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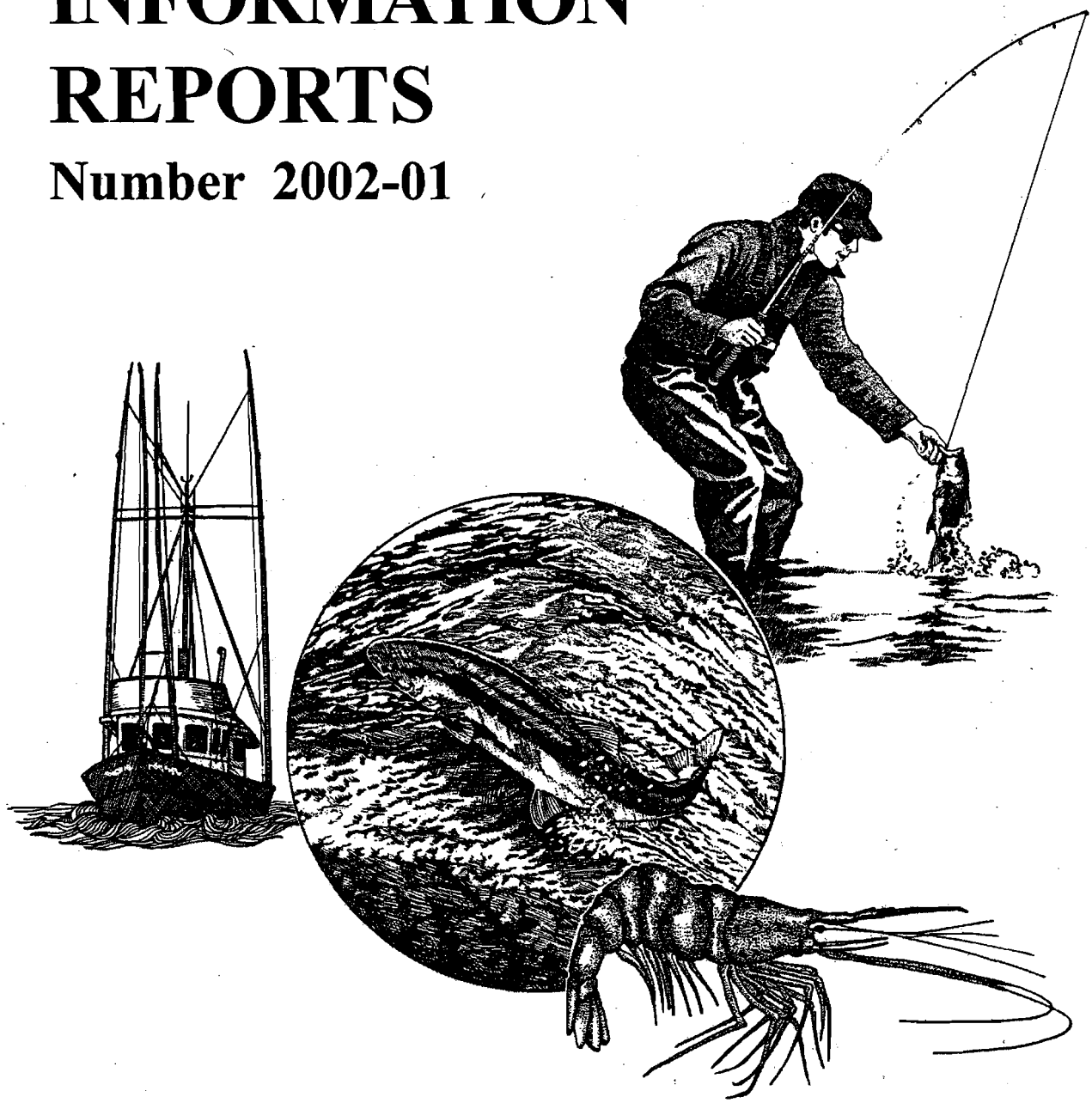

FISH DIVISION

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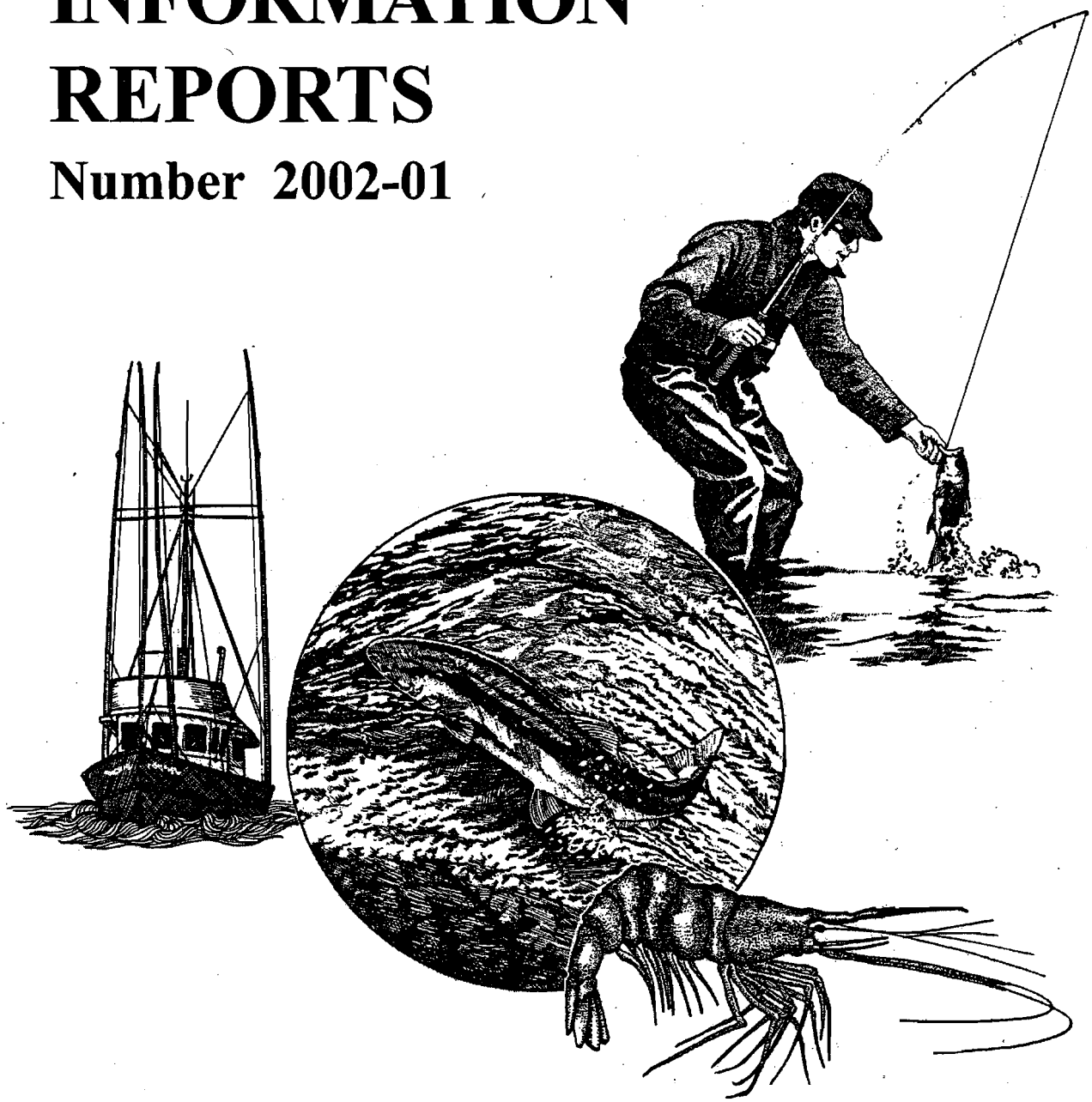

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Oregon Lampreys:

Natural History
Status
And
Analysis of Management Issues

by
Kathryn Kostow

Oregon Department of Fish and Wildlife
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Executive Summary

The jawless lampreys are remnants of the oldest vertebrates in the world. Oregon has somewhere between eight and a dozen species of these primitive fishes. Their taxonomy is obscure because different species tend to look very similar through most of their life cycle, and they have not been well-studied in Oregon. Lampreys occur in the Columbia Basin, including the lower Snake River, along the Oregon coast, in the upper Klamath Basin, and in Goose Lake Basin in southeastern Oregon. They all begin life in fresh water where juveniles burrow into silt and filter feed on algae. As some species approach adulthood they migrate to the ocean or to lakes where they briefly become ecto-parasites, feeding on other live fishes by attaching to them with sucker disc mouths. Other species remain non-parasitic. In addition to some enigmatic species identities, we generally have very little information about the detailed distributions, life histories and basic biology of lampreys.

Lampreys became a conservation concern in the early 1990s when tribal co-managers and some Oregon Department of Fish and Wildlife (ODFW) staff noted that populations of Pacific Lampreys, *Lampetra tridentata*, were apparently declining to perilously low numbers. Pacific Lampreys were listed as an Oregon State sensitive species in 1993 and were given further legal protected status by the state in 1996 (OAR 635-044-0130). Lamprey status is difficult to assess for several reasons: 1) Most observations of lampreys in fresh water are of juveniles and it is difficult to tell the various species apart, even to the extent that the various species are clearly designated; 2) Data on lampreys are only collected incidental to monitoring of salmonids. The design and efficiency of the data collection effort is not always adequate for lampreys; and 3) We have very few historic data sets for lampreys. Therefore, we often cannot determine how the abundances and distributions we see now compare with those in the past.

The limited data that we have suggest that lampreys have declined through many parts of their ranges. The most precipitous declines appear to be in the upper Columbia and Snake basins where we have some historic data from mainstem dam counts. Pacific Lampreys have declined to only about 200 adults annually passing the Snake River dams. We also have evidence of declines of Pacific Lampreys in the lower Columbia and on the Oregon coast, although our data are quite limited. We have little to no information about any of the other species of lampreys. We are not even sure whether some of the recognized species, like the River Lamprey (*L. ayresi*), are still present in Oregon.

This paper concludes with an analysis of management issues for Oregon lampreys. Our biggest problem is poor information, ranging from not knowing basic species identity to having inefficient or no systematic monitoring of lamprey abundance and distribution. ODFW continued an annual harvest on Pacific Lamprey in the Willamette Basin in 2001, but we lack the necessary information to assess the affects of the harvest on the population. Major habitat problems that affect lampreys include upstream passage over artificial barriers, a need for lamprey-friendly screening of water diversions, and urban and agricultural development of low-gradient flood plain habitats.

Chapter 1

Natural History of Oregon Lampreys

Introduction:

The Superclass Agnatha, the jawless fishes, are an ancient assemblage with origins in the Ordovician Period, about 500 million years ago. Many of the first great advances in the evolution of vertebrates occurred in early agnathans, including the development of bone cells, paired limbs, sensory-line systems, dentine tissue, complex eyes and muscles, and the inner ear. The group radiated into many spectacular forms in the mid-Paleozoic, many of which were characterized by elaborate bony shields and body armor. In all cases the agnathans lacked the jaws that would later characterize all other vertebrates. With the radiation of jawed and, later, bony fishes, most agnathans became extinct. By the end of the Devonian Period (about 350 million years ago) only the hagfishes and the lampreys remained (Long, 1995). Modern agnathans lack body armor and paired fins and have simple, elongated bodies. Still jawless, they include members that are filter feeders, scavengers, and ecto-parasites. The parasitic members feed on other live fishes by attaching themselves with an oral sucker disk, cutting the host's flesh with rasp-like teeth, and feeding on the host's blood. Parasitic lampreys produce an anticoagulant to keep the blood flowing during their meal. The host is left with a round sucker scar.

Lampreys have a colored history with humans. Much of what is known about basic lamprey biology is based on research of the parasitic sea lamprey, *Petromyzon marinus*, that has been conducted as part of an extensive effort to eradicate them from the Great Lakes in North America. This species was introduced into the Great Lakes where they contributed to declines of Great Lakes fisheries. Lampreys have been viewed as a threat even where they are native and live in harmony with their own ecosystem (Farlinger and Beamish 1983, Bond and Kan 1973). Some people appear to find the parasitic behavior of some lampreys to be repulsive, a view that is perhaps also sustained by their sliminess and perceived homely appearance. However, lampreys, like all native species, have an intrinsic existence value. Many people find their macabre nature to be fascinating.

Some people also value lampreys for use as food, as a traditional source of medicines and for scientific interest. Fatty and highly nutritious, they are valued as a traditional source of food by Native Americans (Pletcher 1963, Hammond 1979, Downey et al. 1993, Close et al. 1995, Downey et al. 1996, Jackson et al. 2001). Asian people use them as a source of essential oils for traditional medicines. Pacific lampreys were harvested in large numbers at Willamette Falls during the 1940s to be used as a source of vitamins (Mattson 1949) and they have been used as a source of anticoagulants. They are also a delicacy in some European cuisine. Because of their important position in the evolutionary history of vertebrates, they are common subjects for study and dissection in college science classes.

The nutritious, slow-swimming lampreys are also a valued food for some predator and scavenger species (Close et al. 1995, Hammond 1979). Many other fishes eat lamprey eggs and early emerging larva. Older ammocoetes may be partially protected from predators by an unpalatable skin, residence in burrows, and a tendency to leave their burrows only at night (Pletcher 1963). Adults of anadromous species are eaten in the ocean by marine mammals and larger fish (Beamish 1980). Lampreys appear to be targeted by some mammalian and avian predators during migrations to and from the ocean (Roffe and Mate 1984, Merrell 1959). Adult lampreys die after spawning, feeding scavenger species like sturgeon and contributing rich nutrients to freshwater ecosystems. Observations of lampreys made at Willamette Falls in the 1800s and on the Fraser River in 1948 indicate that lampreys were historically extremely abundant at some times of the year (McDonald 1894, Pletcher 1963) and possibly their declines have lead to imbalances and disruptions in natural predator-prey systems and nutrition cycles.

Oregon has two familiar lamprey species. The Pacific Lamprey (*Lampetra tridentata*), with a distribution along the coast and inland to the Snake River Basin (Figure 1), is a large, parasitic species and has received the most management and research attention. This species was listed as an Oregon State sensitive species in 1993 due to a perceived serious decline in abundance since the 1950s (Weeks 1993, Close et al. 1995) and was given further legal protected status by the state in 1996 (OAR 635-044-0130). The little, non-parasitic Western Brook Lamprey (*Lampetra richardsoni*), with a coastal distribution and inland in the Columbia Basin to the confluence of the Snake River (Figure 2), is also recognized as a familiar species but has received little attention. Additional species have also been described in Oregon. The 1995 status review of native fish species in Oregon, conducted by Oregon Department of Fish and Wildlife (ODFW), recognized four species of lamprey in the state (*L. tridentata, richardsoni, lethophaga,* and *ayresi*) (Kostow 1995). There are additional enigmatic groups: some are formally described species but may be local variants of other species, others may be new, undescribed species. One species, the little Miller Lake Lamprey (*Lampetra minima*) was declared to be extinct in the 1970s as a result of an intentional eradication program conducted by the state of Oregon (Bond and Kan 1973). The species was rediscovered in the upper Klamath basin in the late 1990s (Lorion et al. 2000).

Species Identification Challenges:

Lamprey taxonomy and field identification has always been difficult. Species are generally identified based on adult characteristics. The most commonly used traits are adult tooth patterns and adult life history traits. The major life history traits that influence taxonomy include parasitic versus non-parasitic, and anadromous (or adfluvial) versus resident. Spawning adult size may also be an identifying characteristic (Beamish and Neville 1992, Lorion et al. 2000).

But lampreys are adults for a relatively short period of their lives. Some species, such as the River Lamprey *L. ayresi,* are rarely seen in freshwater even if they are abundant (Beamish 1980, Beamish and Youson 1987). Juvenile lampreys, called ammocoetes or

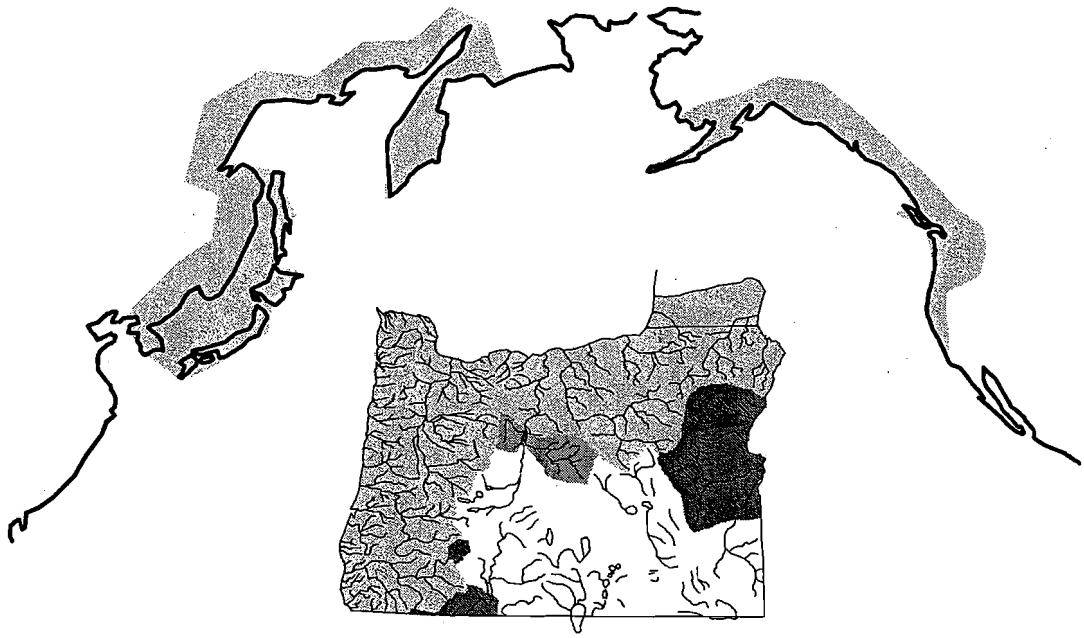

Figure 1. Present and historic distribution of the anadromous Pacific Lamprey (*Lampetra tridentata*) in Oregon and around the Pacific Rim. Present distribution ( ); area of known historic distribution ( ) and areas of suspected historic distribution ( ).

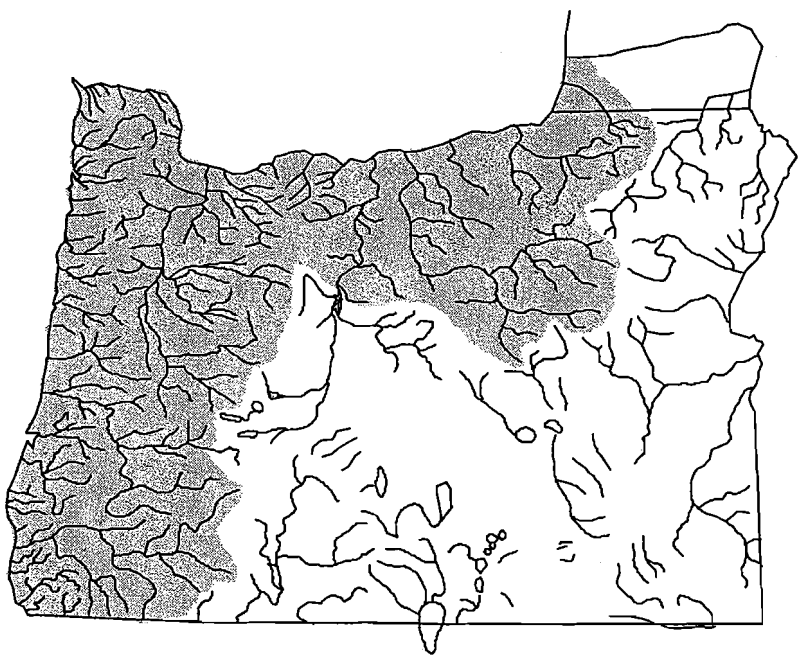

Figure 2. Distribution of the resident Western Brook Lamprey (*Lampetra richardsoni*) in Oregon.

larva, are small, worm-like and eyeless, with small filter-feeding mouths, delicate gill slits and narrow fins. On casual observation they are nearly identical across all *Lampetra* species. Field keys for ammocoetes of Pacific Northwest species have been developed (Richards et al. 1982) but they are based on subtle variations in color that have been unreliable across the range of the species. Efforts to improve the keys are underway (Bayer et al. 2001). Meanwhile, ammocoetes are the most frequent life stage observed during abundance monitoring making status assessment of different species difficult.

Older ammocoetes undergo an extensive metamorphism. In a parasitic species this change leads to a life stage of parasitic feeding. In nonparasitic species the change results in a reproductive adult. The process of change can be very protracted. It begins with a year or more of retarded length growth while lipids are accumulated (Potter 1980). Near the end of that period the lamprey stops feeding and begins an extensive morphological and physiological transformation that may take from two to eight months depending on the species. All species develop eyes and more distinctive fins at this life stage. Their naso-pineal organ, sensitive to light and chemical stimuli, enlarges. The shape of the head, especially the oral disc, enlarges. As appropriate by species, there are changes in the gills, in the gut, in blood chemistry and osmoregulation, and development of the gonads (Pletcher 1963). If the species is parasitic, the rasping teeth begin to develop and at the end of metamorphism the lamprey is parasitic. If the species is adfluvial or anadromous downstream migration occurs late in this period and at the end of metamorphism the anadromous lampreys have physiologically adapted to salt water. During the process of metamorphism, characteristics are changing and can be misleading causing field identification mistakes. Most commonly, some parasitic lamprey species at early states of metamorphosis are mistaken for adult brook lamprey because they have eyes but development of their parasitic oral disk is still incomplete. However, lampreys at late stages of metamorphosis can be more readily assigned to species.

More difficult, the taxonomy of the genus is unsettled. Within *Lampetra*, closely related species occur in groups called "paired", "sister" or "satellite" species. Oregon has two lamprey groups that correspond to two subgenera. These can be distinguished by adult tooth pattern and also by conserved molecular genetic markers. Subgenus *Lampetra* includes the Oregon species *L. ayresi* (which is parasitic), *L. richardsoni*, and *L. pacifica* (which are both nonparasitic). All other Oregon species are in the subgenus *Entosphenus* (Docker et al. 1999). Species within a subgenus can be very similar during metamorphism until the teeth of the parasitic forms are well developed. Mistakes of identity can even occur between subgenera during early stages of tooth development. Adults within a subgenus that have similar life histories also can be difficult to distinguish and species have been split, grouped, and split again in the systematics literature. Species within a complex may be differentiated primarily by adult size at spawning (Lorion et al. 2000). There is a question as to whether parasitism is a clear species characteristic, or whether it may be facultative in some cases (Beamish and Withler 1986, Beamish 1987). *Lampetra tridentata* has been demonstrated to be unable to persist exclusively in freshwater after access to the ocean is blocked (Wallace 1978, Beamish and Northcote 1989) while in other references, freshwater resident *L. tridentata*