**PRELIMINARY RESEARCH PROPOSAL (COE) (FY07)**

TITLE: Developing a separator for juvenile lamprey

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## PROJECT SUMMARY

### Research Goal

The goal of this work is to increase survival of juvenile lamprey during their seaward migration past hydropower dams in the lower Snake and Columbia Rivers.

### Study Objectives

1). Develop a juvenile lamprey separator that separates juvenile lamprey from salmonid fry, subyearling, and yearling juveniles in the bypass systems at Snake and Columbia River Dams.

2). Determine the feasibility of modifying the raceway screens at collector dams to allow juvenile lamprey to pass to the river while retaining juvenile salmonids for transportation.

### Relevance

The Columbia Basin Pacific Lamprey Technical Workgroup (a subgroup of the CBFWA Anadromous Fish Committee) has identified the need to improve lamprey passage and survival at Columbia River hydropower dams as the highest priority for lamprey recovery. A petition to list both the anadromous Pacific lamprey (*Lampetra tridentata*) and the resident western brook lamprey (*Lampetra richardsoni*) as federally-endangered or threatened species was submitted in 2002 to the U.S. Fish and Wildlife Service and lamprey declines have raised concern among tribal agencies throughout the Columbia River basin (Close et al. 2002). This project will address concerns raised by tribal agencies, the U. S. Army Corps of Engineers (COE), and the Northwest Power Planning Council in section 7.5F of the 1994 Columbia River Basin Fish and Wildlife Program, related to effects of FCRPS projects on passage and survival of both Pacific and western brook lamprey in the Columbia and Snake rivers. This project will specifically address the issue of improving juvenile lamprey survival at bypass systems designed to divert and transpot juvenile salmonids. Concerns about juvenile lamprey mortality at dams have been raised repeatedly by Columbia River treaty tribes, for which lamprey are an important cultural resource.

## PROJECT DESCRIPTION

### Background

Pacific lamprey (*Lampetra tridentata*) are an anadromous, parasitic lamprey species. Adults spawn in freshwater tributaries to the Columbia River and the juveniles (ammocoetes, Figure 1) bury into silty substrate and assume a sedentary life style for up to 7 years (reviewed in Close et al. 2002). During this period, ammocoetes may move downstream during freshets, however the extent and mechanisms behind freshwater movements are not well understood (Beamish and Levings 1991). After freshwater rearing, ammocoetes metamorphose, developing eyes and mouth parts for their parasitic phase in seawater. The metamorphosed juveniles (macropthalmia) emigrate from freshwater to the sea, much like juvenile salmonids.

Western brook lamprey (*L. richardsoni*) are a resident, non-parasitic lamprey form. This species also resides for extended periods in freshwater tributaries to the Columbia River. After the

freshwater residence period, Western brook lamprey become sexually mature and spawn in freshwater without making a seaward migration (Pletcher 1963). However, as is the case for Pacific lamprey, Western brook lamprey ammocoetes exhibit downstream movements during freshwater residence that could be extensive (Jennifer Stone, U.S. Fish and Wildlife Service, pers. comm.). The extent and reason for these movements is not known.

During both seaward migration of macropthalmia and downstream movements of ammocoetes, anadromous and resident lampreys may encounter up to 8 or 9 hydropower projects on the Columbia and Snake rivers. Recent research has documented impingement of lamprey at juvenile bypass facilities (Figure 2) and has determined that lamprey are more likely to suffer mortality as a result of screen impingement than from negative effects of passing downstream over dam spillways or through turbines Moursund et al. 2001). Consequently, research has recommended that bar screens be sized to reduce lamprey impingement to improve lamprey survival Moursund et al. 2002, 2003).

Studies to assess lamprey survival through the juvenile bypass systems (JBSs) at McNary and John Day dams have indicated that lamprey survival after guidance into the JBS is high. An extensive program to PIT (passive integrated transponder) tag juvenile lamprey was undertaken during the past few years (Moursund et al. 2002, 2003, R. Moursund, Pacific Northwest National Laboratory, pers. comm.). This work has determined that juvenile lamprey in the McNary and John Day JBS exhibit high survival and that lamprey show downstream rates of movement that are similar to those of salmonids.

Macropthalmia and ammocoetes collected at the JBS are inadvertently transported downstream during barging and trucking operations to transport juvenile salmonids past dams. It is not known whether barging operations are detrimental to lamprey or not. However, the ability to separate lamprey at these operations would allow release of both anadromous and resident lamprey juveniles back into the river after collection. In addition, working out ways to separate juvenile lamprey from juvenile salmonids may have other important applications. During freshets lamprey can occur in very large numbers and become impinged on screens, resulting in screen blockage and lamprey mortality. Methods to separate lamprey at JBS exit raceways may provide insights into ways to reduce other sources of juvenile lamprey mortality at dams.

There is already some indication that behavioral separation of juvenile lamprey from bypass water is feasible. Some juvenile lamprey are currently separated at the Porosity Control Unit located just upstream from the separator at Lower Monumental Dam. In the past, plates in the Control Unit have been composed of materials with relatively small bar spacing (Jonhson Bar Screen or perforated plate), but recently plates with approximately 0.6 wide by 2.5 cm long oblong holes have been used (K. Fone, U.S. Army Corps of Engineers, pers. comm.). Coincident with the use of these plates, there has been greater separation of juvenile lamprey at this location. Using this information, a lamprey separator will be developed and tested at McNary Dam.

Figure 1. Juvenile lamprey prior to metamorphosis (ammocoete) collected in the Snake River drainage. Photo courtesy of J. M. Capurso.

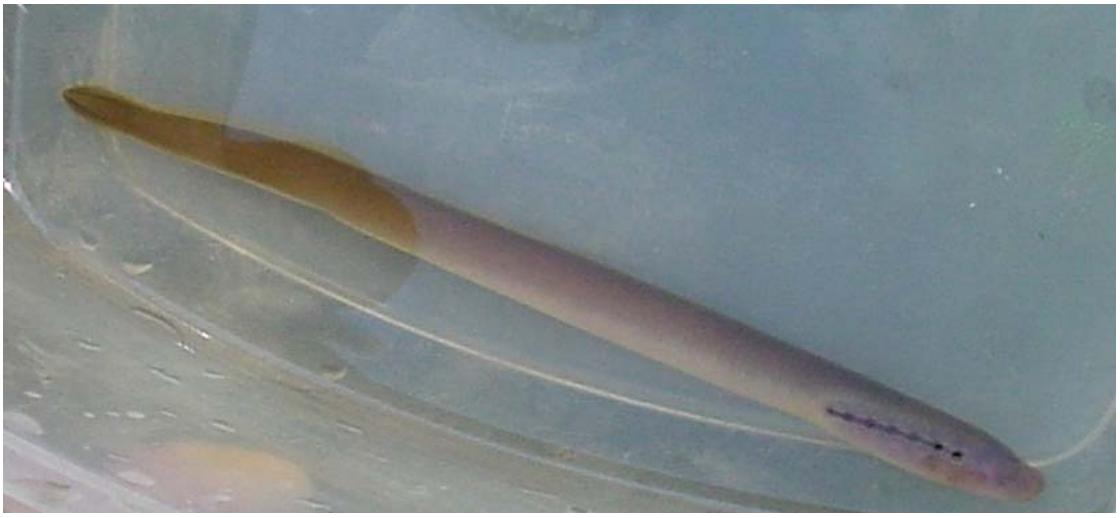

Figure 2. Pacific lamprey macropthalmia impinged on screens at the John Day Juvenile Bypass System. Photo courtesy of the Columbia River Intertribal Fish Commission.

## Objectives

**Objective 1**. Develop a device to separate juvenile lamprey from juvenile salmonids (fry, subyearlings, and yearlings) in bypass systems at Snake and Columbia River dams.

**Objective 2.** Determine the feasibility of modifying raceway screens at collector dams to allow juvenile lamprey to return to the river while maintaining criteria for holding fry, subyearling and yearling salmonids prior to transportation.

## Methods

Both objectives require development of a separation system that will not result in impingement or injury to either juvenile lamprey or salmonids. I propose to conduct research on lamprey behavior under a series of current flows and lighting conditions to determine the feasibility of behavioral separation of juvenile lamprey.

Experiments will be conducted at the McNary Dam covered flume area at the juvenile bypass channel (Figure 3). This area is equipped with a 1.5 × 10-m covered flume. Columbia River water can be diverted into the flume and the amount of flow can be accurately controlled via an inlet valve. The entire experimental area is covered to allow accurate control of lighting and is equipped with an overhead video system (both natural lighting and infrared). This will permit documentation of lamprey behavior during controlled current velocity and light intensity in both day and night.

Initial experiments will test the ability to separate lamprey by exploiting their negative phototaxis. Juvenile Pacific lamprey are nocturnal and avoid bright lighting (Moursund et al. 2000). Moursund et al. (2001) were able to elicit an avoidance response in both flowing and static water conditions with both constant and strobed white light. In this study, experiments will be conducted under varying flow conditions to determine whether lamprey can be separated using light avoidance. A brightly lit, perforated flume will be installed inside the darkened experimental flume to test whether lamprey will exit via the perforations (i.e., avoid bright light). The perforated flume will initially be constructed of material to replicate the dewatering plates in the Lower Monumental Dam Porosity Control Unit. There is already some indication that these dewatering plate perforations (0.6 × 2.5 cm oblong slots) can successfully separate lamprey; however, the efficiency of separation and the effect of slot size has not been examined (K. Fone, U.S. Army Coprs of Engineers, pers. comm.). Replicated, paired experiments will be conducted at day and night under high and low flow. The results will be used to assess the effects of plate orientation, perforation size, lighting and flow on separation of juvenile lamprey.

Figure 3. Experimental covered flume at the McNary Juvenile Bypass Channel.

## Facilities and Equipment

The covered flume facility at the McNary Juvenile Bypass channel (Figure 3) can deliver ambient Columbia River water at controlled velocities under specific lighting conditions during both day and night. In addition, the NMFS Pasco Research Station metal shop is equipped to fabricate custom components for flume experiments and Research Station personnel have extensive experience with development of other separation devices for Columbia River hydropower projects.

## Potential Limitations

The ability to conduct these experiments will depend on the availability of migrating juvenile lamprey for testing. In 2006, juvenile lamprey were collected during de-scaling experiments at McNary Dam at a rate of approximately 25-50/d in mid-April to mid-May and over 200/ day in mid-May to late May. These fish were in good condition when collected in this way at a facility immediately adjacent to the experimental flume. They could be used in the experimental flume and then released, unharmed into the Columbia River. It is likely that over 500 juvenile lamprey will be needed for separation tests (10 replicates of 5 treatments with 10 lamprey per replicate). If insufficient numbers of lamprey are collected during de-scaling experiments, the remainder will be obtained from the McNary bypass system further downstream. All lamprey will be returned to the Columbia River near the capture location.

## Project Impacts

The proposed activities will be coordinated with ongoing projects funded by the Corps of Engineers, the Bonneville Power Administration, and others. Use of the covered flume facility will be coordinated with ongoing de-scaling experiments for McNary modernization (i.e., vertical barrier screen testing). Access to the experimental facility will be needed during both day and night to conduct experiments. In addition, project assistance may be needed to obtain lamprey from bypass collection operations.

## Technology Transfer

This study has broad applicability to ongoing efforts by state, federal, and tribal fisheries managers and hydropower operators to recover lamprey populations. The principal investigator will insure that information and analyses from this work are available to resource managers via presentations at professional meetings, workshops, and when otherwise requested. Technical findings may be published in peer-reviewed journals.

## Key Personnel and Duties

Dr. Mary Moser, principal investigator will design and oversee experiments, analyze data, and report findings. Jim Simonson will provide flume modification design and fabrication. Mike Gessel will help with coordination of juvenile lamprey collection during his de-scaling experiments.

## REFERENCES


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