The Revised Pacific Lamprey

2017 Regional Implementation Plan

for the

Lower Columbia/Willamette

Regional Management Unit

Willamette Sub-Unit

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I. Status and Distribution of Pacific Lamprey in the RMU

A. General Description of the RMU

Willamette River Sub-Unit

The Willamette Sub-Unit of the Lower Columbia River/Willamette Regional Management Unit is comprised of twelve 4th field HUCs that are situated within three Environmental Protection Agency (EPA) Level III Ecoregions: Coast Range, Willamette Valley and Cascades (http://www.epa.gov/wed/pages/ecoregions/level_iii.htm; Figure 1, Table 1).

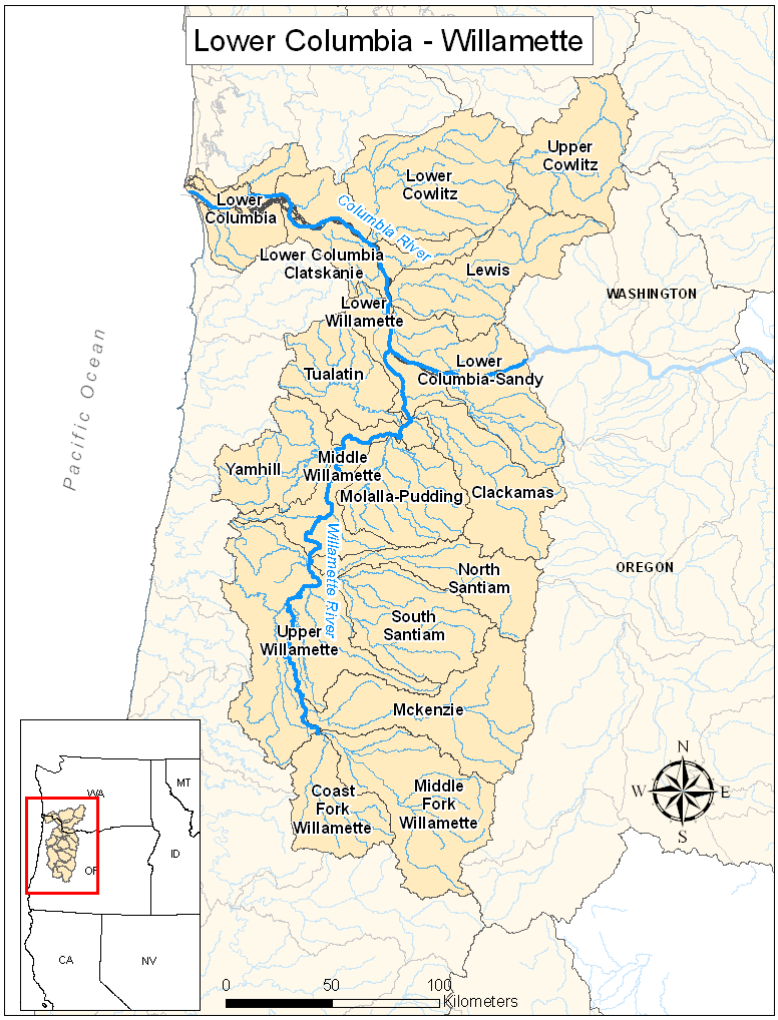

Figure 1. Map of watersheds within the Lower Columbia River/Willamette Regional Management Unit.

Table 1. Drainage Size and Level III Ecoregions of the 4th Field Hydrologic Unit Code (HUC) Watersheds located within the Willamette Sub-Unit.

Watershed	HUC Number	Drainage Size (km2)	Level III Ecoregion(s)
Middle Fork	17090001	3,540	Willamette Valley
Coast Fork Willamette	17090002	1,726	Coast Range
Upper Willamette	17090003	4,850	Willamette Valley
McKenzie	17090004	3,468	Willamette Valley, Cascades
North Santiam	17090005	1,979	Willamette Valley, Cascades
South Santiam	17090006	2,696	Willamette Valley, Cascades
Middle Willamette	17090007	1,841	Willamette Valley
Yamhill	17090008	1,999	Coast Range
Molalla-Pudding	17090009	2,267	Willamette Valley, Cascades
Tualatin	17090010	1,836	Coast Range, Willamette Valley
Clackamas	17090011	2,442	Willamette Valley, Cascades
Lower Willamette	17090012	1,668	Willamette Valley

B. Status of Species

Conservation Assessment and New Updates

Increased attention on Pacific lamprey has increased our understanding of this species in the Willamette Basin. Monitoring efforts, in which lamprey are either the target species or information is collected during other species' monitoring, have expanded the amount of information available and the quality of this information.

Previous studies have suggested a lack of genetic population structure (e.g., Goodman et al. 2008; Spice et al. 2012). However, these studies have focused on large geographical areas and have not controlled for time. Recently, two independent studies on adult Pacific Lamprey, conducted in different years and utilizing different genetic tools have reported evidence for some genetic differentiation among a relatively small body size, early migrating run, and a larger, later migrating run of adult Pacific Lamprey at Willamette Falls (Hess et al. 2015; Clemens et al. 2017a). Moderate genetic differentiation of adult Pacific Lamprey also occurred across years in the Willamette River Basin (Clemens et al. 2017a).

Abundance, Distribution and Connectivity

Since 2010, the Confederated Tribes of Warm Springs Reservation of Oregon have collected information to estimate the abundance of Pacific lamprey adults at Willamette Falls (Falls) and the number passing the Falls through the fishways. Average estimates for this seven year period are 172,718 adults (abundance at the Falls) and 60,689 adults (passing above the Falls; Table 2).

Historical occupancy of Pacific lamprey was extensive throughout the Lower Columbia/Willamette RMU. From the previous threats assessment, Luzier et al. (2011) estimated that the current distribution was reduced 50-70% from historical ranges. Pacific lamprey are currently thought to occupy 2,066 km^2 of the watershed in the Willamette Sub-Unit (Table 3). Current distribution of lamprey in the Willamette Sub-Unit is strongly related to physical migration barriers. Twenty large dams are present within the Willamette Sub-Unit; 13 are owned and operated by the U.S. Army Corps of Engineers' (Corps or USACE) and

collectively referred to as the Willamette Valley Project; at this time, none have successful upstream lamprey passage. Other large dams are for either non-federal hydropower production or water supply. See "Passage" for more discussion on dam passage.

Of the estimated 371 dams present in the Willamette Basin, approximately 148 are privately owned and used primarily for the purposes of irrigation. The greatest concentration of dams can be found in the Tualatin (82) and Yamhill (65) watersheds (Hulse et al. 2002). Culverts are also widespread throughout the watersheds of the Willamette Sub-Region and impact Pacific lamprey distribution to an unknown extent.

Recent information collected during the 2017 Threats Assessment and Regional Implementation Plan meetings will be used to determine the percentage of historical distribution still currently occupied. The intrinsic potential historical distribution for Winter Steelhead was used to estimate Pacific lamprey historical distribution.

Table 2. Estimated Pacific lamprey adult abundance, and numbers passing Willamette Falls, 2010-2016, percent of total that were harvested, percent of total numbers that passed Willamette Falls (Baker and McVay 2017).

Year	Total Abundance At Willamette Falls	Percent Harvested	Numbers Passing Willamette Falls Fishway	Percentage Passing
2010	64,388	2.5%	27,043	42%
2011	107,383	4.0%	46,819	44%
2012	243,048	2.7%	111,559	46%
2013	173,821	4.3%	49,365	28%
2014	336,305	1.1%	125,778	37%
2015	168,398	1.3%	32,112	19%
2016	115,682	2.3%	32,148	28%
Average	**172,718**	**2.6%**	**60,689**	**35%**

Table 3. Current Distribution of Pacific Lamprey by Stream Length and Watershed Area for each 4th Field Hydrologic Unit Code (HUC) Watershed located within the Willamette Sub-Unit. Historical distribution was calculated using Steelhead Intrinsic Potential to determine the percent of historical habitat.

Watershed HUC	Current Distribution Area (km2)	Historical Distribution (km2)	Percent Occupied (%)
Middle Fork	28	1,366	2
Coast Fork Willamette	77	642	12
Upper Willamette	499	3,683	14
McKenzie	114	1,182	10
North Santiam	80	872	9
South Santiam	223	1,334	17
Middle Willamette	172	1,491	12
Yamhill	169	1,736	10
Molalla-Pudding	152	1,543	10
Tualatin	205	1,576	13
Clackamas	210	1,804	12
Lower Willamette	137	866	16
Overall	**2,066**	**18,095**	**11%**

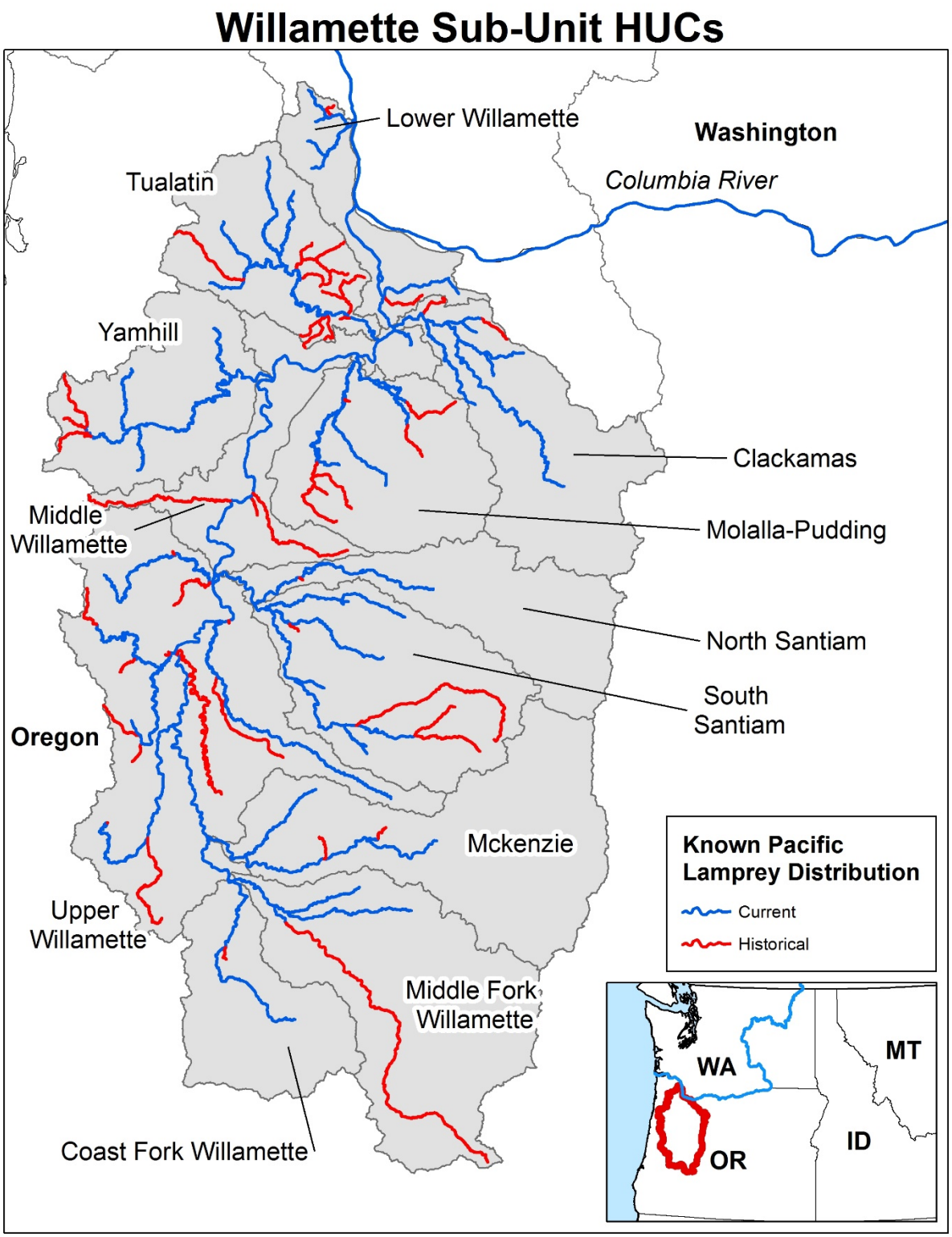

Figure 2. Estimated current and historical distribution for Pacific Lamprey: Lower Columbia and Willamette Regional Management Unit (USFWS Data Clearinghouse 2016).

C. Threats

Summary of Major Threats

The key threats within the Willamette Sub-Unit were identified by RMU participants during the Risk Assessment revision meeting in February 2017 (Table 4). Key threats are defined as those threats in which the average scope and severity across all HUCs was greater than 2.5 on a scale from 1- 4 (>3.5 = High, 2.5- 3.49 =Moderate, 1.5- 2.49=Low and <1.5= Insignificant; U=Unknown). Stream and floodplain degradation (non-dam), water quality (non-dam) and dam-related flow alterations[1] are the highest priority threats in the Willamette Sub-Unit, followed by dam-related stream and floodplain degradation and dam-related passage (Table 4). The "dam-related" threats refer to those threats primarily caused by large dams, which affect multiple parameters (passage, water quality, seasonal baseflows and flood flows (timing, magnitude and duration), floodplain dynamics, habitat (e.g. inundation of habitat, loss of coarse sediment supply), and species composition (e.g. habitat suitability, predator/prey dynamics) This distinction was made to better identify the cause of the threats, and ensure some threats were not masked by the presence of these dams.

Stream and Floodplain Degradation.—Nearly 70 percent of Oregon's population resides in and around the Willamette Basin. Human settlement and development has greatly altered the physical habitat and hydrology of the Sub-Unit. In upland areas, forestry is the predominant land use. Fire suppression and historical and ongoing timber harvest practices have altered the diversity and age/size composition of riparian vegetation and trees. Many watersheds in the Willamette Sub-Unit are lacking mature conifers that play a pivotal role in bank stability, water quality protection, thermal cover, and the provision of large woody debris. In the valley, extensive agriculture and urban development have reduced the quality and complexity of aquatic and riparian habitats. Efforts to reduce flooding (dikes, levees, riprap, dams) and improve navigation (dredging, large wood clearing), have straightened and scoured streambeds, eliminated side channels and cut off flood plains. Cultivation, riparian clearing and conversion of land for crops, pastures, vineyards and development have filled and/or drained wetlands, increased soil erosion and sedimentation, and promoted the establishment and spread of invasive plant species. Simplification of the river channel and flow regulation and simplification of the mainstem Willamette have been hypothesized to be a cause of the decreased numbers of adult Pacific Lamprey harvested by Tribal members at Willamette Falls (Clemens et al. 2017b).

Water Quality.—Elevated water temperature, low dissolved oxygen, bacteria, and toxic pollutants such as herbicides, pesticides, heavy metals and flame retardants, are some of the primary water quality concerns in the Willamette Sub-Unit. These threats may be attributable to a number of human related causes including riparian clearing, water withdrawals, failing septic systems, sewer overflow, and urban and agricultural run-off. Toxins may be particularly harmful to Pacific lamprey because larvae burrow and feed in mud and fine substrates where toxins accumulate (Nilsen et al. 2015; Clemens et al. 2017b). Monitoring efforts to improve and protect water quality for fish, wildlife, and human health are ongoing in the Willamette Sub-Unit.

[1] "Flow Alterations" were formerly referred to as "Dewatering and Flow Management" in Luzier et al. (2011).

A combination of laboratory and field tests and field observations suggest that warm summertime temperatures (greater than or equal to 20^{o}C) during July-August can result in several biological end points that may prevent adult Pacific lamprey from surviving, reproducing, or migrating far up into the Willamette Basin (Clemens et al. 2016). First, summertime temperatures correlated with a large die-off of adult Pacific Lamprey at Willamette Falls , and these temperatures have correlated with skewed sex ratios (more males) in one year at Willamette Falls (Clemens et al. 2016). Second, summertime temperatures correlated with documented testicular atresia (damaged testes) in males, which may affect their ability to subsequently mature and spawn (Clemens et al. 2016). Third, exposure of adult Pacific lamprey to summertime temperatures can result in faster maturation (Clemens et al. 2009). Summertime stream temperatures correlate with slowing and in some cases, ceasing of upstream migration (Clemens et al. 2012a, 2017), which may result in lamprey not spawning as far up into the Willamette Basin (Clemens et al. 2016). Conversely, higher annual flow discharges correlate with farther migration upstream (Clemens et al. 2016, 2017). In summary, this evidence suggests that warm summertime temperatures may thwart penetration into the upper basin with successful reproduction in a few ways.

Flow Alterations – (formerly "Dewatering and Flow Management"). —Flow alterations were ranked as a Moderate key threat. Low flow conditions occur naturally in many watersheds of the Willamette Sub-Unit during summer months. These conditions may be aggravated by water withdrawals for municipal, industrial, commercial and agricultural use. In several tributaries, the large storage dams offset and augment seasonal low flows in much of the Willamette Basin, and some negatively impact natural temperature and flow regimes. Water releases from thermally stratified reservoirs generally result in cooler water temperatures downstream of the dam in summer and warmer water temperatures in fall and winter. Abnormal seasonal temperature fluctuations may impact the behavior, development, and fitness of adult and juvenile lamprey to an unknown extent. In 2005, the USACE completed a water temperature control tower at Cougar Dam on the South Fork McKenzie River, which has alleviated much of the dam-induced seasonal abnormalities in the McKenzie River. Such temperature control structures are still needed elsewhere in the Willamette Basin to return to more normative seasonal temperature regimes (e.g. North Santiam River, the Middle Fork Willamette).

Water diversions and impoundments alter the quantity and timing of flow events, which may impact adult and juvenile lamprey migration cues, decrease spawning habitat availability, prevent access to backwater or side channel habitats, create low water barriers, and contribute to mortality if incubating eggs or burrowing larvae are dewatered or exposed to a high temperature or low oxygen environment (Clemens et al. 2017b). Some improvements to flow regimes have occurred in the Willamette Basin. Since 2002, the USACE has largely operated their Willamette Valley Project dams according to minimum flows and ramping rates that were formalized under the Willamette Project Biological Opinion issued by the National Marine Fisheries Service (NMFS 2008) for the protection of anadromous salmonids. Further, through the Willamette Valley Sustainable River Project, The Nature Conservancy and the USACE and numerous other agencies and organizations are working to ensure that Willamette River flows are managed to benefit fish and wildlife habitats as well as local communities (https://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/oregon/placesweprotect/wv-fact-sheet.pdf?redirect=https-301).

Table 4. Summary of the assessment results for the main threats of the Willamette Sub-Unit. Key Threats are those that rank Moderate or High (2.5 or greater). Threats ranked less than 2.5 are not listed.

Watershed	Dam-Related Passage		Dam-Related Flow Alterations		Dam-Related Stream & Floodplain Degradation		Dam-Related Water Quality		Dam-Related Predation	
	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity
Willamette Sub-Unit										
Middle Fork Willamette	4	4	4	4	4	4	4	4	3	3
Coast Fork Willamette	4	4	4	4	4	4	4	4	2.5	2.5
Upper Willamette	2	4	4	4	3	4	3	4	2	4
McKenzie	3	3	3	3	3	3	3	3	2	2
North Santiam	4	4	4	4	4	4	3	3	1	1
South Santiam	4	4	4	4	4	4	4	4	2	4
Middle Willamette	2	4	4	4	4	4	3	3	1	U
Yamhill	2	2	2.5	2.5	2	2	2.5	2.5	1	1
Molalla-Pudding	2.5	2.5	2.5	2.5	2	2	2.5	2.5	3	3
Tualatin	2.5	2.5	2	2	2	2	2	2	3	3
Clackamas	3	3	1	2	1	1	1	1	3	U
Lower Willamette	1	2	3	3	4	4	4	4	4	4
Average Scope/Severity	2.8	3.3	3.2	3.3	3.1	3.2	3.0	3.1	2.3	2.8
Rank	**M**	**M**	**M**	**M**	**M**	**M**	**M**	**M**	**L**	**M**
Mean	3.0		3.2		3.1		3.0		2.5	
Overall Threat Rank	**M**		**M**		**M**		**M**		**M**	

Table 4 (continued). Summary of the assessment results for the main threats of the Willamette Sub-Unit. Key Threats are those that rank Moderate or High (2.5 or greater). Threats ranked less than 2.5 are not listed.

Watershed	Flow Alterations (non-dam)		Stream & Floodplain Degradation (non-dam)		Water Quality (non-dam)		Predation (non-dam)	
	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity
Willamette Sub-Unit								
Middle Fork Willamette	1	1	3.5	3	2	2	1	1
Coast Fork Willamette	3	2.5	2.5	2.5	3	3	2.5	2.5
Upper Willamette	3.5	3	4	3.5	4	3.5	1.5	U
McKenzie	2	2	3	3	2	1	1	1
North Santiam	3	3	2.5	3	2	3	1.5	3
South Santiam	3.5	3	3	3	3	3	1	U
Middle Willamette	3.5	3	4	4	3.5	4	4	U
Yamhill	3	3	4	4	4	4	3	3
Molalla-Pudding	4	4	4	4	4	4	3	3
Tualatin	2.5	2.5	4	4	4	4	3	3
Clackamas	1	2	3	3	3	3	3	U
Lower Willamette	2.5	2.5	4	4	4	4	4	4
Average Scope/Severity	2.7	2.6	3.5	3.4	3.2	3.2	2.4	2.6
Rank	**M**	**M**	**H**	**M**	**M**	**M**	**L**	**M**
Mean	2.7		3.4		3.2		2.5	
Overall Threat Rank	**M**		**M**		**M**		**M**	

Passage- As previously stated, the current distribution of Pacific lamprey is largely determined by the many large dams throughout the Willamette Basin that do not provide passage (Clemens et al. 2012b; Schultz et al. 2014; Table 5). The USACE Willamette Valley Project dams were primarily built to reduce flood risks, but also generate electricity and provide water storage for irrigation, recreation and drinking water. The structures range in size from 49 feet (Fern Ridge) to 519 feet (Cougar) tall and provide little or no fish passage for Pacific lamprey. Largely constructed in the early 1960s, the USACE dams block hundreds of miles of historical, anadromous spawning and rearing habitat and have adversely affected native fish populations in the basin. Consequently, the Willamette Valley Project Biological Opinion, issued by the National Marine Fisheries Service (NMFS 2008), requires the Corps to improve adult and juvenile salmonid passage at several high priority dams.

USACE's adult fish trap and haul facilities located at the base of these dams are primarily designed for anadromous salmonids, which are trapped and transported by truck and released upstream of the dams. Some of the recent upgrades include features (e.g. rounded walls at fishway entrances and orifices) that may increase the ability to capture and haul adult lamprey if additional infrastructure (such as ramps and collection boxes) was added. Work to date has included the construction or upgrade of adult fish collection facilities at Cougar, Detroit (Minto), Foster, Dexter and Fall Creek Dams to improve trap and haul conditions for salmonids (i.e., improved attractant flows, larger holding areas, less direct handling of fish). At this time, Fall Creek Dam has the only experimental ramps for upstream lamprey passage at these USACE dams.

Downstream fish passage solutions for salmonids at the USACE dams are still under evaluation. No permanent downstream fish passage collection facilities for any of the USACE dams have been completed. Juvenile fish (all species) must pass through turbines, spillway gates, or other routes of water passage as they migrate downstream. USACE has tested a small, experimental, floating surface collector at Cougar Dam for downstream passage of salmonids. Other studies to determine downstream passage solutions at Detroit and Lookout Point Dams continue. It is unclear if passage improvement measures will ultimately restore access to the habitat above these dams for Pacific lamprey.

Although most passage projects in the Willamette Sub-Unit are focused on improving conditions for ESA-threatened spring Chinook salmon and winter steelhead, a growing number of projects are providing passage for Pacific lamprey. In conjunction with Federal Energy Regulatory Commission relicensing, Portland General Electric (PGE) has installed three lamprey passage structures at Willamette Falls Hydroelectric Project (Lower Willamette River), rebuilt the existing fish ladder at River Mill Dam (Clackamas River) and made modifications to the fishway that traverses the Faraday and North Fork Dams (Clackamas River) to improve upstream passage of adult Pacific lamprey. PGE is also monitoring the downstream migration of juvenile lamprey with two, new surface collectors at River Mill and North Fork Dams. These facilities are collecting and enumerating lamprey outmigrants. The collection efficiency of the downstream passage structures are unknown, but thousands of ammocoetes and macropthalmia have been collected each year since construction. PGE is also translocating adult Pacific lamprey into the Clackamas above North Fork Dam to increase larval production (and the pheromones they produce) in the upper basin in efforts to increase adult attraction to this area. In the future, PGE will perform a multi-year radio telemetry study that will assess migration and passage success of adult Pacific lamprey through the fish ladder at North Fork Dam.

Table 5. Passage conditions at most large dams located in the Willamette Sub-Unit.

Dam / ***Ownership***	**River**	**Passage Conditions for Pacific Lamprey**
Dexter, Lookout Point, and Hills Creek *USACE*	Middle Fork Willamette	A trap and haul facility for anadromous salmonids occurs below Dexter Dam, the lower-most dam on the Middle Fork Willamette. Future upgrades may increase the ability to capture and haul adult lamprey upstream of these dams. Permanent downstream passage facilities are not present.
Fall Creek Dam *USACE*	Tributary to Middle Fork Willamette below Dexter Dam	A trap and haul facility for anadromous salmonids occurs below Fall Creek Dam, and USACE has installed a ramp/collection box specific for lamprey. Future upgrades may increase the ability to capture and haul adult lamprey upstream of these dams. CTGR are conducting a reintroduction/translocation of adults captured at Willamette Falls above this dam. Downstream passage facilities are not present; "passage" for downstream migrant salmonids is provided by annual 1-2 week drawdown of the reservoir- typically in December or January each year.
Dorena Dam *USACE*	Row River- Tributary to Coast Fork	No fish passage facilities are present or planned at this dam.
Cottage Grove Dam *USACE*	Coast Fork Willamette River	No fish passage facilities are present or planned at this dam.
Fern Ridge Dam *USACE*	Long Tom River	No fish passage facilities are present or planned at this dam.
Leaburg Dam *EWEB*	McKenzie River	Two upstream fishways are located at Leaburg Dam (~10 feet tall). Lamprey passage efficiency is unknown, but Pacific lamprey are found above this dam. EWEB's diversions are screened to NMFS criteria, which are adequate for larger outmigrants, but may allow the smallest larvae to pass through the screen, and intermediate sized larvae may become impinged or wedged in the gaps of the screen material.
Cougar Dam *USACE*	South Fork McKenzie River	A trap and haul facility for anadromous salmonids occurs below Cougar Dam; recent upgrades may increase the ability to capture and haul adult lamprey upstream if additional infrastructure was added. Permanent downstream passage facilities are not present; USACE is testing a small, pilot facility for downstream passage of salmonids.
Blue River Dam *USACE*	Blue River (tributary to McKenzie River)	No fish passage facilities are present or planned at this dam.

Table 5 continued.

Dam / ***Ownership***	**River**	**Passage Conditions for Pacific Lamprey**
Trail Bridge Dam *EWEB*	McKenzie River	No fish passage facilities are present at this dam. Future upgrades in the next ~5 years will include a trap and haul facility that includes design considerations for trap and haul of adult Pacific lamprey. Downstream passage will be provided by spill and powerhouse shut-down, which will occur year-round.
Mino, Big Cliff and Detroit Dams *USACE*	North Santiam	A trap and haul facility for anadromous salmonids occurs below Big Cliff Dam, the lower-most dam, at Minto. Recent upgrades may increase the ability to capture and haul adult lamprey upstream if additional infrastructure was added. Permanent downstream passage facilities are not present.
Foster and Green Peter Dams *USACE*	South Santiam	A trap and haul facility for anadromous salmonids occurs below Foster Dam, the lower-most dam. Recent upgrades may increase the ability to capture and haul adult lamprey upstream if additional infrastructure was added. Permanent downstream passage facilities are not present.
Scoggins Dam *BLM*	Tualatin River	No fish passage facilities are present or planned at this dam.
River Mill, Faraday, and North Fork Dams *PGE*	Clackamas River	A new fishway at the lower-most River Mill Dam was constructed in 2006 and provides 90% passage efficiency for Pacific lamprey. PGE has recently modified the North Fork Fishway, which traverses both Faraday and North Fork dams, and is currently evaluating passage here. Permanent downstream passage facilities, which are collecting and enumerating lamprey outmigrants, are at North Fork and River Mill dams. The collection efficiency is unknown, but thousands of ammocoetes and macropthalmia have been collected each year since construction.
Willamette Falls Dam *PGE*	Willamette River	Modifications to the existing fishway to improve lamprey passage have been completed. Additionally, seasonal lamprey ramps are installed annually to provide upstream egress for lamprey upstream passage. Modifications to improve downstream salmonid passage have been completed, including improved spill conditions, which are likely to improve passage conditions for lamprey somewhat.

Predation. Predation (both dam-related and not dam-related) was ranked as a moderate threat to lamprey. Predation on lamprey likely occurs throughout the Willamette Basin: sea lion and white sturgeon activity is commonly seen immediately below Willamette Falls, and many warm-water predatory fish species are common throughout the basin in the large reservoirs and lower tributaries of the Willamette. These non-native fish are able to overwinter and survive in the basin largely because of large reservoirs or other modified habitats. At this time, there is very little direct study of predation in the Willamette Basin; thus, while there may be many potential predators of lamprey present, in many areas it is uncertain what the severity of such predation is

to the lamprey population.

Other.—Predicted trends in human population growth, increased development, and anticipated effects of climate change (i.e., elevated water temperatures, increased demand for consumptive surface water use, altered flow regimes) will likely compound existing threats to Pacific lamprey throughout the Willamette Sub-Unit.

2017 Nature Serve Values:
Based on the scores provided above, the following rankings were determined using a modified NatureServe ranking model to assess the current threats and extinction risk to Pacific Lamprey. The use of the NatureServe model is described in Luzier et al. 2011, and the following updated ranks (Table 5; Figure 3) will be further detailed in the 2018 update to that document (*Pacific Lamprey Assessment and Template for Conservation Measures*).

Table 5. NatureServe Rankings by HUC. S1 = Critically imperiled in the jurisdiction because of extreme rarity or because of some factors such as very steep declines making it especially vulnerable to extirpation; S2 = imperiled in the jurisdiction because of rarity due to very restricted range, very few occurrences, steep declines, or other factors making it vulnerable steep declines making it especially very vulnerable to extirpation; S3 = vulnerable in the jurisdiction due to restricted range, relatively few occurrences, recent and widespread declines, or other factors making it vulnerable to extirpation.

NatureServe Ranking	HUC
S1- Critically Imperiled	Middle Fork Willamette
S1- Critically Imperiled	Coast Fork Willamette
S2 – Imperiled	Upper Willamette
S2 – Imperiled	McKenzie
S1- Critically Imperiled	North Santiam
S2 – Imperiled	South Santiam
S2 – Imperiled	Middle Willamette
S1- Critically Imperiled	Yamhill
S1- Critically Imperiled	Molalla-Pudding
S1- Critically Imperiled	Tualatin
S3- Vulnerable	Clackamas
S2 – Imperiled	Lower Willamette

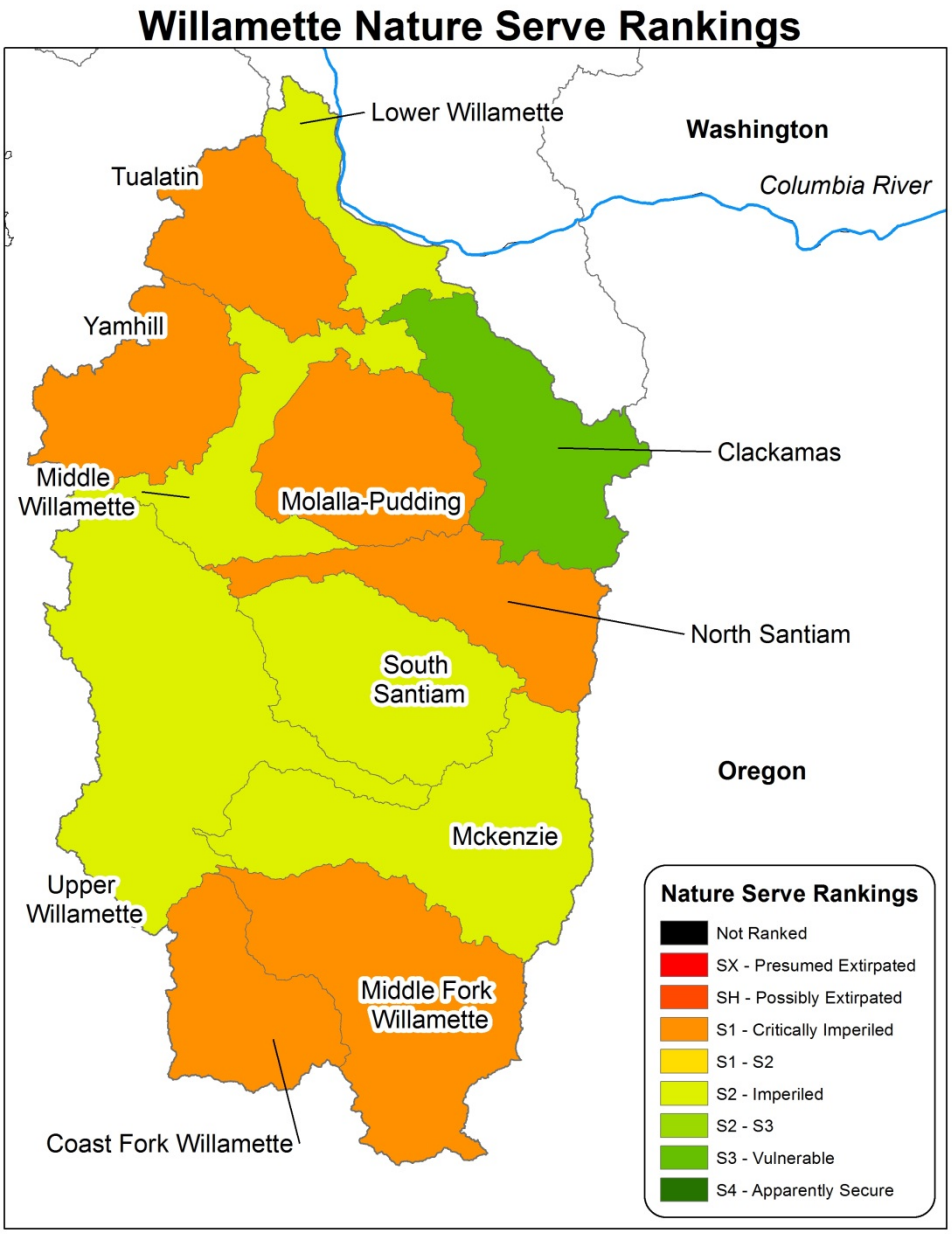

Figure 3. Final NatureServe rankings for the Willamette RMU.

Restoration Actions

The following work was recently completed or is actively occurring in the Willamette Sub-Unit. Additional detail is provided in the Willamette Sub-Unit Meeting Notes for the Pacific Lamprey Threats Assessment and RIP meeting (USFWS 2017).

- Clackamas Watershed
    - Two new surface collectors for downstream fish passage have been completed by PGE at the River Mill and North Fork Dams over the past few years. Both are collecting juvenile lamprey outmigrants.
    - PGE will begin Trap and Haul efforts to transfer adult lamprey above North Fork Dam in 2017, and continuing through 2025.
    - Multiple habitat restoration efforts have occurred in the Clackamas Basin (PGE, Metro and others), including the ongoing "Shade Our Streams" efforts by the Clackamas River Basin Council and PGE.
- Fall Creek (Middle Fork Willamette)
    - The Confederated Tribes of the Grand Ronde is leading a multi-year lamprey translocation study on Fall Creek (2012- present).
    - The USACE is evaluating adult collection facilities at Fall Creek Dam, including lamprey specific ramps. The upgrades to the existing Fall Creek Adult Salmonid Collection Facility (2017-2018) will also include lamprey-friendly features that may ultimately assist with a trap and haul program for Pacific lamprey at this dam.
- The Confederated Tribes of Warm Springs Reservation of Oregon continues to assess passage and abundance of adult Pacific lamprey at Willamette Falls.
- Middle Fork Willamette
    - The existing Mill Pond at the Springfield Millrace was removed, thus improving lamprey access. Additional habitat improvements at this site planned for 2017 will increase habitat diversity and improve habitat for lamprey (City of Springfield and many other partners).
- Ongoing distribution and occupancy sampling. Information collected through these surveys will guide conservation actions throughout the Willamette Sub-Unit.

II. Selection of Priority Actions

A. Prioritization Process

The highest priority threat in the Willamette Sub-Unit is stream and floodplain degradation (score = 3.4). Several other factors ranked above 3.0 : dam-related passage, dam-related flow alteration and water quality. Priority projects identified by participating members of the Willamette Sub-Unit RMU addressed threats to passage, stream and floodplain degradation and uncertainties in Pacific Lamprey distribution and enumeration.

B. High Priority Proposed Project Information

PROJECT: Improving counts of Pacific Lamprey in the McKenzie River (Leaburg Dam)

Project Lead Contact: Katherine Nordholm (ODFW)

Threat addressed by project: Lack of information on the Status of Pacific lamprey

Project Description:

This project addresses the deficiency of information on the status of Pacific lamprey in the McKenzie River Basin. Currently, reliable estimates of population abundance or population trends are lacking. Having unknown population parameters is common throughout Pacific lamprey distribution and most population and trend estimates are bases on counts from Willamette Falls.

Video cameras in Leaburg Dam's fish ladders have recorded fish passage since 1993. Pacific lamprey are observed in these videos however the counts do not completely capture the Pacific lamprey population. Lamprey have been observed passing over the fish ladder without being captured on video. Thus, the counts of Pacific lamprey at Leaburg Dam cannot be used for population estimates or population trend monitoring. In addition, Pacific lamprey may be able to pass upstream of the dam through the auxiliary water supplies for the fish ladders or other routes where water is flowing over smooth surfaces.

The objective of this project is to develop the methodology to provide an accurate annual count of Pacific lamprey passing Leaburg Dam. With infrastructure already in place at Leaburg Dam, there is an opportunity to start a long-term Pacific lamprey population monitoring project. Upgrading the video equipment in both fish ladders at Leaburg Dam will allow a complete count of Pacific lamprey passing over the ladders. Additionally, a telemetry study will be conducted to determine the potential for Pacific lamprey to navigate upstream of the dam without using the fish ladders.

HUC 5 *Location*: McKenzie River, Oregon (#17090004)

Facilities ownership: Eugene Water and Electric Board (EWEB)

Rationale and linkage to the watershed:

Long term dam counts of fish passing over Leaburg Dam are not an accurate record of the total number of Pacific lamprey that pass over the fish ladder. Upgrading the video monitoring equipment in the Leaburg Dam fish ladder will allow complete counts of passing Pacific lamprey. The addition of a telemetry study will determine if Pacific lamprey are able to navigate upstream of Leaburg Dam without passing through the fish ladders.

Expected outcome (threats addressed):

Upgrade the video equipment at Leaburg Dam to accurately monitor population abundance and trends over time. Begin building a long-term data set on Pacific lamprey migration in the McKenzie River.

Identification and coordination with relevant stake holders:

ODFW, EWEB, USACE, Tribal interests

Feasibility and expected timeframes:

Feasibility is high. Project planning and implementation could start immediately.

Proponent Role and Responsibilities:

Install additional video cameras in the Leaburg Dam fish ladders. Fund a position to enumerate fish caught passing the fish ladder. Trap lamprey at the base of Leaburg dam. Tag lamprey with RFID PIT tags, and tag a subset with radio telemetry tags. Fund a position for tracking the telemetry tagged fish and for monitoring and evaluating PIT tag project.

Budget and identification of potential funding source:

ODFW, EWEB, USACE, USFS. Estimated costs can very; a more detailed breakdown of cost can be provided later.

Camera equipment and setup: $7,500

Personnel: Four to eight months: $12,000 to $24,000

Telemetry Equipment: $8,000 - $20,000

Total: $27,500 to $51,500

PROJECT: Estimate N_e Above North Fork Dam on the Clackamas River

Project Lead Contact: Nick Ackerman (PGE)

Threat addressed by project: Small Effective Population Size

Project Description: Estimate N_e Above North Fork Dam on the Clackamas River:

Our objective is to determine the effective population size (N_e) of Pacific lamprey above North Fork Dam on the Clackamas River. This will be accomplished through genetic sampling of juvenile Pacific lamprey collected at Portland General Electric's (PGE) downstream migrant sampling facility in 2017. Our estimate of N_e will be representative of adults from brood years 2009 – 2014.

HUC 5 *Location*: Clackamas: 17090011

Facilities ownership: Portland General Electric

Rationale and linkage to the watershed:

Historically, passage at North Fork Dam has been assumed to be poor (Ackerman et al. 2016). From 2017-2025 PGE will be conducting a trap-and-haul program to improve Pacific lamprey passage around North Fork Dam (Ackerman 2017). The intent of the program is to haul approximately 250 adults per year from River Mill Dam to upstream of North Fork Dam. However, it is unknown how this number compares to the current adult abundance upstream of the dam. Until 2013 there was no means for trapping or counting Pacific Lamprey on the North Fork Ladder, and even after 2013 a newly installed lamprey trap was proven to be ineffective as it was found that lamprey were able to successfully bypass the trap (Ackerman et al. 2016). Therefore, while passage rates through the ladder have been low, an unknown number of lamprey have annually passed through the ladder into the upper basin. A better understanding of the pre trap-and-haul program N_e upstream of North Fork Dam may help refine the trap and haul program and provide valuable baseline information in assessing the effectiveness of the program.

Expected outcome (threats addressed):

Estimate recent effective population size of Pacific lamprey in the upper Clackamas Basin prior to implementation of a significant trap-and-haul program.

Identification and coordination with relevant stake holders:

PGE, Quantitative Consultants, Inc., and Columbia River Inter-Tribal fish Commission (CRITFC)

Feasibility and expected timeframes:

Feasibility is high. Genetic samples will be collected from macropthalmia in the winter of 2017/2018. Genetic analysis will be run in early 2018 with reporting complete by summer of 2018.

Proponent Role and Responsibilities:

Nick Ackerman of PGE will be the main proponent of the project. PGE will collect the genetic samples and provide them to the CRITFC genetics laboratory in Hagerman, ID for genotyping. Estimates of N_e will be made by Quantitative Consultants, Inc., using sibship-based estimators (reviewed in Ackerman et al. 2016b).

Budget and identification of potential funding source:

We estimate the project budget (including the genotyping of 500 juvenile lamprey samples, data analysis, and a project report) to cost $40,000.

PGE will provide $10,000 of the $40,000 project cost and the labor to collect the samples for the project at no cost. PGE operates and maintains the juvenile sampling facilities used for the evaluation at no cost to the project. An itemized budget is available upon request.

PROJECT: Lower South Fork McKenzie River Floodplain Enhancement Project

Project Lead Contact: Kate Meyer (USFS)

Threat addressed by project: Stream & Floodplain Degradation and Water Quality

Project Description: Current large-scale project underway to restore floodplain connectivity and function on over 500 acres of historical alluvial delta at the confluence of the South Fork McKenzie River. Project will remove approx. 40 acres of levees and augment sediment (over 200,000 cubic yards) and large wood (3,000-4,000 pieces) on 4.5 miles of the South Fork below Cougar Dam, resulting in 5-10 miles of secondary channel reconnection (up to 400% increase). This project will dramatically improve spawning and rearing habitat for Pacific lamprey.
HUC 5 *Location*: South Fork McKenzie River Watershed HUC #1709000403, McKenzie River Subbasin

Facilities ownership: Willamette National Forest, US Army Corps of Engineers

Rationale and linkage to the watershed:

Efforts to prevent flooding (dikes, levees, riprap, dams) and improve navigation (dredging, large wood clearing), have straightened and scoured streambeds, eliminated side channels and cut off floodplains throughout the McKenzie River subbasin and Willamette Basin. Pacific lamprey rely

on low gradient, depositional floodplains with abundant fines and gravels and channel complexity for spawning and rearing. Pacific lamprey were positively identified in the project area in 2015.

Expected outcome (threats addressed):
Project would improve the physical, chemical, and biological processes that support a healthy, resilient ecosystem and sustain habitat conditions needed to improve productivity for spring Chinook salmon, bull trout, Pacific lamprey, rainbow trout, cutthroat trout, and other native species. It would specifically improve spawning and rearing habitat for Pacific lamprey that is easily accessible below impassable dams. Project will also help improve water quality and mitigate effects of climate change by: (1) storing more water in the reconnected floodplain and slowly releasing it throughout the year, making more water available during low flow periods; (2) keeping water cooler through increased hyporheic exchange through the floodplain and through augmented sediment; and (3) allowing floodplains to naturally clean and filter water.

Identification and coordination with relevant stake holders:
USFS, McKenzie Watershed Council, USACE, ODFW, NMFS, USFWS, Eugene Water & Electric Board, Outfitters and Guides

Feasibility and expected timeframes:
This is one of the highest priority projects for the Willamette NF. An 80% design has been completed and NEPA will be conducted in 2017. Implementation will begin in 2018 if funding can be secured.

Proponent Role and Responsibilities:
Project is co-managed by McKenzie Watershed Council and Willamette National Forest

Budget and identification of potential funding source:
Potential funding sources include: USFS, EWEB, USACE, BPA, OWEB, USFWS, Drinking Water Provider Partnership, National Fish and Wildlife Foundation, Trout Unlimited; total cost is ~$4 million.

2017 Activities and Specific Requests for Funding

- USFS staff salary for design, planning, NEPA, permitting, grant writing, communication/outreach has all been covered with internal funding and a grant from the Drinking Water Providers Partnership. Funding for collecting local plants and seed and growing them out at a nursery has also covered by grants.

- The McKenzie Watershed Council, who is co-managing this project, is **seeking funds for planning, outreach/communication, and partnership development - $5,000-$10,000.**

- **PRE- PROJECT MONITORING:** We are seeking additional funding (either through the Watershed Council or USFS) for pre-project monitoring, which will likely include:
    - purchase and installation of piezometers to measure change in water table - **$5,000-$10,000**
    - data collection along floodplain transects to measure wetted area, substrate diversity, habitat patch complexity, vegetation, etc. - **$5,000-$10,000**
    - geomorphic change detection using LiDAR or Structure from Motion Aerial

Photography - **$10,000-$20,000**

- pre-project low elevation aerial imagery - **$5,000-$10,000**
- fish abundance (including lamprey) and biomass estimates using eDNA - **$5,000-$20,000** (costs are uncertain – we're trying to track down better estimates)

2018 Activities: Implementation of Phase I – lower 2.0 miles/400 acres of floodplain; Total cost = approx. $1 million; project could utilize any funding amount.

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MEETING NOTES
WILLAMETTE RMU- Pacific Lamprey Threats Assessment and RIP
Feb 15 and 16, 2017

Feb 15, 2017, Attendees (*= on phone)**:**

ODFW: Ben Clemens, Katherine Nordholm, Jeff Ziller, Alex Farrand, Tom Murtaugh*, Ben Walczak*
EWEB: Andy Talabere
PGE: Nick Ackerman, Maggie David, Dan Cramer*
Clackamas River Basin Council: Cheryl McGinnis*
Coast Fork Watershed Council: Amanda Gilbert*
Luckiamute Watershed Council: Kristen Larson*
McKenzie Watershed Council: Jarod Weybright*
Clackamas SWCD: Jenne Reische
Upper Willamette SWCD: Dave Downing*
CTGR: Lawrence Schwabe
BLM: Scott Snedaker
USACE: Greg Taylor, Doug Garletts*, Sean Tackley*
USFS: Doug Larson, Jack Williamson, Kimberly Conley*
USFWS: Erin Butts, Ann Gray, Jen Poirier

Feb 16, 2017, Attendees (*= on phone)**:**

ODFW: Ben Clemens, Katherine Nordholm, Jeff Ziller, Alex Farrand
EWEB: Andy Talabere
PGE: Nick Ackerman, Maggie David,
Clackamas River Basin Council: Cheryl McGinnis*, Suzi Cloutier
Luckiamute Watershed Council: Kristen Larson*
North Santiam Watershed Council: Rebecca McCoun
Yamhill Watershed Council: Luke Westphal
CTGR: Lawrence Schwabe*, Torey Wakefield*
USACE: Greg Taylor, Doug Garletts*
USFS: Doug Larson, Kimberly Conley*
USFWS: Erin Butts, Ann Gray, Jen Poirier

February 15, 2017 Meeting Agenda
Annual Pacific Lamprey Meeting for the Willamette RMU
NatureServe Model Threats Assessment

9:00 am Introductions/ Overview of Day 1 (Jen Poirier)
9:20 am NatureServe Parameters A-C (Jen Poirier)
11:00 am Parameter D /Threats Assessment by HUC
- Middle Fork, Coast Fork, Upper Willamette, McKenzie

12:00 pm LUNCH
12:45 pm Continue Threats Assessment by HUC
3:45 pm Review Action items and talk about next steps
4:00 pm Adjourn

February 16th, 2017 Meeting Agenda
Annual Pacific Lamprey Meeting for the Willamette RMU
NatureServe Model Threats Assessment / Development of 2017 Regional Implementation Plan

9:00 am Introductions/ agenda review (Jen Poirier)
9:15 am Continue ranking of threats for remaining HUCs
- North Santiam; South Santiam; Middle Willamette; Yamhill; Molalla-Pudding; Tualatin; Clackamas; Lower Willamette

11:00 2016 Regional Implementation Plan summary (Ann Gray)
12:00 pm LUNCH
12:30 pm USFWS Website Overview for the Lamprey Conservation Initiative (Erin Butts)
1:15 pm NEXT STEPS - Ongoing/completed Projects benefitting lamprey
Potential RIP Projects from all parties (group discussion)
2016 proposed projects included (which could or could not remain in 2017):
- Fall Creek Dam Upstream Passage Evaluation
- Fall Creek Reservoir – Juvenile Stranding Evaluation
- Willamette Tributaries Passage Evaluation
- South Fork McKenzie- Floodplain restoration (improve spawning and rearing)
- Abundance and Distribution survey (Yamhill basin)

Continue discussion on potential RIP Projects, including new projects;
3:30 pm Review Action items and talk about next steps
4:00 pm Adjourn

MEETING NOTES

THREATS ASSESSMENT RANKING

The 2017 Willamette RMU meeting to re-evaluate the Threats Assessment (TA) and begin development of the 2017 Regional Implementation Plan (RIP) was well attended by many agencies, watershed councils, private hydropower staff, and the Confederated Tribes of the Grand Ronde (CTGR). People were engaged and responsive, even folks who had to call in. Some changes were made to the NatureServe Items A (Watershed population distribution (current)) and Item B (Watershed population abundance); these changes primarily reflect an increase in awareness of Pacific lamprey and some increased data collection specific to Pacific lamprey. All new distribution data was provided to USFWS to update the distribution maps.

The Team strove to assign a ranking for Abundance for each HUC, but acknowledged that specific population estimates for each HUC were uncertain. While the work led by Dr. Cyndi Baker of the Confederated Tribes of the Warms Springs Reservation of Oregon (CTWSRO) estimates the number of Pacific lamprey adults passing Willamette Falls (~ for the past 5 years), the Team agreed that there was not sufficient information to determine the percentages of lamprey entering particular tributaries after passing Willamette Falls.

The majority of the 2-day meeting was spent reviewing the 2011 TA rankings for NatureServe Item D and its many threat categories, and re-evaluating those in light of new information and current understanding of lamprey, based on the knowledge of the RMU Team members present. Most of the changes to the scope and severity of TA categories were from:

1. attention to ranking threat categories in one basin/area relative to other areas in the Willamette (as several people familiar with much of the Willamette Basin stayed the entire process) and to other threats,
2. an attempt to stay fairly consistent about the amount of area or population was affected and about a reasonable time to recovery (e.g. the group kept referring back to the specific definitions for each level of scope and severity, and tried to stay "true" to that).

The RMU Team felt it was important to rank five threat categories in two ways: 1) as that category is affected by the dams, and 2) as that category is affected by other impacts not related to the dams ("non-dam"). The Team discussed that the effects of the large dams mask the other impacts, and therefore subsequently we could miss the opportunity to identify/prioritize restoration efforts that would be highly beneficial and perhaps more easily addressed than impacts at some of the larger dams. Thus, five categories were expanded into 10. In addition, the category formerly known as "dewatering and flow management" was renamed to "Flow Alterations" to better define the threat to lamprey. See Table below for a description of which specific actions are in which category.

THREAT CATEGORY	DAM RELATED	"NON-DAM" RELATED
Passage (up- and downstream)	Dam blockages, passage injuries.	Unscreened ag diversions (entrainment), culverts, tide gates.
Flow alterations	Dam operations that cause changes in the natural hydrograph associated with water storage and ramping rates, reservoir drawdowns.	Water withdrawal, ag diversions/use, dewatering actions.
Stream and Floodplain Degradation	Loss of complex habitats, large wood and coarse sediment routing associated with altered flow regimes (loss of peak and low flows) and sediment/large removal from dams.	Mining, dredging, loss of riparian vegetation and shading, bank hardening (rip-rap, etc.), channelization.
Water Quality	WQ effects tied directly to dam operations- altered temperature regimes, TDG loads, DO.	Temperature and DO problems not associated with dam operations, including contaminants, pesticides,

		agriculture runoff, but could also include other parameters.
Predation	Bottlenecks associated with dams that create additional vulnerability to predation, reservoir predation (create habitat preferred by nonnative predators); Reservoirs creating a significant source of potential predators to move and establish downstream.	Predation not associated with dams or from predators moving downstream of dams- This group was harder for the group to parse apart from the "dam-related" predation.

Harvest of lamprey occurs at Willamette Falls, which borders the Lower and Middle Willamette HUCs. ODFW documents harvest through personal use permits and tribal harvest, and specific information can be found in Kostow 2002, and reports Cyndi Baker has completed reports for the lamprey creel/harvest from Willamette Falls 2010 to present (BPA report project 2008-308). Little known harvest occurs in the Willamette tributaries, and thus ranked insignificant in both scope and severity for all areas outside of the mainstem.

Limited **Translocation** of adult lamprey has occurred. Approximately 250 fish are taken from Willamette Falls annually by CTGR and translocated into Fall Creek above Fall Creek Dam (2012 to present). A trap and haul effort in the Clackamas basin by PGE, beginning in 2017 for two years, will take adult lamprey from River Mill Fishway and moves them upstream of the North Fork Dam. This is in addition to a previous 2 year effort in ~2007/2008, in which PGE transported 100-150 lamprey per year above North Fork Dam. The ranks for translocation were either N/A or "1" for both scope and severity.

Categories for **Disease** and **Small Population Size** were not changed; there is still insufficient information to rank these. **Lack of Awareness** was ranked as a "2" for both scope and severity; people felt there was increasing awareness, especially with agencies, but still private land owners/others who do small projects instream could be unaware and cause some impacts to habitat and juveniles.

RE: **Disease**: Ben Clemens submitted the following information during the draft notes review: Per Clemens et al. 2009, page 425: *"Aeromonas salmonicida* and furunculosis Warm water temperatures (15–20 C) have been correlated with proliferation of *A. salmonicida*, outbreaks of furunculosis, and increased mortality in salmonids (Wedemeyer 1996; Pickering 1997). In addition to warm water, furunculosis outbreaks have been attributed to hydrographic features that can aggregate infected fish, such as at the base of waterfalls (Mackie et al. 1930, cited in Johnsen & Jensen 1994). Pacific lamprey can be found in aggregations at temperatures >20 C at the base of Willamette Falls (B. Clemens, unpublished data), and we have detected *A. salmonicida* in fresh collections of adult Pacific lamprey from this location, and in our experimental fish, which were also taken from this location. Sexual maturation appeared to be associated with incidence of *A. salmonicida*, although we only directly assayed a subset of mortalities (including euthanized fish at the end of the experiment) during spring of 2007 (mortalities were examined for gross symptoms during 2006). Our research raises questions that

warrant further exploration of the nature of the association of *A. salmonicida* with sexual maturation in Pacific lamprey. For example, does *A. salmonicida* proliferate as a result of the sexual maturation process? Does this pathogen kill lamprey before they spawn?"

See also Ward et al. 2012, page 360: "Although disease transmission is a potential risk with interbasin transfers of lamprey, it has been low. Oregon Department of Fish and Wildlife Fish Health Services used standard fish health diagnostic methods to test Pacific lamprey for pathogens (85 adults and 21 larvae). The primary pathogen of concern was a bacterium, *A. salmonicida*, the causative agent of furunculosis. Nine (8.5%) of the lamprey tested were found to have systemic *A. salmonicida* infections over the past decade. These fish represent a single sample that died following collection and transfer in June 2005. Since this event, routine oxytetracycline injections (10 mg/kg) have been implemented and appear to be successful."

Clemens, B. J., S. van de Wetering, J. Kaufman, R. A. Holt, C. B. Schreck. 2009. Do summer temperatures trigger spring maturation in Pacific lamprey, Entosphenus tridentatus? Ecology of Freshwater Fish 18: 418-426.

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Climate change was marked "*Unknown*" for both scope and severity across the Willamette RMU; the Team did not feel we understand enough about climate change and how it will affect lamprey in the future: 1) there is uncertainty surrounding climate change predictions and 2) flow releases from the flood storage dams have the potential to mitigate increasing water temperatures. Both of these factors made it difficult to define scope and severity of this threat.

The 2017 rankings as determined by the group for items A-D are provided in the Tables below. Data Quality Values were ranked for each parameter as follows:
"0" = No information available
"1" = Best professional judgement based on expansion of data for other species (e.g., Steelhead, Coho)
"2" = Largely undocumented but based on extent of habitat, suspected barriers and/or anecdotal information.
"3" = Partial adult, juvenile, or nest survey data in one-half or less of the potential spawning and rearing habitat in the watershed.
"4" = Partial adult, juvenile, of nest survey data in more than one-half of the potential spawning and rearing habitat in the watershed with some estimate of error.
"5" = Comprehensive adult, juvenile, or nest survey data in more than 90% of the watershed incorporating some estimate of error.

2017 RANKS – A. WATERSHED POPULATION DISTRIBUTION

E = 100-500 square km (~25,000-125,000 acres); F = 500-2,000 square km (~125,000-500,000 acres); G = 2,000-20,000 square km (~500,000-5,000,000 acres)

	Area of Occupancy (Current Distribution)			**Area of Occupancy (Current Distribution)**	
	2010 Rank (A1)	**Data Quality (A2)**		**2010 Rank (A1)**	**Data Quality (A2)**
Middle Fork	E	1 and 2	**Middle Willamette**	F	2
Coast Fork Willamette	E	3	**Yamhill**	F	2
Upper Willamette	F/G	2 and 3	**Molalla-Pudding**	F	2
McKenzie	F/G	3	**Tualatin**	F	2
North Santiam	E/F	3	**Clackamas**	F	3
South Santiam	F	3	**Lower Willamette**	F	1 and 2

2017 RANKS – B. WATERSHED POPULATION ABUNDANCE

B = 50–250 individuals; C = 250–1,000 individuals; D = 1,000–2,500 individuals
E = 2,500–10,000 individuals, F = 10,000–100,000 individuals, U = Unknown

	Population Size			**Population Size**	
	2010 Rank (B1)	**Data Quality (B2)**		**2010 Rank (B1)**	**Data Quality (B2)**
Middle Fork	B	1 and 2	**Middle Willamette**	C/D	2
Coast Fork Willamette	C	3	**Yamhill**	B	2
Upper Willamette	C	3	**Molalla-Pudding**	B	2
McKenzie	C	2	**Tualatin**	B	2
North Santiam	D	3	**Clackamas**	E/F	3
South Santiam	C	2	**Lower Willamette**	U	1 and 2

2017 RANKS – C. SHORT-TERM WATERSHED POPULATION TREND

	Short Term Population Trend			Short Term Population Trend	
	2010 Rank (C1)	**Data Quality (C2)**		**2010 Rank (C1)**	**Data Quality (C2)**
Middle Fork	B*	1	**Middle Willamette**	B*	1
Coast Fork Willamette	B*	1	**Yamhill**	B*	1
Upper Willamette	B*	1	**Molalla-Pudding**	B*	1
McKenzie	B*	1	**Tualatin**	B*	1
North Santiam	B*	1	**Clackamas**	F	2 and 3
South Santiam	B*	1	**Lower Willamette**	B*	0

A "B" ranking indicates the population is very rapidly declining (decline of 50-70%). "B*" indicates that the group decided to maintain the rank from 2010, which seem to be based on limited information we have at Willamette Falls (comparing 1940s information to now) and Bonneville Dam (1960s information to now), but acknowledge that there is much lacking in terms of available information, accuracy and consistency on annual population estimates.

"F" indicates an increasing trend (increase of >10%) – the increase in the Clackamas population trend may be an artifact of improved fish passage and collection facilities; the Clackamas River confluence is below and close to Willamette Falls and lower in the Willamette Basin than most of the other large tributaries.

Table of the 2017 RANKS for Item D. THREATS. Threats to Pacific Lamprey and their habitats within the Willamette River Basin as identified and ranked by participants at 2017 Regional Meetings. (*) indicates threat was identified as a "Key Threat" in 2017 (meaning average of scope and severity across all basins was a 3 or greater). High = 4; Moderate/High = 3.5; Moderate = 3; Low/Moderate = 2.5; Low = 2; Insignificant = 1; Unknown = no value.

	*Dam-Related Passage		* Dam-Related FLOW ALTERATIONS		* Dam-Related Stream and Floodplain Degradation		* Dam-Related Water Quality		Harvest		* Dam-Related Predation	
Watershed	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity
Willamette River Basin												
Middle Fork Willamette	4	4	4	4	4	4	4	4	1	1	3	3
Coast Fork Willamette	4	4	4	4	4	4	4	4	1	1	2.5	2.5
Upper Willamette	2	4	4	4	3	4	3	4	U	U	2	4
McKenzie	3	3	3	3	3	3	3	3	1	1	2	2
North Santiam	4	4	4	4	4	4	3	3	1	1	1	1
South Santiam	4	4	4	4	4	4	4	4	1	1	2	4
Middle Willamette	2	4	4	4	4	4	3	3	U	U	1	U
Yamhill	2	2	2.5	2.5	2	2	2.5	2.5	1	1	1	1
Molalla-Pudding	2.5	2.5	2.5	2.5	2	2	2.5	2.5	1	1	3	3
Tualatin	2.5	2.5	2	2	2	2	2	2	1	1	3	3
Clackamas	3	3	1	2	1	1	1	1	1	1	3	U
Lower Willamette	1	2	3	3	4	4	4	4	U	U	4	4
	2.8	3.3	3.2	3.3	3.1	3.2	3.0	3.1	1.0	1.0	2.3	2.8
	3.0		3.2		3.1		3.0		1.0		2.5	

Table of the 2017 RANKS for Item D. THREATS (continued(*) indicates threat was identified as a "Key Threat" in 2017 (meaning average of scope and severity across all basins was a 3 or greater). This page contains the new "non-dam" categories that were not part of the 2011 assessment.
High = 4; Moderate/High = 3.5; Moderate = 3; Low/Moderate = 2.5; Low = 2; Insignificant = 1; Unknown = no value.

	*Passage NON DAM		*FLOW ALTERATIONS NON DAM		*Stream and Floodplain Degradation- NON DAM		*Water Quality- NON DAM		*Predation- NON DAM	
Watershed	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity
Willamette River Basin										
Middle Fork Willamette	2	2	1	1	3.5	3	2	2	1	1
Coast Fork Willamette	2.5	2.5	3	2.5	2.5	2.5	3	3	2.5	2.5
Upper Willamette	2.5	2	3.5	3	4	3.5	4	3.5	1.5	U
McKenzie	2.5	2.5	2	2	3	3	2	1	1	1
North Santiam	2.5	2	3	3	2.5	3	2	3	1.5	3
South Santiam	2.5	2	3.5	3	3	3	3	3	1	U
Middle Willamette	1.5	2	3.5	3	4	4	3.5	4	4	U
Yamhill	3	3	3	3	4	4	4	4	3	3
Molalla-Pudding	2.5	2.5	4	4	4	4	4	4	3	3
Tualatin	2.5	2.5	2.5	2.5	4	4	4	4	3	3
Clackamas	2	2	1	2	3	3	3	3	3	U
Lower Willamette	1	2	2.5	2.5	4	4	4	4	4	4
	2.3	2.3	2.7	2.6	3.5	3.4	3.2	3.2	2.4	2.6
	2.3		2.7		3.4		3.2		2.5	

Table of the 2017 RANKS for Item D. THREATS (continued). (*) indicates threat was identified as a "Key Threat" in 2017 (meaning average of scope and severity across all basins was a 3 or greater). High = 4; Moderate/High = 3.5; Moderate = 3; Low/Moderate = 2.5; Low = 2; Insignificant = 1; Unknown = no value.

	Translocation		Disease		Small Population Size		*Lack of Awareness		*Climate Change	
Watershed	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity
Willamette River Basin										
Middle Fork Willamette	1	1	U	U	U	U	2	2	U	U
Coast Fork Willamette	NA	NA	U	U	U	U	2	2	U	U
Upper Willamette	NA	NA	U	U	U	U	2	2	U	U
McKenzie	1	1	U	U	U	U	2	2	U	U
North Santiam	1	1	U	U	U	U	2	2	U	U
South Santiam	1	1	U	U	U	U	2	2	U	U
Middle Willamette	NA	NA	U	U	U	U	2	2	U	U
Yamhill	NA	NA	U	U	U	U	2	2	U	U
Molalla-Pudding	NA	NA	U	U	U	U	2	2	U	U
Tualatin	NA	NA	U	U	U	U	2	2	U	U
Clackamas	1	1	U	U	U	U	2	2	U	U
Lower Willamette	1	1	2	U	U	U	2	2	U	U
	1.0	1.0	2.0	--	--	--	2.0	2.0	--	--
	1.0		--		--		2.0		--	

Detailed information was documented in the "2010 2017 Threat Tables" and tributary-specific "Questionairre" documents. In these files, the new, 2017 information was added in a different color on top of the information gathered from the 2010 meetings. This method allows these documents to maintain earlier information that was still relevant, and add to that knowledge base.

ONGOING CONSERVATION MEASURES

The NatureServe model also asks for the group to **identify ongoing conservation measures** in this watershed (Item E1).

Clackamas-

- New PGE surface collectors over the past few years at NF and River Mill are collecting juvenile lamprey.
- Trap and Haul efforts to transfer lamprey above North Fork Dam will begin 2017- intent is to increase larval population /pheromone attraction for adults.
- Additional side channel restoration (~3,000 linear ft).
- Metro- restoration efforts (Parsons, Fisher's Bend).
- Clackamas confluence/floodplain restoration.
- Goose Creek/River Island Restoration program.
- Shade our Stream efforts in Clackamas basin.

Fall Creek

- USACE evaluating adult collection facilities at the base of Fall Creek Dam;
- USACE in 2017-2018 to upgrade salmonid adult collection facility- some lamprey improvements included. In recent years, USACE has been in the process of upgrading all of the fish collection facilities associated with the Willamette Project Dams and have worked hard to incorporate lamprey friendly features (reflecting the current state of knowledge) into the new facilities including: smooth rounded surfaces on the orifices and weirs, modifications to the fish ladder entrance (including a second alternative entrance for lamprey at Minto), modification of facility grating location and maximum size.
- Translocation of adults from Willamette Falls to above Fall Creek/radio-tracking of translocated fish by CTGR. Translocation efforts began in 2012, and are planned to occur for at least 7 years. Redd surveys since translocation began have found that these fish are spawning in these reaches. Electrofishing detected ammocoetes in 2015, but due to the small size of the ammocoetes collected, it was not clear if these were Pacific or brook lamprey. CTGR will conduct electrofishing surveys again in the fall of 2017 to further this work.

Willamette Falls

- Continued evaluation of lamprey counts by CTWSRO.

Middle Fork Willamette

- Eliminated the Mill Pond so the Springfield Millrace has improved lamprey access; 2017 habitat improvements will also occur at this site to increase habitat diversity, including habitats used by lamprey (City of Springfield, many partners- $5 million).

NEW CONSERVATION MEASURES

The NatureServe model also asks for the group to **develop new actions** to address threats in this watershed in this watershed (Item E2). The items discussed are listed below. Individuals were asked to submit project proposals which would be ranked by the group at a later date this spring.

- McKenzie River- improve video counts to document adult Pacific lamprey passage at Leaburg Dam, and pair with radiotagged lamprey to see where they might circumvent camera stations (Katherine Nordholm- ODFW).
- Fall Creek- USACE- adult facilities/ improvements?
    - Wing wall ramp not working; lamprey traps- only 4 adults were collected over a 2 year period.
    - Potentially use River Mill design within the new fishway.
    - Monitor/evaluate this trap- ? potentially use translocated fish from Willamette Falls in cooperation with CTGR?- use PIT tags or radio tags?
    - USACE indicated they will be working with their existing O&M funds to finance these actions.
- South Fork McKenzie- large floodplain restoration project at mouth of South Fork- USFS previously provided a project proposal. Project will benefit spawning and rearing and holding of pacific lamprey (all lifestages).

REGIONAL IDENTIFICATION OF RESEARCH, MONITORING, AND EVALUATION NEEDS

The group agreed **a long term, robust, monitoring framework** to guide and adaptively manage pacific lamprey actions, and integrate actions in an overall Willamette Basin-wide manner, using a holistic perspective. Greg Taylor (USACE) suggested the group to look at the Rogue River example. Action item Greg to share these reports. It was suggested such a document, once developed, would function as a Recovery Plan. Ben Clemens mentioned that the Oregon Department of Fish and Wildlife is working on a statewide conservation plan for lampreys of Oregon.

ODFW is currently identifying ways to further **incorporate monitoring Pacific lamprey into existing monitoring efforts** (spawner surveys etc).

- Research with OSU/CTGR/Cramer Fish Sciences- 2009/2010 took fin clips for genetics (neutral microsattelite loci) and found **moderate genetic differentiation** both between 2009 and 2010 and within 2010 (for complete paper, see Clemens et al. 2017 "Temporal genetic population structure and interannual variation in migration behavior of Pacific Lamprey *Entosphenus tridentatus*. Hydrobiologia DOI 10.1007/s10750-017-3096-4). Earlier studies using mitochondrial DNA and neutral microsatellite loci had found little genetic differentiation in Pacific Lamprey, but these studies had looked at very large geographic areas, without controlling for time. Cyndi Baker added the following note in during the review period: "CTWSR has tissue samples from all lamprey tagged for mark-recap 2011 to present. Jon Hess (CRITFC) has analyzed some of these samples."

Other research needs discussed include:

- Determine how to monitor **changes in the habitat below Fall Cr Dam** b/c fine sediment releases from Fall Cr during drawdown, including any research study to document how

the changes from the sediment release may have affected/improved habitats for lamprey? Any relevant Oregon chub habitat information? Little Fall Creek similar habitat outside the influence of the sediment release, so it could be a control / reference site for habitats below Fall Creek Dam.

- Evaluate **stranding of larval lamprey in Fall Creek Reservoir** during drawdown; gate has to be opened wide to have high salmonid outmigrant survival, so limiting drawdown rate may increase injury/mortality of juvenile outmigrants at dam. There is concern with the reintroduction of adult lamprey above Fall Creek Dam that juveniles will then use the Reservoir for rearing and the annual drawdown may be detrimental to those rearing in the sediments. Potential to survey Fall Cr Reservoir during drawdown?
- Sequentially **address passage efficiencies of multiple facilities** (adult collection facilities, fishways, etc). There are multiple small dams throughout the Willamette basin with unknown passage efficiencies. It is not clear who could take the lead on this type of project right now.

USACE (Greg Taylor and Doug Garletts) suggested a small group form to discuss potential actions at Fall Creek Dam the USACE could undertake with regards to habitat changes, the ongoing reintroduction of lamprey above Fall Creek Dam, and lamprey passage. The **FALL CREEK subgroup** included Doug Garletts, Doug Larson, Lawrence Schwabe, Ben Clemens, Jeff Ziller, Katherine Nordholm, and Greg Taylor. The Key Questions identified:

- What is the production capability below Fall Creek Dam?
- What is the production capability above Fall Creek Dam?
- How is the production capability limited by the drawdown?

Re: **Passage at Fall Creek**- USACE was also willing to examine methods to improve upstream passage for adult lamprey at Fall Creek, and was interested in investigating installation of a trap similar to the one used by PGE at River Mill. USACE indicated they will be working with their existing O&M funds to finance these actions.

2017 REGIONAL IMPLEMENTATION PLAN DEVELOPMENT/ NEXT STEPS

Regional Implementation Plans (RIP) for each RMU are to be revisited on an annual basis to highlight:

- key threats identified in the Threats Assessment (which is only once every 5 years),
- recent restoration/conservation benefits to lamprey that have been accomplished in that RMU, and
- restoration/research/monitoring projects for lamprey that address the key threats and research needs that are subsequently submitted for funding.

While the Pacific Lamprey Conservation Initiative currently does not have a consistent source of funding, there are some monies that have been available and used to fund projects in the RIPs. Individuals from the Willamette RMU can put forth any number of projects that are “ready to go” and will address key threats or uncertainties as identified in the Threats Assessment. The Willamette RMU team (team) will then prioritize those projects felt best to be put forward for funding requests. The projects can be for restoration or research, address a critical threat or

information need, and could be opportunistic. The proposal is submitted using the Priority Project Template, which only needs a modest amount of detail for consideration.

The 2016 RIP for the Willamette RMU contained several projects, none of which were funded for 2016. Besides the lack of funding (the primary reason for why very few projects are not funded to date), some proposals did not contain sufficient detail, did not have a clear lead or timeline for implementation, or other "flags" that made it seem the project was not "shovel-ready."

For 2017, the team discussed several potential projects:

- S. Fork McKenzie Floodplain Restoration (carried over from 2016),
- Improve counting stations for lamprey at Leaburg Dam (McKenzie River-new), and
- Genetic pedigree to determine population size (Clackamas- new)
- Passage efficiency of multiple dams throughout the Willamette tributaries
- Stranding of juvenile lamprey in Fall Creek Reservoir

Next Steps: Persons who want to submit a project for consideration by the team should submit a Priority Project description and send it to Ann. There will be a future conference call/webex to rank /prioritize projects and determine which ones will be included in the 2017 Willamette RIP.

Shortly after the team completes the prioritization process, a draft RIP will be out to the team for review. After the review period, Ann will finalize the RIP and submit it to the Conservation Team.

More Resources:

- USFWS Lamprey Conservation Initiative: *www.fws.gov/pacific/Fisheries/sphabcon/**Lamprey**/*
- Contact info for Willamette RIP:
  - Ann_E_Gray@fws.gov
- Contact for mapping information (corrections, etc.) and webpage questions:
  - Erin_Butts@fws.gov

Meeting Adjourned

APPENDIX 2

Pacific Lamprey RMU- Population Abundance Adjustment, based on population estimates at Willamette Falls- See data from 2010-2016 below (Baker and N **23-Feb-18**

Table 1. 2017. 2017 Population Abundance Ranks (based on professional judgment by RMU team) for each HUC; average Willamette Falls adult lamprey estimates (blue and green boxes), and calculations used to revise estimates of adult lamprey in each HUC (yellow box).

Rankings for population Abundance at Feb 2017 Meeting

Watershed	Rank	Bin Range	Bin min	Bin Max		Proportion of population above Will Falls based on Bin MAX	Average number of lamprey passing Will. Falls (2010-2016)	Estimate of lamprey for each watershed (column I x Column K)
Middle Fork	B	50-250	50	250		0.025	60,689	1,517
Coast Fork Willamette	C	250-1000	250	1,000		0.1	60,689	6,069
Upper Willamette	C	250-1000	250	1,000		0.1	60,689	6,069
McKenzie	C	250-1000	250	1,000		0.1	60,689	6,069
North Santiam	D	1000-2500	1,000	2,500		0.25	60,689	15,172
South Santiam	C	250-1000	250	1,000		0.1	60,689	6,069
Middle Willamette	CD	250-2500	250	2,500		0.25	60,689	15,172
Yamhill	B	50-250	50	250		0.025	60,689	1,517
Molalla-Pudding	B	50-250	50	250	Avg 60,689 above	0.025	60,689	1,517
Tualatin	B	50-250	50	250	falls (2010-2016)	0.025	60,689	1,517
						proportion below Wfalls		
Clackamas	EF	2500-100,000	2,500	100,000	112,029 below	0.5	112,029	56,015
Lower Willamette	U	??			falls (2010-2016)	0.5	112,029	56,015

Summed MAX Bin for all HUCs above Falls	**10,000**
Summed MAX below Falls	100,000+??

Table 2. New Rankings proposed for population based on Willamette Falls lamprey population estimates by CTWS.

Watershed	Rank	Pop Estimate	Bin min	Bin Max	
Middle Fork	D	1,517	1,000	2,500	
Coast Fork Willamette	E	6,069	2,500	10,000	
Upper Willamette	E	6,069	2,500	10,000	
McKenzie	E	6,069	2,500	10,000	
North Santiam	F	15,172	10,000	100,000	
South Santiam	E	6,069	2,500	10,000	
Middle Willamette	F	15,172	10,000	100,000	
Yamhill	D	1,517	1,000	2,500	
Molalla-Pudding	D	1,517	1,000	2,500	Avg 60,689 above
Tualatin	D	1,517	1,000	2,500	falls (2010-2016)
SUBTOTAL Above Falls		**60,689**	**34,000**	**250,000**	
Clackamas	F	56,015	10,000	100,000	112,029 below
Lower Willamette	F	56,015	10,000	100,000	falls (2010-2016)
SUBTOTAL BELOW FALLS		**112,029**	**20,000**	**200,000**	

Table 3. Willamette Falls Adult Pacific lamprey estimates from CTWS (Baker and McVay 2017).

YEAR	Total Abundance at Wfalls	Numbers Passing Willamette Falls Fishway	Number that did not pass (those below Wfalls)
2010	64,388	27,043	37,345
2011	107,383	46,819	60,564
2012	243,048	111,559	131,489
2013	173,821	49,365	124,456
2014	336,305	125,778	210,527
2015	168,398	32,112	136286
2016	115,682	32,148	83534
Average	**172,718**	**60,689**	**112,029**