FY 2008-2009 F&W Program Accords (MOA) Proposal Review Narrative

Table 1. Proposal Metadata

Project Number	2008-308-00
Proposer	Confederated Tribes of the Warm Springs Reservation of Oregon
Title	Willamette Falls Lamprey Escapement Estimate
Short Description	This project will develop quantitative measures for indices of abundance and escapement estimates for adult Pacific lamprey at Willamette Falls. Proposed objectives will address the lack of population information in the Willamette River and address how lamprey behavior and vulnerability to predation may affect abundance estimates.
Province(s)	Lower Columbia
Subbasin(s)	Willamette River
Contact Name	Jennifer Graham
Contact email	jgraham@wstribes.org

Information transfer:

A. Abstract

Pacific lamprey (*Lampetra tridentata)* populations throughout the Columbia River Basin (CRB) are in decline. Multiple reasons for the decline have been identified including passage at mainstem CRB dams and habitat degradation. Little is known about factors limiting production in CRB tributaries. Due to declining abundance of lamprey in the Columbia River, harvest has been limited, with the primary collection location for the four Treaty Tribes (Warm Springs, Yakama, Umatilla, and Nez Perce) at Willamette Falls on the Willamette River (Rkm 42.6) in Oregon City. Declining lamprey populations are of primary concern to the Confederated Tribes of Warm Springs Reservation, Oregon (CTWSRO) due to their high cultural and environmental value. Once a staple food in winter, and present at ceremonies, lamprey is often absent due to lack of availability. Despite the cultural significance of this fishery, there is currently no estimate of adult escapement in the Willamette River. Harvest is the only indicator of trends in abundance. However, harvest rates vary greatly due to increased catch regulations and restrictions, therefore, they are very poor indicators of abundance. Recent changes in Oregon fishing regulations promoted greater protection for Willamette River Pacific Lamprey. Commercial harvest on Pacific lamprey at Willamette Falls ceased in 2002 and use of Pacific lamprey for bait was banned in 2005.

In this proposed study, goals in 2010 will focus on 1) developing a protocol for and index of abundance of adult Pacific lamprey at Willamette Falls for long-term monitoring; 2) determining feasibility of an estimate of abundance and escapement of adult Pacific lamprey at Willamette Falls; 3) investigating the detection rate of a half-duplex PIT tag interrogator at the Sullivan Plant at Willamette Falls to detect PIT tagged Pacific lamprey used for the population estimate; and 4) creating a Willamette River Pacific Lamprey Working Group to coordinate research and monitoring activities and provide technical guidance.

Development of a method to track changes in abundance of Pacific lamprey through time and estimate adult escapement will be used to better manage harvest levels and alert biologists of low returns to protect this unique fish species and the cultural fishery. As this project develops, protocols will be established, and monitoring of escapement will continue throughout the life of the Columbia River Accords.

B. Technical and/or scientific background

For Native American tribes, Pacific lamprey are a valued subsistence, ceremonial and medicinal resource (Pletcher 1963; Hunn and Selam 1991; Close et al. 1995; CRITFC 1996). The CTWSRO considers lamprey (referred to as "eels" by CTWSRO members) culturally significant, as described in Tribal Ordinance No. 68 and Warm Springs Tribal Code 490.510. Tribal members historically harvested lamprey at multiple locations throughout the CRB, including but not limited to Celilo Falls on the Columbia River, Fifteenmile Creek at Seufert Falls, and in the Deschutes River at Sherars Falls. After construction of The Dalles Dam during the 1950s, Celilo Falls was inundated and a culturally significant collection site for the people of Warm Springs was lost. The loss of fishing sites as well as insufficient numbers of Pacific lamprey on tribal lands have forced tribal members to supplement their subsistence needs at Willamette Falls, on the Willamette River, Oregon City, Oregon. Lamprey is an important cultural food; however, it is frequently absent from celebrations due to an inability to harvest adequate numbers.

Pacific lamprey is an anadromous, endemic species to the CRB (Beamish 1980). Since the 1940's, declining trends in CRB dam counts have been observed (Kan 1975; Wydoski and Whitney 1979; Close et al. 1995; Kostow 2002). Limited data from the Willamette Basin indicate that the abundance of Pacific lamprey has declined, yet the Willamette River remains the most important production area in the Columbia Basin (Primozich and Bastasch 2004). Despite the importance of the Willamette Pacific lamprey population, no estimates have been made on the population, and harvest data are unreliable indicators of abundance (Kostow 2002).

Little is known about Pacific lamprey life-history and distribution in the CRB. As such, reasons for their decline remain unclear. The relative inability of adult lamprey to navigate upstream through fish passage ladders at Columbia River dams is cited as a major cause for the decline (Long 1968; CRBLTW 1999; Vella et al. 1999a; Vella et al. 1999b; Kostow 2002). Screening that allows out-migrating lamprey to pass unharmed is lacking at many hydroelectric and water withdrawal facilities (Kostow 2002).

Degraded tributary habitat, including decreased flows, increased water temperatures, urban and agricultural development of low-gradient floodplain and poor riparian habitats may also explain the apparent decrease in abundance (CRBLTWG 1999; Close et al. 1995, Kostow 2002).

While four species of lamprey have been reported to exist in Oregon (Kostow 1995), only Pacific lamprey, the largest species, are harvested (Kostow 2002). In addition to Pacific lamprey harvest by Native Americans at Willamette Falls for food and traditional medicine, non-tribal harvest also occurred. Kostow (2002) summarized anecdotal information and limited data on Willamette River lamprey abundance, including observations of great lamprey abundance at Willamette Falls in the 1800s, large numbers harvested in the 1940s and perceived declines in abundance since the 1950s. Pacific Lamprey were listed by Oregon as a sensitive species in 1993 (Kostow 2002) and given further legal protection by the state in 1997 (OAR 635-044-0130). In 2002, ODFW Commission eliminated all commercial harvest of lamprey (www.dfw.state.or.us/agency/commission/minutes/07/may/B_1_Summary.pdf). To address

ongoing illegal commercialization of lamprey, the Commission adopted statewide regulations to prohibit the use of lamprey for bait in all commercial and recreational fisheries in 2005.

Lamprey harvest at Willamette Falls is the primary indicator of abundance trends and no attempts to estimate the proportion of the population harvested have been made (Kostow 2002). Because harvest efforts can differ among years due to regulations, harvest is a poor index of abundance. In the decade preceding the elimination of the commercial fishery (1991 to 2001), the annual lamprey harvest at Willamette Falls averaged 30,500. Since the elimination of the commercial fishery, annual harvest has ranged between 1,600 and 7,000 lamprey, predominantly by tribal members (www.dfw.state.or.us/agency/commission/minutes/07/may/B_1_Summary.pdf).

C. Rationale and significance to regional programs

The Columbia River Basin Accords recognize the need to protect lamprey. This understanding is based on the cultural importance of the species, as well as the desire to avoid an Endangered Species Act listing.

The Northwest Power and Conservation Council (NPPC) Fish and Wildlife Program documents the need to obtain information necessary to begin restoring lamprey populations as a regional biological objective for anadromous fish (NPPC 2000). The need to determine status and limiting factors for anadromous and resident lamprey is identified in the draft Columbia River Basin Research Plan (NPCC 2005).

The need to "Obtain the information necessary to begin restoring the characteristics of healthy lamprey populations" is cited as an objective for performance of losses in the 2000 Fish and Wildlife Program (NPPC 2000). This project relates specifically to sections 7.5F and 7.5F.1 of the NPPC Fish and Wildlife Program (NPPC 1994) which noted the apparent decline of the Pacific lamprey in the CRB and requested a status report to identify research needs. Section three of the resulting report (Close et al. 1995) outlines these research needs (in part) in section III.A, abundance studies.

Pacific lamprey is recognized in the Willamette Subbasin Plan as a species significant to tribes (Primozich and Bastasch 2004). The Willamette Subbasin Plan acknowledges a lack of sufficient information to develop an adequate management plan for lamprey species and supports efforts to determine the status, trends, and habitat use for lamprey species (Primozich and Bastasch 2004).

D. Relationships to other projects

Fish collection methods developed during implementation of BPA funded Project 200201600 "Evaluate the Status of Pacific Lamprey in the Deschutes Basin" and 200700700 "Determine status and limiting factors of Pacific lamprey in Fifteenmile Subbasin, Oregon" will be considered for use in the Willamette River. Methods for estimating lamprey population proposed for the Willamette River differ from projects in Fifteenmile Creek and the Deschutes River, which employ mark-recapture techniques.

We will co-ordinate with researchers at Oregon State University, Columbia River Inter-Tribal Fish Commission and Portland General Electric (PGE) if studies in which lamprey implanted with radio transmitters below Willamette Falls continue to be used to study passage efficiency

and characteristics over the Falls. CRITFC will be radio tracking Pacific lamprey in the Willamette Basin starting April, 2009. Information collected in a previous radio-tracking study of Pacific lamprey in the Willamette River may be useful (Clemens et al. 2006).

The Yakama Nation is developing a long-term Management and Action Plan specific to Pacific lamprey in close cooperation with local and regional government entities and consistent with efforts associated with the CRITFC Pacific Lamprey Tribal Recovery Plan, the U.S. Fish and Wildlife Service Conservation Initiative, the Lamprey Management Plans that have been or are currently being developed through the FERC relicensing processes of Chelan County, Douglas County and Grant County Public Utility Districts and other ongoing efforts conducted by the Nez Perce, Umatilla, and Warm Springs Tribes. Objectives of the Yakama Nation's study is to: 1) Document historic distribution of adult lamprey from historical records, literature reviews and oral interviews and compare with known current distribution; 2) Participate in and contribute to regional consistency in data collection, data management, analysis and reporting; 3) Document current status of larval Pacific lamprey with presence/absence surveys to determine distribution of recruitment; 4) Document biologic condition, migration behaviors and environmental cues that trigger migration for both adult and juvenile Pacific lamprey; and 5) Identify habitat characteristics that are preferred at various life stages and determine the extent these habitats are available and are being utilized (habitat mapping).

Table 2. Relationship to existing projects

Funding Source	**Project #**	**Project Title**	**Relationship (brief)**
BPA	2008-524-00	Lamprey Passage Design	Additional information on adult lamprey arrival at Willamette Falls and also spawning locations upstream.
BPA	2008-470-00	Yakama Nation Pacific Lamprey Program	Document biologic condition, migration behaviors and environmental cues that trigger migration for both adult and juvenile Pacific lamprey within the Yakama Nations Ceded Lands and in the Usual and Accustomed areas.
BPA	2007-007-00	Determine status and limiting factors of Pacific lamprey in Fifteenmile Subbasin, Oregon	Complementary project – information can be exchanged between project staff and sampling plans developed for the Fifteenmile Creek will be utilized.
BPA	2002-016-00	Evaluate the Status of Pacific Lamprey in the Deschutes Basin	Complementary project – information can be exchanged between project staff and sampling plans developed for the Deschutes will be utilized.

E. Project history (for ongoing projects)
New project

F. Proposal biological/physical objectives, work elements, methods, and metrics
The goal of this project is to develop quantitative measures for indices of abundance, abundance estimates and escapement estimates for adult Pacific lamprey at Willamette Falls (Figure 1).

Proposed objectives will address the lack of population information in the Willamette River and address how lamprey behavior and vulnerability to predation may affect abundance estimates. The study sites will include the Willamette River immediately below Willamette Falls (approximately 1 Rkm) and on the top of the Falls where PGE operates hydropower and fish passage facilities.

Objective 1. Investigate the performance of a half-duplex PIT tag interrogator at the Sullivan Plant at Willamette Falls to detect PIT tagged Pacific lamprey for a population estimate.

Adult lamprey abundance estimation has never been done in the Willamette River. Willamette Falls is located at Rkm 42.6 on the Willamette River. The Willamette River drops about 9 m at Willamette Falls (Ellis et al. 2003) and is a natural place for upstream migrating fish to congregate before ascending fish ladders or passage ramps (Figure 2). The location of the falls is the only area open to lamprey fishing on the Willamette River and presents an opportunity to estimate adult Pacific lamprey escapement in the Willamette River.

General approach

In the first year of the study we will investigate the feasibility of estimating the escapement of adult Pacific lamprey to the upper Willamette River (above the falls). An abundance estimate of adult lamprey escapement may be made using a ratio of tagged and untagged fish at passage locations over the falls. If lamprey implanted with PIT tags can be read by PIT tag interrogators at four lamprey passage locations over Willamette Falls (Figure 1), and lamprey passing through the passage structure can be counted via underwater camera (located adjacent to PIT tag antennae), the ratio of tagged to untagged lamprey can be calculated at the fishway and the expansion applied to passage locations with no counting camera. The number of lamprey counted via camera plus the estimates of lamprey passing through the other three sites (lamprey ramps) with the expansion applied would yield an estimate of adult lamprey ascending Willamette Falls.

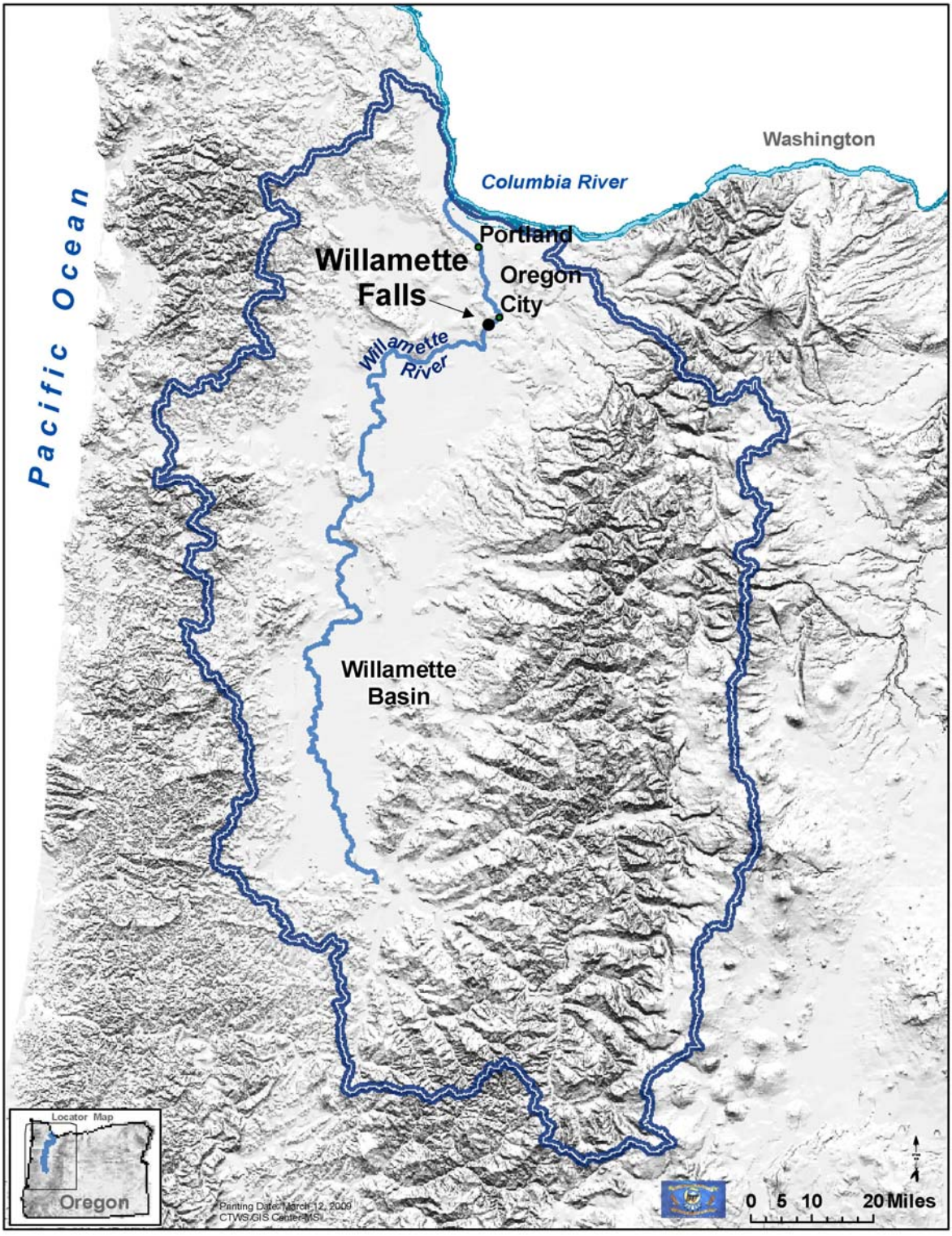
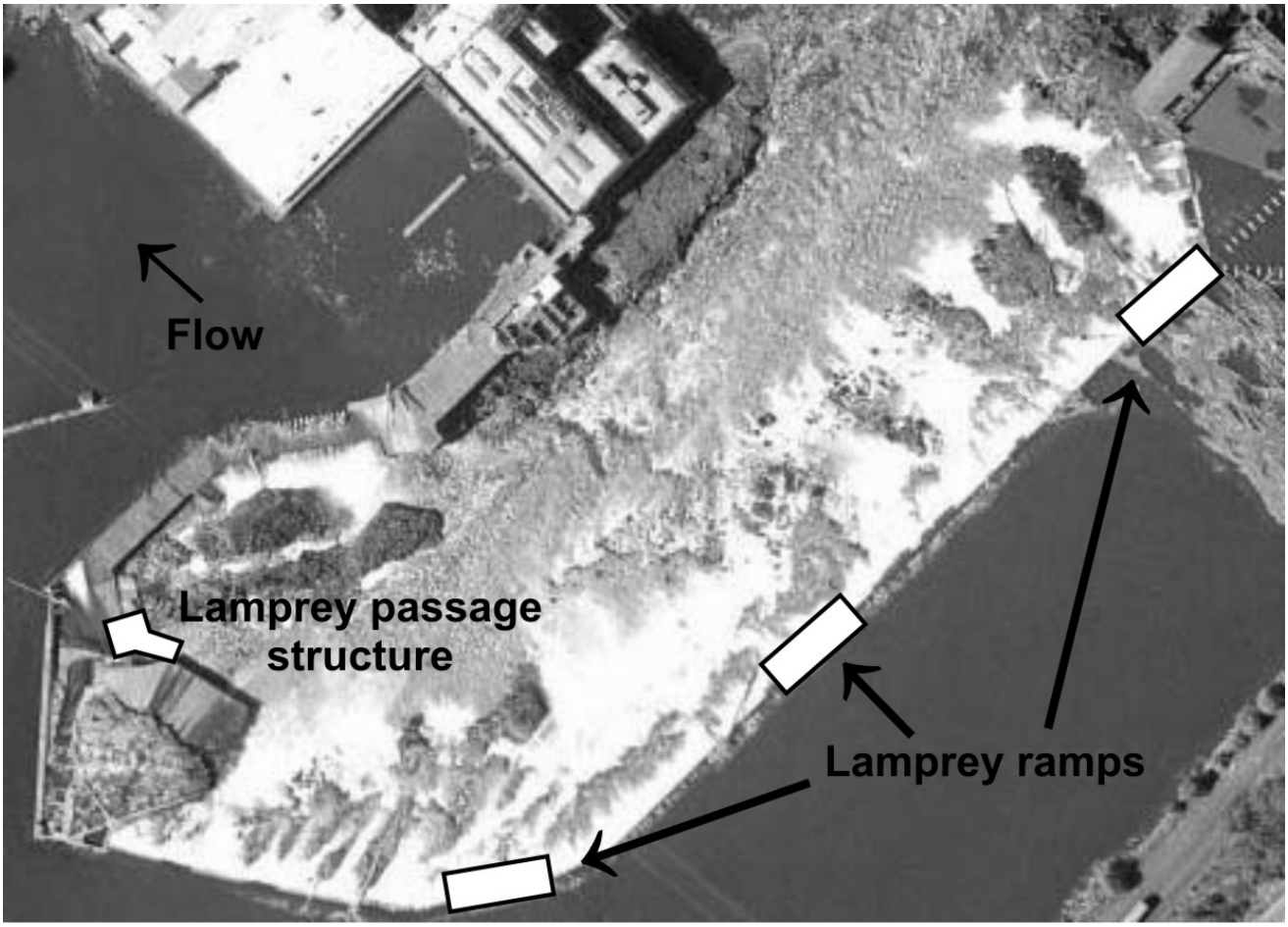


Figure 1. Willamette Falls on the Willamette River, near Oregon City, Oregon.



courtesy of Portland General Electric

Figure 2. Plan view of Willamette Falls showing lamprey passage structures and ramps.

To estimate abundance of adult lamprey at Willamette Falls many components of the data gathering process must be refined. Sufficient numbers of lamprey would need to be PIT tagged. PIT tag interrogators would need to be installed at four locations at Willamette Falls where lamprey are able to pass and have reasonable detection probabilities. Underwater cameras would need to be installed at locations where lamprey pass through without excessive fallback to facilitate counting. A statistical model to estimate parameters associated with fish escapement routes would need to be developed, as well as estimates of a 95% confidence interval around the escapement estimate.

Lamprey collection

Lamprey will be systematically collected from the fish ladder at the Sullivan Plant at Willamette Falls using a long-handled dip net and/or live traps throughout the run period. If dip nets are determined to be a viable technique, we will collect lamprey once per hour for 5-6 hours per night, 4 nights per week. We will use an elapsed time dipping protocol to standardize effort. If live traps prove feasible, and do not interfere with salmonid movement, we will deploy them for 5-6 hours per night to capture lamprey. Lamprey will be inspected for tags, measured, tagged, and released approximately 1 Rkm downstream of Willamette Falls.

PIT tagging adult lamprey

PIT tagging of lamprey will be based on procedures in the CBFWA tagging standards (CBFWA 1999). Half-duplex (HD) PIT tags (23mm RFID tags) will be used instead of full-duplex PIT tags due to greater detection distance, and to avoid interference with detection of PIT tagged salmon by full-duplex PIT tag interrogators installed at PGE's Sullivan Plant at Willamette Falls. Captured lamprey will be anesthetized, measured and weighed. Each fish will receive a HD tag. Tags will be surgically implanted into the body cavity. After tagging and recovery, fish will be released approximately 1 Rkm downstream of Willamette Falls. We will tag as many lamprey as possible to maximize the number detected at interrogators.

Establish PIT tag interrogation sites

Half duplex PIT tag arrays will be installed at PGE's Sullivan Plant at Willamette Falls and tested for detection efficiency of PIT-tagged adult Pacific lamprey. The sites will be determined after consultation with PGE biologists and other technical advisors but four sites are tentatively identified in Figure 1. Detection ability of PIT tagged lamprey will be characterized at each interrogator site. Detection is expected to be flow dependent. Antennae and interrogator settings may require adjustment.

In-stream interrogation sites will consist of a reader, data logger unit, and antenna tuner connected to flow-through antennae that span a constriction where lamprey may pass. Antennae will be constructed from loops of high gauge braided copper cable, with the lower portion of the loop running along the river substrate or bottom of ladder and the upper portion at the depth of or immediately below the water surface.

Counting lamprey via underwater camera

Lamprey will be recorded moving through two fishways using a video capture and review system at two locations at Willamette Falls (Figure 1). Total numbers of lamprey through the two locations will be related to the number of PIT tagged lamprey detected at these sites for use in population estimates. The video system will be operated prior to spawning, in April 2010 through the end of the spawning period, in July 2010. While lamprey have been known to remain in front of cameras at fish counting facilities, water velocities through the fishway at Willamette Falls are expected to be sufficient to encourage lamprey to move through and facilitate counting (Tim Shibahara, PGE fish biologist, pers. comm.). Prior to startup, we will investigate the possibility of installing infrared lights at the fish counting window at Willamette Falls so that lamprey can be enumerated at night.

FishTick® software will be used to enable the video reviewer to quickly scan through images of possible fish passage, in which lamprey images are selected by the reviewer. Information on species, date and time are saved to a Microsoft Excel spreadsheet.

Develop statistical model for population estimate

A simple mark-recapture could be used to determine the adult escapement (using equations 1 and 2, Seber 1982):

(1) $$\hat{N}_{i,t} = \frac{(n_{i,t}+1)(n_{e,t}+1)}{m_{e,t}+1} - 1$$

(2) $$v\left[\hat{N}_{i,t}\right] = \frac{\hat{N}_{i,t}\left(n_{i,t} - m_{e,t}\right)\left(n_{e,t} - m_{e,t}\right)}{\left(m_{e,t} + 1\right)\left(m_{e,t} + 2\right)}$$

where $\hat{N}_{i,t}$ is the adult lamprey in the Willamette at time *t*, $n_{i,t}$ is the number of lamprey marked at the capture facility with pit tags, $n_{e,t}$ is the total number of adults sampled at the trap when moving up again after release below the falls, and $m_{e,t}$ is the number of lamprey in that sample (recaptured) with the mark (possibly a pit-tag or external mark).

Assumptions of the model for population estimate are that fish do not shed their PIT tags, tagged fish are not removed from the population (*e.g.* predation, harvest), and there is no mortality between the time fish are tagged and when they are detected. In conjunction with marking and recapturing adult lamprey, a single access site creel survey will be conducted to estimate tribal harvest of adult Pacific lamprey

Note, we can correct for estimates of tag loss and predation by using simulation, and bootstrap based techniques.

Escapement estimates of Pacific lamprey ascending Willamette Falls will be made using detection probabilities at the four interrogator sites and the proportion of PIT tagged lamprey detected and the total number counted passing through the two passage sites with cameras. The proportion of tagged to non-tagged lamprey will be expanded to the other three sites. Total lamprey counted at the two camera sites plus the estimated total lamprey from three non-camera (HD PIT tag detector only) sites will be added for a total escapement estimate.

Harvested fish are not subtracted from the population estimate using the approach of a ratio of tagged to untagged lamprey for estimating escapement because the model estimates the population immediately upstream of where harvest occurs. However, harvested fish should be scanned for HD PIT tags so that the ratio can be adjusted. Assumptions of the model are that fish do not shed their PIT tags, tagged fish are not removed from the population (*e.g.* predation, harvest), and there is no mortality between the time fish are tagged and when they are detected.

The assumption of no lamprey mortality from predation (*e.g.* great blue heron, cormorant, sturgeon) may be false. Validating this assumption and developing methods for quantifying predation should begin during the first year. Avian predation on lamprey had been observed (Tim Shibahara, PGE fish biologist, pers. comm.). The section of river below Willamette is a well-established sturgeon fishery, for which lamprey is a preferred food item. It is not clear whether sturgeon actively prey on live lamprey or scavenge post-spawn lamprey.

Harvest estimate

Single access site creel surveys will be conducted to estimate tribal harvest of adult Pacific lamprey. Interviews will be conducted throughout the harvest period May through July 2010. Creelers will examine all harvested lamprey for PIT tags. Creel numbers will be extrapolated to estimate total harvest and 95% confidence intervals generated.

Total effort and harvest will be extrapolated from each sampling day by:

$$\hat{E} = \sum_{i=1}^{n} (e_i / \pi_i)$$

Total Effort:

Total Catch: $\hat{C} = \sum_{i=1}^{n} (c_i / \pi_i)$

Variance will be approximated each sampling week by:

$$Var(\hat{E}_1) \approx N_1^2 Var(\bar{e}_1)$$

Weekly variances will be summed to estimate total variance of the harvest estimate.

Objective 2. Develop a protocol for long-term monitoring and index of abundance of adult Pacific lamprey at Willamette Falls.

If an index of lamprey abundance can be developed then fisheries managers would have a tool to estimate adult escapement without having to produce a population estimate. An index of lamprey abundance will be developed from the proportion of lamprey counted via underwater camera and the total abundance of adult lamprey estimated from this study (simple linear regression, perhaps with variable transformation). Additional environmental/categorical variables may be required to develop the relationship (multiple linear regression) between lamprey counted via underwater camera and the total abundance of adult lamprey estimated from this study (*e.g*. flow, water temperature, Julian day) if the simple model is insufficient (*e.g* $r^2<0.70$).

Currently, CRITFC (Dr. Jeff Fryer and Bob Heineth) and ODFW (Clackamas) are investigating the possibility of using video currently recorded at the fish-counting window by ODFW to enumerate lamprey. It was previously thought that it would be impossible to enumerate lamprey using this video due to then tendency for large numbers of lamprey to remain in front of the camera, especially during the spawning migration. However, if CRITFC and ODFW develop a method for counting lamprey from ODFW video at the fish-counting window then this may also be related to abundance estimates from this study and the video counts used as an index (as a proportion of the abundance estimate).

If the relationship between lamprey counts and abundance estimates can be described, it may be used in the future to index lamprey abundance in the Willamette River by maintaining an underwater camera at the old fish ladder (Figure 1), counting adult passage, and extrapolating the abundance using the relationship established from counts at all passage locations. If the relationship represents only a small portion of the variance in lamprey abundance, counts through the old ladder can still be used as an index if CRITFC and ODFW are successful at counting lamprey from the video.

Objective 3. Create a Willamette River Pacific Lamprey Working Group to coordinate research and monitoring activities and provide technical guidance.

Developing an appropriate method for estimating adult Pacific lamprey abundance at Willamette Falls is a daunting task because 1) it has never been attempted in the Willamette River; 2) because of the size of the Willamette River at Willamette Falls (5^{th} order river), we will probably need to tag a large number of fish to get enough detections for reliable estimates at each of the five detection sites; 3) we do not know what to expect in terms of number of lamprey that we will be able to mark and detect. Because of these perceived difficulties, technical guidance from

a group of experts is needed. PGE's hydropower plant will facilitate collection of lamprey so permission and assistance from a PGE biologist is necessary for the success of this project.

After contacting biologists that are currently, or have recently worked with Pacific lamprey in the Willamette River, a list of participants for the Willamette River Pacific Lamprey Working Group quickly developed. To date, Tim Shibahara (PGE), Kathryn Kostow (ODFW), Stuart Ellis, Bob Heineth, Jeff Fryer, Rishi Sharma (CRITFC), Ben Clemens (OSU), and authors of this proposal (CTWSRO) have expressed interest in meeting in 2009 to begin collaboration on Pacific lamprey research in the Willamette River.

G. Monitoring

Success of this project hinges on: 1) the rate at which PIT tag interrogators will be able to detect tagged lamprey at lamprey ramps and in the fish ladder; 2) whether we can PIT tag sufficient numbers of lamprey to later detect them at the interrogators; and 3) our ability to enumerate lamprey via underwater camera (day and night). Once PIT tag detectors are installed, they will be tuned to provide the greatest detection range. Re-tuning may have to be done on a periodic basis. PIT tag antennae will be visually inspected during data download (daily or every other day) and data inspected to ensure the apparatus is working. Periodic meetings with the working group are expected to facilitate adaptive management of the project.

H. Facilities and equipment

PGE will provide office space at the Sullivan Plant at Willamette Falls for CTWSRO field technicians stationed in Oregon City. In order to meet project goals, we will also need to lease a vehicle and purchase field gear. Field gear will include but not be limited to dip nets and other sampling gear to capture lamprey, PIT tag equipment (e.g., antenna, receiver, tags). Purchase of FishTick® video capture and review systems may be required if another arrangement cannot be secured. We anticipate subcontracting the installation and maintenance of the PIT tag equipment. A computer and software will also need to be purchased for field technicians to enter data.

I. References

Beamish, R. J. 1980. Adult biology of the river lamprey (*Lampetra ayresi)* and the Pacific lamprey (*Lampetra tridentata)* from the Pacific coast of Canada. Canadian Journal of Fisheries and Aquatic Sciences 37:1906-1923.

Clemens, B. J., and coauthors. 2006. Aerial tracking of Pacific Lamprey in the Willamette River Basin, Oregon. Oregon State University, Department of Fish and Wildlife, Corvallis, OR.

Close, D. A., M. Fitzpatrick, H. Li, B. Parker, D. Hatch, and G. James. 1995. Status report of the Pacific lamprey (*Lampetra tridentata*) in the Columbia River Basin. Project # 9402600. Bonneville Power Administration, Portland, Oregon.

Coccoli, H. 2004. Hood River Soil and Water Conservation District. *Hood River Subbasin Plan*. Hood River, Oregon. Report to Northwest Power and Conservation Coucil, Portland, Oregon.

CRBLTWG (Columbia River Basin Lamprey Technical Workgroup). 1999. Planning of the Columbia Basin Pacific lamprey projects and needs. Report to Northwest Power Planning Council and Bonneville Power Administration, Portland, Oregon.

CRBLTWG (Columbia River Basin Lamprey Technical Workgroup) 2005. Critical Uncertainties for Lamprey in the Columbia Basin: Results from a strategic planning retreat of the Columbia River Technical Workgroup, Columbia Basin Fish and Wildlife Authority, Portland OR.

CRITFC.1996. WY-KAN-USH-MI WA-KISH-WIT. The Columbia River Anadromous Fish Restoration Plan of the Nez Perce, Umatilla, Warm Springs, and Yakama Tribes. Portland, Oregon.

CTWSRO and BIA. 1992*a*. Integrated Resources Management Plan for the Forested Area (IRMP I). Warm Springs

CTWSRO and BIA. 1992*b*. Integrated Resources Management Plan for the Non-forested and Rural Areas (IRMP II). Warm Springs, Oregon

Efron, B. and R.J. Tibshirani. 1993. An introduction to the bootstrap. Chapman Hall, New York. 436 pp.

Ellis, D. V., K. French, and Y. P. Hajda. 2003. Willamette Falls Hydroelectric Project (FERC Project No. 2233), Research for the Identification and Evaluation of Traditional Cultural Properties. Portland General Electric, Portland, OR.

Fifteenmile Creek Watershed Council and Wasco County Soil and Water Conservation District. 2005. Fifteenmile Watershed Action Plan.

Graham, J. and C.V. Brun. 2004. Determining lamprey species composition, larval distribution and adult abundance in the Deschutes River, Oregon, Subbasin. 2003 Annual Report. Bonneville Power Administration, Portland, Oregon.

Hammond, R. J. 1979. Larval biology of the Pacific lamprey, *Entosphenus tridentatus* (Gairdner), of the Potlach River, Idaho. MS thesis. University of Idaho, Moscow.

Hankin, D. G. and G. H. Reeves. 1988. Estimating total fish abundance and total habitat area in small streams based on visual estimation methods. Canadian Journal of Fisheries and Aquatic Sciences 45:834-844.

Hardisty, M. W., and I. C. Potter. 1971. The behavior, ecology, and growth of larval lampreys *in* The Biology of Lampreys, vol. 1 (edited by M. W. Hardisty and I. C. Potter). London-New York Academic Press.

Hunn, E. S. and J. Selam. 1991. Nch'i-Wana "The Big River": Mid-Columbia Indians and their lands. University of Washington Press, Seattle, Washington.

Kan, T. T. 1975. Systematics, variation, distribution, and biology of lampreys of the genus *Lampetra* in Oregon. Ph.D. dissertation. Oregon State University, Corvallis, OR.

Kostow, K. 1995. Biennial Report on the Status of Wild Fish in Oregon. Oregon Department of Fish and Wildlife, Portland, OR.

Kostow, K. 2002. Oregon lampreys: Natural history, status, and analysis of managment issues. Oregon Department of Fish and Wildlife, 2002-01.

Long, C. W. 1968. Diel movement and vertical distribution of juvenile anadromous fish in turbine intakes. Fishery Bulletin 66:599-609.

NPCC, 2005. Columbia Basin Research Plan (draft), Portland, Oregon.

NPPC. 2000. Columbia River Fish and Wildlife Program. Council Document 2000-19. Portland, Oregon.

NPPC. 1994. Columbia River Fish and Wildlife Program. Portland, Oregon.

ODFW. 2005. Oregon Native Fish Status Report – Public Draft. Oregon Department of Fish and Wildlife, Fish Division, Salem, Oregon.

Oregon Department of Fish and Wildlife and Confederated Tribes of the Warm Springs Reservation of Oregon. 1990. Columbia Basin System Planning Salmon and Steelhead Production Plan. Funds provided by NWPPC.

ODFW and US Forest Service. *Fifteenmile Basin Fish Habitat Improvement Implementation Plan*. 1987

O'Neil, L .B. 1987. AbP-2 operator's manual. Instrumentation Systems Center, University of Wisconsin, Madison.

Primozich, D., and R. Bastasch. 2004. Draft Willamette Subbasin Plan. Willamette Restoration Initiative, Portland, OR.Fifteenmile Creek Watershed Council and Wasco County Soil and Water Conservation District. 1997. Fifteenmile Watershed Action Plan.

Seber, G. 1982. On the Estimation of Animal Abundance and Related Parameters. 2nd edition. Charles Griffin and Sons, Ltd., London.

van de Wetering, S. J. 1998. Aspects of life history characteristics and physiological processes in smolting Pacific lamprey, *Lampetra tridentata*, in a central Oregon stream. M.S. theses, Oregon State University, Corvallis, Oregon.

Vella, J., L. Steuhrenberg, and T. C. Bjornn. 1999a. Migration patterns of Pacific lamprey (*Lampetra tridentata*) in the lower Columbia River, 1997. Annual Report of Research to the U.S. Army Corps of Engineers, Portland District, Portland, Oregon.

Vella, J., L. Steuhrenberg, and T. C. Bjornn. 1999b. Migration patterns of Pacific lamprey (*Lampetra tridentata*) in the lower Columbia River, 1996. Annual Report of Research to the U.S. Army Corps of Engineers, Portland District, Portland, Oregon.

(WCSWCD) Wasco County Soil and Water Conservation District and Fifteenmile Coordinating Group. *Fifteenmile Subbasin Plan*. The Dalles, Oregon, May 2004.

Wydoski, R. S. and R. R. Whitney. 1979. Inland Fishes of Washington. University of Washington Press. Seattle and London.

J. Key personnel

JENNIFER GRAHAM, PROJECT MANAGER

This project will be implemented by the CTWSRO Department of Natural Resources personnel. Jennifer Graham will administer the BPA contract, coordinate with basin managers, provide logistical support, assist with data analysis and take the lead for project reporting.

Education

South Dakota State University, BS Biological Sciences – Wildlife and Fisheries Sciences

Professional Experience

Research and Monitoring Program Manager
Confederated Tribes of Warm Springs, 2006-present

Provide professional, scientific, technical and administrative guidance and oversight for the professional and technical staff of the research and monitoring program. Plan, organize, and direct the work of subordinates. Develop goals and objectives of the fisheries research and monitoring

program for anadromous and resident fish, and lamprey. Continue to develop fisheries research and monitoring programs both on and off the Reservation. Pursue and develop new funding sources, projects and staff development opportunities. Provide administrative oversight including contracting, contract compliance, preparation and review of technical reports and the overall coordination of each of the individual elements within the program. Provide tribal policy representatives with information and recommendations for policy decisions regarding all aspects of fish management on the Reservation, Ceded, Usual and Accustomed fishing areas, and aboriginal lands. Prepare annual operating program budgets.

Fisheries Biologist
Confederated Tribes of Warm Springs, 2002-2006
Responsibilities include research project design, direction, and implementation for lamprey; supervise technical and field staff; planning and managing multiple budgets, technical report writing, data analysis and interpretation; conducted field sampling; represent the Confederated Tribes of Warm Springs Reservation of Oregon as a technical liaison for hydro-relicensing and superfund lamprey concerns, as well as the Columbia Basin Lamprey Technical Workgroup; identification of lamprey research needs and potential funding sources; assisting with project funding solicitation; work collaboratively with inter- and multi-agency efforts to address lamprey concerns; and effectively communicate with Tribal constituents.

Recent Publications

Fox, M. and J. C. Graham. 2008. Determining lamprey species composition, larval distribution and adult abundance in the Deschutes River, Oregon, Subbasin. 2007 Annual Report. Bonneville Power Administration, Portland, Oregon.

Brumo, A. F. and J. C. Graham 2008. Electrofishing for Ammocoetes (Larval Lamprey):

An Efficiency Study. 2007 Annual Report to Portland General Electric, Portland, Oregon.

Fox, M. and J. C. Graham. 2008. Determine Pacific lamprey spawn timing, over-wintering, and spawning habitat in the lower Deschutes River. 2007 Annual Report. Bonneville Power Administration, Portland, Oregon.

Graham, J. and C.V. Brun. 2007. Determining lamprey species composition, larval distribution and adult abundance in the Deschutes River, Oregon, Subbasin. 2006-2007 Annual Report. Bonneville Power Administration, Portland, Oregon.

Graham, J. and C.V. Brun. 2006. Determining lamprey species composition, larval distribution and adult abundance in the Deschutes River, Oregon, Subbasin. 2005-2006 Annual Report. Bonneville Power Administration, Portland, Oregon.

CYNDI BAKER, RESEARCH FISHERIES BIOLOGIST

Cyndi Baker will assist with arranging meetings and guide the Willamette River Pacific Lamprey Working Group, supervise Pacific lamprey data collection, manage data, analyze data, and assist with report writing.

Education

Oregon State University, Department of Fish and Wildlife, Ph.D. Fisheries Science, minor in water resources.
Portland State University, Department of Biology, M.S. Biology.
Portland State University, Department of Biology, B.S. Biology.

Western Washington University, Huxley College of Environmental Studies, B.S. Environmental Studies.

Professional Experience

Research and Monitoring Project Leader
Confederated Tribes of Warm Springs, December 2008-present
Completed writing a report on stock origin of out-of-basin fall Chinook in the Deschutes River and analyzed data, wrote a report on validation of fall Chinook aerial redd surveys in the Deschutes River and capture efficiency model of lamprey ammocoetes in the Deschutes River. Currently working on developing a model to predict lamprey abundance from habitat variables and writing a proposal for improvements to current fall Chinook redd surveys in the Deschutes River.

Research Fisheries Biologist
Ducks Unlimited, 2001-2008
Designed a monitoring plan to evaluate effects of habitat restoration on salmon and other fishes, wrote sampling protocol, grant proposals and reports, annual reports, manuscripts, proposed annual work objectives and budget projections, assisted in managing program budget and grants, supervised biologists and technicians, data management and analyses, obtained fish-sampling permits, attended meeting with restoration partners, natural resource regulatory and management representatives, presented findings at conferences, organized a workshop, collected hydrologic data and developed rating curves to predict annual discharge of streams and modeled the current and predicted hydrology at a restoration site to aid in project design.

Fisheries Biologist
US Forest Service, Clackamas River Ranger District, 1992-2001
Collected and analyzed data for juvenile salmonid population estimates using electroshocking, snorkeling, mark and recapture abundance estimates for juvenile salmonids, conducted district-wide fish distribution survey, recorded post-flood large wood movement in Fish Creek, lake and stream habitat surveys, assessed in-stream habitat restoration projects, mapped Big Bottom area of the upper Clackamas River and estimate habitat capacity for juvenile salmon rearing in summer, managed photo points in Arc GIS.