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March 27, 2013

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) – 2012 Pacific Lamprey Management Plan Comprehensive Annual and Biological Objectives Status Report

Dear Secretary Bose,

Please find enclosed the 2012 Pacific Lamprey Management Plan (PLMP) Comprehensive Annual and Biological Objectives Status 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 2012 PLMP Comprehensive Annual and Biological Objectives Status Report summarizes the on-going activities undertaken at the Priest Rapids Project (Project) in 2012, 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 Water Quality Certification Condition requirement to re-evaluate the Biological Objectives included in the PLMP, 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 30, 2013, the Public Utility District No. 2 of Grant County, Washington (Grant PUD) prepared and disseminated the draft 2012 PLMP Comprehensive Annual and Biological Objectives Status 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 and USFWS on February 13, and 19, 2012, respectively. 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. Based on comments received; Grant PUD modified the report to reflect appropriate revisions and edits.

This same report has also been provided to WDOE on March 11, 2013. On March 19, 2013, WDOE approved the Biological Objectives Status Report (Appendix E).

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

Sincerely,

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CC: Tom Dresser, Grant PUD
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Priest Rapids Fish Forum

2012
Pacific Lamprey Management Plan
Comprehensive Annual and Biological Objective Status Report

Priest Rapids Hydroelectric Project (FERC No. 2114)

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March 2013

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 2012, 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 fourth year of implementation of PLMP, Grant PUD continued, for a third year, its assessment of Pacific lamprey behavior and passage efficiency through fishways at Priest Rapids and Wanapum dams in order to evaluate the efficacy of design enhancements installed during the 2009-2010 winter fish ladder maintenance outage. For the 2010 through 2012 migrations, Grant PUD tracked a total of 145 and 75 PIT tagged lamprey at Priest Rapids and Wanapum dams, respectively. Fishway passage efficiency for lamprey was 82% for each dam over the 2010-2011 period. At the time of reporting, passage efficiency for the 2012 migration season were not yet available. These data will be presented in the 2013 annual report.

In 2012, monitoring of juvenile lamprey was also initiated to assess their presence/absence, habitat use, and relative abundance in areas affected by Project operations. In the Wanapum Reservoir, 36 potential shoreline habit locations were sampled. In the Priest Rapids Reservoir, 12 potential shoreline habitat locations were sampled. One juvenile lamprey was captured in the Priest Rapids Reservoir and another was observed, but not captured, in the Wanapum Reservoir. Subsequent juvenile surveys are planned to investigate shoreline habitats at lower operational elevations.

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

Over the past 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 ¾ - 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). 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 in 2012. On June 4-8 and 11-15, 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 (Appendix D). In the Wanapum Reservoir, 36 potential shoreline habit locations were sampled. In the Priest Rapids Reservoir, 12 potential shoreline habitat locations were sampled. One juvenile lamprey was captured in the Priest Rapids reservoir and another was observed, but not captured, in the Wanapum Reservoir. A similar survey will be completed in late 2012 to investigate shoreline habitats at lower operational elevations.

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 demonstrates 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:

> *<u>License Order:</u> 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, 2012) 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, 2011 through October 31, 2012) 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 30, 2013 for review. Written comments were received from WDOE on February 13, 2013 and USFWS on February 19, 2013. 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. Regional working groups will begin meeting in 2013.

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.

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. 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, movement patterns, overwintering and spawning areas for adults and juvenile distribution and abundance sampling are occurring. Multi-year juvenile distribution and abundance sampling and larval trend monitoring is occurring in the Klickitat, Wenatchee, Entiat and Methow watersheds. Surveys to assess juvenile distribution and relative abundance have been conducted in several of the mid-Columbia River reservoirs. Researchers are studying the physiological ecology and life history of adult lamprey during their freshwater residency in the Willamette River. In the laboratory setting, researchers are conducting studies to assess, anesthetic efficacy and the effects of contaminants on lamprey. Additional work is being conducted on lamprey population genetics, developing statistical approaches to evaluate patterns of juvenile occupancy and distribution in rivers, deep water survey methods, regional lamprey identification keys, artificial propagation techniques, 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 (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

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.

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. The 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 (see Section 2.2: Updated Information for additional details).

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 2012 migrations, Grant PUD tracked a total of 145 and 75 PIT tagged lamprey at Priest Rapids and Wanapum dams, respectively. Fishway passage efficiency for lamprey was 82% for each dam over the 2010-2011 period. Efficiencies for 2012 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).

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 (see Section 2.2: Updated Information for additional details regarding Keefer et al. 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).

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 (see Section 2.2: Updated Information for additional details).

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, 2011 through October 31, 2012 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 2012.

	Activity	Hydroelectric Project	River	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	Fifteen Mile 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. Preliminary results not yet available.	CTWSR	Personal communication with Cyndi Baker, CTWSR (9/27/12)
2.	Adult lamprey monitoring and juvenile lamprey density and distribution surveys	No associated hydro project	Deschutes and tributaries	In 2012, escapement estimates of lamprey at Sherars Falls are in progress. In addition, ammocoete density surveys from 2009 are being repeated as well as distribution of ammocoetes. Since the 2009 ammocoete density study, an extensive floodplain restoration project in lower Shitike Creek has been completed. Given lamprey preference for low velocity habitats dominated by silt and organic matter substrate, the restored floodplain area would be expected to have been colonized by ammocoetes. The current study will compare: 1) ammocoete densities in restored and unrestored areas of Shitike Creek; 2) densities of ammocoetes in Warm Spring River and Shitike Creek; and 3) densities from 2009 and 2012.	CTWSR	Personal communication with Cyndi Baker, CTWSR (9/27/12)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				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. Preliminary results not yet available.		
3.	Conduct adult lamprey movement study using radio telemetry	BOR projects in Yakima	Yakima	In 2012, the Mid-Columbia River Fishery Resource Office continued a radiotelemetry study of Pacific lamprey movements in the Yakima River. Ninety radio tagged adult Pacific lamprey were released into the lower Yakima River to assess passage at irrigation diversion dams, movement patterns, overwintering and spawning areas. The 2012 annual report will be available on December 31, 2012.	USFWS	Personal communication with Mark Nelson, USFWS (9/21/12)
4.	Determining adult escapement and adult harvest monitoring	Willamette Falls	Willamette	In 2010, the CTWSRO began a multiple year feasibility project to estimate lamprey escapement at Willamette Falls, funded by the Bonneville Power Administration, through the Columbia River Accords. The complex nature of both the study area and lamprey behavior requires a step-wise approach incorporating new technologies, addressing statistical error, and understanding of lamprey biology and behavior. In 2011, lamprey estimates were partitioned into escapement through the fish ladder and abundance of fish in congregational areas or straying below the Falls. Partitioning the estimate allowed error and uncertainty to be compartmentalized. Based on statistical changes in 2011, the 2010 abundance and escapement estimates were recalculated.	CTWSR	Personal communication with Cyndi Baker, CTWSR (9/27/12)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				The study design revolved around mark-recapture methods (MRC), in which lamprey abundance was estimated using Chapman's modification of the Peterson Estimator. Captured lamprey received a HDX PIT tag and a secondary mark. Additionally, HDX antennae and video equipment was installed in the fish ladder to detect lamprey passing upstream and record movement of non-tagged fish, respectively. Half duplex antennae were also installed at the crest of the Falls along "lamprey ramps". The HDX PIT tags and antennae provided estimates for lamprey returning to the fish ladder (45.7%) and for lamprey that failed to return to the ladder but were likely congregating areas downstream of the Falls, referred to as strays (54.3%). Estimated escapement of lamprey through the fish ladder between May 25 and September 12, 2011 was 49,072. The abundance of lamprey below the falls for the same period was 58,217. This period does not include the first 22.7% of the run. Based on cumulative catch in 2010, the estimate was expanded for a total escapement through the ladder of 63,483 and 75,313 below the Falls. Video from the fish ladder was used to support that the estimated escapement was credible. In 2012, the same methods were used to estimate escapements of lamprey through the fish ladder. Video cameras were used to document movement patterns of lamprey through the fish ladder, capturing the early part of the run, which was missing in 2011. Additional cameras were installed to record lamprey movement over lamprey ramps at the crest of the falls from July through October, 2012. Two lamprey ramp antennae were installed		

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				to detect PIT tagged lamprey ascending the falls. Preliminary work to plan for installation of half-duplex antenna in the old fishway (ca. 1904) and cameras to enumerate and record movement patterns of lamprey through this part of the falls has been completed. New equipment in the old fishway will be installed in 2013.		
5.	Occurrence, detection and habitat use of larval lamprey	No associated hydro project	Lower Willamette River	We used a generalized random tessellation stratified approach to select sampling quadrats (30X30m) in a random, spatially balanced order. Pacific lampreys, *Lampetra* spp., and unidentified lampreys were found in the Willamette River; larvae were detected in all areas except the Multnomah Channel. We calculated reach- and quadrat-specific detection probabilities and the amount of sampling effort required for 80% confidence that larval lampreys were in fact absent when they were not detected. Lampreys were detected in a variety of areas (although relatively low numbers were collected), including shallow, nearshore areas; midchannel areas (depth up to 16 m); and anthropogenically affected areas. Detection probabilities were 0.07 (reach) and 0.23 (quadrat). The sampling effort required for 80% confidence that lampreys were absent when undetected was 20 quadrats (in the lower Willamette River) and 6 quadrats (within a quadrat). Differences in lamprey detection by depth were not observed. A variety of sizes was collected (20-144 mm total length), indicating the likely occurrence of multiple ages of larvae. Our study identifies how the occurrence of larval Pacific lampreys can be quantified with statistical rigor in a large river. The effect of channel management activities on larval lampreys should be considered in efforts to conserve these important species.	USFWS	Occupancy and Detection of Larval Pacific Lampreys and *Lampretra* spp. In a Large River: the Lower Willamette River (Jolley et al. 2012)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
6.	Occurrence, detection and habitat use of larval lamprey	No associated hydro project	White Salmon, Wind, and Klickitat	In 2012, we estimated occupancy of larval lamprey at tributary mouths (including the Lower White Salmon, Wind, and Klickitat rivers within Bonneville Reservoir and the Deschutes River within The Dalles Reservoir, 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*. All locations were occupied with larval lamprey however these data have not yet been analyzed. A final report will be available in 2013.	USFWS	Personal communication with Greg Silver, USFWS (9/24/12)
7.	Lamprey monitoring	No associated hydro project	Hood River	Ammocoete density surveys were completed during fall 2009 prior to the removal of Powerdale Dam in summer 2010. Powerdale Dam (rkm 7.2) was a barrier to lamprey passage into Hood River. Ammocoete distribution surveys upstream of the Powerdale Dam site after removal indicate recolonization. Larval lamprey (ca. 40 – 50 mm) were sampled approximately 1.2 km upstream of the mouth of East Fork Hood River (enters Hood River approx. rkm 20 from mouth). Only one size class was found, suggesting recent recolonization. One half-duplex antenna was installed in Hood River near the mouth. Lamprey inserted with PIT tags at Bonneville Dam may be detected by this antenna array. As of late-September 2012, four detections were recorded.	CTWSR	Personal communication with Cyndi Baker, CTWSR (9/27/12)
8.	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.	CTUIR	Personal communication with Aaron Jackson, CTUIR (11/29/12)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				In total, 60-80 fish were tagged and monitoring consisted of both fixed stations and mobile surveys. Results are not yet available.		
9.	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). In order 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) timing and locations of spawning and overwintering, 2) spawning and rearing distribution, and 3) habitat associations. 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	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 2012nm) Personal communication with Cyndi Baker, CTWSR (9/27/12)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				ammocoetes (95% prediction interval = 3.7 to 7.5 million ammocoetes) for the identified habitat. 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.		
10.	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. Preliminary results are not yet available.	CTUIR	Personal communication with Aaron Jackson, CTUIR (11/29/12)
11.	Conduct juvenile distribution and abundance sampling	No associated hydro project	Yakima	Surveys in 2012 in the Yakima Basin are continuing and building from findings in 2010 and 2011. In general, very few juvenile Pacific lamprey are found throughout the basin consistent with very low recent adult counts at Prosser Dam. Juvenile surveys will continue to focus on status and trend monitoring and will also emphasize baseline information associated with future supplementation activities. Whereas most surveys in 2011 were in the upper subbasin (above Roza Dam) more recent surveys will focus on the lower subbasin where we envision most of our initial recovery work to occur.	Yakama Nation	Personal communication with Bob Rose, Yakama Nation (9/4/12) Yakama Nation Pacific Lamprey Restoration Project. Annual Progress Report (YNPLP 2012)
12.	Conduct juvenile lamprey surveys in irrigation canals	No associated hydro project	Yakima	The Yakama Nation Pacific Lamprey Project (YNPLP) was very active in November surveying dewatered irrigation canals within the lower Yakima River subbasin for juvenile lamprey within these diversions. Lamprey of various sizes were found behind screens and a technical report is available upon request.	Yakama Nation	Personal communication with Bob Rose, Yakama Nation (9/4/12) Yakama Nation

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
						Pacific Lamprey Restoration Project. Annual Progress Report (YNPLP 2012)
13.	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 draft report is in progress.	USFWS	Personal communication with Mark Nelson, USFWS (9/21/12)
14.	Conduct status and trend larval monitoring program	No associated hydro project	Methow	In 2012, 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. 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 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 2013.	Wild Fish Conservancy and USFS	Personal communication with John Crandall, Wild Fish Conservancy (10/11/12)
15.	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 2012.	Wild Fish Conservancy and Yakama Nation	Personal communication with John Crandall, Wild Fish Conservancy (10/11/12)
16.	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 (*Lampetra* and *Entosphenus*). A report is available as of July 2012 (Wyss et al. 2012).	Oregon Cooperative Fish and Wildlife Research Unit	Personal communication with Lance Wyss, OSU (9/18/12)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				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.	at OSU	Relative Abundance and Associated Habitat Characteristics of Larval Lamprey in Five Willamette River Tributaries (Wyss et al. 2012)
17.	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 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).	Chelan PUD	Distribution, Composition, and Abundance of Juvenile Lampreys (Lampetra sp.) within the Observed Operating Range of Rocky Reach Reservoir, 2011 (Chelan PUD 2012b)
18.	Presence/Absence, habitat use, and relative abundance of juvenile lamprey	Priest Rapids and Wanapum	Columbia	On June 4-8 and 11-15, 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, 36 potential shoreline habit locations were sampled. In the Priest Rapids Reservoir, 12 potential shoreline habitat locations were sampled. One juvenile lamprey was captured in the Priest Rapids reservoir and another was observed, but not captured, in the Wanapum reservoir. These results suggest that Pacific lamprey ammocoetes are rare in the shoreline areas of the Project. A similar study will be completed in late 2012 to investigate shoreline habitats at lower operational elevations.	Grant PUD	Personal communication with Mike Clement, Grant PUD (10/29/12)
19.	Lamprey physiology, behavior,	N/A	N/A	A manuscript on oxygen consumption of adult	USGS	Personal

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
	and performance laboratory studies			Pacific lampreys at rest and during swimming is in the final editing stages. The paper, if accepted, will be available in 2013.		communication with Matt Mesa, USGS (10/12/12)
20.	Lamprey artificial propagation	N/A	N/A	Pacific lamprey adults were collected in summer 2011 and held over winter at ambient water conditions. Eggs and milt were stripped from anaesthetized fish after they reached sexual maturity in early June 2012 (two females and three males). The eggs from both females were combined in a plastic container, and the milt samples were combined in a separate container. A sample of the eggs was immediately mixed with the milt, allowed to harden in water, rinsed, and housed in upwelling jars (Eager Inc.) at the Prosser Fish Hatchery. These eggs were held at ambient water temperature throughout the incubation period. Some of the remaining eggs and milt were transferred to separate sealed plastic containers and maintained at approximately 14°C for 7 h during transport to the Mukilteo Research Station (MUK). These eggs were then fertilized using the same methods used at Prosser. Three egg disinfection methods were tested at MUK: no disinfection, disinfection on day 1 only, and disinfection every 3 d for the first week of development. Disinfection involved gentle transfer of fertilized eggs into a 100 ppm iodophor (Argent Argentyne) solution for 10 min followed by gentle rinsing. All treatments were held in 10-L chambers with recirculating, UV-irradiated water at 14°C throughout incubation. For all treatments, eggs were checked regularly throughout the incubation period by viewing a subsample using a dissecting microscope. Fertilization success for the Prosser culture was high and 99% survived to hatching. However, only about 50% of the transported eggs were successfully fertilized. Of these, nearly all of	NOAA Fisheries	Personal communication with Mary Moser, NOAA Fisheries (12/5/12)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				the non-disinfected and one-time disinfection treatments survived to hatching. However, the eggs disinfected at later stages of development exhibited very high mortality. These results indicate that: 1) both re-circulating and flow-through culture options worked equally well for lamprey egg incubation, 2) delayed fertilization of eggs resulted in lower survival, and 3) if egg disinfection is employed, it should not be done after approximately day 5 of embryo development.		
21.	Lamprey artificial propagation	N/A	N/A	The YNPLP initiated artificial propagation of Pacific lamprey this year. 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 successfully propagate several tens of thousands of larval and will continue to learn how to feed and care for these throughout the year.	Yakama Nation	Personal communication with Bob Rose, Yakama Nation (9/4/12)
22.	Assess Atrazine effects on lamprey	No associated hydro project	Willamette and Siletz rivers	Pacific lamprey (Entosphenus tridentatus) are experiencing population declines throughout their range. Xenobiotics could be an important risk factor for lamprey populations. Our goal was to establish if common herbicides, as used in forest management, could affect reproductive fitness. We determined that atrazine was a likely compound of greatest concern to lamprey populations. Using an odorant response behavioral assay we were able to demonstrate that environmentally relevant concentrations of atrazine caused a depressed response to adult lamprey holding tank effluent, likely pheromones. Atrazine also depressed their activity level; the number of times they crossed into the effluent arm after being treated with atrazine was significantly lower than controls. In addition, activity level post exposure to atrazine differed between adult life history stages,	The Oregon Cooperative Fish and Wildlife Research Unit at OSU Confederated Tribes of the Siletz Indians	Effects of Atrazine on Olfactory-Mediated Behaviors in Pacific Lamprey (*Entosphenus tridentatus*) (Smith 2012)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				something which was not significantly different during control trials. Using an odorant detection assay, based on evaluating ventilation rate, we were able to show that environmentally relevant concentrations of atrazine caused a significant increase in ventilatory response to a repulsive odorant, a conspecific necromone. Through the detection study we also showed that lamprey, exposed to atrazine, had a slight increase in ventilatory response to odor from adult lamprey. If we are concerned about the decline in Pacific lamprey populations, then we should logically be concerned with their exposure to atrazine in the environment.		
23.	Develop new apparatus and methods to survey for juvenile lamprey in deep water habitats	N/A	N/A	Researchers developed a means to survey for the presence of juvenile lamprey ammocoetes in deep water habitats. A weighted sled outfitted with an electroshocker (modified ABP-2 backpack unit) and video camera was tested in the laboratory using groups of western brook lamprey ammocoetes (70-150 mm) confined to a net pen consisting of artificial substrates. Voltages averaged 0.34 V within the shocking region (1,200 cm^2). The mean detection rate was 60% for three test trials (10 fish/trial).	PNNL	Laboratory Testing of a Modified Electroshocking System Designed for Deepwater Juvenile Lamprey Sampling. (Mueller et al. 2012)
24.	Deep-water survey for juvenile lamprey in the lower Snake River	No associated hydro project	Lower Snake	Two surveys conducted in July- September 2011 at 12 sites from Asotin to Ice Harbor Reservoir. The total survey area for each trip was ~300 m^2. No larval lamprey were found during both survey periods. Water clarity was poor during the initial survey which limited the cameras field of view. The sampling system has the capability to document lamprey presence over a wide range of habitats and can determine physical habitats including (grain size, water velocity, depth, water temperature, and GPS locations).	PNNL	Habitat Quality and Fish Species Composition/Abundance at Selected Shallow-Water Locations in the Lower Snake River Reservoirs, 2010–2011 (Arntzen et al. 2012)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
25.	Field sampling of deep-water shocking system	No associated hydro project	Columbia and Wind	A field test of the deep-water juvenile lamprey shocker was conducted in August 2012. We were able to shock lamprey of all life stages at about 50% of the locations we sampled (54 total). Lamprey were detected with the video camera inhabiting various habitats, including sand, silt, mixed sand/silt with woody debris and near macrophytes. Lamprey lengths were also determined using incorporated paired lasers for scaling.	PNNL	Personal communication with Bob Mueller (9/12/12)
26.	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 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	USGS	Personal communication with Matt Mesa, USGS (10/12/12)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				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. 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.		
27.	Collect Pacific lamprey genetic samples for CRITFC basin-wide assessment	No associated hydro project	Entiat and Wenatchee	Collection of juvenile Pacific lamprey genetic samples during distribution surveys in Entiat and Wenatchee rivers. Analysis conducted by Jon Hess, CRITFC, Hagerman, ID.	USFWS	Personal communication with Mark Nelson, USFWS (9/21/12)
28.	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 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.	The Confederated Tribes of Grand Ronde and USFWS Abernathy Fish Technology Center	Personal communication with Rebecca McCoun, CTGR (9/11/12)
29.	Population genetics of Pacific lamprey	N/A	N/A	Previous genetic studies in the anadromous Pacific lamprey (*Entosphenus tridentatus*) have both supported and rejected the hypothesis of natal homing. To resolve this, we used nine	Dept. of Biological Sciences. University of	Neither philopatric nor panmictic: microsatellite and mtDNA evidence

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				microsatellite loci to examine the population structure in 965 Pacific lamprey from 20 locations from central British Columbia to southern California and supplemented this analysis with mitochondrial DNA restriction fragment length polymorphism analysis on a subset of 530 lamprey. Microsatellite analysis revealed (i) relatively low but often statistically significant genetic differentiation among locations (97% pairwise FST values were <0.04 but 73.7% were significant); and (ii) weak but significant isolation by distance (r2 = 0.0565, P = 0.0450) but no geographic clustering of samples. The few moderate FST values involved comparisons with sites that were geographically distant or far upstream. The mtDNA analysis—although providing less resolution among sites (only 4.7% FST values were significant)—was broadly consistent with the microsatellite results: (i) the southernmost site and some sites tributary to the Salish Sea were genetically distinct; and (ii) southern sites showed higher haplotype and private haplotype richness. These results are inconsistent with philopatry, suggesting that anadromous lampreys are unusual among species with long migrations, but suggest that limited dispersal at sea precludes panmixia in this species.	Manitoba	suggests lack of natal homing but limits to dispersal in Pacific lamprey (Spice et al. 2012)
30.	Population genetics of Pacific lamprey	N/A	N/A	Restriction site-associated DNA sequencing was employed to genotype single nucleotide polymorphism (SNP) loci for 518 individuals collected over a broad geographical area including British Columbia, Washington, Oregon, and California. A subset of putatively neutral markers (N=4068) identified a significant amount of variation among three broad populations: northern British Columbia, Columbia River/southern coast, and 'dwarf' adults (p<.001). Additionally, 162	Columbia River Inter-Tribal Fish Commission (CRITFC)	Population genomics of Pacific lamprey: adaptive variation in a highly dispersive species (Hess et al. 2012)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				SNPs were identified as adaptive through outlier tests, and inclusion of these markers revealed a signal of adaptive variation related to geography and life history. Further analyses using a genomic browser available for sea lamprey found that these outliers were significantly associated with geography, run timing and dwarf life history (42) as well as known genes or highly conserved genomic regions (27). This study provides both neutral and adaptive context for observed genetic divergence among collections and thus reconciles previous findings of population genetic heterogeneity within a species that displays extensive gene flow.		
31.	Incidence of male intersex in adult Pacific lamprey	N/A	N/A	This paper reports the incidence of male intersex in adult Pacific lamprey during their pre-spawning migration into freshwater. Although hermaphrodites have been suggested in other adult lampreys this is the first detailed description and discussion of this phenomenon. A total of 0.5% of adult Pacific lamprey from Willamette Falls (2 out of 427) were intersex, with oocytes in the testes. This phenomenon was identifiable only by histological examination. Because premetamorphic lamprey can possess both female and male gonad cells, we hypothesize that intersex is a remnant larval trait and that these fish failed to fully develop into males during metamorphosis.	The Oregon Cooperative Fish and Wildlife Research Unit at OSU	Incidence of male intersex in adult Pacific lamprey (*Entosphenus tridentatus*), with a brief discussion of intersex vs. hermaphroditism in lampreys (Petromyzontiformes) (Clemens et al. 2012)
32.	Identification workshops and development of regional keys	N/A	N/A	The purpose of the project was to develop lamprey identification keys specific to geographic regions within the Columbia River, Coastal Oregon, Coastal Washington including Puget Sound and present lamprey species identification methods at multiple workshops through the Pacific Northwest. In total, seven workshops were held in Washington and Oregon in 2011.	Western Fishes	Pacific Lamprey – Identification Workshops and Development of Regional Keys. Final Report (Reid 2012) Lampreys of the

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				An updated version of a Columbia Basin field identification key was developed for lampreys. Species includes Pacific, River, Western Brook, and Pacific Brook lamprey. The identification key uses pigmentation, trunk myomere counts, oral and other morphological characteristics to distinguish between both juvenile and adult life history stages of these species. The document is intended to be iterative with updates as more information becomes available.		Columbia Basin: Field ID Key (Reid 2011).
33.	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.	CTUIR	Personal communication with Aaron Jackson, CTUIR (11/29/12)
	Lamprey Migration in Rivers					
34.	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	In 2011, adult lamprey were collected at Bonneville Dam and tagged with HDX-PIT tags. Passage was monitored at multiple projects in the Columbia and Snake rivers. A second group of lampreys was tagged with both HDX-PIT and acoustic transmitters (JSATS) and was monitored in reservoirs and at some tributary sites. The primary objectives of the evaluation were to estimate lamprey escapement past the monitored sites, to assess the final known distribution of tagged fish, and to integrate 2011 results with those from HDX, JSATs, and radio-tagged lampreys from previous years. A total of 929 adult lamprey were HDX-PIT tagged and 85 were double tagged (HDX and	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: 2011 Half Duplex PIT-TAG Studies (Keefer et al. 2012a) Matthew Keefer, University of Idaho, Presentation at AFEP Review, Portland, OR (11/29/12)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				JSAT). The combined basin-wide results in 2011 indicated improved passage efficiency at Bonneville Dam and through some upstream reaches, despite river discharge that was well above average (typically associated with lower escapement). Recent modifications made to fishway operations and structures potentially improved lamprey passage at dams (especially Bonneville Dam). In 2012, 898 adult lampreys at Bonneville Dam were HD PIT-tagged with 823 (92%) being released downstream, 50 (6%) released into the Cascades Island lamprey passage system (LPS), and 25 (3%) released into the Bonneville forebay. Upstream passage was monitored at the four lower Columbia and Snake river dams, at Priest Rapids and Wanapum dams, and at tributary locations. As of the November 2012, some lamprey (2012 tagged) were still actively migrating, monitoring sites were still deployed, and data were not yet fully processed. Preliminary results indicate that escapement from release below Bonneville Dam to top of ladder antennas was 53% in 2012 which is in the middle of the range of estimates from 2005-2011. Escapement estimates from release past The Dalles Dam (26%) and past John Day Dam (22%) in 2012 were also in the range of previous results. Notably, preliminary estimates of escapement into the Snake River (1.3%) and to Priest Rapids Dam (2.5%) are at the high end of estimates for those sites and we expect that estimates will increase slightly when the late fall dam passage data and tributary detections are incorporated into the database.		
35.	Migration characteristics and	No associated	Willamette	The goal of the study was to understand the	The	Migration

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
	distribution in the Willamette Basin	hydro project		migration characteristics and distribution of adult Pacific lamprey, Entosphenus tridentatus, in the Willamette Basin, and potential barriers to the migration of these fish. Analyses were run on 372 radio-tagged fish that were released immediately below or above Willamette Falls. Results are as follows: • Through cluster analysis, we identified 9 distinct migratory clusters. These clusters were statistically significant (A-statistic = 0.26, P < 0.001). Migratory behaviors varied widely, and the fish did not always exhibit a unidirectional upstream movement. • Fish distributed more rapidly throughout the mainstem Willamette during the relatively higher flow year of 2010 in comparison to 2009, suggesting that fish actively migrated further when higher flows were available. • Many, but not all, lamprey held in one location during the late summer (August through September), and they moved more during other times of the year when higher, cooler flows were experienced. • Adult lamprey that held in the same location in the mainstem Willamette used areas with coarse substrate (e.g., rock revetments, logs, boulders) that may have provided cover from light and predation from birds or other fish (e.g., white sturgeon). Past observations and the results of the study suggest that Pacific lamprey were widely distributed in the Willamette Basin and more likely widely distributed in its upper reaches.	Confederated Tribes of Grand Ronde (in collaboration with Cramer Fish Sciences and the Oregon Cooperative Fish and Wildlife Research Unit at OSU)	characteristics and habitat use of the imperiled adult Pacific lamprey in the Willamette Basin: Prelude to estimating requirements for persistence (Clemens et al. 2012)
36.	Migration Characteristics and	No associated	Willamette	From May to August 2009 and 2010, a total of 407	The	Migration Behavior

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
	Habitat Use in the Willamette Basin	hydro project		lamprey were radio-tagged at Willamette Falls Dam (rkm 42.6). Twenty-two fixed radio telemetry receiver sites were installed in the Willamette watershed to track lamprey movements. The majority of movement occurred from mid-May to mid-August. Ninety three percent of lamprey were observed in mainstem and tributary habitats during active migration, traveling 0-48 km per day, with average migration speeds of 3 and 4 km per day in 2009 and 2010, respectively. A wide range of migration behaviors were observed. Spring movement peaked at 11°C and summer movement at 22°C; however, statistical analyses did not support our hypothesis that temperature was a strong determinant of lamprey movement patters in the upper Willamette Basin. We suspect that lamprey, much like salmon and steelhead, are proficient at modulating the physiological effects of warming river conditions by seeking thermal refugia near the mouths of tributaries and hyporheic seeps. This would explain observations that lamprey were capable of upstream movements when mainstem water surface temperatures exceeded 26°C. Although tagged lamprey utilized all 13 tributaries, detections were most frequent in the Santiam, Coast Fork Willamette, Calapooia, Yamhill, and Mollalla rivers. Lamprey also appeared to use the mainstem Willamette extensively during winter months. Future studies should focus on learning more about environmental constraints in the mainstem Willamette River. Emphasis should also be placed on Pacific lamprey use of specific subbasins, particularly the Santiam River system. The disproportionately high use of these key watersheds suggests that they may be critical for population persistence and likely provide the best	Confederated Tribes of Grand Ronde (in collaboration with Cramer Fish Sciences and the Oregon Cooperative Fish and Wildlife Research Unit at OSU)	and Distribution of Adult Pacific Lamprey in the Willamette Basin (Courter et al. 2012) Personal communication with Rebecca McCoun, CTGR (9/11/12)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				opportunities to learn about the factors limiting lamprey production elsewhere in the Willamette Basin. In 2012, the Tribe continues to monitor 22 lamprey telemetry sites in the Upper Willamette Basin for 119 fish that were tagged in 2011. A third year of analysis will be conducted in fall 2012 and compared to 2010-2011 results.		
37.	(1) Evaluate adult lamprey migration through Winchester Dam (2) Assess adult lamprey habitat at Winchester Dam in relation to temperature (3) Analyze upstream migration behavior (effects of river environment and morphology) (4) Assess adult lamprey habitat use (holding, overwintering and spawning)	Winchester Dam (not a hydroelectric project)	North Umpqua (outside of Columbia River Basin)	This work had three research goals: 1) to describe the passage efficiency and migration routes of adult Pacific lamprey at Winchester Dam; 2) to evaluate the seasonal movement patterns of adult Pacific lamprey and their use of holding habitat at Winchester Dam in relation to temperature conditions; and 3) to portray the diversity of upstream migratory behaviors of adult Pacific lamprey and the environmental factors that influence these behaviors. This radio telemetry study was conducted between March 2009 and August 2011 with a combination of fixed stations and manual tracking. Passage efficiency was low in both years (8% and 19%, respectively), and all tagged lamprey that successfully passed the dam used routes other than the fish ladder. Lamprey that migrated early within the run and those with relatively small tags had higher passage rates and traveled further than the other groups of lamprey. Lamprey released above of the dam or those that passed the dam on their own distributed themselves widely in the upstream environment, suggesting that the dam deterred their upstream migration. Using mark-recapture data for the two years, the adult Pacific lamprey population upstream of Winchester Dam was estimated at 960 (95% C.I. [188, 4760]) in 2009	Oregon Cooperative Fish and Wildlife Research Unit at OSU Partnership for Umpqua Rivers ODFW	Passage, Migration Behavior, and Autoecology of Adult Pacific Lamprey at Winchester Dam and within the North Umpqua Basin, Oregon, USA (Lampman 2011)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				and 556 (95% C.I. [110, 2798]) in 2010, which was considerably lower than historical counts at the dam (between 14,532-46,785 in 1965-1971). Most tagged lamprey that did not pass the dam remained at the base of the dam at the end of the summer migration (63% in 2009 and 67% in 2010). Types of habitat most frequently used by lamprey downstream from the dam included the dam surface (wooden structures with crevices), interface zones between fast and slow water, and highway bridge pilings. The lamprey movement changed considerably between August and September, and the frequency of movements decreased sharply during this period. Tagged lamprey were detected using thermal refuges immediately downstream of the dam that were 0.4 to 2.8 C° colder than the mean river temperature at the dam, and this temperature differential increased as the season progressed. Lamprey may be seeking overwintering habitat associated with hyporheic exchange flows at the dam towards the end of the summer season after their display of heightened activity early in the summer. Ninety-five percent of the overall upstream migration took place during the first spring/summer period, and only small-scale upstream movements were observed during the winter and second spring/summer (4% and 1%, respectively). The rate of upstream migration (median) was the fastest during the initial migration phase and was 1.9 km/day (ranging from 0.3 to 11.0 km/day) for tagged lamprey released above Winchester Dam. During winter, 71% of the lamprey remained in the same location where they initiated holding.		

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				Multiple regression analysis indicated that the total upstream distance traveled by individual lamprey was most strongly related to presence/absence of Winchester Dam, relative tag size, and water temperature and photoperiod conditions at release. The presence of Winchester Dam, large relative tag size, and high water temperature / short photoperiod conditions at release significantly reduced upstream migration distance.		
38.	Evaluate movement and fate of adult Pacific lamprey in Bonneville Reservoir and Lower Columbia River	Bonneville	Columbia	In 2011, 85 adult lampreys were collected at Bonneville Dam and tagged with both JSATS and HD-PIT transmitters from 11 June through 3 September. The objectives were to calculate lamprey travel times, to estimate escapement past the monitored sites, and to evaluate JSATS detection efficiency. Two types of JSAT transmitters were used: a 60 day and 400 day battery life type. All fish were released at either the Hamilton Island boat ramp in the Bonneville Dam tailrace or the Stevenson boat ramp in Bonneville Reservoir. Sixteen autonomous receivers were deployed between Bonneville and The Dalles Dam tailraces including one in the Klickitat River 300m from the mouth. The escapement estimate for lampreys released into the Bonneville Dam tailrace past the dam was 35%, lower than estimates from previous HD-PIT studies (41-53%). The escapement estimate from release in Bonneville Reservoir past The Dalles Dam (39%) was similar to that for HD-PIT tagged adults released to the Reservoir and was slightly lower than JSATS-tagged adults from 2010 (43%). Distributions and final fates of tagged fish through early spring were similar to those seen in previous	ACOE (prepared by the University of Idaho Cooperative Fish and Wildlife Research Unit)	Adult Pacific Lamprey Migration Behavior and Escapement in the Bonneville Reservoir and Lower Columbia River monitored using the Juvenile Salmonid Acoustic Telemetry System (JSATS), 2011 (Noyes et al. 2012)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				years. The majority (84%) of fish that entered or were released into Bonneville Reservoir passed through the majority of the reservoir and were detected at the Lyle, WA receiver gate, 16 km from The Dalles Dam. This suggests that migration conditions and factors during summer and fall such as predation are not strongly contributing to the overall unaccounted losses in the Bonneville Reservoir and that fish are not overwintering in the downstream two-thirds of Bonneville Reservoir. Acoustic monitoring has continued from receiver deployment in mid-May 2011 to date (May 2012). The 400 d battery life transmitters are still active. Of the 85 lamprey tagged in 2011, seven (8.2%) were subsequently detected in 2012. Five of these were last recorded near the mouths of Bonneville Reservoir tributaries.		
39.	Evaluate adult Pacific lamprey movements and fate in Columbia River reservoirs	Bonneville	Columbia	The effectiveness of a stationary array of acoustic JSAT receivers for monitoring the migration of tagged adult lampreys in Bonneville Reservoir was evaluated. Three hundred adult lamprey were tagged with 400-day duration JSAT tags from 5 June through 1 September 2012. A total of 146 fish were released upstream of Bonneville Dam at the Stevenson, WA or Cascade Locks Marina. The remaining 154 fish were released into the Bonneville Dam tailrace. Gates of one to three receivers at thirteen locations were deployed from Rooster Rock, OR (rkm 209.7) to the John Day River (1.2 km upstream of the mouth (rkm 352)). Monitoring is still ongoing and results are not yet available.	NOAA Fisheries	Christopher Noyes, Presentation at AFEP Review, Portland, OR (11/29/12)
40.	Design and construction of flume to test irrigation	N/A	N/A	In 2012, the USGS designed and constructed a large, oval flume to test the effects of irrigation	USGS	Personal communication

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
	diversion screening			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 mechanical revisions. Actual testing may start as early as Fall, 2012.		with Matt Mesa, USGS (10/12/12)
41.	Effectiveness of fish screen materials for juvenile lamprey	N/A	N/A	We tested the effectiveness of five common fish screen materials for excluding lamprey ammocoetes: interlock (IL), vertical bar (VB), perforated plate (PP), and 12-gauge and 14-gauge wire cloth (WC12) and (WC14).When fish (28–153 mm) were exposed for 60 min to screen panels perpendicular to an approach velocity of 12 cm/s in a recirculating flume, the percentage of ammocoetes entrained (i.e., passed through the screen) was 26% for the IL, 18% for the PP, 33% for the VB, 62% for the WC14, and 65% for the WC12 screens. For all screens, most fish were entrained within the first 15–20 min. Fish length significantly influenced entrainment, with the PP, VB, and IL screens preventing fish greater than 50–65 mm from entrainment and the WC14 and WC12 screens preventing entrainment of fish greater than 90–110 mm. Fish of all sizes repeatedly became impinged (i.e., contacting the screen for more than 1 s) on the screens, with the frequency of impingement events increasing during the first 5min and becoming relatively stable thereafter. Impingement ranges were highest on the IL screen (36–62%), lowest on the WC14 andWC12 screens (13–31%), and intermediate on the PP and VB screens (23–54%). However, the WC14 and WC12 screens had fewer and larger fish remaining as time elapsed because so many were entrained. For all screen types, injuries were	USGS	Effectiveness of Common Fish Screen Materials to Protect Lamprey Ammocoetes (Rose and Mesa 2012)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				rare and minor, and no fish died after overnight posttest holding. Our results indicate that wire cloth screens should be replaced, where practical, with perforated plate, vertical bar, or interlocking bar screens to reduce lamprey entrainment at water diversions.		
42.	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. Data for 2012 is still be analyzed and may be available in 2013.	CTUIR	Personal communication with Aaron Jackson, CTUIR (11/29/12)
	Adult Passage at Hydroelectric Facilities					
	Structural and Operational Fishway Modifications					
43.	Ladder tours	McNary, Ice Harbor, Lower Monumental, Little Goose, Lower Granite	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 (9/18/12) and Steve Juhnke, ACOE (9/13/12)
44.	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 2012, 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 facilities, newly designed count stations, and ramps downstream of perched orifices) and to identify any potential passage problem areas.	Grant PUD	Personal communication with Mike Clement, Grant PUD (10/22/12)
45.	Improving adult lamprey passage using lamprey passage structures (LPS) and refuges	Bonneville	Columbia	At Bonneville Dam, refuge boxes were installed along the bottom of the WA-shore auxiliary water supply (AWS) channel, thereby improving	ACOE (prepared by NOAA	Steve Corbett, NOAA Fisheries, Presentation at

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				retention in this area. Thirty-six of the 977 PIT-tagged lamprey released below the dam were subsequently detected in refuge boxes. Of the PIT-tagged lamprey detected existing the WA-shore fishway or LPS, 11.8% had previously used a refuge box. At the Cascade Island LPS, tests were conducted to determine whether reducing water volume through the lower part of this structure would improve collection efficiency and/or passage success. Lamprey use of this structure in 2012 was the highest of any previous year of operation. Experiments to determine passage success indicated that 41/50 (82%) PIT-tagged fish released into the structure successfully ascended to the trap at its terminus. Thus, modifications made in 2012 to enhance the entry and retention at rest boxes appears to have improved passage success relative to 2011. Efforts to identify additional trapping locations at Bonneville Dam continued in 2012. At the Cascade Island AWS Channel, which has no direct outlet to the forebay, 268 lamprey were opportunistically captured, transported, and released upstream from the dam. This location should be a focus of future efforts to collect lamprey for transport or research purposes.	Fisheries)	AFEP Review, Portland, OR (11/29/12)
46.	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.	CTUIR	Personal communication with Aaron Jackson, CTUIR (11/29/12)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
47.	Passage improvement design	John Day	Columbia	Completed design work and awarded contracts for extensive salmonid and lamprey passage improvements to North Fish Ladder lower ladder and entrance areas. Entrance 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"), removal of lower ladder weirs, and a planned entrance area LPS. Construction commenced in Winter 2011-12 and Winter 2012-13.	ACOE	Personal communication with Sean Tackley, ACOE (9/18/12)
48.	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.	ACOE	Personal communication with Steve Juhnke, ACOE (9/13/12)
49.	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 (10/22/12)
50.	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	ACOE	Personal communication with Sean Tackley, ACOE (9/18/12)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				timely salvage. Procedures are in place and ongoing.		
51.	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 and Andrew Gingerich, Douglas PUD (9/13/12)
52.	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 and Jeff Osborn, Chelan PUD (9/10/12)
53.	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 (10/22/12)
54.	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 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. In 2012, Portland General Electric (PGE) continued to operate the “old fishway” and install lamprey ramps to facilitate adult lamprey passage at Willamette Falls Dam.	PGE	Personal communication with Tim Shibahara, PGE (9/18/12)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
55.	Initiated design work for fishway modifications	Ice Harbor, Lower Monumental	Snake	Initiated design work and awarded contract for minor modifications to fishway. Lamprey orifices in control section weir walls, ramps to elevated salmon orifices, and diffuser grating landing plates will be installed during the winter outage period (Jan-Feb 2012). Construction was completed in February 2012. Post-construction monitoring of one lamprey orifice per ladder, using optical cameras is ongoing.	ACOE	Personal communication with Steve Juhnke, ACOE (9/13/12)
56.	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 (Jan-Feb 2013).	ACOE	Personal communication with Steve Juhnke, ACOE (9/13/12)
57.	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.	Chelan PUD	Personal communication with Steve Hemstrom and Jeff Osborn, Chelan PUD (9/10/12)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
58.	Design and construction of prototype fishway entrance bypass system for adult lamprey	Bonneville	Columbia	Completed design of alternative water supply system for the prototype Bonneville Washington Shore Fish Ladder, North Downstream Entrance Lamprey Flume System, now to be installed in Winter 2012-13. The gravity water supply system replaced the screened pump system included in the original design. This will save on operations and maintenance costs, may provide a cost break up for initial construction, and eliminates noise concerns associated with having a 53 cfs pump in the Powerhouse 2 tailrace. A contract for construction was awarded in Summer 2012.	ACOE	Personal communication with Sean Tackley, ACOE (9/18/12)
59.	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. • The auxillary water comes into the entrance pool through a wall diffuser rather than a floor diffuser. • A 3"W x 4"H orifice through the dog-leg wall, on the floor and against the side wall. • A rounded instead of square end on the dog-leg • All lips, floor bumps and width changes (e.g. to and from pool and transport channels) have 4" radius corners. • In 2012, engineering design continued with all of the above elements in place.	EWEB	Personal communication with Andy Talabere, EWEB (9/11/12)
60.	Reduced water velocities at fishway entrances	Bonneville	Columbia	In 2012, continued reduced nighttime flow operations at the Washington Shore Fish Ladder to improve lamprey passage efficiency.	ACOE	Personal communication with Sean Tackley, ACOE (9/18/12)
61.	Reduced water velocities at fishway entrances	McNary	Columbia	In 2012, continued reduced nighttime flow operations at the Oregon Shore Fish Ladder	ACOE	Personal communication

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				entrances (except SFE2), to improve lamprey passage efficiency. The entrance gate for SFE2 were modified to provide a 16" deep water attraction slot (bottom gate was elevated 16" off sill) to evaluate an alternate lamprey passage route. This is a pre-construction test for the upcoming lamprey entrance structure (line item 48).		with Steve Juhnke, ACOE (9/13/12)
62.	Reduce water velocities at fishway entrances	Wells	Columbia	Studies in 2009 and 2010 at Wells Dam that used Dual Frequency Identification Sonar (DIDSON) technology to observe the behavior of lamprey attempting to pass the fishway entrances under different operating conditions. The results of those studies indicate that lamprey entrance efficiency may be enhanced by reducing the collection-gallery-to-tailwater head differential from 1.5' to 1.0' between 17:00 and 0:59 hours during the peak of the lamprey migration. Post-hoc analyses indicate this is the eight-hour block with the lowest diel salmonid passage activity and highest diel lamprey activity. Based upon DIDSON studies conducted in 2009 and 2010 at the Wells Dam fishway entrances, Douglas PUD operated the Wells fishway collection galleries at a 1.0' head differential from 17:00 to 00:59 daily during the 2012 lamprey migration. The operations commenced three days after the day on which the cumulative passage of lamprey at Rocky Reach Dam equaled five lamprey, and terminated on September 30.	Douglas PUD	Personal communication with Chas Kyger and Andrew Gingerich, Douglas PUD (9/13/12)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
63.	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). 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 record-sized run. ACOE plans to make similar modifications at the Washington Shore Fish Ladder in winter 2012-13	ACOE	Personal communication with Sean Tackley, ACOE (9/18/12)
64.	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 (9/18/12)
65.	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 (9/18/12)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
66.	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 (9/13/12)
67.	Maintain fishway operations criteria	Rock Island	Columbia	Pursuant to the Rocky Reach and Rock Island Fish Passage Plan (Chelan PUD 2012a), fishway operations criteria are in place.	Chelan PUD	Personal communication with Steve Hemstrom and Jeff Osborn, Chelan PUD (9/10/12)
68.	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 (10/22/12)
69.	Minor fishway modifications	The Dalles	Columbia	Installed aluminum ramps to four elevated submerged orifices (2 orifices per weir, 2 weirs) in overflow weir section of The Dalles East Fish Ladder during winter 2011-2012. All other overflow weirs in the ladder, with the exception of one in the transition pool, are contiguous with the fishway floor.	ACOE (installed by NOAA Fisheries)	Personal communication with Sean Tackley, ACOE (9/18/12)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
70.	Fishway modifications to facilitate lamprey collection and counting	John Day	Columbia	Initiated design effort to modify 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 will be reduced to ¾ inches, except near the bottom, where openings will allow lamprey to enter a small flume system leading to a trap and video, mechanical, or electronic counting mechanism (to be determined). When not in collection mode, the system will allow lamprey to continue moving up the fishway. ACOE is currently completing a design documentation report (DDR), and expects installation of the prototype in winter 2012-2013.	ACOE	Personal communication with Sean Tackley, ACOE (9/18/12)
	Project Passage Effectiveness					
71.	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. Two objectives of the study were to 1) Synthesize data from ACOE funded radio telemetry (1997-2002, 2005-2010) and HD PIT-tag (2005-2011) studies; and 2) develop models to help prioritize investments in lamprey passage improvements at individual dams (fishway bottleneck models). The data synthesis indicated that fishway entrance, fishway segment, total fishway, and dam passage efficiency estimates are consistently lowest at Bonneville and John Day dams. Performance was up to 50% higher at The Dalles and McNary dams. Samples sizes at Snake River dams precluded comparisons.	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. 2012b) Matthew Keefer, University of Idaho, Presentation at AFEP Review, Portland, OR (11/29/12)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				Modeling indicated that serpentine weirs, the Powerhouse 2 junction pool/transition pool, and the Powerhouse 1 (A-branch) transition area may be the highest priority sites for future improvements at Bonneville Dam. At the Dalles, John Day, and McNary dams, transition areas were also identified as potential priority sites. The upriver escapement models suggest that Bonneville Dam should remain the highest priority site given the number of lamprey affected. However, incremental improvements at multiple dams were also shown to provide significant upriver escapement benefits.		
72.	3-D Modeling Tools to document information and prioritize improvements	Bonneville, The Dalles, John Day, McNary	Columbia	To facilitate efficient communication and to support prioritization of future fishway modifications for adult Pacific lamprey, a 3-D fishway model of the Bonneville Washington Shore fishway that can serve as a "wiki" that provides rapid and spatially linked access to diverse information sets, was developed. Costs and benefits of several platforms were assessed and Google/Trimble Sketchup was selected because the platform is adaptable, has well-developed user support, and can be easily customized for specific applications. Sketchup was used to develop a base model of the 3D-geometry of the Washington Shore fishway, including PH2 entrances, overflow weir sections, and upper ladder sections. The base model was then populated with data layers including water level at low, average and high tailwater elevation, telemetry monitoring locations, photos of important structural elements, and passage data.	University of Idaho	Christopher Caudill, University of Idaho, Presentation at AFEP, Portland, OR (11/29/12)
73.	Underwater video and	McNary	Columbia	In 2012, the ACOE changed the entrance slot at	ACOE	Frank Loge, UC

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
	DIDSON to evaluate adult lamprey passage behavior			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. 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.	(prepared by UC Davis)	Davis, Presentation at AFEP Review, Portland, OR (11/29/12)
74.	DIDSON monitoring	Bonneville	Columbia	In the summer of 2011, a DIDSON pilot study was completed at Bonneville Dam to evaluate potential applications of this technology for evaluating lamprey behavior and passage at fine scales. A secondary objective was to determine whether DIDSON monitoring could provide quantitative estimates for common passage metrics. Overall, 1413 hours of DIDSON imagery was collected. We found that we were generally able to distinguish adult lamprey from other species because of their morphology and unique swimming behavior. In a quality control evaluation, six trained technicians independently	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 Dam, 2011 (Johnson et al. 2012)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				watched 11.5 h of DIDSON landscape and portrait files and scored lamprey events. There was considerable variability among viewers and between deployment sites, particularly in portrait mode and for events scored with 'low' confidence. Among-viewer agreement increased with the confidence level for the target, which was often a function of how long lamprey were visible. Scoring differences among viewers indicate that adequate DIDSON training and careful post-processing quality control evaluations are needed in future DIDSON studies. Overall, we found that the DIDSON was an effective monitoring tool for detailed observation of adult lamprey behavior at the fine- to meso scale (i.e., < 10 m). DIDSON can therefore be effectively used to evaluate research questions about lamprey behavior near and inside fishways when used in study designs that carefully consider the optimum placement of the camera, the limited observation range and volume of the instrument, and the inability to track individual fish. Qualitative findings indicate that DIDSON can be used to: (1) develop repeatable protocols for identification of acoustic targets such as adult lamprey, (2) infer lamprey swimming direction, including fishway entrance and exit behavior, (3) quantify differences in day- versus night-time activity, (4) quantify lamprey depth distributions and lateral distributions within the sampled volume, and (5) identify white sturgeon-lamprey interactions. These data provide important and complementary results to PIT, radio and acoustic telemetry studies.		
75.	Evaluation of lower fishway using DIDSON	Bonneville and John Day	Columbia	In summer of 2012, a second year of DIDSON monitoring was conducted at Bonneville Dam at	University of Idaho	Chris Caudill, University of

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				the north downstream entrance (NDE) of the Washington shore fish ladder and junction pool. The lower section of the John Day north fishway, after the addition of a variable width entrance weir and bollard field were also evaluated. The objective of the 2012 study was to characterize behavior and vertical/lateral distribution of lamprey. In total, 689 hrs of DIDSON imagery at Bonneville Dam and 773 hrs at John Day Dam were collected. Data is still being analyzed and results will be available in 2013.		Idaho, Presentation at AFEP, Portland, OR (11/29/12)
76.	Evaluate fishway modifications	Priest Rapids, Wanapum	Columbia	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 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. Data analysis will be completed as part of 2012 activities and preliminary information included in the 2012 annual report (see Table 4, Line #7).	Grant PUD	Personal communication with Mike Clement, Grant PUD (10/22/12)
77.	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	CTUIR	Personal communication with Aaron Jackson, CTUIR (11/29/12)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				Diversion (August 2010). 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. Information to date indicates no detections higher in the watershed however, complete monitoring results are not yet available.		
78.	Evaluate passage at low elevation dams	Jim Boyd and other irrigation diversion dams	Umatilla	Radiotelemetry was used to assess lamprey passage efficiency at seven dams located within the lowest 55-km reach of the Umatilla River. During this 4-year study, we tracked 217 adult Pacific lampreys that were implanted with radio transmitters and released downstream from the dams. Logistic regression analysis indicated that dam design, fish size, and temperature had the greatest effects on passage efficiency. Poor performance (<30% fitted passage probability) was recorded at the two lowest dams in the system and resulted in limited escapement to upper sites. During the study, one dam was breached, after which passage efficiency there immediately improved from 32% to 81%. In addition, water augmentation actions at Three Mile Falls Dam apparently contributed to improved mean passage efficiency of migratory-phase fish (from 17% to 50%). Thus, actions to improve adult lamprey access to historical spawning areas are feasible and are key to successful restoration of this species.	CTUIR	Low-Elevation Dams Are Impediments to Adult Pacific Lamprey Spawning Migration in the Umatilla River, Oregon (Jackson and Moser 2012)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
	Lamprey Counts at Dams					
79.	Conduct 24-hour lamprey counts	Bonneville, The Dalles, John Day, McNary, Lower Granite	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 (9/18/12)
80.	Conduct 24-hour lamprey counts	Wells	Columbia	On-going 24-hour fishway monitoring since the 1990's.	Douglas PUD	Personal communication with Chas Kyger and Andrew Gingerich, Douglas PUD (9/13/12)
81.	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 and Jeff Osborn, Chelan PUD (9/10/12)
82.	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 (10/22/12)
83.	Non-invasive methods to evaluate Pacific Lamprey counts and passage behavior	The Dalles, John Day	Columbia	In 2011 and 2012, underwater video in fishways and 24 hr counts at fish count stations to estimate total number of adult lamprey passing dams were collected. Work is ongoing and data from both years are being processed. In 2012, additional cameras were added to sites in fishways and a DIDSON camera was tested at The Dalles Dam. Report expected in 2013.	ACOE (prepared by the USFWS)	Personal communication with Chris Peery USFWS (10/30/12)
84.	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	ACOE	Personal communication with Mary Moser, NOAA Fisheries

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				operational in LPS systems at the facility in 2011. Improvements to the remotely-accessed LPS counting system occurred in 2012.		(9/5/12)
85.	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. 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 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.	UC Davis	Frank Loge, UC Davis, Presentation at AFEP Review, Portland, OR (11/29/12)
	Predation					
86.	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)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
	Juvenile Passage at Hydroelectric Facilities					
	Structural and Operational Fishway Modifications					
87.	Delayed deployment of extended length screen during outmigration	McNary	Columbia	Installation of extended screens were delayed in the spring of 2012 to reduce impacts to juvenile lamprey migrating out early.	ACOE	Personal communication with Sean Tackley, ACOE (9/18/12)
88.	JBS modifications	Lower Monumental	Snake	Modified JBS raceway screens mesh size to allow juvenile lamprey to volitionally pass from the raceway back to the river.	ACOE	Personal communication with Steve Juhnke, ACOE (9/13/12)
89.	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.	ACOE	Personal communication with Steve Juhnke, ACOE (9/13/12)
90.	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.	ACOE	Personal communication with Steve Juhnke, ACOE (9/13/12)
91.	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 (9/18/12)
92.	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	Douglas PUD	Personal communication with Chas Kyger and Andrew

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				Dam, juveniles downstream per the Wells Pacific Lamprey Management Plan.		Gingerich, Douglas PUD (9/13/12)
93.	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 and Jeff Osborn, Chelan PUD (9/10/12)
94.	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 species during annual ladder maintenance activities.	Grant PUD	Personal communication with Mike Clement (10/22/12)
95.	Maintain bypass operations criteria	Rock Island	Columbia	Pursuant to the Rocky Reach and Rock Island Fish Passage Plan (Chelan PUD 2012a), bypass operations criteria are in place.	Chelan PUD	Personal communication with Steve Hemstrom and Jeff Osborn, Chelan PUD (9/11/12)
96.	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 (10/22/12)
	Project Passage Effectiveness					
97.	Develop PIT-tagging protocols for juvenile lamprey	N/A	N/A	In this study, we addressed two outstanding issues related to handling and tagging juvenile lampreys. First, we tried to mitigate freshwater fungal infections by reducing irritation and stress from anesthesia and by treating tagged fish briefly with a prophylactic immediately after tagging. The second question we addressed was whether activity would increase tag loss in PIT-tagged lampreys. Our results support anesthesia with MS-222 or BENZOAK®. We found that active	USGS	Reducing Fungal Infections and Testing Tag Loss in Juvenile Pacific Lampreys Implanted with Passive Integrated Transponders (Christiansen et al. 2012a)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				swimming did not cause tag loss if fish were first held for 20–24 h after tagging. If field studies show that lampreys are not reaching salt water (where fungal infections are mitigated) within 1–2 weeks after release, further study of prophylactic treatments may be warranted. The results from this work further refined our tagging protocol for juvenile lampreys.		Refinement of a Juvenile Pacific Lamprey PIT Tagging Protocol: Identification of an Optimal Anesthetic, Application of Prophylactic Treatments, and Analysis of Activity Effects on Tag Loss (Christiansen et al. 2012b)
98.	Evaluation of barotrauma during hydroturbine passage	N/A	N/A	In this study, juvenile brook and Pacific lamprey acclimated to 146.2 kPa (equivalent to a depth of 4.6 m) were subjected to rapid (<1 s) or sustained decompression (17 min) to a very low pressure (13.8 kPa) using a protocol previously applied to juvenile salmon. No mortality or evidence of barotraumas was observed following rapid decompression, nor up to 120 h after sustained decompression. In contrast, mortality or injury would be expected for 97.5% of juvenile Chinook salmon exposed to a similar rapid decompression to these very low pressures. Additionally, juvenile Chinook salmon experiencing sustained decompression died within 7 min. Thus, juvenile lamprey may not be susceptible to barotraumas associated with turbine passage to the same degree as juvenile salmonids.	PNNL	The effect of rapid and sustained decompression on barotrauma in juvenile brook lamprey and Pacific lamprey; Implications for passage at hydroelectric facilities. (Colotelo et al. 2012)
99.	Monitor passage timing, number, and mortalities of juvenile lamprey collected at projects with juvenile fish	Bonneville, McNary, Lower Monumental,	Columbia and Snake	Monitoring is occurring at all of the identified projects.	ACOE	Personal communication with Sean Tackley, ACOE (9/18/12)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
	bypass facilities	Little Goose, Lower Granite				
100.	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 at Bonneville, John Day, McNary, Lower Monumental, Little Goose, Lower Granite, and Rock Island dams. Below is a brief summary of the findings from the 2012 program: • In 2012, all SMP sites were successful in collecting lamprey data under the new lamprey monitoring program that was first implemented in 2011. • The expansion of lamprey condition monitoring to Bonneville, John Day, and McNary dams was successful in 2012. More work is needed in distinguishing between body injuries attributable from the bypass system and those caused by predators. • For the second year, sample counts at the Snake River and Upper Columbia River SMP sites were relatively low. • It appears that lamprey juveniles, particularly Pacific macropthalmia, are experiencing higher mortality at Bonneville and McNary dams than salmonids.	FPC	Memo: Results of 2012 lamprey monitoring (FPC 2012)
	Predation					
101.	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)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
102.	Avian array lines	The Dalles	Columbia	Expanded avian line array to provide additional coverage in the powerhouse tailrace area, where gull predation on juvenile lamprey appeared significant in recent years. This was part of a larger effort, completed in March 2011, to revise the avian line array at The Dalles Dam. Operation of arrays is ongoing.	ACOE	Personal communication with Sean Tackley, ACOE (9/18/12)
103.	Predation control measures	Wells	Columbia	As part of their HCP obligations, Douglas PUD implements predation control activities. The northern pikeminnow control program to protect outmigrating juvenile anadromous salmonids removes approximately 20,000 northern pikeminnow annually but removal numbers have dropped to approximately 10,000 during the last two years (2011 and 2012). Nonlethal avian control actions include maintenance of a wire array over the tailrace to hinder avian predators, and hazing with foot patrols, motorized vehicles (boats and pickups) and pyrotechnics. These activities are also expected to directly benefit outmigrating juvenile lamprey at the project.	Douglas PUD	Personal communication with Chas Kyger and Andrew Gingerich, Douglas PUD (9/13/12)
104.	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	Chelan PUD	Personal communication with Steve Hemstrom and Jeff Osborn, Chelan PUD (9/10/12)

	Activity	Hydroelectric Project	River	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.		
105.	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 dietary sub sampling. It would be expected that these predation control activities will indirectly benefit outmigrating juvenile lamprey at the project.	Grant PUD	Personal communication with Mike Clement, Grant PUD (10/22/12)
	Policy/Recovery Activities					
106.	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. 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 2012 (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)
107.	Implementation of Pacific lamprey restoration plan	All ACOE projects	Columbia and Snake	In July 2009, ACOE finalized its 10-year (2008-2018) passage improvements implementation plan. Pursuant to a May 2008 MOA between the Action Agencies (ACOE and USFWS), the Accord Treaty Tribes (Umatilla, Warm Springs, and Yakama) and the Columbia River Inter-Tribal Fish Commission, the ACOE collaborated with the tribes and the USFWS to develop a 10-year lamprey plan that	ACOE	ACOE Pacific lamprey passage improvements implementation plan, 2008-2018 (ACOE 2009)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				provides a proposed funding stream and total cost of implementing improvements, and identifies specific actions to be considered to improve lamprey passage and survival. Implementation of actions identified in the plan are ongoing (and described in detail in other line items of this table).		
108.	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 bypass operations criteria at the Project, regional data sharing and protocol development, and participation in regional conservation and recovery activities. Early implementation of some management plan activities is underway and includes a passage and enumeration study in 2013. This study will employ radiotelemetry, whereby 125 mixed source lamprey will be tagged and monitored at Wells Dam. Fish source includes Bonneville dam and Priest Rapid. Biologists will focus on entrance efficiency under reduced head differential, passage efficiency and improving counts at the existing count window by excluding lamprey from bypassing the count station through picketed leads.	Douglas PUD	Personal communication with Chas Kyger and Andrew Gingerich, Douglas PUD (9/13/12)
109.	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. In addition to fishway evaluations and activities to improve adult lamprey passage and juvenile passage and survival (when technology exists),	Chelan PUD	Rocky Reach Pacific Lamprey Management Plan (Chelan PUD 2005)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				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.		
110.	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. 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)
111.	Annual report and plan on lamprey measures	No associated hydro project (focused on irrigation diversion dams)	Yakima and Umatilla	Per the 2008 Columbia River Fish Accords, this report serves to document BOR's assessment of projects in the Columbia River Basin that may affect Pacific lamprey, with a focus on the Yakima and Umatilla basins. Studies supported by BOR and detailed in this report include: 1. Passage structures and juvenile lamprey sampling in the Umatilla Basin. 2. Radiotelemetry studies, juvenile canal, and rapid assessment surveys in the Yakima Basin. 3. Fish Screen Evaluation 4. Physical and Behavioral Juvenile Guidance Study 5. Swimming Performance Study (Studies which had continuing activities in the 2012 reporting year are described in greater detail in other line items of this table).	BOR	Pacific Lamprey 2011 Annual Report and 2012 Plan (BOR 2012)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
112.	Pacific lamprey artificial propagation and rearing investigations	Rocky Reach	Columbia	The Rocky Reach Fish Forum (RRFF) commissioned developing a report to investigate reliable and technically feasible techniques for culturing Pacific lamprey, and the feasibility of rearing juvenile lamprey to metamorphosis for potential use as test fish in studies (when technology exists) attempting to measure Project effects. A final report is not yet available.	Chelan PUD	Pacific Lamprey (*Lampetra tridentata*) Breeding and Rearing Methodologies – Recommendations for Chelan County PUD. (Wade and Beamish in press)
113.	Juvenile Pacific Lamprey Seminar	All ACOE projects, Wells, Rocky Reach, Rock Island, Priest Rapids	Columbia	The RRFF commissioned conducting a seminar to provide information regarding: 1) culture practices for spawning, early rearing and long-term rearing of Pacific lamprey; 2) hydroelectric Project effects on juvenile Pacific lamprey that have been identified, and results of research that has been conducted to simulate passage effects; and 3) examination of possible methods for measuring the type and magnitude of any ongoing Project effects on the downstream passage of juvenile Pacific lamprey.	Chelan PUD	Juvenile Pacific Lamprey Seminar Agenda. Presented by the Rocky Reach Fish Forum. August 1, 2012. (Chelan PUD 2012c)
114.	Lamprey Technical Work Group • Passage Subgroup • Translocation Subgroup • Supplementation Subgroup • PTAGIS Subgroup • Passage Engineering 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 prioritizing critical uncertainties regarding lamprey conservation; 2) providing a forum for discussion regarding lamprey-related concerns; and 3) disseminating technical information. In 2012, the CRBLTWG met twice (3/19/12, 11/2812). Additional subgroup meetings were convened during the year to discuss lamprey passage metrics, translocation supplementation, tagging issues/PTAGIS, passage engineering, smolt monitoring program, and Northwest Power	USFWS	Personal communication with Christina Luzier, USFWS (10/11/12)

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				and Conservation Council (NPCC) synthesis reporting. The Passage Standards Subgroup continued to work on Phase 3 and presented an update in 2012. In 2012, the Translocation Review paper authored by the Translocation Subgroup was accepted and published in the journal Fisheries. In 2012, 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 2013. In 2012, the Tagging Subgroup participated in a PTAGIS steering committee meeting to inform them about juvenile and adult lamprey tagging. The subgroup will be working with PTAGIS to get half duplex tag data into their system and the region on making PIT tag data reporting mandatory. In 2012, the Passage Engineering Subgroup had a conference call and continue to work on developing a paper on known engineering fixes to aid lamprey passage at dams and other barriers. In 2012, the CRBLTWG continued to assist the Fish Passage Center with the smolt monitoring program for lamprey at Federal Columbia River Power System (FCRPS) dams. Lampreys were identified, counted at all projects and condition was recorded at Bonneville, John Day, and McNary dams.		

	Activity	Hydroelectric Project	River	Results / Description of Activity	Lead Entity(ies)	Source
				In 2012, the CRBLTWG continued to work on a synthesis report for NPCC that includes a synopsis of Fish and Wildlife Program projects and answers to status questions posed by the ISRP. A revision is being worked on due to additional comments by the ISRP.		
115.	Pacific Lamprey Conservation Initiative	All ACOE projects, Wells, Rocky Reach, Rock Island, Priest Rapids	Columbia and Snake	The Pacific Lamprey Conservation Initiative, developed in 2007, is an effort led by the USFWS to facilitate communication and coordination for the conservation of Pacific lampreys throughout their range. The primary goal of the initiative is to develop a Pacific Lamprey Conservation Plan (Plan) which will initiate the implementation of conservation actions and research to restore and sustain habitat and Pacific lamprey populations throughout their range. In 2012, the Conservation Initiative Team developed 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. Note that initiative activities and recommendations are not regulatory requirements and that not all entities participating in regional working groups are signatories to the agreement. Non-signatory participants include the Mid-Columbia PUDs.	USFWS	Conservation Agreement for Pacific Lamprey (*Entosphenus tridentatus*) in the States of Alaska, Washington, Oregon, Idaho, and California. U.S. Fish and Wildlife Service. June 20, 2012.

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 2012, 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 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 145 unique PIT tags at Priest Rapids and 75 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. 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 two years of monitoring (2010 and 2011), estimated FPE for Priest Rapids Dam is 82% and estimated FPE for Wanapum Dam is 82%. Metrics for 2012 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 is included in this annual report (see Section 5).	Yes, ahead of schedule
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. 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. 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. 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. The preliminary results of these activities are presented in Appendix D.	No

Notes:
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:

1). "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.

2). "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.

3). "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) Winchester Dam (not a hydro project) (I)	Yakima North Umpqua	#3 #37	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) Rocky Reach (P)	Columbia Columbia	N/A[2] 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) Willamette Falls (I) No associated hydro project (I)	Yakima Willamette Fifteen Mile Creek Deschutes and tributaries Hood Umatilla	#3 #4 #1 #2 #7 #8	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	Rocky Reach (I) Priest Rapids and Wanapum (I) No associated hydro project (I) Wells (P)	Columbia Columbia Lower Snake Fifteen Mile Creek Deschutes and tributaries Lower Willamette White Salmon, Wind and Klickitat Columbia	#17 #18 #24 #1 #2 #5 #6 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) Wells (P) Rocky Reach (P)	Fifteen Mile Creek Columbia Columbia	#1 N/A[2] N/A[3]	No.	No. This activity is not required by Grant PUD's PLMP.	N/A
6.	Monitor juvenile population status and trends (unrelated to counting at hydroelectric projects)	Priest Rapids and Wanapum (I) Willamette Falls (I) N/A (I) No associated hydro project (I) Wells (P)	Columbia Willamette Deschutes and other tributaries Hood Umatilla Yakima Entiat and Wenatchee Methow Methow (Chewuch) Columbia	#18 #16 #2 #7 #10 #11, #12 #13 #14 #15 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 to detect presence/absence and Project operational zone. Required to be conducted within the PRPA within 10 years of license issuance.

	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
7.	Evaluate lamprey physiology, energy use, swimming performance	N/A (I)	N/A	#19, 31	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	Rocky Reach (I) Pelton Round Butte (I) No associated hydro project (I) N/A (I)	Columbia Deschutes Umatilla N/A	#112 #9 #33 #20, 21	Yes.	No. This activity is not required by Grant PUD's PLMP.	N/A
9.	Evaluate the impact of contaminants on lamprey	No associated hydro project (I)	Willamette and Siletz	#22	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	No associated hydro projects (I) N/A (I)	Lower Willamette White Salmon, Wind, and Klickitat Lower Snake Columbia and Wind N/A	#5 #6 #24 #25 #20, 21, 23, 26, 32	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

	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
11.	Determine genetic structure and maintain genetic integrity	No associated hydro projects (I) N/A (I) PR (as identified in the Tribal Pacific Lamprey Restoration Plan for the Columbia River)	Entiat and Wenatchee Willamette (Agency Creek) N/A N/A	#27 #28 #29, 30 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
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	Rocky Reach (I)	Columbia	#112	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) The Dalles (I) John Day (I) McNary (I) Ice Harbor (I) Lower Monumental (I) Little Goose (I) Lower Granite (I) Priest Rapids and Wanapum (I) No associated hydro project (I) Winchester Dam (not a hydro project) (I)	Columbia Columbia Columbia Columbia Snake Snake Snake Snake Columbia Willamette North Umpqua	#34, 38, 39 #34 #34 #34 #34 #34 #34 #34 #34 #35, #36 #37	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 2012 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	#40, 41	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	#42	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	McNary (I) Ice Harbor (I) Lower Monumental (I) Little Goose (I) Lower Granite (I) Priest Rapids and Wanapum (I) Wells (P)	Columbia Snake Snake Snake Snake Columbia Columbia	#43 #43 #43 #43 #43 #44 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) Priest Rapids and Wanapum (I) Wells (P)	Columbia Columbia Columbia	#57 #110 N/A[2]	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) John Day (I) McNary (I) Westland diversions (I)	Columbia Columbia Columbia Umatilla	#45 #47 #48 #46	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 project, this method would not be appropriate to implement.	N/A
21.	Design / install bollard arrays	John Day (I)	Columbia	#47	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) John Day (P) McNary (P)	Columbia Columbia Columbia	#49 N/A[5] 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) Wells (I) Rocky Reach (I) Rock Island (I) Priest Rapids and Wanapum (I)	Columbia / Snake Columbia Columbia Columbia Columbia	#50 #51 #52 #52 #53	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	#54	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) Other ACOE projects (exact ones unspecified) (P) Wells (P)	Columbia Columbia / Snake Columbia	#47, 70 N/A[5] 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 grating 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) Ice Harbor (I) Lower Monumental (I) Little Goose (I) Lower Granite (I) Rocky Reach (I)	Columbia Snake Snake Snake Snake Columbia	#47 #55 #55 #56 #56 #57	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	Ice Harbor (I) Lower Monumental (I) Little Goose (I) Lower Granite (I)	Snake Snake Snake Snake	#55 #55 #56 #56	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) John Day (P) McNary (P) Ice Harbor (I) Lower Monumental (I) Rocky Reach (I)	Columbia Columbia Columbia Snake Snake Columbia	#69 N/A[6] N/A[6] #55 #55 #57	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) Rocky Reach (I) Trail Bridge Dam (I) Ice Harbor (P)	Columbia Columbia McKenzie Snake	#47 #57 #59 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	#57	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 2012 migration seasons.
31.	Design / install water supply or auxillary water supply systems	Bonneville (I) Trail Bridge Dam (I)	Columbia McKenzie	#58 #59	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) McNary (I) Wells (I) Priest Rapids (P) Ice Harbor (P)	Columbia Columbia Columbia Columbia Snake	#60 #61 #62 N/A[8] 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	#110	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	#110	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) The Dalles (I) John Day (I) McNary (I) Ice Harbor (I) Lower Monumental (I) Little Goose (I) Lower Granite (I) Wells (I) Rocky Reach (I) Rock Island (I) Priest Rapids and Wanapum (I)	Columbia Columbia Columbia Columbia Snake Snake Snake Snake Columbia Columbia Columbia Columbia	#63 #64 #65 #66 #66 #66 #66 #66 #108 #109 #67 #68	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) Priest Rapids and Wanapum (P)	Columbia Columbia	N/A[3] 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) Bonneville (I) The Dalles (I) John Day (I) McNary (I)	Columbia and Snake Columbia Columbia Columbia Columbia	#71 #72 #72 #72 #72	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) The Dalles (I) John Day (I) McNary (I) Ice Harbor (I) Lower Monumental (I) Little Goose (I) Lower Granite (I) Priest Rapids (I) Wanapum (I) Winchester Dam (not a hydro project) (I) Threemile Falls Dam, Maxwell and Feed diversions (I) Jim Boyd and other irrigation diversion dams (I) Rocky Reach (P)	Columbia Columbia Columbia Columbia Snake Snake Snake Snake Columbia Columbia North Umpqua Umatilla Umatilla Columbia	#34, 74, 75 #34, 75 #34 #34, 73 #34 #34 #34 #34 #34, 76 #76 #37 #77 #78 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 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. 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) Rocky Reach (P) [Note: evaluations performed on existing structural / operational improvements at ACOE dams are identified earlier in the table, under the heading, *Structural and Operational Fishway Modifications*.]	Columbia Columbia	#76 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 modification 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 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. 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) The Dalles (I) John Day (I) Lower Granite (I) Wells (I) Rocky Reach (I) Rock Island (I) Priest Rapids and Wanapum (I) McNary (I) Ice Harbor (I)	Columbia Columbia Columbia Snake Columbia Columbia Columbia Columbia Columbia Snake	#79 #83 #83 #79 #80 #81 #81 #82 #85 #85	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) Wells (P)	Columbia Columbia	#84 N/A[2]	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	#86	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) Wells (P)	Columbia Columbia	#110 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	#87	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) Lower Monumental (I)	Columbia Snake	#89 #88	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) Wells (I) Rocky Reach (I) Rock Island (I) Priest Rapids and Wanapum (I)	Columbia / Snake Columbia Columbia Columbia Columbia	#91 #92 #93 #93 #94	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) Rocky Reach (I) Rock Island (I) Priest Rapids and Wanapum (I)	Columbia Columbia Columbia Columbia	#108 #109 #95 #96	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	#97	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) Rocky Reach (P) Priest Rapids and Wanapum (P)	Columbia Columbia Columbia	N/A[2] N/A[3] 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	#98	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) John Day (I) McNary (I) Lower Monumental (I) Little Goose (I) Lower Granite (I) Rock Island (I)	Columbia Columbia Columbia Snake Snake Snake Columbia	#99, 100 #100 #99, 100 #99, 100 #99, 100 #99, 100 #100	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	#109	Yes.	No. Priest Rapids and Wanapum dams are not equipped with turbine intake or diversion screens.	N/A
	Predation						
58.	Continue predation control measures (pike minnows and birds)	<u>Pike minnow only</u> All ACOE projects (I) <u>Pike minnow and birds</u> The Dalles (I) Wells (I) Rocky Reach (I) Rock Island (I) Priest Rapids and Wanapum (I)	 Columbia / Snake Columbia Columbia Columbia Columbia Columbia	 #101 #102 #103 #104 #104 #105	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 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) Wells (I) Rocky Reach (I) Priest Rapids and Wanapum (I)	Columbia / Snake Columbia Columbia Columbia	#106, 107 #108 #109 #110	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 this 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) Wells (I) Rocky Reach (I) Priest Rapids and Wanapum (I)	Columbia / Snake Columbia Columbia Columbia	#106, 107 #108 #109 #110	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	#110	No.	Yes. The PLMP does not include a specific PM&E related to this activity; however, Grant PUD participates in education 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) Wells (I) Rocky Reach (I) Priest Rapids and Wanapum (I) No associated hydro project (focused on irrigation diversion dams) (I)	Columbia / Snake Columbia Columbia Columbia Yakima and Umatilla	#106, 107, 114, 115 #108 #109 #110 #111	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	Rocky Reach (I)	Columbia	#113	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
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 Biological Objectives Status Report

As part of the Project's WQC, Grant PUD is required to develop a Year Five Biological Objectives Status Report for Pacific Lamprey (Condition 6.2(5)(c)) which:

1). Summarizes the results of the M&E program and evaluates the need for modification of the program;

2). Describes the degree to which each Biological Objective has been achieved; and if not, the prospects for achieving those objectives in the next reporting period;

3). Reviews management options (both operational and structural) taken to meet the Biological Objectives;

4). Recommends any new or modified implementation and/or evaluation measures that are needed to meet any of the Biological Objectives, to the extent reasonable and feasible. Such recommendation shall contain a schedule for timely implementation.

The biological objectives identified in Appendix C of the WQC include:

1). Overall Combined Goal: No Net Impact (NNI). Identify, address, and fully mitigate Project effects to the extent reasonable and feasible.
2). Adult Upstream and Downstream Migration: Provide safe, effective, and timely volitional passage (as defined by the PRFF).
3). Juvenile Downstream Migration: Provide safe, effective, and timely volitional passage (as defined by the PRFF).
4). Rearing: Avoid and mitigate Project impacts on rearing habitat

The following sections are organized by the biological objectives as described in Appendix C of the WQC, and are intended to meet the requirements of Year Five Biological Objectives Status Report for Pacific Lamprey (Condition 6.2(5)(c)).

5.1 No Net Impact

Over the past 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 PLMP has been a formalization of recent research and implementation measures required in the Project's License Order as issued by the FERC, but is largely a continuation and expansion of activities that were informed by adult telemetry passage evaluations (Nass et al. 2003), implementation of bypass and fishway operations criteria (i.e., bypass criteria, and counts, dewatering and salvage protocols, etc.), regional participation in the CRBLTWG, and collaboration with tribes, agencies, and other hydroelectric operators during the Project relicensing process.

Since license issuance in 2008, Grant PUD has begun the implementation of requirements described in its PLMP (see Table 4 for more detail) consistent with and at times, in advance of the prescribed deadlines. Activities have included the implementation of fishway modifications and the ongoing evaluation of those modifications for adult lamprey through an underwater video evaluation in 2010 and ongoing monitoring through a complex network of HDX PIT arrays within the fish ladders at Wanapum and Priest Rapids dams. Grant PUD continues to operate the Project consistent with Fishway Operations Protocols and juvenile bypass criteria and

implement salvage protocols during fishway winter maintenance outages toward the protection of lamprey. Each year during the maintenance period, Grant PUD offers fishway tours to PRFF members and researchers and experts in the basin toward improving passage for adult lamprey at the Project. Most recently, Grant PUD began conducting assessments of juvenile lamprey distribution and relative abundance in Project reservoirs in fulfillment of its requirement to assess Project effects to juvenile lamprey. Grant PUD has continued to participate in regional conservation and recovery forums such as the Columbia Basin Pacific Lamprey Technical Workgroup, USFWS Conservation Agreement, and CRITFC Pacific Lamprey Restoration and Recover Plan. These forums are often the source of state-of-the-science research and information that Grant PUD continually evaluates for applicability to the Project's PLMP implementation. The information presented above is described in greater detail in the sections below.

With regard to evaluating NNI at the Project, the information, both site-specific and originating from regional research and recovery discourse suggests that the existing data and methodologies are not yet available to rigorously quantify this target. An evaluation of NNI requires information at the population scale using a comprehensive life cycle approach where limiting factors to production and probability of conversion success are evaluated at each individual life history stage. For the adult life history stage, passage efficiency and count information at numerous Projects is available; however, the rates of survival and subsequent reproductive success of fish are necessary to more effectively quantify impacts. For juvenile fish, quantifying Project survival is critical toward understanding impacts however; acquiring such information requires the development of technology that is currently unavailable. Regional technical working groups continue to work toward developing approaches to address these data gaps. At this time, Grant PUD, through its active participation in these discussions through participation with the LTWG and PRFF during monthly meetings, and the past and present implementation of on-the-ground lamprey activities at the Project, continue to make steady progress toward addressing the NNI objective identified in its Project license and WQC. Recent discussions related to defining NNI as it relates to Grant PUD's PLMP can be viewed at www.grantpud2.org/rc/PRFF.htm.

5.2 Adult Migration

Over the four years of PLMP implementation since issuance of the Project license, Grant PUD has continued to implement measures to improve adult lamprey passage at the Project. To facilitate tagging and fish husbandry research, Grant PUD expanded its fish handling facilities at Priest Rapids Dam by building innovative adult lamprey collection and holding facilities for the most efficient and non-invasive processing of study fish. Activities to facilitate adult migration have included fishway modifications that were completed in 2010 and were comprised of the installation of passage-enhancing structures at Priest and Wanapum dams. New structures included diffusion grate aluminum plating, ramps ascending perched orifices, and lamprey-friendly video fish count crowders; all modifications were specifically designed to facilitate lamprey passage.

Following the installation of these structures, Grant PUD and the PRFF implemented a multi-faceted approach to evaluating passage effectiveness which included underwater video monitoring and PIT monitoring. During the 2010 migration, an assessment of lamprey passage was conducted using underwater video. In this study, cameras were placed in multi-directions to view newly installed aluminum plating on the diffusion grating, the floor through weir orifices, and several areas to evaluate the fish count stations and associated crowders. 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 and window area. 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 or approach the chute from downstream. Also in 2010, Grant began using an extensive network of HDX-PIT arrays at Priest Rapids and Wanapum dams that was operated to monitor the passage of lamprey originating from tagging activities conducted at dams downstream of Priest Rapids Dam (resulting from collaboration with the ACOE). A total of 20 HD-PIT arrays were operated each migration season to track lamprey through the Project area. Further, yearly winter fishway maintenance operations recover adult lamprey during NOAA approved dewatering procedures. This procedure includes scanning recovered lamprey for the presence of a PIT tag, recording the appropriate information, and subsequent release into the forebay of the respective dam. For the 2010 through 2012 migrations (2012 data were not yet available and will be included in the 2013 annual report), Grant PUD tracked a total of 145 and 75 PIT tagged lamprey at Priest Rapids and Wanapum dams, respectively. Fishway passage efficiency for lamprey was 82% for each dam over the 2010-2011 period. Grant PUD, in coordination with the PRFF, continues to collaborate with downstream operators (ACOE and U of I researchers) to passively monitor the passage of tagged adult lamprey to continue monitoring passage efficiency as well as to contribute regional adult lamprey passage information to resource management issues at a basin-wide scale (e.g., dam to dam conversion rates, travel times, etc.).

As in previous years and for the term of the Project's operating license, Grant PUD continues to maintain 24-hour fishway counting during the adult migration season and Project fishways pursuant to its Project Fishway Operations Plan which requires implementing specific operations criteria and specific dewatering and salvage protocols during winter maintenance for the benefit of adult lamprey and all species. Grant PUD conducts tours annually during scheduled maintenance outages with the PRFF members and other interested parties to evaluate the modifications to the fish ladders to improve adult lamprey passage (i.e., plating installation, adult lamprey collection facilities, newly designed count stations, and ramps downstream of perched orifices) and to identify any potential passage impediments. In addition, Grant PUD remains an active participant and contributor in regional research and forums where state-of-the-science research focused on improving adult migration and survival is available. Grant PUD is continually evaluating the information available from these forums for its applicability to the Project adult lamprey requirements (see Table 5).

5.3 Juvenile Migration

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 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).

Currently, anecdotal observations and recent research suggest that juvenile lamprey have a higher rate of survival than juvenile salmonids when downstream passage occurs via turbines. Colotelo et al. (2012) evaluated the frequency barotraumas in juvenile lamprey and salmon during simulated rapid decompression events similar to turbine passage. Results found that in juvenile lamprey, no mortality or evidence of barotraumas was observed following rapid decompression, for up to 120 hours after sustained decompression. In contrast, mortality or injury would be expected for 97.5% of juvenile Chinook salmon exposed to a similar rapid decompression to these very low pressures. Additionally, juvenile Chinook salmon experiencing sustained decompression died within 7 minutes. Thus, juvenile lamprey may not be susceptible to barotraumas associated with turbine passage to the same degree as juvenile salmonids.

Despite the currently available information, Grant PUD remains committed to identifying and mitigating Project effects on juvenile passage as identified in Objective 3 of the PLMP. However, at this time, the information 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, however, no active tagging technology has been developed that will meet the requirements to support the necessary evaluation.

In the interim, Grant PUD continues to maintain bypass spill operations required by its Project Fishway Operations Plan and NOAA Biological Opinion (NOAA Fisheries 2004) which indirectly benefit juvenile lamprey. Implementation of predation control measures (avian and aquatic) to protect outmigrating, anadromous salmonids as a requirement of Grant PUD's NOAA Biological Opinion also occur annually. These measures include use of lethal and non-lethal control and monitoring presence and absence of juvenile lamprey through dietary sub sampling. It would be expected that these predation control activities will indirectly benefit outmigrating juvenile lamprey at the Project as well as those measure decribed above. In addition, Grant PUD continues to be an active participant and contributor in regional research and forums where state-of-the-science research continues on developing tag technology to quantify juvenile lamprey survival at hydroelectric facilities. Grant PUD is continually evaluating the available information from these forums for its applicability to the Project's juvenile lamprey requirements (see Table 5).

5.4 Rearing

In 2012, Grant PUD began monitoring of juvenile lamprey within the Project area as required by its PLMP. On June 4-8 and 11-15, 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 (Appendix D). In the Wanapum Reservoir, 36 potential shoreline habit locations were sampled. In the Priest Rapids Reservoir, 12 potential shoreline habitat locations were sampled. One juvenile lamprey was captured in the Priest Rapids reservoir and another was observed, however not captured, in the Wanapum Reservoir. A similar survey was completed in late 2012 to investigate shoreline habitats at lower operational elevations (information not yet available) and additional sampling for continued evaluation of juvenile presence and relative abundance within the Project area will continue in 2013.

6.0 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;
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 2012, 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 (Appendix C). 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 – 2012 will be presented 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 2013, 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 2012-2013 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). Continue 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 survey will be combined with the results of a November 2012 survey and presented in the next annual report.

Assuming the trend toward exclusive tagging effort in the lower Columbia River, monitoring activities for adult lamprey will begin in May 2013 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 2012 monitoring will be conducted through the period November 15, 2012 and March 31, 2013, respectively.

Grant PUD will continue to conduct surveys to determine the distribution and relative abundance of juvenile lamprey in the operations zone of the Project area, as appropriate and based on the cumulative results of surveys conducted in 2012. 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 for 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 Annual Report

From: Mangold, Marcie (ECY)
To: Mike Clement
Subject: FW: DRAFT 2012 Pacific Lamprey Management Plan
Date: Wednesday, February 13, 2013 10:05:26 AM
Attachments: PRP 2114 LA 401(a)(12) 2012 PLMP Annual Comprehensive Report_Final Draft_013013.pdf

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Mike,

Thank you for the opportunity to review the Draft Pacific Lamprey Management Plan. Overall, the report was very informative and an extremely useful document as a reference to all the studies and projects regarding Pacific lamprey in the Columbia River. Ecology does not have any comments and appreciates all your time and effort.

Thank you,

D. Marcie Mangold
Department of Ecology
Water Quality Program
phone (509) 329 3450
fax (509) 329 3570

From: Debbie Williams [mailto:Dwilli1@gcpud.org]
Sent: Wednesday, January 30, 2013 10:17 AM
To: Aaron Jackson (AaronJackson@ctuir.org); Alyssa Buck; Brian McIlraith; Dach, Bob; Debbie Williams; Doris Squeochs; Easterbrooks, John A (DFW); Gingerich Andrew (andrewg@dcpud.org); Hallock, Molly; Hatch, Keith; Hildebrand, Larry; Hillman, Tracy; Irle, Pat (ECY); Jackson, Chad S (DFW); James, Brad W (DFW); Jeff Grizzel; Julie Pyper; Korth, Jeff (DFW); Lewis, Steve; Malone, Kevin; Mangold, Marcie (ECY); McLellan Jason (Jason.McLellan@colvilletribes.com); Merkle, Carl; Mike Clement; Mike Nicholls; Miller, Donella (mild@yakamafish-nsn.gov); Miller, Joe; Nass, Bryan; Nelle, RD; Nine Bret (Bret.Nine@colvilletribes.com); Nordlund, Bryan; Osborn, Jeff; Parker, Blaine; Powell, Jim; Rex Buck, Jr.; Rohr, Dennis; Rose, Bob (rosb@yakamafish-nsn.gov); Ross Hendrick; Scott, Teresa L (DFW); Steve Parker; Suzumoto, Bruce; Tom Dresser; Tweit, William M (DFW); Ty Ehrman; Verhey, Patrick M (DFW); wsteverainey@aol.com
Subject: DRAFT 2012 Pacific Lamprey Management Plan

Hello,

Attached please find the DRAFT 2012 Pacific Lamprey Management Plan. This document will be discussed during next week's PRFF meeting.

Debbie Williams
Administrative Assistant
Fish, Wildlife & Water Quality
Lands & Recreation
Grant County Public Utility District
Office: 509-754-5088 Ext. 2471
Cell: 509-220-1724
dwilli1@gcpud.org

From:	Lewis, Stephen
To:	Mike Clement; Verhey, Patrick M (DFW); Mangold, Marcie (ECY); RD Nelle
Subject:	Re: DRAFT 2012 Pacific Lamprey Management Plan
Date:	Tuesday, February 19, 2013 5:24:25 PM

Hi Mike-

Below are a few comments related to the 2012 PLMP Annual Comprehensive Report for the Priest Rapids Hydroelectric Project. Thanks for giving us the opportunity to review this document. The comments are only focused in two areas and we appreciate the efforts in 2012 to remedy lamprey passage at the project:

- ***Section 5.1 No Net Impact (pages 105 & 106):*** This section does not appear to reflect the recent discussions we have had within the confines of the PRFF related to this subject. While I agree, in general, with the overall discussion of this section, the state of lamprey is so perilous that we cannot wait until all applicable information is at our disposal (i.e., juvenile life history stage aspects). That's why we've had these recent discussions related to a broad interpretation of NNI. We know with a certain amount of rigor that adult passage is not 100%, 100% of the migratory timeframe. So, our general intention is to have the mid-Columbia PUD's offset that "remaining portion" of passage efficiency by completing tasks that further our collective knowledge of all life history stages of lamprey. These may include, but not limited to, reservoir passage or use in select tributaries as examples...to be determined. I just want to make sure this section accurately reflects the preliminary discussions we've had to date. Please include a reference to the PRFF NNI discussions.

- Finally, there's a lot of great information in this document. However, I've always thought that these types of documents would benefit from a brief section that touches on "recommended next steps." Give some thought to this type of section in order to maintain steady progress at the Project.

S-

On Wed, Jan 30, 2013 at 10:17 AM, Debbie Williams <Dwilli1@gcpud.org> wrote:

> Hello,
>
> Attached please find the DRAFT 2012 Pacific Lamprey Management Plan. This document will be discussed during next week's PRFF meeting.
>
> Debbie Williams
>
> Administrative Assistant

Fish, Wildlife & Water Quality

Lands & Recreation

Grant County Public Utility District

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****
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"If a road has no obstacles, it probably doesn't lead to anywhere." S. Lewis

Appendix B
Summary of PRFF Comments on Draft PLMP Comprehensive Annual Report and Grant PUD Responses

Summary Table of Agency/Tribal Comment and Grant PUD Responses for 2012 PLMP Annual Comprehensive Report

Submitting Entity	Date Received	Paragraph #	Agency Comment	Grant PUD Response
WDOE	2/13/13	1	Thank you for the opportunity to review the Draft Pacific Lamprey Management Plan. Overall, the report was very informative and an extremely useful document as a reference to all the studies and projects regarding Pacific lamprey in the Columbia River. Ecology does not have any comments and appreciates all your time and effort.	Comment noted. Grant PUD appreciates WDOE's review of the document.
USFWS	2/19/13	1	Below are a few comments related to the 2012 PLMP Annual Comprehensive Report for the Priest Rapids Hydroelectric Project. Thanks for giving us the opportunity to review this document. The comments are only focused in two areas and we appreciate the efforts in 2012 to remedy lamprey passage at the project:	Comment noted. Grant PUD appreciates USFWS review of the document.
		2	***Section 5.1 No Net Impact (pages 105 & 106):*** This section does not appear to reflect the recent discussions we have had within the confines of the PRFF related to this subject. While I agree, in general, with the overall discussion of this section, the state of lamprey is so perilous that we cannot wait until all applicable information is at our disposal (i.e., juvenile life history stage aspects). That's why we've had these recent discussions related to a broad interpretation of NNI. We know with a certain amount of rigor that adult passage is not 100%, 100% of the migratory timeframe. So, our general intention is to have the mid-Columbia PUD's offset that "remaining portion" of passage efficiency by completing tasks that further our collective knowledge of all life history stages of lamprey. These may include, but not limited to, reservoir passage or use in select tributaries as examples...to be determined. I just want to make sure this section accurately reflects the preliminary discussions we've had to date. Please include a reference to the PRFF NNI discussions.	Grant PUD has included additional information in Section 5.1 "No Net Impact" and reference to ongoing discussions within PRFF meetings related to defining, interpretation, and collaborative use of adaptive management to meet Grant PUD's NNI requirement.

		3	Finally, there's a lot of great information in this document. However, I've always thought that these types of documents would benefit from a brief section that touches on "recommended next steps." Give some thought to this type of section in order to maintain steady progress at the Project.	Grant PUD generally agrees with this recommendation and references “Table 5-Evaluation of Activities in the Columbia River Basin Relative to the Priest Rapids Project” as summarizing all Pacific lamprey activities throughout the Columbia River Basin and comparison of their applicability to the Priest Rapids Project in addition to Section 6.0 “Summary” which includes discussion of future years efforst in coordination with the PRFF.

Appendix C Adult Lamprey Assessment using HD PIT: Presentation to the PRFF

Assessment of Pacific Lamprey Behavior and Passage Efficiency at Priest Rapids and Wanapum Dams

SUBMITTED TO:

Public Utility District No. 2 of Grant County

SUBMITTED BY:

LGL Limited

environmental research associates

76 Packwood Lane

Ellensburg, Washington, 98926

and

Cramer Fish Sciences

Blue Leaf Environmental

Long View Associates

PRINCIPAL PROPONENTS:

Bryan Nass, LGL Limited

Dr. Chris Peery, Cramer Fish Sciences

Mark Timko, Blue Leaf Environmental

Bao Le, Long View Associates

October 30, 2009

Executive Summary

A 401 Water Quality Certification was issued by the Washington State Department of Ecology (WDOE) on April 3, 2007, and amended March 6, 2008, for the operation of the Priest Rapids Hydroelectric Project (Project). A new license for the Project was issued by the Federal Energy Regulatory Commission (FERC) on April 17, 2008 (FERC 2008). Under FERC License Article 401(a)(12) and the 401 Certification (6.2 (5)(b)), Public Utility District No. 2 of Grant County (Grant PUD) is required, in consultation with the Priest Rapids Fish Forum (PRFF), to develop and submit for approval a Pacific Lamprey Management Plan (PLMP). On February 19, 2009 Grant PUD filed its PLMP with FERC and received on May 1, 2009 an "order modifying and approving" the PLMP.

The goals and objectives of the PLMP are to be achieved through a series of Protection, Mitigation, and Enhancement (PME) measures. PME measure 4.2.5 of the plan requires structural modifications to the fishway diffusion gratings at Priest Rapids Dam. More specifically, flat aluminum plating is to be installed on edges of diffusion grating that extends to the vertical wall of the fishway. In addition, Grant PUD has also proposed to use the same plating to cover the fishway floor through orifice openings in the weirs, and to create ramps at orifices where they are elevated above the floor. Further, substantial modifications have been proposed for the fish count station structure to facilitate lamprey passage.

This document proposes to implement a monitoring study in support of the following PME measures as identified in the PLMP:

4.2.6 – Adult telemetry: evaluate the effectiveness of fishway modifications to facilitate lamprey passage;

4.2.8 – Reducing fishway flows at night: evaluate the effectiveness of operating the fishway with reduced attraction flow to facilitate lamprey passage.

The objectives of this study are to:

1) Determine the fishway passage efficiency for adult lamprey at Priest Rapids and Wanapum dams;
2) Evaluate the passage of adult lamprey through sections of the Priest Rapids fishways where new structures have been installed to facilitate upstream movement;
3) Determine if a reduction of flow (i.e., velocity) in the lower fishways at Priest Rapids Dam affects the use and passage of lamprey of the fishway.

A combination of technologies will be used to monitor the behavior of Pacific lamprey, and quantify the overall passage effectiveness through standard metrics (Nass et al. 2002). Adult lamprey will be collected at Priest Rapids Dam, outfitted with half-duplex passive integrated transponder (HDX PIT) tags, released downstream of the dam, and monitored using an array of detectors to measure passage efficiency. Underwater video will be used at specific locations to describe lamprey behavior as related to fishway structure modifications. Acoustic telemetry will be used to evaluate the movement of lamprey through the bifurcation pool in the Priest Rapids Dam left bank fishway. PIT telemetry will be operated at Priest Rapids and Wanapum dams, and underwater video and acoustic telemetry will be operated only at Priest Rapids Dam.

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1.0 Introduction

A 401 Water Quality Certification was issued by the Washington State Department of Ecology (WDOE) on April 3, 2007, and amended March 6, 2008, for the operation of the Priest Rapids Hydroelectric Project (Project). A new license for the Project was issued by the Federal Energy Regulatory Commission (FERC) on April 17, 2008 (FERC 2008). Under FERC License Article 401(a)(12) and the 401 Certification (6.2 (5)(b)), Public Utility District No. 2 of Grant County (Grant PUD) is required, in consultation with the Priest Rapids Fish Forum (PRFF), to develop and submit for approval a Pacific Lamprey Management Plan (PLMP). On February 19, 2009 Grant PUD filed its PLMP with FERC and received on May 1, 2009 an "order modifying and approving" the PLMP.

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3) Determine if a reduction of flow (i.e., velocity) in the lower fishway affects the use and passage of lamprey of the fishway.

1.1 2001-2002 Lamprey Study in Priest Rapids Project Area

In 2001, Grant PUD conducted an assessment of Pacific lamprey migratory behavior at the Priest Rapids Hydroelectric Project (Nass et al. 2002). The primary purpose of the study was to assess the migration and passage timing of lamprey at Wanapum and Priest Rapids dams. Pacific lamprey were captured and radio-tagged during the period 23 July – 8 September 2001, and 23 July – 7 September 2002 at Priest Rapids Dam on the mid-Columbia River. A total of 51 and 74 fish were tagged and released in the Priest Rapids Dam area in 2001 and 2002, respectively. A combination of fixed station monitoring at both dams and extensive mobile tracking were used to determine migration and passage characteristics. Of the 51 lamprey released in 2001, 18 had detection histories in Priest Rapids fishways, and 3 were observed in Wanapum fishways. A total of eight radio-tagged lamprey passed Priest Rapids Dam, and 3 passed Wanapum Dam. Of the 74 lamprey released in 2002, 48 had detection histories in Priest Rapids fishways, and 27 were observed in Wanapum fishways. A total of 41 radio-tagged lamprey passed Priest Rapids Dam, and 23 passed Wanapum Dam. Overall passage success (proportion of individuals approaching the fishway that exit) was 30% and 70% at Priest Rapids, and 100% and 51% at Wanapum in 2001 and 2002, respectively. Overall median dam passage time (first at entrance to last at exit) was 1.2 d and 1.1 d at Priest Rapids, and 1.1 d and 1.8 d at Wanapum in 2001 and 2002, respectively. The last known locations of 2001 radio-tagged lamprey extended from Coyote Rapids to the tailrace of Rock Island Dam, and the last known locations of 2002 radio-tagged lamprey, extended from Coyote Rapids to the forebay of Rocky Reach Dam

In the fishways at Priest Rapids, the visual counting stations and the first orifice walls in the lower fishway appeared to be the locations of greatest passage delay. In the fishways at Wanapum, locations that appeared to delay passage were less pronounced than at Priest Rapids; on the left-bank the visual counting station caused the largest delays, and on the right-bank no area caused substantial delays. The areas identified during the 2001-2002 studies as potential impediments to lamprey migration in the Priest Rapids fishway are scheduled to be modified during the 2009-2010 winter fishway outage to improve lamprey passage and will be evaluated as part of this study.

2.0 Scope of Work

A combination of technologies will be used to monitor the behavior of Pacific lamprey, and quantify the overall passage effectiveness through standard metrics (Nass et al. 2002). Adult lamprey will be collected at Priest Rapids Dam, outfitted with half-duplex passive integrated transponder (HDX PIT) tags, released downstream of the dam, and monitored using an array of detectors to measure passage efficiency. Underwater video will be used at specific locations to describe lamprey behavior as related to fishway structure modifications. Acoustic telemetry will be used to evaluate the movement of lamprey through the bifurcation pool in the Priest Rapids Dam left bank fishway. PIT telemetry will be operated at Priest Rapids and Wanapum dams, and underwater video and acoustic telemetry will be operated only at Priest Rapids Dam.

The primary activities of the study will include:

- Design and installation of PIT, underwater video and acoustic arrays;
- Collect, tag (PIT / acoustic), and release adult lamprey;
- Conduct telemetry and video monitoring operations;
- Conduct analysis of telemetry data to calculate passage metrics;
- Conduct analysis of underwater video imagery to characterize behavior;
- Evaluate structural or operational modifications of the Priest Rapids fishways on Pacific lamprey passage;
- Prepare study report.

2.1 Evaluation of Passage Efficiency

2.1.1 HDX PIT Monitoring

Historically, telemetry studies at lower and mid-Columbia projects have been used to characterize adult Pacific lamprey behavior and passage performance at dams (e.g. Nass et al. 2002; Moser 2002a; Moser et al. 2002b; Moser et al. 2003). More recently, HDX PIT tags have been employed to track adult Pacific lamprey movements at and between dams (Keefer et al. 2009a; Keefer et al. 2009b; Daigle et al. 2008; Boggs et al. 2008; Cummings et al. 2008). Advantages to using HDX PIT technology include the relatively low cost compared to radio-telemetry and Full Duplex (FDX) PIT systems, smaller tags (Figure 1. Relative sizes of full duplex (FDX) PIT tags as used in salmon research and the larger half duplex (HDX) PIT tags used in adult Pacific lamprey research.), longer tag life, less invasive tagging procedures and handling, and greater ability to monitor a representative sample of the population as compared to larger radio transmitters. For example, in recent studies conducted at lower Columbia River dams, adult lamprey outfitted with HD PIT tags were almost twice as likely to re-approach and pass Bonneville Dam (56%) than lamprey that had been tagged with either radio transmitters (24%) or doubled tagged with radio tags and PIT tags (29%) (Keefer et al. 2009c). In addition, the PIT tag detection systems at each ladder will also detect fish tagged and released from downstream hydropower facilities which will increase the sample size for evaluations at Priest Rapids and Wanapum dams. For example, of a potential 100 fish to be PIT tagged at McNary Dam in coming years, approximately 30 to 50 individuals would reach Priest Rapids Dam. A similar number may be expected from the, approximately, 1,000 PIT-tagged lamprey that would be released at Bonneville Dam for USACE funded research in coming years.

Figure 1 Relative sizes of full duplex (FDX) PIT tags as used in salmon research and the larger half duplex (HDX) PIT tags used in adult Pacific lamprey research.

HDX telemetry equipment will be installed in the fish ladders at Priest Rapids and Wanapum dams at strategic locations. Proposed locations for HDX PIT detectors at Priest Rapids (Figure 2) and Wanapum (Figure 3) dams include:

- just inside entrances;
- at the terminus of pools which constitute the beginning of a fishway section with diffusion grating;
- pools which constitute the end of a fishway section with diffusion grating;
- downstream of count stations;
- upstream of count stations; and
- at fishway exits.

Figure 2 Location of HDX PIT detection arrays at Priest Rapids Dam.

Figure 3 Location of HDX PIT detection arrays at Wanapum Dam.

Numbers of antennas to be installed will vary with location. Antennas at fishway entrances typically have detection efficiencies of 35 to 65% and so redundant antennas will need to be installed to assure sufficient detection efficiencies. The remaining antenna sites (fishway weirs, count stations, and ladder exits) typically exhibit 90 to 100% detection success and so single antenna arrays may be sufficient.

Antennas will be fabricated and installed during the winter de-watering period. Readers and associated hardware will be installed prior to start of the Pacific lamprey migration. Adult Pacific lamprey will be collected and sampled as described in Section 2.1.2 (Fish Capture) below. Once anesthetized, a small incision is made to the abdomen and the HDX PIT tag (23 mm x 4 mm, 0.6 g) is inserted. No sutures are required. After surgery, Pacific lamprey will be held for a monitoring period of approximately 8-12 hours before they are released into the Columbia River at dusk. The target release sites are located in the tailrace area of Priest Rapids Dam downstream of the fish ladder entrances. Telemetry data will be downloaded from HDX PIT readers weekly and stored into a relational database for analyses.

2.1.2 Fish Capture

Adult Pacific lamprey will be captured according to methods similar to previous lamprey passage studies conducted at Grant and Douglas PUD (Nass et al. 2002; Murauskas et al. 2008). Adult Pacific lamprey will be collected in the lower fishways of Priest Rapids Dam (Figure 4, pool 27 on left bank and pool 33 on right bank) using custom designed traps (Figure 5 and Figure 6). These locations are the lowest feasible sites for trapping – they are above the mean normal influence of tailrace elevation and are accessible for trap installation and operation. The fishway pool below the traps do not have diffusion grating. Two traps will be operated on each of the left and right bank fishways and will be installed on to the same weir wall (one trap on either side of the fishway adjacent to the wall). Traps will be operated between 20:00 hrs and 04:00 hrs. The orifice gate on the weir wall will be closed during night-time trapping operations (20:00 hrs and 04:00 hrs) to maximize the catch efficiency, but will be open during the day-time period to facilitate passage for other fish.

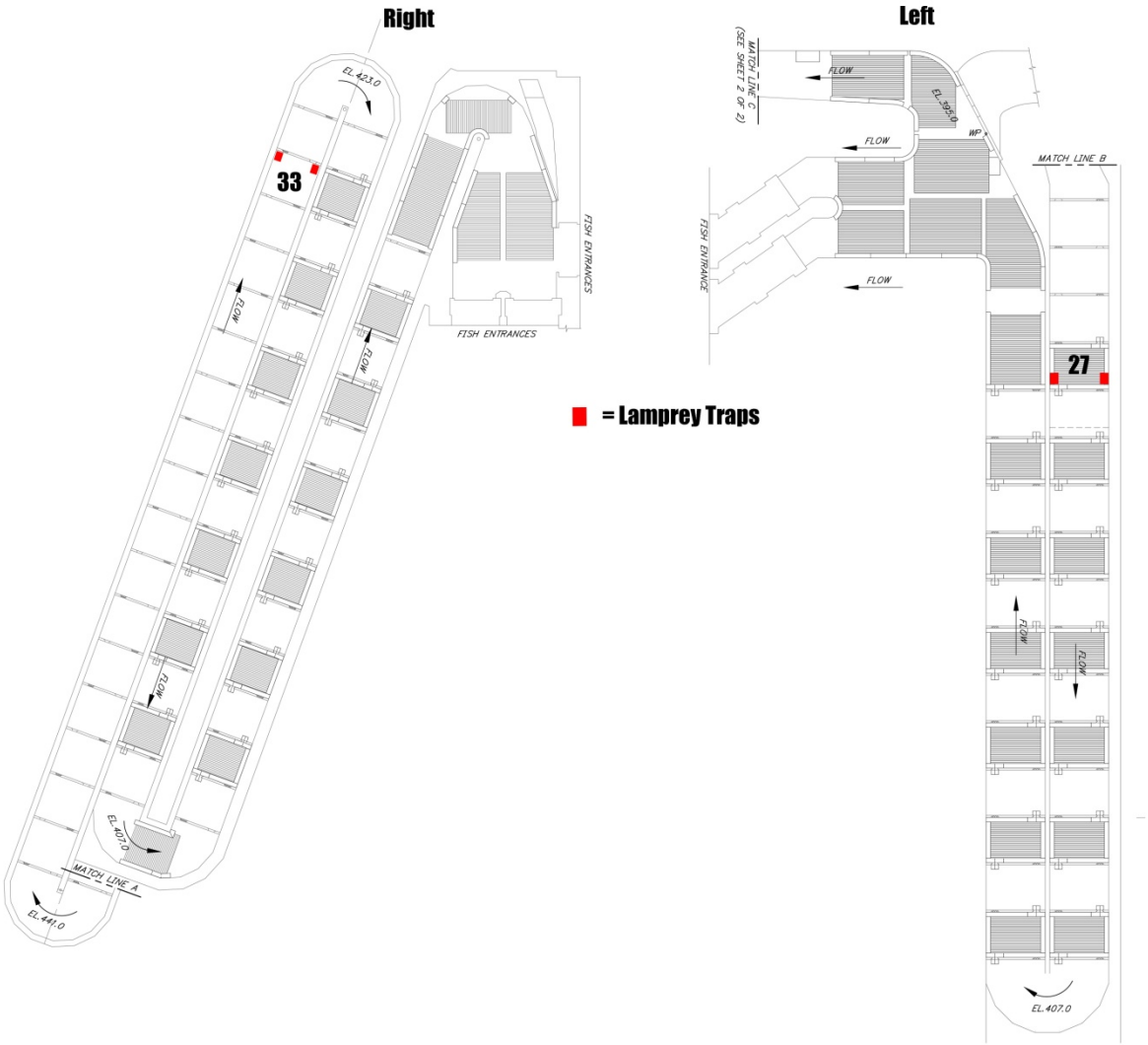


Figure 4 Location of lamprey traps at Priest Rapids Dam.

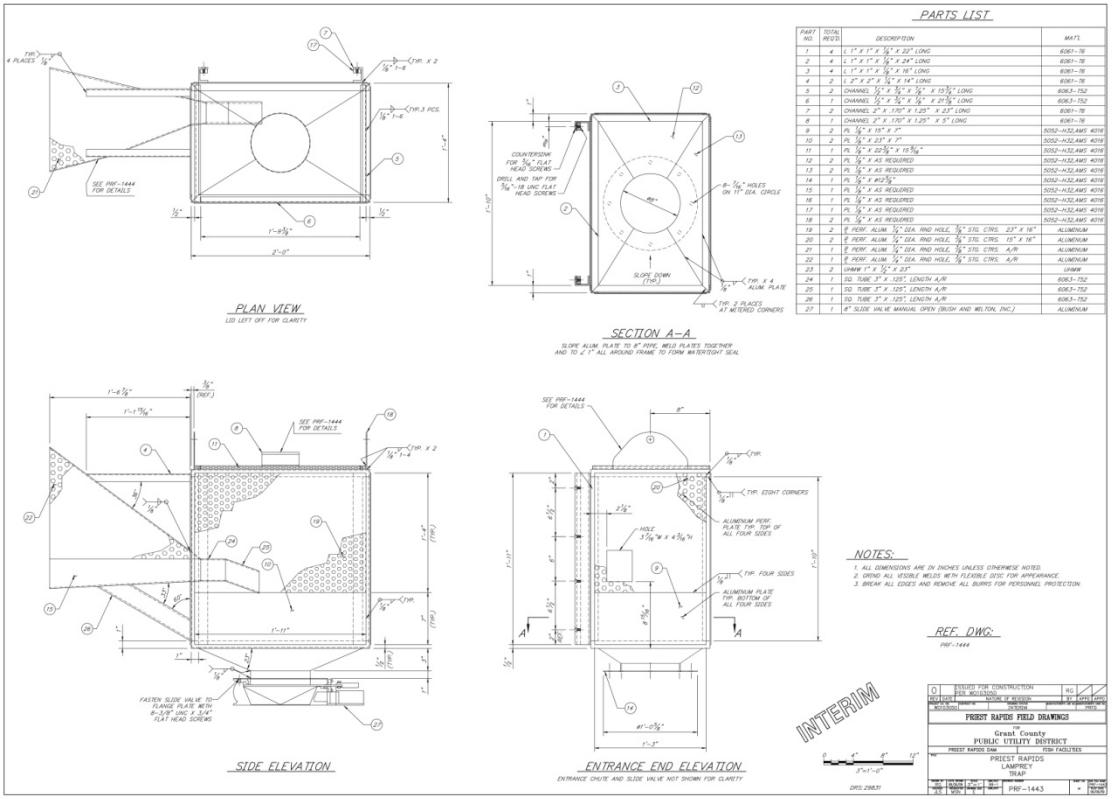


Figure 5 Proposed lamprey trap to be used in the Priest Rapids Dam fishways.

Figure 6 Lamprey trap in fishway.

Trapping will begin on approximately 7 July and continue until the target number of lamprey for tagging has been achieved. Lamprey will be collected for tagging opportunistically on an "as they come" basis. In contrast to "tagging in proportion to the run", this approach increases the likelihood of achieving the tagging target (especially for small populations), uses individuals that are actively migrating and have the likelihood to continue migration, and therefore achieves the overarching objectives of the passage evaluation. The traps will be removed and the orifice opened after the tagging operation is complete. If this trapping method turns out to be insufficient, manual dip-netting at strategic locations will be implemented to supplement total catch. Captured Pacific lamprey will be transported to a holding facility and placed into large tanks fed with river-water. Biological sampling and tagging will be performed to support the objectives of the study. Collection and tagging of 300 fish is proposed in order to address the three study objectives. Tagged lamprey will be released in the proportion of which they are captured on the left and right bank fishways, and will be released on the same side of the river in which they were captured (historically, 70% left bank and 30% right bank).

2.1.3 Data Analysis

Fishway passage efficiency will be calculated as the number of lamprey successfully exiting a fishway divided by the number that entered the fishway (Objective 1). Passage time of lamprey through diffusion grated and non-grated sections of the fishway, and through count stations, will be calculated for comparison of passage time through these sections (Objective 2). Control (normal) and treatment (decreased fishway attraction flow) conditions will be evaluated using Cox Hazard Analysis (Keefer et al. *In press*) to relate passage metrics (use and passage times) with entrance flow level (low vs. normal) and to account for biological (fish size) and environmental (temperature) co-variables (Objective 3).

The following is an example of the data that may be expected from 2010 monitoring operations. Of an anticipated 300 fish tagged and released downstream from Priest Rapids Dam, 65 to 90% (195 to 270) will return to the dam and attempt passage. If fishway entrances are relatively effective, as indicated from previous telemetry studies, 80% or more (minimum of 156 to 216) of these fish will successfully enter a fishway at Priest Rapids Dam. With dual array PIT antennas as described above, detection efficiencies will be 80 to 90% (125 to 194 fish detected). This value will be determined from records at upstream detection sites (number of fish detected at upstream sites not detected at entrance site divided by number of fish detected at both sites) and will be used to adjust for the number of fish not detected. Passage efficiencies in previous studies for lamprey were in the range of 50 to 70%. If modifications as described here are effective, an improvement in passage success at both projects is expected. Using the 70% rate, 111 to 151 fish are expected to successfully pass through fishways and enter the forebay at Priest Rapids Dam, of which about 88 to 136 would have been detected at a fishway entrance. It is anticipated that exit arrays will be 90 to 100% effective at detecting fish. This can be confirmed from records of fish known to be in the fishway that were not detected at Priest Rapids fishway exit site but were later detected at Wanapum Dam.

2.2 Assessment of Lamprey Behavior using Underwater Video

During the annual fishway maintenance period, Grant PUD will make structural modifications in the Priest Rapids fishways including:

- plating on the edges of diffusion grating that extends to the vertical wall of the fishway;
- plating on the fishway floor of weir orifices;
- plating in the form of a ramp where the weir orifice is elevated above the fishway floor;
- redesign of the counting station structure.

The intent of these modifications is to provide conditions that improve lamprey passage in areas that were identified in previous studies as potential passage impediments or having increased passage time. One method to assess Pacific lamprey use of these new modifications is by collecting underwater video imagery. Much like the imagery collected to enumerate fish at fishway count windows, similar equipment can be deployed in strategic locations to record the behavior of lamprey during passage events. Since this method relies upon the run-at-large and not on a tagged population, an adequate sample of fish will be achieved to describe the use of the new structures by lamprey.

A large variety of video technology exists that can be considered for use in this application. Primary considerations in designing a suitable video system include (Nass 2007):

- site access, equipment mounting locations, power;
- channel layout and hydraulic conditions;
- suitable water clarity during the monitoring period;
- lighting and background coloration and texture;
- distance from camera to target;
- imagery resolution, capture, and storage;
- behavior and speed of target.

These aspects will be considered with respect to collecting data on the use of the modified structures by Pacific lamprey. The video system will be designed for reliability, ease of modification and maintenance, and efficient imagery review.

Several cameras will be deployed to view a target area from different angles and distances to provide imagery to address the objective of the study. Strategic locations from which to monitor a specific modification were determined by a pre-season field test and assessment. Imagery will be collected from the beginning of the migration through the peak passage period. Analyses of the data will be conducted to determine fish use of the new fishway structures and evaluation of fish behavior relative to the new structures (Objective 2) and treatment flow regime (Objective 3).

Video monitoring will be conducted at two locations on the Priest Rapids right bank fishway facilities. The right bank was chosen to conduct the study as it provided suitable access and the fishway is narrower compared to the left bank. The number of lamprey passage events may also be proportionally lower compared to the left bank as based on historical counts, but the event data collected should be adequate for the purpose the study. Pool 29 will be used to evaluate the use of plating modifications and Pool 72 will be used to evaluate the newly designed fish counting station crowder (Figure 7). Pool 29 is the last pool in the lower fishway with diffusion grating and the newly installed plating. Pool 72 is the fixed location for the fish counting station. An evaluation metric will be the proportion of observed lamprey using a specific structure.

Uni-strut will be fastened to the weir or stem walls of the fishway at all locations. Trolleys for the uni-strut will be fabricated with a 12”x12” horizontal mounting plate on which one or two cameras will be mounted. All components will be rounded and ground smooth for a fish-friendly profile. Cameras may also be mounted directly to the crowder structure.

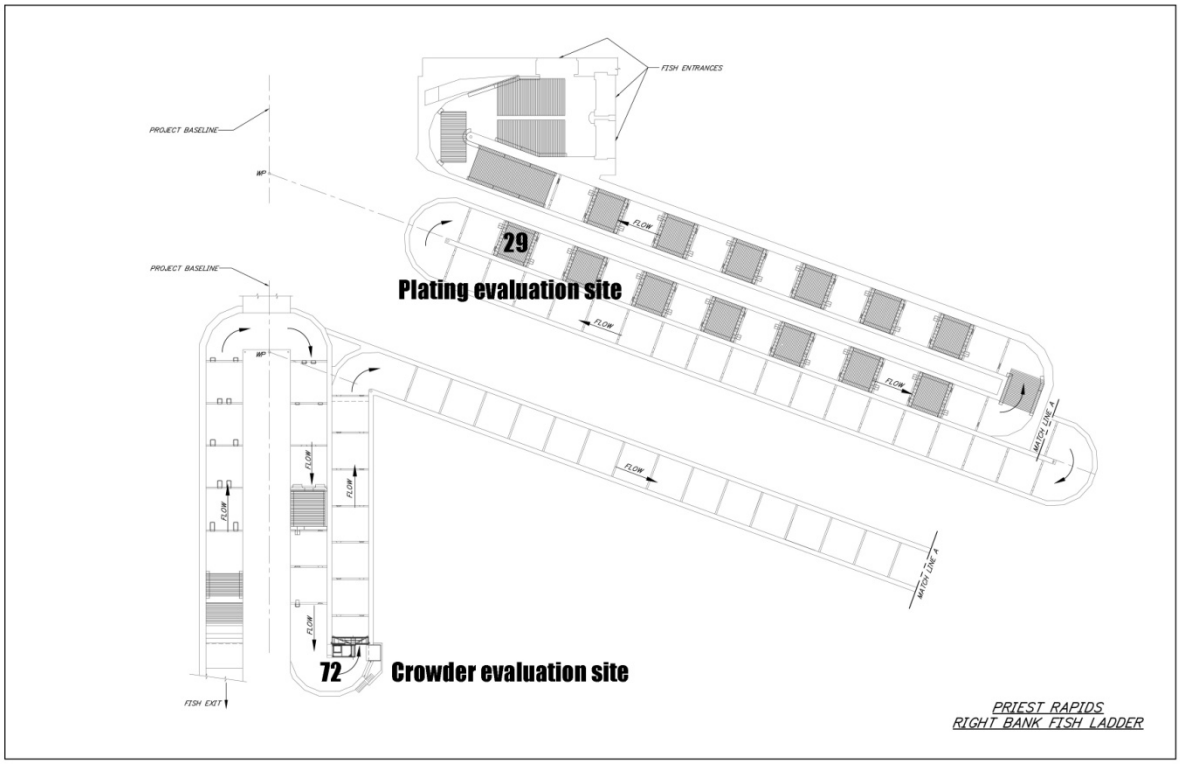


Figure 7 Priest Rapids right bank fish facilities.

A total of eight cameras will be deployed in, or in proximity to, Pool 29 for observing lamprey movement and behavior in proximity to plating structures (Figure 8) including:

- 4 observation locations of the edging plate (B, C, D, E)
- 1 location for approach to an orifice from a pool with no diffusion grating (A),
- 1 location for approach to an orifice from a pool with diffusion grating (E),
- 1 location for egress from an orifice into a pool with no diffusion grating (F), and
- 1 location for egress from an orifice into a pool with diffusion grating (B).

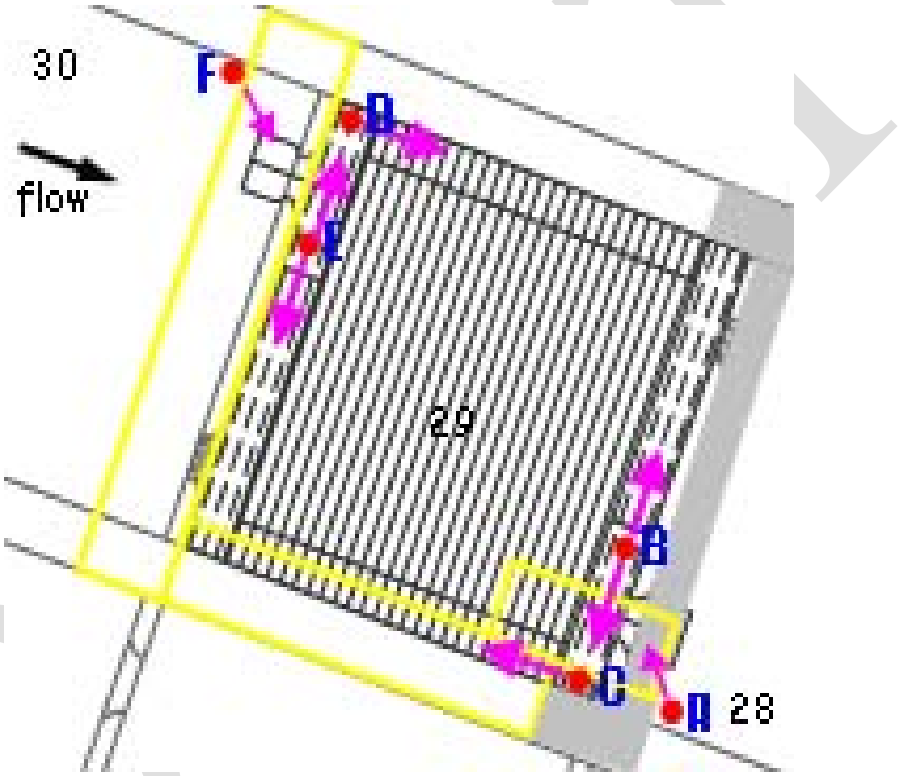


Figure 8 Priest Rapids pool 29 and proposed camera array.

- The yellow lines bound the catwalk to be installed,
- The grey shaded areas on the stem wall of the fishway indicates where concrete columns are located,
- The grey shaded area crossing the fishway is a concrete beam,
- The red dots are the locations where uni-strut will be installed (A thru F), and
- The pink arrows indicate the direction in which a camera will be pointed.

A total of four cameras will be deployed in Pool 72 for observing lamprey movement and behavior in proximity to the crowder (Figure 9) including:

- 2 locations for approach to the crowders' downstream edge,
- 2 locations for approach to the main crowder ramp.

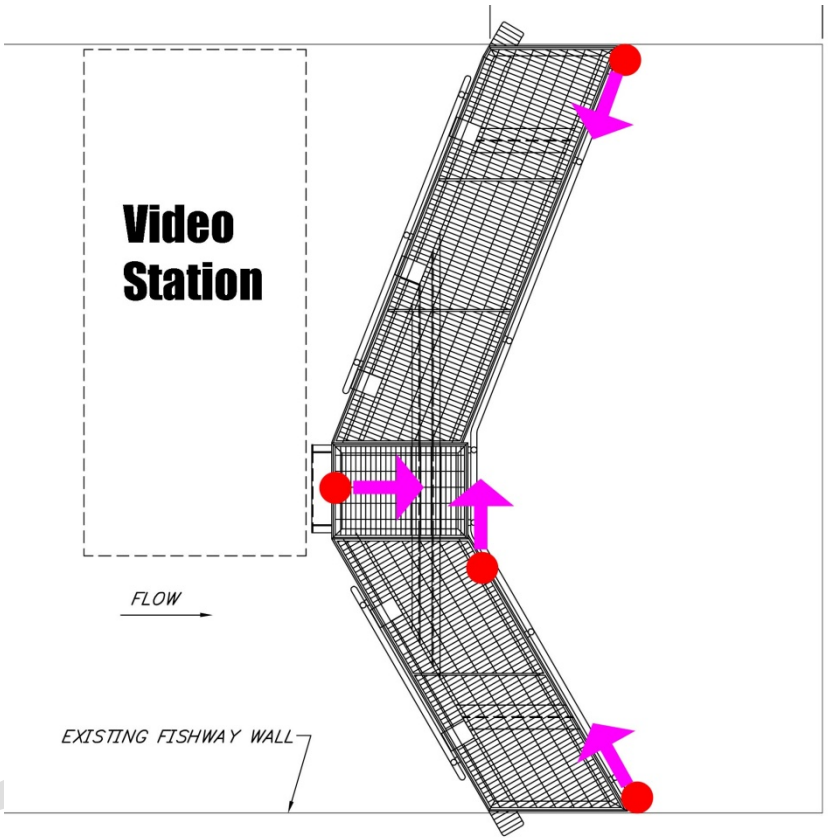


Figure 9 Priest Rapids Pool 72 and proposed camera array.

A selection of still photos collected in Pool 29 are presented in Appendix A (Figure 12, Figure 13, Figure 14, Figure 15, Figure 16, Figure 17, Figure 18, Figure 19) to illustrate the type of imagery that can be expected from the video study.

2.3 Evaluation of reduced night-time flows

Objective 3 of this plan (PME 4.2.8 of the PLMP) is to determine if a reduction of flow (i.e., velocity) in the "lower fishway" (i.e., below Pool 27, last diffusion supply chamber) affects the use and passage of lamprey of the fishway. This objective will be achieved by implementing a series of control and treatment flow scenarios in the Priest Rapids left and right bank fishway facilities. Standard or control criteria is 1.5 ft differential at the entrance and results in approximately 4 ft/sec over the weirs in the fishway and 6 ft/sec at the entrance (near surface). Flow velocity at the bottom of all fishway entrances at Priest Rapids and Wanapum dams is near 0 ft/sec. Proposed treatment criteria is 1.0 ft differential at the entrance and is anticipated to be

substantially different enough from standard conditions to effect passage characteristics of lamprey, if there was going to be an effect. It is important to note that the treatment scenario decreases the total attraction flow to the fishway and may affect entrance efficiency. Control and treatment scenarios will be conducted during the peak period of lamprey migration in August. Each control and treatment will last one calendar week to provide two control periods and two treatment periods. The one week duration of each test period is necessary to ensure adequate time for tagged lamprey to enter and pass through the lower fishway under a single scenario. Low flow conditions will be implemented from 20:00 hrs through 04:00 hrs for an eight-hour duration. This duration is necessary to ensure lamprey have the opportunity to encounter the modified flow regime after entering the fishway and to have an adequate period during which to ascend the lower fishway. The primary evaluation metric is the travel time for lamprey between the fishway entrance and end of diffusion chambers in the lower fishway.

2.4 Assessment of Lamprey Behavior using Acoustic Telemetry

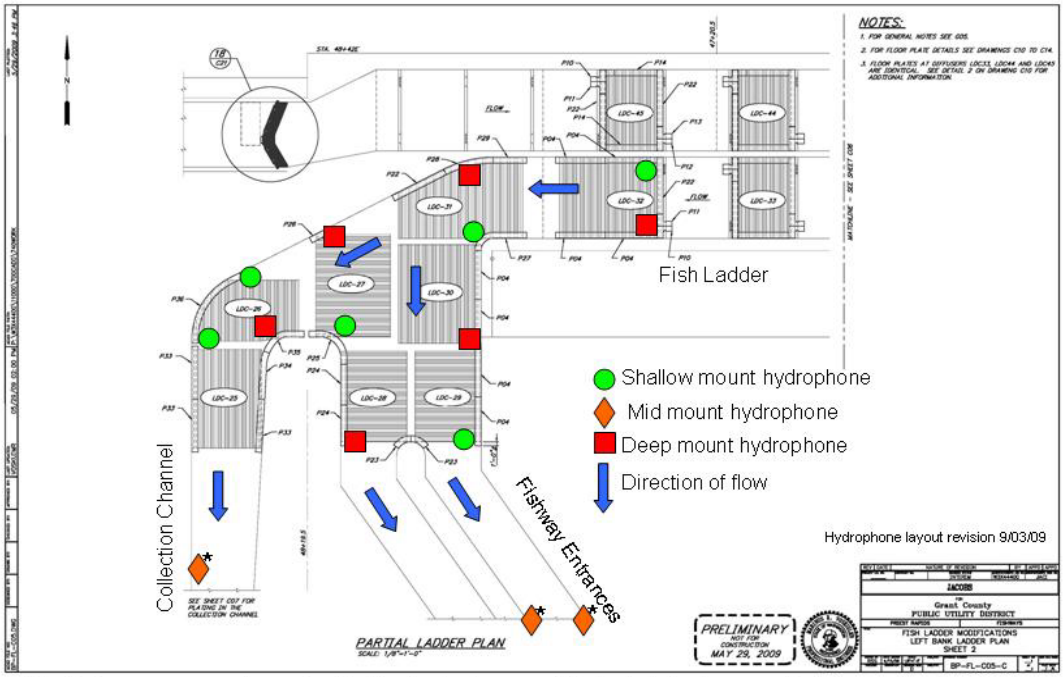
The bifurcation pool at Priest Rapids Dam is located at the base of the left bank fish ladder. Upstream migrating lamprey may enter the bifurcation pool from either the collection channel or through the left bank fish entrance. Previous studies have shown that some lamprey enter the bifurcation pool and do not select the lower fish ladder for upstream passage, but instead exit the bifurcation pool through either the collection channel or one of the fishway entrances. To examine migration behavior by lamprey approaching the entrance to the fishway and in the bifurcation pool, a three-dimensional acoustic telemetry study will be conducted.

Acoustic telemetry hydrophones will be installed along the walls of the bifurcation pool using appropriate materials to protect the equipment and provide a fish-friendly profile. Hydrophones will be strategically mounted around the perimeter of the junction pool in an alternating deep/shallow configuration to best capture the entire volume of water for three-dimensional tracking of tagged lamprey (Figure 10). Additional hydrophones at the upper end of the collection channel, at the first weir of the fishway, and in proximity to the entrance will assist in defining movements into and out of the junction pool area. Further, the hydrophones near the entrance will assist in evaluating the approach of lamprey to the entrance from the tailrace. For example, if there are 10 unique lamprey in the tailrace that are detected in proximity to the entrance, and the same 10 individuals are detected in the junction pool, then it can be concluded that entrance efficiency was 100%. Hydrophones will be cabled to a single acoustic receiver and data will be collected throughout the study period.

Additional acoustic monitoring will also be conducted in the forebay of Priest Rapids Dam to detect lamprey that exit the fishways. Data will be used to confirm passage through the fishways and provide insight on movement behavior after they enter the forebay. Further, mobile tracking surveys will be conducted in the Priest Rapids and Wanapum reservoirs for the duration of tag life to assess the timing, distribution and movement through the reservoirs.

Up to 50 lamprey captured on the left bank will be surgically implanted with acoustic tags (15.5 mm x 6.7 mm, 0.65 g, and 21 d life). This group of lamprey may also be PIT tagged (i.e., double tagged, total weight of 1.25 g) to provide detection efficiencies for the PIT entrance array. Collection, handling, and release protocols will be identical to those described for HDX PIT Monitoring in section 2.1.1. Surgical protocol will differ slightly from HDX protocol - up to two sutures will be used to close the abdominal incision.

Detection efficiency of acoustically tagged lamprey that enters the bifurcation pool is expected to be 100%. Three-dimensional tracks (Figure 11) of lamprey will be analyzed for behavior patterns to determine how the bifurcation pool is utilized by lamprey. Evaluation metrics will include the proportion of directional movements by lamprey (e.g., move upstream from the bifurcation pool into the lower fishway, move into the collection channel, drop-back, drop-out, exit).



*Indicates a permanent mount. All other hydrophones will be installed using a vertical channel system to allow for in-study depth adjustments.

Figure 10 Left bank bifurcation pool and location of proposed acoustic hydrophones at Priest Rapids Dam.

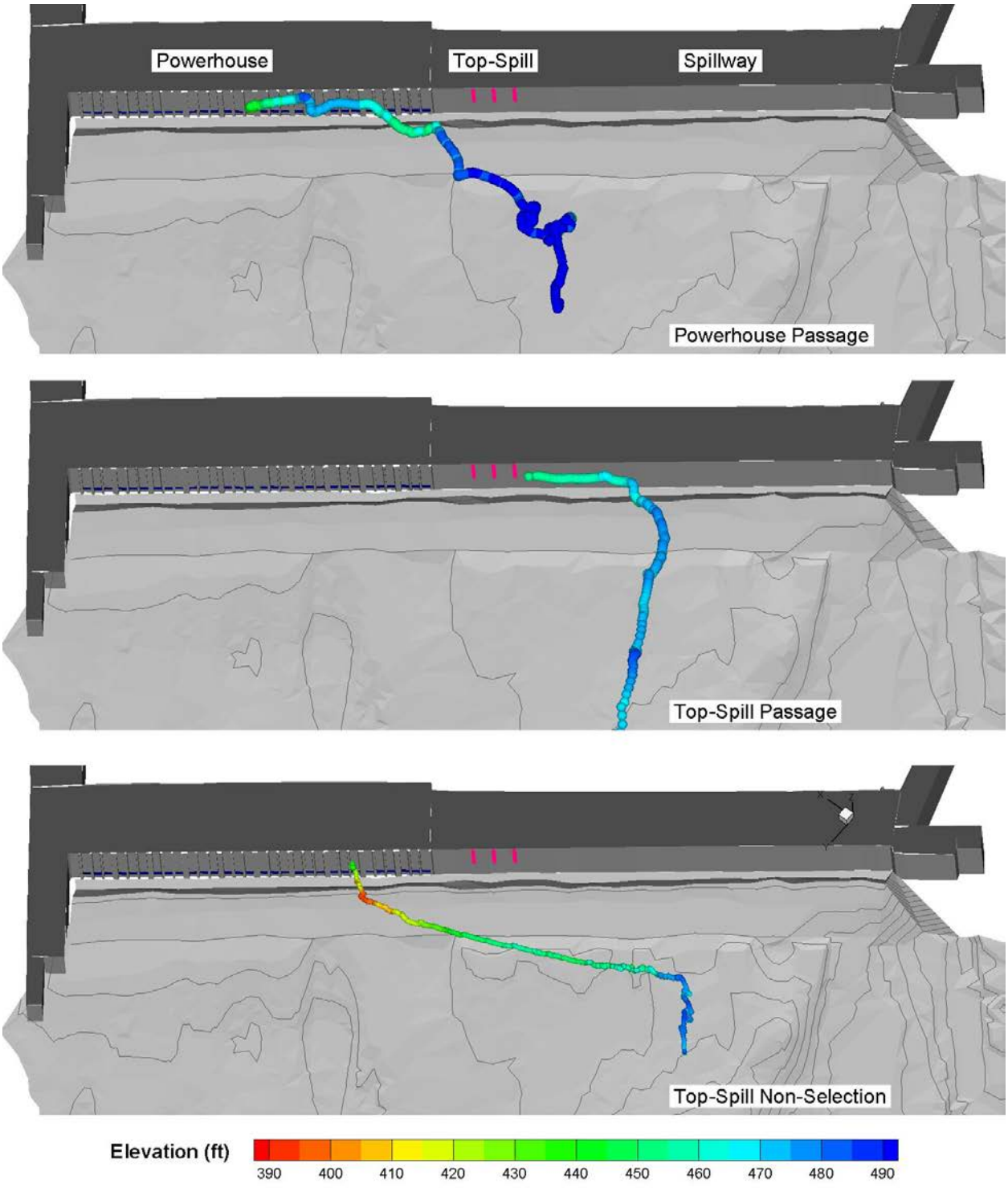


Figure 11 Examples of three dimensional tracks of individual Chinook salmon smolts in the forebay of Priest Rapids Dam.

2.5 Analysis and Reporting

Data will be compiled and used to measure passage efficiency and behavioral patterns. These metrics will be compared between test conditions when applicable, and with data previously collected in previous studies, where appropriate.

2.6 Contingency Planning

The number of lamprey that will reach Priest Rapids Dam and be available for capture in 2010 is uncertain. The return of lamprey in 2009 appears to be below average with anticipation of even lower returns in 2010 (PRFF meeting discussion, 1 July 2009). Since the design of the passage study and its resulting metrics are based in part on the number of fish which are tagged, it is necessary to prioritize activities according to run size. The study objective with the largest impact on the required sample size is the flow reduction evaluation component. A control and treatment scenario essentially reduces the sample size for each scenario compared to a single condition study. In order to achieve adequate sample size for comparison of treatment and control scenarios, the study target of 300 tagged fish needs to be achieved. In the case of a low run year where fewer fish can be tagged (e.g., 150), the reduced flow component will not be conducted as statistical comparisons will not be robust.

2.7 PRFF Comments on the Draft Study Plan

A summary of comments by the PRFF as received by Grant PUD on earlier versions of the Lamprey Passage Study Plan have been compiled along with responses from Grant PUD (Appendix B). The summary is based on written (Appendix C) and verbal (Appendix D) comments.

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Appendix A
Photo Plates from Pool 29

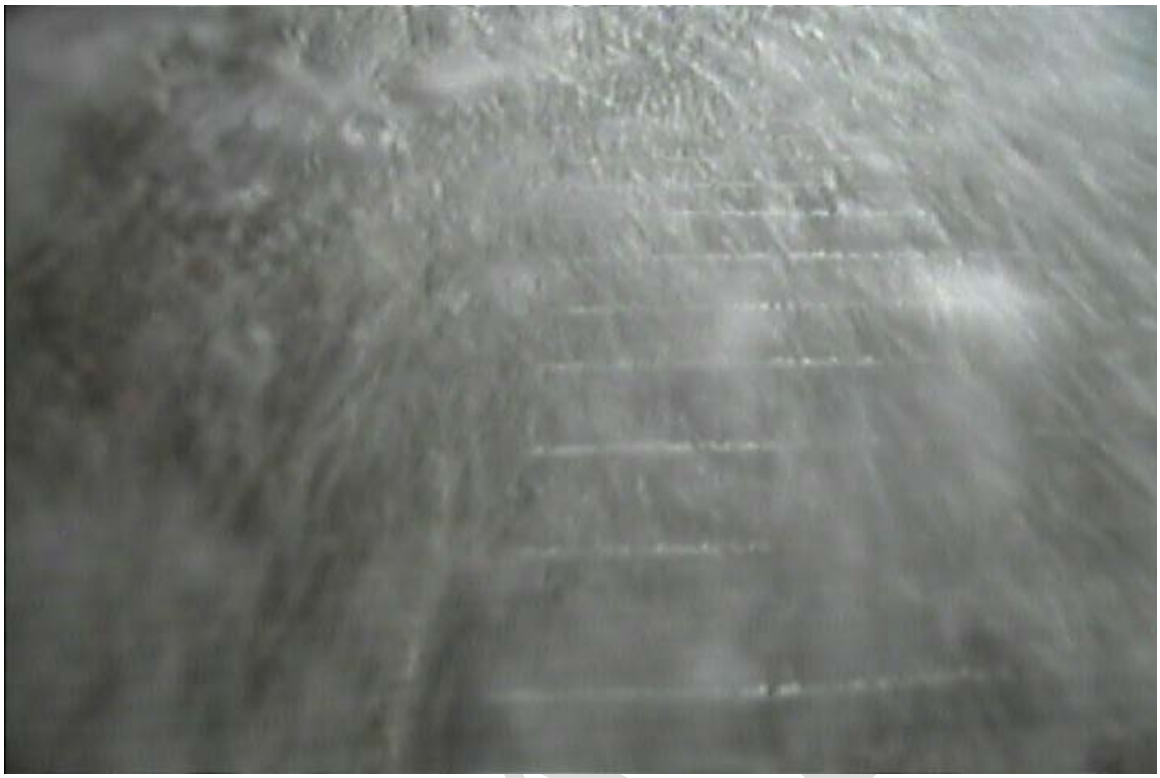

Figure 12 Location D looking downstream along stem wall when entrained air was high.

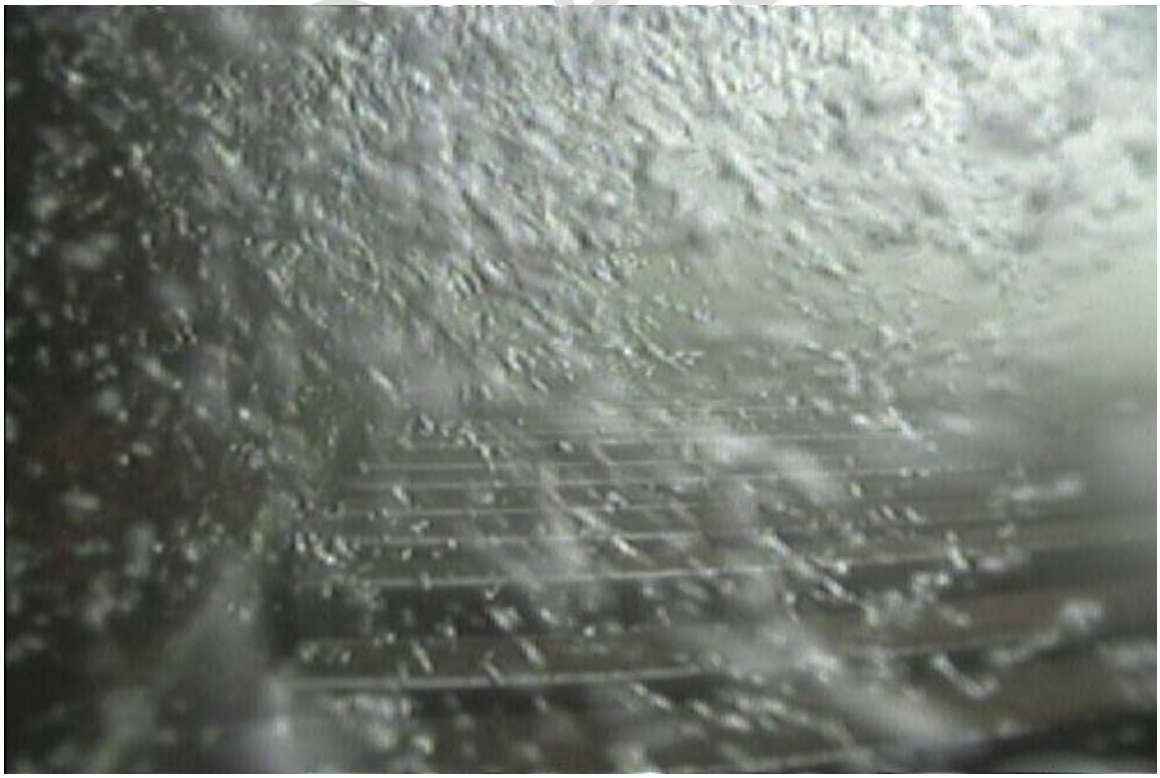

Figure 13 Location D looking downstream along stem wall when entrained air was at its lowest.

Figure 14 Location E looking toward the orifice when entrained air was high.

Figure 15 Location E looking toward the orifice when entrained air was low.

Figure 16 Location E looking along the weir wall when entrained air was high.

Figure 17 Location E looking along the weir wall when entrained air was low.

Figure 18 Adjacent to Location F looking downstream at orifice when entrained air was high.

Figure 19 Adjacent to Location F looking downstream at orifice when entrained air was low.

Appendix B
PRFF Comments Summary

GRANT PUD'S RESPONSE TO AGENCY AND TRIBAL COMMENTS FOR THE PACIFIC LAMPREY PASSAGE STUDY PLAN

Submitting Entity	Date Received	Agency Comment	Grant PUD Response
PRFF Meeting Discussion	1 July 2009	Grant PUD should investigate the amount of time fish spend in the collection channel and bifurcation pool {in more detail than presented in the study plan}.	Grant PUD will conduct a detailed behavior study of adult lamprey in the bifurcation pool and lower fish ladder using three-dimensional acoustic telemetry. Grant PUD has modified the study plan accordingly.
PRFF Meeting Discussion	1 July 2009	Members prefer fish be trapped lower in the Priest Rapids ladder.	Grant PUD will trap adult lamprey at pool 31 on the left fishway and pool 33 on the right fishway. These are lowest practical locations. Grant PUD has modified the study plan accordingly.
Email from WDFW (M. Hallock)	22 July 2009	There are issues that need to be addressed such as the trapping. I share your concern about trapping and evaluating passage at the same time, although I'm not sure how to get around it. You don't want to hold them too long and certainly not long enough to get 300. Something to kick around this fall and winter.	Grant PUD will conduct trapping operations only as required to collect the minimum number of fish for tagging. This will minimize any impact on the migrating fish or compromise the results of the study.
Email from WDFW (M. Hallock)	22 July 2009	Also, another issue not addressed is the flow reduction regime. I take that will be hammered out fall-winter as well.	Grant PUD has revised the study plan to include a night-time flows reduction component as required by the PLMP.
Email from WDFW (M. Hallock)	22 July 2009	Right now we need to figure out if everything is ready for dewatering: 1. telemetry equipment installation sites - they look good to me. 2. camera sites - your proposed sites look good, may want to kick this around some more. I think we decided it wouldn't work in the collection channel-entrance pool area.	Grant PUD and contractors have conducted detailed site assessments of the fishways and determined where the telemetry (PIT) and video methods are feasible and will meet the objectives of the study. The collection channel – entrance area will be assessed using three dimensional acoustic telemetry. Grant PUD has modified the study plan accordingly.
Email from USFWS (S. Lewis)	4 Aug 2009	We recommend the additional placement of PIT detection arrays within the collection channel to assess lamprey activity in this area.	The study plan proposes to monitor the entrance to the collection channel and the left-bank bifurcation pool using PIT detection. No other areas of the collection channel can be feasibly monitored using this technology. However, Grant PUD is utilizing three dimensional acoustic telemetry which will determine the movement and behavior of lamprey into and out of the collection channel from the bifurcation pool.
Email from USFWS (S. Lewis)	4 Aug 2009	I suggest that we do not totally discount the possibility of incorporating a fishway velocity reduction aspect into this 2010 study perhaps at Wanapum Dam.	Grant PUD has modified the study plan to include evaluation of reducing flows in the lower fishways at Priest Rapids Dam, consistent with the PLMP.
Email from USFWS (S. Lewis)	4 Aug 2009	Similar to previous studies conducted at Wells, four traps will likely be required for the Priest Rapids 2010 study in order to achieve an appropriate sample size. I think this is the only way to achieve the 300 lamprey criteria. It's my suggestion to place these traps at the overflow	Grant PUD will fish a total of four traps, two in each fishway at overflow weirs at Priest Rapids Dam. Grant PUD has modified the study plan accordingly.

		weirs as I'm sure you already anticipate.	
Email from USFWS (S. Lewis)	4 Aug 2009	I'm still not quite convinced that we totally understand how these critters approach the fishway entrances at Priest Rapids, so I suggest incorporating a fishway entrance efficiency component into the 2010 study if possible.	This request is outside the scope of the objectives identified in the PLMP. However, Grant PUD will conduct a detailed study of adult lamprey in the vicinity of the left fishway main entrance using acoustic telemetry to assess entrance behavior and efficiency. Grant PUD has modified the study plan accordingly.
PRFF Meeting Discussion	5 Aug 2009	Members recommended that 3D hydro-acoustics be used in the entrance and collection channel area to determine entrance efficiency and to define behavior of lamprey as they approach the entrance.	See above response.
PRFF Meeting Discussion Yakama (B. Rose)	2 Sep 2009	B. Rose would like to understand the behavior of fish as they approach and enter the fish ladder.	See above response.
PRFF Meeting Discussion Yakama (B. Rose)	2 Sep 2009	B. Rose explained that because JSAT tags are being used to tag fish at Bonneville Dam, he would like to monitor those fish as well.	Grant PUD will passively monitor HD PIT-tagged fish that were tagged downstream, but no other tag types.
PRFF Meeting Discussion Yakama (B. Rose)	2 Sep 2009	B. Rose asked that all other fishways in the Priest Rapids Project also be monitored for {acoustic tagged} lamprey passage.	Grant PUD believes that because all 6 fish ladder entrances in the Priest Rapids Project are identical, and because the PRD left-bank entrance receives the highest amount of lamprey activity, that location was selected for monitoring.
PRFF Meeting Discussion Yakama (B. Rose)	2 Sep 2009	B. Rose suggested that acoustic tag receivers be placed at the exit of the fishway to determine if fish go into the turbines and back through the Project, or continue up stream.	Grant PUD will monitor acoustically tagged lamprey in the forebay at Priest Rapids Dam. Grant PUD has modified the study plan accordingly.
PRFF Meeting Discussion Yakama (B. Rose)	2 Sep 2009	Rose asked that different {fish collection} strategies are added to the study proposal {tagging in proportion to the run}.	Grant PUD has modified the study plan to provide a clear rationale for tagging methodologies.
PRFF Meeting Discussion Yakama (B. Rose)	2 Sep 2009	Rose suggested that mobile tracking {of acoustically tagged fish} be included in the Study Plan, so that when acoustic tags leave the Project, the ability to track them upriver remains.	Grant PUD will monitor acoustically tagged lamprey in the Priest Rapids Project reservoirs using mobile tracking during the period that the tags are active. Grant PUD has modified the study plan accordingly.

Email from WDFW (M. Hallock)	14 Sep 2009	"We propose to use a combination of technologies to monitor the behavior of Pacific lamprey, and quantify the overall passage effectiveness through standard metrics (Nass et al. 2002)." Trying not to be nit-picky, but for clarity's sake you might use the term "fishway" instead of 'overall". Overall passage success in the 2001-2002 study as defined above (proportion of individuals approaching the fishway that exit). I gather, though, you are hoping to capture approach through the acoustic telemetry component?	Grant PUD has modified the study plan accordingly. Lamprey approaching the Priest Rapids left fishway entrance will be evaluated using acoustic telemetry.
Email from WDFW (M. Hallock)	14 Sep 2009	"Surgical protocol will differ slightly from HDX protocol as acoustic tags are about 40% wider than PIT tags and will require up to two sutures to close the abdominal incision." Any thoughts on if these tag type might affect behavior?	Grant PUD has modified the study plan to describe the available information regarding tagged fish performance.
Email from WDFW M. Hallock)	14 Sep 2009	"In the case of a low run year where fewer fish can be tagged (e.g., 150), we propose that the reduced flow component not be conducted ." I concur. Entrance flow (as yet) has not been identified as a problem. In fact, as you know, too low a velocity could reduce attraction. I pushed for the including flow component earlier, but I'm neutral/against it now.	Comment noted.
Email from USFWS (S. Lewis)	18 Sep 2009	The study plan looks good. As discussed during the previous meeting, we would like to use some type of mobile tracking to fully utilize tag life during the study. It would be nice to see what these critters do within the reservoirs and/or tribs if at all possible.	Grant PUD will monitor acoustically tagged lamprey in the Priest Rapids Project reservoirs using mobile tracking during the period that the tags are active. Grant PUD has modified the study plan accordingly.
Email from Wanapum (A. Buck)	28 Sep 2009	We would like to have members of the Wanapum River Patrol on site during any manual dip netting collection captures.	Grant PUD will include Wanapum River Patrol staff during any manual dip netting collection activities.
Email from Wanapum (A. Buck)	28 Sep 2009	We request any mortalities be set aside for Wanapum subsistence purposes.	Grant PUD will provide any collected lamprey that become mortalities to the Wanapum.
Email from Wanapum (A. Buck)	28 Sep 2009	We also request a video clip of the migratory behavior through new structure modifications for our repository for documentation purposes for future Wanapum generations.	Grant PUD will provide video imagery clips of lamprey collected during the study to the Wanapum.

Appendix C
PRFF Comments Via E-Mail

>>> "Hallock, Molly (DFW)" <Molly.Hallock@dfw.wa.gov> 7/22/2009 1:36 PM >>>

Mike,

I looked over the study plan again, and as you said in the July 01 meeting, it is a barebones outline, but I think is an excellent start. The meeting with Chris and Bryan was very informative and filled in many of the gaps. There are issues that need to be addressed such as the trapping. I share your concern about trapping and evaluating passage at the same time, although I'm not sure how to get around it. You don't want to hold them too long and certainly not long enough to get 300. Something to kick around this fall and winter. Also, another issue not addressed is the flow reduction regime. I take that will be hammered out fall-winter as well.

Right now we need to figure out if everything is ready for dewatering:
1. telemetry equipment installation sites - they look good to me.
2. camera sites - your proposed sites look good, may want to kick this around some more. I think we decided it wouldn't work in the collection channel-entrance pool area.

Molly Hallock
Washington Department of Fish and Wildlife
Fish Biologist (Freshwater Native Nongame)
Workdays: Monday-Wednesday
600 Capitol Way North
Olympia WA 98501
(360)902-2818

-------- Original Message --------
Subject: Re: UPDATE Priest Rapids Fish Forum Conference Call - August 5, 209
Date: Tue, 4 Aug 2009 16:06:02 -0700
From: Stephen_Lewis@fws.gov
To: Debra Williams <Dwilli1@gcpud.org>

Mike Clement:

I have a few random thoughts to chew on related to the 2010 Pacific Lamprey Study Plan:

* We recommend the additional placement of PIT detection arrays within the collection channel to assess lamprey activity in this area
* I suggest that we do not totally discount the possibility of incorporating a fishway velocity reduction aspect into this 2010 study perhaps at Wanapum Dam. Douglas PUD will be conducting a similar study in 2009 at Wells and we may have a better idea as to whether a flow reduction would work at Wanapum?
* Similar to previous studies conducted at Wells, four traps will likely be required for the Priest Rapids 2010 study in order to achieve an appropriate sample size. I think this is the only way to achieve the 300 lamprey criteria. It's my suggestion to place these traps at the overflow weirs as I'm sure you already anticipate.
* I'm still not quite convinced that we totally understand how these critters approach the fishway entrances at Priest Rapids, so I suggest incorporating a fishway entrance efficiency component into the 2010 study if possible. I'm open to discussion ;-)

That's all I have for now! I look forward to the discussion on Wednesday...

S-

****
Stephen T. Lewis
Mid-Columbia Relicensing Coordinator
U.S. Fish and Wildlife Service
Central Washington Field Office
215 Melody Lane, Suite 119
Wenatchee, WA 98801
phone: (509) 665-3508 Ext. 14
fax: (509) 665-3523
e-mail: Stephen_Lewis@fws.gov

>>> "Hallock, Molly (DFW)" <Molly.Hallock@dfw.wa.gov> 9/14/2009 2:26 PM >>>

Hi Mike,

Just a few comments. Nothing critical. I hope the fish numbers are up next year!

Molly Hallock
Washington Department of Fish and Wildlife
Fish Biologist (Freshwater Native Nongame)
Workdays: Monday-Wednesday
600 Capitol Way North
Olympia WA 98501
(360)902-2818

>>> >>> <Stephen_Lewis@fws.gov> 9/18/2009 10:39 AM >>>

Hi Mike-

The study plan looks good. As discussed during the previous meeting, we would like to use some type of mobile tracking to fully utilize tag life during the study. I think perhaps RD's shop would be willing to help with that aspect as well....I can verify if needed. It would be nice to see what these critters do within the reservoirs and/or tribs if at all possible.

S-

****
Stephen T. Lewis
Mid-Columbia Relicensing Coordinator
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215 Melody Lane, Suite 119
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fax: (509) 665-3523
e-mail: Stephen_Lewis@fws.gov

>>> >>> Alyssa Buck 9/28/2009 4:15 PM >>>

Mike,

The Wanapum appreciate the opportunity to comment on the Pacific Lamprey Study Plan and have the following comments. Pacific Lamprey are an important cultural resource to the Wanapum. We have traditionally gathered Pacific Lamprey in the Priest Rapids Project and Columbia Basin Drainage areas. The study plan is an acceptable path forward towards meeting the goals and objectives of the Pacific Lamprey Management Plan. As we stated in our management plan comments, we are interested in participating with recovery efforts regionally including any Priest Rapids Project efforts. We would like to have members of the Wanapum River Patrol on site during any manual dip netting collection captures. We request any mortalities be set aside for Wanapum subsistence purposes. We also request a video clip of the migratory behavior through new structure modifications for our repository for documentation purposes for future Wanapum generations.
Don't hesitate to email or call if you have any questions.

Alyssa Buck
Wanapum License Coordinator
Grant Co. P.U.D
abuck1@gcpud.org
(509) 793-1442 - work
(509) 750-0533 - cell

Appendix D
PRFF Meeting Minutes

Grant County
PUBLIC UTILITY DISTRICT
Excellence in Service and Leadership

Priest Rapids Fish Forum

Wednesday, July 01, 2009
9:00 a.m. – 4:00 p.m.
Grant County PUD Natural Resources Office
Conference Room "C"

Members

Stephen Lewis, USFWS	Patrick Verhey, WDFW
Bob Rose, YN	Carl Merkle, CTUIR
Keith Hatch, BIA	Joe Peone, CCT
Marcie Mangold, WDOE	Mike Clement, GCPUD

Attendees

Patrick Verhey, WDFW	Molly Hallock, WDFW
Brad James, WDFW (on phone)	Bob Rose, YN
Keith Hatch, BIA	Marcie Mangold, WDOE (on phone)
Steve Lewis, USFWS	RD Nelle, USFWS
Brian Nass, LGL	Chris Peery, Cramer Fish Sciences
Lela Buck, Wanapum	Mike Clement, GCPUD
Ben Lenz, GCPUD	Ross Hendrick, GCPUD
Debbie Williams, GCPUD	Kevin Malone, Facilitator

Action Items:

1. **Clement will talk to Nass, Peery and Nicholls regarding trapping efficiencies and potential locations for lamprey ladder evaluations. This information will be included in the final study plan.**
2. **Peery will report what is going on with the US. Corp lamprey study at Bonneville and how the PIT-tag detection system efficiency at entrances relates to PRD and WAN entrances.**
3. **Clement/Nass will schedule a trip to evaluate Bonneville PIT-tagging and fish handling techniques.**
4. **Comments on equipment placement, methodologies and other issues related to the 2010 study should be provided to Mike Clement by August 5th**
5. **Clement will research the use of clove oil vs. MS222 for handling lamprey.**
6. **Peery and Nass will provide PRFF members a list of identified areas of the 2001-02 study and provide explanation of how those areas will be measured at the September PRFF meeting.**

7. **Provide all Lamprey Study Plan comments regarding equipment needs and placement to Clement and Nass by the next meeting, August 5, 2009.**

Draft Meeting Minutes

Welcome and Introductions – Kevin Malone welcomed the Priest Rapids Fish Forum (PRFF) and asked attendees to provide self introductions.

Agenda Review – No additional items were added to the agenda.

Action Item Review

Brad James provided genetic history of the WDFW sturgeon source population to PRFF members.

On June 5, 2009, Malone requested an official vote of approval for the Lamprey Ladder Modification Designs. The PRFF approved the designs.

Clement has not yet received any Lamprey Study plan ideas/agendas from PRFF Members.

On June 5, 2009, Malone requested an official vote of approval for the Bull Trout Hydrologic and Water Quality Plan (BTHWQP). It was subsequently e-mail approved by all PRFF members except Heinith. On June 5, 2009 Heinith requested and received a summary of water quality studies related to past, present and future temperature data from Ross Hendrick, Grant PUD Limnologist. Some of the data requested will be covered in the DO, pH and Temperature in Shallow Water Habitat Plan. The information provided by Hendrick will be inserted into the BTHWQP.

Clement explained that PRFF members, other than Heinith have approved the BTHWQP, and that Grant PUD would like all voting members to reach a consensus vote prior to sending the plan to Ecology. Malone, Lewis and Clement have attempted to contact Heinith regarding his vote, with no success. Members discussed how to move forward with a plan if no response is received from a PRFF member. Malone noted that the protocols state an issue can continue to be discussed indefinitely if consensus can't be reached, until a PRFF member abstains, or the issue goes to dispute resolution. PRFF members suggest Malone send an email to Heinith requesting he take action on the BTHWQP within two weeks. Any further concerns from Heinith will be addressed at the next PRFF meeting. Within the next month, Grant PUD would like to distribute the BTHMP to Washington Department of Ecology (WDOE) so it can be approved and sent to FERC.

Hendrick discussed the upcoming water quality monitoring plans related to questions that arose related to the BTHMP. The studies will include DO, pH, and temperature monitoring and temperature modeling throughout the Project Area.

Hendrick explained that six years after receipt of the new license (2013), the MASS 1 model will be rerun using new data. The last MASS 1 model covered data from 1973 to 2000. He noted that if the water supply is modified in the PR Ladder, a Temperature Study would be conducted at that time. Temperature data was collected from 2000 to 2003 in the PR ladder, which would be used as baseline data for comparison with new data collected after/if the attraction source water is modified (to make sure there are no negative impacts to temperatures). The new attraction water source would likely use new pumps so the Gravity Intake Gate (GIG) can be removed.

Hendrick hopes to have the second draft of the Aquatic Invasive Species (AIS) Plan ready for distribution to WDOE, WDFW, and the PRFF by September 2009. Rapid response and monitoring methods will be discussed in the plan.

The United Airlines Moses Lake flight schedule was sent to members**.**

PRFF Protocol Discussion

Review of CRITFC Protocols Update (Bob Heinith edits) – Members reviewed protocol comments made by Heinith. PRFF members agreed that based on discussion, formal decision motions should be made and seconded. If the motion is not seconded, the action/issue will be tabled. Stakeholders and a voting member can participate on a technical subcommittee. A voting member can ask that a technical person attend and participate. PRFF members had previously agreed to not have a formal approval of meeting minutes. Comments to the minutes will be attached to the draft and posted to the Grant PUD PRFF website. Meeting location, date or time can be altered by consensus vote of members. Thirty (30) days, instead of sixty (60) days will be provided for meeting notification. Meetings will be held the first (1st) Wednesday of each month.

Malone will make edits to the protocols, distribute them to members, and request an email vote of approval. PRFF Protocols are a living document that can be changed at any time by consensus vote of PRFF members.

Attachment A – PRFF Subcommittee Protocols address issues sent to dispute resolution. Members decided these protocols won't be revisited until a dispute is called. PRFF members will provide guidance as to

what biological success means. The definition of cost effectiveness was discussed at the February meeting. Grant PUD will be involved in determining cost effectiveness criteria.

Consensus Vote on Protocols – A vote was not taken.

White Sturgeon Update – The White Sturgeon Management Plan was submitted to FERC for approval on April 13, 2009. Grant PUD continues to wait for FERC approval of the plan. White Sturgeon Hatchery engineering designs are expected to be complete by the end of 2009.

Cranbrook Field Trip – Ben Lenz, Mike Clement, Mike Nicholls, and Kevin Malone will be traveling to Cranbrook, B.C. on July 14th to volunteer during sturgeon spawning.

Egg collection at Coulee – WDFW provided Lenz with a summary of the Lake Roosevelt sturgeon egg collection procedures and protocols that will be used to collect eggs for Yakama Nation (YN) stocking purposes. Lenz noted he was comfortable with the genetic background and collection protocols because they are the same that Grant PUD uses. He questioned what the YN intends on doing with the eggs.

Verhey explained that WDFW and YN discussed what to do with the fish once they're raised. They agreed the discussion regarding release locations should be held with the individual PUD's that are proposed to have fish released in their Project area. Verhey noted the YN hasn't reached an internal decision as to where the fish would be released.

A viable egg take of 10,000 to 20,000 eggs has been discussed. Three weeks ago, 3 females and 5 males were on station. James wasn't aware of the current status, but thinks the program is moving forward without difficulties. It is WDFW's intent that the Columbia Hatchery be used to raise sub-yearling sturgeon for long term supplementation of Lake Roosevelt, explained James.

Bull Trout Hydrologic and Water Quality Plan

ACTION ITEM: Vote to approve Bull Trout Hydrologic and Water Quality Study Plan – No action was taken. See discussion above under III, D.

Pacific Lamprey Study Plan

Group Discussion of Methods and Performance Criteria

On June 24, 2009, the PRCC approved lamprey ladder modification designs. A contract is currently being developed for the pre-fabrication of parts.

Brian Nass, LGL and Chris Peery, Cramer Fish Sciences have been working on the development of an Adult Lamprey Study Plan that will take place in August 2010.

Members discussed the proposed study plan outlined by Grant PUD's lamprey team. The following topics were discussed.

- The proposed monitoring season would be from August 01, 2009 through October 01, 2009.
- Fish would become part of the treatment or control scenario to measure passage efficiency immediately when they enter the fishway.
- Reduction of flows isn't conclusive for success of passage but it will be measured by individuals entering the fishways during these treatments.
- Current flows are approximately 8 ft per second, which would be reduced to 3 ft per second for testing. If nighttime flow reduction should be utilized. During the study, if it is concluded that lamprey don't find the ladder because of flow reductions, Clement will contact all PRFF members to see if this portion of the study should be stopped. Clement explained that NOAA is comfortable with a reduction in fishway flows. However, if early results indicate that because fishway flows are reduced and lamprey have a difficult time finding the fishways, Clement will contact PRFF members prior to abandoning the treatment.
- Members agreed the study must be flexible enough to handle situations that arise unexpectedly.
- Investigate the amount of time fish spend in the collection channel and bifurcation pool.

- Can it be identified when a fish comes into the fishway and drops back? Clement/Nass explained that any fish that enters the fishway/entrance and drops back will be measured at the entrance or if it occurs further up in the ladder, will be detected at the next downstream detection location. If detection locations are going to be added, clearly define why you think they should be placed in each location.

- Data collected will determine if improvements from the 2001-02 study were sufficient. Grant PUD has changed operation of the lower fishway since then.

- Grant PUD is in the process of determining if a baseline adult salmonids study should be conducted during the summer of 2010 to look at adult salmonid passage, should a decision be made to test a shut down of the collection channel ? This is related to the FERC License requirement to explore tailrace pumping options. The PRFF would need to make a recommendation to NOAA in order to move forward with collection channel closures if a high amount of time is being spent in the collection channel by lamprey. Grant PUD is hopeful that fixing differentials in the collection channel will improve passage. The collection channel was not identified as a problem in the 2001 study but by excluding fish from this area, should decrease overall passage time.

- The study will determine passage efficiency, based on the proportion of fish that make it to a monitoring location at the ladder exit. Success is defined by the number of detected lamprey that exits the fishway, divided by the number of detected lamprey that enters the fishway. Kevin Malone asked if a fish is detected at the top of the ladder, but not at the bottom is it deemed a success? Peery believes a fish must be detected at the entrance and exit in order to be included in the passage efficiency test. He noted there could be a number of fish detected at upstream sites that weren't detected at the fishway entrance, biasing passage estimates. The ability to determine the tag detection efficiency of the antenna will be important. The results from the Bonneville study will provide initial data on what detection efficiencies are in a ladder. Perry noted that multiple antennas could be placed at the entrance and exit to ensure that all tags are detected. This is the approach used for PIT tag detectors located at Columbia River dams.

- Trap and haul. Effective at collecting lamprey where they congregate. Priest Rapids doesn't offer a location to trap unless

an orifice is closed off. That method doesn't offer volitional passage.

- Passage efficiencies will include data of support showing how long it takes a lamprey to pass through each fishway. However, fish passage efficiency does not have a time component associated with it. If fish are tagged and choose to overwinter between dams, the fish will likely be detected the following year.

- HD tags, a physiological study hasn't been done to determine negative tag effect on swim performance. When compared to a run at large, lamprey match up well with fish upstream. Recent studies in the lower Columbia indicate that PIT-tagged fish perform better than radio tagged fish. Once a fish makes it into the ladder entrance (i.e. detected), it becomes part of the sample. Fish not detected at the ladder entrance are not included in the sample. HD tags are 65-80% effective at detecting fish in a large opening. Higher in the ladder, they become 95% effective at detecting fish.

- Passage efficiency criteria need to be calculated using the same methods for all dams on the river. Passage efficiency for the Priest Rapids Project needs to be defined by the PRFF. Clement cautioned the group that based on lamprey life history, the potential for overwintering during migration, and because dams fishways are not the same, passage efficiency should be entrance to exit, measuring the dams efficiency to pass fish.

- Hatch explained that BIA would like to see 80% passage effectiveness. He showed a table of passage efficiencies for each of the dams on the Columbia. Verhey suggested a regional context discussion be had.

- Fish release: Sample size of 300 is being proposed. However, sample size will be dependent on the precision required around the passage efficiency estimate and the detection efficiency of the antennas. Sample size and precision justification will be provided in the study plan. Option of releasing test downstream of Priest Rapids (PR), or a split release below and above PR. Peery recommends releasing all fish below PR. For evaluation, a velocity test wouldn't be necessary at Wanapum. In 2001, fish were released below PR. Very few fish made it to the fishway, likely due to large tags. In 2002 tag size was much smaller and fish were released in closer proximity to the ladder entrance, which resulted in more fish entering the ladder. That study was more successful. Nass recommends fish be released at this location again. Nass suggests using two traps on each ladder to

trap fish for the study. Recaptured fish would give you a lot of information that you wouldn't otherwise gather. Members prefer fish be trapped lower in the Priest Rapids ladder. **Clement will talk to Nass, Peery and Nicholls regarding trapping efficiencies** and impacts to migrating fish.

- The group asked if there is a size difference in lamprey that goes over a weir wall vs. going through an orifice. No data to date suggest this is the case.

- **Peery will report what is going on with the US. Corp study at Bonneville at a future meeting of the PRFF**.

- Members discussed whether radio tags should be used to help determine entrance efficiencies and fish behavior. Nass explained that isn't part of this study and the requirement is to measure passage efficiency and test the modifications made to ladder. The use of radio tags would be of little benefit because of the known tag affect. Fish entrances will be evaluated because HD Pit-tag detection will be located at each fish ladder entrance and will measure fall back if it occurs. Clement explained that he was not comfortable using a larger tag that would compromise and affect the swim performance of lamprey. He is concerned that studies performed recently showed a significant decrease in performance of lamprey that were tagged with radio tags vs. those tagged with HD PIT-tags. Clement explained that he would prefer to use a detection method that is representative of a non-tagged lamprey and that is why the Grant PUD lamprey team is proposing the use of underwater video vs. radio tags to measure lamprey behavior relative to the ladder modifications (i.e., plating, count stations).

- **Clement/Nass will research Bonneville fish handling techniques.**

- Data Analysis: Compare passage efficiency from 2001-02 to now. Regression Analysis or Survival Analysis could be used. Determine the probability of a fish passing the dam in one day if they entered a low (reduced flow) vs. high velocity condition in the ladder.

- Underwater Video – Camera location and placement will be conducted by Nass and crew. They plan on having multiple moveable cameras. Engineering is planning on 87 days for installation of all plating. **Provide all Lamprey Study Plan comments regarding equipment needs and placement to Clement and Nass by the next meeting, August 5, 2009.**

Comments on other aspects of the study can be submitted later.

- Mangold explained that clove oil is not lawful to use for putting fish to sleep. **Clement will research the use of clove oil vs. MS222 for handling lamprey**

- **Peery and Nass will provide PRFF members a list of identified problems of the 2001-02 study**. Attending Voting Members are comfortable with the objective of the study as outlined by Nass and Peery.

Additional Items – No discussion took place.

Next Meeting: August 5, 2009 at 10:00 a.m. at the Grant PUD Natural Resources Office, Ephrata, WA.

Priest Rapids Fish Forum

Wednesday, August 05, 2009
9:00 a.m. – 12:00 p.m.
Conference Call

Members	
Stephen Lewis, USFWS	Patrick Verhey, WDFW
Bob Rose, YN	Carl Merkle, CTUIR
Keith Hatch, BIA	Joe Peone, CCT
Marcie Mangold, WDOE	Mike Clement, GCPUD

Attendees	
Patrick Verhey, WDFW (in person)	Bob Heinith, CRITFC
Brad James, WDFW	Marcie Mangold, WDOE
Bryan Nass, LGL (in person)	Mike Clement, GCPUD
Ben Lenz, GCPUD	Ross Hendrick, GCPUD
Debbie Williams, GCPUD	Kevin Malone, Facilitator

Action Items:

1. **Malone will re-distribute edited protocols for review. An e-mail vote will be asked for 10 days after they are distributed to members.**
2. **Clement and Nass will include in the lamprey study plan, a list of study plan priorities and objectives for distribution at the September meeting.**
3. **Mangold will contact Pat Earl, WDOE representative on the Rocky Reach Fish Forum regarding coordination with the PRFF on lamprey issues.**
4. **Mangold will find further information regarding clove oil vs. MS22.**
5. **Peery and Nass will provide PRFF members a list of identified problem areas of the 2001-2002 study.**
6. **Williams will set up the meeting as a WebEx conference**.

Draft Meeting Minutes

Welcome and Introductions – Kevin Malone welcomed the Priest Rapids Fish Forum (PRFF) and asked attendees to provide self introductions.

Agenda Review – No additional items were added to the agenda.

Action Item Review

All action items were reviewed and discussed during the lamprey discussion in Section VII.

PRFF Protocol Discussion

Consensus Vote on Protocols – Keith Hatch asked that a vote not be taken during today's meeting because he will not be in attendance.

Members discussed protocol edits provided by Patrick Verhey. **Malone will re-distribute edited protocols for review. An e-mail vote will be asked for 10 days after they are distributed to members.**

Aquatic Invasive Species Plan – Ross Hendrick, Grant PUD Limnologist gave a brief update on the plan. Once the plan is complete, it will be sent to Washington Department of Ecology (WDOE) and Washington Department of Fish and Wildlife (WDFW) for a pre cursory look. Hendrick anticipates that the plan will be distributed for a 60 day consultation period in September. Zebra mussel sampling will take place in the Wanapum Reservoir on August 6, 2009. WDOE and WDFW will be involved to critique Grant PUD's sampling protocol, and to look at other sites for potential sub-straight monitoring. Jesse Schultz, WDFW will be participating.

Shallow Water Temperature Plan – Ross Hendrick will present a PowerPoint presentation on potential shallow water temperature monitoring locations during the September PRFF meeting. The draft plan will be distributed to the PRFF in November. The final draft of the plan will be sent to FERC prior to the March 31, 2010 deadline.

The 401 Certification is unclear as to what the definition of shallow water is. Mangold explained that water quality standards state "Shallow water should not be monitored" because proper mixing doesn't occur in shallow water. Mangold has been discussing Grant PUD's requirement to monitor shallow water with the WDOE Environmental Program so they aren't dinged each time they submit temperatures that are out of range. She is also looking into the procedure that WDOE will require Grant PUD to follow for their shallow water monitoring system.

Eight transects throughout the Priest Rapids Project were looked at as possible data collection sites. Grant PUD staff has discussed using the eight original sites to continue baseline data collection, or to use a combination of sites that are shallow, but still have water running through them. Other sites that have water depths of 2' to 10' have been looked at by the Geographic Information System (GIS) to determined if they would work as monitoring sites.

Fish Ladder Temperature Study Plan – The plan will be developed after it is determined what will happen with the Priest Rapids tailrace and fish ladder. Hendrick expects the plan to be distributed in December 2009.

White Sturgeon Update – The White Sturgeon Management Plan (WSMP) was submitted to FERC on April 13, 2009. Grant PUD continues to wait for approval of the plan. Lenz suggested PRFF members send letters to FERC supporting the White Sturgeon Plan. Gerry O'Keefe, Grant PUD Natural Resources Director, is currently in Washington D.C. meeting with FERC to discuss the status of this and other submitted plans.

Lenz explained that if approval of the plan is granted soon, there is still the potential to do field work this fall. Activities could include juvenile and adult tag purchases and the installation of a buoy array tag detection system. The window of opportunity has been missed this year to collect data regarding the abundance, maturity, and spawning characteristics of sturgeon in the Priest Rapids Project. In the spring, determining the location of fish could start right away. Because FERC hasn't approved the plan, the timeline for implementation of work will have to be adjusted, explained Lenz.

The Grant PUD sturgeon facility will be similar to the Canadian hatchery located in Cranbrook, B.C. Two distinct differences are the use of a water recirculation and effluent treatment system at the Grant PUD facility. Mike Nicholls, Grant PUD Engineer will discuss hatchery design with PRFF members in the future.

Verhey explained that WDFW is interested in developing a Statement of Work (SOW) for Section C of the WSMP. The Yakama Nation (YN) and Wanapum's have also expressed the same interest to Lenz. Golder Associates Ltd. is currently on contract to oversee Monitoring and Evaluation (M&E) work. Lenz explained that Grant PUD would like to have Golder manage the program until there is a comfort level that other parties could participate because of their expertise in the field. WDFW, YN and the Wanapum's could, in the future, decide where they will all fit into the program.

Grant PUD would like to be involved in any regional coordination efforts regarding sturgeon issues. Verhey explained that WDFW would like to be involved in M&E. At this time WDFW hasn't developed anything more than a general overview, stated James. Bill Tweit and Jeff Korth, WDFW believe WDFW should be involved in managing the populations and setting harvest levels of sturgeon on the Columbia River.

The model to be used as a management based tool will be reviewed by the PRFF.

Cranbrook Field Trip – Ben Lenz, Mike Clement, Mike Nicholls and Kevin Malone recently visited the Cranbrook White Sturgeon hatchery to participate and train during sturgeon spawning. Lenz

stated, “An invaluable amount of information was gained by participation in the spawning process. All participants felt the trip was extremely educational. Grant PUD staff plan to participate in spawning next year at the hatchery, and will once again extend the invitation to all PRFF members.

Bull Trout Hydrologic and Water Quality Plan

ACTION ITEM: Vote to approve Bull Trout Hydrologic and Water Quality Study Plan – The PRFF approved this plan by email vote on July 20, 2009. It was subsequently sent to WDOE on July 31, 2009.

Pacific Lamprey Study Plan

Group Discussion of any items related to the 2010 Adult Lamprey Evaluation prior to drafting of the Final Study Plan

Yesterday, Brian Nass, LGL, Chris Peery, Cramer Fish Sciences, Mike Clement and Grant PUD Engineering staff toured the fish ladders to find out if acoustic tags can be detected in that location. If so, it would be the first time acoustic tags have been used in lamprey work on the upper Columbia River. Also discussed were logistics of issues brought to light by the PRFF during last months meeting.

Clement noted his discomfort with using external antenna radio tags in lamprey. Blue Leaf Environmental will be exploring if acoustics will perform the job, and at how fine a scale they can be detected outside the collection channel and bifurcation pool. Clement stated that if testing works, acoustic tags will be used, and if not, radio tags will be used.

Nass has received comments on the draft Lamprey Study Plan that was distributed at last months PRFF meeting from WDFW and USFWS. All comments are being addressed.

During the ladder inspection yesterday, Nass noted that specific details of conducting the study were fleshed out. Key points are listed below:

Pit-tag arrays as described in the draft study plan look feasible and should be able to gather passage efficiency data.

An area on the PR left bank ladder near the counting station within a 5 pool stretch, has been selected to place the underwater video camera for optimum viewing. The site identified is used by most lamprey passing through the ladder. It will capture modifications to the counting station, plating through an orifice, and plating on the diffusion grating. It hasn’t been defined how many camera’s will be used. The area selected is accessible and will allow fiber to be installed for remote

monitoring. PRFF members will have the ability to monitor the site away from the dam.

Members recommended that 3D hydro-acoustics be used in the entrance and collection channel area to determine entrance efficiency and to define behavior of lamprey as they approach the entrance. Clement explained that the objective (as outlined in the PLMP) is to determine passage efficiency which is defined as the number of fish that enter a fish entrance divided by the number that exit. The acoustic data would determine presence, absence, and behavioral information outside of the project entrance and how the fish reacted to the collection channel and bifurcation channel. The acoustic component will be on a sub range of fish, not on all fish. Acoustics' are a different method that needs to be done to figure out how it works.

Lamprey will be tagged and released in proportion of the trap efficiency of the left and right bank. Fish will be released on the bank that they were caught. Historically, 70% use the left bank ladder. As long as sample sizes can be achieved, there should be enough fish for the study.

Lamprey escapement hasn't been good this year. 400 lamprey have been counted at PR so far. Bonneville counts are less than 10,000, and only a quarter of those are showing up at The Dalles. Because the numbers have been so low, University of Idaho staff has stopped tagging fish at Bonneville. Why 60 to 70% of lamprey are lost between Bonneville and The Dalles remains a question. The US Corps of Engineers(Corps) Walla Walla District hoped to complete their McNary Dam evaluation this year, but hasn't had enough lamprey return to do so. The Corps are changing the structural entrance at McNary Dam and hoped to have enough lamprey passing through to gather baseline data this year. Willamette River numbers are also down this year. There are a quarter fewer lamprey returning from the ocean this than last year.

Clement and Nass will include in the study plan final draft a list of study plan priorities and objectives for distribution at the September meeting.

Grant PUD has had discussions with Chelan and Douglas regarding coordination of efforts. Lamprey studies related to CPUD and DPUD are addressed in their respective forums. **Mangold will contact Pat Earl, WDOE representative on the Rocky Reach Fish Forum regarding coordination with the PRFF on lamprey issues**. RRFF has had their second meeting. Mangold will have Pat Earl, WDOE contact Bob Heinith with RRFF meeting information. If Grants going to

the effort of tagging considerable numbers of fish, it makes sense that other PUD's coordinate the tracking of them.

PRFF members discussed the use of clove oil vs. MS22. **Mangold will find further information regarding clove oil vs. MS22**.

Peery and Nass will provide PRFF members a list of identified problem areas of the 2001-2002 study.

Williams will set up the meeting as a WebEx conference.

Next Meeting: September 02, 2009 at 10:00 a.m. at the Grant PUD SeaTac Office, Seattle, WA.

DRAFT Meeting Minutes

Priest Rapids Fish Forum

Wednesday, September 02, 2009
9:00 – 3:00
Grant PUD SeaTac Office

Technical Members

Stephen Lewis, USFWS	Patrick Verhey, WDFW
Marcie Mangold, WDOE	Bob Dach, BIA
Tom Dresser, GCPUD	Mike Clement, GCPUD
Ben Lenz, GCPUD	

ATTENDEES:

Brad James, WDFW (on phone)	Brian Nass, LGL
Molly Hallock, WDFW	Marcie Mangold, WDOE (on phone)
Patrick Verhey, WDFW	Bob Rose, YN (on phone)
Mike Clement, GCPUD	Keith Hatch (on phone)
Ben Lenz, GCPUD (on phone)	Ross Hendrick, GCPUD
Debbie Williams, GCPUD	Kevin Malone, Facilitator

Draft Meeting Minutes

Welcome and Introductions – Attendees introduced themselves around the table and on the conference line.

Agenda Review – No additions were made to the agenda.

Action Item Review - All action items were reviewed.

PRFF Protocol Discussion

Discussion and proposed Vote on Protocols – No discussion or vote took place because of the lack of a quorum.

White Sturgeon Update - FERC approval hasn't been received yet, so field work (Section C of Plan) will be moved to 2010. FERC approval was received for the Native Resident Fish Management Plan on Monday, August 31, 2009. In order of submission, Grant PUD anticipates that the White Sturgeon Management Plan should be next up for approval. Via Web Ex Conferencing, Lenz and Clement shared video of their trip to the White Sturgeon facility in Cranbrook, B.C. Approximately one million eggs were taken during the 2009 spawning season in B.C. Grant PUD staff will be visiting the facility again during the various life cycles and invited PRFF members to attend. Juvenile releases happen in the spring, with spawning taking place mid June to the end of July. Disease issues, and how to handle them were discussed. Biosecurity precautions were followed diligently at the facility.

Aquatic Invasive Species (AISP) and Shallow Water Monitoring Plan (SWMP) - Hendrick provided an update on the AIS and Shallow Water Monitoring Plans. The second preliminary draft of the AIS was sent to WDOE and WDFW on September 01, 2009. After consultation with Washington Department of Ecology (WDOE) and Washington Department of Fish and Wildlife (WDFW), PRFF members will be provided with a 30 day review period. The final report will be submitted to the Federal Energy Regulatory Commission (FERC) and WDOE prior to March 31, 2010.

AISP - The plan covers education (with focus on recreational use), monitoring designed to help catch new species before they establish themselves (36 samples collected throughout each reservoir monthly for presence/absence of zebra/quagga mussel veligers, substrate monitoring, and shoreline/boat launch AIS plant surveys), and rapid response (pro-active approach; coordination with WDFW/WDOE).

SWMP – Hendrick explained that main purpose today's presentation was to provide PRFF with an opportunity to discuss and provide input on selection of sampling locations, based on past studies. Hendrick explained that past (1999-2002) water quality monitoring efforts have provided a good picture of Dissolved Oxygen (DO), pH, and water temperatures in each reservoir. These locations were selected by the Limnological Solution Working Group during the re-licensing period, based on available information on habitat use. These locations are also well-mixed, which is in-line with WDOE's water quality standards (which state that samples taken for compliance purposes should be taken from well-mixed portions of the river). Hendrick suggests that in order to gather direct comparisons with historical data and to remain within well-mixed portions of the river, the same monitoring locations be used for the SWMP as in the 1999 - 2002 studies. Mangold stated that WDOE will be checking to make sure the SWMP sampling locations are in well-mixed portions of the river, in accordance with WDOE water quality standards.

Lewis asked clarifying question regarding the purpose of the SWMP in relation to the Bull Trout Management Plan (BTMP). Hendrick noted that the

SWMP is not specifically intended to meet the BTMP water quality monitoring components, as the fixed-site monitoring stations (which collect data year-round) will be used for that purpose as identified in the BTMP.

Hendrick will begin preparing the draft SWMP using the same locations used in the 1999 – 2002 studies, with the goal of sending it out for PRFF review by November 01, 2009. I f members have areas other than those discussed in today's presentation that they would like to have monitored, he asked that they be emailed to him prior to the next meeting on October 07, 2009 along with support of the rational (biological or other) behind the request.

Pacific Lamprey Study Plan

Group Discussion of any items related to the 2010 Adult Lamprey Evaluation prior to drafting of Final Study Plan - Nass explained that PRFF member's comments have been incorporated into the Pacific Lamprey Study Plan (PLSP).

Members discussed objectives of the study and tagging alternatives. Rose would like to understand the behavior of fish as they approach and enter the fish ladder, and questioned if flow reductions would make a difference.

The primary goal of the study is to tag 300 fish to evaluate fish ladder improvements and determine passage efficiency. If more fish are trapped, Nass explained that they would also be tagged. Half Duplex Pit-tags will be used for the study, with new detection arrays being placed in the fish ladders. Grant PUD will also be tagging lamprey with acoustic tags to evaluate the lower PRD fishway and to see if changes to the ladder operations have improved since the 2001 – 2002 studies.

Rose explained that because JSAT tags are being used to tag fish at Bonneville Dam, he would like to monitor those fish as well. The Yakama Nation has 95 radio tags that could possibly be used for lamprey tributary behavior studies. Rose would like to coordinate use of the radio tags if anyone has ideas of how to use them. Nass noted there is no intention to install radio tags in lamprey at Priest Rapids (PR), or to monitor fish that have been tagged with them other than monitoring HD PIT-tagged fish that were tagged by the COE downstream. Rose asked that all other fishways in the Priest Rapids Project (Project) also be monitored for lamprey passage. Clement noted that all 6 fish ladder entrances are identical and because the PRD left-bank entrance receives the highest amount of lamprey activity, that is the location which will be monitored. Previous studies provided information that suggests that fish readily approached and entered fishway entrances at both Wanapum and Priest Rapids dams.

Acoustic tags being used for the lamprey study are left over from the salmonid spring study. A tag battery life test has been conducted and will be approximately 21 to 25 days.

An acoustic telemetry study will be conducted at the PR left bank junction pool.

Members discussed the following contingency plans if there is a low run year. Structure passage efficiency - video, entrance to exit – HD PIT, junction pool use - Acoustic, and nighttime flow reductions. Nass questioned what the committee would want to achieve by implementing nighttime flow reductions. He explained that Grant PUD is addressing lamprey passage in the lower fishway by modifications to the fishway.

Fish ladder outages will start in mid - November. If so we need to know any requested changes before then. Plan to move ahead with testing things, we will continue to move ahead with this plan, and any adjustments would be made on the fly, stated Nass.

Rose suggested that acoustic tag receivers be placed at the exit of the fishway to determine if fish go into the turbines and back through the Project, or continue up stream.

The plan is to trap lamprey every night until the target sample size is collected, then traps will be pulled. In an effort to minimize recapture there is no plan to sample the run.

Rose suggested that an alternative strategy to fish collection be considered. Because lampreys travel through the Project from August to October, Rose questions if fish trapped at the beginning of the season might be different than fish trapped later in the season. Could changes in water temperature change a lamprey's performance, size, and metabolical capabilities? Clement cautioned that as soon as the water cools off, the fish stop moving and begin over wintering and could possibly not move through the fishway at all. Rose asked that different strategies be added to the study proposal. Clement suggested that Rose provide some alternate strategies for the group to discuss but that because this is a passage study, we should try and select fish earlier in the run that are more representative of actively moving and migratory fish. Fish later in the run, would be more likely to be representative of fish that are preparing to over winter, thus, we would potentially not be able to monitor or measure there passage.

Fish count discrepancies between PR and Rock Island Dam were discussed. Fish counting methodologies and differences between PUD's is a concern. Rose suggested that a mobile tracker be included

in the Study Plan, so that when acoustic tags leave the Project, the ability to track them upriver remains. Clement stated that can be included in the study, but reminded members that it's difficult to track fish in noisy area's. As soon as crowders are installed, lamprey will have no other way to get through the fishways but through the video count stations. That should make counts in the Project extremely accurate. The release of acoustic tagged fish in pulses of 3 might give a more efficient with mobile tracking, suggested Rose.

Because tracking fish after they leave the Project is outside the original scope of work, Nass and Clement will have to discuss this issue further. Clement thought that a boat survey of the reservoir could possibly be conducted to monitor the acoustically tagged lamprey. Rose noted that he would like to have the ability to extend the nature of the study. Clement suggested that Bob provide this in more detail for future discussions.

Next Meeting: October 07, 2009, Grant PUD Natural Resources Office, Ephrata, WA.

Appendix D Juvenile Lamprey Assessment Study Plan Presentation to the PRFF

Assessment of Juvenile Lamprey Presence/Absence, Habitat Use, and Relative Abundance in the Priest Rapids Project Area

SUBMITTED TO:

Public Utility District No. 2 of Grant County

SUBMITTED BY:

Nathan Jahns, LGL Limited

environmental research associates

76 Packwood Lane

Ellensburg, Washington, 98926

PRINCIPAL PROPONENTS:

Bryan Nass, LGL Limited,

Mark Timko, Blue Leaf Environmental

Bao Le, Long View Associates

March, 2012

EXECUTIVE SUMMARY

A 401 Water Quality Certification was issued by the Washington State Department of Ecology (WDOE) on April 3, 2007, and amended March 6, 2008, for the operation of the Priest Rapids Hydroelectric Project (Project). A new license for the Project was issued by the Federal Energy Regulatory Commission (FERC) on April 17, 2008 (FERC 2008). Under FERC License Article 401(a)(12) and the 401 Certification (6.2 (5)(b)), Public Utility District No. 2 of Grant County (Grant PUD) is required, in consultation with the Priest Rapids Fish Forum (PRFF), to develop and submit for approval a Pacific Lamprey Management Plan (PLMP). On February 19, 2009 Grant PUD filed its PLMP with FERC and received on May 1, 2009 an "order modifying and approving" the PLMP.

The goals and objectives of the PLMP are to be achieved through a series of Protection, Mitigation, and Enhancement (PME) measures. This document proposes to implement a monitoring study in support of the following PME measure as identified in the PLMP:

4.4.1- Juvenile Lamprey Presence/Absence, Habitat Use, and Relative Abundance in the Project Area: use existing aerial photographs, bathymetry, shoreline slope, velocity, and substrate characteristics to segregate habitat types into those areas with high, medium, and low potential for use by juvenile lamprey, and assess presence/absence in areas that may be affected by Project operations using electroshocking sampling.

The objective of this study is to:

1) Assess presence/absence, habitat use, and relative abundance of juvenile lamprey in areas that may be affected by Project operations.

Existing Grant PUD bathymetry data were analyzed using GIS for those areas affected by the Project's operation. This area, known as the operational zone, was layered onto existing aerial photographs and further segregated into Habitat types with high (Type 1), medium (Type 2), and low potential (Type 3) for use by juvenile lamprey. Sample sites will be chosen in Type 1 habitat and water less than 1 m will be sampled using a backpack electroshocker starting in June 2012. Catch per unit effort will be recorded during sampling. Captured lamprey will be measured for length and species and will have a small tissue sample removed from the end of the caudal fin. Presence/absence will be determined for each sample location and CPUE at individual sites will be compared in order to determine relative abundance between sample locations. Mean or median CPUE estimates will be applied to GIS based habitat areas to illustrate relative abundance in the Project area.

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1.0 INTRODUCTION

A 401 Water Quality Certification was issued by the Washington State Department of Ecology (WDOE) on April 3, 2007, and amended March 6, 2008, for the operation of the Priest Rapids Hydroelectric Project (Project). A new license for the Project was issued by the Federal Energy Regulatory Commission (FERC) on April 17, 2008 (FERC 2008). Under FERC License Article 401(a)(12) and the 401 Certification (6.2 (5)(b)), Public Utility District No. 2 of Grant County (Grant PUD) is required, in consultation with the Priest Rapids Fish Forum (PRFF), to develop and submit for approval a Pacific Lamprey Management Plan (PLMP). On February 19, 2009 Grant PUD filed its PLMP with FERC and received on May 1, 2009 an "order modifying and approving" the PLMP.

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1.1 Juvenile Lamprey

Pacific Lamprey (*Lampetra tridentata*) numbers have declined since the 1940's as a result of spawning habitat loss, impediments to migration, changing ocean conditions, and decreased water quality (Close et al. 1995, 2002). Much focus over the past 10 years has been placed on studying migrating adults. Modifications have been made to many dam operations and structures to improve lamprey passage. Little work, however, has been devoted to investigating lamprey while in their juvenile stage.

Pacific lamprey eggs hatch after approximately 19 days (Pletcher 1963 as cited in Close et al. 1995, Lê et al. 2004, Luzier and Silver 2005). Once hatched, larvae drift downstream until encountering a silt/sand substrate and low velocity flow conditions (Pletcher 1963 as cited in Close et al. 2002). At this stage the juveniles are known as ammocoetes. They reside and burrow in fine sediment (Close et al. 2002) filter feeding on diatoms, algae, and detritus (Beamish and Levings 1991) for up to seven years (Beamish and Northcote 1989, Hammond 1979 as cited in Close et al. 1995). During this time they may move down stream during high water flows (Lê et al. 2004). Pacific lamprey then enter a transformation phase characterized by morphological and physiological changes that begin in the latter period of substrate residence and continues into their downstream migration to the ocean. After a parasitic life in the ocean, the Pacific lamprey returns to freshwater to spawn. Both sexes die after spawning.

River (*L. ayresii*) and Western Brook (*L. richardsonii*) lampreys are also present in Columbia River Basin (Wydoski and Whitney 1979). Less research has been conducted on these two species but their life cycles have been observed to be somewhat similar to that of Pacific lamprey. Western Brook lamprey do not migrate to the ocean for the parasitic portion of their life and prefer smaller substrate that Pacific lamprey for spawning. Adults of both species are much smaller than that of Pacific lamprey (Scott and Crossman 1973 as cited in Luzier 2005). River and Western Brook are found at much smaller numbers than Pacific lamprey and Western

Brook lamprey distribution tends to be associated with coastal streams (Wydoski and Whitney 1979). Juveniles of all three species are difficult to distinguish.

The Priest Rapids Project shoreline is affected by the operation of Priest Rapids and Wanapum dams and is subject to fluctuating water levels. This area, known as the operational zone, contains a variety of habitat types including soft sediment, sand/gravel, or hard rock with the latter two being the most frequent. Depending on shoreline slope, near-shore juvenile lamprey habitat below the ordinary high water mark may be dewatered during low water operations. This reservoir fluctuation has the potential to impact ammocoetes inhabiting the operational zone.

The objective of this study is to:

1) Assess presence/absence, habitat use, and relative abundance of juvenile lamprey in areas that may be affected by Project operations.

1.2 Study Area

Wanapum and Priest Rapids dams, known collectively as the Priest Rapids Project, are operated by Grant PUD and span some 58 miles of the Columbia River. The Wanapum Reservoir is 38 miles long and has a surface area of approximately 14,680 acres. A total of ten tributaries; Johnson, Skookumchuck, Whisky Dick, Sand Hollow, Quilomene, Trinidad, Tarpiscan, Colockum, Douglas, and Brushy creeks enter into the reservoir. The Priest Rapids Reservoir is 18 miles long and has a surface area of approximately 7,725 acres. Two tributaries; Crab, and Hanson creeks, enter into the reservoir.

2.0 JUVENILE LAMPREY DISTRIBUTION AND ABUNDANCE SAMPLING METHODS

2.1 Habitat Mapping

2.1.1 ArcGIS and existing bathymetry data were used to map the shoreline elevations affected by operation of Priest Rapids Project.

2.1.2 This elevations, known as the operational zone, was further segregated into Habitat areas with high (Type 1), medium (Type 2), and low potential (Type 3) for use by juvenile lamprey based on local knowledge of the substrate type in the area.

2.1.3 A final, Geographic Information System (GIS) map was developed outlining the operational zone and habitat types.

2.1.4 Prior to selecting areas to sample, Type 1 habitats will be visited by boat over the course of a day to confirm the desktop habitat assessment. Sampling methods will also be tested.

2.1.5 Type 1 habitats not consistent with the desktop classification will be redefined as Type 2 or 3 and changed in the GIS data.

2.1.6 Inaccessible sample areas will be noted and not chosen during site selection.

Table 1. Habitat type description. [1]Close and Aronsuu 2003, [2]Hansen et al 2003.

Habitat Type	Description
Type 1	[1]Mixture of soft sediment particles including silt, clay, fine organic matter, and some sand [2]Preferred larval habitat that usually consists of sand, fine organic matter, and cover (detritus, aquatic vegetation), which is usually formed in areas of deposition
Type 2	[1]Similar to Type I habitat but with a larger component of sand [2]Acceptable, but not preferred, larval habitat that usually consists of shifting sand, gravel, or rubble, and very little or no fine organic matter, but is soft enough for larvae to burrow into
Type 3	[1]Bedrock, hard clay, cobble, or coarse gravel substrates [2]Cannot be penetrated by larvae, so is unacceptable habitat, and usually consists of bedrock or hardpan clay, with rubble and coarse gravel

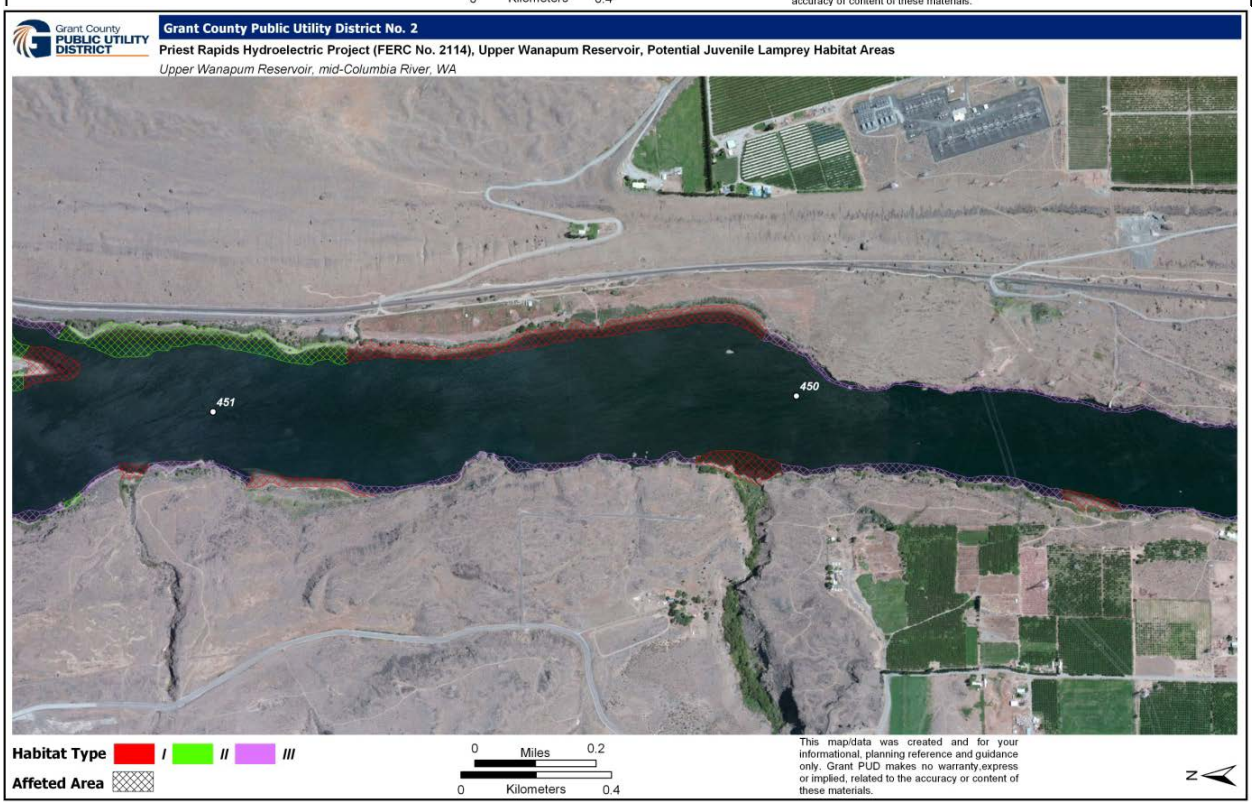

Figure 1. Examples of Habitat types in the Priest rapids project.

2.2 Sampling schedule

2.2.1 Sampling will occur over two seasons with two periods, early June and again sometime between late October and February, in each season. Exact starting dates will depend on conditions. June was chosen because it occurs after high spring flows and before increased summer macrophyte abundance. October was chosen because the water levels are much lower and macrophyte senescence has occurred.

2.2.2 Each period of sampling will run on the same schedule of 10, 10 hour days. As many sites as possible will be sampled each day within the 10 days.

2.2.3 Sampling will run no longer than 10 days each period regardless of total catch and areas sampled.

2.3 Sample Site Selection

2.3.1 At the beginning of the first period (June 2012), all habitat areas will be grouped according to habitat type and reservoir (PR Type 1, PR Type 2, PR Type 3, WA Type 1, WA Type 2, and WA Type 3). Habit areas in each group will be assigned a unique number ID and a random number generator will be used to assign an order of sampling. Not all areas in each reservoir and habitat group will be sampled in the 10 days but having an order predetermined will provide a non-biased sequence of sites. The overall random sampling design will provide an assessment of distribution throughout habitats types in the Priest Rapids Project

2.3.2 More areas will be sampled in Type 1 habitat than 2 and 3 as this is considered preferred habitat for juvenile lamprey and therefore has the highest probability of capture. A target of 80% of areas sampled will be Type 1 habitat while Type 2 and 3 will each be targeted in 10% of the samples. These values may be adjusted accordingly in subsequent years.

2.3.3 Sampling effort will also be weighted towards Wanapum reservoir as it contains three times more area than Priest rapids in its operational zone. A target of 66% of areas sampled will be in Wanapum while 33% will be in Priest rapids.

2.3.4 Most habitat areas will be too large to sample in their entirety. Specific locations to sample will be chosen in each area. GIS will be used to place points (referred to as locations) five meters apart along the shore line of each habitat area (Figure 2). Each location will be assigned a number ID and a random number generator will be used to select one location within each area. These locations will be the starting point for sampling efforts and are not confined by a sampling boundary. Locations will vary in slope, substrate type, and catch and defining a required coverage could result in uneven effort between sites. Instead, a specific duration of electroshocking will be performed at each location and coverage will vary.

2.3.5 Elevations sampled will not be planned by the sampling crew as reservoir elevation varies throughout the day. As a result, sampling may not occur

directly at and around the randomly chosen sample location coordinates. The sampling crew will sample the water closest to the original location.

2.3.6 An effort will be made to sample locations with a large coverage of high water inundation during high waters in June. Conversely, an effort will be made to sample locations with a large coverage of low water inundation during low water in October-February. Targeting high and low water habitat will result in a full assessment of the operational zone.

2.3.7 The predefined order of habitat areas will remain for the following three seasons. The order will change when the need exists to sample high and low water inundation locations at opportune times.

2.3.8 A small number of locations which produced high catches in previous season may be sampled again in subsequent seasons. These index sites will increase the likelihood of capture and allow for a thorough assessment of habitat use.

2.3.9 If all habitat areas of a Type are sampled once, the order will repeat and second locations within habit areas will be selected for sampling.

Table 2. Percentage of sample areas in entire Priest Rapids Project operational zone to be sampled. Effort is weighted proportionately towards WA as it has a larger operational zone area (km^2) than Priest Rapids and towards Type 1 habitat as it is considered preferred habitat for juvenile lamprey. Total km^2 for each reservoir and Type are included in the ( ) and calculations to determine percentages are in the [ ].

Habitat Type	Priest Rapids	Wanapum	Total
1	29% (0.9 km^2) [0.9 km^2/ 2.5 km^2 x .8]	51% (1.6 km^2) [1.6 km^2/ 2.5 km^2 x .8]	80% (2.5 km^2)
2	3% (0.8 km^2) [0.8 km^2/ 2.7 km^2 x .1]	7% (1.9 km^2) [1.9 km^2/ 2.7 km^2 x .1]	10% (2.7 km^2)
3	3% (1.6 km^2) [1.6 km^2/ 4.7 km^2 x .1]	7% (3.1 km^2) [3.1 km^2/ 4.7 km^2 x .1]	10% (4.7 km^2)
Total	33% (3.3 km^2) [3.3 km^2/ 9.9 km^2]	66% (6.6 km^2) [6.6 km^2/ 9.9 km^2]	100% (9.9 km^2)

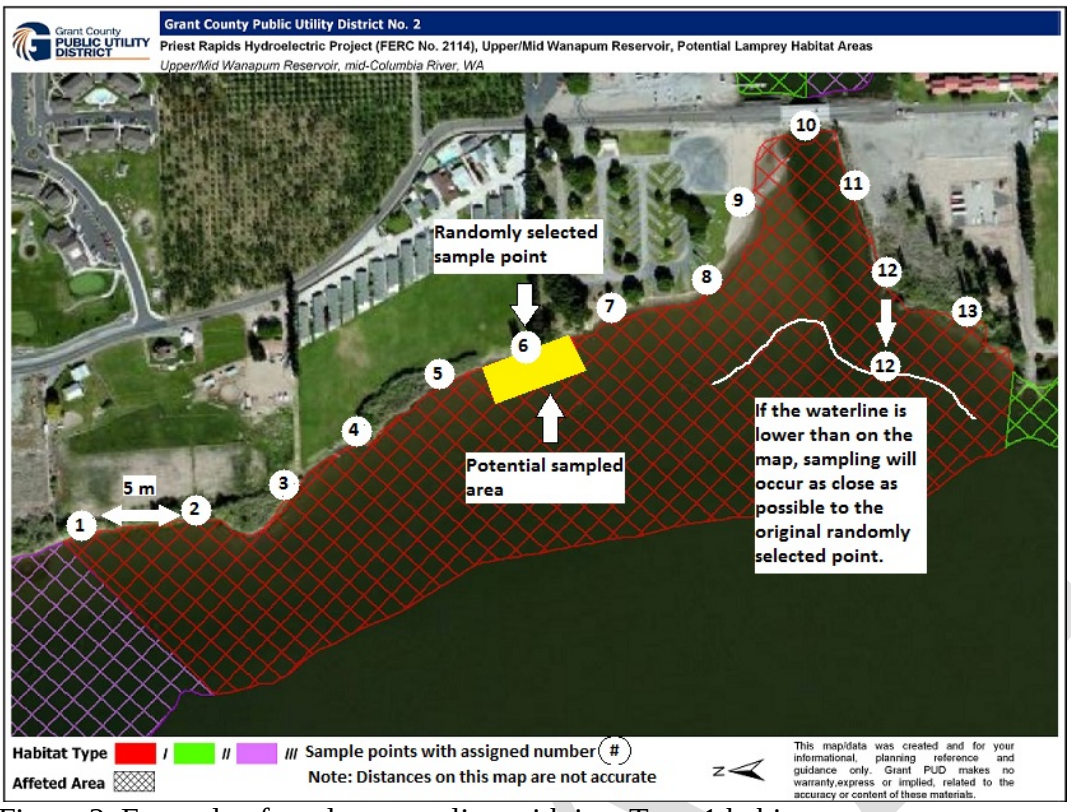

Figure 2. Example of random sampling with in a Type 1 habitat.

2.4 Data collection

2.4.1 Sampling will be conducted by two, two person survey crews. Each crew will use a backpack electroshocker in separate locations and will be ferried from site to site by a designated boat driver. A second boat may be added if one boat proves inefficient (i.e. one crew spends too much time waiting for the boat while it is transferring the other crew).

2.4.2 Sites will attempted to be sampled in an 8:16:1:2:1:2 ratio (PR Type 1, WA Type 1, PR Type 2, WA Type 2, PR Type 3, WA Type 3, respectively) in order to obtain the goals set in 2.3.2 and 2.3.3.

2.4.3 Sampling will be skipped at locations with non-favorable environmental conditions (i.e. wind, waves). The next location in the sampling order will be sampled and the skipped location will be revisited when conditions improve.

2.4.4 Sampling will occur for 20 minutes (based on electroshocker's operational time) with no sediment electroshocked multiple times. Catch-per-unit-effort (CPUE) will be recorded during sampling to determine relative abundance. Fish per minute will be the constant unit and, therefore, recording area covered is not required nor does it need to be constant between sites (John Crandall, Wild Fish Conservancy, Pers. Comm.).

2.4.5 Other aspects of sampling will be standardized between sites: ABP-2 Backpack Electrofisher settings will be held at 125 volts (DC) with 3

pulses/second, a 25% duty cycle, and a 3:1 pulse train. Passes will occur at a slow walking pace.

2.4.6 Sampling at locations will consist of electroshocking in depths from 0-1 m. Shocking at depth greater than 1 m increase the risk of submerging the backpack components which could result in damaging the equipment and/or electrical shock. Non-submerged and greater than 1 water depths will not be sampled.

2.4.7 Locations producing zero ammocoetes may be shocked for a second pass to confirm absence. Locations producing high number of ammocoetes may be shocked for a second pass to collect more ammocoete data, determine catch efficiency, and further investigate habitat use. In both scenarios, catch data will be separated by pass number so that first pass data can be compared between locations. Including subsequent passes would be an unfair assessment of relative abundance.

2.4.8 Water elevation, GPS coordinates taken at each corner of the sampled area, date, and beginning and end time of sampling will be recorded for each electroshocking session.

2.4.9 The GPS data can later be imported into ArcGIS to create sampled area polygons. The mean percent of time in a 24 hour period that each sampled area is not submerged can be calculated based on historical reservoir operational data.

2.4.10 Captured lamprey will be placed in an aerated bucket and anesthetized with MS-222. Ammocoetes will be measured for length and a sterile fingernail clipper will be used to remove a small tissue sample from the end of the caudal fin (Figure 3). All clips taken at a sampling location will be placed in a vial of 100% ethanol (Nelson and Nelle 2007). Lamprey will then be held in a bucket until they have recovered (swimming vigorously), and then released.

2.4.11 Ammocoetes will be identified and enumerated as Pacific, River, or Western Brook species using a U.S. Fish & Wildlife Service key (Figure 4) and characteristics describes in Richards et al. 1982.

2.4.12 Pictures and notes describing features of potential significance, if any, will be taken for each sample location.

Figure 3. Clipped caudal fin of an ammocoete (Nelson and Nelle 2007).

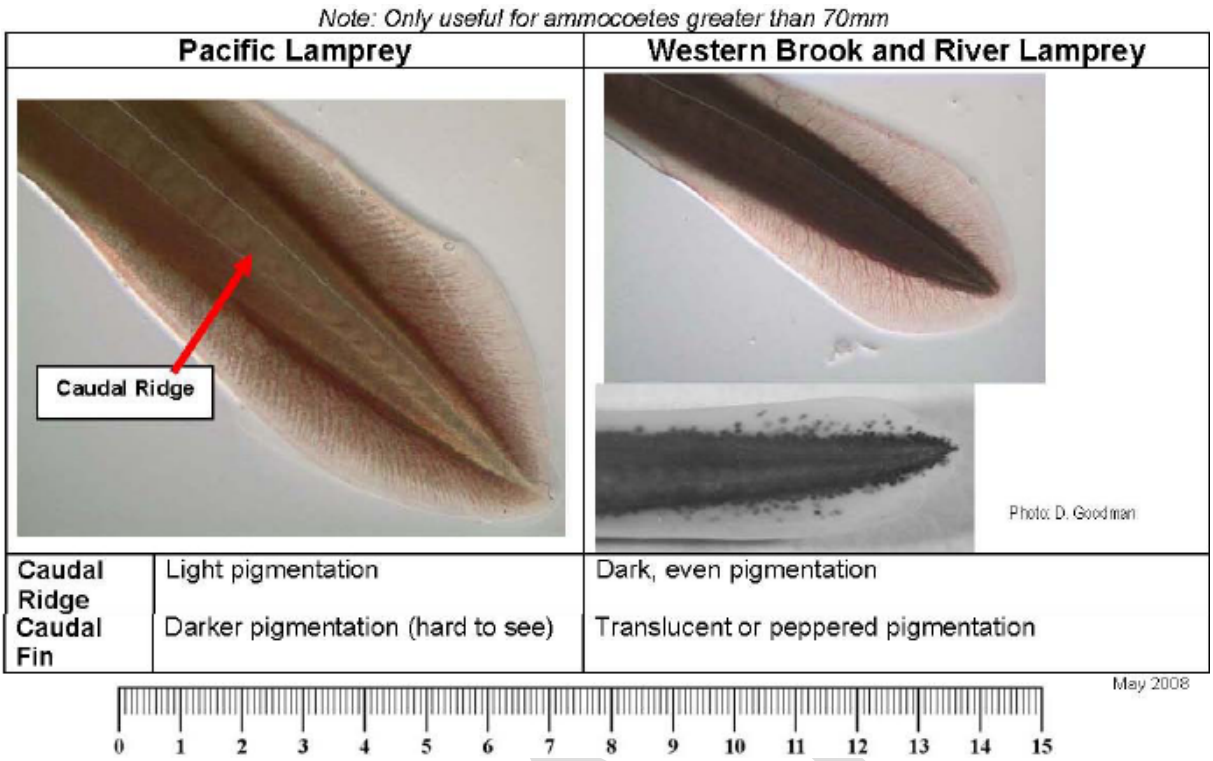

Figure 4. Key to identify ammocoete Pacific, River, and, Western Brook Lamprey ammocoettes (USF&W 2008).

3.0 ANALYSIS

3.1 Presence/absence will be determined for each sample location.

3.2 CPUE at individual sample locations and/or reservoirs will be compared in order to determine relative abundance between sample locations.

3.3 CPUE per habitat types (1, 2, & 3) and/or reservoirs will be graphed. With sufficient data, Analysis of Variance (ANOVA) between mean CPUEs will be conducted to determine if significant habitat preferences exist.

3.4 ANOVAs between mean lamprey lengths in each habitat type (1, 2, & 3) and/or reservoirs will be conducted to determine if habitat quality produced significantly different sized ammocoetes.

3.5 Mean or median CPUE estimates will be applied to GIS based habitat areas to illustrate relative abundance in the Project area.

3.6 With sufficient data, CPUEs will be correlated with percent of time a sample location is dewatered. This analysis will describe the relationship between presence and abundance of Pacific lamprey in Type 1, 2, and 3 habitats to a corresponding operational elevation.

4.0 LITERATURE CITED

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Appendix E
Washington Department of Ecology's Approval Letter for the 2012 White Sturgeon Management Plan Annual Report & Year Five Biological Objective Status Report

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

March 19, 2013

Mr. Tom Dresser
Manager – Fish, Wildlife, and Water Quality
Grant County Public Utility District
P.O. Box 878
Ephrata, WA 98823

RE: Request for Approval – Priest Rapids Hydroelectric Project No. 2114 – Submittal of Year Five Biological Objective Status Report for Pacific Lamprey, Section 6.2(5)(c) of the 401 Certification

Dear Mr. Dresser:

We have received your request to approve the Year Five Biological Objectives Status Report, Section 6.2(5)(c), which was emailed to the Department of Ecology (Ecology) on March 11, 2013.

We have reviewed the status report as contained within the 2012 Pacific Lamprey Management Plan Comprehensive Annual and Biological Objectives Status Report.

Ecology approves the report as fulfilling the requirement of Section 6.2(5)(c) for the Pacific Lamprey Management Plan in that recommendations contained within the report will be implemented and a Year Ten Biological Objectives Status Report will be completed as required under Section 6.2(5)(d) of the 401 certification.

Please feel free to contact me at (509) 329-3450 or by email at dman461@ecy.wa.gov if you have any further questions regarding this matter.

Sincerely,

D. Marcie Mangold

D. Marcie Mangold
Water Quality Program

DMM:dw
cc: Ross Hendrick, GCPUD
David Knight, Ecology/WQP