Preliminary Proposal for FY 2007 Funding

Title: Investigation of run timing and effects of turbine passage for juvenile Pacific lamprey

Study Codes: BPS-W-00-4 (new proposal)

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Project Summary

Research Goals

The goals of this research are to elucidate the out-migration timing of juvenile Pacific lamprey in the Columbia River and to assess the feasibility of evaluating the survival of juvenile lamprey through hydroelectric projects using non-active tags.

Study Objectives

Objective 1: Conduct weekly sampling from January through March 2007 at the John Day Dam for juvenile Pacific Lamprey to elucidate run timing. Juvenile lamprey will be collected using fyke nets placed in the intake of a turbine unit.

Objective 2: Assess the effects of turbine passage on juvenile Pacific lamprey. We propose to evaluate the feasibility of assessing the effects of passing through turbine units at John Day Dam by employing and evaluating the efficacy of using active capture techniques (i.e., with ichthyoplankton nets, trawls, etc.) to capture juvenile lamprey below John Day Dam during a period before guidance screens and spill operations.

Objective 3: Assess the feasibility of recapturing marked juvenile lamprey released directly into turbine units at John Day Dam using active capture techniques (i.e., with ichthyoplankton nets, trawls, etc.).

Project Description

Background and Justification

The Pacific lamprey (*Lampetra tridentata*) is an anadromous fish native to the Columbia River Basin. Larval lamprey inhabit streams, burrowed in mud, filter-feeding for 4-7 years. They metamorphose and migrate to the ocean as juveniles and spend several years as adults feeding parasitically before returning to freshwater to spawn and die. Like Pacific salmon (*Oncorhynchus* spp.), Pacific lamprey numbers have declined in the Columbia River Basin over the last forty years (Close et al. 2002). The state of Oregon listed Pacific Lampreys as a sensitive species in 1993 and gave further legal protected status (OAR 635-044-0130) in 1996 (Kostow 2002). Hydroelectric projects have been identified as a possible factor contributing to their decline (Close et al. 1995).

Migration through hydroelectric projects in the Columbia River Basin is thought to affect the survival of out-migrating juvenile lamprey both indirectly and directly, although very few studies have been done. Dam operations may increase the risk of predation for lamprey by concentrating them spatially and temporally (Hatch and Parker 1998). Also, similar to migrant juvenile salmonids, juvenile lamprey likely have slower travel times delaying their ocean migration (Close et al. 1995) and prolonging predation risk due to the impoundment of the river. Possible direct effects of dam passage include injury and instantaneous mortality. Reports of large numbers of juvenile lamprey being wedged between the bars of fixed bar screens at The Dalles and McNary dams (Hatch and Parker 1998) lead to recent research efforts focusing on juvenile lamprey interactions with the turbine bypass screens. Results from laboratory studies suggest that the relatively poor swimming capabilities of juvenile lamprey were insufficient to overcome velocities at the screen face and lamprey were subsequently impinged on and sometimes permanently wedged in the screens (Moursund et al. 2000).

Moursund et al. (2003) used underwater cameras to observe lamprey interactions with a modified extended-length submersible bar screen (ESBS) at John Day Dam. The majority of lamprey observed contacted the screen; however, the narrower bar spacing of the modified ESBS prevented them from becoming wedged and most were able to move along the screen face. Moursund et al. (2003) also tested the guidance efficiency of the modified ESBS using releases of pit-tagged juvenile lamprey that were recaptured with dip-nets in the gatewell, fyke nets in the turbine intake, and detected at the primary detector coils in the juvenile bypass system. Of the lamprey accounted for, 98% were recaptured in the upper rows of the fyke nets in the turbine intake, suggesting that they passed through the gap between the top of the ESBS and the flow vane. The ability of juvenile Pacific lamprey to survive turbine passage is unknown, but a laboratory study exposing them to jet velocities simulating turbine passage that injured and/or killed salmonids resulted in no immediate deaths or gross injuries for lamprey (Moursund et al. 2000).

Previous research suggests that as juvenile lamprey migrate downstream they tend to travel low in the water column (Long 1968, Moursund 2003); this behavior has been attributed to their lack of a swim bladder and their relatively poor swimming capabilities. Consequently, structures designed to guide surface-oriented juvenile salmonids away from turbines and into the juvenile bypass system are likely ineffective at guiding bottomoriented juvenile lamprey, thus making juvenile lamprey prone to turbine passage. Another factor that may increase the probability of lamprey passing through turbines is the timing of their out-migration.

Data from smolt monitoring facilities at five dams on the lower Columbia and Snake rivers suggest that the juvenile lamprey out-migration peaks in May or June (Figure 1). However, sampling doesn't begin until early to mid March. Studies examining the timing of juvenile Pacific lamprey out-migration in Oregon that include winter sampling have found that out-migration peaks in winter (van de Wetering 1998, Kostow 2002, Graham and Burn 2003). Comparing juvenile lamprey run timing at John Day Dam with screw-trap sampling on the lower Umatilla, Kostow (2002) suggested that lamprey may be passing John Day Dam undetected in the winter (Figure 2). If significant numbers of juvenile lamprey are migrating through the Columbia and Snake rivers during the winter months when a) spill is not occurring and b) when screens are not in place, the contribution of the spillway and juvenile bypass passage routes to the mortality of migrant Pacific lamprey at dams will be minimized and understanding the effects of turbine passage will become a high priority. Thus, an understanding of the run timing of juvenile Pacific lamprey will help to refine research needs regarding understanding the effects of turbine passage.

The ability of juvenile Pacific lamprey to survive turbine passage is unknown. Current methods used to estimate survival of out-migrating juvenile salmonids through Columbia River Basin dams will not work for Pacific lamprey because the smallest radio-telemetry and acoustic transmitters currently available are too large for juvenile lamprey, and it is unlikely that transmitters of appropriate size will be developed in the near future. Without active tags, alternate ways of assessing the effects of dam passage on migrating juvenile Pacific lamprey need to be found. Active fish capture methods, techniques, and gears have been used to capture and provide indices of abundance of ichthyoplankton below hydroelectric projects on the Columbia and Snake rivers (Counihan et al. 1994, 1997; Parsley 1995, 1996). We hypothesize that similar methods can be used to capture juvenile lamprey as they migrate through hydroelectric projects on the Columbia River and that, if successful, such methodology can provide insight into the effects of dam passage on Pacific lamprey survival.

Objectives and Methodology

Objective 1: Conduct weekly sampling from January through March 2007 at the John Day Dam for juvenile Pacific lamprey to elucidate run timing. Juvenile lamprey will be collected using fyke nets placed in the intake of a turbine unit.

Rationale

Data from smolt monitoring facilities at five dams on the lower Columbia and Snake rivers suggest that the juvenile lamprey out-migration peaks in May or June (Figure 1). However, sampling doesn't begin until early to mid March. Studies examining the timing of juvenile Pacific lamprey out-migration in Oregon that include winter sampling have found that out-migration peaks in winter (van de Wetering 1998, Kostow 2002, Graham and Burn 2003). Comparing juvenile lamprey run timing at John Day Dam with screw-trap sampling on the lower Umatilla, Kostow (2002) suggested that lamprey may be passing John Day Dam undetected in the winter (Figure 2).

If significant numbers of juvenile lamprey are migrating through the Columbia and Snake rivers during the winter months, their primary route of passage will be through turbines. If a significant portion of the run occurs when a) spill is not occurring and b) when screens are not in place, the contribution of the spillway and juvenile bypass passage routes to the mortality of migrant Pacific lamprey at dams will be minimized and understanding the effects of turbine passage will become a high priority. Thus, an understanding of the run timing of Pacific lamprey will help to refine research needs regarding understanding the effects of turbine passage**.**

Methods

We propose to install fyke nets in the intake of a turbine unit at John Day Dam as per Brege et al. (2001) and Moursund et al. (2003). Nets will be fished for 3-6 h during three sampling periods per week. Sampling periods will be randomly selected. Past research suggests that juvenile lamprey migrate primarily at night (Long 1968, Potter 1980, Beamish and Levings 1991). Thus we propose to sample during nighttime hours. Nets will be fished from January – March or until the screens are installed at the powerhouse. If possible, a period of overlap between the fyke net sampling and screen installation would be beneficial to index the fyke net capture with collection in the juvenile bypass.

Task 1.1: Prepare fyke nets for sampling.
Schedule: December 2006 - January 2007

Task 1.2: Conduct sampling.
Schedule: January –March 2007

Task 1.3: Summarize results and produce draft final report.
Schedule: May – September 2007

Objective 2: Assess the effects of turbine passage on juvenile Pacific lamprey. We propose to evaluate the feasibility of assessing the effects of passing through turbine units at John Day Dam by employing and evaluating the efficacy of using active capture techniques (i.e., with ichthyoplankton nets, trawls, etc.) to capture juvenile lamprey below John Day Dam during a period before spill is initiated and the juvenile bypass is not operating.

Rationale

The ability of juvenile Pacific lamprey to survive turbine passage is unknown. Current methods used to estimate survival of out-migrating juvenile salmonids through Columbia River Basin dams will not work for Pacific lamprey because the smallest radio-telemetry and acoustic transmitters currently available are too large for juvenile lamprey, and it is unlikely that transmitters of appropriate size will be developed in the near future. Without active tags, alternate ways of assessing the effects of dam passage on migrating juvenile Pacific lamprey need to be found. Active fish capture methods, techniques, and gears have been used to capture and provide indices of abundance of ichthyoplankton below hydroelectric projects on the Columbia and Snake rivers (Counihan et al. 1994, 1997; Parsley 1995, 1996).

We hypothesize that similar methods can be used to capture juvenile lamprey as they migrate through hydroelectric projects on the Columbia River and that, if successful, such methodology can provide insight into the effects of dam passage on Pacific lamprey survival. Active capture methods have been used in other river systems to assess turbine mortality (Gibson and Myers 2002). By conducting our sampling during a period when spill has not been initiated, we can reasonably infer that the condition of lamprey captured will be due to turbine passage and not due to passage through the spillway or juvenile bypass system.

Methods

We will identify and/or develop the necessary active capture gear that will be suitable for sampling the ichthyoplankton below John Day Dam. The gear will likely be similar to a Tucker trawl that has the ability to sample at different depths. This will allow us to assess the efficacy of fishing at various positions in the water column. We propose that the nets be fished on both the north and south channels associated with the island in the tailrace of John Day Dam. Sampling will occur from approximately mid-February – March 2007. Ichthyoplankton tows will vary in length as per Gibson and Myers (2002). Lamprey collected will be examined for physical injury in the field, preserved, and then necropsied in the laboratory.

Task 2.1: Prepare for field data collection.
Schedule: December 2006 - January 2007

Task 2.2: Initiate and conduct field collections.
Schedule: February –March 2007

Task 2.3: Necropsy collected animals in laboratory.
Schedule: April 2007

Task 2.4: Summarize results and produce draft final report.
Schedule: May – September 2007

Objective 3: Assess the feasibility of recapturing marked juvenile lamprey released directly into turbine units at John Day Dam using active capture techniques (i.e., with ichthyoplankton nets, trawls, etc.).

Rationale

Without active tags, alternate ways of assessing the effects of dam passage on migrating juvenile Pacific lamprey need to be found. Active fish capture methods, techniques, and gears have been used to capture and provide indices of abundance of ichthyoplankton below hydroelectric projects on the Columbia and Snake rivers (Counihan et al. 1994, 1997; Parsley 1995, 1996). If we are able to recapture marked animals that have been released through a particular route, the utility of sampling during periods when multiple routes are operating will be increased and mark-recapture techniques and estimation procedures could be used.

Methods

We propose to mark juvenile lamprey with coded wire tags and then release them into turbine units at the John Day Dam powerhouse using a hose release mechanism. We will employ the same capture methods as stated in Objective 2. Juvenile lamprey will be collected at the John Day Dam juvenile bypass facility, marked and then held until release. A recent study has indicated that tag retention was high, and mortality negligible for juvenile lamprey tagged with coded wire tags (Meeuwig et al. *In press*).

Task 3.1: Collect, tag, mark and hold juvenile Pacific lamprey.
Schedule: May 2007

Task 3.2: Conduct sampling.
Schedule: May 2007

Task 3.3: Summarize results and produce draft final report.
Schedule: May – September 2007

Impacts

Other research projects

We do not anticipate any effects on ongoing research.

Systems Operations

The installation of the fyke nets in the turbine intakes should not alter system operations per se but will require project support.

Biological Effects

We have tried to structure the sampling for this study to minimize any effects on endangered or threatened salmon species or stocks. The gears used and the period we will sample should limit our interactions with migrant or juvenile salmon.

Collaborative Arrangements and/or Sub-contracts

This research will be coordinated with proposed juvenile salmon survival studies at John Day Dam during 2007. We will also coordinate with ACOE and PSFMC personnel for project support and at the juvenile bypass at John Day Dam.

List of Key Personnel and Project Duties

Tim Counihan	Project Management, Data Analysis, Report Preparation
Amy Puls	Project Management, Field sampling, Data Analysis, Report Preparation

Technology Transfer

Information obtained will be disseminated in annual technical project reports, peer review publications, presentations to workgroups, and at professional meetings. A draft annual report of research will be submitted to the U.S. Army Corps of Engineers by December 31, 2007. After a 45-day review period, 60-day revision period and receipt of comments, the final report will be submitted by April 15, 2008.

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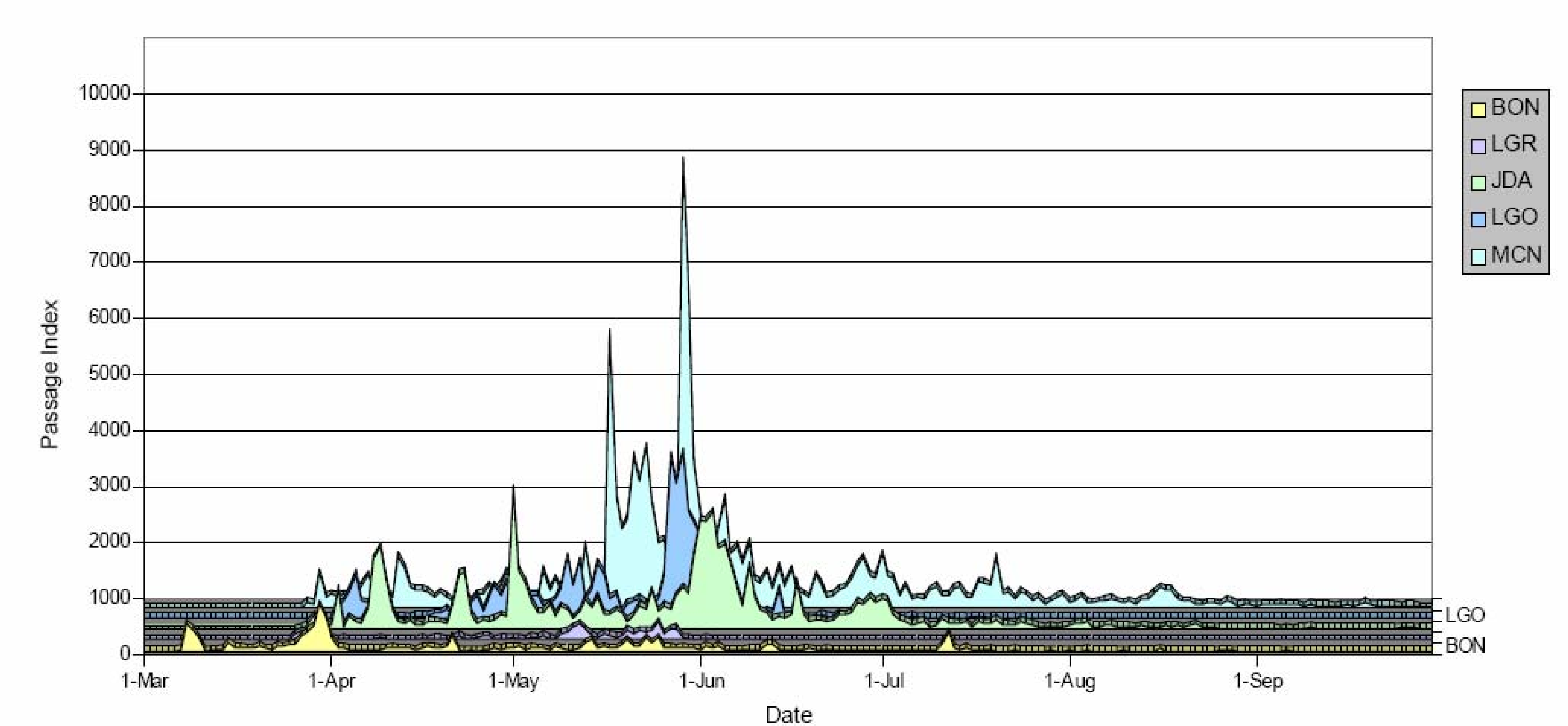
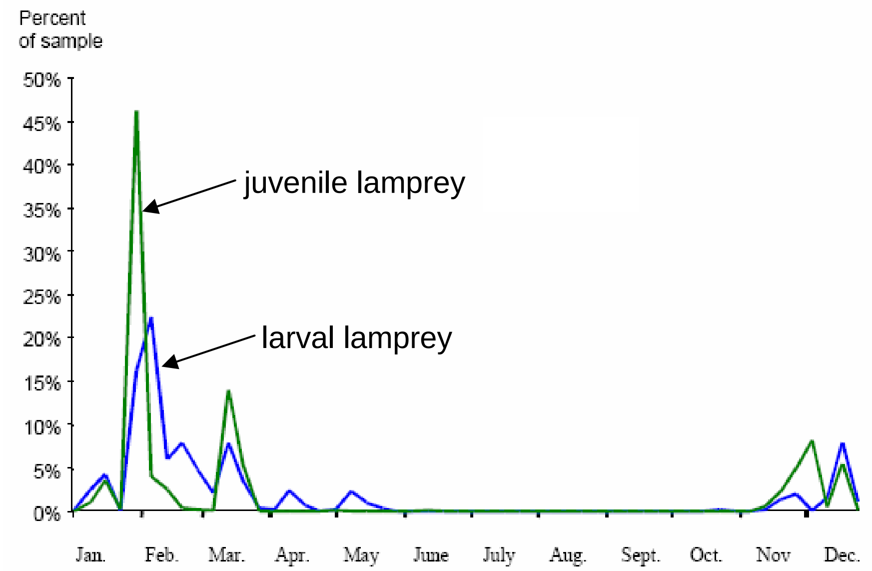


Figure 1. Historical run timing of five dams on the lower Columbia and Snake rivers. The figure represents collection estimates based on a daily average sample rate; the same sampling procedures are followed at each of the dams listed. (from Moursund et al. 2003) Data are averages of the following years: BON 1988-2001, LGR 1992 & 1994-2001, JDA 1988-2001, LGO 1997-2001, and MCN 1994-2001.

(A)



(B)

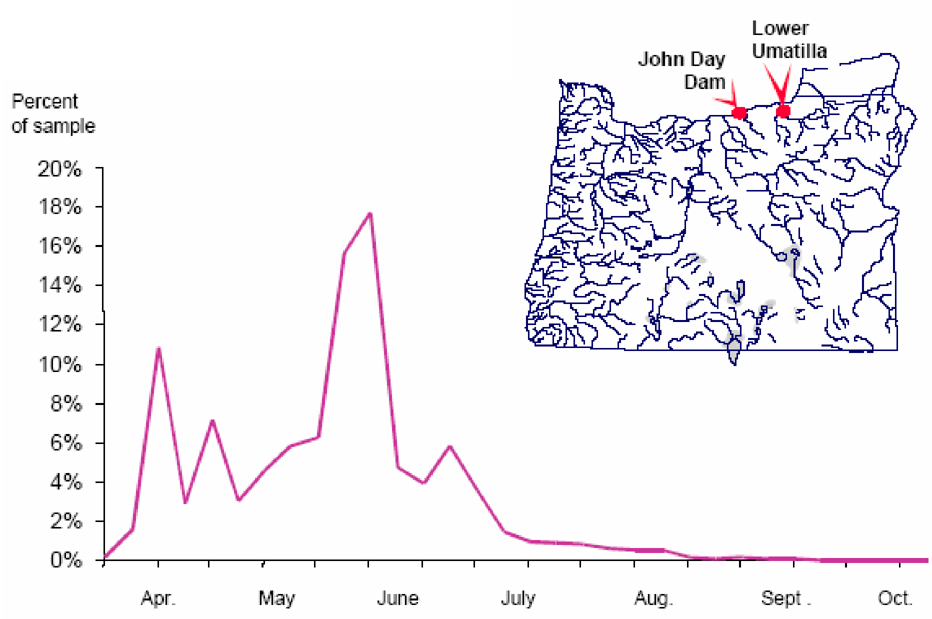


Figure 2. (A) Date of capture of lamprey in smolt traps in the lower Umatilla, Columbia Basin; weekly counts 1998 - 2001. All years and traps combined. N = 1,162 larvae and N = 914 juvenile lamprey. All lamprey observed were likely Pacific Lamprey. (B) Date of capture of juvenile lamprey at John Day Dam, mainstem Columbia River, 1988 - 2000 all years combined. N = 479,160. Sampling did not occur from November through mid-March. (from Kostow 2002)