species. However, the petition did not adequately define what portion of the species range should be listed under the Endangered Species Act; hence no status review was initiated (USFWS 2004).

As of 2010 in the Northwest region, state fisheries management agencies have classified Pacific lamprey conservation status as follows: Oregon-Sensitive, Washington-Monitor, and Idaho-Endangered. Federally, it is a USFWS-Species of Concern. Columbia River Basin Tribes (Nez Perce, Umatilla, Yakama, and Warm Springs) have drafted a Pacific lamprey restoration plan, and consider the species abundance and distribution to be "declining precipitously" (CRITFC 2008).

The USFWS has initiated a Conservation Initiative for the Pacific lamprey with the goal that listing may not become necessary if adequate reduction of threats to the species occurs. It is expected that while the Service would facilitate this proactive effort, it would do so with partners that are interested in the development of this Plan and implementation of its subsequent conservation actions. As a federal natural resource agency working on private lands in Idaho, Oregon, and Washington, NRCS is one of these key partners that can contribute to this conservation effort, as required in General Manual 190, Part 410, Subpart (B) 410.22 - Endangered and Threatened Species and Species of Concern. NRCS policy pertinent to Species of Concern, such as Pacific lamprey, is found in Appendix D. Further information for on-going conservation efforts, as well as current literature sources, can be found in Appendix A.

Pacific Lamprey Description, Life History, and Freshwater Habitat Requirements

There is considerable uncertainty about the biology and life history variations across the geographic range of Pacific lamprey. Research focusing on Pacific lamprey has increased over the last decade, due to concern for the species survival. This document summarizes what is known about the species and identifies conservation measures that should be taken during the planning and implementation of projects occurring in stream corridors, including streams, floodplains, and riparian areas. Additional details about lamprey biology and up-dated information can be found at the USFWS Pacific lamprey webpage, including the full version of the 2008 Proceedings of the Pacific Lamprey Conservation Initiative Work Session from which most of this information was assembled.

http://www.fws.gov/pacific/fisheries/sp_habcon/lamprey/pdf/October%202008%20Work%20Session%20Proceedings%20Final%204-9-09.pdf

This link to the USFWS Pacific lamprey website is also listed in Appendix A, along with a contact list for biologists currently working on Pacific lamprey conservation and management.

Species Description: Pacific lamprey belong to the genus *Entosphenus* in the subfamily Petromyzontinae, a primitive group of cartilaginous fish that are eel-like in form but lack jaws and paired fins. Lampreys have a round sucker-like mouth (oral disc), no scales, and multiple gill openings instead of an operculum (gill cover). Adult Pacific lampreys are characterized by the presence of three large teeth (cusps) and posterior teeth on the oral disc (Wydoski and Whitney 2003; Moyle 2002). Their lack of paired fins and elongated body shape causes them to swim by using an undulatory (snakelike) movement. They do not have swim bladders that allow them to maintain neutral buoyancy and must swim constantly or hold fast to objects to maintain their position in the water column.

Life History: Pacific lampreys are anadromous, spawning and rearing in freshwater, then spending most of their adulthood in the ocean. Like salmon, survival to maturity and spawning success is determined by the many challenges lamprey face moving thru multiple habitats in freshwater, estuaries, and the sea. The life cycle of the Pacific lamprey is complicated, each stage using different habitats over a broad geographical range (Figure 1). For this reason, habitat degradation or alterations in only one of its required habitats can affect the viability of lamprey populations.

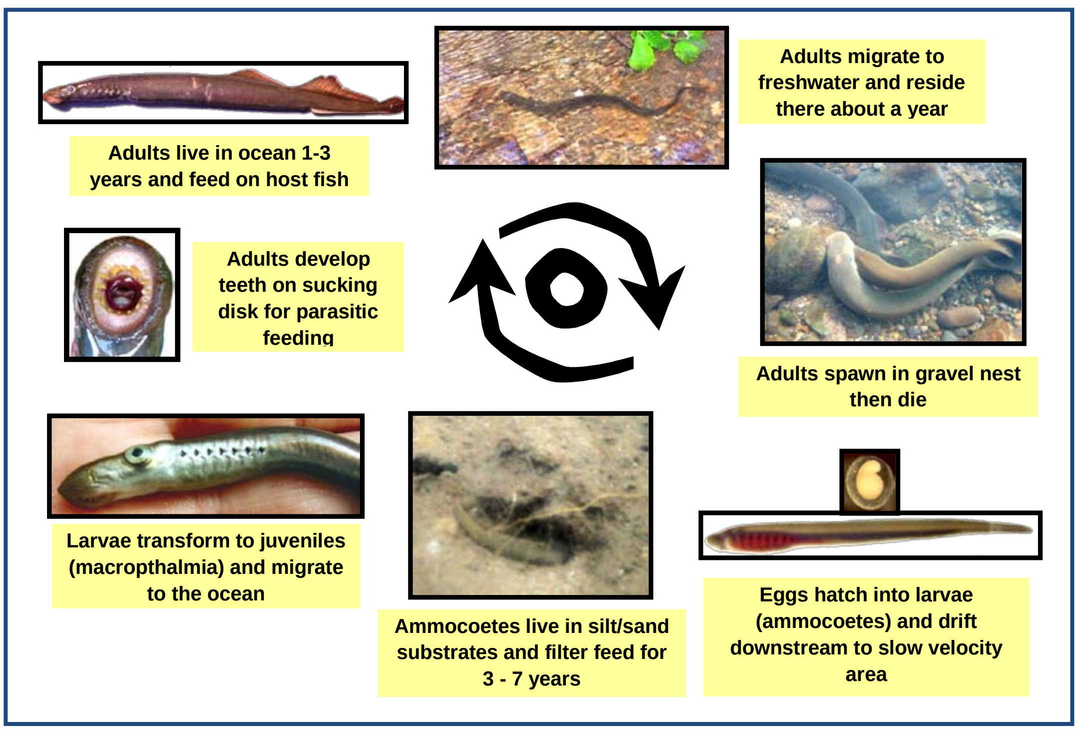

Figure 1 Pacific lamprey life cycle (Streif 2009*)*

Freshwater life history stages and habitats: After spending 1 to 3 years in the marine environment, Pacific lampreys are thought to return to freshwater largely between April to June (Kostow 2002). At this time, adult size varies from around 35 to 72 cm (14 - 28 in). Long migrations up the Columbia River and tributaries, such as the Snake, can continue as late as September. Keefer found that Columbia River adult lamprey annual run timing was dependent on temperature and river discharge rates, i.e. it was earliest during warm and low flow years and later in cold and high flow years (2009). At all life stages, the majority of migration occurs at night (Moser and Close 2003, Bayer et al. 2001, Close et al. 1995). Studies in the John Day and the Deschutes River found adult lamprey became dormant during the period from mid-September to mid-March, coinciding with decreasing temperature, day length and increasing stream/river discharge (Bayer et al. 2001, Graham and Brun 2007). Radio-tagged lampreys in these studies overwintered under large boulders in riffle and glide habitat before spawning the following spring. Adult Pacific lampreys do not feed after entering freshwater, relying on lipid reserves to survive through winter and subsequent spawning.

Spawning occurs primarily between March and July, depending upon location. In Oregon, coastal populations spawned early (March-May), while inland Columbia River populations spawned in June and July (Close et al. 1995). Spawning habitat is generally low-gradient stream reaches with areas of gravel deposits. Velocities are typically low, between 0.2 – 1.0 meter/second (0.7 to 3.3 feet/second) in areas less than 1 meter (3.3 ft) deep (Close et al. 1995; Gunckel et al. 2009). Some studies show that adults *may* select spawning streams by following pheromones emitted by ammocoetes (Robinson 2009). Further research is clearly needed to clarify many aspects of spawning biology, including redd (nest) selection, factors that determine upper limits of distribution, and spawning habitat requirements. Spawning activity typically occurs at night, with both sexes constructing the redd by moving individual stones with their mouths. Multiple redd construction has been documented, including redds that did not contain viable eggs (Moser and Close 2003). Fecundity is high but variable, with females producing between 20,000 and 200,000 eggs (Moyle 2002). Lamprey redds can be differentiated from steelhead or trout redds, that may occur during the same time period, by noting the placement of individual rocks upstream and to the side of the redd. More information and photos are provided in Appendix C. After the eggs are deposited and fertilized, the adults typically die within 3 weeks (Kostow 2002).

After the eggs are fertilized and deposited in the redd, embryos hatch in approximately 19 days at 15° Celsius (59° Fahrenheit). Upon hatching, larvae spend another week to a month in the redd. Emergent larvae are from 7-10 mm (0.3 - 0.4 in) and drift downstream to areas of low velocity with silt or sand substrate (Close 1995). Successful spawning grounds appear to be those located in riffle/gravel areas close to pools or other silt deposits so that the initial movement into burrows by the tiny larva is successful (Kostow 2002). Due to poor swimming ability, current over 0.305 m/s (1 foot/second) prohibits burrowing by these emergent larvae (Close et al. 1995). For the next 3 to 7 years, ammocoetes remain in their U-shaped burrows filter-feeding on diatoms, algae and detritus (Kostow 2002; Moyle 2002). Downstream movement occurs year-round, correlated with discharge events, as ammocoetes move gradually downstream, seeking coarser sand/silt substrates and deeper water as they grow. At this stage they range in length from approximately 13 to 20 cm (5 – 8 inches). In a 2003 survey of NE Oregon streams, ammocoete density ranged from a high of over 80/m^2 (7.4/ft^2) in the Middle Fork John Day basin, to a low of 2.1/m^2 (0.2/ft^2) in the Grande Ronde basin (Moser and Close 2003).

Once the ammocoetes are 11-16 cm (4-6 in), they begin metamorphosis into macropthalmia (Beamish 1980; Kostow 2002). This metamorphosis takes place over several months as developmental changes occur, including the appearance of eyes and teeth, as they leave the substrate to enter the water column and begin their migration to salt water. As with salmon juveniles, downstream migration of transforming ammocoetes and macropthalmia is passive and is thought to occur primarily from fall to early summer, with pulses during late spring and early summer freshets (Close et al. 1995; Kostow 2002).

Saltwater stage: As ocean adults, Pacific lampreys are parasitic and feed on a variety of marine and anadromous fish. They are preyed upon by sharks, sea lions, and other marine animals. They have been caught in depths ranging from 90 to 800 meters (300 to 2,600 feet), and as far as 100 kilometers (62 miles) off the coast in ocean haul nets (Close et al. 2002). Although the freshwater ecology of lamprey is currently poorly documented, data on their marine phase is even more limited. *For the purposes of this document, the protection guidelines focus on the freshwater habitats of Pacific lamprey.*

Pacific Lamprey Habitat Conservation During Freshwater Life Stages

The occurrence of substantial areas of juvenile lamprey habitat in a stream or river may not signify presence of lamprey populations at any particular time. However, it is beneficial to maintain the integrity of ALL of these areas as their use by spawning lamprey likely varies year to year. At present there is little evidence to suggest that adult lamprey home to their natal stream to spawn, although this has not been adequately studied. Actions that protect or restore lamprey habitats in streams and rivers will also improve stream corridor functions, and most likely habitat for other native fish such as salmon and steelhead.

Routinely considering the needs of Pacific lamprey in watersheds where they are likely to occur will contribute to their conservation/restoration and that of those habitats they require during their freshwater residency. When providing technical assistance to landowners implementing conservation practices in or near stream corridors, it is important to address the needs of juvenile and adult lamprey and their habitats. Project planning or approval should always consider the need to:

1. Provide or restore lamprey passage among freshwater habitats and between these habitats and the ocean.
2. Protect or restore suitable spawning and rearing lamprey habitat and associated stream channel complexity.
3. Protect or restore water quality and quantity.
4. Protect or restore the natural flow regime.

NRCS conservation practices that have the potential to positively or negatively impact lamprey individuals or habitat include (but are not limited to):

- Stream Habitat Improvement and Management; Fish Passage;
- Channel Stabilization, Streambank and Shoreline Protection; Open Channel, Clearing and Snagging;
- Water Control Structure, Pumping Plant for Water Control;
- Stream Crossing, Access Road;
- Pest Management, Nutrient Management;
- Dam, Diversion; Dike; Diversion; Grade Stabilization Structure; Watering Facility
- Irrigation Canals or Lateral, Irrigation Field Ditch; Irrigation Water Conveyance, Irrigation System, Surface and Subsurface, Pipeline, Pond; Surface Drainage, Field Ditch; Subsurface Drain; Surface Drainage, Main or Lateral;
- Shallow Water Management for Wildlife, Spring Development, Wetland Restoration, Wetland Wildlife Habitat Management, Wetland Enhancement, Fish and Wildlife Structure Obstruction Removal, and;
- Riparian Forest Buffer, Riparian Herbaceous Cover, Tree and Shrub Establishment, Critical Area Planting

While some Conservation Practice Standards address impacts and/or threats to aquatic species of concern in either the standard's Criteria or Considerations, a relatively quick assessment of the site to specifically address the need to protect Pacific lamprey and their habitats is warranted. Ground-disturbing activities in or near streams, rivers, floodplains, riparian areas and riverine wetlands can be implemented in ways to minimize their impact to Pacific lamprey and other stream and riparian species, using Best Management Practices (BMPs) described in this document.

Lamprey, and all stream species, may potentially be harmed by actions that alter or degrade these 3 habitat elements:

1. **Natural flow characteristics** (volume, timing, area of inundation).
   - Practices that alter natural flows include diversions, dams, dikes, and road crossings.
2. **Streambed material**.
   - Activities that disturb streambeds include dredging, in-stream excavation/fill, and channelization.
3. **Water quality** (temperature, turbidity, chemical applications).
   - Actions that affect water quality include riparian vegetation removal, chemical applications, effluent discharges, diversion of surface water.

The extent and severity of the impacts to local Pacific lamprey individuals or populations depends greatly on *project timing* and the *potential for lamprey habitat found within the impacted project area*. A project may impact one, two or all three habitat elements listed above***. During the project planning stage,*** use the Dichotomous Key on the next page to assess potential impacts to Pacific lamprey from a specific project. Along with the 3 habitat elements listed above, Table 1 (below) summarizes the habitat requirements and timing for each life stage to aid in determining potential impacts of the project.

Table 1. Pacific lamprey freshwater life stage timing and key habitat use.

Adult spawning and egg/larval incubation	**Ammocoete** (rearing)	**Macropthalmia** (transformation and downstream migration)	**Adult** (upstream migration and overwintering)
• low gradient • gravel substrate (2-5 cm or 0.8-2 in)	• low gradient and low velocity • silt, sand downstream of suitable adult spawning habitat	• unimpeded downstream connection to ocean	• unimpeded upstream migration corridor from ocean • overwintering areas in riffles and glides, esp. areas containing large boulders
March – July; with range from Feb-Sept, dependent on location. Eggs hatch in around 20 days.	Year-round	Downstream migration from fall to early summer, with peaks during spring and summer freshets	Potentially present year-round: Upstream migration from Feb - Sep; peaking April - June. Overwinter Sept - March.

Dichotomous Key for Analyzing Potential Impacts to Lamprey During Project Implementation

1. **Will the project have potential to alter (disturb) natural stream flow, streambed material or water quality?** This includes both short-term and long-term effects.

    No - No need to further consider lamprey in project design.

    Yes – Go to 2.

2. **Is the project in known lamprey range? If unknown, is the project within anadromous fish range (which is the current surrogate for historic or potential lamprey habitat)?** Consult the most current lamprey distribution maps, provided here in Appendix C; contact the NRCS State Biologist, as well as consult with local State Department of Fish and Wildlife biologists. Further information is provided in Appendix A: an abbreviated list of relevant references, as well contact information for USFWS biologists currently on the Western Lampreys Conservation Team.

    No – Go to 3.

    Yes – Go to 4.

3. **Does the project have potential to negatively impact potential lamprey habitat downstream through flow alteration, sediment input or water quality degradation?** Reference Pacific lamprey habitat provided in Table 1.

    No – No need to further consider lamprey in project design.

    Yes – Go to 4.

4. **Can actions be designed to prevent negative impacts to lamprey habitat while the specific life stage is present?** Project plan modifications to reduce impacts to lamprey include (a) adjusting the in-stream work window to avoid spawning adults and incubating eggs, or (b) avoiding disturbance of key habitats during lamprey use periods, as indicated in Table 1. Refer to the Best Management Practices (BMPs) provided later in this document to minimize disturbance of specific habitat elements.

    No – Identify specific habitat elements that may be disturbed by the program activity and incorporate applicable BMPs listed in the next section to limit adverse effects to lamprey. Include opportunity to restore habitat use or passage for lamprey, as consistent with the local geomorphology.

    Yes – Proceed with program project, including opportunities to restore habitat use for lamprey, as consistent with the local geomorphology.

Desirable Pacific lamprey habitat attributes include:

- Stream and river reaches that have relatively stable flow conditions (sustained increases or decreases that take place over days and weeks rather than hours) and that are not extreme or flashy, offer the best opportunities to support all life stages of lampreys;
- Large substrates (i.e. very large cobble and boulders) submerged in low or no flow areas of rivers and streams may provide high quality adult overwintering habitat.
- Areas of small to medium cobbles, free of fine sediment, serve as spawning habitats. Spawning habitats created or enhanced for salmonids are generally compatible with the needs of lampreys;
- Depositional areas, including alcoves, side channels, backwater areas, pools, and low velocity stream and river margins that recruit fine sands and silts, downstream of spawning areas, provide ideal ammocoete rearing areas and should not be reduced.
- A mix of deep pools, low velocity rearing areas with fine sand or silt, and silt-free cobble areas upstream of rearing areas, all combined with summer temperatures that rarely or never exceed 20^{o} C, is believed to provide high quality habitat conditions for all life stages.
- Occurrence of substantial areas of juvenile lamprey habitat may not signify presence of lamprey populations as populations have a disparate distribution. However, it is important to maintain the integrity of these areas as their use by lamprey may vary temporally.

Best Management Practices to Reduce Impacts to Pacific Lamprey from NRCS Instream and Riparian Actions

1. Alteration or disruption of natural stream flow

Threats: Reduced natural stream flow *at any time and for any duration* directly reduces the amount of habitat available downstream in the short and long-term. Rapid fluctuations in stream water levels can cause injury or mortality through desiccation of lamprey redds, disruption of adult upstream migration, and stranding of ammocoetes, macropthalmia, and over-wintering adults. One dewatering event in ammocoete habitat can have a significant effect on a local lamprey population if multiple year classes are in, or downstream of, the de-watered area.

Diversions and dams can impede or fully block upstream migrations by adult lampreys and downstream movement of ammocoetes and macropthalmia. Evidence suggests dams with fish ladders designed for salmonids do not provide passage for lampreys. Due to their body shape, lampreys swim differently from trout and salmon, especially in high velocity areas. A hanging (perched) culvert of even a couple of inches is a barrier to lampreys (Moser and Mesa 2009). The excessive use of swimming energy required by adult Pacific lampreys to negotiate fish ladders or culverts combined with sharp angles and high water velocities, effectively block or restrict them from migrating upstream. Dams and fishways designed to pass adult salmon have an entrance criteria to maintain velocities of about 3 m/s (9.8 feet/s), while adult lamprey have a difficult time swimming forward in velocities over 2 m/s or 6.6 feet/s (Mesa et al. 2003). When the water velocities exceed their swimming speed, adult Pacific lamprey will attach to a nonporous surface with their oral disc. Once attached, the lamprey is then able to move forward with short incremental bursts, reattaching in between, until it is through high velocity areas. Thus, any constriction such as sharp corners, vertical walls and lips, and diffuser gratings in areas with high water velocities can delay or block lamprey movements, because they cannot attach effectively to these surfaces. Adult lampreys have been observed to slip through gratings and be trapped below floor diffusers during fishway dewatering. Other fishway features developed for salmon, such as sharp-cornered serpentine weirs, diffuser gratings with large gaps below and above submerged orifices, and vertical slots mpair adult lamprey passages (Moser et al. 2009; CRITFC 2008). Based on experiments at Bonneville Dam, reduction in diffuser gratings from 2.5 cm (1 in) to 1.9 cm (¾ in) eliminated trapping of adults below main fishway channels (Moser et al. 2008).

Ammocoetes can make short upstream migrations, but are more likely to move downstream (Moser and Mesa 2009). During downstream migrations larval lampreys (both ammocoetes and transforming ammocoetes) may be entrained in water diversions. In many cases, water diversion projects have been screened to bypass juvenile salmonids. However, due to their small size and dissimilar swimming ability, juvenile lampreys are impinged on the screens, resulting in injury or death. Vertical barrier screens developed to bypass and collect juvenile salmon for transportation over dams also result in impingement of juvenile lamprey (CRITFC 2008). Drum and flat plate screens installed in irrigation and municipal water withdrawal structures were designed to exclude juvenile salmon with a maximum approach velocity of 0.15 m/s (0.5 ft/s). These velocities are in well in excess of the swimming avoidance capabilities of lamprey ammocoete and macropthalmia (Ostrand 2004). Ostrand conducted laboratory tests on lamprey macropthalmia on screens that met salmon criteria and found that lamprey tended to adhere to the screens and were likely to be crushed by cleaning devices used to clear the screens of debris. Decreasing the cycle time for debris brushing could potentially lower lamprey impingement rates, but further research is needed to quantify effectiveness rates. At the low water velocities tested, the screen velocity criteria seemed appropriate for juvenile lamprey, however; even then, lamprey did tend to group in areas where attachment was facilitated. With thousands of these screens now in place, or planned for installation throughout the Columbia River Basin, the challenge to design screen or other occlusion structures that protect and keep juvenile lamprey out of withdrawal structures is critical.

Laboratory studies conducted by Battelle in 2000 (Moursund et al. 2001) demonstrated that the primary factors causing lamprey to become stuck on hydroelectric facility screens are a combination of water velocity and time in contact with the screen. Juvenile lamprey cannot swim faster than the water velocities found at the screen face. These studies also demonstrated that juvenile lamprey were likely to become stuck in 3.2 mm (1/8-in) bar screen when approach velocities exceed 0.9 m/s (3 ft/s). As a result they experience an almost instantaneous impingement on the screen. Most are able to move along the screen face; however, some become stuck in the 3.2 mm (1/8-in) spacing between the bars. Replacement of 3.2 mm (1/8”) screen with 2.3 mm (3/32") bar material, along with decreases in water velocity past the screen, would decrease impingement of juvenile lamprey.

New NRCS projects that will divert, alter, or dam natural waterways should incorporate short and long-term protection of lamprey at the onset of project planning. Short-term protection for lamprey includes the minimization of harm during project implementation. Long-term protection includes analysis for benign effects to Pacific lamprey due to structure design and placement. In addition, opportunities also exist for retrofit of existing structures to facilitate lamprey passage.

Flow alterations can be divided into 2 types of duration: temporary or permanent. Temporary flow alterations often occur from de-watering discrete areas of a stream to complete work in the channel. Temporary dewatering is required to minimize downstream sedimentation, reduce impacts to aquatic species of concern (such as salmon, steelhead and bull trout), and allow construction of concrete structures, culverts, weirs, logjams, etc. in dry conditions. Permanent stream flow alterations or disruptions are largely a result of water diversions for various uses, such as irrigation, hydro-power, or stock ponds.

Recommended BMP for activities that will cause alteration or disruption of natural stream flow

(1) Temporary de-watering

- Timing of instream activities is an extremely important consideration to avoid affecting spawning adults (generally March –July in low gradient gravel beds) and disruption of existing redds. Lamprey and steelhead redd photos are provided in Appendix C in case excavated redds are noted at the project site. Reference Table 1 and consult local area biologists (Appendix A) to pinpoint timing of spawning runs as much as possible. Instream work windows to avoid adverse impacts to spawning anadromous salmonids typically last from July through August, which would partially avoid impacts to lamprey on the tail end of the spawning/rearing season only. Due to geographic location or high elevation, spawning and subsequent egg incubation may start as early as March and extend into September, or later. In these cases, work with local biologists (DFW, NMFS, or USFWS) to conduct surveys and/or obtain an extension of the in-water work window to balance the needs of both lamprey and other federally listed fish species. As ammocoetes, macropthalmia and adults can be present almost year-round; it is not possible to avoid impacts from timing alone.
- De-watering in areas of known, or suspected, lamprey habitat should be avoided as much as possible. If de-watering is unavoidable by project design or timing restrictions, involve a partner agency or entity that can survey and move lamprey juveniles to a safe area. See Appendix C for a publication of methods for detection and salvage is (Moser et al 2007).
- If de-watering is necessary in ammocoete habitat: *(directly from April 2010 BMPs for FS, BLM and USFWS).*
  - Make all attempts to de-water the habitat within the work area over several days to allow for ammocoetes to burrow out and relocate to new sites downstream (availability of suitable habitat should be identified).
  - Identify areas adjacent to ammocoete habitat outside of the disturbance area but within the channel and dig holes (e.g., few scoops with a backhoe, etc.) where ammocoetes may take refuge as dewatering occurs. Cover these ‘refuge’ holes to protect them from predators; anecdotal information suggests ammocoetes will move into areas that retain water;
  - Try an experimental technique – there is some evidence to suggest that if straw bales are placed in habitats where ammocoetes are present, they will move into the straw as dewatering occurs and can be safely removed the next day. If successful, document and provide this information to the US Fish and Wildlife Service (contact information in Appendix A).

(2) Permanent de-watering

Negotiate water savings and ditch consolidation wherever possible to provide more instream flow. Avoid reduction in streamflows of a magnitude that redds and occupied ammocoete habitat would be exposed and desiccated.

Diversions

- When diversion structures are opened, request that they are opened during the day (lampreys move at night) and operated slowly to avoid entraining ammocoetes or macropthalmia.
- When shutting off a diversion, do so slowly, ideally starting at night and lasting for several days, so the lamprey can escape if they are between the headgate and any fish screen, or trapped behind the screen in the ditch. Start by cutting the flow to 50% for the first 24 hours, and then to 75% over the next two days. Then, drop flow to 80-90% for a few days with the screen lifted (if applicable). This technique is also used for salmonids. The goal is to keep a continuously wetted channel between the diversion point and downstream wetted area in the ditch to facilitate movement out of the ditch.

Fish Passage

- Provide passage over diversions, dams, culverts, and other structures that block upstream passage for adult lamprey. Design structures that reduce passage flow to <2m/s (6.6 ft/s) to facilitate adult passage. Create smooth surfaces and rounded corners (with no 90^o bends) in high velocity areas. Replace culverts with poor passage efficiency (such as hanging culverts) with a stream simulation design culvert or bridge. Temporary passage at hanging culverts can be improved by piling rock at a culvert outlet in the water overflow or fitting the outlet with attachment surface (e.g., flat plate) for temporary passage.

  There are existing designs that will pass adult lamprey. Contact the USFWS for assistance with choosing a passage structure with the most current and site-specific design (contact information in Appendix A). Recent retrofits to facilitate adult passage have included installation of ramps, plates over diffuser areas, modifying head differentials over weirs, rounding sharp corners, and more recently installing long, fabricated, metal boxes (Lamprey passage systems or LPS) that allow lamprey passage access over difficult passage areas such as serpentine weirs in fish ladders and wall dividers (Streif 2009; Moser et al. 2009).

- Reduce approach velocities to less than 0.40 ft/s for active screens or 0.20 ft/s for passive screens to allow for ammocoetes and macropthalmia avoidance of the structure (Dauble et al. 2006). Ammocoetes were found to become impinged on bar screens at hydroelectric facilities at velocities of 1.5 ft/s or higher (Moursund et al. 2001). In testing three types of screen materials (hydroelectric facilities), no lampreys became permanently stuck on 2.3 mm (3/32”) bar screen (Moursund et al. 2001).

  The combination of screen type, water velocities, screen orientation, and screen material will have different effects on juvenile lamprey. Currently, research that would derive at precise criteria to prevent entrainment of juvenile lamprey at diversions is lacking. Contact the USFWS for assistance with choosing a by-pass system that would include the most current and site-specific design (contact information in Appendix A).

2. Alteration or disturbance of streambed material

Threats: Dredging, excavation, heavy machinery tread, and other activities that disturb or remove silt or sand substrate materials may result in injury or mortality of rearing ammocoetes. Activity in low gradient gravel substrate during spawning period may result in injury or mortality of spawning adults incubating eggs. Avoid depositional areas, including alcoves, backwater areas, pools, and low velocity stream and river margins that recruit fine sands and silts downstream of spawning areas. These provide ideal ammocoete rearing areas. Ammocoetes also may use low velocity pockets of water with sand behind boulders (Streif 2009).

Recommended BMP for activities that will cause streambed alteration or disturbance

- Meet current criteria for salmonids to minimize downstream effects from turbidity or sedimentation during project construction.
- Adults - Timing of instream activities is the only way to avoid affecting spawning adults (generally March –July in low gradient gravel beds) and disruption of existing redds when the project action will disturb occupied spawning habitat. Lamprey and steelhead redd photos are provided in Appendix C in case redds are noted at the project site. Reference Table 1 and consult local area biologists (Appendix A) to pinpoint timing of spawning runs to the extent feasible. Instream work windows to avoid adverse impacts to spawning anadromous salmonids typically last from July through August, which would partially avoid impacts to lamprey on the tail end of the spawning/rearing season only. Due to geographic location or high elevation, spawning and subsequent egg incubation may start as early as March and extend into September, or later. In these cases, work with local biologists (ODFW, WDFW, IDFG, NMFS, or USFWS) to conduct surveys and/or obtain an extension of the in-water work window to balance the needs of both lamprey, and other federally listed fish species or species of concern.
- Larvae/Juveniles – Ammocoetes and macropthalmia are present year-round in suitable habitat, thus timing restrictions do not address risk of direct mortality. Extensive streambed disturbance in areas of known, or suspected, lamprey habitat should be avoided. If dredging, excavation, or other fine sediment disturbance is unavoidable by project design, involve a partner agency or entity that can survey and attempt to salvage lamprey juveniles to a safe area. A publication that provides methods for detection and salvage is located in Appendix C (Moser et al 2007).
- Protect ammocoete rearing habitat by maintaining channel stability (gradients) by preventing headcutting.

Photos of Pacific lamprey ammocoete (right) and macropthalmia (left) showing multiple age-classes that may be present in suitable habitat, courtesy of ODFW

3. Alteration or degradation of water quality

Threats: Chemical treatment (pesticides, herbicides, biocides) can injure or kill ammocoetes burrowed in streams, depending on concentration and distance from point sources. Herbicides have potential to have indirect effects to lamprey through short-term depletion of phytoplankton and zooplankton communities. Water temperatures of 22^{o} C (71.6^{o} F) or higher may cause significant mortality or deformation of eggs or ammocoetes. Accumulated toxins in the lower reaches of streams and rivers may affect ammocoetes because they are often found in these areas.

Use of chemicals with potential impacts to fish has been highly regulated. Studies have reported both lowered and increased primary productivity due to various herbicide applications to control aquatic macrophytes, as well as a great deal of variability in toxicity among microbial species (Schaffer and Sebetich 2004, DeLorenzo et al. 2000). Studies to quantify indirect impact from chemical application on larval lamprey food supply is not available, although indirect impacts from herbicide use on aquatic primary productivity in phytoplankton have been hypothesized (NCASI 2009).

Elevated water temperature has been documented as a mortality factor for eggs and early stage ammocoetes under laboratory conditions. In a 2005 study of Columbia River Pacific lamprey, survival appeared to be optimal between 10-18^{o}C (50-64.4^{o} F), with a sharp decline in survival at 22^{o}C (71.6^{o} F) (Meeuwig 2005). This may be a common occurrence in degraded streams during the early to mid-summer period of lamprey spawning and ammocoete development.

Recommended BMP for Activities That Will Alter or Degrade Water Quality

- In watersheds occupied by lamprey, avoid actions that will modify natural temperature regimes of water bodies, especially where it may result in the increase of water temperatures over 22^{o}C (71.6^{o} F). Example actions include riparian vegetation removal, ponded water release, diverting water from the stream, stream channelization, floodplain wetland drainage, excavation of the channel to remove bedload.
- Evaluate the use of chemical applications for toxicity ratings using Window Pesticide Screening Tool (WIN-PST); apply mitigation measures for rating of Intermediate and higher.
- Incorporate buffers, as needed, to reduce risk of water quality impairment from project actions.

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Appendix A – Further sources of information and contacts

Website link for USFWS Western lamprey conservation planning (including spawning video)**:** http://www.fws.gov/pacific/fisheries/sp_habcon/lamprey

Tribal Pacific lamprey restoration plan for the Columbia River Basin. (Provides background and **d**escription of the significance of lamprey to tribal culture)**:**

http://www.critfc.org/text/lamprey/restor_plan.pdf

Pacific lamprey spawning videos (e spawning habitat visuals): http://www.youtube.com/watch?v=wEkeHATroXo

Oregon lamprey natural history, status, and analysis of management Issues (2002) - Excellent summary for Oregon populations (there are currently no comparable reports for WA and ID states): http://nrimp.dfw.state.or.us/CRL/reports/info/2002-01.pdf

Best Management Practices to Minimize Adverse Effects to Pacific lamprey (*Entosphenus tridentatus*), April 2010. This document was written for USDA Forest Service, USDI Bureau of Land Management, and USDI Fish and Wildlife Service activities in the Columbia River basin, but it is generally applicable to guide instream activities anywhere within Pacific lamprey range.

http://www.fws.gov/pacific/fisheries/sp_habcon/lamprey/pdf/Best%20Management%20Practices%20for%20Pacific%20Lamprey%20April%202010%20Version.pdf

Publication not yet available online:

2009 American Fisheries Society publication: *Biology, Management, and Conservation of Lampreys in North America*, edited by Larry Brown, Shawn Chase, Matthew Mesa, Richard Beamish, and Peter Moyle; Purchase information located at http://www.afsbooks.org/54072P

Lamprey information contacts USFWS Western Lamprey Conservation Team (2009):

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(208) 756-5162, jody_brostrom@fws.gov

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Bianca Streif – Oregon Fish and Wildlife Office, Portland, OR
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Appendix B. Current distribution of Pacific lamprey in Oregon, Washington and Idaho, as of March 2010. Sources are referenced for each map.

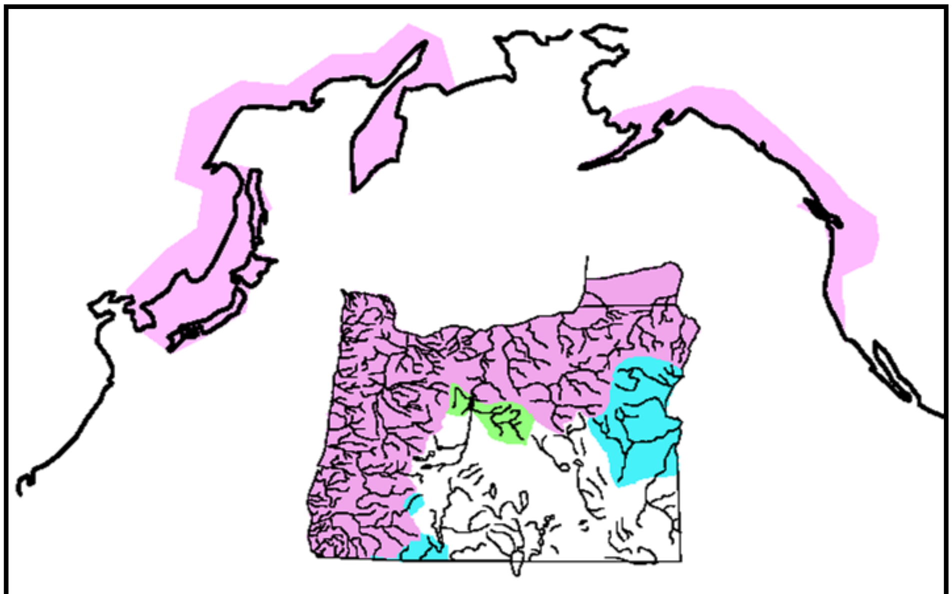
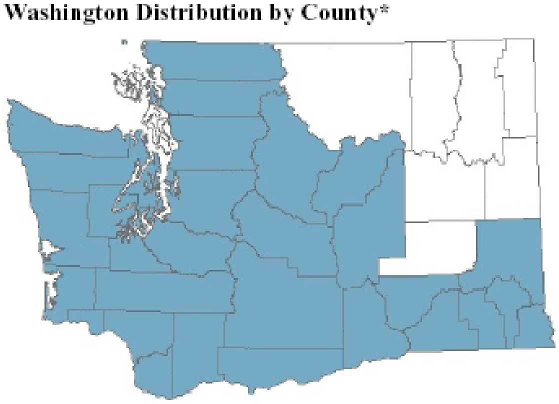


Figure 1. Present and historic distribution of the anadromous Pacific Lamprey (*Lampetra tridentata*) in Oregon and around the Pacific Rim. Present distribution (pink); area of known historic distribution (green) and areas of suspected historic distribution (blue).

ODFW Kostow, (2002). More detailed distribution maps can be found in her report

Pacific Lamprey
Lampetra tridentata

Washington Distribution by County*

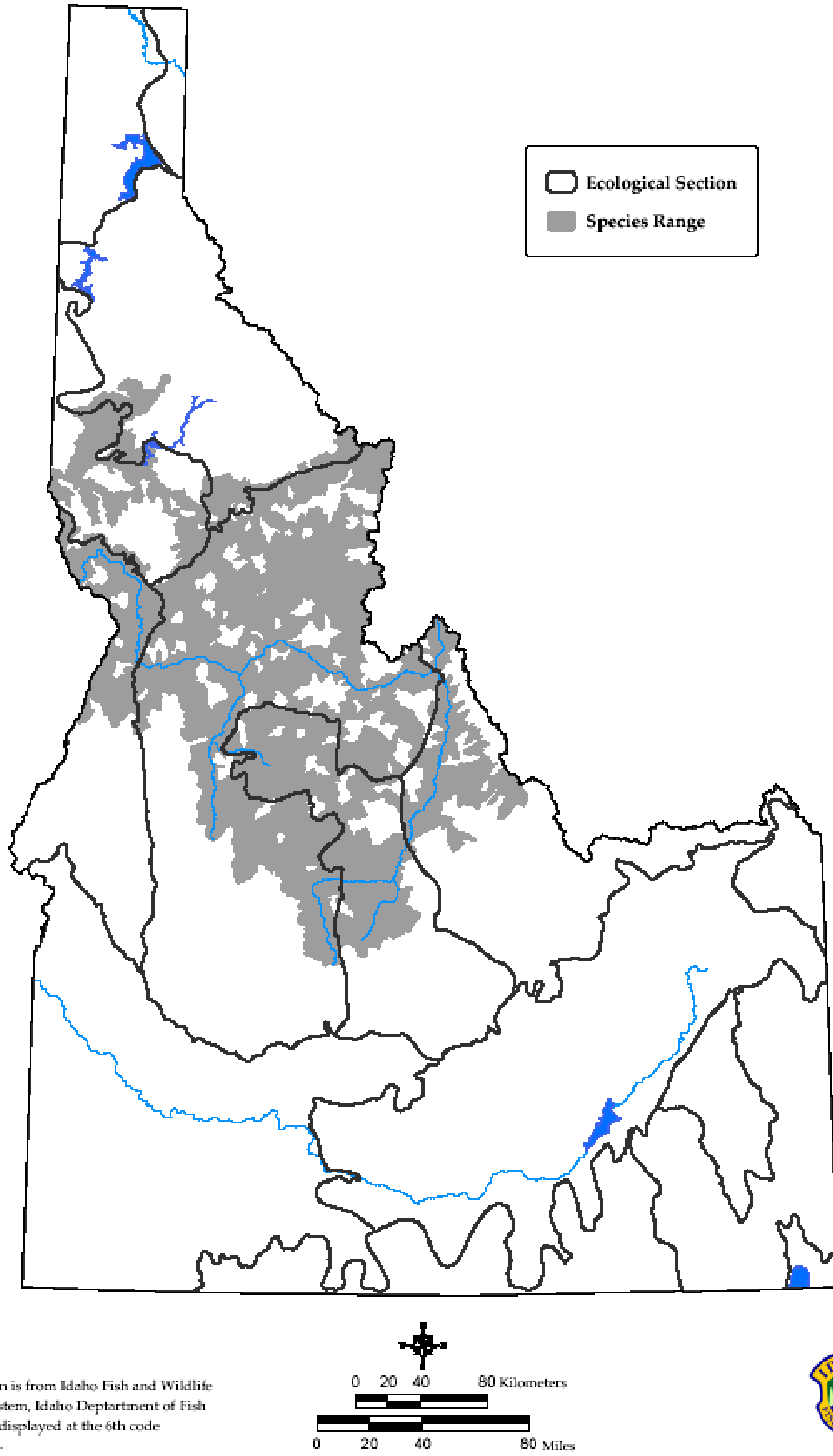


State Status: None **Federal Status:** Species of Concern	
PHS Species Criteria #3	
Priority Area - Any occurrence	
Online information and guidelines for management of **Pacific Lamprey**: NatureServe Species Report	

WDFW Priority Species and Habitat website (http://wdfw.wa.gov/hab/phslist.htm)

Pacific Lamprey

Lampetra tridentata



15 August 2005
Fish information is from Idaho Fish and Wildlife Information System, Idaho Deptartment of Fish and Game and displayed at the 6th code hydrologic unit.

Appendix C. Lamprey survey methods

A detailed review of the capture and collection of lampreys can be found at Moser et al. 2007.

Moser, M. L., J. M. Butzerin, D. B. Dey. 2007. Capture and collection of lampreys: the state of the science. Reviews in Fish Biology and Fisheries.17(1):45–56.

http://www.springerlink.com/content/d252704418507201/fulltext.pdf

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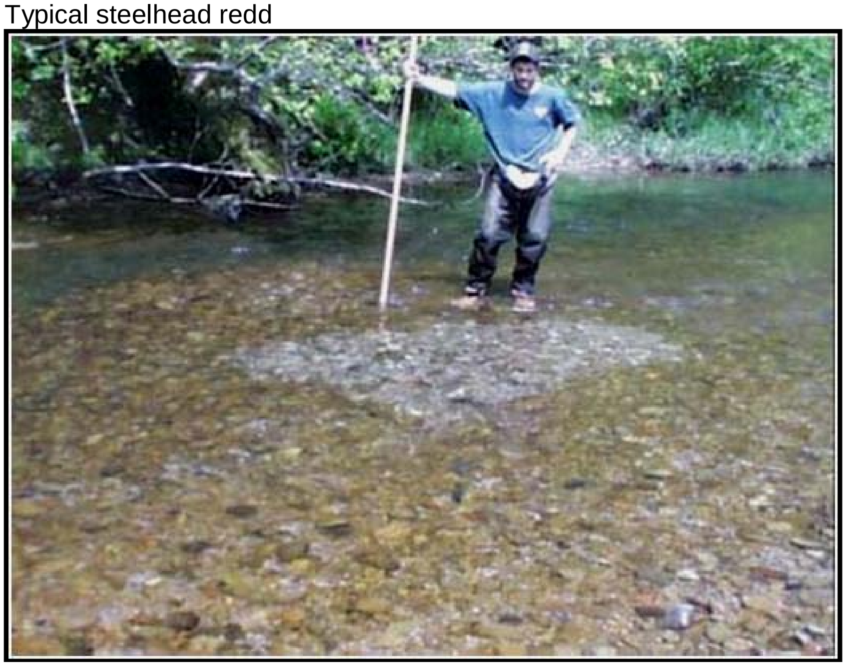
Photos of lamprey redds to assist with identification are provided below, courtesy of ODFW.

Lamprey redd showing placement of spawning substrate (gravel and cobble) upstream and to the side of the redd (unlike steelhead redds).

Multiple lamprey redds, about 5 feet wide but tailings of only 2 feet long.

Small lamprey redd, 1 foot in diameter

Typical steelhead redd



Typical pacific lamprey redd

Appendix D. NRCS General Manual Directive (policy requirements pertinent to Pacific lamprey are underlined):

GM_190_410_B_22 - 410.22 - Endangered and Threatened Species and Species of Concern

Purpose This policy prescribes the requirements for providing NRCS technical assistance to clients, implementing NRCS actions, and meeting NRCS' responsibilities for the conservation of species identified by Federal, State, and Tribal entities.

Authorities (3) NRCS regulations at 7 C.F.R. Section 650.22(b) require that the NRCS concern for species and habitats will not be limited to those federally listed or proposed under ESA, but will include those designated by State agencies and tribal governments as endangered, threatened, or species of concern*****.

NRCS Policy

(1) NRCS is committed to supporting its clients and partners by providing technical assistance and NRCS actions to conserve and improve natural resources on private lands. Within this framework, and consistent with legal requirements, the implementation of conservation programs through planning and application of conservation practices and measures shall provide for the conservation of:

- (i) Federally listed species (endangered and threatened).
- (ii) Species proposed for Federal listing.
- (iii) Federal candidate species.
- (iv) Federally designated and proposed critical habitat.
- (v) State and Tribal species of concern and their habitats.

(7) Federal Candidate, State, and Tribal Designated Species of Concern.

- (i) NRCS shall use its authorities and programs to provide for the conservation of Federal candidate and State and Tribal species of concern.
  NRCS shall contact the Services, State agencies, and Tribal governments to identify Federal candidate, State and Tribal designated species, and NRCS actions which have the greatest potential to affect those species and their habitats.
  NRCS shall determine which candidate species and species of concern are to be considered during planning and implementation of NRCS actions.
- (ii) Federal Candidate Species
  NRCS Technical Assistance or NRCS Action – When NRCS concludes that a proposed action "may adversely affect" Federal candidate species identified in (7)(i)(A) above, NRCS will recommend only alternative conservation treatments that will avoid adverse effects, and to the extent practicable, provide long-term benefit to the species. If the species becomes federally listed, proposed for listing, or the critical habitat is federally designated or proposed prior to the completion of the action, the project will be halted while the necessary consultation or conferencing requirements are met.
- (iii) State and Tribal Designated Species of Concern
  NRCS shall fully incorporate the species protection requirements identified during State and Tribal coordination into NRCS conservation plans and contracts. NRCS shall ensure that NRCS funded or controlled actions do not violate State or Tribal law or administrative rule.
  Discretionary conservation recommendations from States and Tribes shall be incorporated to the maximum extent practicable.
  NRCS technical assistance only. When NRCS concludes that a proposed action "may adversely affect" State or Tribal designated species of concern, NRCS will recommend only alternative conservation treatments that will avoid or minimize adverse effects to the extent practicable. Should the client or landowner refuse to apply the recommended alternative conservation treatment, NRCS will inform the client and landowner of the NRCS policy and shall terminate assistance for the action or portion of the action affecting the species of concern.
  NRCS Action – When NRCS has authority controlling the implementation of actions which may affect State or Tribal designated species of concern, NRCS shall coordinate with the appropriate State or Tribal government and receive concurrence on recommended alternatives when required by State law or administrative rule. Any needed permits shall be obtained by the landowner or their designee. Should the client or landowner refuse to apply the recommended alternatives, NRCS will inform the client and landowner of the NRCS policy and shall terminate assistance for the action or portion of the action affecting species of concern.

*****Definition of "Species of concern" = any species officially designated by law or administrative rule by a State or Tribe as endangered, threatened, rare, declining, sensitive, or otherwise at risk.

GM_190_411 - Part 411 - Riparian Area Recognition and Management

411.0 Purpose

This policy is to guide NRCS personnel in providing assistance on lands that include riparian areas. NRCS assistance helps land users make sound resource management decisions. NRCS must strive to provide the best alternatives for the proper use and management of these important natural resources.

411.3 Planning Riparian Areas

A. NRCS will assist the land user to recognize the values and functions of riparian areas including their contribution to flood control, stream bank stability, nutrient cycling, stream food webs, large wood recruitment to stream channels, pollutant filtering, sediment retention, and wildlife migration corridors. Riparian areas provide fish and wildlife habitat, forage and forest product production, and recreational activities. Local and regional water cycles will affect the size and value of a riparian area.

B. Riparian areas are not a separate land use, but may exist within all land covers and uses, such as cropland, hayland, pastureland, rangeland, and forest land.

C. Riparian areas will be described in the Conservation Management System planning process contained in the National Planning Procedures Handbook for the appropriate land use. Plans that include riparian areas will meet the quality criteria for the soil, water, air, plant, and animal resources within the riparian areas. Additional planning guidelines are contained in the National Biology Manual, National Forestry Manual, National Biology Handbook, and National Range and Pasture Handbook. These manuals or handbooks will be updated and amended at the State and national levels to address the proper conservation use and management of riparian areas that occur within the various land uses.

D. Riparian area management shall be integrated into plans and management alternatives developed for the conservation treatment unit (CTU). Management alternatives will be based on those resource concerns and conservation treatments necessary to solve all the resource concerns in the CTU and meet the land user's objectives. Because of a riparian area's unique position near watercourses or water bodies, the planner should always consider the water quality and quantity benefits, and fish and wildlife benefits provided. The plans must maintain or improve those benefits. Intermittent and perennial streams transport sediment, water, energy, and propagules across property boundaries and provide fish and wildlife corridors so plans must carefully consider downstream and upstream effects of conservation practices and systems. If the land user's objectives are in conflict with conservation of the riparian area resources, alternatives must be presented that identify ways to resolve conflicts.

E. Ecological Site Descriptions provide the specific and dynamic ecological interactions occurring within riparian areas and can assist the land user in making management decisions for these areas.

F. Leadership for riparian area technology and application will be shared among technical disciplines. The identified land use of a riparian area will determine the appropriate manuals, handbooks, and other documents to use for inventorying, planning, and plan implementation.