Background
The Pacific lamprey (*Entosphenus tridentatus*) is an ecologically and culturally valuable species native to western North America and populations are in rapid decline. Understanding the biology and ecology of this species is critical for conservation. Pacific lamprey life history is unique due to a 4 to 7 year larval phase. Due to the protracted nature of the larval stage, larvae may be particularly vulnerable to environmental disturbances.

The Columbia River estuary encompasses the area from Puget Island/Cathlamet to the Pacific Ocean. Determining the distribution larval Pacific lamprey in the Columbia River basin is a management priority. Within the Columbia River mainstem, larval lamprey occupancy of the lower river and estuary, including areas of tidally induced variation in salinity is not known. The Columbia River estuary is a large, nutrient rich area with abundant fine sediments that are suitable for larval lampreys (Figure 1). While larval lamprey likely occur in the lower Columbia River, occupancy and distribution of larval lamprey in this area is not known and has not been investigated. Within the estuary, salinity profiles vary daily and seasonally according to tidal cycles as well as Columbia River discharge (Figure 2). Tolerance of larvae to intermittent exposure to salinity may shape their distribution in this region.

Larval Pacific lampreys are generally thought to be stenohaline and obligatory to fresh water. However, recent laboratory experiments suggested that larval Pacific lampreys may be able to tolerate moderate salinity for some period of time. To better understand larval Pacific lamprey salinity tolerance and osmoregulatory ability, we are conducting laboratory research to evaluate and compare survival and physiological parameters across numerous salinity exposure regimes. These results will be used in combination with salinity profile data of the Columbia River estuary obtained from the Center for Coastal Margin Observation and Prediction (CMOP), to delineate areas in the estuary that are potentially suitable for larval lamprey occupancy.

**Figure 1.** The Columbia River estuary encompasses the area from Puget Island/Cathlamet to the Pacific Ocean.

**Figure 2.** Maximum bottom salinity in the Columbia River estuary between 1999-2006 (data from CMOP).
Methods

This ongoing project is comprised of both laboratory and field components. In a laboratory setting larval Pacific lamprey are being reared in a variety of saltwater treatments, including direct transfer and tidal simulation salinity treatments. Direct transfer experiments were conducted in 6, 8, 10, 12, 15, 25 and 35 ppt. salinity. In fluctuation experiments, salinity cycled from 0 to 25 ppt., 0 to 15 ppt., and 0 to 12 ppt. approximately every 6 hours. Survival through 14-day exposure period was assessed, and physiological parameters including plasma osmolality, plasma cation concentrations, and % water content were determined at 96 hours and 14 days.

Figure 3. Boat mounted deepwater electrofisher used to sample the Columbia River estuary for larval lamprey.

A pilot effort to sample the lower Columbia River and estuary for larval Pacific lamprey was conducted in 2010. Using ArcGIS and Program R, 30 m x 30 m sample quadrats within the lower Columbia River were delineated in a random, spatially-balanced manner. The boat-mounted deepwater electrofisher coupled to a suction dredge was then used to sample river bottom sediments at sample quadrats for larval lamprey (Figure 3). A substrate sample was collected at each site using a Ponar dredge, and water temperature, conductivity and salinity were recorded.

What have we found?

Direct transfer experiments
- At and below 10 ppt. salinity no larval lamprey mortality was observed through 14 days after transfer (Figure 4).
- In 12 ppt. saltwater and greater, 100% mortality was observed within 30 hours of transfer from freshwater (Figure 4).

Tidal fluctuation experiments
- In 12 ppt. cycles, no mortality occurred through 96 hours, while in 15 ppt., 30% mortality occurred through 96 hours.
- In 25 ppt. cycles, 80% mortality occurred within 12 hours.

Figure 4. Direct transfer experiments had high survival rates below 10 ppt. salinity through 14 days.

Lower Columbia River sampling
- In 2010, we sampled 15 quadrats in the Lower Columbia River for larval lamprey. No larval lampreys were detected at any sample quadrat (Figure 5).

The Future

A sample framework for the lower Columbia River and estuary is currently being developed, and additional sampling efforts will be conducted in 2013 to investigate larval lamprey occupancy in areas where periodic tidally induced variation in salinity occurs. Larval lamprey occupancy of tributaries that enter the mainstem Columbia River within the estuary, such as the Chinook River and the Youngs River may also be investigated.
Figure 5. Sample quadrats in the lower Columbia River. No larval lampreys were detected at the 14 quadrats sampled.

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