Pacific Lamprey

2017 Regional Implementation Plan

for the

Lower Columbia/Willamette

Regional Management Unit

Lower Columbia Sub-Unit

Submitted to the Conservation Team June 2017

Primary Authors		Primary Editors
J. Poirier,	U.S. Fish and Wildlife Service	

This page left intentionally blank

I. Status and Distribution of Pacific lamprey in the RMU

A. General Description of the RMU

The Lower Columbia Sub-Unit within the Lower Columbia River/Willamette Regional Management Unit (RMU) is comprised of six 4th field HUCs that are situated within four EPA Level III ecoregions: the Coast Range, Willamette Valley, Puget Lowland, and Cascades (https://www.epa.gov/eco-research/level-iii-and-iv-ecoregions-continental-united-states). Watersheds within the Lower Columbia River Sub-Unit range in size from 1,753 to 3,756 km^2 and include the Lower Columbia-Sandy, Lewis, Upper and Lower Cowlitz, Lower Columbia-Clatskanie, and Lower Columbia River (Table 1). The spatial arrangements of these HUCs are displayed in Figure 1. A list of major tributaries within each HUC can be found in *Appendix A.*

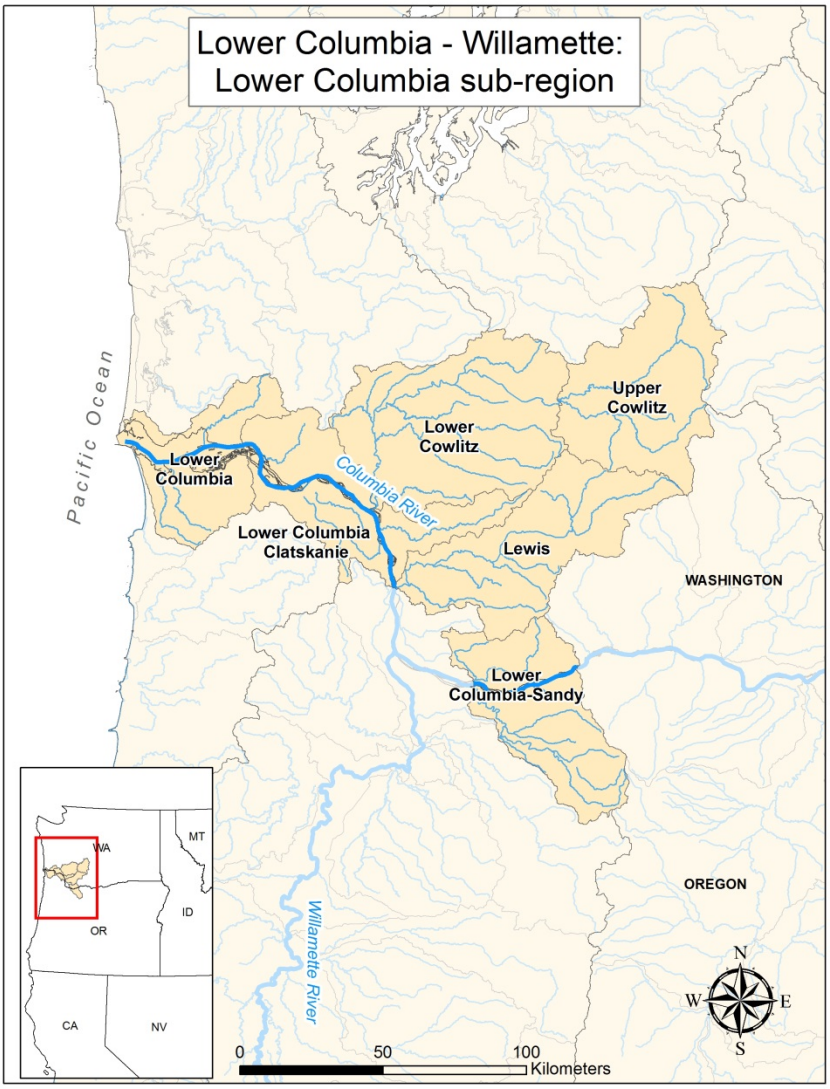

Figure 1. Map of watersheds within the Lower Columbia/Willamette RMU, Lower Columbia Sub-Unit.

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

Watershed	HUC Number	Drainage Size (km^2)	Level III Ecoregion(s)
Lower Columbia-Sandy	17080001	2,263	Willamette Valley, Cascades
Lewis	17080002	2,719	Puget Lowland, Willamette Valley, Cascades
Upper Cowlitz	17080004	2,654	Puget Lowland
Lower Cowlitz	17080005	3,756	Puget Lowland, Cascades
Lower Columbia-Clatskanie	17080003	2,349	Coast Range, Willamette Valley
Lower Columbia	17080006	1,753	Coast Range

B. Status of Species

Conservation Assessment and New Updates

Current Pacific Lamprey distribution in the Lower Columbia Sub-Unit is still greatly reduced from historic range (Table 2). Although distribution has remained the same in most watersheds since the completion of the 2011 Assessment (see Luzier et al. 2011), understanding of distribution has expanded considerably in many Oregon State tributaries due to increased sampling effort (e.g., smolt trapping, redd surveys, occupancy sampling). Less is known about lamprey distribution in Washington State tributaries. Existing information is largely based upon anecdotal observations, or has been collected incidentally while monitoring salmonid species. A compilation of all known larval and adult Pacific Lamprey occurrences in the Lower Columbia Sub-Unit are displayed in Figure 2, which is a product of the USFWS Data Clearinghouse.

Pacific Lamprey population abundance was updated in the Lower Columbia-Sandy, Lower Columbia-Clatskanie, and Lower Columbia River HUCs using new information from Oregon Department of Fish and Wildlife (ODFW) to estimate a range of abundance using available redd counts. As part of the monitoring for winter steelhead spawning populations, the Oregon Adult Salmonid Inventory and Sampling (OASIS) field crews record data on lamprey spawners and redds. These estimates are considered minimum population numbers, as the surveys are focused on steelhead, and end before the completion of Pacific Lamprey spawning (see Jacobsen et al. 2014; Jacobsen et al. 2015; Brown et al. 2017). Abundance estimates were calculated for four lower Columbia River tributaries in multiple run years: the Sandy River (2010, 2012-2016), Clatskanie River (2012-2013, 2015-2016), Youngs Bay and Big Creek (2012-2013). Average abundance of adults ranged from 2-293 fish in the Sandy Basin (avg. of avg. 97 fish), 157-782 fish in the Clatskanie River (avg. of avg. 408 fish), and 25-980 fish in Youngs Bay and Big Creek Combined (avg. of avg. 354 fish). NatureServe population size rankings for the HUCs above were based upon OASIS abundance estimates and anecdotal information of lamprey in other Oregon and/or Washington tributaries (Table 2). Adult Pacific Lamprey abundance is currently unknown in the Lewis and Lower Cowlitz HUCs. Washington Department of Fish and Wildlife collects Pacific Lamprey redd and live count information in the East Fork Lewis and Coweeman River that

could be used to estimate adult abundance in a future Assessment. Pacific Lamprey are believed to be extirpated from the Upper Cowlitz River. The Cowlitz Salmon Hatchery Barrier Dam and Mayfield Dam effectively block access to the upper portion of the Lower Cowlitz River (above RM 49.6) and entire Upper Cowlitz basin.

Short-term population trend was ranked as unknown in all HUCs of the Lower Columbia Sub-Unit (Table 2). Mainstem dam counts provide one of the only long term records of adult Pacific Lamprey numbers in the Columbia River basin. Despite data gaps and monitoring inconsistencies, counts of adult Pacific Lamprey at Bonneville Dam indicate a significant downward trend in abundance over time. Counts of adult Pacific Lamprey prior to 1970 averaged over 100,000 fish (1939-1969), while the recent 10 year average is just over 24,000 fish (USACE 2016). Historic harvest records at Willamette Falls also suggest a decline in adult Pacific Lamprey abundance. Harvest estimates have ranged from a peak of ~400,000 pounds of fish in 1946 to less than 12,000 pounds since 2001 (Ward 2001). This reduction may be attributable to reduced fishing effort, more stringent regulations, different harvest methods, or a decline in lamprey abundance (Kostow 2002). Unfortunately no long term counts of Pacific Lamprey exist in tributary or mainstem areas of the Lower Columbia Sub-Unit. Populations are believed to be declined (from historic levels), but adequate information does not exist to estimate the magnitude of the decline. Oregon Department of Fish and Wildlife OASIS estimates provide 2-6 years of good abundance information in select lower Columbia tributaries (i.e., Sandy, Clatskanie, Youngs Bay and Big Creek), but this data set is not long enough to infer population trends.

Table 2. Categorical rank inputs and resulting NatureServe ranks for Pacific Lamprey population groupings within the Lower Columbia Sub-Unit 2017 (U = unknown; Z = zero or extant).

Watershed	Distribution		Population Size (#)	Short Term Trend (% decline)
	Historic (km^2)	Current (km^2)		
Lower Columbia-Sandy	D (1,000-5,000)	F (500-2,000)	B,C (50-1,000)	U
Lewis	D (1,000-5,000)	F (500-2,000)	U	U
Lower Columbia-Clatskanie	D (1,000-5,000)	F (500-2,000)	C,D (250-2,500)	U
Upper Cowlitz	D (1,000-5,000)	Z (0)	Z	U
Lower Cowlitz	D (1,000-5,000)	F (500-2,000)	U	U
Lower Columbia	D (1,000-5,000)	F (500-2,000)	C,D (250-2,500)	U

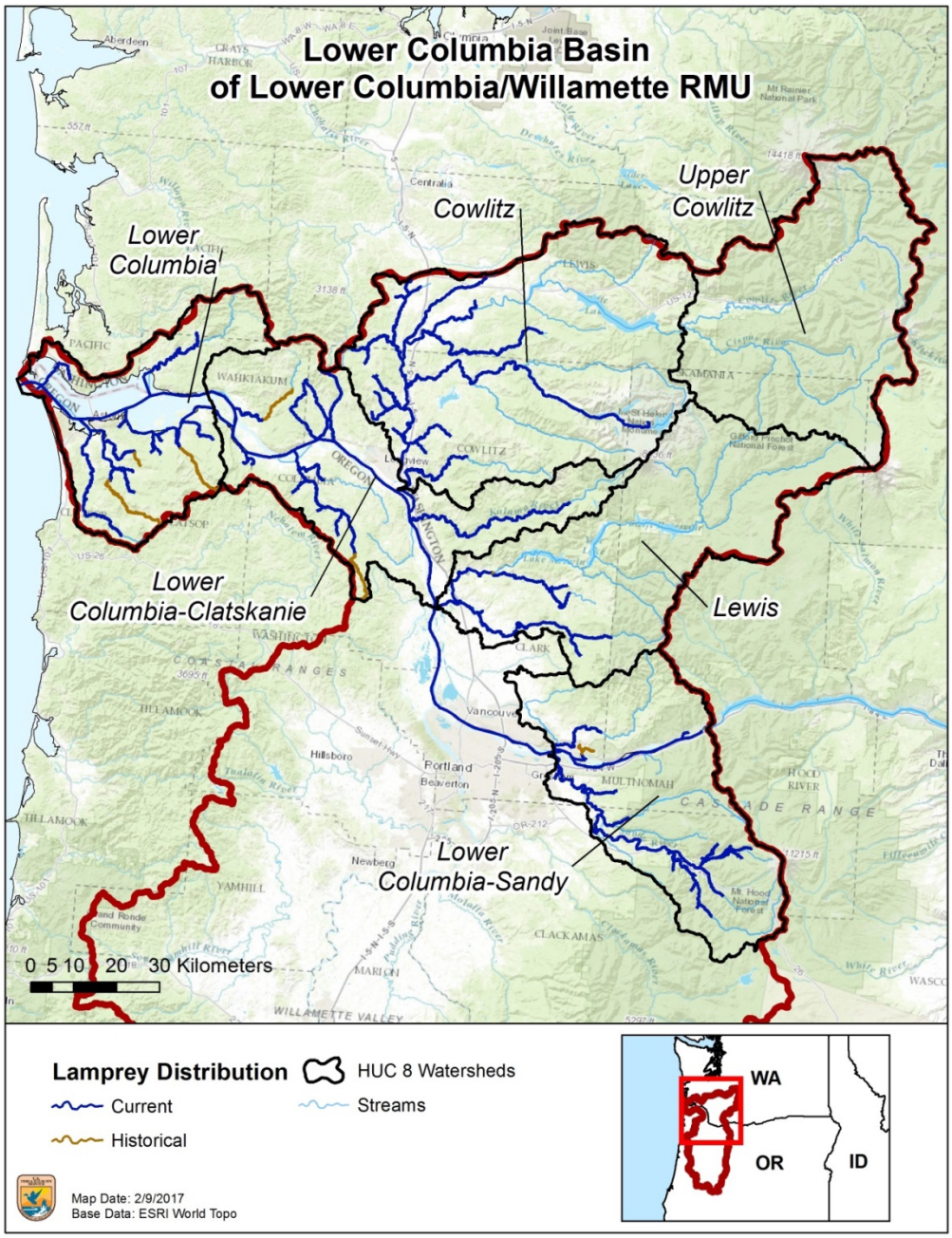

Figure 2. Current and historic known distribution for Pacific Lamprey: Lower Columbia/Willamette Regional Management Unit, Lower Columbia Sub-Unit (USFWS Data Clearinghouse 2017).

Distribution and Connectivity

Threats to passage were considered moderate in the Lower Columbia Sub-Unit (Table 3). While adult passage is not impeded by dams of the Federal Columbia River Power System (FCRPS), lamprey in these HUCs are affected by other large hydroelectric dams including Merwin, Swift, and Yale Dams in the Lewis Basin, and

Mayfield, Mossy Rock and Cowlitz Falls in the Lower and Upper Cowlitz Basins. These dams were built without fish passage and completely block upstream migration and access to important spawning and rearing habitat. To compensate for loss of passage, salmon and steelhead are diverted into a collection facility where they are sorted, hauled by truck and released above dams. Downstream passage for juveniles is accomplished using floating surface collectors. It is unknown whether Pacific Lamprey have ever been collected at Cowlitz Salmon Hatchery or Merwin adult fish collection facilities. No trap-and-haul of lamprey currently takes place above these dams. Other significant passage barriers in the Lower Columbia Sub-Unit include the multi-dam complex on the Bull Run River in the Sandy basin, and Sediment Retention Structure on the North Fork Toutle River. Culverts, tide gates, and small dams/weirs are also a concern throughout the RMU.

Road crossing culverts are prevalent in the Lower Columbia Sub-Unit. Poorly designed or installed culverts may fragment aquatic habitat and impede the migration of fish. Culverts with excessive water velocity (>0.86 m/s), inadequate attachment points, perched outlets, or added features with abrupt 90 degree angles (e.g., baffles, fish ladder steps, outlet aprons), may obstruct passage of adult lamprey (Moser et al. 2002; Mesa et al. 2003; Keefer et al. 2003; Stillwater Sciences 2014; Crandall and Wittenbach 2015). Many impassable culverts occur low in watersheds (near tributary outlets), preventing access to miles of potential habitat. An extensive effort is underway to inventory and prioritize problem culverts for removal, replacement or repair.

Tide gates are broadly distributed in tidally influenced tributaries of the Lower Columbia Sub-Unit. Estuarine wetlands and floodplains were historically constrained by dikes and gated culverts to prevent flooding and drain land for agriculture, livestock grazing, and/or residential development. Traditional top-hinge tide gates do not allow tidal backflow and thus provide few (if any) passage opportunities for fish. Furthermore, many of the older wood and cast iron tide gates have become damaged or corroded over time and are in need of maintenance. Stakeholder groups are actively working to remove or replace failing structures with fish friendly gates that remain open for a portion of incoming tide. The Oregon Watershed Enhancement Board has recently requested funding to perform a comprehensive statewide inventory of tide gates to identify structures in need of repair or replacement.

Fish hatcheries in the lower Columbia River basin often utilize barrier dams and fish ladders to divert adult salmon into the hatchery during brood collection, or to regulate fish passage above the hatchery. Many of these structures are suspected passage barriers to adult Pacific Lamprey (e.g. Cedar Creek Hatchery diversion (Sandy R.), Kalama Falls Hatchery diversion, Big Creek Hatchery diversion, North Fork Klaskanine Hatchery diversion), but the extent of the impact is unknown. One of the high priority projects submitted by the Lower Columbia RMU (below) would address this information gap by performing a basin-wide assessment of hatchery diversions and fishways to identify structures that may impede passage of adult lamprey.

C. Threats

Summary of Major Threats

The following table summarizes the known key threats (i.e., score ≥3.00) within the Lower Columbia Sub-Unit tributaries as identified by RMU participants during the Risk Assessment revision meeting in May 2017. The highest priority threat in the Lower Columbia watersheds is Dewatering and Flow Management followed by, Passage, Stream and Floodplain Degradation, and Water Quality.

Table 2. Key threats to Pacific Lamprey and their habitats within the Lower Columbia River Sub-Unit, 2017. High = 4; Moderate/High = 3.5; Moderate = 3; Low/Moderate = 2.5; Low = 2; Unknown = no value

Watershed	Passage		Dewatering and Flow Management		Stream and Floodplain Degradation		Water Quality	
	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity
Sandy	2.5	3	3.5*	2	2.5	3	3*	3*
Lewis	3	3	4	4	3	3	3	3
Upper Cowlitz	4	4	4	4	3	3	1	1
Lower Cowlitz	3	3	3	4	3	3	1	2
Clatskanie	3.5	4	3*	3*	4	3	3.5*	3.5*
Lower Columbia	2	2.5	2.5	2	3.5	3	3	4
Mean	3.00	3.25	3.33	3.17	3.16	3.00	2.42	2.75
Rank	**M**	**H**	**M**	**M**	**M**	**M**	**L**	**M**
Mean Scope & Severity	3.13		3.25		3.08		2.59	
Drainage Rank	**M**		**M**		**M**		**M**	

"*****" indicates areas that were ranked higher because of the mainstem Columbia River

Current Threats

Dewatering & flow management

Dewatering and Flow Management was ranked a moderate threat in the Lower Columbia Sub-Unit. Low seasonal streamflow and Bonneville Dam flow regulation were identified as key issues in the region. Low flow conditions occur naturally in many watersheds during summer months (e.g., Grays River), but land use practices and consumptive water use may exacerbate conditions further. Water withdrawals for irrigation, livestock, municipal, or industrial purposes leave many watersheds in the Lower Columbia Sub-Unit dewatered or with inadequate flow during summer and fall months (e.g., Sandy River, Washougal River, East Fork Lewis River, Kalama River, Clatskanie River, Lewis and Clark River, Youngs River, Big Creek, and the South Fork Klaskanine River). Low flows can impact fish by reducing spawning and rearing habitat availability, creating low water passage barriers, or impairing water quality. The projected rise in human population and anticipated effects of climate change (i.e., elevated ambient temperatures, decreased surface water availability, altered flow regimes), may increase the frequency, duration and intensity of low flow conditions the future.

The mainstem Columbia River downstream from Bonneville Dam is susceptible to frequent fluctuations in discharge and water level resulting from the operation of Bonneville Dam for hydropower production and flood control. Flow regulation has significantly altered the natural flow patterns of the Columbia River (see Lower Columbia Fish Recovery Board (LCFRB) 2010). These changes can negatively impact aquatic species that rely on environmental cues (i.e., temperature, photoperiod, flow) to trigger important developmental or behavioral events such as emergence, growth, maturation or migration. In the Columbia River basin, the spring freshet takes place an average of two weeks earlier and flow volume is reduced from historic levels (LCFRB 2010; Naik and Jay 2011). Diminished spring flows may increase the duration of fish migration, potentially increasing exposure to predators and other threats. Additionally, the shift of peak flows to earlier in the spring could result in even longer periods of low flow and warm water temperatures during summer and fall months (Naik and Jay 2011). Rapid water level fluctuations below Bonneville Dam (i.e., hydropeaking) repeatedly inundate and dewater shallow water areas, directly impacting the quantity, accessibility and suitability of spawning and rearing habitat. Lamprey larvae are especially vulnerable to stranding as they rear in fine sediments along river margins and delta regions, but impacts related to hydropeaking below Bonneville Dam are unknown (Jolley et al. 2012; Mueller et al. 2015).

Stream & floodplain degradation

Stream and Floodplain Degradation was also ranked a moderate threat. Channel confinement, channel manipulation, and floodplain development are the primary concerns in the Sub-Unit. Human settlement and land development have greatly altered the physical habitat of tributaries in the region. In upland areas, stream cleaning, forest fires (e.g., Yacolt Burn), and historic timber harvest practices have completely deforested or altered the diversity and age structure of riparian vegetation and trees. Many watersheds are lacking mature trees that play a pivotal role in bank stability, water quality protection, thermal cover, and input of wood into channels. Large wood can benefit streams by influencing the structural complexity of the channel (i.e., creating pools or

undercut banks), increasing the deposition of fine substrate and organic matter, thereby providing important rearing habitat for juvenile salmonids and larval lamprey (Gonzalez et al. 2017). Within lowland areas, river channels have been straightened, diked and armored to protect property against flooding and erosion. Channel simplification and conversion of land for agriculture, grazing, and development (rural, urban, commercial, industrial) has reduced or eliminated a substantial amount of side channel and wetland habitat.

The Columbia River mainstem below Bonneville Dam has been straightened and confined by major railroad and transportation corridors that run parallel to the river. Much of the shoreline is armored with riprap and connection to tributaries occurs through culverts and bridges. In the Lower Columbia River and estuary, dikes and levees have disconnected the mainstem from floodplain and estuary habitat (e.g., tidal swamp, marsh, wetlands), reducing the river to a single channel. Efforts to maintain the shipping channel (e.g., jetties, pile dikes) have altered flow patterns and increased sediment accumulation that requires periodic dredging to remove. The impacts of channel maintenance dredging on larval lamprey in the Lower Columbia River have not been thoroughly documented. Dredging may displace, injure or kill burrowing larvae, disturb or destroy potential rearing habitat, or re-suspend contaminated sediments into the river (Maitland et al. 2015; Clemens et al. 2017). Preliminary deep water larval sampling in the Lower Columbia River downstream from the City of Skamakawa (RM 33.5) did not detect larval lamprey in the 15 quadrats surveyed (Jolley et al. 2011a). Multiple size class and species of lamprey have been observed in other areas within the Columbia River mainstem (Jolley et al. 2011b; Jolley et al. 2012), but habitat use and distribution within the estuary is still unknown.

Water quality

Elevated water temperature is the primary water quality concern in Lower Columbia tributaries. Excessive temperatures generally occur during summer months and may be attributed to increased air temperature, lack of riparian cover, reduced instream flows associated with water withdrawal, and warm irrigation water returns. The impacts of relatively warm water temperatures (e.g., ≥20°C) on Pacific Lamprey embryonic development, physiology, adult migrations, reproductive capability and evolutionary pressures can be multitudinous and substantial (Clemens et al. 2016). Other water quality concerns in tributaries include low dissolved oxygen, pH extremes, and presence of bacteria (e.g., fecal coliform, e coli), that may be associated with elevated water temperatures and agricultural or urban runoff.

Major water quality concerns in the Lower Columbia mainstem include elevated water temperature, low dissolved oxygen, gas supersaturation, and biological and chemical contaminants. Average water temperature below Bonneville Dam often exceeds 19°C in late June to early September (Bragg and Johnston 2016). High water temperatures are likely a result of warmer ambient temperatures and cumulative effects of water withdrawal and land use activities in tributary and mainstem areas. Dissolved gas supersaturation resulting from spill from Bonneville Dam can exceed the EPA mandated limit of 110% saturation for several months during normal and low water years (Schneider and Barko 2006). These levels may extend throughout the entire lower Columbia River. Short-term exposure to gas levels <120% has minimal ill effects for juvenile salmonids. However, long term or repeated exposure to sublethal levels (<110%) may increase susceptibility to predation, disease, toxins, or other environmental stressors (McGrath et al. 2006). Furthermore, aquatic organisms inhabiting shallow water

habitats or exposed during vulnerable life stages (e.g., incubating embryos, sac fry, or larvae) may be more sensitive to sublethal effects. The vulnerability of Pacific Lamprey to gas bubble disease or potential sensitivity at different life stages is unknown. Industrial discharge and surface water runoff from farms, roads and urban areas are the primary source of contaminants entering the Columbia River mainstem. Toxic contaminants such as DDE, PCBs, and heavy metals settle out and accumulate in fine sediments, reaching concentrations that may be harmful to aquatic and terrestrial organisms. Toxins and heavy metals may be a particular concern for Pacific Lamprey because direct exposure in water or sediment during larval and adult life stages can result in high concentrations of contaminants accumulating in fatty tissues that may compromise fish health and development (Nilsen et al. 2015; Clemens et al. 2017). Monitoring and restoration efforts to improve and protect water quality for fish, wildlife, and human health are ongoing in the Lower Columbia Sub-Unit.

Predation

Although not ranked a 'key threat', predation of adult and juvenile lamprey by native and non-native fish, birds, and marine mammals is known to occur in the Columbia River Basin (Close et al. 1995; Zorich et al. 2011; Madson et al. 2017). Pacific Lamprey encounter many of the same predators as salmonids during migration, but the severity of the threat is not well understood. Dams and other human changes to the environment can increase habitat suitability for predator species and may contribute to the decline of lamprey by delaying/slowing migration or exposing fish to increased mortality in areas where piscivorous predators may congregate (e.g. Bonneville Dam tailrace, Sand Island, etc.). In addition, temperature increases predicted with climate change models may expand the territory of warmwater predators into tributaries, putting further stress on native fish communities (Lawrence et al. 2014).

Restoration and Research Actions

To date, the primary lamprey restoration activities that have occurred or are occurring within this RMU are being performed by organizations focused on salmon and steelhead recovery on both the Oregon and Washington side of the river. Many instream and floodplain habitat restoration activities have been identified in subbasin and watershed management plans (e.g., Oregon Lower Columbia River Conservation and Recovery Plan (2010), Washington Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan (2010), Lower Columbia River Recovery Plan for Salmon and Steelhead (2013)). The vast majority of these actions have been funded and designed for salmon recovery, but work may improve habitat conditions for lamprey as well. Current Pacific Lamprey research has focused on gaining a better understanding of distribution and habitat use within the Columbia River mainstem and tributaries. The following lamprey research and restoration actions have recently occurred within the Lower Columbia Sub-Unit:

- USFWS has performed deep water sampling to document the distribution and habitat use of larval lamprey in the Columbia River mainstem (Jolley et al. 2011a; Jolley et al. 2011b; Jolley et al. 2012).
- ODFW will continue to perform lamprey surveys jointly with existing steelhead surveys in Lower Columbia tributaries.
- USFWS completed a laboratory and field study investigating salinity tolerance and larval

lamprey occurrence in a tidally influenced estuarine stream (Silver 2015).

- Washington DNR is investigating the use of eDNA to monitor the effectiveness of a large wood placement project and recolonization of larval lamprey following restoration.
- Marmot Dam and the Little Sandy Dam were removed in the Sandy River in 2007 and 2008 respectively. Dam removals and stabilization of sediment movement has significantly addressed passage threats in the basin.
- Large wood placement projects in the Sandy River, Clatskanie River, NF Klaskanine River, and a proposed project on Eric Creek (Tributary of Abernathy Creek).
- Proposed restoration projects on the SF Toutle River to improve riparian conditions and instream structure in Bear-Harrington, and rehabilitate natural ponds in Little Cow Springs.
- Proposed removal of Kwoneesum Dam (Washougal River).

II. Selection of Priority Actions

A. Prioritization Process

Participating members of the Lower Columbia Sub-Unit met in Vancouver, Washington in May 2017 to revise the 2011 Risk Assessment, discuss current threats to Pacific Lamprey, and identify specific actions and research needed to address threats and uncertainties within the region. Three projects were selected by the Lower Columbia RMU for inclusion in the 2017 RIP. The first project addresses the key threat of Passage, and will assess adult lamprey passage potential at various fish hatchery diversions. The remaining projects address a key information gap in the region. Instream and floodplain habitat restoration projects restore function to the stream and improve conditions for salmon and steelhead, but it is unknown whether the work will also benefit lamprey. The proposed projects will assess the before and after effectiveness of a stream restoration project for adult and larval lamprey in Abernathy Creek (Longview, WA).

B. High Priority Proposed Project Information

High Priority Proposed Project Information

Passage Improvement at Fish Hatchery Diversions

Project Description: This project would initiate a systematic review and evaluation of adult Pacific lamprey passage efficacy at fishways and barrier dams associated with salmon hatcheries in the RMU. Throughout the Northwest, fish passage criteria used to engineer and manufacture barrier dams and fishways utilized adult salmon passage criteria which often limit or preclude adult Pacific lamprey passage**.**

- **HUC 5 *Location*:** Varies
- ***Facilities ownership:*** Varies

- ***Rationale and linkage to the watershed:*** Throughout the Lower Columbia RMU there are approximately 25 fish hatcheries (Figure 1). Many of these hatcheries use barrier dams and fishways to convey adult salmon into the hatchery proper. Unfortunately, many of these structures are major barriers to adult Pacific lamprey returning to spawn upstream. The degree to which these hatcheries limit or delay passage has never been evaluated.

- ***Expected outcome (threats addressed):*** The scope and severity of specific passage threats will be identified at each hatchery evaluated. These will be new threats identified. Many of the hatchery structures (threats) could be modified to facilitate or improve passage by adding orifices, Lamprey Passage Devices, eel tiles or other methods depending on the specific problem identified.

- ***Identification and coordination with relevant stake holders:*** ODFW, WDFW, USFWS
- ***Feasibility and expected timeframes:*** Feasibility is high. Project would be immediately actionable pending funding.
- ***Proponent Role and Responsibilities:*** Conduct fishway evaluations at hatcheries
- ***Budget and identification of potential funding source:*** USFWS - $19,000 depending on the number, type and complexity of fishways evaluated.

- ***Project Lead:*** Joe Skalicky – USFWS, Columbia River Fish and Wildlife Conservation Office

Hatchery ID	Hatchery Name	Stream Name
1	Abernathy FTC	Abernathy Creek
25	Big Creek	Big Creek
26	Bonneville	Tanner Creek
27	Gnat Creek	Gnat Creek
28	Trojan Pond	Columbia River
29	Klaskanine	North Fork Klaskanine River
30	Sandy	Cedar Creek
54	Grays River Rearing Pond	Grays River
55	Beaver Creek Hatchery	Beaver Creek
56	Cowlitz Trout Hatchery	Blue Creek
57	Gobar Rearing Pond	Gobar Creek
58	Skamania Hatchery	West Fork Washougal River
72	Cowlitz Salmon Hatchery	Cowlitz River
73	Elochoman Hatchery	Elochoman River
74	Grays River Hatchery	West Fork Grays River
75	Kalama Falls Hatchery	Kalama River
77	Lewis River Hatchery	Lewis River
78	Fallert Creek Hatchery	Hatchery Creek
83	Speelyai Hatchery	Speelyai Creek
84	North Toutle Hatchery	Green River
85	Washougal Hatchery	Washougal River
105	CEDC	Youngs River
111	North Toutle Hatchery FCF	North Fork Toutle River
230	Deer Springs Pond	Deer Creek
293	Alder Creek Rearing Pond	Alder Creek
307	Germany Creek Project	Germany Creek
310	Mossyrock Hatchery	Cowlitz River
316	Sea Resources Hatchery	Chinook River
336	Merwin Hatchery	Lewis River
359	S. Fk. Klaskanine Pond	South Fork Klaskanine River
491	Coweeman Rearing Pond #1	Coweman River
492	Coweeman Rearing Pond #2	Coweman River
498	South Toutle Trap	South Fork Toutle River
524	Kalama Trap	Kalama River

High Priority Proposed Project Information

Address critical uncertainties in stream and floodplain restoration

Project Description:

Threats to Pacific salmonid and lamprey populations include stream and floodplain degradation. Much habitat restoration is being implemented for salmonids and a general assumption made is that these restoration activities will also benefit Pacific lamprey. However, little empirical data exist on whether this assumption is true. We propose to evaluate this by assessing adult lamprey use in areas that have seen recent habitat restoration measures versus areas that have not seen treatment in the Abernathy Intensively Monitored Watershed.

- **HUC 5 *Location*:** Lower Columbia-Clatskanie; Abernathy Creek Watershed (#1708000304)
- ***Facilities ownership:*** N/A
- ***Rationale and linkage to the watershed:*** Adult lampreys depend on areas of well oxygenated small cobble for redd construction. Streams and floodplains have been significantly altered by humans during the last 150 years. Great effort is currently spent restoring streams for steelhead and salmon, but benefits to lamprey populations remain uncertain.
- ***Expected outcome (threats addressed):*** This project will provide much needed information on the relationship between salmonid habitat restoration and lamprey conservation by linking lamprey redd distribution data to an extensive stream habitat database from an ongoing watershed scale habitat restoration project (http://wdfw.wa.gov/conservation/research/projects/watershed_monitoring/). This knowledge on habitat use can then be used in future salmon habitat restoration planning to maximize benefits to lamprey populations.
- ***Identification and coordination with relevant stake holders:*** Washington Department of Fish and Wildlife, Washington Department of Natural Resources, Cowlitz Tribe, Interfluve, Lower Columbia Fish Recovery Board, U.S. Fish and Wildlife Service.
- ***Feasibility and expected timeframes:*** Feasibility is high.
- ***Proponent Role and Responsibilities:*** Design study, collect distribution data, link distribution data to habitat data, and disseminate results through peer-review scientific publications and professional presentations.
- ***Budget and identification of potential funding source:*** Estimated cost is $20,000
- ***Project Lead:*** Ben Kennedy USFWS

High Priority Proposed Project Information

Address critical uncertainties in stream and floodplain restoration

Project Description:

- Threats to Pacific salmonid and lamprey populations include stream and floodplain degradation. Much habitat restoration is being implemented for salmonids and a general assumption made is that these restoration activities will also benefit Pacific lamprey. However, little empirical data exist on whether this assumption is true. We propose to evaluate this by assessing larval lamprey use in areas that have seen recent habitat restoration measures versus areas that have not seen treatment in the Abernathy Intensively Monitored Watershed.
- **HUC 5 *Location*:** Lower Columbia-Clatskanie; Abernathy Creek Watershed (#1708000304)
- ***Facilities ownership:*** N/A
- ***Rationale and linkage to the watershed:*** Larval lampreys depend on areas of fine sediments to live and feed as well as suitable gravel areas for spawning. Streams and floodplains have been significantly altered by humans during the last 150 years. Great effort is currently spent restoring streams for steelhead and salmon, but benefits to lamprey populations remain uncertain.
- ***Expected outcome (threats addressed):*** This project will provide much needed information on the relationship between salmonid habitat restoration and lamprey conservation by linking larval lamprey distribution data to an extensive stream habitat database from an ongoing watershed scale habitat restoration project (http://wdfw.wa.gov/conservation/research/projects/watershed_monitoring/). This knowledge on habitat use can then be used in future salmon habitat restoration planning to maximize benefits to lamprey populations.
- ***Identification and coordination with relevant stake holders:*** Washington Department of Fish and Wildlife, Washington Department of Natural Resources, Cowlitz Tribe, Interfluve, Lower Columbia Fish Recovery Board, U.S. Fish and Wildlife Service.
- ***Feasibility and expected timeframes:*** Feasibility is high.
- ***Proponent Role and Responsibilities:*** Design study, collect distribution data, link distribution data to habitat data, and disseminate results through peer-review scientific publications and professional presentations.
- ***Budget and identification of potential funding source:*** Estimated cost is $20,000
- ***Project Lead:*** Ben Kennedy USFWS

References

Bragg, H.M., and M.W. Johnston. 2016. Total dissolved gas and water temperature in the lower Columbia River, Oregon and Washington, water year 2015: U.S. Geological Survey Open-File Report 2015-1212, 26 p., http://dx.doi.org/10.3133/ofr20151212.

Brown E, R Jacobsen, J. Nott, M. Weeber and M. Lewis. 2017. Assessment of Western Oregon Adult Winter Steelhead and Lamprey – Redd Surveys 2016. Monitoring Program Report Number OPSWODFW-2016-09. Oregon Department of Fish and Wildlife, Salem, Oregon.

Clemens, B., C. Schreck, S. van de Wetering, & S. Sower. 2016. The potential roles of river environments in selecting for stream- and ocean-maturing Pacific Lamprey, *Entosphenus tridentatus* (Gairdner, 1836). pp. 299 – 322. *In*: A. Orlov, & R. J. Beamish (eds.) Jawless Fishes of the World. Cambridge Scholars.

Clemens, B.J., R.J. Beamish, K.C. Coates, M.F. Docker, J.B. Dunham, A.E. Gray, J.E. Hess, J.C. Jolley, R.T. Lampman, B.J. McIlraith, M.L. Moser, J.G. Murauskas, D.L.G. Noakes, H.A. Schaller, C.B. Schreck, S.J. Starcevich, B. Streif, S.J. van de Wetering, J. Wade, L.A. Weitkamp, and L.A. Wyss. 2017. Conservation Challenges and Research Needs for Pacific Lamprey in the Columbia River Basin. Fisheries 42:5, 268-280.

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. Annual Report of the Oregon Cooperative Fish and Wildlife Research Unit to the Bonneville Power Administration, Portland, Oregon.

Crandall, J.D., and E. Wittenbach. 2015. Pacific Lamprey Habitat Restoration Guide. Methow Salmon Recovery Foundation, Twisp, Washington. First edition 54 p.

Gonzalez, R., J. Dunham, S. Lightcap, and J. McEnroe. 2017. Large Wood and In-stream Habitat for Juvenile Coho Salmon and Larval Lampreys in a Pacific Northwest Stream. North American Journal of Fisheries Management 37:4, 683-699.

Jacobsen, R., J. Nott, E. Brown, M. Weeber and M. Lewis. 2014. Assessment of Western Oregon Adult Winter Steelhead – Redd Surveys 2014. Monitoring Program Report Number OPSW ODFW-2014-09. Oregon Department of Fish and Wildlife, Salem, Oregon.

Jacobsen, R., J. Nott, E. Brown, M. Weeber and M. Lewis. 2015. Assessment of Western Oregon Adult Winter Steelhead and Lamprey Redd Surveys 2015. Monitoring Program Report Number OPSWODFW-2015-09. Oregon Department of Fish and Wildlife, Salem, Oregon.

Jolley, J.C., G.S. Silver, and T.A. Whitesel. 2011a. Occurrence, detection, and habitat use of larval lamprey in Columbia River mainstem environments: The lower Columbia River. 2010 Annual Report. U.S. Fish and Wildlife Service Columbia River Fisheries Program Office, Vancouver, WA.

Jolley, J.C., G.S. Silver, and T.A. Whitesel. 2011b. Occurrence, detection, and habitat use of larval lamprey in Columbia River mainstem environments: Bonneville reservoir and tailwater. 2010 Annual Report. U.S. Fish and Wildlife Service Columbia River Fisheries Program Office, Vancouver, WA.

Jolley, J.C., G.S. Silver, and T.A. Whitesel. 2012. Occupancy, detection, and habitat use of larval lamprey in Columbia River mainstem environments: Bonneville tailwater and tributary mouths. 2011 Annual Report. U.S. Fish and Wildlife Service Columbia River Fisheries Program Office, Vancouver, WA.

Keefer, M. L., W. R. Daigle, C. A. Peery, H. T. Pennington, S. R. Lee, and M. L. Moser. 2010. Testing adult Pacific lamprey performance at structural challenges in fishways. North American Journal of Fisheries Management 30: 376–385.

Kostow, K. 2002. Oregon Lampreys: Natural History Status and Analysis of Management Issues. Oregon Department of Fish and Wildlife. Salem, OR.

Lawrence, D.J., B. Stewart-Koster, J.D. Olden, A.S. Ruesch, C.E. Torgersen, J.J. Lawler, and J.K. Crown . 2014. The interactive effects of climate change, riparian management, and a nonnative predator on stream-rearing salmon. Ecological Applications 24(4), 895-912.

LCFRB (Lower Columbia Fish Recovery Board). 2010. Washington Lower Columbia Salmon Recovery and Fish & Wildlife Subbasin Plan. LCFRB, Longview, WA.

Luzier, C.W., H.A. Schaller, J.K. Brostrom, C. Cook-Tabor, D.H. Goodman, R.D. Nelle, K. Ostrand and B. Streif. 2011. Pacific Lamprey (Entosphenus tridentatus) Assessment and Template for Conservation Measures. U.S. Fish and Wildlife Service, Portland, Oregon. 282 p., http://www.fws.gov/columbiariver/publications.html.

Madson, P.L., B.K. van der Leeuw, K.M. Gibbons, and T.H. Van Develingen. 2017. Evaluation of pinniped predation on adult salmonids and other fish in the Bonneville Dam tailrace, 2016. U.S. Army Corps of Engineers, Bonneville Lock and Dam, Cascade Locks, Oregon.

Maitland, P.S., C.S. Renaud, B.R. Quintella, D.A. Close. Conservation of native lampreys. In: Docker M.F. editor. Lampreys: biology, conservation and control, fish & fisheries series 37. Dordrecht: Springer; 2015. p. 376–428.

McGrath K.E., E.M. Dawley, and D.R. Geist. 2006. Total Dissolved Gas Effects of Fishes of the Lower Columbia River. Pacific Northwest National Laboratory final report to the U.S. Army Corps of Engineers, Contract DE-AC05-76RL01830, Portland, Oregon.

Mesa, M. G., J. M. Bayer, and J. G. Seelye. 2003. Swimming performance and physiological responses to exhaustive exercise in radio-tagged and untagged Pacific lampreys. Transactions of the American Fisheries Society 132:483–492.

Moser, M. L., P. A. Ocker, L. C. Stuehrenberg, and T. C. Bjornn. 2002. Passage efficiency of adult Pacific lampreys at hydropower dams on the lower Columbia River, U.S.A. Transactions of the American Fisheries Society 131: 956–965.

Mueller, R.P., C.L. Rakowski, W.A. Perkins, and M.C. Richmond. 2015. Assessment of fluctuating reservoir elevations using hydraulic models and impacts on larval Pacific Lamprey rearing habitat in the Bonneville Pool. PNNL-23876, final report submitted to the U.S. Army Corps of Engineers, Portland District, Portland, Oregon, by Pacific Northwest National Laboratory, Richland, Washington.

Naik, P.K., and D.A. Jay. 2011. Distinguishing human and climate influences on the Columbia River: Changes in mean flow and sediment transport. Journal of Hydrology 404: 259-277.

Nilsen, E.B., W.B. Hapke, B. McIlraith, and D. Markovchick. 2015. Reconnaissance of contaminants in larval Pacific lamprey (*Entosphenus tridentatus*) tissues and habitats in the Columbia River Basin, Oregon and Washington, USA. Environmental Pollution 201, 121-130.

Schneider, M.L., and K. Barko. 2006. Total Dissolved Gas Characterization of the Lower Columbia River below Bonneville Dam. Draft report to US Army Engineer District (Portland, OR) by US Army Corps of Engineers, Dallesport, WA.

Silver, G.S. 2015. Investigations of larval Pacific lamprey *Entosphenus tridentatus* osmotic stress tolerance and occurrence in a tidally-influenced estuarine stream. Master's thesis, Portland State University, Portland.

Stillwater Sciences. 2014. Evaluation of barriers to Pacific Lamprey migration in the Eel River basin. Prepared by Stillwater Sciences, Arcata, California for Wiyot Tribe, Loleta, CA.

USACE (U.S. Army Corps of Engineers). 2016. Annual fish passage report, Columbia and Snake rivers for salmon, steelhead, shad, and lamprey. Northwestern Division, U.S. Army Corps of Engineers, Portland and Walla Walla.

Ward, D.L. 2001. Lamprey Harvest at Willamette Falls, 2001. Oregon Department of Fish and Wildlife, Clackamas, Oregon.

Zorich, N.A., M.R. Jonas, and P.L. Madson. 2011. Avian predation at John Day and The Dalles Dams 2010: Estimated fish consumption using direct observation with diet analysis. U.S. Army Corps of Engineers, CENWP-OD-TFF 45 p.

Appendix A: List of most major tributaries within the Lower Columbia Sub-Unit.

Lower Columbia-Sandy	Lewis	Upper Cowlitz	Lower Cowlitz	Lower Col-Clatskanie	Lower Columbia
Beaver Creek	Cedar Creek	N/A	Arkansas Creek	Abernathy Creek	Bear Creek
Boulder Creek	Chelatchie Creek		Blue Creek	Beaver Creek	Big Creek
Bull Run River	EF Lewis River		Campbell Cr.	Beaver Dredge Cut	Chinook River
Campen Creek	Lewis River		Coweeman River	Carcus Creek	Columbia River
Cast Creek	Lockwood Creek		Cowlitz River	Clatskanie River	Ferris Creek
Cedar Creek	NF Chelatchie Cr.		Delameter Creek	Columbia River	Gnat Creek
Cheeney Creek	Rock Creek		King Creek	Conyers Creek	Grays River
Clear Creek			Lacamas Creek	Elochoman River	Hillcrest Creek
Clear Fork			Leckler Creek	Germany Creek	Klaskanine River
Columbia River			Monahan Creek	Gobar Creek	Lewis And Clark River
Copper Creek			NF Toutle River	Kalama River	Little Bear Creek
Gibbons Creek			Olequa Creek	Mill Creek	Little Creek
Gordon Creek			Ostrander Creek	Miller Creek	Mill Creek
Hardy Creek			Salmon Creek	Plympton Creek	NF Klaskanine River
Little Clear Creek			SF Ostrander Cr.	West Creek	Rock Creek
Lost Creek			Stillwater Creek	West Creek	Shweeash Creek
Minikahda Creek			Toutle River	Westport Slough	SF Klaskanine River
Muddy Fork					Wallooskee River
Salmon River					West Fork Grays River
Sandy River					Youngs Bay
South Fork Salmon R.					Youngs River
Still Creek					
Washougal River					
Zigzag River					