Pacific Lamprey
2018 Regional Implementation Plan
for the
Lower Columbia/Willamette
Regional Management Unit
Lower Columbia Sub-Unit

Submitted to the Conservation Team August 6th, 2018

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

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I. Status and Distribution of Pacific lamprey in the RMU

A. General Description of the RMU

The Lower Columbia River sub-unit within the Lower Columbia River/Willamette Regional Management Unit includes watersheds that drain into the Columbia River mainstem from Bonneville Dam at Rkm 235, west to confluence of the Columbia River with the Pacific Ocean. It is comprised of six 4th field HUCs ranging in size from 1,753−3,756 km^2 (Table 1). Watersheds within the Lower Columbia River sub-unit include the Lower Columbia-Sandy, Lewis, Upper and Lower Cowlitz, Lower Columbia-Clatskanie, and Lower Columbia River (Figure 1).

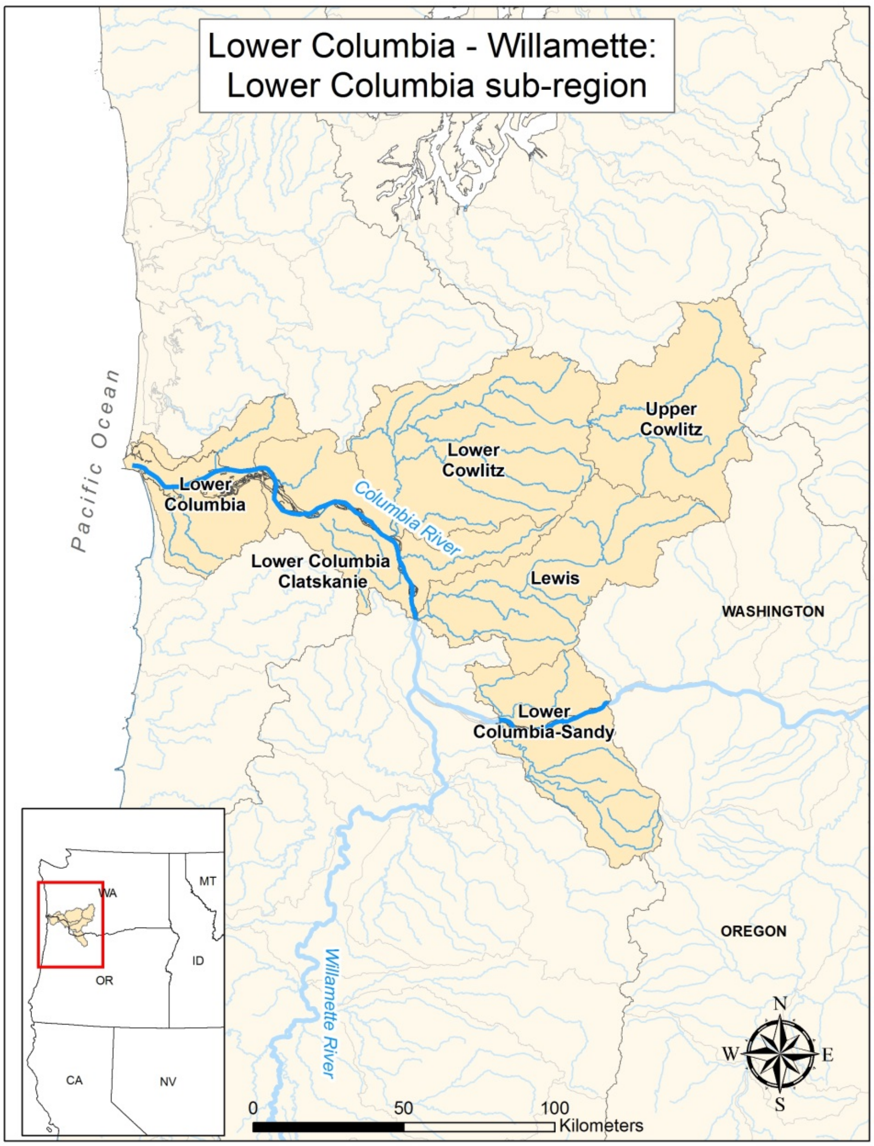

Figure 1. Map of watersheds within the Lower Columbia/Willamette RMU, Lower Columbia sub-unit.

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 greatly reduced from historical range (Table 2). The revised Risk Assessment ranking of current distribution was reduced in all HUCs in 2017. The decline in these areas is a result of more accurately calculating the numeric area of occupancy (versus using a visual estimate), rather than a decline in Pacific Lamprey range. Overall, 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). Adult Pacific Lamprey abundance is currently unknown in the Lewis and Lower Cowlitz HUCs, and 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 upper Cowlitz basin.

Short-term population trend (defined as the degree of change in population size over 3 lamprey generations or 27 years), 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 30,600 fish (USACE 2017). Historical 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 historical 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. Population demographic and conservation status ranks (see Appendix 1) of the 4th Field HUC watersheds located within the Lower Columbia sub-unit. Note – steelhead intrinsic potential was used as a surrogate estimate of historical lamprey range extent in areas where historical occupancy information was not available. Ranks highlighted in yellow indicate a change from the 2011 Assessment.

Watershed	HUC Number	Conservation Status Rank	Historical Occupancy (km^2)	Current Occupancy (km^2)	Population Size (adults)	Short-Term Trend (% decline)
Lower Columbia-Sandy	17080001	S2	1000-5000	100-500	50-1000	Unknown
Lewis	17080002	S1↓	250-1000	100-500	Unknown	Unknown
Upper Cowlitz	17080004	SH	1000-5000	Zero	Zero	Unknown
Lower Cowlitz	17080005	S2	1000-5000	100-500	Unknown	Unknown
Lower Columbia-Clatskanie	17080003	S1S2↓	1000-5000	100-500	250-2500	Unknown
Lower Columbia	17080006	S2	1000-5000	100-500	250-2500	Unknown

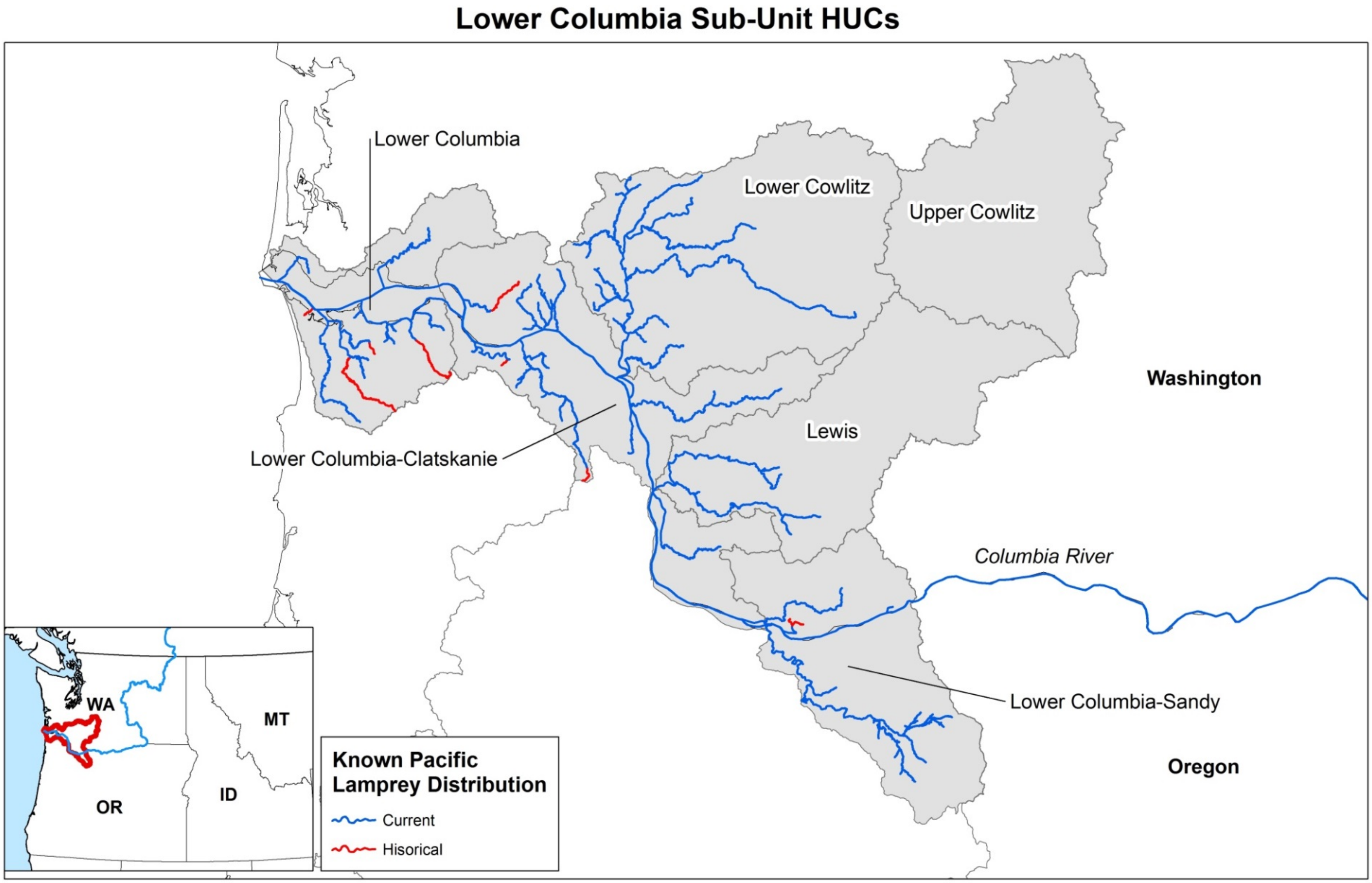

Figure 2. Current and historical known distribution for Pacific Lamprey: Lower Columbia/Willamette Regional Management Unit, Lower Columbia sub-unit (USFWS Data Clearinghouse 2017). Historical Pacific Lamprey distribution depicted in map was obtained from published literature, tribal accounts and state and federal agency records.

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 dam 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.

C. Threats

Summary of Major Threats

The following table summarizes the known key threats (i.e., score ≥2.50) 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 historical 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 historical 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 were initiated or recently completed by RMU partners in the Lower Columbia sub-unit from 2012-2017.

HUC	Threat	Action Description	Type	Status
RMU	Population	Environmental DNA, spawning ground surveys, smolt trapping and occupancy sampling to better understand lamprey distribution.	Survey	Ongoing
RMU	Stream Degradation	Implementation of instream and floodplain habitat restoration activities.	Instream	Ongoing
RMU	Passage	Evaluation of adult Pacific Lamprey passage efficacy at fishways and barrier dams associated with salmon hatcheries.	Assessment	Underway
RMU	Population	Distribution surveys of mainstem and principal tributaries	Survey	Ongoing
RMU	Population	Use of eDNA to monitor effectiveness of large wood placement projects and recolonization of larval lamprey following restoration	Assessment	Proposed/ Underway
RMU	Lack of Awareness	Consideration of lamprey when planning and implementing instream habitat restoration work	Coordination	Ongoing
RMU	Passage	Map, assess and prioritize passage barriers in tributaries and evaluate available lamprey habitat upstream	Assessment	Proposed
Sandy	Stream Degradation	Sandy River floodplain reconnection, gravel augmentation in Bull Run River.	Instream	Complete
Sandy	Stream Degradation	Large wood augmentation, side channel reconnection in upper Sandy River.	Instream	Complete
Clatskanie	Population	Conduct adult spawning ground surveys to monitor Pacific Lamprey distribution, timing, and number of redds to develop relative abundance indexes.	Survey	Ongoing
Clatskanie	Population	Deep water sampling to document distribution and habitat use of larval lamprey in Columbia River mainstem.	Assessment	Complete
Clatskanie	Passage	Tide gate and culvert modification and removal projects to restore access to spawning and rearing habitat.	Instream	Ongoing
Lower Columbia	Passage	Evaluation of passage constraints for lamprey at Big Creek and North Fork Klaskanine Hatchery diversions	Instream	Proposed
Lower Columbia	Population	Conduct adult spawning ground surveys to monitor Pacific Lamprey distribution,	Survey	Ongoing

		timing, and number of redds to develop relative abundance indexes.		
Lower Columbia	Passage	Tide gate and culvert modification and removal projects to restore access to spawning and rearing habitat.	Instream	Ongoing
Lower Columbia	Population	Investigation of salinity tolerance and larval lamprey occurrence in tidally influenced estuarine stream.	Assessment	Complete

II. Selection of Priority Actions

A. Prioritization Process

Participating members of the Lower Columbia sub-unit met in Vancouver, Washington in May 2018 to discuss completed and ongoing conservation actions and identify specific projects and research needed to address threats and uncertainties within the region. The following projects were submitted by RMU members for the Lower Columbia sub-unit Regional Implementation Plan in 2018:

- Southwest Washington Adult/Juvenile Lamprey Abundance Data Summary
- Evaluation of Salmonid Habitat Restoration and a Salmonid Electronic Weir on Larval Lamprey Presence and Abundance
- Pacific Lamprey Passage Assessments of Fish Hatchery Fishways and Barrier Dams in the Lower Columbia Regional Management Unit.

B. High Priority Proposed Project Information

Project Title: **Southwest Washington Adult/Juvenile Lamprey Abundance Data Summary**

Project Applicant/Organization: Washington Department of Fish and Wildlife (WDFW)
Contact: Tom Wadsworth
Email: Thomas.Wadsworth@dfw.wa.gov
Phone: 360-906-6709

Project Location: Tributaries to the Columbia River in Southwest Washington State

NPCC Subbasin (4th HUC Field) name: Lower Columbia-Sandy, Lewis, Lower Cowlitz, Lower Columbia, and Lower Col-Clatskanie
Watershed (5th HUC Field): Cedar Creek, EF Lewis, Coweeman River, Cowlitz River, Chinook River, Grays River, Toutle River, Elochoman River, Skamokawa Creek, Chinook Green River, Kalama River, Mill Cr., Abernathy Cr., Germany Cr., Washougal River, Hardy Creek
Lamprey RMU population: Lower Columbia sub-unit

HUC4 Risk Level: Lower Columbia-Sandy (S2), Lewis (S1), Lower Cowlitz (S2), Lower Columbia-Clatskanie (S1S2) and Lower Columbia (S2)

Requested funds: $15,622

Short Project Description:

For many years WDFW has counted adult and juvenile lamprey during annual monitoring of salmon and steelhead in most southwest Washington tributaries to the Columbia River. These data have not been examined and in some data have not been digitized in a database. WDFW staff are not currently funded to examine or report on lamprey data in this area and without additional funds will not be able to supply data to ongoing assessments of the Lower Columbia lamprey sub-unit. Funds requested through this proposal would support WDFW Region 5 staff to digitize, examine and report on all available lamprey data collected by WDFW in this area.

1.0 Detailed Project Description

Data have been collected on Pacific Lamprey and other lamprey species during various WDFW monitoring programs and projects. Annual stream surveys designed to count winter steelhead in southwest Washington tributaries to the Columbia River have also produced counts of lamprey redds and live adult lamprey, as the spawn timing often overlaps for winter steelhead and lamprey in these areas. Additionally, WDFW operates smolt traps to estimate outmigrating anadromous salmonids in several Columbia River tributaries, during which incidentally captured juvenile lamprey are counted. Lastly, there are other WDFW projects that have encountered lamprey over the years, which we can summarize and evaluate as potential methods of estimating lamprey populations (e.g., electrofishing surveys, snorkel surveys, etc.). Requested funds would be used to support WDFW staff to: (1) digitize and summarize available WDFW adult and juvenile data; (2) produce a time-series of available count data by watershed, life-stage and species; and (3) produce a report that includes data collection methodologies throughout the time-series, tables and/or figures showing trends by watershed as appropriate, current data gaps, and recommendations for improving data collection. These results could be directly used in future lamprey assessments for these watersheds. The results will also help guide future monitoring and research efforts.

2.0 Regional Priorities: Linkage of actions to Identified Threats

- What threat(s) does this project address?

1. Dewatering and Flow Management, 2. Passage, 3. Stream and Floodplain Degradation, and 4. Water Quality

- How does this project address this key threat(s)?

Identifying spatial and temporal distribution of lamprey at juvenile and adult life stages throughout southwest Washington will help inform an analysis of threat impacts throughout this RMU.

- Does this project address a threat(s) specific only to this RMU or does the project address the threat(s) for multiple RMUs?

Only this RMU.

3.0 Project Goals/Objectives and Species/Habitat Benefits:

- What life stage or stages will benefit from action? How?

The project will benefit juvenile and adult lamprey in the watersheds where data have been collected by enhancing current population assessments and informing restoration and management needs.

- What other species may benefit from action?

Unknown.

- How will the project provide meaningful measureable results to improve lamprey populations and/or their habitat conditions?

The project will improve our understanding of the distribution and abundance of lamprey species in southwest Washington, thereby improving our current population assessments and informing prioritization of future restoration and management needs.

4.0 Project Design / Feasibility

- Have the designs for the project been completed already or will they be completed before planned project implementation?

Yes.

- Are the appropriate permits (ESA and environmental compliance) in place already or will they be in place before planned project implementation?

No permits are needed.

- Can the project be implemented within the defined time frame?

Yes.

5.0 Partner Engagement and Support:

- What partners are supporting the project?

USFWS.

- What partners are active in implementing the project?

None.

- What partners are providing matching funds or in-kind services that directly contribute to the project?

None.

6.0 Monitoring and Evaluation – Contribution to Knowledge Gaps:

- If this is a monitoring or evaluation project or an on the ground project with a monitoring or evaluation component:
    - Is there a monitoring framework in the proposal?

Currently, we are not proposing a monitoring framework; however, results from this project may help develop a WDFW monitoring framework focused on southwest Washington lamprey populations in the future.

- <u>Does the monitoring framework provide clear objectives and measureable metrics that can be observed over time?</u>

  We are not currently proposing a monitoring framework; however, the results of this project will inform the objectives and measureable metrics of a potential future monitoring framework.

- <u>If this is an on the ground project without a monitoring or evaluation component:</u>
  - <u>How is completion of the project going to be documented?</u>

    A report would be completed as described in Section 1.0.

7.0 Budget and Timelines

Project Budget

Category	Description	Months	Total
Personnel	WDFW Scientific Technician 3	2	11,679
	WDFW Information Technology Specialist 2	0.5	3,743
Supplies	Paper, pens etc.		200
Total			15,622

Project Timeline

Proposed project tasks would be completed by May 30, 2019 assuming funding is available by March 1, 2019

Project Title: Evaluation of salmonid habitat restoration and a salmonid electronic weir on larval lamprey presence and abundance

Project Applicant/Organization: U.S. Fish and Wildlife Service
Contact: Benjamen Kennedy
Email: benjamen_kennedy@fws.gov
Phone: 360-425-6072 ext. 332

Project Location: Abernathy Creek, Washington

NPCC Subbasin (4th HUC Field) name: Lower Columbia-Clatskanie (#17080003)
Watershed (5th HUC Field): Abernathy Creek Watershed (#1708000304)
Lamprey RMU population: (Lower Columbia sub-unit)

HUC4 Risk Level: Lower Columbia-Clatskanie (S1S2)

Requested funds: $29,990

Short Project Description:

Threats to Pacific salmonid and lamprey populations include stream and floodplain degradation (Clemens et al. 2017). Although much habitat restoration is being implemented for salmonids, little empirical data exist on if lamprey populations also benefit (Gonzalez et al. 2017). We propose to evaluate larval lamprey presence and abundance in areas that have seen recent salmonid habitat restoration measures versus areas that have not seen treatment. The objective is to add to the knowledge gap of limiting freshwater habitat and evaluate if salmonid habitat restoration techniques are positively addressing lamprey limiting habitat.

Additionally, passage barriers are a major threat to lamprey populations (Clemens et al. 2017). This study will take place on Abernathy Creek which has been the site of an electric weir located at Abernathy Fish Technology Center. This weir is used in the collection of adult steelhead and has been in operation for 13 years from mid-November through mid-June. Our study design will allow us to measure presence and abundance of larval lamprey above and below the weir facilities. This will evaluate is the weir is negatively affecting the lamprey population.

1.0 Detailed Project Description

Study design

A nested sampling design will be used to examine larval lamprey presence and abundance at two spatial scales (within and among sites; Armitage and Cannan 1998; Togersen and Close 2004). Additionally, lamprey abundance will be compared below and above Abernathy's electric weir and fish ladder adult steelhead trapping facilities (rkm 5). Eight sites along Abernathy Creek will be sampled during base flow conditions when habitat may be most limiting. Four sites will be below Abernathy Fish Technology Center and four sites will be above the Center. Of the four sites below the Center two will be in salmonid restoration areas and two will be in non-restoration areas. Of the four sites above the Center, two will be in restoration areas and two will be in non-restoration areas.

Each site will be made up of two riffle-pool combinations. Each site will be divided into preferred (Type I), acceptable (Type II), and unacceptable (Type III) habitat types (Moser et al 2007; Mullett and Bergstedt 2003; Slade et al. 2003). Five 1 m^2 subsamples from each habitat type will be randomly selected for sampling.

Field sampling

Lamprey will be collected from each 1 m^2 subsample via lamprey specific electrofishing methods (Dunham et al. 2013). Abundance will be determined using 70% depletion estimation methods (Stone and Barndt 2005). Captured lamprey will be measured and weighed. Lamprey over 60 mm will be identified between *Entoshenus* and *Lampetra* using methods described by Goodman et al. (2009).

For each subsample location a multitude of habitat variables will be measured. These variables include water depth, organic depth, water velocity, channel unit type, substrate size, habitat type (I, II, or III), channel position (margin or mid-channel), wetted width, canopy closure, pH, rkm and water temperature.

Data analyses

For each larval lamprey species, presence and absence among sites and habitat variables will be evaluated using logistic regression. Larval abundance among sites and habitat variables will be evaluated using linear regression. For each type of regression a set of candidate models in an information-theoretic approach using Akaike's information criterion (AIC) will be simultaneously ranked to determine the best approximating model (Burnham and Anderson 2002).

Additionally, once lamprey abundance and habitat relationships are determined. This data can be linked with the IMW's extensive habitat monitoring data to evaluate how habitat restoration changes have influenced larval lamprey population throughout Abernathy Creek as well as compare to two similar nearby creeks that have received little (Germany Creek) or no habitat restoration work.

2.0 Regional Priorities: Linkage of actions to Identified Threats

- What threat(s) does this project address?

Larval lampreys depend on areas of fine sediments to live and feed. 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. Also, this project will address the impact of an electric weir.

- How does this project address this key threat(s)?

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 (https://wdfw.wa.gov/publications/01398/;
https://www.lcfrb.gen.wa.us/libraryimwcomplex).
This knowledge on habitat use can then be used in future salmon habitat restoration planning to maximize benefits to lamprey populations. Additionally, if the electric weir is found to impact lamprey distribution, operation modifications or timing may be adjusted to benefit lamprey passage.

- Does this project address a threat(s) specific only to this RMU or does the project address the threat(s) for multiple RMUs?

This project addresses habitat threats that are important across the entire distribution of lamprey. Additionally, knowledge of the passage impact of an electric weir may be used in the planning or cancelation of electric weirs planned in the future.

3.0 Project Goals/Objectives and Species/Habitat Benefits:

- What life stage or stages will benefit from action? How?

Lamprey ammocoetes and macropthalmia will benefit most from this study as knowledge leading to better habitat restoration practices should lead to better survival and higher larval lamprey abundance. This in turn should lead to higher adult abundance.

- What other species may benefit from action?

Multiple species that feed on lampreys including, birds, seals, sea lions, etc. should benefit from increased numbers of lamprey.

4.0 Project Design / Feasibility

- Have the designs for the project been completed already or will they be completed before planned project implementation?

Habitat restoration work has been completed.

- Are the appropriate permits (ESA and environmental compliance) in place already or will they be in place before planned project implementation?

Appropriate permits for habitat work were completed. A Washington Department of Fish and Wildlife Scientific Collection Permit and NOAA section 10 permit will be obtained prior to fish sampling.

- Can the project be implemented within the defined time frame?

Yes.

5.0 Partner Engagement and Support:

- What partners are supporting the project?

Washington Department of Fish and Wildlife, Washington Department of Natural Resources, Cowlitz Tribe, Interfluve, Lower Columbia Fish Recovery Board.

- What partners are active in implementing the project?

Washington Department of Fish and Wildlife, Washington Department of Natural Resources, Cowlitz Tribe, Interfluve, Lower Columbia Fish Recovery Board.

- What partners are providing matching funds or in-kind services that directly contribute to the project?

Partners have completed over 8 km of instream and off-channel habitat restoration as well as over 32,000 m^2 of riparian area restoration. Activities have included increasing instream habitat complexity, off-channel reconnection, floodplain reconnection, fish passage, riparian planting, and bank stabilization.

6.0 Monitoring and Evaluation – Contribution to Knowledge Gaps:

- If this is a monitoring or evaluation project or an on the ground project with a monitoring or evaluation component:
    - Is there a monitoring framework in the proposal?

      There is currently no monitoring framework for lamprey associated with these habitat restoration projects. However, this study can add to current knowledge gaps and be used as a tool for future monitoring frameworks in this watershed as well as many others.

- If this is an on the ground project without a monitoring or evaluation component:
    - How is completion of the project going to be documented?

      Project results will be presented in report and/or peer reviewed journal article.

7.0 Budget and Timelines

Benjamen Kennedy, US Fish and Wildlife Service (06 11 2018)	Quantity	Unit	Unit Cost	Cost (dollars)
Proposed Budget: Evaluation of stream and floodplain restoration on lamprey habit				
Fish Biologist (GS 11/7)** - (Project leader)	346	hrs.	$ 37.38	$ 12,933
BioTech (GS-5/5)** - (Field Technician)	160	hrs.	$ 19.26	$ 3,082
		Subtotal regular		**$ 16,015**
		Benefi	**$ 0.35**	$ 5,605
*** rates based OPM salary table 2018-POR*				
B. Equipment and Supplies				**$ -**
Electrofishing and habitat measuring gear and supplies			in kind	$ -
C. Travel				**$ -**
Gas			in kind	$ -
D. Administration/Indirect Costs				**$ 8,369**
AFTC administrative costs @ 10% [10% × subtotal (A+B+C)]				$ 2,162
US Fish & Wildlife indirect costs @ 26.1% [26.1% x (10% AFTC admin cost + A+B+C)]				$ 6,207
E. Total AFTC budget				**$ 29,990**

Timeline

Study preparation January-June 2019
Field work July-September 2019
Data analyses and report writing October 2019-March 2020

8.0 References

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Project Title: Pacific Lamprey Passage Assessments of Fish Hatchery Fishways and Barrier Dams in the Lower Columbia Regional Management Unit.

Project Applicant/Organization: U.S. Fish & Wildlife Service, Columbia River Fish and Wildlife Conservation Office, Vancouver, WA
Contact: Joe Skalicky
Email: joe_skalicky@fws.gov
Phone: 360-604-2544

Landowner Organization/Contact Person**:** ODFW, WDFW, USFWS and private parties

Project Location: Lower Columbia River tributary hatcheries including: State, Federal and private parties.

NPCC Subbasin (4th HUC Field) name: Lower Columbia, Lower Columbia-Clatskanie, Lower Cowlitz, Lewis, and Lower Columbia-Sandy
Watershed (5th HUC Field): Varies
Lamprey RMU population: Lower Columbia sub-unit

HUC4 Risk Level: Lower Columbia (S2), Lower Columbia-Clatskanie (S1S2), Lower Cowlitz (S2), Lewis (S1) and Lower Columbia-Sandy (S2)

Requested funds: $28,760

Short Project Description:

In the 1900s, over 200 fish hatcheries were built in the Columbia River Basin to mitigate for significant declines in salmonid populations. Unfortunately, these hatcheries were only designed to primarily pass adult salmonids upstream, which can significantly limit or prelude passage for many other species, including Pacific Lamprey. In extreme cases, some hatcheries completely preclude any fish passage upstream to reduce pathogens loads (Berg and Nelson 2003). The entirety of the problem is only now becoming apparent as evidenced in work we conducted in 2018 at three hatcheries in the Lower Columbia Regional Management Unit (RMU), which were all found to be major barriers to Pacific Lamprey (CRFWCO 2018, unpublished data).

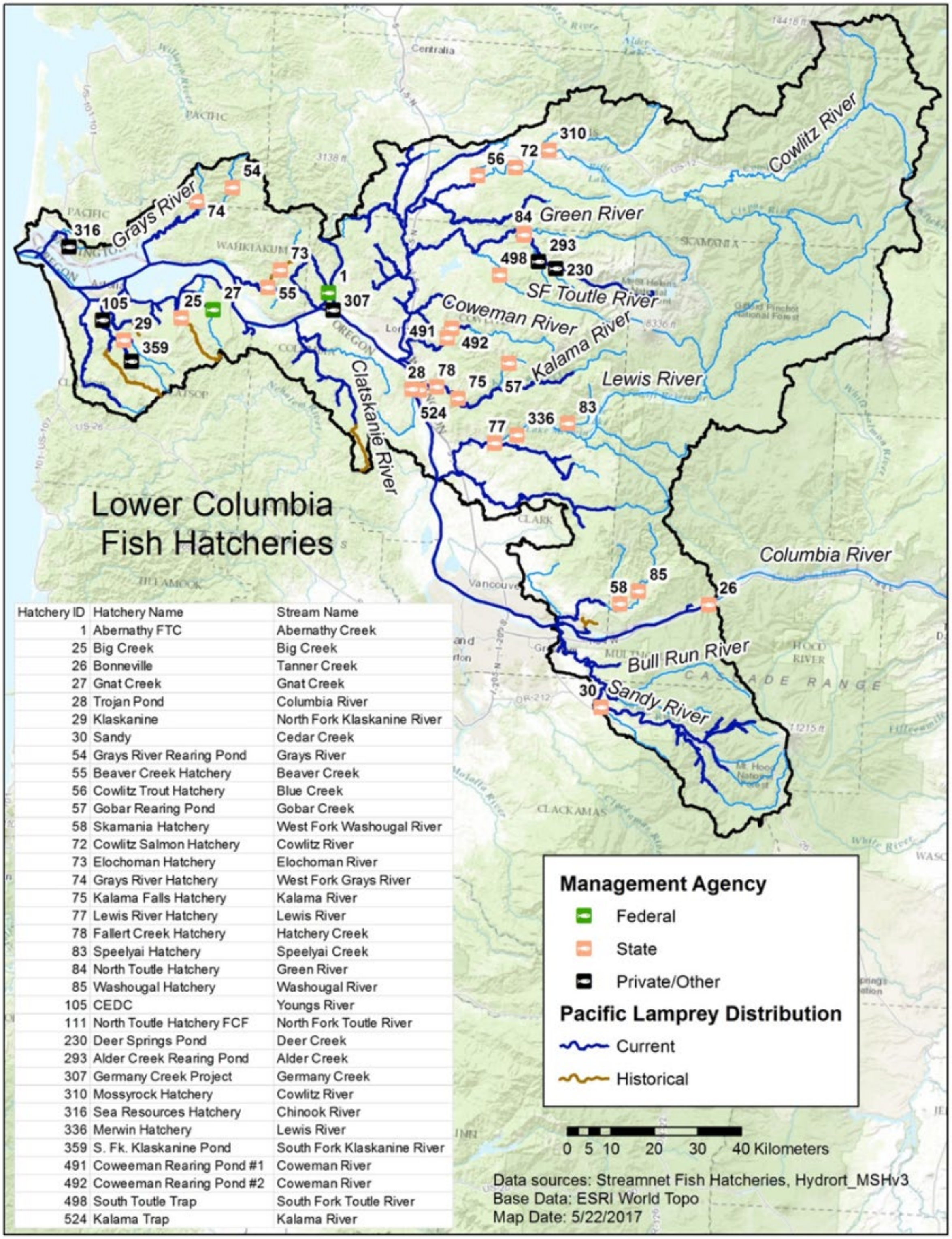
Throughout the Lower Columbia River RMU, there are 15 adult salmon hatcheries on tributaries to the Columbia River between the Pacific Ocean and Bonneville Dam. Most of these hatcheries use one or even multiple barrier dams and fishways to convey adult salmon into the hatchery proper and to pond up water for gravity feed water delivery systems. Many of these structures could be significant barriers to adult Pacific Lamprey and other native species returning to spawn upstream. The 12 unevaluated hatcheries may limit or delay upstream adult passage posing a significant threat to access of spawning habitat. In addition, Berg and Nelson (2003) in 2002 found that of seven hatcheries evaluated on the Washington side of the RMU, most failed to meet adult salmon passage criteria.

The scope and severity of specific passage threats will be assessed at each of the hatchery structures affecting upstream passage of adult Pacific Lamprey. We will not be evaluating downstream passage of ammocoetes and macropthalmia past the hatcheries. Throughout the Columbia River Basin fish hatcheries and their associated passage structures have not been considered barriers to lamprey. However, when specific passage issues are identified, hatchery structures could be modified to facilitate passage by adding simple metal ramps, cutting orifices through weirs, rounding corners over barrier dams, constructing a Lamprey Passage Device (LPS), adding eel tiles or other solutions depending on the specific problem identified.

The project will continue to evaluate Pacific Lamprey passage at hatcheries in other RMUs. With the completed hatchery evaluations within the Lower Columbia River RMU as a template, we propose to complete hatchery evaluation within one RMU each year, depending on the number of hatcheries and structures that need to be assessed and available funding.

Descriptive Photographs-illustrations-Maps:

A lamprey (eel) tile used to facilitate passage of anguilliform swimming lamprey over a barrier dam in a European river. This is a simple and cost effective solution to provide adult lamprey passage.



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

Fish hatcheries and rearing facilities located in Lower Columbia RMU. Not all of these facilities listed are suitable for a passage assessment as some are rearing facilities only.

Barrier dam evaluated in 2018 at Big Creek Hatchery in the Lower Columbia RMU. With five 90 degree angles, the dam is likely a significant barrier to lamprey migrating upstream. Big Creek and many of the hatcheries in the RMU use multiple dams at single hatchery to facilitate operations, with each dam and fishway having its own unique set of passage issues.

Fishway exit evaluated in 2018 that is adjacent to the barrier dam at Big Creek Hatchery. The fishway only functions at higher flows and the both the entrance and exit have two foot jumps and all structures have 90 degree angles. Together, both the barrier dam and associated fishway may significantly limit or delay upstream passage.

Barrier Dam at Klaskanine Fish Hatchery photographed July 13, 2018. Note that there is no flow over the barrier dam as all water is diverted through the hatchery resulting in no possible passage during lower flows.

1.0 __Detailed Project Description__

Goal– Broad goals are to 1) Identify and assess fishways, dams and related passage structures that may significantly delay or limit passage of adult Pacific Lamprey in the Lower Columbia RMU; 2) Provide a practical technical reference on how to accommodate retrofits of existing structures for persons designing, operating, managing and maintaining fish fishways, dams and related structures and how to best conduct additional studies.

Objective 1. Conduct a broad review of water bodies with fish hatcheries in the Lower Columbia River using current distribution and barrier data to prioritize hatcheries that could be limiting passage.

Objective 2. Conduct Pacific Lamprey specific passage assessments at hatcheries identified in Obj. 1.

Approach (Obj. 1 & 2) For the 12 remaining unevaluated hatcheries in the Lower Columbia RMU, we will conduct a systematic passage assessment of all structures potentially affecting adult lamprey passage. Hatchery locations have been plotted in our GIS and as available, other explanatory metrics will be uploaded including: current and historical lamprey distribution, redd locations, natural and manmade passage barriers, miles of habitat above hatchery and any other informative data. If a natural barrier such as a substantial water fall is just upstream of the hatchery, it may not be evaluated. For the actual fishway assessments, we will use the Pacific Lamprey passage guidelines that have recently been published (PLTW 2017) as well as a comprehensive "Pacific Lamprey Fishway Inspection Checklist" that we developed based on the new guidelines. The checklist is attached at the end of this document.

Field Protocol: At each hatchery, a team of experienced biologists will conduct initial reconnaissance surveys to meet with hatchery personnel and assess the fascility to determine specific equipment needs such as scaffolding and required safety equipement. For the hatchery evaluation, we will assess each stucuture using survey equipment to measure physical structures and head differentials as well a velocity meter to measure water velocities. Photographs will be taken of all relevent structures to document their current state. The Pacific Lamprey Fishway Inspection List (attached) will be used at each passage structure and barrier dam.

Data Analysis: All data collected in the field will be tabulated and compared to the current guidelines regarding Pacific Lamprey swimming and climbing abilities. The assessement and recommendations will be summarized in a report accordingly. This projected will use the best available science as summarized in the table below for evaluating Pacific Lamprey passage at hatchery fishways and associated structures. As new science is developed, relevant metrics will be incorporated into our methodology.

Pacific Lamprey swimming abilities and behaviors relative to water velocities (PLTW 2017).

Parameter	Speed	Source
Sustained swimming speed [1]	0.9 m/sec (3.0 fps)	Bell (1991)[4]
Critical swimming speed [2]	0.9 (+/- .075) m/sec 2.8 fps (+/- 0.25) fps)	Mesa et al. (2003) Moser and Mesa (2009) estimate "conservative"
Burst swimming speed [3]	2.1 m/sec (7.0 fps) >80% passage for 2.4 m/sec (7.9 fps) in lab tests- (thus length of sustained burst and presence of turbulence interacts with velocities)	Bell (1991) [4] Kirk et al. (2016)
Free-swimming abilities	<1.2 m/sec "Lamprey more readily moved through sections where water velocity was ≤ 1.2 m/sec (3.9 fps), below the estimated burst swim speed for adults."	Keefer et al. (2011) Keefer et al. (2012)
Barrier: Head differential	Slot entrance with > 0.4 m (1.5 feet) head – may eliminate passage	Keefer et al. (2010)
Behaviorally-lamprey change to burst and attach	>0.6 m/sec (~2.0 fps)	Daigle et al. (2005)

locomotion		
Burst swim speed and burst and attach locomotion exceeded	2.5 - 3.0 m/sec (8.2 - 9.8 fps)	Keefer et al. (2010); Kirk et al. (2016)
Attach and burst locomotion "ineffective"	When velocities exceed burst swim speed (2.1 m/sec (7.0 fps)) or confusing stimuli guide fish to impassable areas	Moser et al. (2009)
Exclusion Grating	Open space ≤ 1.9 cm (0.75 inches) for new migrants entering the Columbia River, as determined at Bonneville Dam. At other locations, reduced gap size is likely needed because lamprey shrink over time. Pacific Lamprey in the upper Columbia Basin, and perhaps other drainages, are probably smaller and could get through this gap size.	Moser et al. (2008) Moser, pers. comm. (2016)
Climbing abilities	Able to climb vertical or near vertical surfaces when appropriate attachment surface is provided, and can use climbing behaviors to move past areas with high velocities.	Reinhardt et al. (2008) Kemp et al. (2009) Moser et al. (2009)

2.0 __Regional Priorities: Linkage of Actions to Identified Threats__

This project directly addresses threats as identified in the Lower Columbia/Willamette Regional Management Unit including: passage, dewatering and flow management and predation. It should also be noted that, based on the evaluations at the three hatcheries assessed in 2018, the rankings for passage; scope and severity in the Lower Columbia RIP are possibly ranked lower than they should be. For example, even though we only assessed 3 of 15 hatcheries, all three had major passage issues for Pacific Lamprey. On our initial site visit, we observed a mink with an adult Pacific Lamprey just below a barrier dam at one of the hatcheries. Sightings of both mink and river otter have been confirmed at two of the three hatcheries. Passage delays and blockages are likely providing feeding stations for these predators. Restoring passage for lamprey at these projects will address all the threats.

3.0 __Project Goals/Objectives and Species/Habitat Benefits:__

This project will provide the data and recommendations required to engineer passage solutions for Pacific Lamprey. It will also greatly improve our understanding of hatcheries as adult passage barriers. There is very little knowledge on this subject and based on the three hatcheries that we assessed in 2018, passage at fish hatcheries is a major problem, especially considering that there are many miles of available habitat upstream. Depending on the technical recommendations and engineered fixes for each hatchery, there is potential that anadromous and resident fishes could benefit along with Pacific Lamprey.

4.0 Project Design / Feasibility

This project is highly feasible and has already been partially initiated in 2018 with evaluations of three hatcheries in the RMU using internal USFWS funds. No funding for 2019 has been identified to complete the evaluations in the RMU. No sampling permits are required when conducting the evaluations and assessment of the 12 remaining hatcheries can be completed in 2019. The CRFWO has the expertise and equipment available to conduct the evaluations.

5.0 Partner Engagement and Support:

Most of the hatcheries are owned and operated by ODWF and WDFW and we have had full support thus far. In 2018, ODFW offered an intern to assist with portions of the field work.

6.0 Monitoring and Evaluation – Contribution to Knowledge Gaps:

This project is a direct evaluation of hatchery passage structures and the resulting recommended engineered fixes to facilitate passage for adult Pacific Lamprey. As passage issues are successively implemented, subsequent monitoring and evaluation of actual passage performance would be warranted. However, not until specific passage issues are identified would we propose monitoring and evaluation. As identified, we would work with the project owners and other entities to identify funding, implement fixes and conduct monitoring and evaluation. The results of monitoring and evaluation could be used to adjust specific passage remedies and inform future passage improvements.

7.0 Budget and Timelines

Items	Weeks	Unit Cost	Requested Funds
Personnel Services			
Project Lead	8	$ 2,150	$ 17,200
Asst. Lead	3.5	$ 1,860	$ 6,510
Services and Supplies	Days	Unit Cost	Requested Funds
Travel Related	8 X 2	$ 175	$ 2,800
Equipment and Supplies			$ 2,250
Administative Overhead (0 %)			$ -
Project Total			$ 28,760

Timeline:

Workflow	Date Completed
Pre-project preparation	February-May 2019
Field Surveys	June-July 2019
Assessment & Reporting	July-September 2019

Literature Cited

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Pacific Lamprey Fishway Inspection Checklist

Hatchery Name: ____________________ Waterway: ____________________

Barrier Name and Number: ____________________

Owner (Organization): ____________________ Date/Time: ____________________

Inspector(s): ____________________

Owner (s) or Rep(s) On-site: ____________________

Comments: ____________________

Fishway Status (current):
- ☐ de-watered/non-operation
- ☐ watered or underwater/non-operational
- ☐ unknown damaged/non-operational
- ☐ watered/operational
- ☐ damaged/operational
- ☐ current since: ____________

Fishway operation period:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

1) Target species for fishway: ____________________

2) U/S migration period:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

3) U/S fish passage design flow: HIGH ________ (cfs) LOW ____ (cfs)

4) D/S migration period:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

5) Drainage & current river flow (if known): ________ (mi^2) ________ (cfs)

6) Temperature and conductivity (if known) ________ (°C) ________ (µs)

7) Is the fishway and dam part of a hydroelectric project? ☐ YES ☐ NO

8) Is there a powerhouse at this location? ☐ YES ☐ NO

Fishway Exit

9) Waterway upstream of the exit is clear of debris? ☐ YES ☐ NO ☐ n/a

10) Headgate and/or headboards are in good condition? ☐ YES ☐ NO ☐ n/a

11) If operational, have headboards been removed or gates raised? ☐ YES ☐ NO ☐ n/a

12) Are adjustable weirs/baffles set to track head water? ☐ YES ☐ NO ☐ n/a

13) Trashrack is in place and clean? ☐ YES ☐ NO ☐ n/a

14) Is a staff gage installed in the fishway exit channel? ☐ YES ☐ NO

15) Is a staff gage installed in the headpond? ☐ YES ☐ NO

16) Differential head between the exit and head pond: ________ (ft)

Comments on exit: ____________________

1

(P) Denotes photo (s) taken

Use a separate datasheet for each barrier

Pacific lamprey Fishway Inspection Checklist based on Pacific lamprey passage guidelines (PLTW 2017) that will be used to assess hatchery structures in the RMU. Page 1 of 5.

Pacific Lamprey Fishway Inspection Checklist

Ladder and Fishway

17) Ladder type: ☐ Vertical Slot ☐ Ice Harbor ☐ Pool & Weir ☐ Denil ☐ Steeppass ☐ Other ______

18) Fishway is free of trash and large woody debris? ☐ YES ☐ NO
19) Was the fishway de-watered during inspection? ☐ YES ☐ NO
20) Concrete walls/floors are free of cracks, erosion, leaks, spalling: ☐ YES ☐ NO
If YES, describe extent and location ______

21) Pools are free of sand, rocks and other material: ☐ YES ☐ NO
If NO, describe accumulations, locations and plan to remove: ______

22) Has the fishway been inspected for damage that created sharp edges, formed wooden splinters, or resulted in new obstacles (in the flow field) that could injure fish? ☐ YES ☐ NO ☐ n/a
Comments: ______

23) Is there a protective grating cover in place and structurally sound? ☐ YES ☐ NO ☐ n/a

24) Representative head and velocity measurements (over weir crest, through vertical slot): describe location and method (e.g., pool or weir number from entrance):

Weir No.	Head (ft)	Velocity (ft/s) (L)	Velocity (ft/s) (R)	Orifice (ft/s)
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

25) Is there volitional passage (i.e. no trap)? ☐ YES ☐ NO
26) Adequate attraction flow? ☐ YES ☐ NO
27) Are bulkhead slots/stop log guides present? ☐ YES ☐ NO
28) Artificial lighting present near entrance? ☐ YES ☐ NO
29) Equipment Used & Comments: ______

30) IF the fishway is operation, is the AWS operating? ☐ YES ☐ NO ☐ n/a
31) AWS flow is driven by: ☐ Gravity ☐ pump

2

(P) Denotes photo (s) taken *Use a separate datasheet for each barrier*

Pacific lamprey Fishway Inspection Checklist, page 2 of 5.

Pacific Lamprey Fishway Inspection Checklist

32) Is the facility equipped for trapping and sorting? ☐ YES ☐ NO ☐ n/a
33) Are picketed leads used for trapping salmon? ☐ YES ☐ NO ☐ n/a
If yes what is the gap size? ________ (in.)
34) Is there a counting house/room at the site? ☐ YES ☐ NO ☐ n/a
35) Is there a CCTV and camera system in use? ☐ YES ☐ NO ☐ n/a

LAMPREY SPECIFIC
36) Have hatchery staff observed adult lamprey in the fishway? ☐ YES ☐ NO ☐ n/a
37) Have hatchery staff observed adult lamprey anywhere at the hatchery? ☐ YES ☐ NO
38) Is the fishway a functional dead-end for Pacific lamprey? ☐ YES ☐ NO
39) Should lamprey be precluded from entering fishway? ☐ YES ☐ NO

Attraction flows and Entrance Conditions: Velocity: (L) ________ (R) ________ (ft/s)
Head differential: ________ (ft)

40) Continues attachment surfaces present near the entrance? ☐ YES ☐ NO ☐ n/a
41) Rounded 3-4" radii corners at entrance ☐ YES ☐ NO ☐ n/a
42) Can flows be reduced at night? ☐ YES ☐ NO ☐ n/a
43) Are corners free of 90 degree angles? ☐ YES ☐ NO ☐ n/a

Ladder (General)
44) Ladder walls generally smooth for lamprey to attach? ☐ YES ☐ NO ☐ n/a
Irregularities should be less than 0.08 inch (2mm)
45) Are low velocity resting areas present? ☐ YES ☐ NO ☐ n/a
Low velocity comments: ________________________________

46) If Orifices are present, do they lack a step or sill? ☐ YES ☐ NO ☐ n/a
Orifice Comments: ________________________________

Add Sketch ________________________________

47) Are ladder corners free of 90 degree angles? ☐ YES ☐ NO
48) Diffuser grating smaller than 0.7 inches to exclude lamprey Size: ________ (in)
49) Are bulkhead slots and gaps present? ☐ YES ☐ NO ☐ n/a
50) Picketed leads present in entrance? spacing ________ (in) ☐ YES ☐ NO ☐ n/a
51) Are Lamprey ever observed in or around the trapping facility? ☐ YES ☐ NO ☐ n/a
52) If wild fish are transported upstream, does this include lamprey? ☐ YES ☐ NO ☐ n/a
53) Predators noted onsite: ________________ ☐ YES ☐ NO
Species: ________________________________

General Ladder Comments: ________________________________

(P) Denotes photo (s) taken *Use a separate datasheet for each barrier*

Pacific lamprey Fishway Inspection Checklist, page 3 of 5. Pages 4 and 5 are for sketches and notes.

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Appendix 1

The following are the definitions for interpreting the NatureServe conservation status ranks in Table 2.

SX Presumed Extirpated.—Species or ecosystem is believed to be extirpated from the jurisdiction (i.e., nation, or state/province). Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered. (= "Regionally Extinct" in IUCN Red List terminology).

SH Possibly Extirpated.—Known from only historical records but still some hope of rediscovery. There is evidence that the species or ecosystem may no longer be present in the jurisdiction, but not enough to state this with certainty. Examples of such evidence include: (1) that a species has not been documented in approximately 20–40 years despite some searching or some evidence of significant habitat loss or degradation; or (2) that a species or ecosystem has been searched for unsuccessfully, but not thoroughly enough to presume that it is no longer present in the jurisdiction.

SU Unrankable. .—Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.

S1 Critically Imperiled.—Critically imperiled in the jurisdiction because of extreme rarity or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the jurisdiction.

S2 Imperiled.—Imperiled in the jurisdiction because of rarity due to very restricted range, very few occurrences, steep declines, or other factors making it very vulnerable to extirpation from the jurisdiction.

S3 Vulnerable.—Vulnerable in the jurisdiction due to a restricted range, relatively few occurrences, recent and widespread declines, or other factors making it vulnerable to extirpation.

S4 Apparently Secure.—Uncommon but not rare; some cause for long-term concern due to declines or other factors.

S5 Secure.—Common, widespread, and abundant in the jurisdiction.