January 28, 2003

In the Office of Endangered Species
Fish and Wildlife Service
United States Department of the Interior

A Petition for Rules to List:

Pacific Lamprey (*Lampetra tridentata*);
River Lamprey (*Lampetra ayresi*);
Western Brook Lamprey (*Lampetra richardsoni*); and
Kern Brook Lamprey (*Lampetra hubbsi*)

as Threatened or Endangered Under the Endangered Species Act.

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Klamath-Siskiyou Wildlands Center, Siskiyou Regional Education Project, Umpqua Watersheds, Friends of the Eel, Environmental Protection Information Center, Native Fish Society, Center for Biological Diversity, Northcoast Environmental Center, Oregon Natural Resources Council, Washington Trout, and Umpqua Valley Audubon petition the Secretary of the Interior in the alternative as follows:

1) to list as threatened or endangered and designate critical habitat for Pacific lamprey, river lamprey, western brook lamprey and Kern brook lamprey found in California, Oregon, Washington and Idaho; or

2) to list as threatened or endangered and designate critical habitat for one or more distinct population segments of Pacific lamprey, river lamprey, western brook lamprey, and Kern brook lamprey, comprised of one or more major river basins within California, Oregon, Washington, and Idaho.

Petitioners file this petition under the Endangered Species Act (herein after the "Act" or "ESA"), 16 U.S.C. sections 1531-1543 (1982). This petition is filed under 5 U.S.C. section 553(e), and 50 C.F.R. part 424.14 (1990), which granted interested parties the right to petition for the issue of a rule from the Assistant Secretary of the Interior. The petitioners' request that Critical Habitat be designated pursuant to 50 CFR 414.12, and pursuant to the Administrative Procedures Act (5 U.S.C. 553). The U.S. Fish and Wildlife Service (USFWS) has jurisdiction over this petition (USFWS 1974). Petitioners understand that this petition sets in motion a specific process placing definite response requirements on the USFWS and very specific time constraints upon those responses. The petitioners are conservation organizations. Failure to grant the requested petition will adversely affect the aesthetic, recreational, commercial, research, and scientific interests of petitioning organizations' members and of the citizens of the United States. Aesthetically, recreationally, and commercially, the public shows increasing demand for wild ecosystems and increasing concern for imminent loss biodiversity.

Submitted by:

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I. Petitioners

The **Klamath Siskiyou Wildlands Center** is a tax-exempt, non-profit public interest organization with over 400 members. Its mission is to protect the biological diversity and wild areas in the Klamath-Siskiyou region and its interregional connections. The Public Lands Oversight and Biodiversity Campaigns are designed to curb the loss of essential ecological elements of natural systems.

The **Siskiyou Regional Education Project** is a tax-exempt, non-profit public interest organization with over 1500 members. For future generations of all species, the Siskiyou Project is the grassroots network dedicated to permanently protecting the globally outstanding Klamath-Siskiyou forests from logging, mining and habitat destruction The Siskiyou Project combines science, education and advocacy to build and inspire an effective national constituency for this special place.

Umpqua Watersheds is a tax-exempt, non-profit public interest organization with over 400 members. Its mission is "dedicated to the protection of and restoration of the watersheds in the Umpqua River basin and beyond. Its Wild Forest and Mighty River Protection Program is designed to keep trees standing on public lands and keep rivers and streams clean and free flowing for fish, wildlife and communities.

The **Friends of the Eel** is a tax exempt, non-profit organization with over 2,000 members, whose mission is to restore the Eel River and all of her tributaries to a natural state of health and abundance, wild and free.

The **Northcoast Environmental Center** (NEC) is a nonprofit public interest organization formed in 1971 under the laws of the state of California. NEC has more than 4000 members, a number of whom live in southern Oregon and northern California and who visit the rivers and streams located there, including the Klamath River. These members are concerned with the continued decline of fish and wildlife species in the western United States. NEC members include sports and commercial fishers, amateur and professional naturalists, river recreationists, American Indians and others with a conservation interest in protecting endangered species and restoring the abundance of healthy aquatic ecosystems to the region.

The **Environmental Protection Information Center** (EPIC) is a grassroots, non-profit organization that strives to preserve one of the world's most productive and endangered ecosystems: the coastal low elevation ancient forests of northern California. Since 1977, EPIC has been protecting the forests and endangered species of Northern California through education and strategic litigation.

The **Native Fish Society** is a tax-exempt non-profit grassroots membership organization that advocates scientifically sound conservation, protection and recovery actions for native fish and their habitats. The Native Fish Society involves the public in policy decisions and promotes scientifically based management solutions to problems while connecting people to the beauty, mystery and value of native fish and their environment.

The **Center for Biological Diversity** is a nonprofit environmental organization dedicated to the protection of native species and their habitats in the Western Hemisphere. The Center works to protect and restore natural ecosystems and imperiled species through science, education, policy, and environmental law.

The **Oregon Natural Resources Council** is a non-profit corporation with 7,500 members throughout the state of Oregon and Pacific Northwest. Founded in 1974, Oregon Natural Resources Council's mission is to aggressively protect and restore Oregon's wild lands, wildlife, and waters as an enduring legacy. The Council and its members are dedicated to protecting and conserving the region's wildlife, lands, waters, and natural resources.

Washington Trout is a non-profit conservation and science organization dedicated to the preservation and recovery of Washington's wild fish and their habitats. We are the only statewide organization devoted solely to all aspects of wild fish conservation and recovery, including harvest, hatcheries, and habitat preservation and restoration. Through scientific research, advocacy, and habitat restoration, Washington Trout seeks to improve conditions for all of Washington's native wild fish, most notably wild salmon, trout, and char.

The **Umpqua Valley Audubon Society** is a non-profit organization formed in 1977 under the laws of the state of Oregon. Umpqua Valley Audubon's mission is to conserve and restore natural ecosystems, focusing on birds and other wildlife, for the benefit of humanity and the earth's biological diversity.

II. Summary

Lampreys are an ancient jawless fish that superficially resemble eels but are not related to them. Similar to Pacific salmon, adult lampreys dig depressions in gravel bedded streams, spawn, and die. Eggs hatch into larval lamprey called ammocoetes that filter feed on organic material (mostly algae) while partially buried in fine silt and sand along the margins of creeks and rivers. The worm-like ammocoetes filter feed for 4-6 years in freshwater before transforming into 4-5 inch young adults with eyes and teeth. Lamprey species are either parasitic as adults (river lamprey and Pacific lamprey) or reproduce without parasitizing other fish (Western brook lamprey and Kern brook lamprey). River lampreys grow to about 10 inches during 4 months of parasitic feeding in estuaries and the ocean before returning to freshwater to spawn and die. Pacific lampreys feed in the ocean for several years and grow to 16-27 inches before returning to spawn and die. The degree of fidelity of sea-going Pacific lamprey and river lamprey to natal streams (i.e., homing behavior) is not known. The Western brook lamprey is a non-parasitic sister species of the river lamprey that does not migrate to the ocean to feed. After transforming into a 5-6 inch adult, it spawns and dies in its freshwater stream without feeding. The Kern brook lamprey is another non-parasitic sister species of the river lamprey with a restricted range in the San Joaquin River Basin, California. Western brook lampreys are found in the Sacramento River basin northward into British Columbia. River lampreys are found in rivers from south of San Francisco Bay to British Columbia. Pacific lampreys range around the Pacific Rim from northern Mexico to Japan.

Tribal cultures in the Columbia Basin and coastal rivers value Pacific lamprey as a food source. Although lampreys parasitize and kill salmon in the ocean, lampreys buffer migrating adult salmon from predation by marine mammals in estuaries. Seals and sea lions prefer lamprey when feeding in estuaries because they are easier to catch. High concentrations of larval ammocoetes are important because they clean the stream by filter feeding organic material and provide a food source for predator fish, including juvenile salmonids.

Lamprey declines and local extinctions have been documented in the industrialized areas of the Northern Hemisphere, primarily in the United States and southern Europe, but none of the 34 species have become extinct. Similar to Pacific salmon species, Pacific lamprey show a declining trend in the southern and Columbia River portions of its range where human impacts to freshwater habitat are severe and cumulative. Robust populations of Pacific lamprey were estimated at 600,000 during the 1980s in the undammed Fraser River, British Columbia. Counts of Pacific lamprey at Ice Harbor Dam on the Snake River declined from 50,000 in the early 1960s to less than a thousand during the 1990s. Counts at Winchester Dam on the North Umpqua River declined from 46,785 in 1966 to less than 50 annually since 1995. Counts from Gold Ray Dam on the Rogue River, Oregon ranged from 155-2,370 since 1993 but abundance is believed to be much below historic numbers. Red Bluff Diversion Dam counts from the upper Sacramento River, California declined from 38,492 in 1972 to 107 or less since 1996. Pacific lampreys are rare along the southern coast of California and have been extirpated from many streams where they formerly existed. Ocean tows along the West Coast found Pacific lamprey concentrated along the southern and central Oregon coast with few captures along the California coast. Frequency of Pacific lamprey catch from triennial ocean hauls increased from 0.3 percent in 1980 to 2.5 percent in 2001.

Improved ocean conditions that increased adult salmon returns to the west coast since 2000 appears to have also resulted in increased Pacific lamprey passing Bonneville Dam on the Columbia River and Red Bluff Diversion Dam on the Sacramento River but no increases occurred at Gold Ray Dam on the Rogue River or Winchester Dam on the North Umpqua River.

In 1979, an estimated 6.5 million young adult river lamprey left the Fraser River, British Columbia, but river lamprey have not been documented in the Columbia River or anywhere in Oregon since 1980. Scattered reports of river lamprey are available from California but abundance or trend is unknown. Few reports of river lamprey may be caused by a general lack of sampling effort and interest in the United States but a more likely explanation is that they have declined and disappeared from large areas where they were historically abundant.

Western brook lamprey is relatively common in forested coastal basins such as the Alsea River, Oregon but has largely disappeared from Columbia River basins above Bonneville Dam. Since these fish are nearly identical to river lamprey during freshwater growth, they would need to be protected to ensure protection for the apparently much rarer river lamprey.

Dams and other artificial barriers such as road culverts block or impede passage of lamprey species. The situation is severe on the Columbia and Snake Rivers where less than half of the adult Pacific lamprey are able to pass some dams. Water diversions, dredging, streambed scouring, channelization, chemical poisoning, introduction of eastern USA fishes, and destruction of riparian vegetation in freshwater or estuarine habitats are believed to be responsible for long-term declines. Variable ocean conditions such as fluctuating salmon populations probably only affect short-term variation in abundance.

Federal protection of stream habitat from the Northwest Forest Plan is not likely to protect lamprey species from further declines. Lamprey distribution appears to be disappearing from small, high elevation public land streams. Pacific lamprey are now concentrated in medium and large sized low-gradient streams on agricultural, coastal commercial timberlands, and rapidly urbanizing areas of watersheds. On private lands lamprey are vulnerable to habitat losses because private streams lack: minimum flow requirements; adequate protection of riparian vegetation; protection from chemical pollution; and passage requirements at dams and roads. Introduction of alien predators such as smallmouth bass has probably been a factor in declines. Existing lamprey populations are particularly vulnerable to extirpation because lamprey tend to concentrate in small portions of watersheds where a local chemical spill or authorized industrial activity (e.g. dredging, temporary dewatering) could eliminate 6 age classes of ammocoetes

Existing data, although sparse, suggests that each of these species is likely to become extinct or endangered with extinction in the foreseeable future throughout all or parts of their range in the coterminous United States.

III. Introduction

Renaud (1997) found that of the 34 lamprey species in the Northern Hemisphere, ten are endangered with extinction and eight are vulnerable to extinction in at least part of their range. Industrial and agricultural pollution, urbanization, dewatering of streams, blockages of migration routes and alien predators appear to be the principal causes of declines. Some field offices of the US Fish and Wildlife Service (e.g., Western Washington Office and Upper Columbia River Basin Field Office) have identified Pacific lamprey and river lamprey as "species of concern", but the USFWS has "virtually no information on Pacific lamprey (memo dated 9/25/00 from Karolee Owens to USFWS field offices). Although no lamprey species are on the U.S. endangered species list, Ohio, Illinois, Nebraska, South Dakota, Kentucky, and North Carolina have listed several lamprey species as threatened or endangered (Renaud 1997). No west coast lampreys have been state listed as threatened or endangered. The Pacific lamprey was listed as an Oregon state sensitive species in 1993 and was given protected status in 1996 with OAR 635-044-0130 (Kostow 2002:2). Protected status merely means that a person must obtain a permit from ODFW before possessing Pacific lamprey.

During the early 1990s several declining populations of salmon and steelhead were petitioned for Endangered Species Act listing resulting in status reviews and listings by the National Marine Fisheries Service. In 1994 the Fisheries Service initiated a schedule for status reviews of anadromous species under their jurisdiction (59 FR 46808 September 12, 1994). Status reviews were not initiated for Pacific lamprey[1] (*Lampetra tridentata*) or river lamprey (*Lampetra ayresi*) because jurisdiction for these anadromous fish is with the USFWS. One purpose of this petition is to provide a legal and scientific framework for the Fish and Wildlife Service to initiate a formal status review of Pacific lamprey, river lamprey and related non-parasitic species of river lamprey (western brook lamprey and Kern brook lamprey)

This petition includes four species of lamprey from the West Coast of North America (Pacific lamprey, river lamprey, western brook lamprey, and Kern brook lamprey). Since lamprey species with known population data (primarily *L. tridentata*) are declining, a prudent and reasonable course of action is that each of the four species receives timely consideration for listing. Initiation of status reviews for each of the four species will make data collection and analyses consistent for each species involved and reduce the need for multiple requests of information from agencies, individuals, and scientific institutions. A multi-species approach also gives the Fish and Wildlife Service the greatest amount of discretion in determining which species or distinct population segments merit listing. A piecemeal approach to federal listing of lamprey species could result in a failure to provide timely conservation measures to those species or distinct populations most threatened with extinction.

Lampreys require a multi-species approach to conservation to ensure that individuals of a rare or listed species are conserved when mixed (sympatric) with other similar species of lamprey. Our inability to recognize individual species based on observations of ammocoetes could result in severe declines or extinctions going unnoticed. For example, western brook lamprey and river lamprey distributions overlap with the more common Pacific lamprey. Unlike Pacific lamprey, river lamprey and western

[1] Lampreys are often erroneously called eels because they superficially resemble this jawed fish that is common in the Atlantic Ocean.

brook lamprey have very short lives as adults making capture and positive identification difficult (Kostow 2002). Similarly, in the upper Klamath basin of Oregon a complex of 4 species of lamprey are nearly identical during the ammocoete stage. One species, the Miller Lake lamprey (*L. minima*) was thought to have been extirpated with rotenone in 1958, only to be rediscovered 35 years later in several streams of the upper Klamath Basin (Lorion et al. 2000; Kostow 2002).

If one species of lamprey or distinct population segment merits ESA listing then all other sympatric lamprey species must also be protected because of similarities during the ammocoete stage. If only one species is listed from a species complex, ammocoetes of that species could not be effectively protected with the ESA because it could not be proven that an individual ammocoete is not an unlisted species with similar characteristics. Provisions of the ESA that provide for protection of species similar to listed species must be applied to lampreys because of the lack of distinguishing characteristics during the ammocoete stage. Thus, section 1522 (e) also known as 4(e) would apply because there are other lamprey species which so closely resemble the imperiled lamprey in appearance that enforcement personnel would have substantial difficulty in attempting to differentiate between the listed and unlisted species.

The Pacific brook lamprey (*Lampetra pacifica*) was not petitioned because it is believed to be synonymous with the western brook lamprey (*L. richardsoni)* by the American Fisheries Society (Robbins et al. 1991), Bond and Kan (1986), and Moyle (2002:99,104,105). Renaud (1997) disagrees with conclusions about synonymy with *L richardsoni* and considers *L. pacifica* to be a distinct species until a rigorous study is made comparing the two species.

Unique but undescribed Goose Lake lampreys (currently classified as non-anadromous *Lampetra tridentata*) were excluded from this petition because conservation efforts among public and private entities appear to have been effective in reducing the risk of extinction subsequent to a severe drought during the early 1990s (Kostow 2002:30). Klamath River lamprey (*Lampetra similis),* Pit –Klamath brook lamprey (*Lampetra lethophaga),* resident dwarf Pacific Lamprey (*Lampetra tridentata)* and (Miller Lake lamprey) *Lampetra minima* are also excluded from this petition. This unique species complex is limited to the upper Klamath River and Pit River basins of southern Oregon and northern California and may include several undescribed species (Docker 1997). For example resident *Lampetra tridentata* found in the Sprague River are believed to be a distinct species (memo dated 9/25/00 from S. Ried [USFWS Klamath Falls, OR] to Karolee Owens (USFWS Lacey, WA). Despite the relatively small geographic distribution of these species, each of these endemic species consists of several populations (see Lorion et al. 2000). Spawning adult lamprey of these species are common in areas of good habitat during peak periods of reproduction (personal communication between R. Nawa [Siskiyou Project] and S. Reid [US Fish and Wildlife Service, Klamath Falls, OR], telephone interview 17 June 2002). A possible fifth endemic species to the upper Klamath Basin (*L. folletti*) is thought to be synonymous with *L. lethophaga* (Lorion et al. 2002) and is not recognized by the American Fisheries Society (Robbins et al. 1991). Renaud (1997) does recognize *L.folleti* and Moyle (2002:99) states that "technically [*L. folleti*] should continue to be recognized as a species until its designation has been formally refuted in a thorough analysis."

The need for ESA listing of one or more of the upper Klamath and Pit River endemic lamprey species at some future date may be warranted for the following reasons: the lack of documented population monitoring by state and federal agencies; failure of governing agencies to reduce habitat threats (primarily from poor water quality and lack of adequate summer flows); failure to screen lamprey from irrigation ditches and canals; permitted use of herbicides and chemical poisons such as acrolein; and the naturally limited range of these species. Hopefully state, county, and federal agencies will coordinate efforts to make lamprey conservation, education, and monitoring a priority to ensure viability of endemic lamprey populations.

Pacific lampreys are harvested as a highly nutritious subsistence food by various tribes along the Pacific coast and are highly regarded for their cultural value (Close et al. 2002:19). From 80,000 to 500,000 Pacific lampreys were harvested annually at Willamette Falls during the 1940s for vitamin oil, fish meal, and protein food for livestock and poultry (Close et al.1995:3; Close et al. 2002:24; Kostow 2002:3). Lampreys have medicinal uses as an anticoagulant and Native Americans apply the oil to ailing parts of the body (Close et al. 2002:22). Lampreys have been used as an instructional aid in anatomy classes and researchers have inserted lamprey brains into small robots to cause the robot to move towards light (Gugliotta 2001).

Observations of lampreys at Willamette Falls in the 1800s, Fraser River in 1948, Rogue River during the 1950s, and the Eel River as late as the early 1980s indicate that adult lampreys were historically extremely abundant at some times of the year and their declines have possibly led to imbalances and disruptions in natural predator-prey systems and nutrition cycles (Close et al. 2002:21; Kostow 2002:4). Similar to salmon, lamprey transport important nutrients such as nitrogen to freshwater ecosystems.

Lampreys are an important food source for numerous animals (Close et al. 1995:4). High concentrations of adult and larval lamprey made them an important and once dependable food source for birds, fish and mammals, especially seals and sea lions. Adult pacific lampreys function as a buffer to reduce predation on adult migrating salmon from seals and sea lions. For example, feeding studies at the mouths of the Klamath and Rogue rivers found that lamprey were the food item for 92-96 percent of sea lion feeding observations (NOAA 1997). Historically, Pacific lamprey were probably a significant cause of mortality of salmon and other fishes in the ocean, but during the 1990s lamprey scars on salmonids were rarely seen by hatchery managers.

IV. EVOLUTION, TAXONOMY, GENERAL DISTRIBUTION, LIFE CYCLES, DISTINCT POPULATION SEGMENTS

Complex armored fishes without jaws (agnaths) first appeared in the fossil record 500 million years ago (Bond 1979:107). Agnath species were abundant 450 million years ago, but only the lampreys and hagfishes exist today (see Kostow 2002:3 or Moyle and Cech 2000 for a more detailed evolutionary account). Adult lampreys are eel-like with lateral eyes and a ventral mouth consisting of a circular disc set with horny teeth. Arrangement of teeth on the oral disc is the principle morphologic feature used to distinguish species (Page and Burr 1991:18-19). They lack paired fins and have no scales. All lamprey species have an extended larval life called an ammocoete. Most observations of lamprey in freshwater are of ammocoetes. Ammocoetes of sympatric species tend to be morphologically identical making it difficult to impossible to accurately identify ammocoetes to species.

Bond (1979:110-111) provides the following account of lamprey life cycles:

> Very small eggs are deposited in nests made in gravel bottoms of streams. When the tiny larvae hatch they drift to soft bottoms in pools and eddies and begin a life of straining out organic matter at the mud water interface. This period may be up to five years or so in length, after which metamorphosis takes place and new type of existence is begun.
>
> There are two types of lampreys, parasitic and nonparasitic. The parasitic types make their living by attacking fishes with their sucking mouths, rasping holes in the skin with their piston-like tongues, and pumping out blood and body fluids... Some lampreys of this [parasitic] type are anadromous, spending their adult growth period in salt water before returning to streams to spawn and die. These may reach a meter in length.
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> Nonparasitic lampreys are usually called "brook" lampreys. These confine feeding to the larval stage, and after metamorphosis they spend a few months in hiding while gonads mature. They then spawn and die.

Some adults in Washington streams and the Santa Clara River, California have been observed to survive after spawning and may repeat spawn as do steelhead (Moyle 2002:98)

Most non-predatory lampreys on the Pacific coast (including Kern brook lamprey and western brook lamprey) are derived from river lamprey (*L. ayresi*), but 4-6 endemic lamprey species in the upper Klamath and Sacramento basins are derived from Pacific lamprey (*L. tridentata*) (Moyle 2002:95,105, see Docker 1997 and Docker et al. 1999 for genetic rationale).

1. Pacific Lamprey (*Lampetra tridentata*)

Pacific lamprey range around the Pacific Rim from Hokkaido Island, Japan, through Alaska, and down to Rio Santo Domingo in Baja California, Mexico (Moyle 2002:96-97; Page and Burr 1991: map 7; Kostow 2002:49). Kostow (2002), Moyle (2002), and Close et al. (2002) provide detailed descriptions of early life history, courtship, and spawning.

Sea lampreys (*Petromyzon marinus*) in the Great Lakes show no evidence of homing[2] behavior (Bergstedt and Seelye 1995), which is consistent with their rapid colonization across the Great Lakes. Instead of homing to natal streams, sea lamprey select spawning streams based on physical stream attributes such as flow, temperature, or substrate (Young et al. 1990) or are attracted to pheromones produced by exiting larval populations (Bjerselius et al. 2000). Contrary to speculation that Pacific lamprey have no homing behavior and therefore no population structure (Kostow 2002:11), preliminary genetic data suggest that there is at least some population structure in the anadromous Pacific lamprey (M.F Docker, unpublished data, University of Windsor, ON). Docker examined 209 specimens from populations from northern British Columbia (e.g., the Nass and Bulkley rivers) to northern California for variability in mitochondrial DNA. Docker identified four genetic types (ND1 haplotypes) in the Oregon and California populations, but only the two more common haplotypes were found in Pacific lamprey from British Columbia and Washington. Docker believes this data indicates a lack of mixing on a large geographic scale, but differences among populations within a region were not detectable with the sample size examined thus far. Although they were not statistically significant, some differences were found in the frequencies of the four haplotypes between some Oregon rivers (e.g., between the McKenzie and Coquille rivers). Larger sample sizes and other genetic markers, as well as tagging studies (e.g., Bergstetd and Seelye 1995, Kostow 2002) are necessary to better evaluate the degree of homing in Pacific lampreys. Data suggest that at least some Pacific lamprey likely return to natal streams to spawn but the importance of homing or the degree of stream fidelity within basins remains poorly understood (Beamish 1980).

Life history traits suggest within basin variability. Pacific lamprey in large river systems, such as the Klamath and Eel, may have a number of distinct runs or races like salmon (Moyle 2002:97). In the Klamath River there may be at least two distinct runs: a spring run that spawns immediately after the upstream migration and a fall run, which holds over and spawns in the following spring.

Moyle (2002:97) further speculates that some upstream populations may have individuals that remain resident, rather than going to sea much like rainbow trout. There may be two distinct forms of Pacific lamprey in California's Trinity River, one smaller and paler than the other, that represent either separate runs or resident versus migratory individuals. Kostow (2002:14) reports observations of tight balls of perhaps 15-20 small adults less than 10 cm long in the Coquille River and Oregon coastal streams further south. These non-parasitic adults do not appear to be brook lamprey and could be resident forms of *L. tridentata* as hypothesized by Moyle.

Lamprey fecundity in the John Day River was significantly lower than lamprey spawning in coastal Oregon streams and may be related to a higher energy cost of migration (environmental factor) resulting in fewer eggs produced (BioAnalysts 2000:16). Alternatively the differences in fecundity could be genetic, suggesting populations on the Oregon Coast are distinct from inland Columbia populations.

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[2] Homing refers to the ability of offspring to return to their natal streams and is fundamental to the development of genetically unique stocks or populations as described by Ricker (1972).

Genetic and life history data suggest that for federal listing and recovery purposes Pacific lamprey populations could be subdivided into distinct population segments at spatial scales similar to the ESUs developed for listed salmon species (see ESUs for steelhead in NMFS 1996:5). Petitioners believe that delineation of distinct population segments is best left to the discretion of USFWS.

2. River Lamprey (*Lampetra ayresi*)

The distribution of the small parasitic river lamprey extends from the Sacramento River to 20 km north of Juneau and inland in the Columbia River to the Columbia Gorge (Kostow 2000:12; Page and Burr 1991; Moyle 2002:101). River lamprey is the parasitic "sister" species of the non-parasitic western brook lamprey. Each is indistinguishable from each other except during the last six months to one year of life when they reproduce (Kostow 2002:13). River lampreys migrate to the ocean for only ten weeks scavenging or feeding on smelt and herring. Populations of river lamprey concentrate in the lower ends of large rivers such as the Fraser, Columbia and Sacramento, although specimens have also been taken from smaller Oregon coastal streams (Kostow 2002:13). Kostow reports that "since [river lamprey] do not move far from the estuaries of their natal river when they are in the ocean they probably return to those rivers to spawn so that the river lamprey likely has a considerable degree of population structure." Kostow (2002:36) identifies studies from Canada that found river lamprey in the ocean only near the mouths of the river that produced them. River lampreys at the mouth of one river were unlikely to travel to different rivers to spawn. Petitioners believe that delineation of distinct population segments is best left to the discretion of USFWS.

3. Western Brook Lamprey (*Lampetra richardsoni*)

The non-parasitic Western brook lamprey is distributed from southeastern Alaska south to California, with major inland distributions in the Columbia (as far as the Yakima River) and Sacramento-San Joaquin drainages (Kostow 2002:11, Moyle 2002:104, Page and Burr 1991). Kostow (2002:11-12) and Moyle (2002:105) describes life history and spawning. Moyle (2002:105) states that "*L. richardsoni* may not fit standard species definition well because it is derived from the anadromous river lamprey, to which it is very similar biochemically. The presence of brook lampreys in coastal streams most likely represents many independent evolutionary events rather than a single separation from river lamprey followed by dispersal of the nonpredatory form." Analysis of mitochondrial cytochrome b and ND3 gene sequences found no differences between *L. ayresi* and *L. richardsoni* suggesting that these genetically indistinguishable species diverged less than 70,000 years ago (Docker et al. (1999). Western brook and river lampreys will hybridize in the laboratory, but hybrids have never been observed in the wild (Moyle 2002:105). Western brook lamprey are likely to have significant population structure in coastal areas because neither adults nor larvae are capable of entering salt water or of making long-distance movement within a river system (Kostow 2002; 12, Moyle 2002:105). Kostow (2002:36) believes that many populations are likely in complete isolation and have been for thousands of years leading to distinct population segments in the Columbia Basin because they do not move much within or between basins. Similarly, Moyle (2002) believes that a number of the more isolated populations may deserve species status.

4. Kern Brook Lamprey (*Lampetra hubbsi*)

Distribution is summarized by Moyle (2002:103):

> This species is endemic to the east side of the San Joaquin Valley. Kern brook lampreys were first collected form the Friant-Kern Canal but have since been found in the lower Merced, Kaweah, Kings and San Joaquin River. Ammocoetes found in the San Joaquin River between Millerton Reservoir and Kerkoff Dam probably also belong to this species, as do those collected in the Kings River above Pine Flat Dam (Fresno County). In 1988 ammocoetes and adults were collected from the siphons of the Friant Kern canal when they were poisoned as part of an effort to eradicate white bass from the system.

5. Undescribed taxa

Kostow (2002:14) discusses the observations of a small parasitic *tridentata*-like lamprey that has been closely observed in the Coquille River. Similar observations of "dwarf" Pacific lamprey have been documented from the Siletz River, Oregon, and Trinity River, California (Moyle 2002:97), and Canadian streams. Different sized spawning adults is a reproductive isolating mechanism in lamprey because only similar sized adults can achieve fertilization.

V. POPULATION STATUS AND LOCAL DISTRIBUTION

Population monitoring of lamprey species is difficult because the most frequent life stage observed during abundance monitoring is the ammocoete. Ammocoetes are nearly identical across all *Lampetra* species. When 2 or more species of lamprey inhabit a stream, the abundance of either species is impossible to determine based on captures of ammocoetes. For example, parasitic lamprey species at early states of metamorphism (*L. tridentata*) are often mistaken for adult brook lamprey (*L. richardsoni*) because they have eyes but development of the parasitic oral disks is incomplete.

1. Pacific Lamprey (*Lampetra tridentata*)

Pacific lampreys 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. All populations that have qualitative (anecdotal) observations or quantitative data from before 1970 have substantially declined. No lamprey populations south of the Canadian border are known to have maintained themselves at numbers present during late 1800s to 1970. As late as the 1970s, Pacific lamprey were reported to be "fairly abundant" throughout its range (Morrow 1980).

Lampreys became a conservation concern in Oregon in the early 1990s when tribal fish managers and Oregon Department of Fish and Wildlife (ODFW) staff noted that populations of Pacific Lamprey were apparently declining to <u>perilously low numbers</u>. (emphasis added) (Kostow 2002:2). For example, Pacific lamprey counts at Winchester Dam located in the coastal Umpqua River, decreased exponentially in numbers from a maximum of 46,785 in 1966 to 34 fish in 2001. Counts at Ice harbor Dam in the Snake River decreased from a maximum of 49,454 in 1963 to 203 lamprey in 2001 (Close et al. 2002:19). Tribal elders on the Oregon coast and Columbia River basin report that lampreys were once common and easy to catch, but by the 1990s had become very rare (Kostow 2000:21).

Native American fishermen in northern California also report that runs in north coast California streams are much smaller than they used to be (Moyle 2002:98). Moyle (2002:98) believes that Pacific lamprey in California are declining but are not yet in serious trouble.

Populations of Pacific lamprey can be highly variable, varying by orders of magnitude from one year to the next (Kostow 2002:37; Beamish and Levings 1991). Highly variable adult populations create uncertainty about trends and viability. Besides environmental condition, population variability may be caused by a lack of homing to natal streams that would further confound viability assessments.

Mexico

Pacific lamprey have been found south to Rio Santo Domingo in Baja California (Moyle 2002:97). A single Pacific lamprey ammocoete was collected on 19 February 1995 in a tributary to a lagoon at the mouth of Rio Santo Domingo, Baja California. This represents the southernmost freshwater record and the first freshwater record of the species in Baja California (Ruiz-Campos and Gonzalez-Guzman 1996).

California

Moyle (2002:98) reports that Pacific lampreys are still present in most of their native areas, but the large runs described as great "wriggling masses of lampreys" seen ascending barriers and fish ladders in early spring that once characterized streams such as the Eel River have largely disappeared (Kimsey and Fisk 1960, Moyle 2002).

California South Coast

Pacific lampreys have been eliminated from many streams in the urbanized southern end of their range. In general, lampreys have a disjunct distribution south of San Luis Obispo County. A study of the 18 southern most drainages in California (Santa Maria south to Otay River) found Pacific lamprey in Malibu Creek and the Santa Clara River, but absent in 16 other drainages (Wells and Diana 1975). Hubbs (1967) reported "no evidence of any lamprey occurrence at anytime in coastal streams south of the Los Angeles Plain. Here, as over much of the West depletion of the water and introduction of more aggressive Eastern [USA] fishes have rapidly brought the native fish fauna to or beyond the brink [of extinction]."

Los Angeles River, CA (Los Angeles County)

Pacific lamprey were historically found in the Los Angeles River (Culver and Hubbs 1917) including ammocoetes (Hubbs 1967), but Wells and Diana (1975) found no evidence of their existence.

San Gabriel River, CA (Los Angeles County)

Hubbs (1967) reported Pacific lamprey ammocoetes from San Gabriel Canyon in 1945.

Malibu Creek, CA (Los Angeles County)

Lamprey regularly occur in Malibu Creek, the southern end of distribution in California (Wells and Diana 1975, Moyle 2002:97).

Santa Clara River, CA (Ventura County)

By 1975 Pacific lamprey were rare in Sespe Creek, a tributary to the Santa Clara River (Wells and Diana 1975). A 1996 study found lamprey migrating to relatively undisturbed upper reaches of the basin (Moyle 2002:98).

Santa Ynez River, CA (Santa Barbara County)

Pacific lamprey are found in the Santa Ynez River below Bradbury Dam (SYRTAC 1999).

Santa Margarita River, CA (San Luis Obispo County)

Lampreys have occasionally been found in Santa Margarita River (Wells and Diana 1975).

Salinas River, CA (San Luis Obispo County)

Pacific lamprey were reported by Snyder (1913) in the mainstem Salinas River and in the tributary Nacimiento River in the mountains above the current Nacimiento Dam site. Pacific lamprey have been incidentally observed and collected recently during steelhead surveys in the Nacimiento River (Hagar 1995; Page et al. 1995). "Numerous" spawning adult Pacific lamprey have been seen recently in the Salinas River tributary, Arroyo Seco (Hagar 1995, 1996).

California Central Valley

Sacramento River

Adult lamprey counts at Red Bluff Diversion Dam decreased from a high of 38,492 in 1972 to 11 or less during 1998-2000 (Table 1). After 1986 gates were raised on the dam during non-irrigation season which reduced counts, but the gates are in place during June and July, the expected peak period of adult lamprey migration. At times 25-50 Pacific lamprey have been observed attached to the downstream parts of Red Bluff Diversion Dam (US Fish and Wildlife Service, North Central Valley Fish and Wildlife Office, Red Bluff, CA).

Battle Creek, CA (Shasta and Tehama Counties)

Videotapes at a weir recorded low numbers of Pacific lamprey since 1995 (Table 1).

Table 1. Adult Pacific lamprey counts from Red Bluff Diversion Dam on the Sacramento River and videotape counts from a weir on Battle Creek. Battle Creek numbers are partial counts because fish can get by the trap and weir without being counted. (US Fish and Wildlife Service, Northern Central Valley Fish and Wildlife Office, Red Bluff, California)

Year	Red Bluff Dam	Battle Creek
1967	401	no data
1968	1903	no data
1969	1865	no data
1970	2717	no data
1971	5781	no data
1972	38,492	no data
1973	2,994	no data
1974-94	no counts made	no data
1995	327	3
1996	78	47
1997	107	0
1998	0	0
1999	11	22
2000	2	8
2001	54	2
2002	53	1

Putah Creek, CA (Yolo and Solano Counties)
Pacific lampreys have managed to maintain small runs following construction of the Solano Project that dewatered much of the lower creek. The species is "scarce" in this drainage and a small spawning run was observed in 1999 (Moyle 2002:98).

Cache Creek, CA (Lake and Yolo Counties)
Pacific lamprey once spawned in tributaries of Cache Creek up through Clear Lake (Moyle 2002).

San Joaquin River, CA
Pacific lamprey once utilized the San Joaquin River, its tributaries, and Tulare Lake (Moyle 1976; Moore 1990).

San Francisco Bay Area
Leidy (1998) surveyed 81 streams in eight San Francisco Bay area counties (Alameda, Contra Costa, Marin, Napa, San Mateo, Santa Clara, Solano and Sonoma) from 1992-1998 and found Pacific lamprey in only three streams; Coyote Creek, Conn Creek and Sonoma Creek.

Alameda Creek, CA (Alameda County)
A survey in 1955 found 31 adults and 5 ammocoetes (Leidy 1984). Surveys by California Department of Fish and Game confirmed its presence in lower Alameda Creek (Aceituno et al. 1976). Leidy (1984) found lampreys in upper Alameda Creek in 1981 but failed to find lampreys on subsequent surveys in the 1990s. In 1998 Trihey (1999) found larval lampreys in upper Alameda Creek between the Sunol water treatment plant and Leyden Creek. Adults have been observed ca 1998 in Sunol Regional Wilderness in upper Alameda Creek (SFPUC 1998). A probable chlorine spill in upper Alameda Creek in the Sunol Valley in April 2002 killed at least 24-36 adult lampreys, probably Pacific lamprey (2002 personal communication between Jeff Miller, Alameda Creek Alliance, Canyon, CA and Mike Mullen, U.S Geological Survey, Fremont, CA). A few adult upstream migrants have been seen in lower Alameda Creek and ammocoetes have been found in upper Alameda Creek within Sunol Regional Wilderness in recent years (J. Miller, pers. comm., 2002).

Walnut Creek, CA (Contra Costa County)
Pacific lamprey have been found above the Concord Avenue Bridge crossing in Walnut Creek (Wang 1986) but none were found by Leidy during 1992-1998 (Leidy 1998)

Walker Creek, CA (Marin County)
Specimens from Walker Creek taken in 1958 are held at the California Academy of Sciences (Froese and Pauly 2002).

Lagunitas Creek, CA (Marin County)
Specimens taken in 1964 are held at the California Academy of Sciences (Froese and Pauly 2002).

Napa River, CA (Napa County)
Lampreys have been collected near Calistoga before 1907, and in 1908 and 1943 (Snyder 1907, 1908; Froese and Pauly 2002). Ammocoetes were found in the tributaries Chiles Creek and Conn Creek in 1945 (Leidy 1984). A 1979 fish kill in the Napa River killed 35 lampreys (Leidy 1984).

Surveys during the 1990s found no lamprey in the Napa River and one lamprey in Conn Creek (Leidy 1998).

Coyote Creek, CA (Santa Clara County)
Lamprey collections from upper and lower Coyote Creek were made by Snyder in 1898 and 1905; Hubbs in 1922 and 1923; and Follet in 1932 and 1941 (Leidy 1984). Hubbs was able to collect 91 lamprey ammocoetes (21-50mm) on a single day in 1922 and 750 lampreys (9-21mm) on a singe day in 1923 from Coyote Creek in San Jose (Leidy 1984). Acietuno et al. (1976) failed to find lamprey during surveys in 1973, but Scopettone and Smith (1978) found them at one site in lower Coyote Creek in the mid 1970s and they were present in 1978 (Leidy 1984). Lamprey were found in lower Coyote Creek in 1995 (Leidy 1998) and 1997-1999 (SCVWD 1997, 1998; Cressey 1998; SCVURPP 1999). Surveys in the 1990s failed to find lamprey in the upper Coyote reach or in Penetencia Creek (Buchan 1999).

San Lorenzo River, CA (Santa Cruz County)
The California Academy of Sciences has Pacific lamprey specimens taken in 1929, 1945 and 1955 (Froese and Pauly 2002).

Dry Creek, CA (Sonoma County)
The California Academy of Sciences has Pacific lamprey specimens taken from Dry Creek in 1964 (Froese and Pauly 2002).

Pena Creek, CA (Sonoma County)
The California Academy of Sciences has Pacific lamprey specimens taken from Pena Creek in 1965 (Froese and Pauly 2002).

Sonoma Creek, CA (Sonoma County)
Pacific lamprey have been found below Boyes Spring Historical Park Dam on Sonoma Creek (Wang 1986). Leidy found three Pacific lampreys in 1993 (Leidy 1998).

California North Coast

Garcia River, CA (Mendocino County)
Snyder (1907) documented pacific lampreys in the Garcia River 10 miles from the mouth.

Big River, CA (Mendocino County)
Pacific lamprey once occurred in the Big River (Snyder 1907).
Pacific lamprey were found in the North Fork of Big River, within Jackson State Forest 9 June 1999 (California Natural Diversity Database)

Eel River, CA (Humboldt, Mendocino Counties)
Lampreys are often mistakenly called eels because they superficially resemble this jawed fish that is common in the Atlantic Ocean. Former large runs of lamprey are responsible for the name Eel River. An early newspaper account in 1879 reported the Eel river to be filled with "eels" by the millions (Wainwright 1965). As early as 1908 huge numbers of lampreys were electrocuted at power generating turbines on the Eel River to prevent them from interfering with power generation for the city of Ukiah

(Popular Mechanics, January 1914, p.69). Snyder (1907) found lamprey in the South Fork Eel River near Garberville. Larvae were caught in the lower Eel River in 1950 (< biblio >). Pacific lampreys were captured in the mainstem Eel, Middle Fork Eel, South Fork Eel and Van Duzen River (a tributary to the lower Eel) from 1959-1970 (Puckett 1976). Monroe and Reynolds (1974) noted spawning in the lower Eel River in the 1970s. Lamprey appeared plentiful in the Eel River during the 1980s with high numbers of dead and dying lamprey observed at Van Arsdale Dam, but by the early 1990s comparatively few were seen at Van Arsdale Dam (personal communication, May 2002 telephone interview between R. Nawa, Siskiyou Project and Tracy Thiele, Environmental Protection Information Center).

A historical run of Pacific lamprey existed in the North Fork Eel River in late spring, which Native Americans fished for subsistence uses (USDA and USDI 1996). Lamprey numbers in this drainage have decreased in number similar to salmonids. Spawning sites noted during surveys from 1967 to 1992 indicate the presence of lamprey in the North Fork Eel (USDA and USDI 1996).

Mattole River, CA (Humboldt County)
Pacific lampreys were found in Conklin Creek in the Mattole River watershed in May 1992 (California Natural Diversity Database).

Mad River, CA (Humboldt County)
Pacific lampreys were seen ascending the fish ladder at Sweasy Dam in July 1950 (Murphy and De Witt 1951). Ammocoetes were found in the Mad River in 1998 (Halligan 1998).

Klamath River, CA
In Siskiyou County near the Oregon border, above Iron Gate Dam, Pacific lamprey have been observed preying on salmon at the Klamathon Racks and have been collected from the tributary Cottonwood Creek near Hornbrook (Coots 1962). These observations may represent a non-anadromous, dwarf landlocked parasitic form (Coots 1962). These observations by Coots are probably *L. similis* not *L. tridentata.*

Pacific lamprey spawn in the mainstem Klamath River, but their tributary distribution is poorly known. Anadromous Pacific lampreys are suspected of utilizing the Scott, Shasta, and Salmon River tributaries of the Klamath (Hardy and Addley 2001). Native American fishers currently catch Pacific lampreys at the mouth of the Trinity River near Weitchpec. A general decline in Pacific lampreys is recognized by Native American fishers at the mouth of the Klamath (USFWS 1991). The Klamath Fish Restoration Plan reports "no data" for population trends in the Klamath (Memo dated 9/21/00 from Ron Iverson, USFWS, Yreka Fish and Wildlife Office to Karolee Owens, USFWS, Western Washington Field Office).

South Fork Trinity River, CA
Residents of the South Fork Trinity River basin believe the abundance of the species has declined over the years (PWA 1994).

Klamath River, OR (Klamath County)
Anadromous Pacific lampreys were historically "abundant" in Klamath Lake (Gilbert 1897). A 26-cm specimen was taken at Klamath Falls on the Klamath River near the outlet of Klamath Lake in June 1894 (Gilbert 1897). Evermann and Meek (1897) collected a Pacific lamprey in upper Klamath Lake in November 1896. These observations of lamprey by early fish biologists are probably an undescribed resident endemic taxon. According to Stewart Reid (USFWS, Klamath Falls) there are no historical records of Pacific lamprey in the upper basin (memo dated 9/25/00 to Karolee Owens, USFWS).

Dwarf landlocked lampreys are reported in upper Klamath Lake, Oregon (Hardy and Addley 2001).

Smith River, CA (Humboldt County)
In the 1970s, Pacific lampreys were seen in the Smith River estuary during spawning runs in the spring (Monroe et al. 1975). The species was also sometimes found in Lake Earl (Monroe et al. 1975).

Oregon Coast
Pacific lamprey were historically found "in almost all of the larger streams in Oregon which allow access to and from the ocean" (Cleaver 1951). Surveys for spawning winter steelhead found adult lamprey redds or adults in 85 of the 241 (35%) surveys conducted in 1999 (Jacobs et al. 2000:75). Lamprey redd counts for 1998 and 1999 (Table 2) probably underestimate lamprey abundance in these basins because surveys were concentrated in tributaries where lamprey do not occur or adult densities are low. For example, redd densities in Smith River tributaries were 0.91 redds/mile while mainstem reaches had 39.7 redds per mile (Table 6) (Jacobs et al. 2002:81). Spawning ground counts of lamprey redds during winter steelhead surveys may not be a good measure of lamprey abundance because lamprey will produce many false redds during courtship (Kostow 2002:29,108-110), however, studies by ODFW indicate that 1.3 lamprey per redd is a valid estimator. Lamprey ammocoetes and young adults are found in salmonid smolt traps. Kostow (2002:29,105-107) reports that lamprey production based on smolt traps appears to be lowest in the Tillamook Bay, Nestucca, and Yaquina basins and highest in parts of the Alsea watershed, Cummins Creek, and Tenmile Creeks. The Winchester Dam counts on the North Umpqua demonstrate that Pacific lampreys declined severely since the late 1960s but similar historic data is not available from elsewhere on the Oregon Coast to determine whether this trend is coast-wide or unique to the North Umpqua (Kostow:2002:29). Subjective data indicates that trends are down on the Oregon coast. Abundance of adults is down substantially in the Coos/Coquille district since the early 1980s based on subjective appraisals (ODFW Memo dated 28 January 1993 from H. Weeks to J. Martin)

Table 2. Pacific lamprey redds-per-mile from steelhead trout spawning surveys (Corvallis Fish Research Website, Susac and Jacobs 1999, Jacobs et al. 2001, Illinois River winter steelhead survey reports by G. Bennet and S. Bowman available from Siskiyou National Forest, Grants Pass, Oregon)

	Redds/Mile				
Stream	98	99	00	01	02
Necanicum	65	28	--	--	--
N.F. Ecola Creek	18	5	--	--	--
Arch Cape Cr.	7	5	--	--	--
Nehalem R. (lower)	0	0	--	--	--
N.F. Nehalem	4	1	--	--	--
Salmonberry River	0	0	--	--	--
Kilchis River	0	0	--	--	--
Wilson River	9	0	--	--	--
Nestucca River	--	--	--	9	27
Salmon River	1	<1	--	0	0
Siletz River	<1	1	--	1	0
Yaquina River	16	17	--	9	--
Alsea River	2	<1	--	28	13
Yachats River	--	--	--	32	7
N.F. Beaver Creek	--	8	--	7	4
Siuslaw River	25	3	--	--	--
Lake Cr. (Siuslaw)	8	7	--	--	--
Wolf Cr. (Siuslaw)	11	0	--	--	--
North Umpqua	<1	<1	--	--	--
South Umpqua	0	0	--	--	--
Smith River	0	0	34	28	13
Millicoma River	--	1	--	--	--
S.F. Coos River	--	5	--	--	--

	Redds/Mile				
N.F. Coquille	--	12	--	--	--
E.F. Coquille	--	<1	--	--	--
M.F. Coquille	--	20	--	--	--
S.F. Coquille	--	4	--	--	--
New River	--	9	--	--	--
Illinois River	--	--	3	2	--
Stream miles surveyed	208	186	196	220	189
Redds Observed	1402	656	1360	2140	3206
Average redds per mile	7	4	14	10	17

Rogue River, OR

Snyder (1907) found Pacific lamprey in the Rogue River at Grants Pass. The following is excerpted from Rivers (1963:193):

> The Pacific lamprey is fairly abundant. Its upstream migration extends to nearly all portions of the basin that are accessible to salmon and steelhead, and in some instances, slightly farther where the salmonids are blocked by a dam or falls. They are found in more limited numbers in the upper Rogue above Dodge Bridge, in the Applegate above the mouth of the Little Applegate, and in many tributaries of the Illinois system.

During the late 1940s and early 1950s hundreds to thousands of lampreys were observed by Bob Buckmaster and Cole Rivers ascending Savage Rapids Dam on the Rogue River (personal interview between R. Nawa, Siskiyou Project and Bob Buckmaster, Grants Pass, Oregon). High densities of lampreys have not been seen at Savage Rapids Dam since the early 1960s. R. Nawa (Siskiyou Project) videotaped 4 Pacific lampreys climbing the face of Savage Rapids Dam on 13 June 2002. Gold Ray Dam counts of naturally produced coho salmon indicate a sharp upward trend during the past ten years while Pacific lamprey remain static at relatively low abundance (Table 3).

Table 3. Adult Pacific lamprey and wild coho salmon counts at Gold Ray Dam (RM 126), Rogue River, Oregon (unpublished data, ODFW, Central Point, Oregon).

Year	Pacific Lamprey	Wild Coho Salmon
1990	--	212
1991	--	195
1992	--	0
1993	346	756
1994	155	3,265
1995	732	3,345
1996	2,370	2,554
1997	710	4,565
1998	705	1,310
1999	523	1,417
2000	960	15,652
2001	235	tapes not read
2002	377	run in progress

Illinois River, OR (Josephine County)
Lamprey redd densities on private lands were 12 times higher than on federal lands in the Siskiyou National Forest and Medford BLM District (Table 4). Many streams on federal lands had no lamprey redds but were accessible and used by steelhead trout and coho salmon.

Table 4. Lamprey redd counts from private and federal lands in Illinois River Basin, Oregon. Data compiled from unpublished winter steelhead survey reports by G. Bennet and S. Bowman available at Siskiyou National Forest, Grants Pass, Oregon.

Stream	Date	Privmi.	Rds	Rds/ mi.	Fed mi.	Rds	Rds/ mi.
E.F. Illinois	6/01/00	11.0	48	4.3	1.0	0	0.0
E.F. Illinois	5/06/01	11.0	28	2.5	1.0	0	0.0
W.F. Illinois	6/22/00	12.9	62	4.8	4.9	3	0.4
W.F. Illinois	5/23/01	12.9	91	7.1	4.9	2	0.4
Deer Cr.	6/25/00	16.1	184	11.4	3.8	17	4.4
Sucker Cr.	6/07/00	11.6	28	2.4	10.4	0	0.0
Sucker Cr.	5/28/01	11.6	75	6.5	10.4	2	0.2
Grayback Cr.	7/??/00	0.0	--	--	2.8	0	0.0
Althouse Cr.	6/10/00	8.7	67	7.7	4.8	0	0.0
Briggs Cr.	6/??/00	0.0	--	--	13.0	4	0.3
Briggs Cr.	6/??/01	0.0	--	--	13.0	1	0.1
E.F. Indigo	6/16/00	0.0	--	--	12.0	6	0.5
E.F. Indigo	6/08/01	0.0	--	--	12.0	10	0.8
Indigo Cr.	6/16/00	0.0	--	--	9.5	12	1.3
Indigo Cr.	6/09/01	0.0	--	--	9.5	11	1.2
Josephine Cr.	7/??/00	0.0	--	--	9.5	0	0.0
Silver Cr.	5/23/99	0.0	--	--	16.5	0	0.0
Silver Cr.	5/19/00	0.0	--	--	16.5	0	0.0
Silver Cr.	5/12/01	0.0	--	--	16.5	24	1.5
Collier Cr.	6/15/99	0.0	--	--	6.8	0	0.0
Lawson Cr.	6/02/99	0.0	--	--	13.2	0	0.0
Totals		95.8	583	6.1	192	92	0.5

Applegate River, OR (Josephine and Jackson Counties)
Pacific lamprey are found in the mainstem Applegate River and the lower portions of the Little Applegate River, Williams Creek, and Slate Creek (Rossa 2000). Local residents report that abundance is much below historical numbers.

Coquille River, OR (Coos County)
Pacific lampreys were first found in the Coquille River at the Middle Fork (Snyder 1907). Lamprey redds were common on forks of the Coquille River during 1998-1999 (ODFW steelhead spawning surveys, Table 2) but abundance is down substantially since the early 1980s (ODFW Memo dated 28 January 1993 from H. Weeks to J. Martin).

North Umpqua River, OR (Douglas County)
Lamprey counts at Winchester Dam declined from a high of 46,780 in 1966 to a low of 15 in 1997 with consistently low counts in recent years making them vulnerable to extinction (Table 5; Kostow 2002:28,100; PacifiCorp 1998:7-59). In 1998 a live Pacific lamprey and one redd was found in Cavitt Creek and in 1999 two redds were found in the East Fork of Rock Creek (ODFW steelhead spawning surveys, Table 2).

Pacific lamprey were the only species that experienced a discernible population decline following the 1964 flood (Pacficorp 1998:7-60). The flood eliminated large amounts of the marginal deposition habitat preferred for rearing. Declines of lamprey also coincided with increases of smallmouth bass that consume ammocoetes and young adults. While Pacific lamprey were declining steadily during 1965-2002, wild coho salmon increased dramatically between 1992 and 2002. Factors affecting the abundance of these two species must be different.

Table 5. Pacific lamprey and wild coho salmon counts from Winchester Dam, North Umpqua River (ODFW, Roseburg, Or.)

Yr.	Lamprey	Coho	Yr.	Lamprey	Coho
65	37,566	1,166	84	1,048	10
66	46,785	2,262	85	13,433	10
67	14,532	917	86	1,856	1,317
68	17,896	1,295	87	1,547	1,000
69	27,297	1,647	88	1,171	1,063
70	30,427	563	89	660	795
71	27,523	204	90	1,129	1,789
72	7,714	638	91	472	414
73	9,455	407	92	879	1,823
74	1,713	568	93	472	1,949
75	2,266	416	94	428	1,012
76	2,597	529	95	54	1,162
77	2,994	262	96	80	1,570
78	1,512	578	97	15	1,329
79	1,874	394	98	144	909
80	1,663	465	99	26	1,065
81	877	335	00	35	1,506
82	6,628	1,491	01	34	2,449
83	1,632	1,175	02	33	3,069

South Umpqua River, OR (Douglas County)

Snyder (1907) found Pacific lamprey in the South Umpqua at Roseburg and in the tributary Cow Creek. Anadromous Pacific lampreys were collected from Cow Creek in the Umpqua River basin in 1973 (Bond and Kan 1973). No Pacific lamprey or redds were observed in the South Umpqua during 1997-1998 steelhead spawning surveys (Table).

Smith River, OR (Douglas County)
Lamprey redds found during intensive winter steelhead surveys on the Smith River enabled the ODFW to make estimates of total redds (Table 6). The EMAP methodology estimated 1,870 redds ± 501 (95% CI) in spawning areas above Smith River Falls during 2000; 3,310 ± 1,137 (95% CI) for 2001, and 2,344± 945 (95% CI) for 2002 (Jacobs et al. 2001, 2002). Redd densities were 34 to 88 times higher on mainstem surveys than in tributaries (Table 6).

Table 6. Pacific lamprey redds detected during winter steelhead surveys on the Smith River (Corvallis Research Lab website; Jacobs et al 2002)

	Miles	Live	Obs. Redds	Redds/mile			Estimated Total Redds
				Mainstem	Tribs	Total	
1998	5.0	0	0			0	--
1999	5.0	0	0			0	--
2000	--	113	933	34.3	1.0	--	1,870
2001	48.6	151	1,333	68.9	0.78	27.7	3,310
2002	--	66	982	39.7	0.91	--	2,344

Coos River, OR (Coos County)
Pacific lampreys were found in Coos Bay and in the Coos River up to river mile 30 in 1971 (Cummings and Schwartz 1971; Roye 1979). The South Fork Coos River had 5 lamprey redds per mile in 1999 (ODFW steelhead spawning surveys, Table 2).

Siuslaw River, OR (Lane County)
Steelhead spawning surveys in the Siuslaw Basin found 25 Pacific lamprey redds per mile in 1998 and 3 redds per mile in 1999 (Table 2). Lake Creek had 8 redds per mile in 1998 and 7 in 1999. Pacific lamprey in Lake Creek formerly passed over Lake Creek Falls annually to spawn above Triangle Lake (USBLM 2002). Lamprey were also reported from Triangle Lake (USBLM 2002). Pacific lampreys are now thought to be eliminated from the upper Lake Creek basin for a number of years. Although many lampreys were seen at the falls in 1989, none have been seen in the basin in recent years (USBLM 2002).

The numbers of Pacific lamprey spawning in Wolf Creek and its tributaries have declined since about 1990 (USBLM 2002). During 1998 Wolf Creek had 14 redds per mile but none in 1999.

Tenmile Creek, OR (Lane County)
Between 1993 and 2001 adult lampreys caught in smolt traps varied between 40 and 240 (Kostow 2002:29,103). Smolt traps were used to estimate abundance of outmigrating lampreys in Tenmile Creek. During 1994, 6,569 lampreys outmigrated and 3,592 migrated in 1995 (van de Wetering 1998:15, Kostow 2002:29).

Cummins Creek, OR (Lane County)
Between 1993 and 2001 the number of adult lampreys caught in smolt traps was always less than 50 fish, much lower than nearby Tenmile Creek (Kostow 2002:29,103).

Alsea River, OR (Benton County)
A systematic survey for Pacific lampreys found them missing in the upper most stream reaches of the basin. Lampreys were often missing above road culverts. Nevertheless, Pacific lamprey were present in most catchments averaging 100 hectares in size indicating that lamprey were well distributed within the Alsea Basin (Schooler and Garono 2000:14). Steelhead spawning surveys found 2-28 redds per mile between 1998 and 2002 (Table 2).

Siletz River, OR (Lincoln County)
Siletz tribal members have observed decreased annual harvests from the Siletz River, Oregon (Downey et al. 1993). Redd densities were one or less during steelhead spawning surveys in 1998 and 1999 (Table 2).

Nestucca River, OR (Tillamook County)
Pacific lampreys were historically found in the Nestucca River (Snyder 1907). Steelhead spawning surveys counted 9 lamprey redds per mile in 2001 and 27 per mile in 2002 (Table 2).

Tillamook Bay and Rivers, OR (Tillamook County)
Pacific lamprey were found in Tillamook Bay during 1974-76 surveys (Forsbeg et al. 1977) and in the Wilson River during steelhead spawning surveys (Table 2).

Necanicum River, OR (Clatsop County)
Redd count indicate that Pacific lamprey are common in the Necanicum watershed (CSTC 2002, Table 2).

Columbia Basin
Dam counts, fish kills, commercial harvest, and smolt traps provide population data. As recently as the early 1980s lampreys were so thick at fish counting windows on Columbia River dams that devices were installed to keep them away from fish counting windows (ODFW internal memo dated 3 February 1993 from H. Weeks to J. Martin). During the late 1990s lampreys were rarely seen at these windows indicating abundance declines (Kostow 2000:20). Adult lamprey counts have decreased at all Columbia River Dams with the greatest declines at Snake River dams where counts have declined to fewer than 200 adults in the late 1990s (Kostow 2000:83-85). Passage counts of adult and juvenile lamprey at Bonneville, the Dalles, John Day, McNary, Ice Harbor, Rock Island, Rocky Reach and Wells dams indicate a general decreasing trend; large declines occurred in the late 1960s and early 1970s (BioAnalysts 2000:5). Long-term fish counters at McNary dam have noticed a significant decline in adult numbers passing through the dam (ODFW 1994 Umatilla District Report). Since 1993 counts at Rocky Reach and Rock Island dams have increased, but this increase is probably due to night counts instituted during this period. Even though there are inconsistent counting methods, adult numbers show a general decreasing trend throughout the Columbia basin through 1999 (BioAnalysts 2000:5-6). Many tribal elders of the Confederated Tribes of the Umatilla who were interviewed felt that lampreys in the Columbia River are declining (CTUIR and DNR 1994). Historically, lamprey passage occurred from

May through August, with peak passage occurring in July but during 1987-1989 adult lamprey passage peaked in early June with little or no passage after mid-June (CRFMP 1991:2).

From 2000 to 2002, counts of Pacific lamprey at Bonneville and other dams on the Columbia have increased substantially (US Army Corps of Engineers, Appendix B). For example, adult lamprey at Bonneville Dam increased from 19,002 in 2000, to 27,947 in 2001, and 84,141 through 15 August 2002. During this period adult returns of chinook salmon and steelhead to the Columbia were some of highest on record suggesting that lamprey recovery may be linked to salmon recovery (Close et al. 1995:1). Improved ocean productivity increased salmon smolt to adult survival and provided lamprey with an increased prey base (other prey fishes besides salmon are likely to have increased as well). Young adult Pacific lamprey leaving the Columbia feed on adult anadromous salmonids that are congregating in estuaries for upstream migration to fresh water, but the young lamprey do not migrate upstream with the salmon (Farlinger and Beamish 1984, Beamish 1980). Thus, if cohorts of young lamprey are benefited from increased adult salmon populations at the mouth of the Columbia the increases of returning adult lampreys would be delayed 1-2 years while the lamprey grow to maturity. This hypothesis is supported by increased lamprey counts at Bonneville that are occurring about 1-2 years after the initial large adult salmon return in 2000 (Appendix A).

Kostow (2002: Fig 22) provides a distribution map of remaining Pacific lamprey populations in the Oregon portion of the inland Columbia River. Data from streams below Bonneville Dam (Gnat and Scappoose Creek, see below) suggest that dams alone are not the only factor reducing lamprey in the Columbia Basin.

Gnat Creek and Scappoose Creek, OR (Clatsop and Columbia Co.)
Adult lamprey counts from Gnat Creek weir between 1956 and 1962 ranged from hundreds to several thousand. Lamprey counts from nearby Scappoose Creek between 1999 and 2001 were well below those from the Gnat Creek data set, suggesting a substantial decline in lamprey abundance in the lower Columbia since the early 1960s (Kostow 2002:26,96,97).

Willamette River, OR
During the late 1800s the rocks at Willamette River Falls in Oregon were completely covered with masses of lamprey. During 1913, 24.5 metric tons of lamprey were harvested to feed hatchery salmonids (Close et al. 2002:22). From 1943 to 1949, 80,000 to 500,000 lamprey were harvested, which was estimated to be 10-20 percent of the run (Close et al. 1995). In some years after 1941, 200 tons were taken annually (Pike 1953). Abundance of this magnitude has not been reported for decades (Kostow 2002:93). In 1994, 1,800 kg (about 5,000 lamprey) were exported to Europe. The Oregon Fish and Wildlife Commission in 2002 discontinued commercial harvest because effects of commercial harvest could not be determined. Tribal and personal harvest was allowed to continue (OAR 635-017-0090, revised sport fishing regulations for Willamette Basin).

Since completion of the Willamette Valley Project and building of 13 U.S. Army Corps of Engineers dams in 1967, annual commercial harvest has decreased from an average of 218,000 lbs (1943-1952) to 13,000 lbs. (1969-2001) (Table 7; Ward 2001). Decreased harvests of lamprey at Willamette Falls since 1967 indicates a large population decline from the 1940s. Although harvest does not track population abundance precisely because of varying degrees of effort (Kostow 2002:26,93) the lamprey return to Willamette Falls appears to have stabilized during the 1990s (Ward 2001). Based on harvests during the 1990s, the Willamette Basin is still the most important production area for Pacific lamprey in the Columbia Basin (Kostow 2002:25).

Juveniles of either western brook lamprey or Pacific lamprey were observed with boat electroshocking in the mainstem Willamette (RM 0.6-23.9) from May 2000 to December 2002 and are widely distributed in many streams in the Portland Metropolitan area (Eric Tinus, ODFW, Clackamas, Or, (503) 657-2000).

Table 7. Commercial Pacific lamprey harvest at Willamette Falls, Oregon 1943-2001 (Ward 2001:4). One lamprey weighs about 1.3 lbs.

Year	Pounds	Year	Pounds	Year	pounds
43	207,000	63	no data	83	4,482
44	73,000	64	no data	84	3,391
45	249,000	65	no data	85	6,381
46	397,000	66	no data	86	4,740
47	360,000	67	no data	87	5,633
48	231,000	68	no data	88	10,896
49	115,000	69	15,102	89	8,366
50	100,000	70	3,771	90	14,203
51	184,000	71	3,000	91	32,221
52	262,000	72	1,273	92	9,089
53	no data	73	0	93	17,858
54	no data	74	4,000	94	14,260
55	no data	75	3,138	95	21,897
56	no data	76	865	96	31,264
57	no data	77	1,481	97	34,242
58	no data	78	9,090	98	28,218
59	no data	79	8,935	99	29,449
60	no data	80	3,223	00	20,938
61	no data	81	4,666	01	14,608
62	no data	82	39,169		

Kelley Creek, OR (Multnomah County)
On 9 July 2002, one adult Pacific lamprey (260 cm) was captured downstream of the culvert at 162nd. About 50 lamprey ammocoetes (either western brook lamprey or Pacific lamprey) were captured below the culvert and two ammocoetes were captured above the culvert (Memo dated June 17, 2002 from Kim Gould, Steve Johnson, Fishman Environmental Services to Dan Layden, City of Portland).

Clear Creek, OR (Clackamas County)
Lampreys were historically found in Clear Creek, a tributary to the Clackamas River (Snyder 1907).

Marys River, OR (Benton County)
In 1996, a single Pacific lamprey was documented in the Marys River, a tributary to the Willamette River (NANFA 2002).

Row River, OR (Lane County)
USBLM (2002) reported Pacific lamprey in the Row River below Dorena Reservoir.

McKenzie River, OR (Lane County)
Adult lamprey counts at Leaburg Dam on the McKenzie since the early 1980s have mostly been less than 50 fish (Kostow 1994; USBLM 2002). Two accidental fish kills on Pringle Creek turned up 147 adults and 36 adults (Kostow 2002: 26, 95).

Franz Lake, WA (Skamania Co)
Pacific lamprey are found in nearby streams and likely inhabit Franz Lake National Wildlife Refuge in Skamania County (USFWS 2002).

John Day River, OR
Pacific lampreys were collected from Clear Creek in the John Day River basin in 1973 (Bond and Kan 1973). Recent lamprey distribution seems intact in the John Day basin based on collections of ammocoetes. Close and Bronson (2001) found Pacific lamprey (ammocoetes) throughout the John Day basin except for several survey stations in the upper South Fork and the very upper North Fork. Current adult abundance is unknown. The large historic migrations are gone and no one sees concentrations of adults anywhere in the basin; passage problems at dams, not instream habitat, is believed to be the major cause of declines (Internal ODFW memo dated 3 February 1993 from H. Weeks to J. Martin).

A 1969 rotenone treatment of the North Fork John Day River killed 33,000 adult lamprey and another rotenone event on the John Day in 1982 killed thousands of lamprey ammocoetes (Kostow 2002:24). In February 1990 a tractor trailer rig overturned and spilled a load of hydrochloric acid in the John Day River, resulting in the death of an estimated 10,000 ammocoetes (CRMP 1991:2).

Deschutes River, OR
Pacific lamprey adults are observed and occasionally harvested at Sherars Falls. Sherars Falls was once an important place for Native Americans to capture lampreys. Tribal subsistence fishers collected none at Sherars Falls in 1990 (CRMP 1991:3). No lampreys have been captured in smolt traps on Trout Creek, an important steelhead spawning stream (Kostow 2002).

Umatilla River, OR
Pacific lampreys were rare in the lowest reaches of the Umatilla (Close and Bronson 1991, Kostow 2002:22). During 1993 and 1994 no ammocoetes were seen (ODFW Umatilla District Reports) but in the late 90s larval lampreys (species unknown) have been regularly observed in smolt traps in the lower Umatilla River (Kostow 2002:22). Indian tribes have captured adult lamprey from John Day Dam and placed them in the Umatilla River in an effort to restore the lost lamprey runs.

Tucannon River, WA (Columbia County)
Pacific lampreys were rare in the lowest reaches of the Tucannon River (Close and Bronson 2001; Kostow 2002:22).

Walla Walla River, WA (Walla Walla County)
The ODFW reports 47 ammocoetes in trap boxes during 1993, 114 in 1994, but none present in 1999 (ODFW Umatilla District Reports; Kostow 2002:22).

Yakima River, WA
Pacific lamprey occurred inland in the Yakima River System (Wydoski and Whitney 1979).

Wenatchee River, WA (Chelan County)
Lampreys are found in the lower 27 miles of river below Tumwater Dam (BioAnalysts 2000:4), suggesting that the dam has eliminated upstream distribution. Distribution is also likely in the lower portions of Icicle, Peshastin, and Mission Creeks.

Entiat River, WA
Juvenile lamprey have been found near RM 16 of the Entiat River (BioAnalysts 2000:4).

Methow River, WA (Okanogan County)
Lampreys have been found at RM 5 and below the Twisp River (BioAnalysts 2000:4).

Okanogan River, WA (Okanogan County)
Although suitable habitat for lamprey is available, electrofishing and sampling between 1983 and 1999 found no lamprey adults or ammocoetes (BioAnalysts 2000:4).

Snake River Basin

Table 8. Adult Pacific lamprey counts from Ice Harbor Dam, Snake River, Washington (CRFMP 1991, US Army Corps of Engineers web site)

Yr	Lamprey	Yr	Lamprey
1962	36,863	70-94	no data
1963	49,454	1995	
1964	16,960	1996	
1965	9,818	1997	
1966	15,106	1998	
1967	4,836	2000	315
1968	6,676	2001	203
1969	5,548	2002	641

<u>Grande Ronde River, WA/OR</u>
Pacific lampreys were rare in the lowest reaches of the Grande Ronde River (Close and Bronson 2001; Kostow 2002:22). Smolt traps operational on the Grande Ronde since 1997 caught only 13 lamprey in 2001 (Kostow 2002:22). A single lamprey was collected from Wallowa Lake, date unknown (Froese and Pauly 2002).

<u>Snake River, ID</u>
Pacific lamprey reportedly ascended the Snake River in Idaho in large numbers (Wydoski and Whitney 1979). Everman and Meek (1897) collected Pacific lamprey from Aturas Lake and Big Payette Lake in the Snake River Basin, Idaho in 1896. Although not well documented, the number of Pacific lampreys in Idaho is now known to have declined substantially in recent decades (AFS 2002).

Washington Coast

<u>Chehalis River, WA</u>
In the 1960s, Pacific lamprey were "quite common" in the Chehalis river system and were observed spawning in the main river and tributaries (Deschamps et al. 1971)

Olympic Peninsula
Collection records show Pacific lamprey widely distributed on the Olympic Peninsula: in the Hoh, Queets, Quinault, Humptulips, and Satsop rivers as well as smaller streams flowing into the Straight of Juan de Fuca (Mongillo and Hallock (1997:19).

Puget Sound and Tributaries
One collection record exists for the Skokomish River mapped by Mongillo and Hallock (1997:19). Surface trawls captured lamprey in 2 of 177 tows in the Nisqually Reach area of Southern Puget Sound (Fresh et al. 1979:29).

British Columbia
Pacific lamprey were reported to be abundant off the entire coast of British Columbia (Clemens and Wilby 1961) including Point Moody Arm (PMES 2002) and Queen Charlotte Islands (MSRM 2001).

Cowichan River, BC
Pacific lampreys were known to parasitize freshwater fishes in the Cowichan River and Cowichan and Elsie Lakes on Vancouver Island (McPhail and Lindsey 1970; Hart 1973). The landlocked population in Cowichan Lake was known to be considerable because eight out of ten game fish taken from the lake bore fresh or old lamprey scars (Carl 1953). About seven years after the construction of a dam that blocked passage for lamprey, the Elsie Lake population disappeared (Beamish and Northcote 1989).

Fraser River, BC
In 1948 masses of lamprey covered the walls of Hell's Gate Canyon on the Fraser River. Beamish and Levings estimated that the Fraser River produced 600,000 spawning adults based on ammocoete and young adult counts during 1984-1988 with 100,000 produced by the Nicola River. Young adult counts in 1984-1985 were nine times higher than in 1985-1986. Large between-year fluctuations were also noted by Pletcher (1963) for the Fraser and Bulkley Rivers. The upstream range in the Fraser-Thompson system was reported as far up as Shuswap Lake by Scott and Crossman (1973) but a small spawner was taken at Prince George on the Fraser River, upstream of the range of sea-run lamprey (McPhail and Lindsey 1970)

Skeena River, BC
Native Americans on the Skeena and Fraser rivers scoop lampreys from the rivers' canyon wall (Scott and Crossman 1973:45).

Alaska

The Pacific lamprey ranges southward from Unalaska Island in the Aleutians, but is apparently rare north of the Alaska peninsula with only one specimen known to be taken form the Wood River entering Bristol Bay (McPhail and Lindsey 1970). Morrow (1980) reports Pacific lamprey from Nome, Saint Mathew Island, Wood River, and Unalaska Island. Pacific lamprey potentially occur in the Togiak Wildlife Refuge in southwest Alaska (the Kanektok, Tiak, and Goodnews Rivers are major drainages in the refuge) (USFWS 2001). From 1967 through 1972 Pacific lamprey was caught off Amchitka Island, in the Aleutian Islands (USFWS 1998). McPhail and Lindsey (1970) noted spawning in the Copper River in June. Heard (1966) failed to find the species during extensive collecting in Grosvenor Lake, despite earlier reports of the species there. Lampreys (species unknown) were once taken in large numbers in the Yukon River by native fishers (Evermann and Goldborough 1907). Lampreys of the lower Yukon River are mostly anadromous, the lampreys of the Chatanika River are strictly freshwater, and both forms occur in the Naknek River (Morrow 1980).

Pacific Ocean
Pacific lampreys captured with ocean hauls were concentrated along the southern Oregon coast. Few lampreys were captured along the California coast, suggesting low relative abundance (Table 9). Frequency of catch increased from none in 1983 and 1986 to 2.5 percent in 2001 (Table 10). The depths sampled (55-500m) are in the depth zone where Pacific lamprey are found. Beamish (1980) reported captures of young adults off the Pacific coast at depths from 100-250 m, but they generally occupy mid-water plankton layers.

Table 9. Distribution of 1980-2001 of Pacific lamprey and unidentified lamprey catches from 4,832 ocean tows at 55-500m depth. Unidentified lampreys were assumed to be *L. tridentata.* (National Marine Fisheries Service, Northwest Science Center, unpublished data).

State	Latitude	Tows with Lamprey
WA	50	0
WA	49	0
WA	48	2
WA	47	2
OR	46	3
OR	45	5
OR	44	3
OR	43	8
OR	42	6
CA	41	1
CA	40	0
CA	39	1
CA	38	0
CA	37	2
CA	36	0
CA	35	1
CA	34	0
CA	33	0

Table 10. Percent occurrence of Pacific lamprey and unidentified lamprey from triennial ocean tows at 55-500m depths, 1977-2001. (National Marine Fisheries Service, Northwest Science Center, unpublished data).

Year	No. of Tows	Percent Occurrence
1977	664	0.0
1980	505	0.3
1983	561	0.0
1986	507	0.0
1989	539	0.2
1992	501	0.7
1995	521	0.8
1998	528	1.3
2001	506	2.5

2. River Lamprey (*Lampetra ayresi*)

River lamprey are distributed from Tee Harbor, near Juneau, Alaska, to the Sacramento-San Joaquin drainage, California (Froese and Pauly 2002). Distribution and population data for river lamprey are sparse because they mostly spawn in large rivers where they are hidden from observation unless special sampling techniques such as trawls are used. Identifications based on juveniles are often suspect because of the difficulty in distinguishing river lamprey from Pacific lamprey during larval and early adult stages.

California

Trend data is unavailable from California but it is likely the species has declined, along with the decline of suitable spawning and rearing habitat in the lower reaches of larger rivers (Moyle 2002:102).

Central Valley, CA

Most records for river lamprey are from the lower Sacramento-San Joaquin River system, including the Stanislaus, and Tuolumne rivers. River lamprey are captured every year in the fish rescue facilities in the south Delta but they have not really been looked for in most other streams (Moyle 2002:102). None were captured in rotary screw traps operated during 1996-2000 near Red Bluff Diversion Dam (unpublished data, USFWS, North Central Valley Fish and Wildlife Office). River lampreys were historically present in Mill Creek, a tributary to the Sacramento River in Tehama County (Vladykov and Follett 1958). Froese and Pauly (2002) provide records of river lamprey from the Sacramento River in 1947 and 1949; and Middle River in 1948.

San Francisco Bay Streams, CA

River lampreys are reported to exist in the Napa River, Sonoma Creek and Alameda Creek (Moyle 2002:102) but none have been observed during the 1980s and 1990s. A river lamprey was last collected by J. D. Hopkirk from Alameda Creek near Niles in 1966 (Leidy 1984). River lampreys were also collected historically from Coyote Creek (Froese and Pauly 2002). The California Academy of Sciences has specimens taken from San Francisco Bay in 1945, 1954, 1955 and 1971 (Froese and Pauly 2002). Froese and Pauly (2002) also provide records of river lamprey from the San Francisco Bay and off Alameda in 1955; Carquinez Straight in 1962; Marin Colk and off Net Depot in 1971; and from San Pablo Bay and Fieldbrook on unknown dates.

Cache Creek, CA (Lake County)

River lamprey were once observed spawning in Cache Creek, but they are now extirpated (Moyle 2002b).

Russian River, CA (Mendocino County)

River lampreys are regular spawners in Salmon Creek and lower Russian River tributaries (Moyle 2002:102).

Eel River, CA (Mendocino County

A single adult female was collected at Cape Horn Dam, date unreported (Moyle 2002:102).

Klamath River, CA

Traditional tribal “eelers” often see smaller “jack lamprey” when they are gaffing or dipnetting for the larger Pacific lamprey at the mouth of the Klamath River between November and April. These “jack lamprey” are probably river lamprey. Every once in a while a "jack" lamprey is seen coming in the wave trying to make its way up the Klamath River. Frank Lake (Oregon State University Dept. Fisheries and Wildlife <fklake@coas.oregonsate.edu>) hooked what was probably a river lamprey during March 2002. It was about 10 inches long. Most tribal “eelers” don't try to capture “jack lamprey” because of their small size but they appear to be common on incoming high tides mixed in with smelt.

Trinity River, CA

River lamprey are captured annually in smolt traps in the Trinity River (pers. com. between R. Nawa [Siskiyou Project] and Frank Lake [Oregon State University, Dept. Fisheries and Wildlife, Corvallis, Or. <fklake@coas.oregonstate.edu>])

Oregon

In Oregon, adult river lampreys are currently known only from museum collections. Kostow (2002:120) reports that "[t]he Oregon Department of Fish and Wildlife have not observed river lamprey for many years and have no information about it." This lack of observations may be because the species is very rare or that the species is difficult to find in fresh water. The last collection records are from the Columbia River in 1980.

Yaquina River, OR

The Oregon State University GIS data base shows 5 records of river lamprey from the Yaquina River (Kostow 2002:70, Moyle 2002:102).

Necanicum River, OR

The Oregon State University GIS data base shows one record of river lamprey from the Necanicum River (Kostow 2002:70).

Columbia River

The Oregon State University museum has 19 collections for river lamprey from the lower Columbia River (Kostow 2002:70, Moyle 2002:102). Lampreys were collected from 1940-1980 with most collections during 1979-1980. A survey of 23 sites in the Yakima River basin found one specimen of river lamprey (Cuffney et al. 1990).

Washington Coast

No distribution records are known to be available for Washington, although it probably occurred in most major rivers (Wydoski and Whitney 1979). Specimens were collected from the Bogachiel River on 3 September 1897, Lake Pleasant, date unknown, and off the coast of Washington in 1991 (Froese and Pauly 2002). Ocean surface trawls conducted by the National Marine Fisheries Service picked up a river lamprey 4 miles off La Push, Washington on 28 June 2002 (unpublished data available from Bob Emmett, NMFS, Newport, OR).

Puget Sound

Nisqually River, WA (Thurston County)

During May and June in the early 1980s, salmonid smolt traps captured river lamprey ammocoetes in the Nisqually River (Cook-Tabor 1999:1).

British Columbia

Historical collections of river lamprey in British Columbia include: English Bay, Vancouver, in 1800; off Discovery Island in 1942; the Strait of Georgia, off Vancouver Island, in 1953; off west Vancouver, from the Sechelt Area in Malaspina Strait Sea, from Chatham Sound northeast of Porcher Island, and at Cranberry Lake, in 1958; at Skidegate Lake in the Copper Creek headwaters of Moresby Island, in Harris Strait north of Victoria, and in Howe Sound, in 1959; at Locarno and Spanish Banks beaches in Vancouver in 1960; at Burrard Inlet 1 mile north of Spanish Banks, and at Porlier Pass, in 1961; at Spanish Banks in 1962; at East Sound, Orcas Island in 1967; and at Point Gray, Vancouver in 1969 (Clemens and Wilby 1961; Froese and Pauly 2002). Other British Columbia records include Porlier Pass and the Skeena River (Hart 1973).

Recent observations of river lamprey in British Columbia include: off the west coast of Vancouver Island in 1991 (Froese and Pauly 2002); in Cloyoqut Valley on western Vancouver Island (NEI 2002); and in Burnaby Lake and its tributary streams (COB 2002). River lampreys occur in Point Moody Arm, British Columbia (PMES 2002). Haas (1998:31) assumed that river lampreys are rare in BC based on limited collections (Carl et al. 1977).

Fraser River, BC

River lampreys 93 to 267 mm were common within freshwater reaches of the mouth of the Fraser River and in Saanich Inlet in the late 1960s (Hart 1973). In 1979 an estimated 6,500,000 young adult river lamprey migrated out of the Fraser River (Beamish and Youson 1987).

Alaska
River lamprey are distributed from Tee Harbor, Alaska southward (Froese and Pauly 2002). Historical collections of river lamprey in Alaska were made from 1958-1960 at Lake McDonald in southeast Alaska, Lynn Canal, the southern end of Portland Canal, Douglas Island off Outer Point, the Taku River and just north of Tee Harbor (Froese and Pauly 2002).

3. Western Brook Lamprey (*Lampetra richardsoni*)

California
Moyle (2002a:104-105) rates western brook lamprey as "special concern"; the species is in decline, so species management is needed to keep it from becoming threatened or endangered." Moyle (2002:105) speculates that western brook lampreys are probably more common than records indicate because special efforts have to be made to collect them and to separate ammocoetes from river and Pacific lampreys. Populations likely occur in many streams along the California coast, especially in large rivers or their tributaries. However, it is unlikely that they can withstand severe pollution or habitat changes, so they are probably restricted to less disturbed sections of streams.

Los Angeles River, CA
Ammocoetes collected from streams in the Los Angeles River basin ca 1917 may be western brook lamprey or an undescribed species (Hubbs 1967). This population is now extirpated (Moyle 2002a:105).

Sacramento-San Joaquin River, CA
In California populations of western brook lamprey have been identified mainly from the Sacramento drainage (Moyle 2002a:15). Although extirpated or rare in the Putah and Cache Creek watersheds, a small population may remain in Kelsey Creek, a tributary to Clear Lake in Lake County (Moyle 2002a:105,2002b).

Coyote Creek, CA (Santa Clara County)
Western brook lampreys were collected by C.L. Hubbs in San Jose in 1923 (Leidy 1984).

Russian River, CA (Mendocino County)
Western brook lampreys were collected in 1954 in Mark West Creek (Froese and Pauly 2002) tributary to the Russian River in Sonoma County, and according to Moyle (2002a:105) are still present there.

Navarro River, CA (Mendocino County)
Spawning adults were collected in 1999 from the Navarro River (Moyle 2002a:105).

Eel River, CA (Mendocino County)
Western brook lampreys are present above Pillsbury Reservoir (Moyle 2002a:105).

Willow Creek, CA (Humboldt County)
Western brook lamprey were present in 1978 (Moyle 2002a).

Oregon Coast

Illinois River, OR (Josephine County)
Rivers (1963) reports that one specimen of brook lamprey was found in 1948 at Tannen Lake in the Siskiyou National Forest, none have been found there, or elsewhere, since.

Siuslaw River, OR (Lane County)
Western brook lampreys are found in the Siuslaw River (USBLM 2002).

Alsea River, OR (Lincoln, Benton Counties)
A systematic survey for both Pacific and western brook lamprey found that both species were present, but the Pacific lamprey was more common (Kostow 2002:28). Brook lampreys could either be more dispersed or rarer. Analysis of catchments averaging 100 hectares found brook lamprey present in most catchments (Schooler and Garono 2000:15). Lampreys were not found in the most upstream reaches of the basin and both species were often absent above road culverts (Kostow 2002:28).

Neskowin Creek, OR (Lincoln County)
Western brook lamprey were recently identified in Neskowin Creek (USFWS 2000).

Columbia River

Historically, western brook lampreys were found as far inland as the lower reaches of the Yakima River (Wydoski and Whitney 1979). At Franz Lake National Wildlife Refuge (Skamania County) western brook lamprey are found in nearby streams (USFWS 2002).

Willamette River, OR
Western brook lamprey occur in the McKenzie River, Row River, below Dorena Reservoir, Cox Creek (NANFA 2002), and Wolf Creek (USBLM 2002).

Walla Walla River, WA
Kostow (2002:24) reports that the situation for western brook lamprey is precarious because they were completely absent from all areas inventoried above Bonneville Dam except for a small population in the South Fork Walla Walla River.

Yakima River, WA
A survey of 23 sites in the Yakima River basin found three specimens of western brook lamprey at 2 sites (Cuffney et al. 1990).

Washington
Western brook lampreys were considered common in Washington in 1936 (Schultz 1936).

Washington Coast
As many as 170 ammocoetes per square meter have been reported in the lower reaches of coastal streams in Washington and Oregon (Scott and Crossman 1973).

Olympic Peninsula
Collection sites for western brook lamprey are from the Quillayute, Queets, Quinault, Humptulips, Wynooche, and Satsop rivers on the Olympic Peninsula (Mongillo and Hallock 1997)

Puget Sound
Four specimens were collected from North Creek, 15 miles north of Seattle in 1955 (Froese and Pauly 2002). Western brook lampreys were collected in 1979 in Dry Creek, Mason County (Froese and Pauly 2002). Western brook lampreys (primarily adults) have been captured in May and June in the lower reaches of the Nisqually River (Cook-Tabor 1999:1).

British Columbia, Canada
The western brook lamprey was known to occur in the Cowichan River on Vancouver Island, streams entering the Fraser River, Hooknose Creek, and King Island (Scott and Crossman 1973). Western brook lamprey have been reported recently in Blake Creek and Burns Bog (Simms et al. 2000) and is still present in the Queen Charlotte Islands (McPhail and Careth 1993; MSRM 2001).

Haas (1998:31) assumed that western brook lampreys are rare in BC based on limited collections (Carl et al. 1977). Morrison Creek (Puntledge River drainage) on Vancouver Island has a freshwater resident population of parasitic brook lamprey (*L. richardsoni marifuga)* (Haas 1998:43), but (Renaud 1997:143) identified the Morrison Creek lamprey as a river resident river lamprey (*L. ayresi*).

Alaska
Ammocoetes were found from McDonald Lake on the Cleveland Peninsula in southeastern Alaska (Vladykov and Follett 1965; Morrow 1980.

4. Kern Brook Lamprey (*Lampetra hubbsi*)
The International Union for Conservation of Nature and Natural Resources (IUCN) listed the Kern brook lamprey as rare in 1990 and near-threatened in 1996. Moyle (2002:104) rates the status of Kern brook lamprey as "special concern":

> Relatively few unequivocal collections of this species have been made since it was fist discovered in 1976. This is because most collections are of ammocoetes that cannot be reliably distinguished from those of the western brook lamprey. Probable populations are thinly scattered throughout the San Joaquin drainage and isolated from one another. This fragmented distribution makes local extirpations likely, without hope of recolonization, followed by eventual extinction. The probability of local extirpation is increased by the fact that all known populations but one are below dams, where stream flows are regulated without regard to the needs of lampreys and where fluctuation or sudden drops of flow may isolate or desiccate ammocoetes..... Ammocoetes may also be carried to "sink" habitats such as the Friant-Kern siphons. Clearly, if this species is going to persist, flows and habitats of lower reaches of rivers of the San Joaquin drainage should be managed so as to consider its needs.

Historical collections of the Kern brook lamprey are known only from the Friant-Kern Canal in Merced County and the Merced River (Froese and Pauly 2002). Seven Kern brook lamprey were documented in November 1995 in Kings River, below the North Fork New River, near Trimmer California (USGS 2002).

VI. PRESENT OR THREATENED DESTRUCTION, MODIFICATION, OR CURTAILMENT OF HABITAT OR RANGE.

Lampreys have experienced declines in abundance throughout the Northern Hemisphere due to human disturbances (Renaud 1997). Lamprey on the Oregon coast, Columbia Basin, and elsewhere have declined along with salmonids occupying the same habitat, which suggests that the same habitat disturbances that have caused the federal listing of anadromous salmonids also affect lamprey (see NMFS 1996,1998; Close et al. 2002:19).

1. Pacific Lamprey (*Lampetra tridentata*)

A. Dams and other artificial barriers

Adult Pacific lampreys are moderately strong swimmers and possess a suctorial disc that allows them to incrementally surmount obstacles such as fish ladders or cascades by interspersing upstream movement with resting periods during which they attach to objects with this disc (PacifiCorp 1998). During June 2002, R. Nawa observed Pacific lamprey clinging and inching their way up vertical cement walls at Savage Rapids Dam on the Rogue River, Oregon. Despite their unique climbing abilities, the range of Pacific lamprey has been greatly reduced by dams that totally blocked adult upstream migrations. Loss of range is greater than that experienced by anadromous salmonids (Frissell 1993) because some dams that pass salmon and steelhead are barriers to lamprey: Powerdale Dam on the Hood River, North Fork Dam on the Clackamas River and Threemile Dam on the Umatilla River (Kostow 2002:21,38). In addition, many culverts that pass salmon and steelhead are barriers to lamprey because lamprey cannot jump.

During the late 1800s Pacific lamprey completely covered Willamette Falls (Kostow 2002). Since completion of the Willamette Valley Project and building of 13 U.S. Army Corps of Engineers dams in 1967, annual commercial harvest has decreased from an average of 218,000 lbs. (1943-1952) to 13,000 lbs. (1969-2001) (Table 7; Ward 2001). Decreased harvests of lamprey at Willamette Falls since 1967 suggest a ten-fold population decline from the 1940s.

One formerly anadromous Pacific lamprey population of the Trinity River in California has persisted as a landlocked population in Claire Engle Reservoir (Moyle 2002:97) but dams usually result in the extirpation of the species after about seven years (Beamish and Northcote 1980). Lamprey may have formerly extended into reaches above Soda Springs Dam in the North Umpqua River, but none were found during fish surveys (Pacificorp 1998:7-61).

Poor passage efficiency on lower Columbia River dams (Bonneville, Dalles, and John Day Dams) contributes to Pacific lamprey declines by limiting access to historical spawning locations (Moser et al. 2002). Less than half of the radio tagged lampreys that approached the Dalles and John Day dams successfully passed above them (Kostow 2002:38). Radio tagging from 1997 to 2000 showed only 38-47 percent passage efficiency for lampreys at Bonneville Dam (with median passage times ranging from 4.43 to 5.7 days), and 50-82 percent efficiency at the Dalles Dam (passage times ranged from 2-4 days) (Moser et al. 2002). Passage efficiency was lowest at the John Day Dam with only 3 percent of the tagged fish reaching areas above John Day Dam (Moser et al. 2002).

During the 1970s and 1980s biologists found that juvenile lampreys impinged on the perforated plates of mainstem Columbia River dams in huge but undocumented numbers (Kostow 2002:40; BioAnalysts 2000:27). The fingerling bypass facility at McNary Dam traps ammocoetes in the tail screens and switching gates causing significant mortality and the new facility will not solve these problems (ODFW Umatilla District 1994 Report). Ironically, passing lamprey through the turbines may be less harmful than the current screens.

Altered hydrographs for flood control or power generation may harm lamprey. For example, lamprey are passive swimmers and increased migration time in the Columbia system may affect them adversely as it does salmonids (for example, through increased predation)(Kostow 2002:41; BioAnalysts 2000:26). Rapid artificial drawdown of streamflow can cause ammocoetes to be stranded in exposed bars and mudflats. The fall dewatering of irrigation screens at Savage Rapids Dam on the Rogue River causes ammocoetes to be stranded in their burrows. Water level fluctuations in the mainstem North Umpqua River caused by hydro-power generation temporarily dewater stream margin habitats used by ammocoetes resulting in observed mortalities (Pacificorp 1998 7-62).

Artificial features such as tide gates, hatchery weirs, and stream diversion structures may also be barriers to upstream migration (Kostow 2002:39).

B. Road Culverts

Similar to dams, culverts that pass adult salmon and steelhead are often barriers to lamprey. A systematic survey of lamprey in the Alsea Basin, Oregon found lampreys were often absent above road culverts (Kostow 2002:39)

C. Water Diversions

Stream diversions can kill juvenile and adult lamprey, either because the diversions are unscreened or the lamprey can get under or through the screens (Kostow 2002, BioAnalysts 2000:25). Low flows or no flow can kill ammocoetes rearing below water diversions and exacerbate temperature and sediment effects (Close 2002:19; BioAnalysts 2000:25). Production from adult lamprey may be lost when they spawn in irrigation ditches. For example, an irrigator in the Entiat Valley, Washington found ammocoetes in the irrigation system when the intake was in the Entiat River (BioAnalysts 2000:4). A constant head orifice at Stony Creek and the Tehama-Colusa Canal (Sacramento River basin) entrained and killed 165 lamprey larvae during January 28 to May 4, 1994, but only 6 were entrained during September 9-22, 1994 (Brown 1994). Lamprey ammocoetes were the third most common fish entrained by experimental pumps on the Sacramento River, but survival ranged from 95-100 percent (Borthwick et al. 1999).

D. Chemical and Organic Waste Poisoning

Bridge crossings, roads, and irrigation ditches make eradication with accidental spills or intentional chemical treatment a high-risk threat. Lampreys are particularly vulnerable to chemical spills because populations in a basin may concentrate in one stream (see Kostow 2002:42). Since lamprey ammocoetes take up to six years before metamorphosing, six years of production are lost during a chemical poisoning. If all or a substantial amount of the stream's ammocoetes are killed, adult lamprey may not be drawn to it to spawn, resulting in local extinction.

A 1999 spill of a herbicide in the lower portions of Fifteenmile Creek, Oregon killed thousands of lampreys. Chemical spills in the Willamette basin have also killed lamprey (Pringle Creek). A 2001 spill of liquid cow manure into Gee Creek near Ridgefield, Washington killed lamprey and other fish (Washington Dept. Ecology 2001). A probable chlorine spill in upper Alameda Creek in the Sunol Valley in April 2002 killed at least 24-36 Pacific lampreys (2002 personal communication between Jeff Miller [Alameda Creek Alliance, Canyon, Ca.] and Mike Mullen [U.S Geological Survey, Fremont, Ca.]).

From the late 1940s through the late 1980s the Oregon Fish Commission killed non-game fishes across the state with rotenone (Close et al. 1995:18). The use of rotenone in John Day River by ODFW killed thousands of lampreys in 1969 and 1982. About 90 and 85 miles of the Umatilla River were poisoned in 1967 and 1974 to eradicate non-game fish. The 1967 treatment killed one million fish, which was about 95% of the fish in the treated area. September poisoning in the Umatilla would have decimated several age classes of larvae, young adults, and adults returning to spawn (efforts are now underway to reestablish lamprey in the Umatilla River).

The ODFW purposely exterminated a unique lake dwelling sub-population of the Miller Lake Lamprey with chemical treatment of Miller Lake (Bond and Kan 1973). Miller Lake lampreys present in Miller Creek have failed to colonize the lake.

The Environmental Protection Agency (EPA) recently detected high levels of polychlorinated biphenyls (PCBs) in lampreys collected from the Columbia River (Kostow 2002:41). Lamprey ammocoetes tend to concentrate in the lower portions of streams and rivers where stream gradients are low. These same areas are often heavily polluted by industry, agriculture, and urbanization (for example, Bear Creek in the Rogue Basin, Willamette River, and Umatilla River). Because ammocoetes spend 4-7 years filter feeding in the benthos they would be vulnerable to chemical toxicants that bioaccumulate (BioAnalysts 2000:26; Close et al. 2002:19).

E. Dredging

Kostow (2002:41) reports that most lamprey die after passing through dredges. Current dredging in the Willamette River, Columbia River, Columbia River backwaters and sloughs, and coastal estuaries would likely affect ammocoetes. Suction dredging for gold would also likely kill developing eggs and ammocoetes.

F. Streambed scouring and degradation

Logging practices such as splash damming and removal of instream wood have caused many streams to scour to bedrock, thus removing necessary spawning and rearing habitat (PSMFC, undated). Lamprey cannot spawn, rear, or overwinter in streams scoured to bedrock. Scouring to bedrock is most apparent on the central coast of Oregon where sandstone geology dominates. Many streams in the Umpqua River basin have scoured to bedrock (US Forest Service and ODFW stream surveys, Turaski 2000).

G. Channelization and destruction of riparian vegetation

Lamprey species depend on muddy bottoms, backwater areas, and low gradient areas during their larval life stage. Lampreys are greatly affected by loss of wetlands, side channels, back eddies, and beaver ponds from conversion to cropland, logging, urban construction in floodplains and channelization for flood control (PSMFC undated). Channelization, floodplain filling, and destruction of riparian vegetation is widespread in low gradient stream areas favored by lamprey for spawning and rearing. River channelization negatively impacts larval lamprey habitat by increasing stream velocity, thereby reducing depositional areas favored by larval lamprey (Close et al. 2002:19). High stream temperatures resulting from the destruction of riparian vegetation are a likely limiting factor because lampreys prefer temperatures below 20 degrees C (BioAnalysts 2000:25). Although most streams in Oregon exceed the Department of Environmental Quality Standard of 17 degrees C, few streams reach 28 degrees C (82 degrees F), the temperature at which lamprey ammocoetes begin to die (van de Wetering and Ewing 1999:2). Other aspects of elevated stream temperature may adversely affect lamprey survival, such as increased metabolic rates during metamorphosis to young adults and decreased stream microbial activity during the summer (van de Wetering and Ewing 1999:7). Urbanization, agriculture and industry have severely affected the Willamette, Rogue, and Umpqua Valleys (Kostow 2002). Puget Sound and the Central Valley of California are similarly affected (NMFS 1996, 1998). Extensive riparian and instream habitat degradation has been documented for mid Columbia tributaries (e.g., Wenatchee, Methow, Entiat, Okanagon) (BioAnalysts 2000:25).

H. Ocean Conditions

Abundance of lamprey may be positively correlated with prey fish abundance in the ocean. Ocean conditions unfavorable for the production of prey would be unfavorable to lamprey. Intense commercial harvest of pacific hake and walleye pollack may deplete the prey base for Pacific lamprey (Close et al. 1995). Lamprey abundance may be dependent in part on salmon populations (Close et al. 1995:1). Lamprey numbers at Bonneville Dam increased from 19,000 to 84,000 during 2000-2002, when salmon and steelhead populations in the ocean would have been very high based on run sizes to Bonneville Dam (US Army Corps of Engineers, Appendix B). Increased numbers of marine mammals may also reduce prey and more importantly increase predation on lamprey adults (Close et al. 1995, BioAnalysts 2000). Declines of Pacific lamprey at Winchester Dam on the North Umpqua River appear unrelated to changing ocean conditions, suggesting a freshwater mortality factor such as predation by smallmouth bass (Pacificorp 1998:7-62; Close et al. 1995).

2. River Lamprey (*Lampetra ayresi*)

Factors affecting Pacific lamprey would also affect river lamprey. The river lamprey is especially susceptible to dredging because it burrows in river bottom sediments in estuaries and most ammocoetes are killed when they pass through dredges (Kostow 2002: 41). Biologists have found river lamprey by sifting through dredge spoils from the lower Fraser River.

3. Western Brook Lamprey (*Lampetra richardsoni*)

Factors affecting Pacific lamprey would also affect western brook lamprey. Western brook lamprey cannot withstand severe pollution or habitat changes so they are probably now restricted to less disturbed sections of streams (Moyle 2002:105).

4. Kern Brook Lamprey (*Lampetra hubbsi*)

Factors affecting Pacific lamprey would also affect Kern brook lamprey. Poisoning, water diversions, and channelization are major threats.

A. Poisoning
In 1988 ammocoetes and adults were collected from the siphons of the Friant Kern canal when they were poisoned as part of an effort to eradicate white bass from the system (Moyle 2002: 103).

B. Water Diversions
The lightless siphons of Friant-Kern Canal mimics habitat preferred by Kern brook lamprey where ammocoetes are abundant at times (Moyle 2002:103). Presumably siphon populations do not contribute to the survival of the species, because adults derived from the siphons wind up in the aqueduct itself where they cannot successfully reproduce (Moyle 2002:103).

C. Channelization and streambed alteration
Channelization and riprap may eliminate backwater areas required by ammocoetes for rearing. Gravel beds needed for spawning may be eliminated or compacted, so they cannot be used by adults (Moyle 2002:104).

VII. OTHER NATURAL OR MANMADE FACTORS AFFECTING CONTINUED EXISTENCE.

1. Lack of monitoring data
Data gathering by state and federal agencies is inadequate to determine population trends and identify conservation measures. Kostow (2002:32-36) has identified monitoring needs for Oregon. For example, a monitoring station is needed at Willamette Falls to count what is believed to be the largest remaining Pacific lamprey population left on the West Coast. Despite requests by state agencies, lamprey counts have been discontinued for long periods at Columbia River dams and only sporadically monitored during the 1990s. Most state sponsored monitoring is inadequate because it is done in conjunction with salmonid monitoring. For example, the existence of river lamprey in Oregon has not been verified during the 1990s perhaps because adults do not spawn in small streams used by salmonids for rearing. Although techniques exist to capture river lamprey (Kostow 2002:35) none have been implemented by state and federal agencies on the Oregon Coast or the Columbia River.

2. Lack of taxonomic determinations
A unique adfluvial *L. tridentata* in the upper Klamath basin and a dwarf *L. tridentata* on the Oregon Coast have not had their taxonomic identity determined. Distinct species, subspecies, or distinct population segments could become extinct because of ignorance about their uniqueness. Funding is lacking for museum collections and publications for identification and conservation.

3. Vulnerability of high density areas
The apparent lack of homing behavior in Pacific lamprey may result in uneven distribution, unexplainable absences, and extremely high densities (see Kostow 2002:42). Distribution of lamprey juveniles is highly variable over space and time. Lampreys may be very abundant in one stream while rare or absent in nearby streams (Kostow 2002:28). For example, extremely high numbers of juvenile lampreys were observed in Clear Creek (Clackamas Basin, Oregon) when compared to adjacent streams with similar habitat (Kostow 2002). A smolt trap on Bear Creek in the upper Rogue River watershed caught 6,000 juvenile lampreys while other traps in the upper Rogue caught a few tens to hundreds. A local habitat disturbance such as a chemical spill or dredging could cause a major loss in a population. Circa 1995 Bear Creek had a large fish kill when a herbicide was released from irrigation ditches. The effect of this

herbicide release on lamprey is unknown. Loss of juvenile populations through chemical poisoning may trigger extinction as fewer adults are attracted to a basin that lacks ammocoete rearing areas (Kostow 2002:27). The Umatilla River may have lost its lamprey population because ammocoetes were poisoned.

VIII. PREDATION

Freshwater fishes (northern pikeminnow, white sturgeon, rainbow trout, smallmouth bass), saltwater fishes (sable fish, spiny dogfish), birds (terns, and gulls) and marine mammals (harbor seal, California sea lion) prey on eggs, ammocoetes and adult Pacific lamprey (see summary table, BioAnalysts 2000:17-18). Studies during the early 1980s found that adult Pacific lamprey were the most abundant item in stomachs of seals and sea lions in Washington, Oregon, and northern California (NOAA 1997; BioAnalysts 2000:22). Sperm whales are known to feed on lampreys (Hubbs 1967). Alien centrarchids such as smallmouth bass may be important predators of ammocoetes and young adults in the Umpqua and John Day rivers. On the North Umpqua, the sharp decline in Pacific lamprey populations during the 1970s occurred as smallmouth bass numbers increased (Pacificorp 1998:7-62). Predation studies in 1992 and 1993 found juvenile Pacific lamprey in the stomachs of 10 percent of smallmouth bass studied (Pacificorp 1998:7-62).

Hubbs (1967) reported "no evidence of any lamprey occurrence at anytime in coastal streams south of the Los Angeles Plain. Here, as over much of the West depletion of the water and introduction of more aggressive eastern [USA] fishes have rapidly brought the native fish fauna to or beyond the brink [of extinction]." River lamprey, western brook lamprey and Kern brook lamprey are also vulnerable to predation by alien fishes, especially in California where conditions are favorable for predator fish from eastern states.

IX. OVERUTILIZATION FOR COMMERCIAL OR RECREATIONAL PURPOSES

The Pacific lamprey is the only lamprey species harvested for food. Up to 500,000 Pacific lamprey have been harvested annually at Willamette Falls (Kostow 2002:92). As recently as 2001, 15,500 adults were taken (Kostow 2002:37). Commercial harvest was discontinued at Willamette Falls in 2002 because the proportion of the run being killed could not be determined. The ODFW believed that failure to restrict harvest of lamprey to allow escapement for reproduction could prevent the maintenance of the Willamette "stock" of this protected species. Tribal harvest of lamprey continues at Willamette Falls, Sherars Falls on the Deschutes and other Columbia Basin locations.

The impact of harvest on lamprey is unknown but could be significant as populations dwindle. For example, counts at Gold Ray dam on the Rogue River are not very high indicating that very little or no harvest should occur in the Rogue system (Kostow 2002:38). Unlimited harvest is currently permitted in California where populations are declining or are at low densities (e.g., Eel River and southern California streams).

River lamprey, Western brook lamprey, and Kern brook lamprey are not harvested for commercial or recreational purposes.

X. INADEQUACY OF EXISTING REGULATORY MECHANISMS

Conservation of native lampreys has not been a fisheries management priority in the United States. Even though these primitive fish share many of the same habitats as salmonids, lampreys have received little attention (Close et al. 2002:19). State agencies, individuals, and corporations have had a negative perception toward lampreys and believe that all lampreys are pests because of their predatory habitats on desirable food fishes such as lake trout and salmon. For example, a unique population of lake lamprey was poisoned from Miller Lake Oregon because they were feeding on stocked trout. Due to declining numbers, Idaho and Oregon (Kostow 2002) have given protective status to several species of lamprey[3], but these rules and regulations do not protect lamprey from habitat degradation or indirect takes (e.g., dewatering of streams, chemical poisoning) that are the most likely cause of declines.

State and federal agencies in California, Oregon, Washington and Idaho have failed to adequately regulate dam building, logging, mining, water withdrawals, road building, and construction that degrades or eliminates stream habitat needed by lamprey species for reproduction, rearing of young, and migration. The state and federal agencies responsible for lamprey conservation have little or no authority to protect habitat from despoliation. Fish managing agencies have been powerless to stop harmful dams, water withdrawals, streamside logging, gravel removal, placer mining, industrial pollution, home building, and road construction that are detrimental to aquatic species such as lamprey.

1. Water Law and Flow Regulation

State agencies have been ineffective at ensuring that aquatic creatures such as lamprey have adequate flows for migration and long freshwater rearing periods. Most streams are over allocated during the critical summer period and the situation is likely to become much worse for aquatic creatures because of increasing human needs exacerbated by persistent droughts (Boggess and Woods 2000). Individuals, cities, and corporations with water rights may dewater a stream entirely, killing all aquatic life. The Environmental Protection Agency and cooperating state agencies such as the Oregon Department of Environmental Quality have no authority to prevent streams from being dewatered or flows from being greatly reduced. For example, flows and habitats of lower reaches of rivers of the San Joaquin drainage are not managed for the needs of Kern brook lamprey. Existing state regulations do not require all diversion ditches to be screened and screens are not required to block passage by lamprey. Lamprey ammocoetes are small enough that they may pass through screens designed for salmonids. Once in the irrigation ditches they are likely to perish there because they cannot get back to a natural waterway before the ditch is drained. Agencies such as the Oregon Department of Environmental Quality allow irrigation districts to use herbicides such as acrolein to kill algae in ditches that would also kill lamprey. Existing regulations are not effective at preventing rapid flow reductions from dams that dewaters stream margins and kill ammocoetes before they can move to deeper water.

2. Passage at Dams and Culverts

Laws and regulations do not require fish ladders and screens at dams (especially Columbia River dams)

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[3] Pacific lamprey were listed as an Oregon state sensitive species in 1993 and were given further legal protected status by the state in 1996 with OAR 635-044-0130 (Kostow 2002:2). River lamprey and western brook lamprey were given protected status in 2002.

to effectively pass adult lamprey upstream or provide for safe passage of ammocoetes and young adults downstream. Culverts are not required to pass lamprey. Most outfalls at culverts would block adult lamprey passage because they cannot jump.

3. Harvest, Escapement Goals

In California, Pacific lamprey may be taken all year with no limits on the number of lamprey taken (2002 California Sport Fishing Regulations p. 20.). Unlimited harvest could preclude recovery where habitat is being improved or exacerbate the likelihood of extinction for local populations vulnerable to harvest (for example, lamprey ascending falls, dams, or fish ladders are easily captured). State agencies have not established escapement goals or methods to monitor lamprey that would help ensure and demonstrate viability of the species.

4. Private Land Logging

State laws such as the Oregon Forest Protection Act do not protect streams from harmful chemicals, siltation, streambed scouring, and barriers at culverts that impede or prevent successful spawning, rearing and migration. The IMST (1999) concluded that the forest practices rules for private forests in western Oregon were insufficient to recover wild salmon.

5. Federal Logging under Northwest Forest Plan

The Northwest Forest Plan (ROD) did not evaluate its effectiveness for Pacific lamprey (FEMAT: V66-68) because of insufficient information on ecology. Although the Aquatic Conservation Strategy is necessary for lamprey recovery, it cannot ensure viable populations because lamprey distribution is skewed towards private lands. Data from river basins dominated by federal lands indicate that Pacific lamprey are either no longer present in viable populations or are at very low densities compared to private lands. For example, lamprey populations have disappeared since the Forest Plan was implemented in Triangle Lake tributaries of the Siuslaw system on the central Oregon coast. Less than 50 Pacific lampreys return annually to the North Umpqua River that is dominated by public lands. Most lampreys appear to spawn primarily on private lands below public land boundaries. For example, although the Illinois River basin in southwest Oregon is 87 percent public land, only 14 percent of the lamprey redds were found on public lands. Similar distribution patterns occur on the Applegate River. Lamprey redd counts in the Smith River (Umpqua Basin) found very low lamprey densities in small tributaries where public lands dominate. Much higher redd densities were found in mainstem areas where private lands dominate (Table 6). Distribution of Pacific lamprey appear to be contracting to the lowest gradient reaches within basins (i.e. private lands) where populations were likely to have been the highest historically. Headwater refugia used by salmonids on public lands is often devoid of lamprey redds and ammocoete densities would be expected to be low or absent. In addition the Northwest Forest Plan does not provide for passage of lamprey species because lampreys appear to be unable to pass culverts with outfalls (lamprey cannot jump like salmonids).

6. Mining and Dredging

State and federal laws do not protect lamprey from dredging which directly kills ammocoetes by removing them from the stream environment and placing them in dredge piles (for example, Columbia River dredging). Placer mining for gold with suction dredges is allowed during lamprey spawning season. Eggs and ammocoetes would be killed. Gravel mining is not regulated to prevent direct killing of lamprey ammocoetes in streambed alluvium or degradation of habitat from downcutting when a flooding river captures gravel pits.

XI. CONCLUSION

Pacific lamprey, river lamprey, western brook lamprey and Kern brook lamprey are likely to become extinct or threatened with extinction in all or parts of their range in the foreseeable future.

1. Pacific lamprey and possibly western brook lamprey have been extirpated from entire subbasins in the Columbia River.

2. Monitoring of populations of Pacific lamprey indicate the species has rapidly declined to near extinction in large river basins such as the North Umpqua River, upper Sacramento River, and Snake River. Dam counts from the North Umpqua River, Rogue River, Sacramento River, and Snake River indicate that Pacific lamprey populations are much below those of currently ESA listed salmonids. For example, coho salmon are at much higher population abundance in the upper Rogue and North Umpqua Rivers than Pacific lamprey. Similarly, endangered Snake River chinook salmon are at higher numbers than unlisted Pacific lamprey.

3. Except for lamprey counts at Bonneville dam, Pacific lampreys have not shown substantial increases during 2000-2002 with improved ocean survival of anadromous salmonids.

4. State and federal agencies, individuals, and corporations have shown little or no interest in the conservation of lampreys. States responsible for the conservation of lampreys have allocated little or no monies for research or management of the species, even though data shows rapid declines of the species. For example, culverts, dams, and fish ladders are often barriers for lamprey because they were not designed to pass lamprey. State and federal agencies have no policies, plans or budget to correct this habitat factor. Conservation efforts appear limited to tribal management in the Columbia River Basin.

5. Monitoring, although necessary, is not sufficient to ward off extinction. State and federal agencies do not know the major limiting factors for lamprey and even if known what is causing declines, state agencies have no budget, management direction or authority to protect lamprey habitat or correct limiting factors. For example, during the past 20 years, Pacific lamprey have slipped towards extinction in the North Umpqua River but the state of Oregon did nothing to either determine the cause of decline or to reduce mortality factors for lamprey. Formerly abundant populations in the Eel River, California and Willamette River, Oregon are not monitored by the state wildlife agencies. Most lamprey monitoring is done in conjunction with salmonids and not given its own budget and priority.

6. Since fishing and collecting are not believed to be a major factor causing declines, elimination of lamprey fishing and collecting is not likely to reverse or even stabilize populations.

7. Techniques used to increase salmonids such as artificial production are not available for lamprey and are not likely to be effective. Similarly, artificial stream improvement structures for salmonids in freshwater are not likely to benefit lamprey because lamprey live in the benthos (an exception are gabions that provide overwintering habitat).

8. River lampreys are not protected from dredging activities in the Columbia, Yaquina and other large rivers.

9. Pacific lampreys are long-lived compared to Pacific salmonids. The relatively long freshwater rearing period (4-7 years) makes them more vulnerable to episodic mortality factors than salmonids (e.g., dewatering, poisons, dredging, streambed scouring, and predation). Assuming that the larvae live for 4-7 years before metamorphosis; returning adults then live for about 9-12 years. Adult counts alone do not ensure that populations will not experience declines over the next 12 years (e.g., adult redd counts on Oregon Coast, dam counts on Columbia River and harvest at Willamette Falls). Reproductive failure or major losses during early life history stages won't be evident in adult counts for 9-12 years. (Currently, there is no systematic monitoring of ammocoetes and young adults to determine population trends during freshwater rearing, although monitoring at Columbia River dams and smolt traps could provide this data if done during peak periods of ammocoete migration.) ~~Once adult lamprey declines are evident the declines are likely to continue for 9-12 years regardless of corrective actions taken for conservation.~~

XIII. REFERENCES

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Appendix A
BioAnalysts 2000

Appendix B
Columbia River Dam Counts
2000-2002