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March 3, 2014

Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
Mail Code: DHAC, PJ-12
888 First Street, N.E.
Washington, D.C. 20426

**RE: Priest Rapids Hydroelectric Project No. 2114 License Compliance Filing – Article 401(a)(12) – 2013 Pacific Lamprey Management Plan Comprehensive Annual Report**

Dear Secretary Bose,

Please find enclosed the 2013 Pacific Lamprey Management Plan (PLMP) Comprehensive Annual Report consistent with the requirements of Article 401(a)(12) and the Washington State Department of Ecology 401 Water Quality Water Quality Certification Condition of 6.2(6)(b) and 6.2(6)(e), (Appendix C) for the Priest Rapids Project.

The 2013 PLMP Comprehensive Annual Report summarizes the on-going activities undertaken at the Priest Rapids Project (Project) in 2013, as identified in the PLMP, for the purpose of identifying and addressing Project impacts on Pacific lamprey. Any variations from the implementation schedule provided in the PLMP have been identified in this document. This report also describes, consistent with the 401 Certification, recent Pacific lamprey passage, behavioral, and survival investigations and measures undertaken in the Columbia River basin, as well as an evaluation to determine if these investigations and measures are: (i) consistent with similar measures taken at other projects; (ii) appropriate to implement at the Priest Rapids Project; and (iii) cost effective to implement at the Priest Rapids Project.

On January 15, 2014, the Public Utility District No. 2 of Grant County, Washington (Grant PUD) prepared and disseminated the draft 2013 PLMP Comprehensive Annual Report to members of the Priest Rapids Fish Forum including the Washington Department of Ecology (WDOE) U.S. Fish & Wildlife Service, Washington Department of Fish & Wildlife, Colville Confederated Tribes, Yakama Nation, the Columbia River Inter-Tribal Fish Commission, Bureau of Indian Affairs, and the Confederated Tribes of the Umatilla Indian Reservation. A request for comments on the draft plan was also distributed to the Wanapum Indians, and other participating stakeholders. Consultation comments were received from WDOE on February 17, 2014. These comments can be found in Appendix A and comment/comment response summary table (showing the agency comment and Grant PUD's response) is attached to the report as Appendix B.

ADDRESS PO Box 878
Ephrata, WA 98823
PHONE 509 766 2505
FAX 509 754 6770
grantpud.org

This same report has also been provided to WDOE on January 15, 2014. On February 17, 2014, WDOE approved the report (Appendix A).

Federal Energy Regulatory Commission staff with any questions should contact Tom Dresser at 509-754-5088, ext. 2312, or at tdresse@gcpud.org.

Sincerely,

Ross Hendrick, Manager
License Compliance Manager
rhendr1@gcpud.org

CC: Tom Dresser, Grant PUD
Mike Clement, Grant PUD
Patrick McGuire – WDOE
Priest Rapids Fish Forum

# 2013
# Pacific Lamprey Management Plan
# Comprehensive Annual Report

# Priest Rapids Hydroelectric Project (FERC No. 2114)

Prepared for:
Public Utility District No. 2 of Grant County
Ephrata, Washington

Prepared by:

Bao Le
HDR Engineering, Inc.
Portland, Oregon

Sara Twitchell
HDR Engineering, Inc.
Portland, Oregon

Rod O'Connor
BlueLeaf Environmental
Ellensburg, Washington

Mike Clement
Public Utility District No. 2 of Grant County
Ephrata, Washington

**March 2014**

## Executive Summary

In accordance with the Priest Rapid Project's License Order, issued by the Federal Energy Regulatory Commission (FERC) on April 17, 2008 (FERC 2008), and the 401 Water Quality Certification (WQC), issued by the Washington Department of Ecology (WDOE) on April 3, 2007 (WDOE 2007) and amended March 6, 2008 (FERC 2008), Public Utility District No. 2 of Grant County, Washington (Grant PUD) is required to develop, in consultation with the Priest Rapids Fish Forum (PRFF), a Pacific Lamprey Management Plan Comprehensive Annual Report (PLMP Comprehensive Annual Report) to be filed with FERC on or before March 31 of each year.

The PLMP Comprehensive Annual Report summarizes the on-going activities undertaken at the Priest Rapids Project (Project) in 2013, as identified in the PLMP, for the purpose of identifying and addressing project impacts on Pacific lamprey. Any variations from the implementation schedule provided in the PLMP have been identified in this document. This report also describes recent Pacific lamprey passage, behavioral, and survival investigations and measures undertaken in the Columbia River basin as well as an evaluation to determine if these investigations and measures are: (i) consistent with similar measures taken at other projects; (ii) appropriate to implement at the Project; and (iii) cost-effective to implement at the Project.

During the fifth year of implementation of PLMP, Grant PUD continued, for a fourth year, its assessment of Pacific lamprey behavior and passage efficiency through fishways at Priest Rapids and Wanapum dams to evaluate the efficacy of design enhancements installed during the 2009-2010 winter fish ladder maintenance outage. For the 2010 through 2013 migrations, Grant PUD tracked a total of 243 and 138 HD PIT-tagged lamprey at Priest Rapids and Wanapum dams, respectively. Fishway passage efficiency for lamprey was 66% and 67% at Priest Rapids and Wanapum dams, respectively, over the 2010-2012 period. At the time of reporting, passage efficiency results for the 2013 migration season were not yet available. These data will be presented in the 2014 annual report.

During the 2013 reporting period, the sampling of juvenile lamprey werecontinued over a range of Project/reservoir conditions to assess presence/absence, habitat use, and relative abundance of juvenile lamprey in areas that may be potentially affected by reservoir dewatering conditions. On November 13-16 and December 11-14, 2012, a field crew assessed presence/absence, habitat use, and relative abundance of juvenile Pacific lamprey in areas that may be affected by Project operations. Twenty-seven and 21 shoreline habit locations were sampled in the Wanapum and Priest Rapids reservoirs, respectively. Sampling was conducted at mid-range pool elevations of the FERC-allowed operational range; approximately 570.0 feet (ft) above mean sea level (msl) at the Wanapum Forebay and between 485.3-487.5 ft above msl at the Priest Rapids Forebay. No juvenile lamprey were collected. A second sampling was completed on May 11 and 12, 2013. Ten potential shoreline habitat locations in the Wanapum Reservoir were sampled resulting in the collection of no juvenile lamprey sampled. The pool elevation at the Wanapum forebay was 569.0 above msl during this sampling event. On October 11 and 12, 2013, a final sampling of eight potential shoreline habit locations in the Priest Rapids Reservoir collected seven juvenile lamprey. An additional 10 lamprey were observed but not captured. The elevation of the Priest Rapids Forebay was 480.2 ft above msl during this effort (near allowable reservoir minimum elevation allowed by the FERC license). Additional sampling in the Wanapum Reservoir at low allowable reservoir operational elevations is planned for 2014.

As in previous years, Grant PUD continues to participate in regional research and forums in the basin to promote coordination and information exchange.

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# 1.0 Introduction

## 1.1 General Description of the Priest Rapids Hydroelectric Project

Public Utility District No. 2 of Grant County, Washington (Grant PUD) owns and operates two hydroelectric dams on the Columbia River in the State of Washington; Wanapum and Priest Rapids, known collectively as the Priest Rapids Project (Project), and operated under the terms and conditions of the Federal Energy Regulatory Commission (FERC) Hydroelectric Project License No. 2114.

Wanapum Dam is located at river mile (RM) 415, south of the I-90 bridge at Vantage, Washington; approximately 38 miles downstream of the Rock Island Hydroelectric Project owned and operated by Public Utility District No. 1 of Chelan County, Washington (Chelan PUD) and 18 miles upstream of Priest Rapids Dam. The dam is 8,637 feet long and 186.5 feet high and includes a left and right bank fish passage structure, each with an upstream fish ladder. Wanapum includes ten turbine units with a nameplate capacity of 1,038 megawatts (MW) and a spillway with 12 bays. In April 2008, Grant PUD finished construction of the Wanapum Future Unit Fish Bypass (WFUFB) in the vacant slot of future turbine unit 11 to aid in downstream migration of salmonids. The Wanapum Reservoir is approximately 38 miles long and has a surface area of approximately 14,680 acres. Active storage volume of the Wanapum Reservoir is 160,400 acre-feet and total storage is 693,600 acre-feet. Seven perennial streams (Douglas, Tarpiscan, Johnson, Skookumchuck, Whiskey Dick, Quilomene, Trinidad, and Sand Hollow Wasteway) enter into the Wanapum Reservoir.

Priest Rapids Dam is located at RM 397; approximately 18 miles downstream of Wanapum Dam and the last dam on the Mid-Columbia River before it enters the Hanford Reach. The nearest town is Desert Aire, Washington, which is located approximately two miles upstream on the east-bank from Priest Rapids Dam. The Priest Rapids facility is 10,103 feet long and 179.5 feet high and includes ten turbine units with a generating capacity of 855.0 MW and a spillway with 22 bays. Grant PUD is currently evaluating juvenile salmonid passage and behavior through the Priest Rapids Top-spill bypass which includes modifications to spill bays 19 through 21 to allow near surface route-specific passage. The Priest Rapids Reservoir is approximately 18 miles long and has a surface area of approximately 7,725 acres. Active storage volume of the Priest Rapids Reservoir is 48,600 acre-feet and total storage is 237,100 acre-feet. Two perennial streams (Crab, Hanson) drain into the Priest Rapids Reservoir.

## 1.2 History of Pacific Lamprey-related Activities at the Priest Rapids Hydroelectric Project

For more than a decade, Grant PUD has actively participated in the research of and mitigation for Pacific lamprey related to the Columbia River hydro system and the Project area. The development of Grant PUD's Pacific Lamprey Management Plan (PLMP) has been a formalization of recent research and implementation measures required in the Project's License Order as issued by the FERC on April 17, 2008 (FERC 2008), but is largely a continuation of prior activities. Grant PUD was the first mid-Columbia River utility to assess the passage of lamprey in and through its project area (Nass et al. 2003) and to identify potential actions and modifications to improve successful passage (Final License Application, Grant PUD 2003) without compromising adult salmonid passage. Results of the 2001-2002 lamprey telemetry studies in the Project area formed the basis of proposed modifications which are being conducted as part of implementation of the PLMP. These past studies and measures are partly the result of

participation at the regional level and cooperating with tribes, agencies, and other hydroelectric operators to address resource challenges and their potential solutions. In particular, Grant PUD's past and present participation in the Columbia River Basin Lamprey Technical Work Group (CRBLTWG) has made them an integral part of the regional research foundation. As a founding participant, Grant PUD assisted in the development of the "Critical Needs and Uncertainties" document and provided information to support the Tribal Recovery Plan (Nez Perce Umatilla, Yakama, and Warm Springs Tribes 2011). More recently, Grant PUD has and continues to participate in and provide support to the U.S. Fish and Wildlife Service (USFWS) Lamprey Conservation Initiative, the Yakama Nation Lamprey Recovery Planning efforts, and the Columbia River Inter-Tribal Fish Commission's (CRITFC) Tribal Restoration Plan.

Past activities and future measures implemented by Grant PUD to mitigate for Project impacts to Pacific lamprey are extensive and on-going. Many of the actions and measures recommended by tribal and agency lamprey experts to address hydroelectric project impacts on lamprey are, in general, a result of actions or fish ladder modifications that are currently or were previously implemented by Grant PUD. These include fish counting facilities that operate 24 hours a day, 7 days a week for the upstream migration period; during fishway dewatering procedures, implementation of fish collection protocols by qualified biologists to ensure safe recovery of all fish species present (Grant PUD 2010); and juvenile lamprey protection as a result of Grant PUD's avian predation and Northern pikeminnow control programs that have been proven to be effective at minimizing impacts to juvenile salmonid outmigrants.

Physical fish ladder and dam modifications include the use of "slotted" (hour-glass style) fishway entrances that provide differential velocity elevations with a range of high and low velocity corridors to suit different species, improved 24-hour video fish counting stations to collect reliable and accurate count data, and downstream migrant bypass systems to meet juvenile salmonid survival criteria. Grant PUD believes measures developed to reduce impacts to juvenile salmonids will benefit juvenile Pacific lamprey as well. The slotted entrances were installed prior to the 2001-2002 lamprey study and have provided effective fishway entrance efficiency. In recent years, the Army Corps of Engineers (ACOE) have experimented with similar entrances at lower Columbia River dams (D. Clugston, ACOE, personal communication). The fish counting stations have undergone several staged modifications starting with the conversion from count board stations (visual) to dual orifice video stations, and in 2010, conversion to engineered crowders which utilize a single orifice video station and picket leads with 11/16 - inch gap spacing to accurately enumerate all adult lamprey. Significant improvements for downstream passage have been achieved by development of the WFUFB and the Priest Rapids top-spill bulkhead for juvenile salmon which presumably provides a high survival alternative passage route for juvenile lamprey.

Grant PUD's continued efforts have contributed to the state-of-the-science for Pacific lamprey including: participation in regional forums and conferences; conducting telemetric passage evaluations and literature research; evaluating turbine intake emergency wheelgate slot exclusion screens and; providing upstream and downstream fish passage facilities and support for full-duplex (salmon) and half-duplex (lamprey) passive integrated transponder (PIT) detection systems for basin-wide assessments; and providing educational opportunities for the public to understand the ecological and tribal importance of lamprey in the Columbia River basin.

As referenced in the FERC Order (Order Modifying and Approving Pacific Lamprey Management Plan, Article 401(a)(12) and Water Quality Certificate Condition 6.2(5)(b)), 127

FERC ¶ 62, 091, Grant PUD is required to develop, in consultation with the Priest Rapids Fish Forum (PRFF), and implement a comprehensive evaluation of adult lamprey passage at the Project. As outlined in its PLMP, Grant PUD implemented measures to improve lamprey passage in 2010. These efforts include conducting inspections of the Project passage facilities by the PRFF members, and the installation of passage-enhancing structures in the fishways at Priest Rapids and Wanapum dams. New structures included diffusion grate aluminum plating, ramps ascending perched orifices, and lamprey-friendly video fish count crowders; all specifically designed to facilitate lamprey passage. To facilitate tagging and fish husbandry research, Grant PUD expanded its fish handling facilities at Priest Rapids Dam by building innovative adult lamprey trapping and holding facilities for the most efficient and non-invasive processing of study fish. Following the installation of these structures, Grant PUD and the PRFF conducted a study of the effectiveness of these modifications during the summers of 2010 to 2012. The extensive half duplex passive integrated transponder (HDX-PIT) array at Priest Rapids and Wanapum dams was operated to monitor the passage of lamprey originating from tagging activities conducted at dams downstream of Priest Rapids Dam. A total of 20 HD-PIT arrays were operated each migration season to track lamprey through the project area (Appendix C). All arrays were operational May through December in 2010 through 2012 and from March through December in 2013. Further, yearly winter fishway maintenance operations recover adult lamprey during NOAA approved dewatering procedures. These lamprey are scanned for the presence of a PIT tag and released into the forebay of the respective dams.

Monitoring of juvenile lamprey within the Project area was also conducted during the 2013 reporting period. On November 13-16 and December 11-14, 2012, a field crew assessed presence/absence, habitat use, and relative abundance of juvenile Pacific lamprey in areas that may be affected by Project operations. Twenty-seven and 21 shoreline habit locations were sampled in the Wanapum and Priest Rapids reservoirs, respectively. Sampling was conducted at mid-range pool elevations of the FERC-allowed operational range; approximately 570.0 feet (ft) above mean sea level (msl) at the Wanapum Forebay and between 485.3-487.5 ft above msl at the Priest Rapids Forebay. No juvenile lamprey were captured. Another effort was completed on May 11 and 12, 2013. Ten potential shoreline habitat locations in the Wanapum Reservoir were sampled and no juvenile lamprey were found. The pool elevation at the Wanapum forebay was 569.0 ft above msl during this sampling event. On October 11 and 12, 2013, eight potential shoreline habit locations in the Priest Rapids Reservoir were sampled and seven juvenile lamprey were captured. An additional 10 lamprey were observed but not captured. The elevation of the Priest Rapids Forebay was 480.2 ft above msl during this effort (on the lower end of the operational range allowed by the FERC license). Additional sampling in the Wanapum Reservoir at low operational elevations is planned for 2014.

Grant PUD continues to be active with respect to investigations related to Pacific lamprey passage research through its historical activities and proactive implementation of research and mitigation measures included in the PLMP. Grant PUD is committed to continue into the future in a similar manner. This report illustrates the continued allocation of effort and capital resources to achieve the goals and objectives of the PLMP.

### 1.3 Purpose of the Report

Grant PUD is required to submit the PLMP Comprehensive Annual Report (PLMP Comprehensive Annual Report) in accordance with the Project's License Order, issued by the FERC on April 17, 2008 (FERC 2008), and the 401 Water Quality Certification (WQC), issued

by the Washington Department of Ecology (WDOE) on April 3, 2007 and amended March 6, 2008 (WDOE 2007; FERC 2008), which states:

> *License Order: The licensee shall file annually with the Commission by March 31, beginning 2010, their Annual Pacific Lamprey Management Report. The report shall include the reporting requirements identified under implementation measure 1 of the Biological Objectives and Implementation Measures under Appendix C of the Washington State Department of Ecology 401 Water Quality Certification. Additionally, the licensee's report shall include an updated implementation schedule and identify any variations from the schedule provided in the licensee's filed plan. The licensee shall prepare their report in consultation with the Priest Rapids Fish Forum and allow the Priest Rapids Fish Forum 30 days to review and comment on the report prior to filing with the Commission. The licensee's report shall include any resource agency and Tribe comments and the licensee's response to any comments. The Commission reserves the right to require changes to their plan based upon review of the report.*
>
> *401 Water Quality Certification, Appendix C: By March 31 following issuance of the New License, and each year thereafter for the term of the New License, [Grant PUD shall] provide an annual report summarizing activities undertaken to identify and address impacts of the Priest Rapids Project on Pacific lamprey, including results of those activities. This report shall include a compilation of information on other Pacific lamprey passage and survival investigations and measures being undertaken in the Columbia River Basin in order to determine if adult and juvenile measures being investigated and/or implemented at the Priest Rapids Project are: (i) consistent with similar measures taken at other projects; (ii) appropriate to implement at the Priest Rapids Project; and (iii) cost effective to implement at the Priest Rapids Project.*

To fulfill the requirements, the report is structured as follows:

- Section 2.1: Background and existing information (i.e., through October 31, 2013) about Pacific lamprey passage and survival investigations and measures undertaken in the Columbia River Basin.
- Section 2.2: Information from the reporting year (i.e., November 1, 2012 through October 31, 2013) about passage and survival investigations and measures being undertaken throughout the Columbia River Basin.
- Section 3.0: Status report on Pacific lamprey activities underway at the Project, including identification of any variations from the schedule provided in the PLMP (Grant PUD 2009).
- Section 4.0: An evaluation of whether recent activities in the Columbia River Basin should be considered for the Project.
- Section 5.0: An update on the Project's WQC requirement to develop a Year Five Biological Objectives Status Report for Pacific Lamprey.

- Section 6.0: A summary of preliminary conclusions regarding Pacific lamprey activities to date, anticipated activities in the Columbia River Basin, and future activities at the Project for the upcoming year.

### 1.4 Consultation

Pursuant to the reporting requirements, Grant PUD provided a complete draft of the PLMP Comprehensive Annual Report and Biological Objectives Status Report to the PRFF on January 15, 2014 for review. Written comments were received from Washington Department of Ecology on February 17, 2014. A summary of comments by the PRFF as received by Grant PUD on the draft PLMP Comprehensive Annual and Biological Objectives Status Report have been compiled along with responses from Grant PUD (Appendix B). The summary is based on written (Appendix A) comments.

## 2.0 Pacific Lamprey Activities in the Columbia River Basin

### 2.1 Background and Existing Information

Pacific lamprey (*Entosphenus tridentatus*) are indigenous to many of the tributaries of the Columbia (Jackson et al. 1997a, Jackson et al. 1997b) and the Snake Rivers (Close et al. 1995). Wydoski and Whitney (1979) reported that the Pacific lamprey are one of three species of lamprey in the Columbia River Basin where river lamprey (*Lampetra ayresi*) and western brook lamprey (*Lampetra richardsoni*) have been known to exist. Western brook lamprey and river lamprey distributions overlap with the more common Pacific lamprey but populations are concentrated to coastal tributaries and the lower reaches of the Columbia River (Kostow 2002).

The Pacific lamprey is an important fish of cultural, utilitarian, and ecological significance (Close et al. 2002). Close et al. (1995) reported that Native American tribes of the Pacific Coast and interior Columbia Basin harvested Pacific lamprey for subsistence, ceremonial, and medicinal purposes. In addition, a commercial fishery for Pacific lamprey also occurred during the 1940s and was used as food for livestock and cultured fish. Pacific lamprey are important ecologically throughout their life in terms of nutrient cycling, both as predator and prey. As juveniles, lampreys are filter feeders of detritus and algae, and a food source for fish and birds (Close et al 2002). In the past when they were more numerous, downstream migrants were likely an important food source to fish and birds and may have provided a buffer for juvenile salmon migrants. As adults, lamprey are opportunistic feeders and prey on a variety of fish species, thereby minimizing their impact on any particular one species. Adult Pacific lamprey are also a prey item to marine mammals such as sea lions and likely attract predation away from adult salmon (Close et al. 2002). Pacific lamprey carcasses are a food source to sturgeon, and decomposition provides marine-derived nutrients to riverine systems.

Adult lamprey counts have decreased at all Columbia and Snake River dams as compared with historical estimates, with the greatest declines occurring at the upper Columbia and Snake River projects. 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).

Based on the decreasing trend of adult Pacific lamprey, conservation groups filed a lawsuit against the USFWS in May 2004 to compel USFWS to act on their January 27, 2003 petition to list four species of lamprey for protection under the Endangered Species Act (ESA), including Pacific lamprey. On October 1, 2004, the USFWS initiated its 90-day finding process as part of a

settlement with the conservation groups. On December 22, 2004, the USFWS announced that a petition to list four species of lamprey did not contain sufficient information to warrant further review at that time.

Although Pacific lamprey are currently not ESA-listed, increased regional activity in the Columbia basin aimed at developing coordinated conservation and recovery strategies are proceeding. In addition to the ongoing efforts of the CRBLTWG and implementation activities associated with operations of FERC licensed and federal hydroelectric facilities (e.g., ACOE, Grant PUD, Chelan PUD, early implementation by Douglas PUD, and Portland General Electric [PGE]), the USFWS-led Pacific Lamprey Conservation Initiative, continued its activities by developing a multistate, tribal and Federal Conservation Agreement that will serve as the basis for regional working groups tasked with the development and implementation of conservation actions (USFWS 2012). These initiative activities and recommendations are not regulatory requirements.

### 2.1.1 General Biology and Ecology

Elongate and snake-like in form, the Pacific lamprey is a relatively poor swimmer in high velocity areas due to its anguilliform swimming motion as contrasted with the more efficient subcarangiform motion used by salmonids (Weihs 1982 as cited in Mesa et al. 2001). The lamprey does not have rigid fins, but rather dorsal and ventral fin-folds with minor cartilaginous ray-like supports. In addition, it lacks a swim bladder and must continue swimming (or attach to substrate), or it will sink.

Pacific lamprey are cartilaginous, jawless, anadromous fish that develop morphologically and physiologically in three primary stages. First, Pacific lamprey begin as larvae that hatch after approximately 19 days at 15°C (Close et al. 2002). After hatching, larvae drift freely downstream until encountering suitable substrate (silt and sand) and flow conditions (low velocities) for a sedentary lifestyle (Pletcher 1963 as cited in Close et al. 2002). Ammocoetes reside burrowed in fine sediment (Close et al. 2002) for a period of 4 to 6 years filter feeding on diatoms, algae, and detritus by pumping water through their branchial chamber (Beamish and Levings 1991). Beamish and Levings (1991) observed peak downstream movement of ammocoetes during May and June (Table 1) and determined ages to range from two to six years (using statolith analysis; Volk 1986 as cited in Beamish and Levings 1991).

**Table 1 Annual timing of key biological events in the freshwater life history of Pacific lamprey.**

Annual Timing of Key Biological Events in the Freshwater Life History of Pacific Lamprey

| Event | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ammocoete downstream migration[1] | Unk | ▒ | ▒ | ▒ | ■ | ■ | ▒ | ▒ | ▒ | ▒ | ▒ | Unk |
| Young adult downstream migration[1] | Unk | ▒ | ▒ | ■ | ■ | ▒ | | | ▒ | ▒ | ▒ | Unk |
| Metamorphosis / Transition[2] | | | | | | ▒ | ▒ | ▒ | ▒ | | | |
| Parasitic feeding initiated[2] | | | | | | | | | ▒ | ▒ | ▒ | |
| Entry into saltwater[2] | ▒ | ▒ | ▒ | ▒ | ▒ | ▒ | | | | | ▒ | ▒ |

[1] Beamish and Levings (2001)
[2] Beamish (1980)
Peak period = dark shade

Pacific lamprey then enter a transformation phase characterized by morphological and physiological changes that begin in the latter period of substrate residence. The young adult stage continues during stream residence and into the period of downstream migration from their parent streams to the ocean. The causal mechanisms which initiate the transformation process, trigger emergence from the substrate, and result in migratory behavior are unknown or undocumented. Young adult lamprey are also termed macrophthalmia following major morphological changes, but prior to parasitic feeding (Hardisty and Potter 1971 as cited in Beamish 1980). Pacific lamprey transform from ammocoetes to macrophthalmia from July to November (Hammond 1979 and Close et al. 2002). During transformation, the shape and angle of the head and mouth changes, and the gut develops to allow consumption of flesh and fluids (Hart 1973). The onset of transformation occurs over a relatively large range in lengths. Beamish (1980) observed characteristics associated with metamorphosis in lamprey ranging from 47 millimeters (mm) to 160 mm in length. As such, there is overlap in the length distribution of larval ammocoetes and macrophthalmia. The macrophthalmia migrate to the ocean between late fall and spring (Table 1).

Beamish and Levings (1991) determined age distributions for macrophthalmia to be 4 to 8 years using statolith analysis (Volk 1986 as cited in Beamish and Levings 1991). Metamorphosing lamprey moved into progressively more rocky and higher flow environments over time (Richards 1980 as cited in Beamish 1980), which may be related to their specific stage of transition. Concurrent downstream migrations of several different lamprey life-stages (including ammocoetes and young adults of many different stages of metamorphosis) has been observed (Table 1), providing evidence of natural variation in the timing and developmental stage of migrating lamprey (Beamish and Levings 1991).

Juvenile Pacific lamprey have been found to be largely nocturnal, with > 90% of their swimming activity restricted to hours of darkness (Moursund et al. 2000). This is consistent with prior reports that outmigrating individuals were more active at night while settling onto or into the substrate during the day (Hardisty and Potter 1971 as cited in Moursund et al. 2000; Beamish and Levings 1991). However, strict diel movement patterns appear to be restricted to the upper watershed areas, whereas the migration appears more or less continuous (night and day) in the lower parts of the river (Beamish and Levings 1991).

In the mid-Columbia River area, including the Project, juvenile lamprey are collected incidentally during juvenile salmon collection or salvage activities from April through June. At Priest Rapids and Wanapum dams, juvenile lamprey have also been observed during an evaluation of the emergency wheelgate slot exclusion screens (Wright et al. 2010). These results suggested that downstream run timing of juvenile lamprey coincides with spring runoff upstream of the Priest Rapids Project and throughout the Columbia Basin and supports historical run timing trends of juvenile lamprey (Wright et al. 2010). Juvenile lamprey are also infrequently collected during the fish bypass operation of gatewell dipping (Grant PUD, unpublished data). A portion of these fish are counted and measured for length during juvenile salmonid survival and behavioral evaluations. All fish are subsequently released downstream of the Project. In some years, lamprey have been counted, but not identified beyond the genus level of classification (there are three species of lamprey in the Columbia River). In a separate operation, fyke net sampling at Wells Dam caught lamprey during the period March through August, with the highest catches occurring in May and June (BioAnalysts 2000).

Lamprey are considered adults once all transformations are complete and parasitic feeding begins; a process that is likely completed in salt water (Richards and Beamish 1981 as cited in Beamish and Levings 1991). In addition, laboratory research by Beamish (1980) surmised that completely transformed lamprey (i.e., adults) must move into a saline environment within a relatively short period of time, or they will die. Specifically young adults completing the transition to adulthood between June and September need to be in salt water by January. Physiological experiments showed that Pacific lamprey in the Fraser River begin entering saltwater in December and continue through June (Beamish 1980; Table 1). As an adult (100-700 mm), the animal is fully developed to handle life in salt water, which ranges from 1.5 to 3.5 years (Kan 1975 and Beamish 1980 as cited in Close et al. 2002). In the ocean, Pacific lamprey adults feed as external parasites on marine fish and mammals before returning to freshwater to spawn (Beamish 1980 and Close et al. 2002). Information on Pacific lamprey migration patterns during ocean residency remains a significant data gap for researchers and managers although recent work has been published on the relationship between the abundance of Pacific lamprey in the Columbia River and their common hosts in the marine environment (Murauskas et al. 2013).

Given the basic understanding of the species biology and ecology (in freshwater), recent work on Pacific lamprey has generally focused on topics such as developing more resolute site-specific information on the distribution and abundance of lamprey "populations", and lamprey physiology. However, in addition to site specific distribution and abundance activities, lamprey biologists and researchers have begun to collect the information and develop the necessary tools to address factors that may limit species persistence and recovery. Throughout the Columbia River basin, various activities are being implemented. Monitoring activities associated with documenting key habitat related to spawning, rearing, and overwintering habitat as well as nest and escapement surveys are being conducted annually in the Deschutes and Umatilla rivers. In the Hood River, lamprey monitoring is occurring to document recolonization of lamprey after the removal of Powerdale Dam (2010). In the Yakima watershed, tracking adult movement patterns (via radiotelemetry) around irrigation diversions and to overwintering and spawning areas for adults is occurring. In-river and irrigation canal juvenile lamprey distribution and abundance sampling is also occurring in the Yakima basin. Multi-year juvenile distribution and abundance sampling and larval trend monitoring is occurring in the Klickitatand Methow watersheds. Surveys to assess juvenile distribution and relative abundance have been conducted in several of the mid-Columbia River reservoirs. Additional work includes developing statistical approaches to evaluate patterns of juvenile occupancy and distribution in rivers, evaluating effects of salmonid restoration actions on lamprey, assing recolonization activities,deep water survey methods, artificial propagation techniques, lamprey use of the lower Columbia River estuary, and evaluating translocation (see Section 2.2: Updated Information for additional details).

#### 2.1.2 Migration in Rivers

The upstream migration of adult Pacific lamprey in the Project area (RM 397-453) typically occurs from May through November, with peak migration occurring in August (Nass et al. 2003). In the lower Columbia River (Bonneville Dam, RM 146), this timing is shifted earlier by approximately one month (Ocker et al. 2001). Similarly, peak migration past dams upstream of Priest Rapids occur two to four weeks later. As expected, numbers of lamprey observed at successive dams decreases as fish enter tributaries or cease migration to overwinter, however the inherent challenges of counting lamprey is apparent in the years when counts at upstream facilities are higher than downstream facilities. Timing of freshwater entry is closely tied to

water temperatures and somewhat with discharge. Keefer et al. (2009a) reported that few lamprey pass Bonneville Dam before water temperatures reach 15°C and half the run, on average, pass by the time water temperatures reach 19°C.

Median upstream migration rates have been estimated at 10 RM/day and 13.7 RM/day on the Columbia River (Jackson et al. 1997b and Vella et al. 2001, respectively), and 6.8 RM/day on the John Day River (Bayer et al. 2001). HDX-PIT tagged lamprey migrated at rates of 7.7 RM/day to 8.5 RM/day between Bonneville and McNary dams (~146 miles). As with timing, migration rates were correlated with water temperatures and inversely related to discharge (Keefer et al. 2009b). At Priest Rapids and Wanapum reservoirs, median upstream migration rates were 3.0 RM/day and 6.8 RM/day, respectively (Nass et al. 2003). Pacific lamprey that are migrating upstream are likely heading to holding and/or spawning areas to overwinter. Upstream migration has been documented to cease in mid-September (Beamish 1980 as cited in Close et al. 2002), and resume in mid-March of the following spring if the final spawning destination has not been reached (Bayer et al. 2001).

Spawning occurs in the summer (June and July) following the upstream migration year (Beamish 1980 as cited in Close et al. 2002). Lamprey prefer low-gradient reaches, with gravel-pebble-sand substrate for spawning (Mattson 1949 and Kan 1975 as cited in Close 1995), Further, spawning typically occurs in lotic habitat with velocities ranging from 3 to 4 feet per second (ft/sec) and in depths ranging from 1 to 3.3 feet (Kan 1975). Both sexes begin moving rocks with their buccal funnel to create nests in excavated depressions (Pletcher 1963). Courting consists of a male approaching a female with a gliding motion to stimulate the female. A male attaches his buccal funnel to a female's head, and then wraps his body around the female to provide mixing of simultaneously released gametes. Each spawning act releases approximately 100 to 500 eggs (Pletcher 1963). Nest dimensions are approximately 12 inches wide, 1 to 2 inches deep, and oval in shape. Pacific lamprey die after spawning (Hart 1973) within 3 to 36 days (Kan 1975).

Pacific lamprey do not appear to have natal homing tendencies (return to a place of origin), but will migrate to other locations (Hatch et al. 2001). Distribution is more uncertain in the mid-Columbia area above Priest Rapids Dam compared to the lower Columbia, but since 1958 the furthest upstream extent on the Columbia River has been Chief Joseph Dam where there are no fish passage facilities.

Recent work on adult lamprey migration in rivers has used active tag technology including radio-telemetry and juvenile salmon acoustic telemetry system (JSAT) tags. These studies are occurring in reservoirs of the ACOE projects in the Lower Columbia and Snake rivers and in the Willamette River. Additional large-scale monitoring programs have also utilized half duplex (HDX) passive integrated transponder (PIT) tags in combination with multi-entity coordination to take advantage of the individual monitoring programs occurring throughout the mainstem Columbia River (see Section 2.2: Updated Information for additional details).

Information regarding juvenile migration in rivers is limited. Much of the information available has been collected anecdotally during tributary operations targeting juvenile salmonid outmigrants and is consistent with previous information regarding timing and the environmental variables associated with such movements. Recently, juvenile lamprey were observed using dual frequency identification sonar (DIDSON) during an evaluation of the emergency wheelgate slot exclusion screens at Priest Rapids and Wanapum dams (Wright et. al., 2010). These results suggested that downstream run timing of juvenile lamprey coincides with spring runoff upstream

of the Priest Rapids Project and throughout the Columbia Basin and supports historical run timing trends of juvenile lamprey, and the size of lamprey recorded by the DIDSON also supports the distribution of recorded lamprey to be primarily juveniles (Wright et. al, 2010).

Over the past decade the lack of available tag technology has limited researchers and fish managers' ability to collect more detailed information to better understand and address challenges of juvenile lamprey movement. BioAnalysts (2000) summarized anecdotal information on the distribution of juvenile lamprey in tributaries of the mid-Columbia, which include the Wenatchee, Entiat, Chelan, and Methow rivers. Recent evidence indicates the presence of lamprey in the Similkameen River, a tributary of the Okanogan River (T. Holder, Washington Department of Fish and Wildlife, personal communication) previously thought unused by Pacific lamprey. Further, juvenile Pacific lamprey have been captured in rotary trapping operations on the Okanogan River near Malott (M. Rayton, Colville Tribes Fish & Wildlife, personal communication). Given the high number irrigation diversions in the Columbia River Basin and the recognition that poorly designed or unscreened diversions can result in fish mortality, researchers are beginning to evaluate the efficacy of different irrigation diversion screen panels and the effectiveness of fish screen materials to prevent juvenile lamprey impingement and entrainment at these locations. Furthermore, to begin understanding the potential impacts of irrigation diversions on juvenile lamprey, researchers have begun conducting surveys in irrigation canals in the Yakima watershed (see Section 2.2: Updated Information for additional details).

### 2.1.3 Population Status

#### 2.1.3.1 Distribution

Pacific lamprey are native to the Columbia River Basin and their spawning migration extends into many inland rivers draining Oregon, Washington and Idaho (Kan 1975; Hammond 1979; and Simpson and Wallace 1982). Collections and historic observations of Pacific lamprey are common in the Columbia River below the mouth of the Deschutes River. Areas include numerous small tributaries such as Fifteenmile Creek, Gnat Creek, Elochoman River, and larger tributaries such as the Willamette River. Lamprey probably used all accessible watersheds in the Lower Columbia, including mainstem and slough habitats. A comparison of counts at Bonneville Dam to harvest at Willamette Falls during the 1940s indicates that Pacific lamprey were probably more abundant in the Willamette subbasin at that time than they were anywhere upriver of the Columbia River Gorge (Kostow 2002).

Watersheds upstream of the Columbia River Gorge, specifically noted in historic collections and observations, include the Deschutes extending into the Crooked River above Pelton/Round Butte Dam, John Day, Umatilla, Walla Walla, Yakima, Entiat, Okanogan and Kootenay Lake. In the Snake River Basin, collections and historic observations have been made in the lower Palouse, Clearwater, Salmon, Grande Ronde, Imnaha, and upstream to at least the Powder River. Historic records are too sparse to determine the full extent of historic occupation of these basins; however recent work has focused on collecting more current distribution information and a report documenting the current status of Pacific lamprey in some of these river basins was published in 2011 (IDFG 2011). In the upper Columbia River basin, distribution information is being collected in the Wenatchee and Methow rivers while adult translocation activities by the Nez Perce Tribe indicate that juvenile lamprey in Asotin, Lolo, Newsome and Orofino creeks in the

Snake River were primarily the progeny of translocated adults (Chris Peery, USFWS, personal communication).

The current distribution of Pacific lamprey is substantially reduced from the historic distribution. Lamprey have been lost from all areas that are blocked by impassible barriers. These barriers include the Willamette subbasin dams, and other high dams such as the Pelton/Round Butte complex (Deschutes), Dworshak (Clearwater), Hells Canyon complex (Snake), and Chief Joseph Dam (Columbia) that block upstream passage by all migratory fish. Lesser barriers that may pass salmonids also block upstream passage by lamprey, including smaller dams, small water diversion dams, culverts, tide gates and numerous other barriers. Adult Pacific lamprey are known to pass through the Project, but no radio-tagged lamprey were observed to use tributaries in the Project area (Nass et al. 2003).

#### 2.1.3.2 Abundance

Pacific lamprey populations of the Columbia River have significantly declined in abundance in recent years as evidenced by counts at dams on the lower Columbia and Snake rivers (Close et al. 1995; Vella et al. 1999; Close et al. 2002). Starke and Dalen (1995) reported that adult lamprey counts at Bonneville Dam that regularly exceeded 100,000 fish in the 1960s were estimated at approximately 22,000 in 1993. Specific reasons for this decline are not fully understood, but have been related to similar factors contributing to the decline of Pacific salmon. Close et al. (1995, 2002) identified several factors that may account for the decline in lamprey counts in the Columbia River basin. This includes reduction in suitable spawning and rearing habitat from flow regulation and channelization, pollution and chemical eradication, reductions of prey in the ocean, and juvenile and adult passage problems at dams. Comparison of counts between dams and between years is complicated by variable and inconsistent sampling protocols (BioAnalysts 2000), potential over-wintering between dams, changes in personnel, and counting station passage efficiency (the ability of count station equipment to force individuals through a counting area for observation). Annual counts of adult Pacific lamprey passing select mainstem dams in the Columbia River basin are summarized below in Table 2.

Efforts are underway to improve estimates of the number of adult lamprey passing dams using nighttime video at count stations (Clabough et al. 2009). Adding nighttime passage through count windows increased estimated escapements at Bonneville Dam by 42% in 2007, but decreased the estimated escapement to a negative value in 2008. The net downstream movement observed at Bonneville Dam in 2008 indicates that fish were passing by unmonitored routes such as through picketed leads at count stations. At The Dalles, adding nighttime counts increased estimated escapement by 42% in 2007 and by 70% in 2008.

In addition to adult dam counts, the lack of ammocoetes in surveys in the Snake River basin and limited information of juvenile use in Upper Columbia River tributaries may be an indication of the decline of Pacific lamprey. A study conducted by Idaho Fish and Game from 2000 to 2006 determined that Pacific lamprey currently occupy only about 25% of their historic distribution in the Snake River basin (Hyatt et al. 2006).

**Table 2 Annual counts of adult Pacific lamprey at select Columbia and Snake River basin dams.[1]**

| Year | McNary | Priest Rapids | Wells | Ice Harbor | Lower Granite |
|---|---|---|---|---|---|
| 2000 | 1,281 | 1,468 | NA | 315 | 28 |
| 2001 | 2,539 | 1,624 | 261 | 203 | 27 |
| 2002 | 11,282 | 4,007 | 338 | 1,127 | 128 |
| 2003 | 13,325 | 4,339 | 1,408 | 1,702 | 282 |
| 2004 | 5,888 | 2,647 | 291 | 805 | 117 |
| 2005 | 4,158 | 2,598 | 212 | 461 | 40 |
| 2006 | 2,139 | 3,273 | 21 | 255 | 35 |
| 2007 | 3,389 | 3,419 | 32 [2] | 288 | 34 |
| 2008 | 1,530 | 5,083 | 7 [2] | 264 | 61 |
| 2009 | 676 | 2,713 | 9 | 57 | 12 |
| 2010[3] | 833 | 1,114 | 2 | 114 | 15 |
| 2011 | 868 | 3,868 | 1 | 269 | 48 |
| 2012 | 971 | 4,025 | 3 | 494 | 48 |
| 2013[4] | 1,570 | 5,968 | 21 | 328 | 19 |

Notes:

1 Ice Harbor and McNary day counts only. Wells and Priest Rapids 24-hour counts. Lower Granite counts have been conducted 24 hours a day since 2009.

2 The Pacific lamprey adult passage counts at Wells Dam are not reflective of actual run size during 2007-2008. Trapping, monitoring, and research efforts at Wells Dam artificially lowered the passage numbers for Pacific lamprey; i.e., more fish would have passed without tagging and trapping efforts.

3 Counts through December 5, 2010.

4 Counts through December 8, 2013.

#### 2.1.3.3 Population Structure

Genetic stock information suggests there is uncertainty among different Pacific lamprey stocks regionally. Powell and Faler (2001) determined that Pacific lamprey do not appear to have genetically different stocks, at least between some lower and mid-Columbia basins. These observations are similar to results by Goodman (2006) that found no evidence of mitochondrial DNA divergence in 81 collections of Pacific lamprey from two of the geographical regions common to the Columbia River and Klamath Mountain Province. Conversely, Lin et al. (2007; 2008) found significant differences among collections within those regions using approximately 180 amplified fragment length polymorphisms (AFLP) loci. These results detected significant genetic differences among adult Pacific lamprey returning to streams separated by as little as 54 miles (between the Deschutes River and John Day Dam). The differences between these studies may reflect the increased power of using approximately 180 AFLP loci versus a single mitochondrial DNA locus or differences in polymorphisms due to sampling of adult migrants versus ammocoetes. The geographical scale over which genetically meaningful management units (e.g., stocks, populations, or evolutionarily significant units) occur in this species could not be identified based on the results of Lin et al. Work based upon microsatellite analysis of 21 sites along the west coast of North America found low levels of genetic differentiation, providing support for a lack of natal homing in Pacific lamprey. The report noted that Pacific lamprey from most of the sites examined in this study can be managed as one unit but recommended future investigations to confirm whether this conclusion is applicable to all sites (Docker 2010). The

most recent genetic analyses have continued to add uncertainty to Pacific lamprey population structure. Spice et al. (2012) evaluated the hypothesis of natal homing in Pacific lamprey and had results that were inconsistent with philopatry, suggesting that anadromous lampreys are unusual among species with long migrations, but suggest that limited dispersal at sea precludes panmixia. Work done by Hess et al. (2012) may provide context for observed genetic divergence among collections and thus, could reconcile previous findings of population genetic heterogeneity within a species that displays extensive gene flow.

One recovery strategy for Pacific lamprey is the translocation of pre-spawn adults from downstream Columbia River locations and supplementation with hatchery spawned ammocoetes into suitable habitat upstream. Cummings (2007) found that trapping and translocating adult lamprey did not appear to affect their migration success but the implications to population structure are currently unknown. Since the late 1990's and 2006, the Umatilla and Nez Perce tribes, respectively, have been implementing Pacific lamprey translocation programs as a conservation measure to maintain some level of lamprey production in target spawning streams. A review of translocation programs was conducted in 2009 and monitoring is ongoing (see Section 2.2: Updated Information for additional details about active monitoring efforts).

In 2009, the CRBLTWG was asked to develop a review paper on lamprey translocation and artificial propagation. Due to the uncertainty surrounding the potential implications related to unknown genetic stock structure related to translocation and differing opinions by CRBLTWG members, the CRBLTWG concluded that it would not be able endorse a position or shared opinion at this time and instead completed a literature review paper outlining the potential benefits and risks of translocation (CRBLTWG 2010).

#### 2.1.4 Adult Passage at Hydroelectric Facilities

Radio-telemetry studies of adult lamprey migration patterns past dams and through reservoirs in the lower Columbia River during 1997 to 2002 provided the earliest data sets on lamprey passage timing, travel times, and passage success at hydroelectric projects (Vella et al. 2001; Ocker et al. 2001; Moser et al. 2003a; Moser et al. 2003b). While these studies have shown that 87 to 96% of the radio-tagged lamprey released migrate upstream and are detected at Bonneville Dam, less than 50% of the lamprey which encounter an entrance actually pass the dam. Passage times at lower Columbia River dams (2 to 4 days) were considerably longer compared to salmonids (1 day). Similarly, during 2005 to 2008, at McNary and Ice Harbor dams overall passage efficiencies ranged 58 to 89% and 50 to 59.1%, respectively. Median passage time from the first approach until exit into the forebay for adult lamprey ranged from 1 day to 2 days for both dams (Cummings et al. 2008). Despite different estimation techniques, half-duplex Passive Integrated Transponder HDX-PIT tag results of Daigle (2008) were generally consistent with previous study results for Bonneville, McNary and Ice Harbor dams. Recent evaluations (Keefer et al. 2009c; 2009d) indicated significantly lower passage success from release to passage of John Day Dam for radio-tagged lamprey compared to HDX-PIT-tagged lamprey (2.3 to 4.5% versus 17 to 18%), suggesting previously reported passage estimates were conservative.

Recent radio-telemetry studies at Bonneville Dam have expanded our understanding of adult lamprey behavior and passage performance in the lower Columbia River (Johnson et al. 2009a; Keefer et al 2009c; 2009d). For 2007 and 2008, 68 and 74%, respectively, of lamprey released to the tailrace were known to have returned to the dam. Of these, 32% successfully passed in both years (Johnson et al 2009a; 2009b; Keefer et al. 2009d). Entrance efficiencies (ranged 51 to

76%) were generally poorer than previous years although passage times (around 3.0 d median) was relatively good in 2007and 2008. Researchers speculated performance may have been related to smaller lamprey returning in 2007 and 2008 compared to earlier years.

In the mid-Columbia at Wanapum, Priest Rapids, Rocky Reach, and Wells dams, the results have been more varied, in part due to the use of slightly different metrics (Nass et al. 2003; Stevenson et al. 2005; LGL Limited and Douglas PUD 2008). The Net Ladder Passage Efficiency (NLPE) at Rocky Reach was 47% (Stevenson et al. 2005).

At Priest Rapids and Wanapum dams, the proportion of fish that approached the fishway that exited the ladders was 70% at Priest Rapids, and 51% at Wanapum Dam in 2002 (Nass et al. 2003). Fishway passage efficiencies (entrance to exit) were substantially higher at 87% and 82% for the same study despite substantial delays or termination of active migration near the first weir walls and old style counting stations which have subsequently been modified to include lamprey-specific crowder structures at both Priest and Wanapum dams. Design enhancements (plating and ramps at Priest Rapids Dam) installed during the 2009-2010 winter fish ladder maintenance outage, are also anticipated to address these areas and improve volitional passage efficiency. For the 2010 through 2013 migrations, Grant PUD tracked a total of 243 and 138 HDX PIT tagged lamprey at Priest Rapids and Wanapum dams, respectively. Fishway passage efficiency for lamprey was 66% and 67% at Priest Rapids and Wanapum dams, respectively over the 2010-2012 period. Efficiencies for 2013 will be presented in the next annual report because monitoring and analysis was not complete as of October 31. During the 2010 migration, an additional assessment of lamprey passage was conducted using underwater video. In this study, cameras were placed to view newly installed aluminum plating on the diffusion grating, the floor through weir orifices, and on the fish count station. This monitoring activity produced observations that the plating at weir wall orifices was extensively used by lamprey and was a benefit to lamprey passage. For 19 complete passage events through an orifice, 95% of lamprey used the plating and 100% of the events demonstrated successful passage. The fish count crowder was also observed to promote guidance of lamprey through the counting chute. Of 123 events, 79% of lamprey were successfully guided by the structure to the chute and 40% of these used the plated ramp to stage below the chute.

During a 2008 study at Wells Dam, 18 lamprey were released into the Wells Project tailrace. Twelve of the 18 lamprey yielded sufficient data for analysis. Over the study period, 11 of 12 (91.7%) lamprey approached a fishway entrance with several lamprey making multiple approaches. Only two tailrace-released lamprey successfully entered a fishway and both failed to ascend into the forebay. Overall, 2008 study results indicate that any potential areas of impediment at Wells Dam are restricted entirely to the entrance and lower fishway, as upper fishway passage efficiency (releases in the fishway) was 100% for the two consecutive study years (LGL Limited and Douglas PUD 2008). In 2013, another fishway passage study was conducted at Wells Dam with adult lamprey translocated from Bonneville and Priest Rapids dams (due to low numbers at the dam). Results of the assessment will be presented in the next annual report as data analysis has not yet been completed (see Section 2.2: Updated Information for additional details).

Detailed examination of detection histories for radio-tagged lamprey has concluded that there are several potential explanations for relatively low fishway passage success for adult lamprey. In general, these factors are associated with unique physical characteristics of the individual

fishways and may include a lack of suitable attachment surfaces, water velocities, and channel configuration (Keefer 2008).

Experiments conducted in an experimental fishway at Bonneville Dam in 2004-2006 evaluated lamprey response to: 1) a fishway ramp and the effects of ramp flow volume, ramp angle, and attraction flow at the ramp entrance; 2) a divided fishway with differing flow velocities at each channel entrance; 3) two styles of mid-ramp lamprey "rest boxes"; and 4) three methods of attracting lampreys to the ramp entrance (water jets, air bubble streams, and waterfalls [Keefer 2008]). In the ramp tests, the majority of tagged fish ascended the ramp under all treatment conditions but lamprey passage times differed significantly in response to flow levels. When the fishway was divided, lamprey preferentially used channels adjacent to the flume walls, and this preference increased as flow through the outside channels decreased. Lamprey passage times also increased with concentrated flow through the center channel. With the differing types of "rest boxes", there was little difference in lamprey behavior between rest boxes under various flow treatments, and fish that ascended the ramp appeared to be unaffected by either rest box type. Finally, regarding the various methods of attraction to the ramp entrance, lamprey passage efficiency was highest during the water jet treatment, but differences among tests were not statistically significant.

A potential physiological problem facing successful passage of Pacific lamprey at dams may be related to their unique method of movement as it relates to specific areas within fish ladders. Typically, lamprey move through an adult fishway in a repeated series of motions consisting of attaching to the ladder floor with their mouths, surging forward, and re-attaching. Adult lamprey have an estimated critical swimming speed of about 2.8 feet per second at 15°C (Mesa et al. 2003) and a burst swimming speed calculated at 6.9 feet per second (Bell 1990). Fishway operational criteria at Wanapum and Priest Rapids dams include average velocities over submerged weirs that are approximately 2 to 4 feet per second and 4 to 6 feet per second through the slotted entrance gates near the surface. The design of the slotted entrance gates is such that the velocity gradient will be near zero at the bottom while maintaining average water velocities to the surface of the water column (M. Nicholls, Grant PUD, personal communication). Average velocity through the orifices is approximately 6 to 7 feet per second. The physiological response of adult Pacific lamprey to exhaustive exercise may be immediate, sometimes severe, but short-lived (Mesa et al. 2003). These data suggest that lamprey may have difficulty negotiating fishways that operate according to criteria established for salmonids.

In an effort to improve monitoring of Pacific lamprey in the basin, HDX-PIT tag monitoring sites were deployed at dams beginning in 2005. HDX tags were selected for Pacific lamprey passage evaluations to avoid potential tag collisions with the full-duplex (FDX) PIT tags used to monitor salmonids in the basin. In 2005, HDX detectors were installed at Bonneville Dam to evaluate lamprey passage systems (LPS) in the Bradford Island makeup water channel and at the entrance to the Washington-shore main ladder. Detectors were also installed at McNary and Ice Harbor dams to monitor lamprey in a parallel study (Cummings 2007). In 2006, additional detectors were installed at the tops of ladders at The Dalles and John Day dams. Daigle (2008) concluded that the prototype HDX detectors used in 2005-2006 appeared to be reasonably efficient (e.g., 20-100%) at detecting tagged lamprey passing antennas. Studies comparing the use of radio-telemetry and the HDX-PIT tags were conducted in 2007-2009. Study results indicated higher escapement rates for HDX-PIT tagged fish versus radio-telemetry tagged fish at and between dams. Larger fish of both tag types were significantly more likely than smaller fish to pass

through most monitored dam-to-dam reaches. The results suggest a tradeoff between tagging effects and the collection of high resolution, fine-scale data provided by the active radio telemetry system (Keefer et al. 2009a, 2009b and 2010).

Since the cumulative evidence on adult lamprey passage at dams has indicated that fishway entrances may be a major passage bottleneck, a significant effort was undertaken by the ACOE to develop and evaluate new entrance designs and operations. In 2007, a study was undertaken at Bonneville Dam to evaluate the use of reduced water velocities at entrances at night to improve entrance rates for lamprey (Johnson et al. 2009a). Lowering entrance head levels to 0.5 ft (4 feet per second target velocity level) from 2200 to 0400 hrs at PH2 improved entrance efficiencies from 2% at normal velocity to 26% at the lowered velocity at the north-shore entrance, although the number of lamprey attracted to the entrance appeared lower during reduced velocities (i.e., net entrances may not have been different. There was also evidence that the time to enter during the lower velocity was improved. In 2008, when PH2 entrances were placed in standby mode (0 feet per second velocity) at night, entrance efficiencies were 2 and 12% at the north and south-shore entrances versus 9 and 30% during normal conditions, respectively (Johnson et al. 2009b). Lamprey were also more likely to drop out of the fishways during the standby operations. In 2009, the telescoping weir bulkheads at the Cascade Island fishway entrance at Bonneville Dam were replaced with a variable-width entrance bulkhead. Bollard structures were also added out- and inside the fishway to provide an area of low velocity along the floor as a potential route for lampreys to enter. Preliminary results from radio- and HDX-PIT tag monitoring indicated that lamprey entrance use was improved in 2009 at the Cascades Island entrance but further analyses are planned. In 2009 and 2010, Douglas PUD utilized DIDSON to evaluate lamprey entrance efficiency at the Wells Dam fishways in response to three alternative entrance flow velocities. Although number of observations were low, the data indicated that adult lamprey were able to volitionally enter fishways under reduced nighttime flows (P.N. Johnson et al. 2011). The Wells Dam 2013 passage study conducted by Douglas PUD also included a treatment with alternative entrance flow velocities (see Section 2.2: Updated Information for additional details).

In recent years, Columbia River basin hydroelectric facilities have begun modifying fishways and fishway operations to facilitate the upstream passage of adult lamprey. ACOE and utilities with hydroelectric facilities in the basin are in various phases of design and implementation of passage improvements that include variable width weirs, bollard arrays, ¾ inch diffuser grating, lamprey passage systems LPS in various fishway locations, lamprey orifices in control section weir walls, diffuser grating plating, ramps at perched orifices, rounded edges of fishway walls, temporary velocity reductions at fishway entrances, and lifting picket leads at count stations. Researchers have also begun synthesizing the voluminous sets of data from over a decade of study to develop modeling tools that assist in prioritizing fishway improvements that yield the greatest benefit for lamprey passage (see Section 2.2: Updated Information for additional details).

### 2.1.5 Juvenile Passage at Hydroelectric Facilities

Juvenile lamprey moving downstream may pass through a hydroelectric structure using several different routes, including the powerhouse (turbines), spillway (bottom or top discharge tainter gates), powerhouse gatewell slots (fish bypass collection area), and adult fishways. Potentially high juvenile lamprey turbine entrainment rates are likely given the tendency of juveniles to swim low in the water column (Long 1968 as cited in Moursund et al. 2000). Fyke net capture data from Wells (Douglas PUD) and Rocky Reach (Chelan PUD) further confirm that juvenile

lamprey tend to pass via turbines in the lower half of the water column (BioAnalysts 2000). At the Project, turbine intake emergency wheelgate slot exclusion screen evaluations also observed small numbers of juvenile lamprey in the vicinity of turbine intake areas (Mike Clement, Grant PUD, personal communication).

The lamprey's ability to survive turbine passage, including response to changes in pressure, turbulent flow, and shear stress are not clearly understood. Another concern is how juvenile lamprey respond to diversion screens which are designed to bypass or divert fish into or toward preferred fish passage routes. For example, investigators reported large numbers of juvenile lamprey impinged between individual bars of fixed bar screens at The Dalles and McNary dams (Hatch and Parker 1998). The effects of blade strike or sub-lethal effects, such as increased vulnerability to predation following turbine passage, are not known (Becker et. al. 2003).

#### 2.1.5.1 Effects of Hydrologic Pressures on Juvenile Lamprey

Moursund et al. (2000 and 2001) subjected lamprey to an abrupt pressure spike (using a hyperbaric chamber) in order to simulate turbine passage. Lamprey were examined for injuries immediately after the trial, and then again after 48 hours. Test lamprey showed no immediate or latent injuries. Juvenile lamprey hardiness likely results from their lack of swim bladder, the flexibility associated with an anguilliform body type and cartilaginous skeleton, and the reduced size of vulnerable structures, such as eyes.

To further evaluate Pacific lamprey's ability to survive turbine passage, Pacific Northwest National Laboratory (PNNL) scientists conducted laboratory tests designed to measure a juvenile Pacific lamprey's response to the absolute change in pressure or "pressure drop" during passage through a Kaplan turbine simulation (Neitzel et al. 2000). Tests conducted by PNNL used a hyperbaric chamber to test a single worst-case scenario for lamprey: bottom-acclimated with a surface return. Juvenile lamprey were acclimated to an equivalent pressure of 60-foot depth for 24 hours prior to passage. The entire pressure sequence lasted about 90 seconds (Becker et al. 2003). Results from the simulated turbine passage tests showed no immediate external injuries or mortalities for lamprey exposed to rapid changes in pressure, i.e., ~400 kPa to ~5 kPa in 0.1 second. That juvenile lamprey lack a swim bladder may be one reason for their resistance relative to bluegill sunfish (Becker et al. 2003). In 2011, continued testing by PNNL on the effects of rapid and prolonged decompression simulating hydroturbine passage were conducted on juvenile Pacific lamprey. Generally, no mortalities or barotrauma were observed for lamprey exposed to these decompression scenarios (Colotelo et al. 2012).

#### 2.1.5.2 Effects of Bar Screens on Juvenile Lamprey

Swim trials in a laboratory flume showed that juvenile Pacific lamprey are fair to weak swimmers as compared to salmonids, with an average burst speed of 2.3 feet per second. Sustained juvenile lamprey swim speeds averaged 0.75 feet per second over a five-minute interval and 0.5 feet per second over a 15-minute interval (Moursund et al. 2000).

In laboratory conditions at PNNL in 2000, lamprey interactions with bar screens using an oval flume fitted with 1/8-inch spaced wedge-wire screen were examined. Lamprey were exposed to the screen at water velocities ranging from 0 to 2 feet per second. Observations were recorded using video cameras and infrared illuminators. At all water velocities greater than zero, the lamprey made contact with the bar screen within one minute of their entry into the water column upstream of the screen. At water velocities up to 1 foot per second, they were able to push off the

screen and disperse throughout the test flume. At water velocities greater than 1.5 feet per second, all lamprey made immediate contact with the screen. Seventy percent became impinged within one minute of the exposure. After 12 hours of exposure, 97% of the lamprey were impinged on the screen (Moursund et al. 2000).

Physical model data obtained by the U.S. Army Engineer Research and Development Center suggest that the average perpendicular flow velocity at a typical turbine bypass screen is 2.4 feet per second. Field measurements directly on a screen face at John Day support the model data (Weiland and Escher 2001). They also suggest this velocity exceeds the velocities that caused impingement of juvenile lamprey during laboratory tests and was also higher than the average burst speed of the test population. On an extended-length submerged bar screen, local velocities was as high as 10 feet per second and occurred at the upper end of the screen (Weiland and Escher 2001).

As part of the series of laboratory studies conducted by PNNL in 2000, the effects of screen alignment and angles on lamprey impingement were evaluated. 1999 laboratory flume tests utilized 1/8-inch wedge-wire screen oriented perpendicular to the flow and having vertical bars. Testing in 2000 included having vertical and horizontal bars and screen orientations at 10 degrees from vertical. The angled screen provided upward sweeping velocities that were not present in the previous perpendicular tests. Trials were conducted at velocities from 2 to 5 feet per second. The findings showed lamprey were far more susceptible to become impinged on horizontal bars than on vertical ones. At water velocities of 4 feet per second, 50% of lamprey became impinged on the horizontal bars but none were stuck on the vertical bars. At 5 feet per second, 55% of the lamprey were impinged on the horizontal bars but just 25 became impinged on the vertical bars (Moursund et al. 2002). General findings showed that an increase in either water velocity or the duration of conditions favoring impingement increases the lamprey's chances of permanently becoming stuck on the screens.

Alternative screening material was also tested by PNNL. Previous testing of 1/8-inch square nylon mesh was tested against 2/29-inch bar screen. The narrower spacing was expected to reduce the amount of space for lamprey to work their tails in and become impinged. Testing results showed that while 70% of the juvenile lamprey were permanently impinged on the 1/8-inch bar screen at velocities up to 4 feet per second, none remained stuck on the bars having the smaller 2/29-inch spacing, and just 15% were permanently impinged on the 1/8-inch square mesh (Moursund et al. 2002).

#### 2.1.5.3 Need for Active Tag Technology

A review of the most recent research addressing juvenile lamprey at hydroelectric facilities concludes that there is a current lack of methods and technology to effectively quantify survival of juvenile lamprey migrating through hydroelectric facilities (Douglas PUD and LGL 2008). Furthermore, no studies exist that determine a level of mortality attributed to a project's operations. This is due to the lack of miniaturized active tag technologies to overcome two study limitations: 1) macrophthalmia are relatively small in size and unique in body shape; and 2) migrate low in the water column resulting in the rapid attenuation of active tag signal strength. In 1999, the ACOE funded Oregon State University to assess the applicability of available tag technology to monitor juvenile lamprey macrophthalmia outmigration (Schreck et al. 2000). Results from this effort indicated that the smallest currently available radio-tag is still too large for implantation in the body cavity of a juvenile lamprey (Schreck et al. 2000). Additionally,

external application was not effective as animals removed tags within the first week and fish performance and behavior were affected (Schreck et al. 2000). Internal implantation of PIT tags is currently the most viable option for tagging juvenile lamprey; however this methodology presents severe limitations due to the limited range of detection systems, and the ability to tag only the largest outmigrating juvenile lamprey (Schreck et al. 2000). Since the 1999 assessment, there had been little development in tag technology to assess juvenile lamprey macrophthalmia outmigration until recently. In 2009, two tagging studies were conducted (and continued in 2010); one on the biological criteria for active tags and the second regarding the development of standard protocols for PIT-tagging juvenile lamprey.

#### 2.1.5.4 Gatewell Exclusion Screen Evaluation

During the spring and early summer months of 2010, turbine intake emergency gatewell exclusion screens were monitored at Priest Rapids and Wanapum dams (Grant PUD 2011). Prior to the juvenile salmonid outmigration, a DIDSON camera was installed on the end of the screen that allowed 69% of the screen surface to be effectively imaged. Fishes were enumerated as they passed within the insonified area near the screen, and interactions with the screen were classified by type (contact or non-contact). A total of 18 days of data collection throughout the spring and summer salmonid migration periods were analyzed at each dam. These results showed that fishes observed had a low level of interaction with the screens and a very low level of multiple or extended contact. At Wanapum Dam, 10,632 fishes were observed near the exclusion screen with 784 (7.4%) coming in contact with the screen and at Priest Rapids Dam, 29,340 fishes were observed with 360 (1.2%) contacts with the screen (Wright et. al., 2010). Although the study was originally developed to evaluate juvenile salmonid outmigrants, small numbers of lamprey were also observed at monitored locations at both Wanapum (n=31) and Priest Rapids (n=161) dams (Wright et. al., 2010). During the study period (May 12 to July 15, 2010) no negative impacts or screen impingement events were observed at these locations (Mike Clement, Grant PUD, personal communication).

## 2.2 Updated Information

Pursuant to the requirements of Grant PUD's PLMP (Grant PUD 2009) and specifically for this comprehensive annual report (as described in Section 1.2 above), recent Pacific lamprey passage and survival investigations and measures undertaken in the Columbia River basin are summarized in Table 3. For the purposes of this comprehensive annual report, the "updated" information includes activities that are either occurring or are being reported on during the current reporting period of November 1, 2012 through October 31, 2013. Worth noting is that the table only includes activities that have been implemented through the end of the reporting period. Efforts that are proposed or planned for future implementation or are proposed as a potential measure are not identified in this section. Proposed and planned efforts are, however, addressed in Section 4.0 which contains a comprehensive evaluation of all regional activities (implemented, planned and proposed) and assesses their applicability to the Project.

Information contained in the table includes the activity, project and river in which the activity occurred, results or status of activity, lead entity and information source. Except for the few instances where the Project was one of several dams included in an evaluation, activities regarding the Project are not described herein but rather are detailed in Section 3.0: Status of Pacific Lamprey Activities at the Project.

**Table 3 Pacific lamprey activities in the Columbia River basin in 2013**

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
|---|---|---|---|---|---|---|
| | **General Biology, Ecology, and Population Status** | | | | | |
| 1. | Monitoring entrance timing, escapement, and movement patterns | No associated hydro project | Fifteenmile Creek | In 2011, 124 adult Pacific lamprey were captured and tagged using half-duplex (HDX) passive integrated transponder (PIT) tags for escapement estimates in Fifteenmile Creek. Adult lamprey populations were estimated at 1,504 using Chapman's modification of the Peterson estimate. Tribal harvest was approximately 145 adult lamprey with a total escapement of 1,359. Since 2010, five half-duplex PIT tag antennae have been installed in Fifteenmile Creek and one in Eightmile Creek. The purpose of the half-duplex arrays are to document movement patterns of lamprey tagged at Cushing Falls (river kilometer, rkm, 0.8) during mark-recapture field operations. | CTWSR | Evaluate Status and Limiting Factors of Pacific Lamprey in the lower Deschutes River, Fifteenmile Creek and Hood River Subbasins. Confederated Tribes of Warm Springs Reservation of Oregon, Warm Springs. (Baker, C. and J. Graham. 2013) |
| 2. | Adult lamprey monitoring and juvenile lamprey density and distribution surveys | No associated hydro project | Deschutes and tributaries | Since 2003, data have been collected in the lower Deschutes River Subbasin to develop population trend data and investigate local lamprey biology and ecology. In 2012, a mark-recapture study was completed to estimate the abundance of adult lamprey at Sherars Falls. In addition, a tribal creel was also completed. Escapement was calculated by subtracting tribal harvest from the abundance estimate. Adult lamprey were collected at night from late July though mid October in the Sherars Falls fish ladder (Deschutes River rkm 70.4) using a long handled dip net. Captured fish received a half duplex tag and a fin clip as a secondary mark. A total of 382 fish were tagged, 1,580 inspected, and 58 recaptured. The abundance was estimate to be 10,262 (95% CI = 7,970 – 13,202), which is a | CTWSR | Evaluate Status and Limiting Factors of Pacific Lamprey in the lower Deschutes River, Fifteenmile Creek and Hood River Subbasins. Confederated Tribes of Warm Springs Reservation of Oregon, Warm Springs. (Baker, C. and J. Graham. 2013) |

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
|---|---|---|---|---|---|---|
| | | | | 217% increase from 2011 (4,062). Thirty-seven creel interviews were conducted, with an expanded harvest estimate of 1,461. Escapement above Sherars Falls was estimated to be 8,802. Lamprey implanted with half duplex (HDX) passive integrated transponder (PIT) tags at Sherars Falls were interrogated at antenna sites in Warm Springs River and Shitike Creek. Out of the 327 lamprey that were PIT tagged at Sherars Falls in 2012, 19 were detected in these streams. Of the 19 detected lamprey, 16 ascended Warm Springs River and three passed the mouth of Shitike Creek. The highest site that lamprey were detected in Warm Springs River was just upstream of the Warm Springs National Fish Hatchery at river kilometer 17, where 5 of the 16 passed.<br><br>In 2012, an ammocoete density survey was repeated in Warm Springs River and Shitike Creek that was originally conducted in 2009. Since then, an extensive floodplain restoration project in lower Shitike Creek had been completed, which included adding habitat complexity in the primary stream channel. While ammocoete densities in the natural stream were still higher than the restored area (average 15.9 and 9.6 fish/$m^2$, respectively) it is expected that the restoration area will continue to accumulate fine sediment, found to be a main predictor in ammocoete abundance in Shitike Creek in 2012, and improve as high-quality ammocoete rearing habitat. Overall densities of ammocoetes in Warm Springs River and Shitike Creek subbasins were less than in 2009. Many reasons could explain this including declining abundance of adult lamprey to spawn (lowest counts at Bonneville in 2009) and the lag time for ammocoetes to rebound or disturbance from high water redistributing substrate and ammocoetes. | | |

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
|---|---|---|---|---|---|---|
| | | | | While densities appeared to have been lower in 2012, distribution of ammocoetes remained essentially the same.<br><br>Since 2010, six half-duplex antennae array have been installed in Warm Spring River and Shitike Creek to detect lamprey implanted with half-duplex PIT tags at Sherars Falls during mark-recapture field operations. Data collected from antennae arrays will provide movement patterns (*e.g.,* overwinter and spawning migration patterns) and timing of entry into tributaries and points upstream.<br><br>Preliminary results not yet available. | | |
| 3. | Conduct adult lamprey movement study using radio telemetry | BOR projects in Yakima | Yakima | In 2013, the Mid-Columbia River Fishery Resource Office continued a radiotelemetry study of Pacific lamprey movements in the Yakima River. Eighty radio-tagged adult Pacific lamprey were released into the Yakima River to assess passage at irrigation diversion dams, movement patterns, overwintering and spawning areas. The 2013 annual report will be available on December 31, 2013. | USFWS | Personal communication with RD Nelle, USFWS (10/8/13) |
| 4. | Determining adult escapement and adult harvest monitoring | Willamette Falls | Willamette | In 2012, total estimated abundance of Pacific lamprey at Willamette Falls (escaped over the ladder plus those in/below horseshoe area below falls) = 245,325 (stray rate from ladder 55.4%).<br><br>The next report for this project will include 2012 and 2013 estimates. 2013 estimates and a synthesis of all the lamprey work done by Warm Springs Fisheries will be completed late fall 2013. | CTWSR | Personal communication with Cyndi Baker, CTWSR (10/9/13) |
| 5. | Occurrence, detection and habitat use of larval lamprey | The Dalles | Columbia River | A generalized random tessellation stratified approach was used to select sampling quadrats (30X30m) in a random, spatially-balanced order to | USFWS | Occurrence, detection, and habitat use of larval |

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
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| | | | | evaluate larval lamprey occupancy in the Columbia River mainstem in the Dalles Pool, and near the mouth of the Deschutes River (within the Dalles Pool). No larval lampreys were found in the the Dalles Pool or in the Deshutes River mouth. | | lamprey in the Lower White Salmon River and mouth: post-Condit Dam removal (Jolley et al. 2013) |
| 6. | Occurrence, detection and habitat use of larval lamprey | No associated hydro project | Columbia, White Salmon, Wind, and Klickitat | In 2012, occupancy of larval lamprey post Condit Dam removal was estimated in the White Salmon River mouth (within Bonneville Reservoir) and the Lower White Salmon River below the former site of Condit Dam, by adapting an approach used by Peterson and Dunham (2003) and refined by the U.S. Fish and Wildlife Service (USFWS 2008) to evaluate patch occupancy and detection probability for bull trout (*Salvelinus confluentus*). Larval lamprey occupancy in two neighboring 'reference rivers' was also evaluated, in the Wind River and Klickitat River.<br><br>All locations were occupied with larval lamprey. | USFWS | Occurrence, detection, and habitat use of larval lamprey in the Lower White Salmon River and mouth: post-Condit Dam removal (Jolley et al. 2013) |
| 7. | Pacific lamprey assisted recolonization of Tryon Creek | No associated hydro project | Tryon Creek | Pacific lamprey, thought to historically inhabit Tryon Creek, OR, no longer occur in the watershed. Following restoration activities to improve fish passage at the Highway 43 culvert in 2008, assisted recolonization of Tryon was begun in 2013. To help reestablish a spawning population of Pacific lamprey in Tryon Creek, 1046 larval Pacific lampreys collected in Eagle Creek and North Fork Eagle Creek (Clackamas R | USFWS | Personal communication with Greg Silver, USFWS (11/7/13) |

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
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| | | | | basin) were released in Tryon Creek. Spawning ground surveys and backpack electrofishing surveys to monitor adult and larval lamprey activity within Tryon Creek are ongoing.<br><br>A report will be available in 2014. | | |
| 8. | Lamprey monitoring | No associated hydro project | Hood River | In 2009, preliminary data was collected in the Hood River downstream of Powerdale Dam at river kilometer 5.8 (rkm) to develop a juvenile lamprey distribution map prior to removal of the dam. Lack of adequate passage facilities at Powerdale Dam was believed to have eradicated lampreys from areas upstream. In 2012, ammocoetes were discovered above the old dam site with upper distribution identified in the East Fork of the Hood River (rkm 24.3). Sixty samples were DNA analyzed and confirmed as Pacific lamprey indicating natural re-colonization had occurred. Project objectives were to: 1) estimate adult Pacific lamprey escapement at Cushing Falls in Fifteeemile Creek; 2) describe Pacific lamprey spawning distribution; 3) determine larval lamprey distribution and associated habitat in Hood River and Fifteenmile Creek; 4) monitor adult lamprey movement for re-colonization in Hood River Subbasin; and 5) identify factors limiting Pacific lamprey production within Fifteenmile Creek Subbasin. From April - October, migrating adult Pacific lampreys were trapped and implanted with HDX PIT tags. Using Chapman's modification of the Peterson estimate, a two event mark-recapture (M-R) experiment was employed to estimate escapement. Implanted lampreys were released downstream of thecollection site and detected via HDX antennae as the recapture event. In conjunction with the M-R study, a creel survey | CTWSR | Evaluate Status and Limiting Factors of Pacific Lamprey in the lower Deschutes River, Fifteenmile Creek and Hood River Subbasins. Confederated Tribes of Warm Springs Reservation of Oregon, Warm Springs. (Baker, C. and J. Graham. 2013) |

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
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| | | | | was performed five nights a week. Tribal harvest was approximately 113 adult lamprey with a total escapement of 2,544 above Cushing Falls in Fifteenmile Creek. Ammocoete distribution was conducted to document the upper extent of distribution of lamprey in Fifteenmile Creek and its tributary Eightmile Creek. Ammocoete distribution and abundance surveys were also completed in Hood River Subbasin. Water quality and environmental variables were documented with multiple organizations to assist in the identification of possible limiting factors lamprey may endure throughout all life stages. | | |
| 9. | Adult lamprey monitoring | No associated hydro project | Umatilla | In 2012, the Confederated Tribes of the Umatilla Reservation (CTUIR), continued monitoring of adult lamprey in the Umatilla River via radio-telemetry. The objective of the monitoring is to identify passage bottlenecks within the watershed. In total, 60-80 fish were tagged and monitoring consisted of both fixed stations and mobile surveys.<br><br>A 2013 update to this activity was unavailable at the time of report publication. | CTUIR | Personal communication with Aaron Jackson, CTUIR (11/29/12) |
| 10. | Re-introduction evaluation | Pelton Round Butte | Deschutes | As part of relicensing the Pelton Round Butte Hydroelectric Project (PRB), the licensees, Portland General Electric and CTWSR, developed a Fish Passage Plan approved by the Federal Energy Regulatory Commission. A component of the Fish Passage Plan is the Pacific Lamprey Passage Evaluation and Mitigation Plan (PLEMP). To re-establish lamprey upstream of PRB, a series of assessments is called for in the PLEMP. The first step was to study habitats currently occupied downstream of PRB, then identify potential habitat upstream of PRB. Both juvenile and adult lamprey downstream of PRB were studied to ascertain: 1) | CTWSR | Pacific Lamprey Passage Evaluation and Mitigation Plan: Phase I – Habitat Assessment for Potential Re-introduction of Pacific Lamprey Upstream of Pelton-Round Butte Hydroelectric Project (CTWSR 2012) |

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
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| | | | | timing and locations of spawning and overwintering, 2) spawning and rearing distribution, and 3) habitat associations.<br><br>The culmination of this assessment was a theoretical abundance estimate of Pacific lamprey ammocoetes (larval lamprey) in habitat that may be re-colonized upstream of PRB. The extent of potential ammocoete rearing habitat upstream of PRB includes the Metolius River from the mouth to Camp Creek (rkm 13.8), the Deschutes River from the head of Lake Billy Chinook (rkm 193) to Big Falls (rkm 213), Whychus Creek from the confluence with the Deschutes River to Alder Springs (rkm 2.4) and the Crooked River from the head of Lake Billy Chinook to Opal Springs (rkm 6.9). Two models; a capture efficiency (CE) model and an ammocoete abundance model (AAM) were developed and used in conjunction with water temperature and habitat data upstream of PRB, which resulted in an estimate of 4.8 million ammocoetes (95% prediction interval = 3.7 to 7.5 million ammocoetes) for the identified habitat.<br><br>The evaluation to determine whether lamprey can be re-established upstream of the PRB Hydrologic Complex (rkm 161) in the Deschutes River is still pending. | | Personal communication with Cyndi Baker, CTWSR (10/9/13) |
| 11. | Conduct juvenile distribution and abundance sampling | No associated hydro project | Umatilla | In 2012, index sites were surveyed using backpack electrofishing to assess juvenile lamprey distribution and abundance in the Umatilla watershed. These sites were established in the late 1990's as a research, monitoring and evaluation tool for Tribal translocation activities. Approximately 30 sites are surveyed from river mile (RM) 0 to 70. | CTUIR | Personal communication with Aaron Jackson, CTUIR (11/29/12) |

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
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| | | | | A 2013 update to this activity was unavailable at the time of report publication. | | |
| 12. | Conduct juvenile distribution and abundance sampling | No associated hydro project | Yakima | Surveys in 2013 in the Yakima Basin are continuing and building from past surveys starting in 2009. In general, no juvenile Pacific lamprey have been found above Roza Dam and very few are found downstream of Roza Dam consistent with very low recent adult counts at Prosser Dam. Juvenile surveys have focused on status and trend monitoring and will also emphasize baseline information associated with current and future supplementation activities. Some of the young of the year lamprey captured near supplementation release sites (potential offspring of translocated adults) were preserved for species identification. Reports available upon request. | Yakama Nation | Personal communication with Ralph Lampman, Yakama Nation (10/18/13) |
| 13. | Conduct juvenile lamprey surveys in irrigation canals | No associated hydro project | Yakima | The Yakama Nation Pacific Lamprey Project (YNPLP) has been very active in October/November surveying dewatered irrigation canals within the Yakima River subbasin for juvenile lamprey within these diversions. There seems to be a strong correlation between the amount of fine sediment collected in diversions and the number of larvae found at these facilities. Lamprey of various sizes, sometimes in the thousands, were found behind screens and a technical report is available upon request. For the first time, the Yakama Nation also conducted lamprey monitoring in the irrigation diversions during the irrigation season (before dewatering) to assess lamprey presence, distribution, and movement. This was conducted in Sunnyside Diversion using rotary screw traps and tailor made sediment traps and in Congdon Diversion using Western brook lamprey (various sizes) and propagated Pacific lamprey (young of the year) and collection nets in by pass and the canal (also | Yakama Nation | Personal communication with Ralph Lampman, Yakama Nation (10/18/13) |

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
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| | | | | conducted underwater video monitoring). At the Congdon Diversion (rotating drum screen with 2.4mm mesh wire cloth), most large larvae (>84mm) were able to avoid the screen, many medium larvae (<85mm, >49mm) entangled themselves on the screen (to be eventually rolled over), and most smaller larvae (<50mm) swam right through the mesh screen. However, when larvae were released further upstream, the majority did not move into the bypass or canal outlet, indicating they are burrowing into the fine sediment available at the site. | | |
| 14. | Conduct juvenile lamprey distribution surveys | No associated hydro project | Entiat and Wenatchee | From 2010-2012, juvenile lamprey distribution surveys were conducted in the Entiat and Wenatchee rivers. A report is available on 2010 distribution assessment. Draft 2012 is in progress. | USFWS | Surveys of Pacific Lamprey Distribution in the Wenatchee River Watershed 2010-2011 (Johnsen and Nelson, 2012)<br><br>Personal communication withRD Nelle, USFWS (10/8/13) |
| 15. | Conduct status and trend larval monitoring program | No associated hydro project | Methow | In August 2013, as part of continuing lamprey activities in the Methow watershed (which began in 2008), on-going status and trend monitoring of larval lamprey continued with surveys of the three sites on both the Chewuch and Methow rivers. Several sites in the upper Methow and Twisp River were also sampled but no larvae have been observed in these areas since monitoring began in 2008. Electrofishing was conducted to determine larval presence and relative abundance and all type 1 larval habitat was GIS mapped to determine larval density as well as persistence of larval | Methow Salmon Recovery Foundation, Wild Fish Conservancy, USFS, Yakama Nation and USFWS | Personal communication with John Crandall, Wild Fish Conservancy (11/19/13) |

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
|---|---|---|---|---|---|---|
| | | | | habitat over time. A project status report that will include all lamprey specific work conducted in the Methow since 2009 will be completed in early 2014. | | |
| 16. | Habitat restoration and effectiveness monitoring | No associated hydro project | Methow (Chewuch River) | A salmonid-based habitat restoration action on the Chewuch River at RM 10 is being assessed to determine its effects on 1) the distribution of larval lamprey rearing habitat, 2) the distribution and relative abundance of ammocoetes. The restoration project was initiated by the Yakama Nation and the monitoring component is being coordinated by John Crandall. Pre-treatment data was collected in 2010 and post-treatment data has been collected in subsequent years including 2013. | Wild Fish Conservancy, Methow Salmon Recovery Foundation, and Yakama Nation | Personal communication with John Crandall, Wild Fish Conservancy (11/19/13) |
| 17. | Relative abundance monitoring of larval lamprey | Willamette Falls (tributaries above and below) | Willamette | Backpack electrofishing surveys were conducted during summer/fall of 2011 to ascertain the distribution and relative abundance of larval lamprey. A report is available as of July 2012 (Wyss et al. 2012). Spring adult Pacific lamprey spawning surveys were conducted from May – June 2012. Segments of three basins from the 2011 larval sampling were floated or walked. In mid-late summer of 2012, larval lamprey electrofishing survey sites from 2011 were revisited and four additional basins were also sampled. Data from 2012 is currently being entered and quality assured. A report may be available in early 2013.<br><br>A 2013 update to this activity was unavailable at the time of report publication. | Oregon Cooperative Fish and Wildlife Research Unit at OSU | Personal communication with Lance Wyss, OSU (9/18/12)<br><br>Relative Abundance and Associated Habitat Characteristics of Larval Lamprey in Five Willamette River Tributaries (Wyss et al. 2012) |
| 18. | Reservoir distribution, composition, and abundance of juvenile lamprey | Rocky Reach | Columbia | Per the Rocky Reach Project Pacific Lamprey Management Plan, Chelan Public Utility District (PUD) is required to measure lamprey presence and relative abundance in habitat areas that may be affected by ongoing Project operations. In November 2011, Chelan PUD sampled 8 stations via backpack electrofisher within the Rocky Reach | Chelan PUD | Distribution, Composition, and Abundance of Juvenile Lampreys within the Observed Operating Range of |

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
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| | | | | reservoir. All stations were generally Type 1 habitat. In total, five juvenile lamprey ranging in size from 113-142mm were captured at one site (Sun Cove).<br><br>In 2013, analysis of Rocky Reach Reservoir flushing rates demonstrate the highly riverine, run of river operations, maintained in Rocky Reach Reservoir. Elevation duration curves show the Project maintains stable elevations between 705.5 ml and 706.75 msl (max) 95 percent all hours. RRFF determined reservoir fluctuations are not a limiting factor to juvenile lamprey production. | | Rocky Reach Reservoir, 2011 (Chelan PUD 2012)<br><br>2013 RRH headwater duration curves and 10-year hydraulic retention time analysis (Hemstrom 2013) |
| 19. | Presence/Absence, habitat use, and relative abundance of juvenile lamprey | Priest Rapids and Wanapum | Columbia | On November 13-16 and December 11-14, 2012 a field crew used ABP-2 backpack electrofishers to assess presence/absence, habitat use, and relative abundance of juvenile Pacific lamprey in areas affected by Project operations. In the Wanapum Reservoir, 27 potential shoreline habit locations were sampled. In the Priest Rapids Reservoir, 21 potential shoreline habitat locations were sampled. During this effort, the pool elevation at the Wanapum forebay was approximately 570.0 and Priest Rapids forebay was between 485.3-487.5. No juvenile lamprey were captured. Another effort was completed on May 11 and 12, 2013. The crew sampled 10 potential shoreline habitats in the Wanapum reservoir and found no juvenile lamprey. The pool elevation at the Wanapum forebay was 569.0 during this effort. Another effort was completed on October 11 and 12, 2013. The crew sampled 8 potential shoreline habit locations in the Priest Rapids reservoir and captured 7 juvenile lamprey. Another 10 were | Grant PUD | Personal communication with Rod O'Connor Blue Leaf Environmental (11/12/13) |

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
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| | | | | observed; however, they were not captured. The elevation of the Priest Rapids forebay was 480.2 during this effort. These results suggest that Pacific lamprey ammocoetes are rare in the shoreline areas during normal to low pool operational elevations. Additional sampling in the Wanapum reservoir at low operational elevations is planned for 2014. | | |
| 20. | Lamprey artificial propagation | N/A | N/A | Pacific lamprey adults were collected in summer 2012 and held over winter at ambient water conditions. On 9 May 2013 a single ripe male and female were anaesthetized and stripped of gametes. The eggs and milt were held separately on ice for the 4 h transport to Walla Walla. They were then mixed for 2 min, exposed to culture water for 3 min, rinsed three times and installed in two upwelling jars at 14°C and 0.1-0.2 L/min flow. We recorded 100% fertilization success to the morula stage. For the second test, gametes were stripped from two females and three males on 20 May and transported on ice to Mukilteo. Gametes were held on ice for 6, 18, 24, and 42 h before mixing using the method described above. Fertilization success was 93% for the 6 h treatment, but only 20% at 18 h. For the 24 and 42 h treatments, no eggs developed to the morula stage. A third test was conducted on 5 June using gametes from three males and three females. These gametes was fertilized at Prosser within 2 h of stripping using twelve treatment combinations: a) gametes combined and mixed for 2 min before addition of culture water and then exposed for 3, 6, | NOAA Fisheries, CTUIR, Yakama Nation | Personal communication with Mary Moser, NOAA Fisheries (10/31/13) |

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
|---|---|---|---|---|---|---|
| | | | | or 12 min, and b) gametes combined and mixed with culture water and then exposed for 3, 6 and 12 min. Half of the fertilized gametes from each treatment were rinsed three times with culture water before installation in individual Heath trays. The others were not rinsed. Two observers scored fertilization to the morula stage and successful development to day 12 (near hatching) for three subsamples of 50 embryos from each treatment at each stage of development. The results indicated that fertilization is enhanced slightly by mixing gametes before addition of culture water, but that eggs are easily damaged by "dry" mixing. However, neither effect was statistically significant. For both treatments, the lowest exposure times had highest fertilization rates and survival to day 12. Contrary to expectation, rinsing the fertilized eggs resulted in significantly lower fertilization success and greater rates of egg damage. However, survival to day 12 was significantly higher in rinsed treatments. | | |
| 21. | Lamprey artificial propagation | N/A | N/A | The YNPLP conducted artificial propagation and rearing of Pacific lamprey in 2013. This work was accomplished in close coordination with the Umatilla Tribes (Aaron Jackson), NOAA (Mary Moser) and USGS (Matt Mesa) who are also doing similar activities. We were able to test various propagation and incubation methods/treatments and produced over 200 thousand hatched larvae. Rearing experiments, using various tank sizes, density, and feeds are ongoing to learn how to best feed and care for these larvae throughout the year. 2012 Report is available upon request (executive summary cited below): "Over a 10-week period | Yakama Nation | Personal communication with Ralph Lampman, Yakama Nation (10/18/13) |

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
|---|---|---|---|---|---|---|
| | | | | between April 13 and June 19, 2012, 41 adults were propagated successfully primarily at Marion Drain and Prosser hatcheries. Some of the individuals spawned repeatedly, resulting in a total of 55 propagation events. We discovered that the success of the propagation (namely fertilization and subsequent hatching) depended chiefly on four variables: 1) quality of gametes (sexual maturation level, being neither too immature nor too ripe); 2) seasonality (eggs developed differently depending on whether it was early or late in the season); 3) water quality (water with high silt content made it difficult to keep high survival rates); and finally 4) incubation methods. We experimented with an extensive list of incubation methods from past studies across the world in addition to some of our own designs and were able to compare and contrast the success rates of these various incubation methods for Pacific lamprey. Propagation methods remained fairly consistent throughout the spawning season (dry spawning using the hand-stripping method) with slight modifications in gametes and water mixing procedures, yet survival rates did not appear to vary as much compared to the incubation methods. Biological information related to adult lamprey and sexual maturation was also examined in our analysis. Appropriate substrate material (sand, mud, detritus, filter media, straw) and feeds (active dry yeast, brewer's yeast, hatchfry encapsulon, spirulina, etc.) for burrowing larvae was investigated, and some preliminary conclusions are included in this report. Larvae rearing is ongoing at Prosser Hatchery and significantly more work will be conducted on this life stage in 2013." | | |
| 22. | Field sampling of a Deepwater Electrofishing Platform (DEP) | No associated hydro project | Columbia and Wind | A deepwater electroshocking platform (DEP) was used to detect, and measure the size of larval | PNNL | Personal communication |

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
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| | | | | lampreys (ammocoetes) within deepwater rearing habitats (>1 m). During the summer survey, 36 locations were sampled with ammocoetes detected at 61% of the locations. During the winter survey, 34 locations were sampled using a similar spatial sampling distribution, with ammocoetes detected at 50% of locations. In total, 74 lampreys were detected during summer and 63 were detected during winter. During both seasons, a majority of the lampreys were found in water depths ranging from 1.5 m to 4.5 m. Lamprey size varied from less than 50 mm up to 150 mm. We found 98 ammocoetes less than 75mm and 39 ammocoetes from 75 mm to 150 mm. More ammocoetes (47%) were found within sediments dominated by organic silt than those dominated by silt/sand mixtures (31%) or well graded sands (21%). Lamprey ammocoetes (where present) emerged within approximately 1 minute and were recorded using an optical video camera. The DEP was used to survey aquatic habitat at a sampling rate of approximately 0.55 m2/min and did not require transporting lampreys to the surface or disturbing sensitive benthic habitats. | | with Bob Mueller (10/15/13) |
| 23. | Anesthetic efficacy trials and post-tagging prophylactic treatment tests | N/A | N/A | In 2011, anesthetic efficacy trials and post-tagging prophylactic treatment tests were conducted on juvenile lampreys at the USGS laboratory in Cook, Washington. For the anesthetic efficacy trials, "time to handleable" and "time to recovery" were measured for three concentrations of four anesthetics [MS-222, BENZOAK (20% benzocaine), AQUI-S 20E (10% eugenol), and Aquacalm (metomidate hydrochloride)] with fifteen fish per concentration. MS-222 and BENZOAK were effective anesthetics for juvenile lampreys at concentrations of 100 mg/L and 60 mg/L. Fish were highly agitated by exposure to | USGS | Anesthesia of juvenile Pacific lampreys with MS-222, BENZOAK, AQUI-S 20E and Aquacalm (Christiansen et al. 2013) |

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| | | | | AQUI-S 20E and were sedated slowly even at high concentrations (100–200 mg/L). Aquacalm was ineffective as an anesthetic for juvenile lampreys. Once optimal anesthetic concentrations were determined, an additional 45 fish were anesthetized with MS-222, BENZOAK, or AQUI-S 20E and then held at 12°C for 30 days and monitored for health and survival. Fish anesthetized with BENZOAK presented with the fewest fungal infections and had the best survival, suggesting that it may be a good alternative anesthetic for juvenile lampreys. To test the ability of short-term post-tagging prophylactic tests to reduce freshwater fungal infections, fish were anesthetized with MS-222 or BENZOAK; PIT tagged with 9 × 2 mm tags, and then treated for 30 min with Stress Coat, hydrogen peroxide, salt, or left in plain water. Twelve fish were used per treatment with three treatment replicates per anesthetic. All fish were held at 12°C, and fish health and survival were monitored for 27 days. Survival was generally high for all groups including controls, and few fungal infections were observed. More work is needed to determine the efficacy of prophylactic treatments or if they are needed at all.<br><br>A manuscript of the work titled "Anesthesia of juvenile Pacific lampreys with MS-222, BENZOAK, AQUI-S 20E and Aquacalm," was sent to the North American Journal of Fisheries Management on 8/28/12 for publication. It is currently in review. | | |
| 24. | Genetic characterization of Pacific lamprey | No associated hydro project | Willamette (Agency Creek) | In 2010 and 2011 the Confederated Tribes of Grand Ronde collected tissue samples from ammocoete lamprey caught in the juvenile smolt trap located on Agency Creek, a tributary to the | The Confederated Tribes of Grand Ronde | Personal communication with Rebecca McCoun, CTGR |

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| | | | | South Yamhill. Samples were sent to Denise Hawkins with the USFWS Abernathy Fish Technology Conservation Genetics lab in Washington State. Analysis is continuing with results being compared to a regional database. A final report is not yet available.<br><br>A 2013 update to this activity was unavailable at the time of report publication. | and USFWS Abernathy Fish Technology Center | (9/11/12) |
| 25. | Collection of adult lamprey for translocation, artificial propagation and radio-telemetry studies | No associated hydro project | Umatilla | In 2012, the CTUIR collected adult lamprey from lower Columbia River mainstem dams. In total, 360 adults were captured and transported to the Walla Walla Water Environmental Resources Center. These fish will be used for translocation programs in the upper Umatilla basin; to support radio-telemetry assessments (releases in the lower Umatilla River); and to support artificial propagation research.<br><br>A 2013 update to this activity was unavailable at the time of report publication. | CTUIR | Personal communication with Aaron Jackson, CTUIR (11/29/12) |
| 26. | Assessment of larval Pacific lamprey | No associated hydro project | Columbia River | The U.S. Department of Energy (DOE) conducts ecological monitoring on the Hanford Site to collect and track data needed to ensure compliance with an array of environmental laws, regulations and policies governing DOE activities. Pacific lamprey were selected for monitoring by the Mission Support Alliance (MSA) Public Safety and Resource Protection (PSRP) program due to their listing status, documented regional declines, cultural importance, the lack of available information for the Hanford Reach of the Columbia River, and their potential utility as an indicator species for contaminant uptake.<br><br>Lamprey were sampled via electrofishing along | DOE (contractor implementing the project was the Mission Support Alliance) | Calendar Year 2012 Assessment of Larval Pacific lamprey on the Hanford Reach of the Columbia River (Lindsey et al. 2013) |

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| | | | | the entire reach of the Columbia River through the Hanford Site (approximately 50 miles). Collected lamprey were measured and released near site of capture. Individuals selected for analysis were euthanized and transferred to a commercial laboratory for trace metal analysis.<br><br>Overall, the study collected 53 individual lamprey in approximately 4 hours of electrofishing. Two areas (300 Area and near the 100-H Area) captured lamprey. Both sites were in or immediately adjacent to known contaminated groundwater plumes. In total, 10 lamprey were selected for analysis. Aside from Uranium which was significantly higher in the 300 Area, ANOVA results showed that datasets were not significantly different between the two locations for the remainder of trace metals that were detected (aluminum, chromium, copper, nickel, lead, antimony, selenium, thorium, and zinc). | | |
| 27. | Pacific lamprey in the Columbia River Estuary | No associated hydro project | Lower Columbia Estuary | A manuscript describing the timing, abundance, and size of both juvenile and adult Pacific lamprey in the lower Columbia estuary (below Rkm 60) is being prepared. The work is based on historic (1980-81) and current (2001-2012) sampling in the estuary. The paper, if accepted, will be available in 2014. | NOAA Fisheries | Personal communication with Laurie Weitkamp, NOAA Fisheries (10/4/13) |
| 28. | Pacific lamprey and host relationships in the marine environment | No associated hydro project | N/A | Returns of Pacific lamprey to the Columbia River over the past decade have declined significantly compared with peak returns of the 1950s and 1960s with no quantifiable mechanisms identified. To determine if abundance of documented host species in the marine environment is related to adult returns, we examined stock assessment data, commercial fishery statistics, and counts of adult | Chelan County PUD | Relationship between the Abundance of Pacific lamprey in the Columbia River and their common hosts in the marine environment |

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| | | | | fish at Bonneville Dam between 1997 and 2010. Significant positive correlations were observed between lamprey returns and abundance indices of several commercial species. Several of these fisheries have demonstrated significant reductions in mean landings since the 1950s and 1960s and adult lamprey returns have declined proportionally. Multiple regression techniques indicated that host abundance was the principal factor in predicting lamprey returns, though inclusion of oceanic conditions increased the precision of the model. These results represent the first established relationship to recent trends of Pacific lamprey returns to the Columbia River. We hypothesize that Pacific Lamprey abundance in the Columbia River is cyclical in nature, but limited by availability of several host species over a potentially vast geographic range. Biologists and resource managers should reassess the relatively overlooked marine ecology of Pacific Lamprey. | | (Murauskas et al. 2013) |
| | **Lamprey Migration in Rivers** | | | | | |
| 29. | Estimating upstream passage metrics and performance in Pacific lamprey from the Columbia River hydrosystem | Bonneville, The Dalles, John Day, McNary, Ice Harbor, Lower Monumental, Little Goose, Lower Granite, Priest Rapids, Wanapum | Columbia and Snake | We tagged adult Pacific lamprey collected at Bonneville Dam with half duplex (HD) passive integrated transponder (PIT) tags and monitored their passage and migration behaviors at Bonneville, The Dalles, John Day, McNary, Ice Harbor, Lower Monumental, Lower Granite, and Priest Rapids dams. Additional detection data from upper Columbia River dams and lower Columbia tributaries were provided by cooperating agencies. Our objectives were to calculate lamprey passage times through various | ACOE (prepared by the University of Idaho Cooperative Fish and Wildlife Research Unit and NOAA Fisheries) | Adult Pacific Lamprey Migration in the Lower Columbia River: 2012 Half Duplex PIT-TAG Studies (Keefer et al. 2013a) |

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| | | | | river reaches, to estimate escapement past the monitored sites, and to evaluate potential correlation between lamprey migration and physiological and environmental factors. An additional objective in 2012 was to use the multi-year HD PIT-tag database to evaluate whether escapement rates past dams have changed through time.<br><br>In total, we HD PIT-tagged 899 lampreys in 2012: 823 were released downstream from Bonneville Dam near Hamilton Island, 25 were released upstream from Bonneville Dam near Stevenson, WA, and 50 were released directly into the Cascades Island lamprey passage structure (LPS). An additional 300 lampreys were double-tagged with HD-PIT tags and acoustic transmitters (JSATS); results from the JSATS sample are presented in a separate report.<br><br>Increased cross-agency monitoring efforts improved our final accounting for tagged lamprey. A total of 52 (6%) of the downstream-released sample was last detected at dams in the upper Columbia River (Priest Rapids, Wanapum, Rock Island, Rocky Reach). Eleven (1%) were last detected at Snake River dams, and 22 (3%) were detected in tributaries to the Bonneville or The Dalles reservoirs (Hood River, Fifteenmile Creek, Deschutes River). We expect additional detections at many of these sites in spring 2013 as overwintering lampreys move to spawning areas. Our multi-year (2006-2012) analyses indicated that | | |

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| | | | | there have been incremental increases in HD PIT-tagged lamprey escapement past dams. This pattern may be associated with structural and operational improvements at the USACE dams, though we caution that the available time series is short and that it is difficult to prove causation in a non-experimental monitoring project.<br><br>Lamprey migration times were highly variable in 2012, as in all study years. The median passage time for the downstream-released fish was 11.3 days (< 1 km/d-1) from release to the top of Bonneville Dam. Some fish took more than two months to pass Bonneville Dam. Median times between top-of-ladder antennas were 4.7 days (16 km/d-1) between Bonneville and The Dalles dams, 3.3 days (12 km/d-1) between The Dalles and John Day dams, and 7.5 days (16 km/d-1) between John Day and McNary dams. Lampreys generally migrated faster later in the summer through most reaches, coincident with increasing river temperatures and decreasing river discharge. Notably, slow lamprey passage times from release past Bonneville Dam were associated with reduced upriver escapement distance in our multi-year summary, a pattern that may be related to passage delay and/or the effects of initial fish condition. | | |
| 30. | General migration and upstream passage patterns | Bonneville, The Dalles, John Day, McNary, Priest Rapids Dam, and 3 of 4 | Columbia and Snake | Monitoring adult Pacific lamprey migration in the Columbia River basin is an important part of understanding how dams and environmental factors affect lamprey behavior, dam passage success, and distribution among spawning areas. | | Matthew Keefer, University of Idaho, Presentation at AFEP Review, Walla Walla, WA (12/3/13) |

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| | | lower Snake River dams | | In 2013, we collected and HD PIT-tagged 901 adult lampreys at Bonneville Dam from 10 June through 23 September (median date = 11 July). Of these, 876 (97%) were released downstream from Bonneville Dam and 25 (3%) were released into the Cascades Island lamprey passage structure (LPS). We monitored upstream passage at the four lower Columbia River dams, Priest Rapids Dam, and at three of four lower Snake River dams. Public utility districts monitored lamprey passage at Wanapum, Rock Island, and Rocky Reach dams, and the Confederated Tribes of Warm Springs monitored some tributary sites with instream HD PIT antennas. The primary objectives addressed in this presentation will be: 1) to estimate lamprey escapement past the monitored sites, 2) to assess the final known distribution of tagged fish, 3) to compare 2013 results to those from previous HD PIT study years (2005-2012), and 4) to evaluate the effects of recent management efforts intended to improve lamprey passage through dam fishways.<br><br>At this writing, some lampreys tagged in 2013 were still actively migrating, monitoring sites were still deployed, and cooperating agencies had provided some – but not all– of the data collected to date. For these reasons, the HD dataset was not yet fully processed. | | |
| 31. | Evaluate movement and fate of adult Pacific lamprey in Bonneville Reservoir and Lower Columbia River | Bonneville | Columbia | In this study, we evaluated the effectiveness of a stationary array of acoustic JSATS receivers for monitoring the migration of JSATS-tagged adult Pacific lamprey in Bonneville Reservoir. In addition, we continued to monitor for movement of the 299 lamprey tagged in the summer of 2012 with JSATS tags rated for 400-day tag life.<br>In 2013, 400 adult lampreys were tagged with 400- | University of Idaho Cooperative Fish and Wildlife Research Unit | Christopher Noyes, Presentation at AFEP Review, Walla Walla, WA (12/3/13) |

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| | | | | day duration JSAT tags from 29 June through 23 September. Fish were released above and below Bonneville Dam. Gates of one to five receivers were deployed at thirteen locations from Dodson, OR up to the John Day River (1.2 km upstream of the mouth at rkm 352).<br><br>Of the 299 lamprey we tagged with JSATS transmitters in 2012, seventy-two (24.1%) were subsequently detected in 2013. Eight of these fish were recorded entering spawning tributaries in early spring 2013, representing 12.5% of those classified as having unknown fate in the Bonneville Reservoir based on detections through fall of 2012. Fifteen fish (20.8% of the 72 detected in 2013) had been recorded entering spawning tributaries in 2012 and were detected in late spring and early summer 2013 exiting these tributaries and moving downstream. The remaining forty-nine fish (68.1%) were detected moving between main stem receivers. The majority of these were recorded moving downstream (n = 42, 80%), although seven lamprey (20%) were detected passing Bonneville Dam in 2013. Analysis of records for 2013 JSATS-tagged adults is currently underway and we will present results on migration rates to upstream sites and the distribution of tagged adults through early fall 2013. | | |
| 32. | Design and construction of flume to test irrigation diversion screening | N/A | N/A | In 2012, the USGS began the design and construction of a large, oval flume to test the effects of irrigation diversion screens on juvenile lampreys. These tests will use flows up to 10 CFS, larger, more realistic screen panels, and will incorporate both approach velocities and sweeping velocities. The flume is currently in place at the Columbia River Research Laboratory and is currently undergoing final engineering and | USGS | Personal communication with Matt Mesa, USGS (11/13/13) |

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| | | | | mechanical revisions.<br><br>Update: the flume is in place, a perforated plate screen has been put in place, baffles for the screen have been installed, and an underwater video system is being tested. Several test releases of fish have been and techniques for release and collection of data are being refined. Testing should begin in November, 2013. | | |
| 33. | Juvenile lamprey outmigration monitoring | No associated hydro project | Umatilla | In 2012, the CTUIR continue to operate a rotary screw trap at RM 2.5 of the Umatilla River to document juvenile lamprey outmigration timing. The trap is run from November to May of each year.<br><br>Data for 2012 is still be analyzed and may be available in 2013.<br><br>A 2013 update to this activity was unavailable at the time of report publication. | CTUIR | Personal communication with Aaron Jackson, CTUIR (11/29/12) |
| | **Adult Passage at Hydroelectric Facilities** | | | | | |
| | *Structural and Operational Fishway Modifications* | | | | | |
| 34. | Ladder tours | Bonneville, McNary, Ice Harbor, Little Goose | Columbia and Snake | Completed a tour of fish ladders with regional fish managers and researchers to identify potential minor fishway modification opportunities. | ACOE | Personal communication with Sean Tackley, ACOE (11/14/13) and Steve Juhnke, ACOE (11/18/13) |
| 35. | Inspect fishway at Priest Rapids and Wanapum dams and identify areas that could represent passage problems for adult Pacific lamprey | Priest Rapids, Wanapum | Columbia | In January 2013, Grant PUD conducted tours during scheduled maintenance outages with the PRFF members to evaluate the modifications to the fish ladders to improve adult lamprey passage (i.e., plating installation, adult lamprey collection | Grant PUD | Personal communication with Mike Clement, Grant PUD (10/7/13) |

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| | | | | facilities, newly designed count stations, and ramps downstream of perched orifices) and to identify any potential passage problem areas. | | |
| 36. | Improving adult lamprey passage using lamprey passage structures (LPS) and refuges | Bonneville | Columbia | This project is part of a multi-year effort to understand and improve the passage performance of adult Pacific lamprey at lower Columbia River dams. Efforts to increase adult Pacific lamprey passage in 2013 included structural and operational changes to improve lamprey access to and passage through LPSs at Bonneville Dam. Lamprey use of these structures was assessed with lamprey-activated counters and passive integrated transponder (PIT) detections. Using PIT detections, we tested whether lamprey use refuge boxes installed along the bottom of the Washington-shore AWS channel placed in an effort to improve lamprey retention in this area.<br><br>One hundred fifty-five of the 1048 (15%) lamprey implanted with PIT tags and released downstream from Bonneville Dam were detected at a refuge box. As in previous years (7% in 2011, 12% in 2012), results indicate that lamprey are able to find and take advantage of these relatively small refuge areas. The Cascades Island LPS was operated fully connected from tailrace to forebay for the first time in 2013. Lamprey passage was counted and 0.1% of lamprey PIT-tagged and released downstream from Bonneville Dam was detected at Cascades Island LPS antennas. Experiments to determine passage success indicated that 37 of 47 (79%) PIT-tagged fish released into the lower part of the structure successfully ascended to the newly extended section and exited to the forebay. Similar percentages of radio-tagged lamprey that were released to 1) the lower part of the structure; and 2) the forebay at Cascades Island, were | ACOE (prepared by NOAA Fisheries) | Personal communication with Steve Corbett, NOAA Fisheries (11/8/13) |

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| | | | | subsequently detected at antennas upstream from Bonneville Dam, indicating that LPS passage did not cause fallback. At the Cascades Island AWS channel lamprey were opportunistically captured (n = 625), transported, and released upstream from Bonneville Dam. An antenna at the entrance to the Cascades Island AWS detected 79 of 1048 (8%) of the PIT-tagged lamprey released downstream from Bonneville Dam. These results are consistent with those from past years (2011, 8%, 2012, 10%) and indicate that high numbers of adult lamprey are occupying this area and should be provided with an outlet to the forebay or aggressively trapped and transported upstream. A total of 39 PIT-tagged lamprey were detected at the newly installed lamprey trap at the John Day Dam South fishway. The trap is designed to operate in two modes, one in which lamprey enter and are collected, and one in which lamprey enter and are able to escape upstream. Using test results, the camera system was optimized and will be used to enumerate lamprey during periods that the trap is operated in the pass-through mode. | | |
| 37. | Design LPS for Westland Diversion | Westland diversions | Umatilla | In 2012, the Umatilla Tribe continued design of the LPS for the Westland Diversion. The diversion dam is located in the Umatilla River watershed.<br><br>A 2013 update to this activity was unavailable at the time of report publication. | CTUIR | Personal communication with Aaron Jackson, CTUIR (11/29/12) |

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| 38. | Fishway modification | John Day | Columbia | Completed extensive salmonid and lamprey passage improvements to North Fish Ladder lower ladder and entrance areas. Entrace and transition pool modifications include lamprey-friendly features, such as a variable-width fixed weir, a bollard array to slow lamprey-level velocities at the fishway invert, rounded corners, ¾ inch diffuser grating, less confusing flows, diffuser plating ("lamprey sidewalks"), remove of lower ladder weirs, and entrance area LPS. Construction commenced in Winter 2011-12 and Winter 2012-13.<br><br>Evaluation of the modifications was limited in 2013. 111 lamprey were collected from the holding tank at the terminus of the LPS between July and September operation dates. DIDSON monitoring showed that lamprey readily used the bollard array (structure on fishway floor) and there was evidence of spatial segregation of lamprey and white sturgeon from the entrance to the lower overflow weirs. A radio-telemetry evaluation of this and other recent modifications at Lower Columbia dams is planned for 2014. | ACOE | Personal communication with Sean Tackley, ACOE (11/14/13) |
| 39. | Passage improvement design | McNary | Columbia | Ongoing design refinement of an adult lamprey structure to be installed in the entrance slot of Oregon shore adult fishway (SFE2). Alternate designs were modeled and tested at Engineer Research and Development Center (ERDC) in Vicksburg, MS during 2011. Through regional collaboration a preferred design was selected, and pending addition velocity testing, design will move to construction. Passage structure to be installed in winter 2013-14. Installation is on schedule for February 2014. Pre-work dive scheduled for 11/21/13. Passage structure fabrication scheduled to begin on 12/2/13. | ACOE | Personal communication with Steve Juhnke, ACOE (11/18/13) |

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| 40. | Installation and/or utilization of slotted "keyhole" fishway entrance at Project | Priest Rapids, Wanapum | Columbia | Grant PUD currently utilizes the "keyhole" fishway entrance at Priest Rapids and Wanapum dams. | Grant PUD | Personal communication with Mike Clement, Grant PUD (10/7/13) |
| 41. | Modify dewatering procedures | All ACOE projects | Columbia and Snake | Modifications to dewatering procedures to reduce stranding and mortalities have occurred over the past several years. These include: managing dewatering to better flush fish down to the tailrace; to keep fish remaining in the ladder in standing water while dewatering to reduce the efforts by lamprey to move through gratings when stranded; and adequate personnel and equipment to ensure timely salvage. This is an ongoing action. | ACOE | Personal communication with Sean Tackley, ACOE (11/14/13) |
| 42. | Modify dewatering procedures | Wells | Columbia | Pursuant to the Wells Habitat Conservation Plan (HCP; Douglas PUD 2002), a dewatering protocol is in place. | Douglas PUD | Personal communication with Chas Kyger, Douglas PUD (10/15/13) |
| 43. | Modify dewatering procedures | Rocky Reach, Rock Island | Columbia | Pursuant to the Rocky Reach Unwatering/Waterup Job Plan 1402 and Rock Island Standard Operating Procedures (SOP), fishway, dewatering protocols and fish recovery operations for all species are followed during annual winter fishway maintenance and dewatering activities.. | Chelan PUD | Personal communication with Steve Hemstrom, Chelan PUD (11/18/13) |
| 44. | Modify dewatering procedures | Priest Rapids, Wanapum | Columbia | Pursuant to the Project Fishway Operation Plan, dewatering protocols are followed annually during winter maintenance and dewatering activities. | Grant PUD | Personal communication with Mike Clement, Grant PUD (10/7/13) |
| 45. | Operation of old fishway for lamprey passage | Willamette Falls | Willamette | Based upon past lamprey evaluations conducted at Willamette Falls, activities to restore portions of the existing "old fishway" to operability were completed in 2011 with the completion of a 52m linear curb and an adjustable headgate. The facility will be in operation in early spring 2012 when | PGE | Personal communication with Tim Shibahara, PGE (11/19/13) |

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| | | | | flows decrease below a river elevation (upstream of the falls) below 54'. Current information indicated that lamprey congregate in an area of this fishway early in the migration season. Operations of this fishway will allow lamprey volitional passage to the forebay of the project.<br><br>In 2013, Portland General Electric (PGE) continued to operate the "old fishway" and install lamprey ramps to facilitate adult lamprey passage at Willamette Falls Dam. | | |
| 46. | Initiated design work for fishway modifications | Little Goose, Lower Granite | Snake | Initiated design work and awarded contract for minor modifications to fishway. Lamprey orifices in control section weir walls, and diffuser grating landing plates will be installed during the winter outage period. Work was completed at Little Goose Dam in 2013. Monitoring of modifications was complete at that site. Installation of lamprey orifices is on-going during the dewatered ladder period in Jan-Feb 2014. Monitoring of the passage route will be discontinued after 2013, as no negative impacts were found in 2013 monitoring. | ACOE | Personal communication with Steve Juhnke, ACOE (11/18/13) |
| 47. | Fishway modifications | Rocky Reach | Columbia | Based upon a literature review and site visit conducted in spring of 2010, Chelan PUD made modifications to the Rocky Reach fishway during the 2010-2011 and 2011-2012 fishway maintenance periods to improve adult lamprey passage at the Project. These improvements include installation of plating at diffuser gratings throughout the ladder, plating at orifices in the lower fish ladder sections where overflow weirs are located, ramps at perched orifices in the upper ladder, and an HDX PIT tag detection system at key locations within the fishway. In 2013, HDX monitoring is ongoing at Rocky Reach. 2,155 adult lamprey have been counted passing the dam in 2013. Twenty HD PIT tagged adult lampreys have | Chelan PUD | Personal communication with Steve Hemstrom, Chelan PUD (11/18/13) |

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| | | | | been detected. Eleven have been detected at most-upstream antenna and have presumably exited to forebay, passing safely. Six of the 11 successful passage events were fish were detected at Rocky Reach in July-September, 2012. Evaluation of fishway modifications will continue through 2015. | | |
| 48. | Construction and modifications to prototype fishway entrance bypass system for adult lamprey | Bonneville | Columbia | Completed construction of prototype Bonneville Washington Shore Fish Ladder, North Downstream Entrance Lamprey Flume System. Installed in Winter/Spring 2012-13 and modified in Fall 2013 due to structural issues. Additionally, the LPS at the terminus of the system will be modified to improve maintenance access and performance in Winter 2013-2014. Operation of the system was limited in 2013.<br><br>A radio-telemetry evaluation of this and other recent modifications at Lower Columbia dams is planned for 2014. | ACOE | Personal communication with Sean Tackley, ACOE (11/14/13) |
| 49. | Passage design elements for new fishway construction | Trail Bridge Dam | McKenzie | As part of the implementation of the Carmen-Smith Project FERC license (currently awaiting issuance), the Eugene Water and Electric Board (EWEB) has included several design elements in the Trail Bridge Dam fish ladder that will assist in the upstream passage of Pacific Lamprey.<br>• The auxiliary water comes into the entrance pool through a wall diffuser rather than a floor diffuser.<br>• A 3”W x 4”H orifice through the dog-leg wall, on the floor and against the side wall.<br>• A rounded instead of square end on the dog-leg<br>• All lips, floor bumps and width changes (e.g. to and from pool and transport channels) have 4” radius corners.<br>• In 2013, engineering design continued with all of the above elements in place. | EWEB | Personal communication with Andy Talabere, EWEB (10/9/13) |

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| 50. | Reduced water velocities at fishway entrances | Bonneville | Columbia | In 2013, continued reduced nighttime flow operations at the Washington Shore Fish Ladder to improve lamprey passage efficiency. | ACOE | Personal communication with Sean Tackley, ACOE (11/14/13) |
| 51. | Reduced water velocities at fishway entrances | McNary | Columbia | In 2013, continued reduced nighttime flow operations at the Oregon Shore Fish Ladder entrances, to improve lamprey passage efficiency. This is an ongoing action. | ACOE | Personal communication with Steve Juhnke, ACOE (11/18/13) |
| 52. | Reduce water velocities at fishway entrances | Wells | Columbia | Water velocities were reduced at the Wells fishway entrances in 2013 as a component of a passage study (see line item 80). | Douglas PUD | Personal communication with Chas Kyger Douglas PUD (10/15/13) |
| 53. | Lift picket leads at count station | Bonneville | Columbia | In 2011, lifted picket leads by 1 inch at Bradford Island Fish Ladder count station to improve access to AWS channel LPS. The 1 inch spacers were removed mid-passage season (June 29) due to an incident in which dozens of sockeye salmon were found milling behind picket leads. During an emergency dewatering on June 30, it appeared that the sockeye were able to get behind the picket leads via inconsistencies in the floor surface at the base of the picket leads (some gaps were up to 3 inches).<br><br>ACOE modified picket leads at Bradford Island during winter 2011-12 to allow lifting picket leads by 1 inch while ensuring a contiguous floor surface. University of Idaho monitored these picket leads in summer 2012. Results suggest that adult salmonids, including relatively small-bodied sockeye salmon, jack Chinook salmon, and steelhead, did not attempt to or successfully enter the AWS channel at Bradford Island during the viewing period. Observations from project biologists at Bonneville Dam also did not see sockeye milling behind picket leads, despite the | ACOE | Personal communication with Sean Tackley, ACOE (11/14/13) |

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| | | | | record-sized run.<br><br>Accordingly, ACOE modified the Washington Shore Fish Ladder count station picket leads in winter 2012-13 to improve access to the AWS channel LPS in that fishway. | | |
| 54. | Lift picket leads at count station | The Dalles | Columbia | Lifted picket leads at East and North Fish Ladder count stations by 1.5 inches to provide alternative passage routes for Pacific lamprey. | ACOE | Personal communication with Sean Tackley, ACOE (11/14/13) |
| 55. | Lift picket leads at count station | John Day | Columbia | Lifted picket leads at South Fish Ladder (already lifted at North) count station by 1.5 inches to provide alternative passage routes for Pacific lamprey. | ACOE | Personal communication with Sean Tackley, ACOE (11/14/13) |
| 56. | Lift picket leads at count station | McNary, Ice Harbor, Lower Monumental, Little Goose, Lower Granite | Columbia and Snake | Lifted picket leads at fish ladder count stations by 1.5 inches to provide alternative passage routes for Pacific lamprey. | ACOE | Personal communication with Steve Juhnke, ACOE (11/18/13) |
| 57. | Maintain fishway operations criteria | Rock Island | Columbia | Pursuant to the Rocky Reach and Rock Island Fish Passage Plan (Chelan PUD 2012), fishway operations criteria are in place. | Chelan PUD | Personal communication with Steve Hemstrom, Chelan PUD (11/18/13) |
| 58. | Maintain fishway operations criteria | Priest Rapids, Wanapum | Columbia | Pursuant to the Project Fishway Operation Plan (Grant PUD 2009), fishway operations criteria are routinely maintained. | Grant PUD | Personal communication with Mike Clement, Grant PUD (10/7/13) |
| 59. | Minor fishway modifications | The Dalles and John Day | Columbia | Designed and awarded construction contract to install lamprey diffuser plating immediately upstream and downstream of all overflow weir orifices in the lower sections of The Dalles East Fish Ladder and John Day South Fish Ladder. Installation will be completed in Winter 2013-2014. | ACOE | Personal communication with Sean Tackley, ACOE (11/14/13) |

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
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| 60. | Fishway modifications to facilitate lamprey collection and counting | John Day | Columbia | Modified count station area behind picket leads at John Day South Fish Ladder to facilitate (1) trapping for research or translocation activities; (2) improved escapement estimates. Picket lead spacing was reduced to ¾ inches, except near the bottom, where openings allow lamprey to enter a small flume system leading to a trap and videocounting mechanism still in development.<br><br>When not in collection mode, the system will allow lamprey to continue moving up the fishway.<br><br>Evaluation in 2013 was limited to monitoring the number of lamprey collected in the trap box. In total, 100 were collected by tribal researchers in 2013. Minor modifications to the system will be completed in Winter 2013-14 to improve functionality. | ACOE | Personal communication with Sean Tackley, ACOE (11/14/13) |
| | *Project Passage Effectiveness* | | | | | |
| 61. | Data synthesis and fishway improvement prioritization tools | Federal projects | Columbia and Snake | This project is a part of a multi-year effort to understand and improve the passage performance of adult Pacific lamprey at Lower Columbia River dams.<br><br>The cited report contains summary information on adult Pacific lamprey migration behavior and passage at dams in the Federal Columbia River Power System (FCRPS). It provides managers and researchers with data summaries and synthesis from more than a decade of adult lamprey research using tagged fish and experimental results from an artificial fishway at Bonneville Dam. It also includes a set of reference and modeling tools developed to identify lamprey passage problems at fishways and to help prioritize sites for future | ACOE (prepared by the University of Idaho Cooperative Fish and Wildlife Research Unit) | Adult Pacific Lamprey Passage: Data synthesis and fishway improvement prioritization tools (Keefer et al. 2013b) |

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
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| | | | | fishway improvements. Separate deliverables include standardized fishway maps and a 3-D interactive fishway mapping tool. | | |
| 62. | Develop Lamprey Entrance Efficiency and Operations Study Plan | Wells | Columbia | The Pacific Lamprey Entrance Efficiency (LEE) and Operations Study (OS) Plan is designed to evaluate potential operational and physical ladder entrance modifications to create an environment at the fishway entrances that are conducive to adult lamprey passage without significantly impacting passage of adult salmonids. The LEE and OS Plan outlines a strategy for identifying potential problem areas negatively impacting lamprey entrance efficiency and implementing and evaluating potential modifications to operating criteria or structures to the Wells Hydroelectric Project fishway entrances. Results from previous and ongoing studies of adult Pacific lamprey passage at the Wells Project will serve as the framework for developing future studies and potential modifications to operating criteria and the fishway entrances. In addition, current and emerging information about operational and structural modifications at other Columbia River dams, and the effect of such modifications on adult Pacific lamprey entrance efficiency and passage will be used to inform and guide future activities under the LEE and OS Plan. | Douglas PUD | Adult Pacific Lamprey Fishway Entrance Efficiency7 and Operations Study Plan (Kyger 2013). |
| 63. | Underwater Video Monitoring of Adult Fish Ladder Modifications to Improve Pacific Lamprey Passage at McNary, Ice Harbor, Little Goose, and Lower Granite Dams, 2013. | McNary, Ice Harbor, Little Goose, and Lower Granite dams | Columbia and Snake rivers | Returns of adult Pacific lamprey to the Columbia and Snake rivers have declined and the 2010 return was the lowest on record. Studies have indicated that: 1) passage of FCRPS dams may impede upstream migration of adults and 2) current enumeration techniques are inaccurate. This study will: 1) continue enumeration of adult passage at dams using video technology, 2) continue evaluation adult lamprey behavior at picketed leads and at lamprey orifices using non-invasive | UC Davis and University of Idaho | Personal communication with Frank Loge, UC Davis (10/9/2013) |

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| | | | | observation methods, 3) evaluate adult salmonid behavior near lamprey orifices, and 4) complete development of video image analysis software and package the software for general use. These data will provide rigorous quantitative estimates of adult Pacific lamprey escapement at McNary and Ice Harbor dams, ensure that ladder modifications for lamprey at Lower Granite and Little Goose dams do not impede adult salmonid passage, and improve our understanding of lamprey passage behavior and success at Walla Walla District USACE hydroelectric projects. | | |
| 64. | Underwater video and DIDSON to evaluate adult lamprey passage behavior | McNary | Columbia | In 2012, the ACOE changed the entrance slot at the South Fishway Entrance (SFE2) to promote lamprey passage. Operators raised the SFE2segmental gate 18" off the fishway floor to create a bottom gap with a deep-slot attraction plume, thus providing an alternative lamprey entrance lower in the water column. Low light video cameras and other non-invasive technology (DIDSON) were used at McNary to study lamprey in the SFE under various operational schemes, both to understand the effects of structures and flow on lamprey approach and passage, and to provide supporting information for a future alternative lamprey passage structure, currently planned for installation at the McNary SFE2 in 2014.<br><br>Over 12,000 hours of optical video and 768 hours of DIDSON video were processed. Initial results indicate that: given proper technique and application, DIDSON technology can reliably image lampreys; the modifications to SFE2 may attract more lamprey; and the deep slot does not impede (and may improve) entrance passage for lampreys. | ACOE (prepared by UC Davis) | Underwater Video Monitoring of Adult Fish Ladder Modifications to improve Pacific Lamprey Passage at McNary, Ice Harbor, and Lower Monumental Dams, 2012. (Thompson et al. 2013) |

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| 65. | DIDSON monitoring | Bonneville, The Dalles | Columbia | In the summer of 2012, we conducted a Dual-Frequency Identification Sonar (DIDSON) study at Bonneville and John Day dams to evaluate Pacific lamprey passage behavior at fine scales (1-5 m). Our broad objectives were to collect pre-modification behavior data at the Bonneville Dam north downstream entrance (where a lamprey passage system is being installed in 2013) and pre- and post-modification data at the John Day north fishway where a bollard field was installed in early 2012 and a lamprey passage system (LPS) is being installed in 2013.<br><br>A DIDSON camera was used to monitor horizontal depth strata by placing at different depths or by using an automatic tilting program from 13 June to 18 July at two locations at Bonneville Dam (Powerhouse 2 north downstream and Washington-shore junction pool). The DIDSON camera was then deployed at John Day Dam using a tilting program from 26 July to 30 August at four locations (near the north fishway entrance, upstream from the entrance, at the turnpool, and at the transition pool). Data were collected in high frequency mode at each location for approximately 24 hours per deployment cycle.<br><br>In total, we collected 658 h of DIDSON imagery at Bonneville Dam, of which 180 h were viewed (27% of total collected) using a randomized sub-sampling approach. At John Day Dam we collected 776 h of DIDSON imagery and viewed 177 h (23% of the total collected). A total of 2,293 | ACOE (prepared by the University of Idaho Cooperative Fish and Wildlife Research Unit) | Evaluation of Dual Frequency Identification Sonar (DIDSON) for Monitoring Pacific Lamprey Passage Behavior at Fishways of Bonneville and John Day Dams, 2012 (Johnson et al. 2013) |

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| | | | | and 508 lamprey events were scored at Bonneville and John Day dams, respectively. About two-thirds of the imagery viewed was from night-time hours, which were preferentially sub-sampled given the higher nocturnal activity of the species. Quality control evaluations indicated that adequate DIDSON training and careful post-processing quality control evaluations are needed in DIDSON studies.<br><br>The 2012 study results provided qualitative and quantitative information on the movements and behaviors of adult Pacific lamprey in confined fishway environments without collecting or tagging fish. More specifically the study improved our understanding of the lateral and vertical position of fish in the sample volumes and identified behavioral responses to environmental and operational conditions. Furthermore, these results indicate that we can infer adult lamprey swimming direction, enumerate attachment events, and quantify lamprey distribution in relation to predatory fish. The DIDSON was an effective monitoring tool for specific tasks when applied at appropriate scales (such as monitoring behavior at fine-scale fishway locations). However, the ability to extend the technology to calculate passage metrics like entrance or passage efficiency is limited because the sample range and volume limit the spatial inference of the technology and because individual fish cannot be identified. Nonetheless, DIDSON evaluations can provide important information that complements PIT tag and | | |

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| | | | | radiotelemetry studies. | | |
| 66. | Evaluate fishway modifications | Priest Rapids, Wanapum | Columbia | Grant PUD implemented a comprehensive adult passage evaluation study plan, titled "Assessment of Pacific lamprey behavior and passage efficiency at Priest Rapids and Wanapum dams" (Nass et al. 2009). The goal was to collect data in support of determining whether proposed modifications (plating, ramps at perched orifices, and lamprey-specific crowders at fish count stations) improved adult passage. HDX-PIT system were used to collect data from fish tagged downstream of Priest Rapids Dam. Pacific lamprey tagged at lower river facilities were passively monitored at PRP facilities as directed by the PRFF.<br><br>Data analysis will be completed as part of 2013 activities and preliminary information included in the 2013 annual report (see Table 4, Line #7). | Grant PUD | Personal communication with Mike Clement, Grant PUD (10/7/13) |
| 67. | Evaluate passage at LPS structures | Threemile Falls Dam, Maxwell and Feed diversions | Umatilla | In the Umatilla River watershed, lamprey passage structures (LPS) have been completed and are operational at Threemile Falls Dam (July 2009), Feed Diversion (October 2010), and Dillon Diversion (2011). A flat plate was installed to aid upstream lamprey movement at Maxwell Diversion (August 2010).<br><br>Radio-telemetry monitoring at these structures was conducted in 2012. Preliminary results indicated that 38 lamprey were detected using the LPS while 55 lamprey were detected passing through the traditional ladder at Threemile Dam. A number of fish had undocumented passage at this location so monitoring of the entire facility is planned for 2013.<br><br>Information to date indicates no detections higher in the watershed however, complete monitoring | CTUIR | Personal communication with Aaron Jackson, CTUIR (11/29/12) |

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| | | | | results are not yet available.<br><br>A 2013 update to this activity was unavailable at the time of report publication. | | |
| 68. | Project passage evaluation | Clackamas | Clackamas | In 2013, an active/passive tag evaluation using RT and HDX tags to evaluate passage success through the project was implemented. All fish were tagged at the trap in River Mill Fish ladder and released ~1 mile downstream to evaluate re-assent back through this facility and remaining NF Ladder upstream. A total of 47 fish active/HDX tagged and about 45 just HDX'd. Evaluation started last spring and still ongoing. No draft report out yet or any preliminary results. | PGE | Personal communication with Tim Shibahara, PGE (11/19/13) |
| 69. | Evaluate LPS structures | Bonneville, John Day | Columbia | We assessed lamprey use of the new Bonneville and John Day LPS using adults collected at the upstream of each terminus, including those tagged with half-duplex (HD) PIT tags. HD PIT antennas were integrated into the construction of each LPS and will eventually allow us to estimate the proportion of the run that encounter and use the structures.<br><br>Bonneville Dam Lamprey Flume System was operated from 5 June to 24 June and again from 19 July to 20 August. During this period, 27 adult lamprey passed the entire structure and were trapped at the terminus. Several minor and major structural issues were identified during operation and were likely related to declining capture rates later in the operational period. Several issues were addressed in-season and other modifications have been or will be made prior to the 2014 lamprey run season. The John Day LPS was operated continuously from 19 July through 10 September. During that time, 111 adult lamprey were collected from the box at the top of the LPS. While the LPS | University of Idaho | Chris Caudill, Presentation at AFEP, Walla Walla, WA (12/3/13) |

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
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| | | | | was operated, 2,682 adult lamprey were counted at the John Day north count station during the day and 2,324 were counted at night. The LPS collection to count ratio was therefore 101:5,006 (0.020). It is not possible to estimate LPS collection efficiency at this site because the number of lamprey at the John Day north entrance was unknown. However, the number that passed the LPS was presumably higher than the number that passed the count station, suggesting collection efficiency was <2%. | | |
| 70. | Passage structure evaluations | Bonneville Dam | Columbia River | In 2011-2012, we continued a multi-year study to evaluate and improve adult Pacific lamprey passage at Bonneville Dam. As in previous years, modifications and improvements to lamprey passage structures (LPSs) were made prior to the adult lamprey migration period. During the migration period, we evaluated LPSs and modifications with the following objectives:<br>1) Determine use of LPSs located at the auxiliary water supply (AWS) channels<br>2) Assess the effects of providing refuge areas in AWS channels<br>3) Determine lamprey use of the LPS located at the Cascades Island fishway entrance<br>4) Develop methods to collect lamprey from alternate locations at Bonneville Dam<br><br>To achieve the monitoring objectives, we used two approaches. First, we counted individual river-run lamprey passage in the new and existing structures. For these counts, we used lamprey-activated counters in the Washington Shore and Bradford Island AWS structures and in the | NOAA Fisheries | Development of Passage Structures for Adult Pacific Lamprey at Bonneville Dam (draft report), 2011-2012 (Corbett et al. 2013) |

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| | | | | terminal trap boxes in the Cascades Island and the Washington Shore fishway structures. Second, we marked lamprey with passive integrated transponder (PIT) tags, released them below Bonneville Dam, and monitored their upstream movements within the LPSs. In 2011, we tagged 1,014 migrating adult lamprey with a PIT tag (85 of these fish were also tagged with a JSATS tag for a separate study). In 2012 we tagged 1,197 adult lamprey migrants with a PIT tag, and 299 of these were also tagged with a JSATS tag. Antennas to detect PIT tags were integrated into all of the lamprey passage structures, and an antenna was also operated at the top of the Cascades Island fishway.<br><br>In past years, adult lamprey have been detected and observed accumulating in the Cascades Island auxiliary water supply channel, an obsolete fishway exit that has no direct access to the forebay. Of all PIT-tagged lamprey released downstream from Bonneville Dam, 8% in 2011 and 10% in 2012 were detected at this location. These results were consistent with those from past years and indicated that high numbers of adult lamprey are occupying this area. We concluded that these fish should be either provided with an outlet to the forebay or systematically trapped and transported upstream. | | |
| 71. | Evaluate entrance efficiency at reduced fishway head differential and evaluate count station modifications to | Wells | Columbia | Radiotelemetry was used to study upstream passage behavior and enumeration in the Wells Project fishways. Specific objectives of the study include*:* Evaluate passage efficiency of radio- | Douglas PUD | Personal communication with Chas Kyger, Douglas PUD |

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
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| | improve lamprey enumeration accuracy. | | | tagged adult Pacific lamprey through Wells Dam fishways; with an emphasis in the lower fishway section. Evaluate travel time of radio-tagged adult Pacific lamprey through Wells Dam fishways; with an emphasis in the lower fishway section. Evaluate radio-tagged adult lamprey behavior through Wells Dam fishways; with an emphasis in the lower fishway section. Compare adult Pacific lamprey entrance efficiency under reduced Wells Project fishway entrance velocities to entrance efficiencies at non-reduced velocities. Evaluate enumeration efficiency of adult lamprey at the fish count station at Wells Dam using new, 11/16$^{th}$ inch picketed leads and compare adult lamprey behavior at the fish count station with old picketed leads to behavior at count windows with new, 11/16$^{th}$ inch picketed leads. In December 2012, modifications were made to the fish count station areas of the fishways. Modifications included the addition of smaller 11/16$^{th}$ inch grating to exclude lamprey from a count window bypass area and attachment ramps leading to the count windows. 106 lamprey collected at Bonneville Dam and 9 collected at Priest Rapids dam radio and PIT tagged and released in the Wells tailrace with a subset released directly into the fishways. Radio telemetry antennas were placed in multiple locations throughout both the east and west fishways and also at the mouth of the Methow and Okanogan Rivers. Results of the study will be available in spring 2013. | | (10/15/2013) |
| | *Lamprey Counts at Dams* | | | | | |
| 72. | Conduct 24-hour lamprey counts | Bonneville, The Dalles, John Day, McNary, | Columbia and Snake | Counts include nighttime video window counts. Nighttime counting was expanded in 2012 to include The Dalles and John Day dams. | ACOE | Personal communication with Sean Tackley, ACOE (11/14/13) |

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
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| | | Lower Granite | | | | |
| 73. | Conduct 24-hour lamprey counts | Wells | Columbia | On-going 24-hour fishway monitoring since the 1990's. | Douglas PUD | Personal communication with Chas Kyger Douglas PUD (10/15/13) |
| 74. | Conduct 24-hour lamprey counts | Rocky Reach, Rock Island | Columbia | On-going 24-hour fishway monitoring since the late 1980's. | Chelan PUD | Personal communication with Steve Hemstrom, Chelan PUD (11/18/13) |
| 75. | Conduct 24-hour lamprey counts | Priest Rapids, Wanapum | Columbia | On-going 24-hour fishway monitoring since the mid 1990's. | Grant PUD | Personal communication with Mike Clement, Grant PUD (10/7/13) |
| 76. | Structural modifications to count station | Bonneville Dam | Columbia | In 2010, LPS structures at Bonneville Dam were fitted with web-linked counters and motion-activated counters to allow real-time updates to LPS count records. This new technology was operational in LPS systems at the facility in 2011. Improvements to the remotely-accessed LPS counting system occurred in 2013. | ACOE | Personal communication with Mary Moser, NOAA Fisheries (10/31/13) |
| 77. | Enumeration and evaluation of escapement using underwater video and imaging software | McNary and Ice Harbor | Columbia and Snake | In 2012, eleven low-light video cameras and infrared lighting were installed behind the picketed leads at McNary and Ice harbor fish ladders and operated continuously from June through mid-October, generating over 33,000 hours of video.<br><br>Through September 15, 2012, 631 lampreys were observed in video swimming behind picketed leads at the McNary south ladder, corresponding to 53% of the total counted at the window during the same period. This is a similar proportion to video picketed lead counts in 2011. All data has not been | UC Davis | CBVision Manual v.0.1. Negrea, C. 2013. |

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| | | | | processed however, initial results indicate that monitoring of alternative passage routes past count windows and lamprey orifices are important for determining lamprey escapement and potential risks to salmonid runs and result in more data than human observers can economically or practically review without image processing software. | | |
| | *Predation* | | | | | |
| 78. | Establish predation control measures (sea lions) | Bonneville | Columbia | Ongoing implementation of predation control measures, such as sea lion removal efforts - although planned for salmon, are also expected to benefit adult Pacific lamprey. Efforts are being made to be sure to include concerns for lamprey and adequate monitoring of lamprey predation in future efforts. | ACOE | ACOE Pacific lamprey passage improvements implementation plan, 2008-2018 (ACOE 2009) |
| | **Juvenile Passage at Hydroelectric Facilities** | | | | | |
| | *Structural and Operational Fishway Modifications* | | | | | |
| 79. | Delayed deployment of extended length screen during outmigration | McNary | Columbia | Installation of extended screens was delayed in the spring of 2013 to reduce impacts to juvenile lamprey migrating out early. | ACOE | Personal communication with Sean Tackley, ACOE (11/14/13) |
| 80. | JBS modifications | McNary | Columbia | Extended the JBS raceway waste water outfall pipe and altered JBS raceway screen mesh size to allow juvenile lamprey to volitionally pass from the raceway back to the river. This is the current configuration and an ongoing action. | ACOE | Personal communication with Steve Juhnke, ACOE (11/18/13) |
| 81. | JBS outfall relocation | McNary, Lower Monumental | Columbia / Snake | JBS outfalls were relocated downriver from existing locations. The outfall relocations were done to improve salmonid survival, but juvenile lamprey will benefit from the new locations as well. This is the current configuration and an ongoing action. | ACOE | Personal communication with Steve Juhnke, ACOE (11/18/13) |

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| 82. | Continue salvage activities during ladder maintenance de-watering | All ACOE projects | Columbia / Snake | Modifications to dewatering procedures to reduce stranding and mortalities have occurred over the past several years. These include: managing dewatering to better flush fish down to the tailrace; to keep fish remaining in the ladder in standing water while dewatering to reduce the efforts by lamprey to move through gratings when stranded; and adequate personnel and equipment to ensure timely salvage. | ACOE | Personal communication with Sean Tackley, ACOE (11/14/13) and Steve Juhnke, ACOE (11/18/13) |
| 83. | Continue salvage activities during ladder maintenance de-watering | Wells | Columbia | Pursuant to the Wells Habitat Conservation Plan (HCP; Douglas PUD 2002), a dewatering protocol is in place. Any adult lamprey captured during salvage activities are released upstream of Wells Dam, juveniles downstream per the Wells Pacific Lamprey Management Plan. | Douglas PUD | Personal communication with Chas Kyger Douglas PUD (10/15/13) |
| 84. | Continue recovery activities during ladder maintenance de-watering | Rocky Reach, Rock Island | Columbia | Pursuant to the Rocky Reach Unwatering/Waterup Job Plan 1402 and Rock Island SOP, fishway dewatering protocols and fish recovery operations for all species are followed during annual winter fishway maintenance and dewatering activities. | Chelan PUD | Personal communication with Steve Hemstrom, Chelan PUD (11/18/13) |
| 85. | Continue salvage activities during ladder maintenance de-watering | Priest Rapids, Wanapum | Columbia | Consistent with its Fishery Operations Plan (Grant PUD 2010), Grant PUD conducts salvage operations for all fish species during annual ladder maintenance activities. | Grant PUD | Personal communication with Mike Clement (10/7/13) |
| 86. | Maintain bypass operations criteria | Rock Island | Columbia | Pursuant to the Rocky Reach and Rock Island Fish Passage Plan (Chelan PUD 2012), bypass operations criteria are in place. | Chelan PUD | Personal communication with Steve Hemstrom, Chelan PUD (11/18/13) |
| 87. | Maintain bypass operations criteria | Priest Rapids, Wanapum | Columbia | Grant PUD has existing bypass systems, which includes gatewells, spillways, the WFUFB, and Priest Rapids Top-Spill Bypass (currently under construction). | Grant PUD | Personal communication with Mike Clement, Grant PUD (10/7/13) |
| | *Project Passage* | | | | | |

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| | *Effectiveness* | | | | | |
| 88. | Monitor passage timing, number, and mortalities of juvenile lamprey collected at projects with juvenile fish bypass facilities | Bonneville, McNary, Lower Monumental, Little Goose, Lower Granite | Columbia and Snake | Monitoring is occurring at all of the identified projects. | ACOE | Personal communication with Sean Tackley, ACOE (11/14/13) and Steve Juhnke, ACOE (11/18/13) |
| 89. | Juvenile lamprey monitoring | Bonneville, John Day, McNary, Lower Monumental, Little Goose, Lower Granite, and Rock Island | Columbia and Snake | The Fish Passage Center (FPC), in collaboration with Smolt Monitoring Program (SMP) staff, monitored juvenile lamprey at smolt monitoring facilities. Below is a brief summary of the findings from the 2013 program:<br>• With the addition of the Imnaha River Trap, 2013 was the first year when all SMP sites collected lamprey data under the new lamprey monitoring program that was first implemented in 2011.<br>• Lamprey condition monitoring at the Lower Columbia sites (BON, JDA, and MCN) was successful in 2013.<br>• For the third year, sample counts at the Snake River and Upper Columbia River SMP sites were relatively low. At this time, the FPC still does not feel that lamprey condition monitoring can be expanded to any of these sites.<br>• A PIT-tag study at LGR in 2013 confirmed that Pacific macropthalmia are escaping the sample tank before being counted. This means that estimates of sample and colections at LGR are unreliable and biased low.<br>• It appears that lamprey juveniles, particular macropthalmia, are experiencing higher mortality at Bonneville than salmonids. | FPC | Memo: Results of 2013 lamprey monitoring (FPC 2013) |

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| | | | | Further investigation is needed to determine why lamprey mortality rates are higher at BON. | | |
| 90. | Lower Granite Dam Juvenile Fish Collection Channel Prototype Overflow Weir and Enlarge Orifice Biological Evaluation | Lower Granite | Snake | As part of a study in 2013 to evaluate passage of juvenile fishes through prototype fish passage structures in a gatewell at Lower Granite Dam (LGR), juvenile Pacific lamprey were collected, PIT-tagged, and released. The study was undertaken as part of a broader effort to assess the effectiveness of traditional juvenile bypass systems prescribed by the NOAA Biological Opinion (NOAA 2008, 2010) RPA 54.2. The objectives addressed in the study were: (1) determine how the overflow weir and/or larger orifices affected orifice passage efficiency (OPE) and gatewell residence times compared to current orifice configuration for juvenile lamprey, (2) determine effective collection methods for juvenile lamprey at LGR, Little Goose (LGS), and Lower Monumental (LMN) dams, (3) determine collection efficiency for juvenile lamprey designated for recollection at the Sort by Code (SxC) system at LGR, and (4) evaluate PIT tag retention using two different tagging techniques: surgical methods described by Mesa et al. (2011) and injecting PIT tags with a 16-gauge needle.<br><br>PIT-tagged lamprey (n=1,453) were released at night during the period of May 20, 2013 through June 3, 2013. Fish were released into one of five locations. Statistical tests were used to detect significant differences in travel time between release locations. Collection efficiency, tag | ACOE (prepared by Blue Leaf Environmental) | Personal communication with Rod O'Connor, Blue Leaf Environmental (11/12/13) |

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| | | | | retention, and residence times for different release locations were also evaluated.<br><br>A final report is currently being developed and will be available in the future. | | |
| | *Predation* | | | | | |
| 91. | Establish predation control measures (pike minnows and birds) | All ACOE projects | Columbia | Ongoing implementation of predation control measures such as harassment, avian lines, avian colony management, and the pikeminnow bounty program, although planned for salmon, are also expected to benefit juvenile Pacific lamprey. Efforts are being made to be sure to include concerns for lamprey and adequate monitoring of lamprey predation in future efforts. | BPA | ACOE Pacific lamprey passage improvements implementation plan, 2008-2018 (ACOE 2009) |
| 92. | Predation control measures | Rocky Reach, Rock Island | Columbia | As part of its HCP obligations, Chelan PUD implements predation control activities. Controlling predators of juvenile salmonids, both fish and birds, is a tool Chelan PUD has used to achieve HCP survival standards for juvenile fish. HCP Combined Adult and Juvenile Passage Survival Standards were achieved by Chelan PUD in 2011 for both the Rocky Reach and Rock Island HCPs. Chelan PUD's predator control program for Northern pikeminnow has reduced the number of pikeminnow known to consume large numbers of outmigrating juveniles. The program includes a sport fishing derby, a U.S. Department of Agriculture (USDA) catch-and-remove program, Chelan PUD personnel catch-and-remove program, and a Chelan PUD funded long-lining program. Chelan PUD will also continue working with the USDA and other parties to identify and implement the best methods for deterring predatory birds. Since 2003, Chelan PUD has removed an average of 66,256 Northern | Chelan PUD | Personal communication with Steve Hemstrom, Chelan PUD (11/18/13) |

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
|---|---|---|---|---|---|---|
| | | | | pikeminnow annually from Rocky Reach and Rock Island Project areas combined, and a total of 662,563 Northern pikeminnow from 2003 to 2012. Chelan PUD's control programs continued in 2013, removing more than 65,000 pikeminnow. Adult. 2011-2013 adult ladder counts of pikeminnow passing the projects were the lowest on record since 2003, indicating the removal programs are having the desired effect on larger pikeminnow. (S. Hemstrom personal communication 2013). | | |
| 93. | Predation control measures | Rocky Reach, Rock Island | Columbia | Controlling predators of juvenile salmonids, both fish and birds, is another tool Chelan PUD is using to contribute to achieving HCP survival standards for juvenile fish. Chelan PUD's predator control program for Northern pikeminnow has reduced the number of pikeminnow known to consume large numbers of outmigrating juveniles. The program includes a sport fishing derby, a U.S. Department of Agriculture (USDA) catch-and-remove program, Chelan PUD personnel catch-and-remove program, and a Chelan PUD funded long-lining program. Chelan PUD will also continue working with the USDA and other parties to identify and implement the best methods for deterring predatory birds. Since 2003, Chelan PUD has removed an average of 66,256 Northern pikeminnow annually from Rocky Reach and Rock Island Project areas combined, and a total of 662,563 Northern pikeminnow from 2003 to 2012. | Chelan PUD | Personal communication with Steve Hemstrom and Jeff Osborn, Chelan PUD (9/10/12) |
| 94. | Predation control measures | Priest Rapids, Wanapum | Columbia | Grant PUD implements predation control measures (avian and aquatic) to protect outmigrating, anadromous salmonids as a requirement of Grant PUD's NOAA Biological Opinion (NOAA Fisheries 2004). These measures include use of lethal and non-lethal control and monitoring presence and absence of juvenile lamprey through | Grant PUD | Personal communication with Mike Clement, Grant PUD (10/7/13) |

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
|---|---|---|---|---|---|---|
| | | | | dietary sub sampling. It would be expected that these predation control activities will indirectly benefit outmigrating juvenile lamprey at the project. | | |
| | **Policy/Recovery Activities** | | | | | |
| 95. | Develop/implement implementation plan for Pacific lamprey restoration | All ACOE projects | Columbia and Snake | In May 2009, the Nez Perce, Umatilla, Yakama and Warm Springs tribes ("tribes") developed a Tribal Pacific Lamprey Restoration Plan for the Columbia River basin. A final draft of the Plan was completed in December 2011.<br><br>The tribes propose the plan for restoration of the species to numbers adequate for tribal use and ecological health of the region. Activities to support the objectives identified in the plan were implemented in 2013 (see other categories in Table 3). | Nez Perce, Umatilla, Yakama and Warm Springs tribes | Tribal Pacific lamprey restoration plan for the Columbia River basin (Nez Perce, Umatilla, Yakama, and Warm Springs Tribes 2011) |
| 96. | Implementation of Pacific lamprey restoration plan | All ACOE projects | Columbia and Snake | In May 2009, the Nez Perce, Umatilla, Yakama and Warm Springs tribes ("tribes") developed a Tribal Pacific Lamprey Restoration Plan for the Columbia River basin. A final draft of the Plan was completed in December 2011.<br><br>The tribes propose the plan for restoration of the species to numbers adequate for tribal use and ecological health of the region. Activities to support the objectives identified in the plan were implemented in 2013 (see other categories in Table 3). | ACOE | ACOE Pacific lamprey passage improvements implementation plan, 2008-2018 (ACOE 2009) |
| 97. | Develop/implement management plan for Pacific lamprey restoration | Wells | Columbia | In 2010, a PLMP was filed as part of the Wells Hydroelectric Project FERC License Application. In addition to fishway evaluations and activities to improve adult lamprey passage and juvenile passage and survival (when technology exists), management plan activities also include implementation of adult fishway and juvenile | Douglas PUD | Personal communication with Chas Kyger, Douglas PUD (10/15/13) |

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
|---|---|---|---|---|---|---|
| | | | | bypass operations criteria at the Project, regional data sharing and protocol development, and participation in regional conservation and recovery activities.<br><br>Implementation of some management plan activities is underway and includes a passage and enumeration study in 2013. | | |
| 98. | Develop/implement management plan for Pacific lamprey passage monitoring and improvement | Rocky Reach | Columbia | On-going implementation of the PLMP that was developed and finalized in 2005.<br><br>In addition to fishway evaluations and activities to improve adult lamprey passage and juvenile passage and survival (when technology exists), management plan activities also include implementation of adult fishway and juvenile bypass operations criteria at the Project, regional data sharing and protocol development, and participation in regional conservation and recovery activities. | Chelan PUD | Rocky Reach Pacific Lamprey Management Plan (Chelan PUD 2005) |
| 99. | Develop/implement management plan for Pacific lamprey restoration | Priest Rapids, Wanapum | Columbia | On-going implementation of the PLMP that was developed, finalized, and approved by the PRFF, Ecology, and FERC in 2009.<br><br>In addition to fishway evaluations and activities to improve adult lamprey passage and juvenile passage and survival (when technology exists), management plan activities also include, regional data sharing and protocol development, and participation in regional conservation and recovery activities. | Grant PUD | Priest Rapids PLMP (Grant PUD 2009) |
| 100. | Lamprey Technical Work Group<br>• Passage Subgroup<br>• Translocation Subgroup | All ACOE projects, Wells, Rocky Reach, Rock Island, Priest Rapids | Columbia and Snake | The purpose of the Columbia River Basin Lamprey Technical Work Group (CRBLTWG) is to provide technical review, guidance, and recommendations for activities related to lamprey conservation and restoration. The CRBLTWG accomplishes this by: 1) identifying and | USFWS | Personal communication with Christina Luzier, USFWS (11/19/13) |

| | Activity | Hydroelectric Project | Waterbody | Results / Description of Activity | Lead Entity(ies) | Source |
|---|---|---|---|---|---|---|
| | • Supplementation Subgroup<br>• PTAGIS Subgroup<br>• Passage Engineering Subgroup | | | prioritizing critical uncertainties regarding lamprey conservation; 2) providing a forum for discussion regarding lamprey-related concerns; and 3) disseminating technical information.<br>In 2013, the CRBLTWG met once (8/29/13,). Additional subgroup meetings were convened during the year to discuss lamprey, supplementation framework, tagging issues/PTAGIS, passage engineering, smolt monitoring program, Northwest Power and Conservation Council (NPCC) synthesis reporting, standardized sampling techniques, revision of the critical uncertainties and writing of a new charter for the workgroup.<br><br>In 2013, the Supplementation Subgroup worked on developing a framework for Pacific lamprey artificial propagation and supplementation. The framework will be presented to the whole workgroup for review when completed, probably in 2014.<br><br>In 2013, the Tagging Subgroup updated the workgroup that but juvenile and adult lamprey data are now in PTAGIS.<br><br>In 2013, the Passage Engineering Subgroup continued to work on developing a paper on known engineering fixes to aid lamprey passage at dams and other barriers.<br><br>In 2013, the CRBLTWG continued to assist the Fish Passage Center with the smolt monitoring program for lamprey at Federal Columbia River | | |

Notes:
AAM = ammocoete abundance model
ACOE = Army Corps of Engineers
AWS = auxiliary water supply
BOR = U.S. Bureau of Reclamation
BPA = Bonneville Power Administration
CE = capture efficiency

CRBLTWG = Columbia River Basin Lamprey Technical Work Group
CRITFC = Columbia River Inter-Tribal Fish Commission
CTGR= Confederated Tribes of Grand Ronde
CTUIR = Confederated Tribes of the Umatilla Indian Reservation
CTWSR = Confederated Tribes of the Warm Springs Reservation
DDR = design documentation report
DIDSON = Dual-frequency Identification Sonar
EWEB = Eugene Water and Electric Board
FCRPS = Federal Columbia River Power System
FPC = Fish Passage Center
HCP = Habitat Conservation Plan
HDX = half duplex
ISRP = Independent Scientific Review Panel
JSATS = juvenile acoustic telemetry system
LPS = lamprey passage system
mm = millimeters
MRC = mark-recapture methods
MUK = Mukilteo Research Station
N/A = not applicable
NOAA = National Oceanic and Atmospheric Administration
NPCC = Northwest Power and Conservation Council
ODFW = Oregon Department of Fish and Wildlife
OSU = Oregon State University
PGE = Portland General Electric
PIT = Passive Integrated Transponder
PLEMP = Pacific Lamprey Passage Evaluation and Mitigation Plan
PLMP = Pacific Lamprey Management Plan
PNNL = Pacific Northwest National Laboratory, Battelle
PRB = Pelton Round Butte Project
PRFF = Priest Rapids Fish Forum
PUD = Public Utility District
RM = river mile
RRFF = Rocky Reach Fish Forum
SMP = Smolt Monitoring Program
SNP = single nucleotide polymorphism
SOP = Standard Operating Procedure
USDA = U.S. Department of Agriculture
USFWS = U.S. Fish and Wildlife Service
USGS = U.S. Geological Survey
YNPLP = Yakama Nation Pacific Lamprey Project

## 3.0 Status of Pacific Lamprey Activities at the Priest Rapids Project

Pursuant to the requirements of Grant PUD's PLMP (Grant PUD 2009) and specifically for this comprehensive annual report (as described in Section 1.2 above), activities at the Project related to Pacific lamprey are described in Table 4. The information is organized by the protection, mitigation and enhancement (PM&E) measures for each of the four objectives set forth in the Project's PLMP. Included for each PM&E is the timeframe for implementation/completion of the measure, the action taken by Grant PUD in 2013, and any variations in schedule. In general, measures are currently on or ahead of schedule.

**Table 4 Schedule and status of Pacific Lamprey Management Plan implementation measures at the Priest Rapids Project.**

| | Implementation Measure | Evaluation Timeframe | Relevant to Current Reporting Period | Action Taken in 2012 | Variation from Schedule (if applicable) |
|---|---|---|---|---|---|
| **Objective 1: Identify, address, and fully mitigate Project effects to the extent reasonable and feasible to achieve NNI** | | | | | |
| 1. | Provide an annual report summarizing activities undertaken to identify and address Project impacts. | Annually (by March 31), starting 2010 | Yes | Yes, report will be filed on or before March 31, 2013. | No |
| **Objective 2: Provide safe, effective, and timely volitional passage for adult upstream and downstream migration** | | | | | |
| 2. | Maintain adult fishways. | Annually for the period 2009-2015 | Yes | Grant PUD continues to maintain fishways at the Project in accordance with the NOAA Fisheries Fishway Operations and Criteria Guidelines for salmon (NOAA Fisheries 2008). The plan includes operational criteria for dewatering and the recovery of all fish. | No |
| 3. | Develop adult Pacific lamprey passage criteria. | To be determined by the PRFF<br><br>Annual passage detection monitoring initiated in July 2010, 2011, and 2012 | Yes | Grant PUD installed HDX-PIT tag arrays in the fish ladders at Wanapum and Priest Rapids dams to measure adult Pacific lamprey passage. Passage metrics will be determined when a sufficient sample size has been achieved. Presently, Grant PUD has tracked a total of 243 unique PIT tags at Priest Rapids and 138 at Wanapum since 2010. Fish passage efficiency (FPE) and passage times are being calculated, although the sample size is insufficient for statistical comparisons. | No |

| | Implementation Measure | Evaluation Timeframe | Relevant to Current Reporting Period | Action Taken in 2012 | Variation from Schedule (if applicable) |
|---|---|---|---|---|---|
| 4. | Continue to operate and maintain fish count systems at the Project (upgrade count systems as new technology becomes available). | Annually for the period 2009-2015 | Yes | Grant PUD maintains video stations at the Project to count fish in accordance with the PLMP, NOAA Fisheries Biological Opinion and agreements included in the FERC License.<br><br>Newly designed and fabricated fish crowder facilities were installed and operated at both Priest Rapids and Wanapum dams prior to April 2010. Fish counts are for all species including adult lamprey are expected to be extremely accurate and are available at www.gcpud.org for review. | No |

| | Implementation Measure | Evaluation Timeframe | Relevant to Current Reporting Period | Action Taken in 2012 | Variation from Schedule (if applicable) |
|---|---|---|---|---|---|
| 5. | Develop and implement a comprehensive evaluation of adult lamprey passage at the Project. | Develop / implement: Within one year of license issuance (2009) | Yes | This annual report includes a comprehensive evaluation on adult lamprey passage in the Project area by addressing each measure in the PLMP. PRFF members conducted an on-site inspection of the Priest Rapids and Wanapum left bank fishway facilities during the 2011-2012 winter fish ladder maintenance outage. | No |
| | | Determination of whether proposed modifications improve adult passage: Within four years of license issuance | Yes | Grant PUD implemented components of a comprehensive adult passage evaluation study plan, titled "Assessment of Pacific lamprey behavior and passage efficiency at Priest Rapids and Wanapum dams" (Nass et al. 2009). The goal of the evaluation was to collect data in support of determining whether the modifications improved adult passage. The assessment of plating and count station use in 2010 documented the effective use of these structures by migrating lamprey. FPE and passage times are being calculated, although the sample size is insufficient for statistical comparisons. Data analyses have been conducted annually since 2010 and are ongoing. | No |
| 6. | Implement improvements to the junction pool and the diffusion gratings at the Priest Rapids Dam as identified in the FLA. | Within two years of license issuance (2010) | No | None. Grant PUD completed improvements proposed in the FLA and included in the FERC License in 2010. | No |

| | Implementation Measure | Evaluation Timeframe | Relevant to Current Reporting Period | Action Taken in 2012 | Variation from Schedule (if applicable) |
|---|---|---|---|---|---|
| 7. | Implement an evaluation program to assess the effectiveness of fishway modifications on adult lamprey. | Within one year of completion of fishway modifications at Priest Rapids Dam (2011) | Yes | Grant PUD implemented an evaluation program in coordination with the PRFF to determine and assess the effectiveness of fish ladder modifications. HDX-PIT system were used to collect data from fish tagged downstream of Priest Rapids Dam. Pacific lamprey tagged at lower river facilities were passively monitored at PRP facilities as directed by the PRFF. The assessment of plating and count station use in 2010 documented the effective use of these structures by migrating lamprey. FPE and passage times are being calculated, although the sample size is insufficient for statistical comparisons. Based on three years of monitoring (2010 through 2012), estimated FPE for Priest Rapids Dam is 66% and estimated FPE for Wanapum Dam is 67%. Metrics for 2013 will be provided in the next annual report as monitoring and analysis was not complete as of October 31. | Yes, ahead of schedule. An evaluation program was implemented in 2010 and was continued in 2011. |
| 8. | Implement all modifications identified for adult fishways at the Project as identified in the FLA or as amended by the PRFF. | Within seven years of license issuance (2015) | Yes | Grant PUD has implemented improvements proposed in the FLA and included in the FERC License (see #6 above). Grant PUD will consider additional modifications based on the evaluation of the effectiveness of fishway modifications. | No |

| | Implementation Measure | Evaluation Timeframe | Relevant to Current Reporting Period | Action Taken in 2012 | Variation from Schedule (if applicable) |
|---|---|---|---|---|---|
| 9. | Begin investigation of the efficacy and advisability of reducing fishway flows at night during peak lamprey migration periods. | Following implementation and evaluation of identified fishway modifications | No | Grant PUD began to investigate the efficacy and advisability of reducing fishway flows at night and had incorporated this objective into the 2010 study plan. However, after consideration by the PRFF and NOAA Fisheries, this objective of the study plan was determined to be considered after evaluation of existing fishway modifications (see PRFF meeting minutes for May 5, 2010). | No |
| 10. | Complete a biological objectives status report for WDOE 401 water quality certification. | Every 5th year of the license term (Aug. 2013, 2018, 2023, etc) | Yes | Biological objectives status report update for 2013 was included in last years annual report. . | Yes. |
| 11. | Conduct a monitoring and evaluation study of adult Pacific lamprey passage at Project; if based on the 10-year status report, Ecology concludes that a Pacific Lamprey Biological Objective has not been met; Grant PUD shall continue to implement the Adaptive Management process. | Every 10th year of the license term (2018, 2028, 2038, 2048, 2058) or as recommended by the PRFF | No | None | No |
| 12. | Participate in regional studies, forums and measures and cooperate with other entities performing those activities when useful information may be obtained about Project impacts on adult Pacific lamprey.<br><br>Forums will include (but not limited to) the CRBLTWG. | Annually for the life of the license | Yes | Grant PUD currently participates in regional forums such as the Columbia River Basin Pacific Lamprey Technical Workgroup, the Lamprey Conservation Initiative (USFWS), and the Tribal Restoration Plan activities (CRITFC). Refer to Section 2.2 for specific activities. | No |
| 13. | Continue to operate and maintain the adult PIT-tag detection system (full-duplex) at the Priest Rapids Dam fishway. | Annually for the life of the license | Yes | Grant PUD continues to maintain the adult PIT-tag detection system (full-duplex) at Priest Rapids Dam. | No |

| | Implementation Measure | Evaluation Timeframe | Relevant to Current Reporting Period | Action Taken in 2012 | Variation from Schedule (if applicable) |
|---|---|---|---|---|---|
| **Objective 3: Provide safe, effective and timely volitional passage for juvenile migration** | | | | | |
| 14. | Identify and mitigate for Project effects on juvenile Pacific lamprey | No later than 10 years following license issuance (2018) | Yes | Currently, options for measuring Project effects on juvenile Pacific lamprey are under consideration by the PRFF. | No |
| 15. | Develop juvenile Pacific lamprey passage criteria | No later than 10 years following license issuance (2018) | No | None. At this time, technology does not exist to measure juvenile Pacific lamprey passage. | No |
| 16. | Participate in regional studies, forums and measures and cooperate with other entities performing those activities when useful information may be obtained about Project impacts on juvenile Pacific lamprey.<br><br>Forums will include (but not limited to) the CRBLTWG. | Annually for the life of the license | Yes | Grant PUD currently participates in regional forums such as the Columbia River Basin Pacific Lamprey Technical Workgroup, the Lamprey Conservation Initiative (USFWS), and the Tribal Restoration Plan activities (CRITFC). Refer to Section 2.2 for specific activities. | No |
| **Objective 4: Avoid and mitigate Project impacts on rearing habitat** | | | | | |
| 17. | Determine juvenile lamprey presence / absence, habitat use, and relative abundance in the Project area.<br><br>If significant ongoing effects are identified, Grant PUD shall develop a plan and implement reasonable and feasible measures to address such effects. | No later than 10 years following license issuance (2018) | Yes | Grant PUD implemented a PRFF approved study plan to determine juvenile lamprey presence / absence, habitat use, and relative abundance in the Project area in 2012 and 2013. The preliminary results of these activities are presented in the Results section. | No |

Notes:
CRBLTWG = Columbia River Basin Lamprey Technical Work Group
CRITFC = Columbia River Inter-Tribal Fish Commission
FERC = Federal Energy Regulatory Commission
FLA = Final License Application
FPE = Fish Passage Efficiency
NOAA = National Oceanic and Atmospheric Administration
PIT = Passive Integrated Transponder
PLMP = Pacific Lamprey Management Plan
PRFF = Priest Rapids Fish Forum
PUD = Public Utility District
USFWS = U.S. Fish and Wildlife Services

## 4.0 Evaluation of Activities in the Columbia River Basin Relative to the Priest Rapids Project

This section provides a comprehensive assessment of activities occurring in the Columbia River basin and their applicability to the Project. Table 5 is designed to meet the requirement of the comprehensive annual report (described in Section 1.2 above) to determine whether measures being investigated and/or implemented in the Columbia River basin are: (i) consistent with similar measures taken at other projects; (ii) appropriate to implement at the Project; and (iii) cost effective to implement at the Project.

For purposes of this evaluation, the definitions used for the three stated elements above are as follows:

"Consistent with similar measures taken at other projects" is "Yes" for an activity that has been implemented by a hydroelectric facility operator in a hydroelectric project area other than Grant PUD's Priest Rapids Project.

"Appropriate to implement at the Priest Rapids Project" is "Yes" for an activity that is a requirement of Grant PUD's PLMP (Grant PUD 2009) or is an activity subsequently agreed to by Grant PUD as a result of implementation of the PLMP.

"Cost-effective to implement at the Priest Rapids Project" is "Yes" for an activity where resource benefits are commensurate with the level of effort and cost to implement, and in a manner not inconsistent with anadromous fish passage criteria and habitat requirements. If a measure is "appropriate to implement", then it is also considered cost effective and the specific action being taken by Grant PUD is described. If a measure is not "appropriate to implement," then cost effectiveness is considered not applicable.

The activities identified in the table include both those that have been implemented (as identified and described in Table 3 of Section 2.2: Updated Information above), or planned or proposed pursuant to an existing and approved implementation, restoration, or management plan of another utility, the ACOE, or tribal entities. As such, for each activity, details include the project(s) where the activity has been implemented, planned or proposed, river of each project, and in the case of implemented items, a cross reference to Table 3. For planned or proposed efforts (which are not identified as current activities in Table 3) the source of the information is noted at the end of Table 5.

**Table 5 Pacific lamprey activities in the Columbia River basin and applicability to the Priest Rapids Project.**

| | Activity in Basin (Proposed, Planned or Implemented) | Project where Implemented = I Planned = P or Proposed = PR[1] | River(s) | Table 3 Cross-Reference | Consistent with Measures Taken at Other Projects | Appropriate to Implement at Priest Rapids Project | Cost-Effective for Priest Rapids Project |
|---|---|---|---|---|---|---|---|
| | **General Biology, Ecology, and Population Status** | | | | | | |
| 1. | Identify spawning areas or determine the extent of adult spawning | BOR projects in Yakima (I) | Yakima | #3 | Yes. | No. This activity is not required by Grant PUD's PLMP. Radio-telemetry studies conducted in 2001-2002 did not show use of any tributaries in the PRPA (Nass et al. 2003). | N/A |
| 2. | Develop measures to protect spawning habitat | Wells (P)<br>Rocky Reach (P) | Columbia<br>Columbia | N/A[2]<br>N/A[3] | No. | No. This activity is not required by Grant PUD's PLMP. | N/A |
| 3. | Monitor adult population status and trends (unrelated to counting at hydroelectric projects) | BOR projects in Yakima (I)<br>Willamette Falls (I)<br>No associated hydro project (I) | Yakima<br><br>Willamette<br>Fifteenmile Creek, Deschutes, and tributaries<br>Hood<br>Umatilla<br>Lower Columbia Estuary | #3<br><br>#4<br>#1<br><br>#2<br><br><br>#8<br>#9<br>#27 | No. | No. This activity is not required by Grant PUD's PLMP. | N/A |

| | Activity in Basin (Proposed, Planned or Implemented) | Project where Implemented = I Planned = P or Proposed = PR[1] | River(s) | Table 3 Cross-Reference | Consistent with Measures Taken at Other Projects | Appropriate to Implement at Priest Rapids Project | Cost-Effective for Priest Rapids Project |
|---|---|---|---|---|---|---|---|
| 4. | Determine the extent of juvenile rearing habitat | Priest Rapids and Wanapum (I)<br>The Dalles (I)<br>Rocky Reach (I)<br><br>No associated hydro project (I)<br><br><br><br><br><br><br>Wells (P) | Columbia<br>Columbia<br>Columbia<br>Columbia<br><br>Fifteenmile Creek<br>Deschutes and tributaries<br>White Salmon, Wind and Klickitat<br><br><br>Columbia | #19<br><br>#5<br>#18<br><br>#1<br><br>#2<br><br><br>#6<br><br><br><br>N/A[2] | Yes. | Yes. PLMP Objective 4 requires quantification of lamprey habitat in the Project area. | Yes. Stratified sampling habitat surveys were implemented in 2012 to detect presence/absence and Project operational zone. Required to be conducted within the PRPA within 10 years of license issuance. |
| 5. | Develop measures to protect juvenile rearing habitat | No associated hydro facilities (I)<br>Wells (P)<br>Rocky Reach (P) | Fifteenmile Creek<br>Columbia<br>Columbia | #1<br><br>N/A[2]<br>N/A[3] | No. | No. This activity is not required by Grant PUD's PLMP. | N/A |

| | Activity in Basin (Proposed, Planned or Implemented) | Project where Implemented = I Planned = P or Proposed = PR[1] | River(s) | Table 3 Cross-Reference | Consistent with Measures Taken at Other Projects | Appropriate to Implement at Priest Rapids Project | Cost-Effective for Priest Rapids Project |
|---|---|---|---|---|---|---|---|
| 6. | Monitor juvenile population status and trends (unrelated to counting at hydroelectric projects) | Priest Rapids and Wanapum (I)<br>Willamette Falls (I)<br>N/A (I)<br><br><br>No associated hydro project (I)<br><br><br><br><br><br>Wells (P) | Columbia<br><br>Willamette<br>Deschutes and other tributaries<br>Hood<br>Umatilla<br>Yakima<br>Entiat and Wenatchee<br>Methow<br>Methow (Chewuch)<br>Columbia | #19<br><br>#17<br>#2<br><br><br>#8<br>#11<br>#12, 13<br>#14<br><br>#15<br>#16<br><br>N/A[2] | No. | Yes. PLMP Objective 4 requires the assessment of juvenile presence / absence and relative abundance. | Yes. Stratified sampling habitat surveys were implemented in 2012 and 2013 to detect presence/absence and Project operational zone. Required to be conducted within the PRPA within 10 years of license issuance. |
| 7. | Evaluate lamprey physiology, energy use, swimming performance | N/A | N/A | N/A | No. | No. This activity is not required by the PLMP. Evaluating lamprey physiology, energy use, and swimming performance are not objectives, goals, or measures outlined in the PLMP. | N/A |
| 8. | Evaluate, implement and/or monitor translocation, supplementation, and artificial propagation programs | No associated hydro project (I)<br>Pelton Round Butte (I)<br>N/A (I) | Umatilla<br>Tryon Creek<br>Deschutes<br>N/A | #25<br>#7<br><br>#10<br>#20, 21 | Yes. | No. This activity is not required by Grant PUD's PLMP. | N/A |

| | Activity in Basin (Proposed, Planned or Implemented) | Project where Implemented = I Planned = P or Proposed = PR[1] | River(s) | Table 3 Cross-Reference | Consistent with Measures Taken at Other Projects | Appropriate to Implement at Priest Rapids Project | Cost-Effective for Priest Rapids Project |
|---|---|---|---|---|---|---|---|
| 9. | Evaluate the impact of contaminants on lamprey | No associated hydro projects (I) | Columbia | #26 | No. | No. This activity is not required by the PLMP. Evaluating the impact of contaminants on lamprey are not objectives, goals, or measures outlined in the PLMP. | N/A |
| 10. | Develop and test new technologies / methodologies / protocols for lamprey | The Dalles(I)<br><br>No associated hydro projects (I)<br><br>N/A (I) | Columbia<br><br>White Salmon, Wind, and Klickitat Columbia and Wind<br><br>N/A | #5<br><br>#6<br><br>#22<br><br>#20, 21, 23 | No. | No. This activity is not required by the PLMP. Developing technologies for sampling juvenile lamprey in deep water are not objectives, goals, or measures outlined in the PLMP. However, Grant PUD will determine juvenile lamprey presence / absence, habitat use, and relative abundance in the Project area, in coordination with the PRFF no later than 10 years following license issuance. | N/A |
| 11. | Determine genetic structure and maintain genetic integrity | No associated hydro projects (I)<br><br>N/A (I) | Willamette (Agency Creek)<br><br>N/A | #24<br><br>N/A[1] | No. | No. This activity is not required by the PLMP. Determining genetic structure and maintaining genetic integrity are not objectives, goals, or measures outlined in the PLMP. | N/A |

| | Activity in Basin (Proposed, Planned or Implemented) | Project where Implemented = I Planned = P or Proposed = PR[1] | River(s) | Table 3 Cross-Reference | Consistent with Measures Taken at Other Projects | Appropriate to Implement at Priest Rapids Project | Cost-Effective for Priest Rapids Project |
|---|---|---|---|---|---|---|---|
| 12. | Determine water quality impacts of hydropower projects on lamprey and implement actions to mitigate these impacts | PR (as identified in the Tribal Pacific Lamprey Restoration Plan for the Columbia River) | N/A | N/A[1] | No. | No. This activity is not required by the PLMP. Grant PUD monitors and maintains water quality in compliance with freshwater designated uses and criteria for the Project as required by the Ecology 401 Certification; therefore, no further actions are required. | N/A |
| 13. | Evaluate the need for a lamprey aquaculture facility based upon a limiting factor analysis | N/A | N/A | N/A | No. | No. This activity is not required by the PLMP. | N/A |
| 14. | Restore tributary habitat and passage | PR (as identified in the Tribal Pacific Lamprey Restoration Plan for the Columbia River) | N/A | N/A[1] | No. | No. This activity is not required by the PLMP. Radio-telemetry studies conducted in 2001-2002 did not show use of any tributaries in the PRPA (Nass et al. 2003). | N/A |

| | Activity in Basin (Proposed, Planned or Implemented) | Project where Implemented = I Planned = P or Proposed = PR[1] | River(s) | Table 3 Cross-Reference | Consistent with Measures Taken at Other Projects | Appropriate to Implement at Priest Rapids Project | Cost-Effective for Priest Rapids Project |
|---|---|---|---|---|---|---|---|
| | **Lamprey Migration in Rivers** | | | | | | |
| 15. | Evaluate adult migration in rivers and reservoirs | Bonneville (I)<br>The Dalles (I)<br>John Day (I)<br>McNary (I)<br>Ice Harbor (I)<br>Lower Monumental (I)<br>Little Goose (I)<br>Lower Granite (I)<br>Priest Rapids and Wanapum (I)<br><br>No associated hydro project | Columbia<br>Columbia<br>Columbia<br>Columbia<br>Snake<br>Snake<br><br>Snake<br>Snake<br>Columbia<br><br>N/A | #29, 30, 31<br>#29, 30<br>#29, 30<br>#29, 30<br>#29<br>#29<br><br>#29<br>#29<br>#29, 30<br><br>#28 | Yes. | Yes. The PLMP does not include a specific PM&E related to this activity; however, Grant PUD has committed to collect and evaluate data on the passage of adult lamprey through the Project reservoirs as part of a telemetry evaluation (Objective 2). Grant PUD conducted this activity as part of its 2001-2002 radio-telemetry studies on adult lamprey (Nass et al. 2003). | Yes. Monitoring of lamprey through the Project reservoirs was conducted using HDX-PIT tags in 2010 through 2013 for fish detected at both Priest Rapids and Wanapum dams. Where detection systems are present at upstream projects, the additional data will be evaluated during future adult Pacific lamprey fishway evaluations. |
| 16. | Assess impacts of irrigation water withdrawal structures on juvenile passage/habitat | N/A (I) | N/A | #32 | No. | No. This activity is not required by the PLMP. Assessing the impacts of irrigation water withdrawal are not objectives, goals, or measures outlined in the PLMP. | N/A |
| 17. | Assessing juvenile lamprey outmigration | No associated hydro project (I) | Umatilla | #33 | No. | No. This activity is not required by the PLMP. Assessing the impacts of irrigation water withdrawal are not objectives, goals, or measures outlined in the PLMP. | N/A |

| | Activity in Basin (Proposed, Planned or Implemented) | Project where Implemented = I Planned = P or Proposed = PR[1] | River(s) | Table 3 Cross-Reference | Consistent with Measures Taken at Other Projects | Appropriate to Implement at Priest Rapids Project | Cost-Effective for Priest Rapids Project |
|---|---|---|---|---|---|---|---|
| | **<u>Adult Passage at Hydroelectric Facilities</u>** | | | | | | |
| | *Structural and Operational Fishway Modifications* | | | | | | |
| 18. | Inspect / inventory / document / assess structural improvements for fishway | Bonneville (I)<br>McNary (I)<br>Ice Harbor (I)<br>Little Goose (I)<br>Priest Rapids and Wanapum<br>Wells (P) | Columbia<br>Columbia<br>Snake<br><br>Columbia<br><br>Columbia | #34<br>#34<br>#34<br><br>#35<br><br>N/A[2] | Yes. | Yes. PLMP Objectives 1 and 2 specifically identify methods and reporting requirements for assessing and improving passage conditions for adult lamprey. These activities are a continuation of efforts started in 2001. | Yes. Grant PUD implemented an evaluation program in coordination with the PRFF to determine and assess the effectiveness of fish ladder modifications. HDX-PIT system were used to collect data from fish tagged downstream of Priest Rapids Dam. Pacific lamprey tagged at lower river facilities were passively monitored at Project facilities as directed by the PRFF. The assessment of plating and count station use in 2010 documented the effective use of these structures by migrating lamprey. Fish passage efficiency (FPE) and passage times are being calculated, although the sample size is insufficient for statistical comparisons. |

| | Activity in Basin (Proposed, Planned or Implemented) | Project where Implemented = I Planned = P or Proposed = PR[1] | River(s) | Table 3 Cross-Reference | Consistent with Measures Taken at Other Projects | Appropriate to Implement at Priest Rapids Project | Cost-Effective for Priest Rapids Project |
|---|---|---|---|---|---|---|---|
| 19. | Conduct a literature review of upstream passage improvements | Rocky Reach (I)<br>Wells (I) | Columbia<br>Columbia | #47<br>#98 | Yes. | Yes. PLMP Objective 1 requires compilation of measures taken in the Columbia River basin and an assessment of their applicability to the Project. | Yes. This activity is documented in this PLMP Comprehensive Annual Report (see Section 2.2: Updated Information). |
| 20. | Design / install / evaluate lamprey passage system (LPS) and entrance structures | Bonneville (I)<br>John Day (I)<br>McNary (I)<br>Westland diversions (I) | Columbia<br>Columbia<br>Columbia<br>Umatilla | #36<br>#38<br>#39<br>#37 | Yes. | No. The LPS has been evaluated with respect to application in the Project (2001-2002 radio-telemetry study; Nass et al. 2003) and determined that because there are no areas where lamprey concentrate at either facility, this method would not be appropriate to implement. | N/A |
| 21. | Design / install bollard arrays | John Day (I) | Columbia | #38 | No. | No. This activity is not required by the PLMP. | N/A |
| 22. | Install / evaluate / operate slotted “keyhole” fishway entrances | Priest Rapids and Wanapum (I)<br>John Day (P)<br>McNary (P) | Columbia<br>Columbia<br>Columbia | #40<br>N/A[5]<br>N/A[6] | Yes. | Yes. Keyhole entrances are currently utilized at both Wanapum and Priest Rapids dams. | Yes. See adjacent response. |
| 23. | Develop / implement / evaluate ladder dewatering procedures | All ACOE projects[7] (I)<br>Wells (I)<br>Rocky Reach (I)<br>Rock Island (I)<br>Priest Rapids and Wanapum (I) | Columbia / Snake<br>Columbia<br>Columbia<br>Columbia<br>Columbia | #41<br>#42<br>#43<br>#43<br>#44 | Yes. | Yes. Dewatering procedures were identified as existing at the Project in the PLMP. | Yes. Grant PUD operates its fishways according to the NOAA Fisheries Fishway Operations and Criteria Guidelines for salmon (NOAA Fisheries 2008). The plan includes operational criteria for dewatering and the recovery of all fish. |

| | Activity in Basin (Proposed, Planned or Implemented) | Project where Implemented = I Planned = P or Proposed = PR[1] | River(s) | Table 3 Cross-Reference | Consistent with Measures Taken at Other Projects | Appropriate to Implement at Priest Rapids Project | Cost-Effective for Priest Rapids Project |
|---|---|---|---|---|---|---|---|
| 24. | Rehabilitate and/or operate old or existing fishway for lamprey passage | Willamette Falls (I) | Willamette | #45 | No. | Yes. Subsequent to fishway modifications completed in 2009-2010 outage at Priest Rapids and Wanapum dams, Grant PUD and the PRFF will continue to assess the applicability, feasibility, and appropriateness of other potential modifications. | Yes, as determined by Grant PUD and the PRFF. |
| 25. | Address issues with diffuser gratings and picket leads, e.g., replace gratings with material of ¾-inch spacing (and replace other related structures: e.g., track rack cleaning system and grating support system) | John Day (I)<br>Other ACOE projects (exact ones unspecified) (P)<br>Wells (P) | Columbia<br>Columbia / Snake<br><br>Columbia | #38, 60<br>N/A[5]<br><br>N/A[2] | No. | No. These issues have not been identified in the Project fishways. Members of the PRFF toured the fish ladders at Priest Rapids and Wanapum dams and did not identify that these issues existed at either dam. However, Grant PUD replaced the fish count stations at both dams in 2010 with picket-lead gratings that is 11/16-inch gap to ensure accurate adult counts. | N/A |

| | Activity in Basin (Proposed, Planned or Implemented) | Project where Implemented = I Planned = P or Proposed = PR[1] | River(s) | Table 3 Cross-Reference | Consistent with Measures Taken at Other Projects | Appropriate to Implement at Priest Rapids Project | Cost-Effective for Priest Rapids Project |
|---|---|---|---|---|---|---|---|
| 26. | Install/evaluate plates over diffuser along the bases of walls and weir | John Day (I)<br><br>Little Goose (I)<br>Lower Granite (I)<br>Rocky Reach (I) | Columbia<br><br>Snake<br>Snake<br>Columbia | #38<br><br>#46<br>#46<br>#47 | Yes. | Yes. PLMP Objective 2 requires installation of plating along the edges and through the orifices in the pools with diffusion chambers at Priest Rapids Dam. | Yes. Grant PUD installed aluminum plating on diffuser grates at Priest Rapids during the 2009-2010 winter fish ladder maintenance outage. The effectiveness of the plating was evaluated through the use of underwater video as part of the 2010 assessment of Pacific lamprey behavior and passage efficiency at Priest Rapids and Wanapum dams (Nass et al. 2009). This study showed that lamprey effectively used the plating to move through a weir orifice or past the counting station. |
| 27. | Install lamprey orifices | Little Goose (I)<br>Lower Granite (I) | Snake<br>Snake | #46<br>#46 | Yes. | No. The PLMP does not include a specific PM&E measure related to this activity, nor has it been identified by Grant PUD and the PRFF as an appropriate measure to implement at Priest Rapids and Wanapum dams. | N/A |
| 28. | Install/evaluate ramps at sills and lips | The Dalles (I)<br>John Day (I)<br>Little Goose (I)<br>Lower Granite (I)<br>Rocky Reach (I) | Columbia<br>Columbia<br>Snake<br>Snake<br>Columbia | #59<br>#59<br>#46<br>#46<br>#47 | Yes. | Yes. The PLMP does not include a specific PM&E related to this activity; however, Grant PUD has committed to this activity as part of its ladder modification plan. | Yes. Grant PUD installed aluminum ramps during the 2009-2010 winter fish ladder outage at every perched orifice in the Priest Rapids Dam fishways. |

| | Activity in Basin (Proposed, Planned or Implemented) | Project where Implemented = I Planned = P or Proposed = PR[1] | River(s) | Table 3 Cross-Reference | Consistent with Measures Taken at Other Projects | Appropriate to Implement at Priest Rapids Project | Cost-Effective for Priest Rapids Project |
|---|---|---|---|---|---|---|---|
| 29. | Round sharp corners | John Day (I)<br>Rocky Reach (I)<br>Trail Bridge Dam (I)<br>Ice Harbor (P) | Columbia<br>Columbia<br>McKenzie<br><br>Snake | #38<br>#47<br>#49<br><br>N/A[6] | Yes. | No. Sharp corners have not been identified in the Project fishways. Members of the PRFF toured the fish ladders at Priest Rapids and Wanapum dams and did not identify that sharp corners were an issue at either dam. | N/A |
| 30. | Installed permanent monitoring technology (e.g., HDX-PIT arrays) | Rocky Reach (I) | Columbia | #47 | Yes. | Yes. Grant PUD committed to the installation of a monitoring technology in their PLMP. | Yes. Grant PUD installed HDX-PIT systems during the 2009-2010 fishway outage. The arrays were operated during the 2010 through 2013 migration seasons. |
| 31. | Design / install water supply or auxillary water supply systems | Bonneville (I)<br>Trail Bridge Dam (I) | Columbia<br>McKenzie | #48<br>#49 | No. | No. This activity is not required by the PLMP. | N/A |

| | Activity in Basin (Proposed, Planned or Implemented) | Project where Implemented = I Planned = P or Proposed = PR[1] | River(s) | Table 3 Cross-Reference | Consistent with Measures Taken at Other Projects | Appropriate to Implement at Priest Rapids Project | Cost-Effective for Priest Rapids Project |
|---|---|---|---|---|---|---|---|
| 32. | Reduce/evaluate ladder entrance flow velocities at night | Bonneville (I)<br>McNary (I)<br>Wells (I)<br>Priest Rapids (P)<br>Ice Harbor (P) | Columbia<br>Columbia<br>Columbia<br>Columbia<br>Snake | #50<br>#51<br>#52<br>N/A[8]<br>N/A[5] | Yes. | Yes. PLMP Objective 2 requires that Grant PUD and the PRFF evaluate the efficacy of reducing fishway flows at night. | Yes. Grant PUD developed a PRFF-approved comprehensive study plan to evaluate improvements and modifications to the fish ladders at Priest Rapids and Wanapum dams in 2010. Grant PUD began to investigate the efficacy and advisability of reducing fishway flows at night and had incorporated this objective into the 2010 study plan. However, after consideration by the PRFF and NOAA Fisheries, this objective of the study plan was considered to be unnecessary (see PRFF meeting minutes for May 5, 2010). |
| 33. | Modify/evaluate weir head differentials | PR (as identified in the Tribal Pacific Lamprey Restoration Plan for the Columbia River) | N/A | N/A[1] | No. | No. Fishway operational procedures were identified as existing at the Project in the PLMP. | N/A. Grant PUD operates its fishways according to the NOAA Fisheries Fishway Operations and Criteria Guidelines for salmon (NOAA Fisheries 2008). The plan includes operational criteria for weir head differentials. |

| | Activity in Basin (Proposed, Planned or Implemented) | Project where Implemented = I Planned = P or Proposed = PR[1] | River(s) | Table 3 Cross-Reference | Consistent with Measures Taken at Other Projects | Appropriate to Implement at Priest Rapids Project | Cost-Effective for Priest Rapids Project |
|---|---|---|---|---|---|---|---|
| 34. | Manage flows to a peaking hydrograph | PR (as identified in the Tribal Pacific Lamprey Restoration Plan for the Columbia River) | N/A | N/A[1] | No. | No. Grant PUD operates its facilities as part of a seven dam coordination schedule of flows. The proposed activity is not consistent with operations for power generation, flood control and recreational activities. | N/A |
| 35. | Establish protocol for formal inspection of passage facilities | Priest Rapids and Wanapum (I) | Columbia | #99 | No. | Yes. PLMP Objective 2 requires inspection of passage facilities by PRFF members. | Yes. Inspection by the PRFF is coordinated with annual winter fish ladder maintenance outages. |
| 36. | Establish protocol for annual lamprey passage reporting | Priest Rapids and Wanapum (I) | Columbia | #99 | No. | Yes. PLMP Objective 1 requires an annual report summarizing all PLMP activities. | Yes. Lamprey activities at the Project are documented in this PLMP Comprehensive Annual Report. |
| 37. | Develop and/or maintain fishway operations criteria | Bonneville (I)<br>The Dalles (I)<br>John Day (I)<br>McNary (I)<br>Ice Harbor (I)<br>Lower Monumental (I)<br>Little Goose (I)<br>Lower Granite (I)<br>Wells (I)<br>Rocky Reach (I)<br>Rock Island (I)<br>Priest Rapids and Wanapum (I) | Columbia<br>Columbia<br>Columbia<br>Columbia<br>Snake<br>Snake<br>Snake<br>Snake<br>Columbia<br>Columbia<br>Columbia<br>Columbia | #53<br>#54<br>#55<br>#56<br>#56<br>#56<br>#56<br>#56<br>#97<br>#98<br>#57<br>#58 | Yes. | Yes. PLMP Objective 2 requires Grant PUD to maintain its fishways in a manner that is consistent with the NOAA Fisheries Fishway Operations and Criteria Guidelines for salmon (NOAA Fisheries 2008). In 2011, Grant PUD implemented a Standard Operating Procedure (SOP) for operation of the OLAFT vertical orifice gate to remain open when the OLAFT is not operating. | Yes. Specific operations criteria are presented in Grant PUD's Project Adult Fishways Operational Plan (Grant PUD 2008). |

| | Activity in Basin (Proposed, Planned or Implemented) | Project where Implemented = I Planned = P or Proposed = PR[1] | River(s) | Table 3 Cross-Reference | Consistent with Measures Taken at Other Projects | Appropriate to Implement at Priest Rapids Project | Cost-Effective for Priest Rapids Project |
|---|---|---|---|---|---|---|---|
| | *Project Passage Effectiveness* | | | | | | |
| 38. | Develop adult lamprey passage criteria | Rocky Reach (P)<br>Priest Rapids and Wanapum (P) | Columbia<br>Columbia | N/A[3]<br>N/A[4] | No. | Yes. PLMP Objective 2 requires the development of adult lamprey passage criteria that are not inconsistent with the Fishery Operations Plan (Grant PUD 2010). | Yes. Grant PUD and the PRFF will consider success achieved at other Columbia River basin projects and site specific conditions related to Priest Rapids and Wanapum dams. |
| 39. | Passage modification prioritization activities | Federal projects (I) | Columbia and Snake | #61 | No. | No. This activity is not required by the PLMP. | N/A |

| | Activity in Basin (Proposed, Planned or Implemented) | Project where Implemented = I Planned = P or Proposed = PR[1] | River(s) | Table 3 Cross-Reference | Consistent with Measures Taken at Other Projects | Appropriate to Implement at Priest Rapids Project | Cost-Effective for Priest Rapids Project |
|---|---|---|---|---|---|---|---|
| 40. | Evaluate effectiveness of dam passage | Bonneville (I)<br>The Dalles (I)<br>John Day (I)<br>McNary (I)<br>Ice Harbor (I)<br>Lower Monumental (I)<br>Little Goose (I)<br>Lower Granite (I)<br>Priest Rapids (I)<br>Wanapum (I)<br>Wells (I)<br>Threemile Falls Dam, Maxwell and Feed diversions (I)<br>Jim Boyd and other irrigation diversion dams (I)<br>Clackamas<br>Rocky Reach (P) | Columbia<br>Columbia<br>Columbia<br>Columbia<br>Snake<br>Snake<br>Snake<br>Snake<br>Columbia<br>Columbia<br>Columbia<br>Umatilla<br>Umatilla<br>Clackamas<br>Columbia | #29, 65, 69, 70<br>#29<br>#29, 69<br>#29, 63, 64<br>#29<br>#29<br>#29<br>#29<br>#29, 66<br>#66<br>#62, 71<br>#77<br>#78<br>#68<br>N/A[3] | Yes. | Yes. PLMP Objective 2 requires a comprehensive passage evaluation. | Yes. Grant PUD implemented an evaluation program in coordination with the PRFF to determine and assess the effectiveness of fish ladder modifications. HDX-PIT systems were used to collect data from fish tagged downstream of Priest Rapids Dam. Pacific lamprey tagged at lower river facilities were passively monitored at PRP facilities as directed by the PRFF. The assessment of plating and count station use in 2010 documented the effective use of these structures by migrating lamprey. Fish passage efficiency (FPE) and passage times are being calculated, although the sample size is insufficient for statistical comparisons. Through 2012, Grant PUD has tracked a total of 145 unique PIT tags at Priest Rapids and 75 at Wanapum since 2010. Estimated FPE for 2010-2011 (not including 2012) for Priest Rapids Dam is 82% and estimated FPE for Wanapum Dam is 82%. |

| | Activity in Basin (Proposed, Planned or Implemented) | Project where Implemented = I Planned = P or Proposed = PR[1] | River(s) | Table 3 Cross-Reference | Consistent with Measures Taken at Other Projects | Appropriate to Implement at Priest Rapids Project | Cost-Effective for Priest Rapids Project |
|---|---|---|---|---|---|---|---|
| 41. | Evaluate upstream passage modifications | Priest Rapids and Wanapum (I)<br>Rocky Reach (P)<br><br>[Note: evaluations performed on existing structural / operational improvements at ACOE dams are identified earlier in this table, under the heading, *Structural and Operational Fishway Modifications.*] | Columbia<br><br>Columbia | #66<br><br>N/A[3] | No. | Yes. PLMP Objective 2 requires a comprehensive passage evaluation of modifications to fishways as required per the FERC License Order and PLMP. | Yes. Grant PUD conducted an adult passage evaluation to determine the effectiveness of fish ladder modifications made during the 2009-2010 winter fish ladder maintenance outage (Nass et al. 2009). Specific modifications included diffusion grate plating and new fish crowder structures. HDX-PIT systems were used to collect data from fish tagged downstream of Priest Rapids Dam. Pacific lamprey tagged at lower river facilities were passively monitored at PRP facilities as directed by the PRFF. The assessment of plating and count station use in 2010 documented the effective use of these structures by migrating lamprey. Fish passage efficiency (FPE) and passage times are being calculated, although the sample size is insufficient for statistical comparisons. |

| | Activity in Basin (Proposed, Planned or Implemented) | Project where Implemented = I Planned = P or Proposed = PR[1] | River(s) | Table 3 Cross-Reference | Consistent with Measures Taken at Other Projects | Appropriate to Implement at Priest Rapids Project | Cost-Effective for Priest Rapids Project |
|---|---|---|---|---|---|---|---|
| | *Lamprey Counts at Dams* | | | | | | |
| 42. | Develop feasibility, techniques, and protocols to improve 24-hour counting / conduct counts | McNary (I)<br>Lower Granite (I)<br>Wells (I)<br>Rocky Reach (I)<br>Rock Island (I)<br>Priest Rapids and Wanapum (I)<br>McNary (I)<br>Ice Harbor (I) | Columbia<br>Snake<br>Columbia<br>Columbia<br>Columbia<br>Columbia<br><br>Columbia<br>Snake | #72<br>#72<br>#73<br>#74<br>#74<br>#75<br><br>#77<br>#77 | Yes. | Yes. PLMP Objective 2 requires maintenance and feasible improvements to adult fish counting systems. | Yes. Grant PUD currently provides counts of all fishes 24 hours per day, 7 days per week for the period April 15 – November 15, annually. |
| 43. | Develop/evaluate passage alternatives related to count facilities | Bonneville (I)<br>Wells (I) | Columbia<br>Columbia | #76<br>#71 | Yes. | Yes. PLMP Objective 2 requires maintenance and feasible improvements to adult fish counting systems. | Yes. Grant PUD installed newly designed, lamprey-specific fish crowder structures for all count stations at Priest Rapids and Wanapum dams during the 2009-2010 winter fish ladder maintenance outage. Based on design criteria for the new video fish count crowders (picketed lead gap of 11/16 inches). Grant PUD expects fish count accuracy to be at or near 100% for adult lamprey and other fishes. |
| | *Predation* | | | | | | |
| 44. | Establish predation control measures (sea lions) | Bonneville (I) | Columbia | #78 | Yes. | No. Sea lions are not present in the PRPA. | N/A |

| | Activity in Basin (Proposed, Planned or Implemented) | Project where Implemented = I Planned = P or Proposed = PR[1] | River(s) | Table 3 Cross-Reference | Consistent with Measures Taken at Other Projects | Appropriate to Implement at Priest Rapids Project | Cost-Effective for Priest Rapids Project |
|---|---|---|---|---|---|---|---|
| | **Juvenile Passage at Hydroelectric Facilities** | | | | | | |
| | *Structural and Operational Fishway Modifications* | | | | | | |
| 45. | Conduct a literature review of juvenile Pacific lamprey passage and survival | Priest Rapids and Wanapum (I)<br>Wells (P) | Columbia<br>Columbia | #99<br>N/A[2] | No. | Yes. PLMP Objective 1 requires compilation of measures taken in the Columbia River basin and an assessment of their applicability to the Project. | Yes. This activity is documented in this PLMP Comprehensive Annual Report. |
| 46. | Replace turbine intake screens with smaller spacing | All ACOE projects (P) | Columbia / Snake | N/A[6] | No. | No. Grant PUD dams are not equipped with turbine intake or diversion screens. | N/A |
| 47. | Lift/remove extended length screens during outmigration | McNary (I) | Columbia | #79 | Yes. | No. Grant PUD has existing turbines bypass systems, gatewells and spill, but does not have a system into which a separator could be installed. | N/A |
| 48. | Manage flows to a peaking hydrograph | PR (as identified in the Tribal Pacific Lamprey Restoration Plan for the Columbia River) | N/A | N/A[1] | No. | No. Grant PUD operates its facilities as part of the seven dam coordinated system. The proposed activity is not consistent with operations for power generation, fish protection, flood control and recreational activities. | N/A |

| | Activity in Basin (Proposed, Planned or Implemented) | Project where Implemented = I Planned = P or Proposed = PR[1] | River(s) | Table 3 Cross-Reference | Consistent with Measures Taken at Other Projects | Appropriate to Implement at Priest Rapids Project | Cost-Effective for Priest Rapids Project |
|---|---|---|---|---|---|---|---|
| 49. | JBS modifications | McNary (I)<br>Lower Monumental (I) | Columbia<br>Snake | #80, 81<br>#81 | Yes. | No. Grant PUD has existing bypass systems, which includes gatewells, spillways, the WFUFB, and Priest Rapids Top-Spill Bypass. The WFUFB and experimental Priest Rapids Top-Spill Bypass are operated to achieve safe passage of out-migrating salmonids. It would be expected that juvenile lamprey would also benefit as a result of these operations. | N/A |
| 50. | Establish/continue salvage activities during ladder maintenance de-watering | All ACOE projects (I)<br>Wells (I)<br>Rocky Reach (I)<br>Rock Island (I)<br>Priest Rapids and Wanapum (I) | Columbia / Snake<br>Columbia<br>Columbia<br>Columbia<br>Columbia | #82<br>#83<br>#84<br>#84<br>#85 | Yes. | Yes. Dewatering procedures were identified as existing at the Project in the PLMP. | Yes. Grant PUD operates its fishways according to the NOAA Fisheries Fishway Operations and Criteria Guidelines for salmon (NOAA Fisheries 2008). The plan includes operational criteria for dewatering and the recovery of all fish during all maintenance activities. |
| 51. | Develop and/or maintain bypass operations criteria | Wells (I)<br>Rocky Reach (I)<br>Rock Island (I)<br>Priest Rapids and Wanapum (I) | Columbia<br>Columbia<br>Columbia<br>Columbia | #97<br>#98<br>#86<br>#87 | Yes. | Yes. Grant PUD has existing bypass systems, which includes gatewells, spillways, the WFUFB, and Priest Rapids Top-Spill Bypass. | Yes. The WFUFB and experimental Priest Rapids Top-Spill Bypass are operated to achieve safe passage of out-migrating salmonids. It would be expected that juvenile lamprey would also benefit as a result of these operations. |

| | Activity in Basin (Proposed, Planned or Implemented) | Project where Implemented = I Planned = P or Proposed = PR[1] | River(s) | Table 3 Cross-Reference | Consistent with Measures Taken at Other Projects | Appropriate to Implement at Priest Rapids Project | Cost-Effective for Priest Rapids Project |
|---|---|---|---|---|---|---|---|
| | *Project Passage Effectiveness* | | | | | | |
| 52. | Evaluate tagging and development of miniature tags | N/A (I) | N/A | N/A | No. | No. This activity is not required by the PLMP. Evaluation and development of tags are not objectives, goals, or measures outlined in the PLMP. | N/A |
| 53. | Develop juvenile lamprey passage criteria | Priest Rapids and Wanapum (P) | Columbia | N/A[4] | No. | Yes. PLMP Objective 3 requires the development of juvenile lamprey passage criteria. | Yes. Grant PUD and the PRFF will include consideration of success achieved at other Columbia River basin projects and site specific conditions when the technology exists to measure juvenile lamprey passage. |
| 54. | Evaluate downstream passage and survival when technology available | Wells (P)<br>Rocky Reach (P)<br>Priest Rapids and Wanapum (P) | Columbia<br>Columbia<br>Columbia | N/A[2]<br>N/A[3]<br>N/A[4] | No. | Yes. The PLMP does not include a specific PM&E related to this activity; however, Grant PUD has committed to providing safe, effective and timely passage which could be evaluated when adequate technology exists. | Yes. |
| 55. | Laboratory passage evaluation | N/A (I) | N/A | N/A | No. | No. This activity is not required by the PLMP. Lab passage evaluations are not objectives, goals, or measures outlined in the PLMP. | N/A |

| | Activity in Basin (Proposed, Planned or Implemented) | Project where Implemented = I Planned = P or Proposed = PR[1] | River(s) | Table 3 Cross-Reference | Consistent with Measures Taken at Other Projects | Appropriate to Implement at Priest Rapids Project | Cost-Effective for Priest Rapids Project |
|---|---|---|---|---|---|---|---|
| 56. | Monitor passage timing, number, and mortalities of juvenile lamprey collected at projects with juvenile fish bypass facilities | Bonneville (I)<br>John Day (I)<br>McNary (I)<br>Rock Island (I)<br>Lower Monumental (I)<br>Little Goose (I)<br>Lower Granite (I) | Columbia<br>Columbia<br>Columbia<br>Columbia<br>Snake<br>Snake<br>Snake | #88, 89<br>#89<br>#88, 89<br>#89<br>#88, 89<br>#88, 89<br>#88, 89, 90 | Yes. | No. Grant PUD does not have juvenile collection facilities at either Priest Rapids or Wanapum dams that could be used for this purpose. | N/A |
| 57. | Monitor and report on juvenile impingement | Rocky Reach (I) | Columbia | #98 | Yes. | No. Priest Rapids and Wanapum dams are not equipped with turbine intake or diversion screens. | N/A |
| | *Predation* | | | | | | |
| 58. | Continue predation control measures (Northern pikeminnow and birds) | <u>Pikeminnow only</u><br>All ACOE projects (I)<br><br><u>Pikeminnow and birds</u><br>Rocky Reach (I)<br>Rock Island (I)<br>Priest Rapids and Wanapum (I) | <br>Columbia / Snake<br><br><br>Columbia<br>Columbia<br>Columbia<br>Columbia | <br>#91<br><br><br>#92, 93<br>#92, 93<br>#94 | Yes. | Yes. The PLMP does not include a specific PM&E related to this activity. However, Grant PUD maintains predator control programs for piscivorous birds and Northern pikeminnow in the PRPA. | Yes. Grant PUD maintains both avian and Northern pikeminnow control programs to minimize the effects of predation to salmonids which would also be expected to provide a benefit to lamprey. |
| | **<u>Policy and Recovery Activities</u>** | | | | | | |
| 59. | Develop/implement Pacific Lamprey Management Plans | All ACOE projects (I)<br>Wells (I)<br>Rocky Reach (I)<br>Priest Rapids and Wanapum (I) | Columbia / Snake<br>Columbia<br>Columbia<br>Columbia | #95, 96<br><br>#97<br>#98<br>#99 | Yes. | Yes. Grant PUD is required by FERC to develop and implement a PLMP. | Yes. Grant PUD has a FERC-approved PLMP (Grant PUD 2009). Implementation of that plan is in progress. |

| | Activity in Basin (Proposed, Planned or Implemented) | Project where Implemented = I Planned = P or Proposed = PR[1] | River(s) | Table 3 Cross-Reference | Consistent with Measures Taken at Other Projects | Appropriate to Implement at Priest Rapids Project | Cost-Effective for Priest Rapids Project |
|---|---|---|---|---|---|---|---|
| 60. | Establish regional data protocols for collection, storage and analysis; develop means to widely access and share information | All ACOE projects (I)<br>Wells (I)<br>Rocky Reach (I)<br>Priest Rapids and Wanapum (I)<br>N/A | Columbia / Snake<br>Columbia<br>Columbia<br>Columbia | #95, 96<br><br>#97<br>#98<br>#99<br>#100 | Yes. | Yes. PLMP Objectives 2 and 3 require "Regional Studies" which includes participation and cooperation in studies where useful information may be obtained about project impacts to lamprey. | Yes. Grant PUD participates in regional forums such as the CRBLTWG the USFWS Lamprey Conservation Initiative and the CRITFC Pacific Lamprey Recovery Plan planning processes. |
| 61. | Establish coordinated public education and other outreach programs | Priest Rapids and Wanapum (I) | Columbia | #99 | No. | Yes. The PLMP does not include a specific PM&E related to this activity; however, Grant PUD participates in education programs regarding lamprey. | Yes. Grant PUD participates in the annual Wanapum Indian Archeological Days program and provides technical support and displays regarding the importance of lampreys. |
| 62. | Participate in regional lamprey activities | All ACOE projects (I)<br>Wells (I)<br>Rocky Reach (I)<br>Priest Rapids and Wanapum (I) | Columbia / Snake<br>Columbia<br>Columbia<br>Columbia | #95, 96, 100<br>#97<br>#98<br>#99 | Yes. | Yes. PLMP Objectives 2 and 3 require "Regional Studies" which includes participation and cooperation in studies where useful information may be obtained about Project impacts to lamprey. | Yes. Grant PUD participates in regional forums such as the CRBLTWG the USFWS Lamprey Conservation Initiative and the CRITFC Pacific Lamprey Recovery Plan planning processes. |
| 63. | Environmental analysis and feasibility investigations | N/A | N/A | #100 | No. | No. This activity is not required by the PLMP. Environmental analysis and feasibility investigations related to public transportation and lamprey propagation are not objectives, goals, or measures outlined in the PLMP. | N/A |

Notes:

1. Defined as a measure identified in the Tribal Pacific Lamprey Restoration Plan for the Columbia River (Nez Perce, Umatilla, Yakama, and Warm Springs Tribes 2009), that has not already been implemented or planned by the ACOE or mid-Columbia PUDs.
2. Per requirement in Wells Project PLMP (Douglas PUD 2009).
3. Per requirement in Rocky Reach PLMP (Chelan PUD 2005).

4. Per requirement in Priest Rapids PLMP (Grant PUD 2009); see Table 4 for status.
5. Per commitment in ACOE's 10-year implementation plan (ACOE 2009).
6. Per personal communications with David Clugston, ACOE (11/9/09, 11/10/09, and 12/11/09).
7. "All ACOE projects" includes Bonneville, The Dalles, John Day, McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite.
8. An evaluation of reducing fishway flows at night was planned for the 2009-2010 winter work period; however, the evaluation was not done (as agreed to by the PRFF) as returning numbers were insufficient.

ACOE = Army Corps of Engineers
BOR = Bureau of Reclamation
CRBLTWG = Columbia River Basin Lamprey Technical Work Group
CRITFC = Columbia River Inter-Tribal Fish Commission
FERC = Federal Energy Regulatory Commission
FPE = Fish Passage Efficiency
HDX-PIT = Half-duplex Passive Integrated Transponder
LPS = lamprey passage system
N/A = Not applicable
NOAA = National Oceanic and Atmospheric Administration
PLMP = Pacific Lamprey Management Plan
PM&E = protection, mitigation and enhancement
PRFF = Priest Rapids Fish Forum
PRPA = Priest Rapids Project area
PUD = Public Utility District
SOP = Standard Operating Procedure
USFWS = U.S. Fish and Wildlife Service
WFUFB = Wanapum Future Unit Fish Bypass

## 5.0 Summary

One of the goals of Grant PUD's PLMP is to improve Pacific lamprey passage efficiency through the implementation of structural and, potentially, operational modifications to the Project fishways. In the fourth year of PLMP implementation, several planned activities were conducted on schedule. Grant PUD continued to conduct components of a PRFF-approved study plan titled, "Assessment of Pacific Lamprey Behavior and Passage Efficiency at Priest Rapids and Wanapum Dams" (Nass et al. 2009). The study was conducted to evaluate the effectiveness of structural modifications to Priest Rapids Project fishways that are intended to facilitate lamprey passage.

The study plan objectives were to:

1. Determine the fishway passage efficiency for adult lamprey at Priest Rapids and Wanapum dams; and
2. Evaluate the passage of adult lamprey through sections of the Priest Rapids fishways where new structures have been installed to facilitate upstream movement.

In 2013, Grant PUD, in consultation with the PRFF, continued to passively monitor Pacific lamprey tagged at downstream facilities and added valuable information to the cumulative data set. The intent of the PIT data collection program is to provide sufficient sample size over time to calculate the relevant metrics. Analysis of the cumulative data from 2010 – 2013 will be completed as part of 2014 activities and preliminary information included in the next annual report. Grant PUD continued its regional approach to monitoring lamprey by coordinating among utilities, participating in forums, and the sharing of PIT data with other researchers.

In 2014, Grant PUD plans to complete PLMP-required activities and study planning/implementation efforts including:

1. PRFF on-site inspection of Priest Rapids and Wanapum fish facilities during the 2013-2014 winter fish ladder maintenance outage.
2. Pre-season testing and calibration of HDX-PIT arrays, and maintenance of arrays during the migration season.
3. Tracking lamprey enumeration statistics for the Priest Rapids Project and lower Columbia River dams.
4. Continuing to survey the distribution and relative abundance of juvenile lamprey in the operations zone of the PRPA as based on the results of activities conducted in 2012. Results from the June 2012 surveys will be combined with the results of a November 2013 and 2014 surveys and presented in the next annual report.
5. Continuing to operate HDX-PIT arrays to assess passage metrics (passage efficiency, etc.) and coordinate detection of tagged fish with regional monitoring efforts to evaluate Pacific lamprey passage;, both downstream and upstream of the Priest Rapids Project.

Assuming the trend toward exclusive tagging effort in the lower Columbia River, monitoring activities for adult lamprey will begin in May 2014 and continue until the seasonal migration of lamprey appears to have ceased (approximately November 15). HDX-PIT technology will be used to monitor the behavior of adult Pacific lamprey, and quantify the overall passage effectiveness through standard metrics (Nass et al. 2003). Data analysis and reporting including the results of 2013 monitoring will be conducted through the period November 15, 2013, and March 31, 2014, respectively.

Grant PUD will continue to conduct surveys to determine the distribution and relative abundance of juvenile lamprey in the operational zone of the Project area, as appropriate, and modify sampling based on the cumulative results of surveys conducted in 2013. More specifically, desk-top assessments and field surveys determining juvenile lamprey presence and habitat use will be conducted for biologically appropriate locations within elevations consistent with the low and high water levels as a result of Project operations. The main purpose of these juvenile surveys is to collect baseline data for identifying potential Project effects on rearing juvenile lamprey.

Pursuant to the requirements identified in the PLMP, Grant PUD will continue to monitor lamprey-related efforts occurring throughout the Columbia River basin, will actively participate in regional research and forums, and will assess opportunities for lamprey restoration at the Project.

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# Appendix A
# PRFF Comments on Draft PLMP Comprehensive Plan Comprehensive Report

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
4601 N Monroe Street • Spokane, Washington 99205-1295 • (509)329-3400

February 17, 2014

Mr. Tom Dresser
Manager
Fish, Wildlife and Water Quality
Grant County PUD
PO Box 878
Ephrata, WA 98823

RE: Request for Ecology Review and Approval – *Pacific Lamprey Management Plan Comprehensive Annual Report*
Priest Rapids Hydroelectric Project No. 2114

Dear Mr. Dresser:

The Department of Ecology (Ecology) has reviewed the *Pacific Lamprey Management Plan Comprehensive Annual Report* sent via email to Ecology on January 15, 2014.

Ecology APPROVES the *Pacific Lamprey Management Plan Comprehensive Annual Report* as submitted. The report fulfills the requirements in Section 6.2(5)(c) for the Pacific Lamprey Management Plan under Section 6.2(5)(d) of the 401 certification.

Please contact me at (509) 329-3567 or pmcg461@ecy.wa.gov if you have any questions.

Sincerely,

Patrick McGuire
Eastern Region FERC License Coordinator
Water Quality Program

PDM:jb

cc: Ross Hendrick, Grant County PUD
Mike Clement, Grant County PUD

# Appendix B
# Summary of PRFF Comments on Draft PLMP Comprehensive Report and Grant PUD Response

**Summary of PRFF Comments on PLMP Comprehensive Report and Grant PUD Responses**

| Submitting Entity | Date Received | Paragraph | Agency Comment | Grant PUD Response |
|---|---|---|---|---|
| WDOE | 17-Feb-2014 | 1 | The Department of Ecology (Ecology) has reviewed the Pacific Lamprey Management Plan Comprehensive Annual Report sent via email on Janauary 15, 2014. | Comment noted. |
| WDOE | 17-Feb-2014 | 2 | Ecology APPROVES the *Pacific Lamprey Management Plan Comprehensive Annual Report* as submitted. The report fulfills the requirements in Section 6.2(5)(c) for the Pacific Lamprey Management Plan under Section 6.2(5)(d) of the 401 certification. | Comment noted. |
| WDOE | 17-Feb-2014 | 3 | Please contact me at (509) 329-3567 or pmcg461@ecy.wa.gove if you have any questions. | Comment noted |