Pacific Lamprey
2018 Regional Implementation Plan
for the
Mid-Columbia
Regional Management Unit

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I. Status and Distribution of Pacific Lamprey in the RMU

A. General Description of the RMU

The Mid-Columbia River Regional Management Unit (RMU) includes watersheds that drain into the Columbia River mainstem from the Walla Walla River at Rkm 507, west to Bonneville Dam at Rkm 235 (Figure 10-1). It is comprised of sixteen 4th field HUCs ranging in size from 1,793−8,158 km^2 (Table 1). Watersheds within in the Mid-Columbia RMU include the Walla Walla, Umatilla, Willow, Middle Columbia-Hood, Klickitat, Upper John Day, North Fork John Day, Middle Fork John Day, Lower John Day, Lower Deschutes, Upper Deschutes, Little Deschutes, Beaver-South Fork, Upper Crooked, Lower Crooked and Trout watersheds (Figure 1).

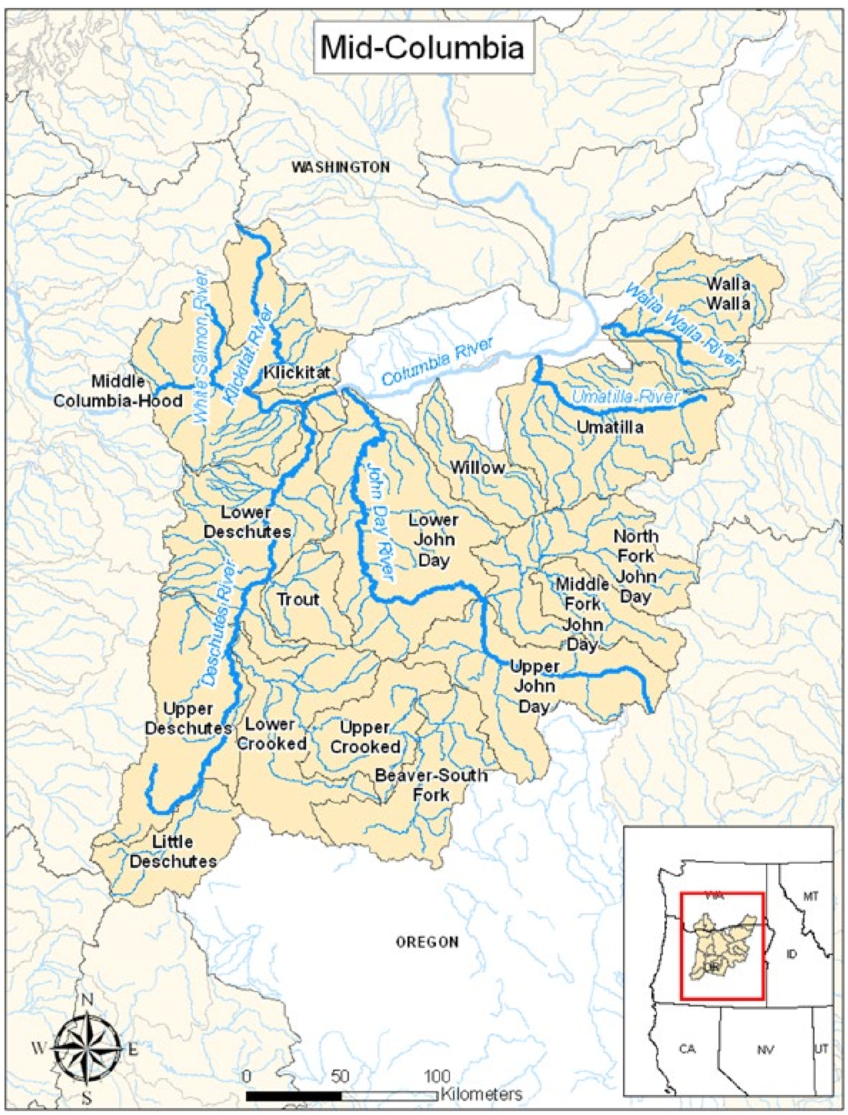

Figure 1. Map of watersheds within the Mid-Columbia Regional Management Unit.

Table 1. Drainage size and Level III Ecoregions of the 4th Field Hydrologic Unit Code (HUC) watersheds located within the Mid-Columbia Region.

Watershed	HUC Number	Drainage Size (km^2)	Level III Ecoregion(s)
Walla Walla	17060102	4,612	Columbia Plateau, Blue Mountains
Umatilla	17060103	6,553	Columbia Plateau, Blue Mountains
Willow	17060104	2,248	Columbia Plateau, Blue Mountains
Mid-Columbia – Hood	17060105	5,587	Cascades, Eastern Cascade Slopes, Columbia Plateau
Klickitat	17060106	3,501	Cascades, Eastern Cascade Slopes, Columbia Plateau
Upper John Day	17070201	5,548	Blue Mountains
North Fork John Day	17070202	4,795	Blue Mountains
Middle Fork John Day	17070203	2,056	Blue Mountains
Lower John Day	17070204	8,158	Columbia Plateau, Blue Mountains
Upper Deschutes	17070301	5,578	Cascades, Eastern Cascade Slopes, Blue Mountains
Little Deschutes	17070302	2,726	Cascades, Eastern Cascade Slopes
Beaver-South Fork	17070303	3,968	Blue Mountains, Northern Basin
Upper Crooked	17070304	2,995	Blue Mountains, Northern Basin
Lower Crooked	17070305	4,787	Cascades, Eastern Cascade Slopes, Blue Mountains, Northern Basin
Lower Deschutes	17070306	5,944	Cascades, Eastern Cascade Slopes, Columbia Plateau, Blue Mountains
Trout	17070307	1,793	Columbia Plateau, Blue Mountains

B. Status of Species

Conservation Assessment and New Updates

Current Pacific Lamprey distribution in the Mid-Columbia RMU is still greatly reduced from historical range. Distribution of lamprey has remained the same in most watersheds since the completion of the 2011 Assessment (Table 2). A compilation of all known larval and adult Pacific Lamprey occurrences in the Mid-Columbia RMU are displayed in Figure 2, which is a product of the USFWS data Clearinghouse .

Population abundance of Pacific Lamprey in the Mid-Columbia RMU is largely unchanged since the 2011 Assessment, with estimates ranging from zero to over 2,500 fish (Table 2). The Umatilla is the only watershed that has seen an increase in adult populations over the last 5-10 years. The Confederated Tribes of the Umatilla Indian Reservation has an active Pacific Lamprey translocation program, ongoing for the last 20 years. This program has contributed to increases in rearing ammocoetes and number of returning adults (Jackson et al. 1997, Close et al. 2003, Howard et al. 2004).

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). Although no long term count of Pacific Lamprey exists in Mid-Columbia tributaries, populations are believed to be declined by 10-70% (Table 2). The Klickitat was the only subbasin to observe a further decline of Pacific Lamprey populations (from 10-30% to 50-70%) in the last five years. Numbers of larval/juvenile lamprey captured in a rotary screw trap near Lyle Falls (RM 2.2) have declined from 2,000-4,000 fish annually (2003-2006), to around 50 fish annually (Ralph Lampman, Yakima Nation Fisheries (YNF), personal communication)

The status of Pacific Lamprey in Willow Creek is unknown. Surveys conducted in 2010 and 2011 found only Western Brook Lamprey at a single location out of the 11 sites surveyed in Willow and Rhea Creek (Reid et al. 2011). Willow Creek dam (RM 52.4) provides no fish passage and targeted sampling has not occurred in the basin. Pacific Lamprey are still believed to be extirpated from the Walla Walla River. Although Western Brook Lamprey are present in the basin, Pacific Lamprey have not been observed during ongoing electrofishing, screw trap and spawning survey efforts. Pacific Lamprey are also believed to be extirpated in Trout Creek as well as the Deschutes River basin upstream from Pelton Dam.

Table 2. Population demographic and conservation status ranks (see Appendix 1) of the 4th Field Hydrologic Unit Code (HUC) watersheds located in the Mid-Columbia RMU. 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)
Walla Walla	17060102	SX	1000-5000	Extinct	Zero to 1-50	>70%
Umatilla	17060103	S1↓	1000-5000	100-500	1000-2500	10-30%
Willow	17060104	SU	Not ranked	Not ranked	Not ranked	Not ranked
Mid-Columbia – Hood	17060105	S1↓	1000-5000	100-500	250-1000	Unknown
Klickitat	17060106	S1	1000-5000	20-100	50-250	50-70%
Upper John Day	17070201	S1	1000-5000	100-500	50-1000	50-70%
North Fork John Day	17070202	S1	1000-5000	100-500	50-1000	50-70%
Middle Fork John Day	17070203	S1	1000-5000	100-500	250-1000	50-70%
Lower John Day	17070204	S1↓	5000-20,000	100-500	50-1000	50-70%
Upper Deschutes	17070301	SX	1000-5000	Extinct	Extinct	Not ranked
Little Deschutes	17070302	SX	Not ranked	Extinct	Extinct	Not ranked
Beaver-South Fork	17070303	SX	1000-5000	Extinct	Extinct	Not ranked
Upper Crooked	17070304	SX	1000-5000	Extinct	Extinct	Not ranked
Lower Crooked	17070305	SX	1000-5000	Extinct	Extinct	Not ranked
Lower Deschutes	17070306	S1S2	1000-5000	100-500	2500-10,000	10-50%
Trout	17070307	SH	1000-5000	Zero	Zero	Unknown

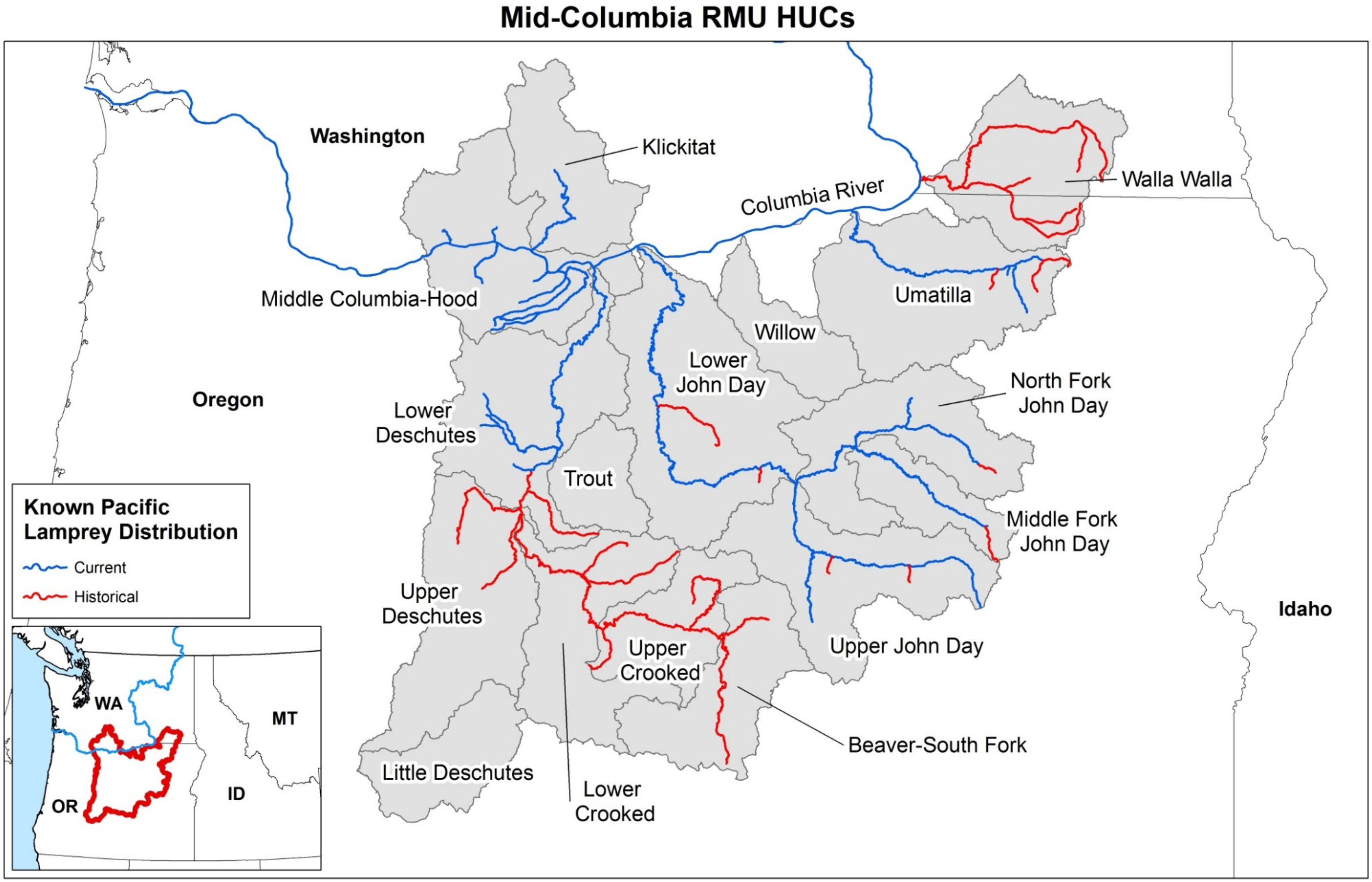

Figure 2. Current and historical known distribution for Pacific Lamprey: Mid-Columbia RMU (USFWS Data Clearinghouse 2017). Historical Pacific Lamprey distribution depicted in map was obtained from published literature, tribal accounts and state and federal agency records.

Distribution and Connectivity

Passage for both adults and juveniles in the Mid-Columbia RMU is impeded by four Federal Columbia River Power System (FCRPS) dams (Bonneville, The Dalles, John Day, and McNary). A multi-agency effort to assess and reduce the impact of mainstem passage is ongoing (CRITFC 2011; USACE 2009). Threats to passage within tributaries were considered moderate in the Mid-Columbia RMU. Four dams that previously blocked fish passage have been removed from the region including Hemlock Dam on the Wind River (2009), Powerdale Dam and Odell Dam on the Hood River (2010 and 2016), and Condit Dam on the White Salmon River (2011). In the Umatilla River basin, adult lamprey passage structures (i.e. Lamprey Passage System or flat plates) have been installed at Three Mile Falls diversion, Maxwell diversion dam, and Feed Diversion Dam to enhance passage. Boyd's diversion dam was recently removed, and two large diversion dams on the lower Umatilla River are scheduled for removal in 2017 (Dillon Diversion dam) and 2018 (Brownell diversion dam). In the John Day basin, over 100 push-up diversion dams have been removed to restore fish passage (Brent Smith, Oregon Department of Fish and Wildlife, personal communication).

While many passage barriers have been removed or structurally modified to improve passage, the region is still affected by a number of dams (e.g., Willow Creek Dam, McKay Dam (Umatilla River), Pelton Round Butte Hydroelectric Project), and low elevation water diversions. Irrigation diversions for crops and/or livestock are numerous, particularly in the Mid-Columbia/Hood, Walla Walla, Umatilla and John Day basins. Contemporary structures are required to operate and maintain screening or by-pass devices to protect fish from impingement or entrainment. Unfortunately there are still a large number of diversions with no screens or inadequate screening that may entrap or impinge migrating juveniles. The structural design of diversion dams may also delay or inhibit the passage of adult lamprey that are unable to navigate past sharp edges (e.g. 90° angles), especially in areas of high velocity (e.g., dam crest; Pacific Lamprey Technical Workgroup 2017).

Fish hatcheries in the lower Columbia River basin often utilize barrier dams/weirs and fish ladders to divert returning adult salmon into the hatchery during brood collection. Many of these structures are major barriers to adult Pacific Lamprey. In the Klickitat River, Pacific Lamprey are distributed upstream to the Klickitat Hatchery where a low head weir currently impedes adult passage (see priority project *Adult Passage Improvement in Klickitat Subbasin*). In addition, the surface water intake pump inadvertently diverts larval lamprey into hatchery ponds where they later become stranded when ponds are dewatered (Ralph Lampman, YNF, personal communication).

The cumulative impacts from this series of passage impediments likely impose a significant impact on distribution and connectivity for Pacific lamprey in most of the watersheds (Clemens et al. 2017).

C. Threats

Summary of Major Threats

The following table summarizes the key threats within the Mid-Columbia RMU tributaries as identified by RMU participants during the Risk Assessment revision meeting in April 2017 (High = 4; Moderate/High = 3.5; Moderate = 3; Low/Moderate = 2.5; Low = 2; Unknown = no value).

Table 3. Summary of the Assessment results for the key threats of the Mid-Columbia RMU

Watershed	Tributary Passage		Dewatering and Flow Management		Stream and Floodplain Degradation		Water Quality		Small Population Size		Lack of Awareness		Climate Change		Mainstem Passage	
	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity
Walla Walla	4	4	4	4	4	4	3.5	3.5	4	4	3	3	3.5	3.5	4	4
Umatilla	4	3	3	3.5	4	4	3.5	3	3.5	3.5	3	3	3.5	3.5	4	4
Willow	4	4	4	4	4	4	3.5	3.5			4	4	4	4	4	4
Mid-Columbia/Hood	2	2	3	4	3	3	3.5	3.5	2.5	2.5	2.5	2.5	4	4	4	4
Klickitat	3	3	2	2	2	2	4	3.5	3.5	3.5	3.5	3	3	3	4	4
Upper John Day	3.5	3.5	3.5	3.5	3.5	4	4	4	3	3	3	3	3.5	3.5	4	4
North Fork John Day	2	2	2.5	2.5	2.5	2.5	3	3	3	3	3	3	3.5	3.5	4	4
Middle Fork John Day	2	2	2.5	2.5	3.5	3.5	3	3	3	3	3	3	3.5	3.5	4	4
Lower John Day	3	3	4	4	3.5	3.5	4	4	2	2	3	3	3.5	3.5	4	4
Lower Deschutes	2	2.5	1.5	1.5	2.5	2.5	2	2	2	2	2	2	3.5	3.5	4	4
Mean	3.30	3.27	3.00	3.15	3.21	3.25	3.36	3.27	3.32	3.32	3.33	3.30	3.55	3.55	4.00	4.00
Rank	M	M	M	M	M	M	M	M	M	M	M	M	H	H	H	H
Mean Scope & Severity	3.28		3.08		3.23		3.32		3.32		3.32		3.55		4.00	
Drainage Rank	**M**		**M**		**M**		**M**		**M**		**M**		**H**		**H**	

Current Threats

Among the many threats identified in the Mid-Columbia RMU, some showed a pervasive impact in the entire region, such as *Mainstem Passage*, *Climate Change*, and *Lack of Awareness*. Other threats were more location specific, but nevertheless showed significant impacts at the local scale, such as *Tributary Passage*, *Dewatering and Flow Management*, *Stream and Floodplain Degradation*, and *Water Quality* (Clemens et al. 2017).

Mainstem and Tributary Passage

A summary of passage issues in Mid-Columbia tributaries were described in the previous section (Distribution and Connectivity). Threats associated with adult and juvenile passage at mainstem FCRPS dams are described in the Pacific Lamprey 2017 Regional Implementation Plan for the Mainstem Columbia River Regional Management Unit (see https://www.fws.gov/pacificlamprey/PLCI_RIPs.cfm).

Climate change

Climate changes is expected to produce changes in ambient temperature, precipitation, and streamflow patterns. In a region heavily dominated by agricultural crop production, rising ambient temperatures will likely increase demand for water for irrigation that will in turn reduce streamflows and elevate water temperatures. These conditions may restrict lamprey habitat availability, hamper adult migration, reduce reproductive capability, or contribute to increased mortality if incubating eggs, burrowing larvae or migrating ammocoetes are exposed to relatively warm temperatures (>20°C) for an extended duration (Clemens et al. 2016). The impacts of climate change will vary across watersheds with some areas more resilient to impacts of climate change (e.g., Klickitat), and some areas at greater risk from potential change based upon the underlying geology, impoundments, land use, or other factors. Climate change is identified as a critical subject for the Mid-Columbia RMU, but the feasibility of making tangible changes will be challenging and require large scale institutional changes. Within the Walla Walla basin, one of the strategies to combat climate change is the acquisition and subsequent protection of habitat. In the John Day basin, stream restoration (e.g., increasing channel complexity, channel deepening, riparian planting, riparian fencing) is being used as a tool to mitigate the effects of climate change.

Lack of Awareness

General knowledge of Pacific Lamprey has improved considerably within conservation and fisheries management communities, however, many stream restoration and passage improvement projects are still funded and designed to benefit salmonids with little understanding of how these actions may impact lamprey. In addition, the general public is still relatively unfamiliar with lamprey, their ecological and cultural importance, and how to avoid impacts to them.

Dewatering & flow management

Natural conditions (e.g., climate, geology, vegetation, topography) and extensive water withdrawals for irrigation leave many watersheds in the Mid-Columbia RMU dewatered or with inadequate flow during summer and fall months. These conditions are most severe in the Walla Walla, Umatilla, and

John Day basins where demand often exceeds available water supply. Streamflow is an important determinant of water quality and aquatic habitat conditions (Clemens et al. 2017). Reduced flows may increase water temperatures to critical levels, lower dissolved oxygen levels, reduce spawning and rearing habitat availability, prevent access to backwater or side channel habitats, and create low water barriers. Actions to restore and protect diminished instream flows will require large scale institutional changes involving water rights and salmonid management and will likely require a long-term effort. Current measures to improve flows include buying or leasing water rights, cooperative exchange of Columbia River water for instream flows (Umatilla Basin Project Act), diversion improvements (e.g., flow measuring devices, fish screens, conversion from flood to sprinkler systems), and irrigation efficiency projects (e.g., replacing open ditches/canals with pipe). These water efficiency improvements may help conserve water for instream flows, but with predicted trends in population growth, increased demand, and the anticipated effects of climate change, water supply issues will likely be an ongoing problem in the Mid-Columbia RMU.

Stream & floodplain degradation

Aquatic habitat conditions within the Klickitat and Lower Deschutes HUCs are relatively intact with only moderate impacts to riparian vegetation. In the majority of the Mid-Columbia RMU however, land use activities and human settlement have greatly altered the physical habitat and hydrology of the region. In upland areas, historical and ongoing timber practices have completely deforested or altered the function and diversity of riparian vegetation. Many watersheds in the RMU 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 lowlands, agriculture and grazing practices have contributed to the loss of aquatic and riparian habitat. Efforts to prevent flooding and provide irrigation for crops and livestock have straightened and scoured streambeds, eliminated side channels and cut off floodplains. Cultivation, riparian clearing and conversion of land for infrastructure (e.g., railroad and roads), crops, pastures and residential development have filled and/or drained wetlands, increased soil erosion and sedimentation, and promoted the establishment and spread of invasive plant species.

Water quality

Elevated water temperature is the primary water quality concern in the Mid-Columbia RMU. Increased temperatures may be associated with excessive solar radiation, removal of riparian vegetation, reduction of instream flow, and flood irrigation water returns. Other water quality concerns include low dissolved oxygen, pH extremes, sedimentation, and the presence of bacteria, heavy metals, and toxic pollutants (e.g., insecticides, PCBs; Clemens et al. 2017). These issues are likely attributable to land use practices or other natural causes. Toxins and heavy metals may be a particular concern for Pacific Lamprey. Direct exposure to toxins 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 Mid-Columbia RMU.

Restoration Actions

Within the mainstem Columbia River, improvements to Bonneville, The Dalles, John Day and McNary hydroelectric dam fishways have occurred to increase adult passage success. Instream and floodplain habitat restoration activities have been implemented in the Mid-Columbia subbasins, although these actions have been designed / funded primarily for salmonid recovery. The following conservation actions were initiated or recently completed by RMU partners in the Mid-Columbia Regional Management 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 juvenile entrainment mechanisms and preventative measures.	Assessment	Underway
RMU	Population	Development of protocols and techniques for artificial propagation and larval rearing of Pacific Lamprey	Research	Underway
RMU	Dewatering/ flow	Water savings through Columbia Basin Water Transactions Program	Instream	Ongoing
Umatilla	Population	Translocation/reintroduction of adult Pacific Lamprey.	Instream	Underway
Umatilla	Population	Monitoring larval density trends and adult passage success to spawning areas.	Instream	Underway
Umatilla	Passage	Installation of Lamprey Passage Systems to enhance passage for Pacific Lamprey at three water diversion dams.	Instream	Complete
Umatilla	Passage	Telemetry to assess use of Lamprey Passage Systems at diversion dams.	Assessment	Complete
Umatilla	Passage	Sampling of Bureau of Reclamation canals to estimate extent of juvenile entrainment into diversions.	Survey	Ongoing
Umatilla	Passage	Removal of Boyd, Dillon and Brownell diversion dams.	Instream	Complete/ Underway
Mid-Col. Hood	Passage	Monitoring natural recolonization above former site of Powerdale Dam on Hood River and Condit Dam on White Salmon River.	Survey	Ongoing
Mid-Col Hood	Population	Larval occupancy/density surveys in principal tributaries.	Survey	Ongoing

Klickitat	Population	Distribution surveys of mainstems and principal tributaries.	Survey	Ongoing
Klickitat	Passage	Installation of Lamprey Passage Structure at Lyle Falls fish ladder.	Instream	Complete
Klickitat	Passage	Passage improvement for adult Pacific Lamprey at Klickitat Hatchery weir	Instream	Proposed
John Day Basins	Stream Degradation	Large channel restoration project in core area for lamprey (Middle Fork John Day)	Instream	Underway
John Day Basins	Passage	Removal of over 100 push-up diversion dams	Instream	Ongoing
John Day Basins	Passage	Fish screening improvements	Instream	Ongoing
Lower Deschutes	Passage	Installation of LPS at Warm Springs National Fish Hatchery fishway	Instream	Complete

II. Selection of Priority Actions

A. Prioritization Process

Mid-Columbia RMU members were unable to meet in 2018, but were contacted via email in July 2018. Pacific Lamprey project proposals were submitted online and sent to RMU members for review with the draft Regional Implementation Plan. The following two projects were submitted by RMU members for inclusion in the 2018 Mid-Columbia RMU Regional Implementation Plan:

- Determination of Optimal Dewatering Rates to Protect larval Pacific Lamprey
- Klickitat Passage Research and Improvement

B. High Priority Proposed Project Information

Project Title: **Determination of optimal dewatering rates to protect larval Pacific Lamprey.**

Project Applicant/Organization: US Geological Survey, Columbia River Research Laboratory
Contact: Theresa "Marty" Liedtke
Email: tliedtke@usgs.gov
Phone: 509-538-2963

Project Location: USGS research facility in Cook, WA

NPCC Subbasin (4th HUC Field) name: no specific Subbasin, information relevant throughout the range
Watershed (5th HUC Field): no specific Watershed, information relevant throughout the range
Lamprey RMU population: Mid-Columbia RMU
HUC4 Risk Level: S1

Requested funds: $37,224

Total Project cost: $41,617 (includes $4,393 of USGS secured cost-share)

Short Project Description:

The goal of this project is to determine a dewatering rate (or range of rates) that will limit the potential to strand larval lamprey in dewatered habitats. Larval lamprey habitats are frequently dewatered due to flow management practices, water withdrawals, or for salvage of lamprey entrained into irrigation diversions. Some laboratory testing has been done (see Liedtke et al. 2015), and there is some evidence from field testing that suggests slower dewatering rates are more protective to lamprey than faster rates. The slower rates allow lamprey to move out of dewatered habitats and relocate where water is available. Specific guidance on dewatering rates, however is lacking. This project will use a controlled laboratory setting to evaluate the risk of stranding for larval lamprey exposed to a range of dewatering rates under both day and night conditions. The product of the project will be a report and recommendations for dewatering rates and timing (day vs. night) that will be protective for larval lamprey.

1.0 Detailed Project Description

This project will use an existing laboratory test system to evaluate the risk of stranding for larval lamprey exposed to different dewatering rates under both day and night conditions. The test system is a tank with a false bottom and a 10-percent (5.7 degree) slope, filled with river sediment, with water inflow and drains that can be manipulated to control the rate of dewatering. The tank was used for previous evaluations of dewatering (see Liedke et al. 2015), when several dewatering levels and two dewatering rates were compared. This project will use a single dewatering level, with variable dewatering rates and light conditions. The dewatering level will be established so that water is available over the sediment in the lowest tank section, at the bottom of the 10-percent slope. We will evaluate "stranding", defined as the number of lamprey either in or on the substrate outside of the watered area. Lamprey that traverse the dewatered section of the tank and enter the water at the lower end of the slope will be classified as "safe".

We will test five dewatering rates under both day and night conditions. The five rates to be tested will be determined through consultation with RMU members and other interested parties to ensure that the project will generate real-world, usable information to guide future dewatering applications. In previous work (Liedtke et al. 2015), we tested 3 inches (7.6 cm) per hour and 20 inches (51 cm) per hour. We anticipate that there will be significant interest in testing rates below 3 inches per hour, and in rates in the 4-8 inches per hour range. Although specific rate data are lacking, there is some field evidence to suggest that lower rates may be beneficial for lamprey. The goal is to test a range of rates so that a statistical relationship can be developed and outcomes from rates not tested directly can be inferred.

For each dewatering rate and light condition, we will complete three replicate trials. Each trial will use 10 larval lamprey over a range of sizes. Previous work (Liedtke et al. 2015) showed a significant effect of size, with larger lamprey more likely to regain access to water following a dewatering event. We will include a similar range of sizes for all trials so we can evaluate the risk of stranding based on size.

Trials will be initiated by stocking 10 lamprey into the uppermost section of the tank, where they will be sequestered by a metal divider inserted through the substrate to the bottom of the tank. Fish will be allowed to acclimate for 12 to 18 hours with a full water level in the tank. Following the acclimation period, the trial will be initiated by applying the dewatering rate. The different dewatering rates will result in variable amounts of time until the substrate in the tank is exposed and the dewatering level is reached. Once the dewatering level has been reached, a 4-hour waiting period will begin to allow lamprey time to move within the tank. At the end of the 4-hour period, lamprey will be located and removed from the tank. Each lamprey will be classified as safe (was located in the watered, lower section of the tank), or stranded (was not located in the watered, lower section of the tank). Additionally, we will record the location of each lamprey within the tank (based on defined tank sections along the tank slope), their position relative to the substrate (burrowed or on the surface of the substrate) and their size. Water temperatures for trials will be matched to the rearing or holding temperatures and will be monitored throughout each trial.

Control trials will be conducted under both light and dark conditions. For control trials, 10 larval lamprey will be stocked into the uppermost section of the tank with a full water level, fish will be allowed to acclimate for 12-18 hours, the trial will be initiated, the 4-hour waiting period applied, and then fish will be located and removed as per the procedures for the other trials. We will conduct three control trials during light conditions and three control trials during dark conditions, making the total number of trials (test and control) 36.

To execute the full study plan (36 trials) we will use 360 larval lamprey. Lamprey for testing will be from our collection of cultured lamprey with possible additions from lamprey cultured by Yakama Nation Fisheries (Ralph Lampman). If non-cultured (wild) larval lamprey are deemed to be more desirable for this project, we will coordinate with Yakama Nation and/or USFWS to collect lamprey from the field.

The project can begin very shortly after funding is established. We anticipate needing 15 weeks of work to complete the full experimental design, with an additional week to allow for set up and fish sorting and sizing activities. A project summary (USGS series report, published online) will be completed to report study findings and make recommendations on dewatering rates.

The project approach can be altered to meet variable information needs or funding levels. For example, the test tank could be reconfigured with a wide range of slopes to investigate different shoreline characteristics. Approaches to reduce lamprey stranding during dewatering could also be tested. For example, using sprinklers to keep the sediment moist during dewatering, or creating a channel in the sediment to encourage and ease lamprey movements. Dewatering scenarios that include rest or recovery periods (e.g., phased dewatering) could also be investigated using this test system.

2.0 Regional Priorities: Linkage of actions to Identified Threat

- What threat(s) does this project address?
  - Dewatering and flow management, as well as lack of awareness
- How does this project address this key threat(s)?
  - By providing guidance on dewatering rates that are protective for larval lamprey, many dewatering applications can have reduced impacts on lamprey. In many cases, the dewatering rate that is applied, for example to dewater an irrigation diversion, can be influenced. The knowledge gap, currently, is what rate should be applied for best outcome. This project can also play a role related to the threat posed by lack of awareness because project managers may not be aware that a change in the dewatering rate may help reduce impacts to lamprey.
- 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 these threats throughout the range of the species, and is not specific to this RMU or any particular water body.

3.0 Project Goals/Objectives and Species/Habitat Benefits:

- What life stage or stages will benefit from action? How?
  - Larval lamprey are the target life stage for this project.

- What other species may benefit from action?
    - No specific benefits to other species.
- How will the project provide meaningful measureable results to improve lamprey populations and/or their habitat conditions?
    - The project will provide the rigorous testing to support a recommended management action, specifically a dewatering rate that can be applied to limit the stranding of larval lamprey.

4.0 Project Design / Feasibility

- Have the designs for the project been completed already or will they be completed before planned project implementation?
    - The study design for the project has been defined, but can be altered through a review process. Input from regional experts and managers will be solicited to determine what dewatering rates will be tested.
- Are the appropriate permits (ESA and environmental compliance) in place already or will they be in place before planned project implementation?
    - No permits will be needed if larval lamprey cultured at the USGS laboratory will be used. If field-captured lamprey are desired, we will coordinate with partners and use existing permits to collect study animals.
- Can the project be implemented within the defined time frame?
    - Yes, the project can be implemented very quickly as the test systems have been built and used in previous experiments.

5.0 Partner Engagement and Support:

- What partners are supporting the project?
    - The Yakama Nation is a partner in this work as they are very interested in dewatering rates, especially at irrigation diversions where larval lamprey are annually dewatered and salvage operations are required. The USFWS has been a partner (including providing funding) for our previous work on dewatering effects.
- What partners are active in implementing the project?
    - If funded, project implementation will be conducted by USGS. Partners will be involved in project design review prior to implementation and report review prior to publication.
- What partners are providing matching funds or in-kind services that directly contribute to the project?
    - USGS has confirmed in-kind services and the Yakama Nation may also contribute, depending on what fish source is selected for project implementation.

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:
- n/a—no monitoring plan is included for the project
    - Is there a monitoring framework in the proposal?
    - Does the monitoring framework provide clear objectives and measureable metrics that can be observed over time?
    - Does the framework provide a clear description of the expected outcome?

- If this is an on the ground project without a monitoring or evaluation component:
  - How is completion of the project going to be documented?
  - Is the project's effectiveness linked to another M&E project?

7.0 Budget and Timelines

The project can begin very shortly after funding is established. We anticipate needing 15 weeks of laboratory work to complete the full experimental design, with an additional week to allow for set up, and fish sorting and sizing activities. A project summary (USGS series report, published online) will be completed to report study findings and make recommendations on dewatering rates. A draft report can be available within approximately 90 days following the completion of the testing period.

		# Hours or units	Cost per unit	Funds requested	USGS Cost-share	Total
a	**Personnel:**					
	a. Technician	564	39.69	22,385		22,385
	b. Project Leader	40	74.63	2,985		2,985
	c. Project Leader	20	74.63		1,493	1,493
b	**Travel:**	0		0		0
c	**Equipment:**					
	a. tank				2,000	2,000
	b. temp loggers				500	500
d	**Supplies:**					
	a. tank supplies	Misc.	250	250		250
	b. tank upgrades				400	400
e	**Other:**					
	a. publishing	1 report		800		800
f	**Direct Charges SubTotal**			26,420	4,393	30,813
g	**Indirect Charges:**	%		10,804	0	
h	**TOTALS**			$37,224	$4,393	$41,617

8.0 References

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Project Title: Klickitat Passage Research & Improvement

Project Applicant/Organization: Yakama Nation Fisheries, Pacific Lamprey Project
Contact: Ralph Lampman
Email: lamr@yakamafish-nsn.gov
Phone: 509-388-3871

Landowner Organization/Contact Person: WDFW, YKFP operates the facility through lease agreement.
Project Location: Lyle Falls
NPCC Subbasin (4th HUC Field) name: Klickitat (17070106)
Watershed (5th HUC Field): Lower Klickitat (1707010604)
Lamprey RMU population: Middle Columbia
HUC4 Risk Level: S1

Requested funds: $25,000

***Total Project cost*:** $35,500

Short Project Description:

Adult passage at Lyle Falls (river km 4.2) is critical for the subpopulation of Pacific Lamprey within the Klickitat Subbasin for lamprey to access primary spawning habitat. Although a lamprey passage structure (LPS) was constructed when Lyle Falls fish passage facility was recently upgraded in 2012, a few key elements need to be modified to make this passage structure more effective for all season adult lamprey passage. 1) The outlet of the LPS will be extended to ensure the bottom stays under the water surface during summer low flow conditions in July – September (an important migration season for fresh migrants coming from the ocean). 2) The angle of the upstream end terminal of the LPS will be modified to prevent fallbacks at the ladder entrance and provide a smoother transition to the ladder where they can orient themselves better. 3) The trap box will be enlarged and modified so that lamprey can be safely and effectively trapped (for future research and monitoring). A pilot PIT tag study will also be conducted simultaneously in 2019 to further our understanding of lamprey passage behavior at Lyle Falls.

***Descriptive Photographs-illustrations-Maps*:**

Figure 1. Lamprey Passage Structure at Lyle Falls Fish Ladder. The entrance of the LPS is in a great location, but the volitional release point is currently at the bottom of the fish ladder (inhibiting passage of adult lamprey if they struggle within the fish ladder).

Figure 2. The resting box (left photo) for the Lamprey Passage Structure at Lyle Falls Dam. With some modification, adult lamprey could potentially be trapped here daily and PIT tagged to evaluate passage at Lyle Falls and within the fish ladder (to determine the best way to increase passage here).

Figure 3. The Lyle Falls LPS is perched during low flow season, often preventing adult lamprey from using it during the key migration period in the summer (July-September)

1.0 Detailed Project Description

Screw trap monitoring of larval/juvenile lamprey by Yakima-Klickitat Fisheries Project in the Klickitat Subbasin indicates that the overall abundance of lamprey has been decreasing over time (1,500-4,000 lamprey were trapped annually between 2003-2006, but these numbers decreased to less than 800 between 2007-2011 and less than 200 have been captured since 2012). The precise root cause of this gradual decline over time is unknown, but adult passage likely plays a large role within the Klickitat Subbasin. The first passage structure that adult lamprey encounter within the mainstem Klickitat River is Lyle Falls Facility. Although this is originally a natural waterfall site, it has been modified considerably over the years on the right bank (looking downstream) with the construction of a fish ladder and state-of-the-art fish monitoring facility (most recent upgrades were made in 2012). A lamprey passage structure (LPS) was constructed as well in 2012 to facilitate adult Pacific Lamprey passage on the right bank and within the fish ladder. Although it was built with the best intentions at the time, there are a few issues surrounding the existing design.

- The outlet (downstream terminal) is perched during critical times of the summer low flow season (July-September).
- The inlet (upstream terminal) is located at the bottom of the ladder where lamprey could potentially be swept downstream immediately after they transition into the ladder.
- No counting system is installed to account for the number of lamprey passing.
- The trap rest box is too small to safely trap more than a few lamprey and it is not working as a trap (as a result, accounting for the use is virtually impossible).

The first and foremost goal in 2019 is to modify the Lyle Falls LPS so that we can tackle the four issues outlined above. Enhancing the passage at Lyle Falls (river km 4.2) will contribute to at least 65.2 km of prime spawning and larval rearing habitat upstream. Some of the modifications may require extra measures and procedures, such as a crane basket to access the outlet of the LPS structure, and disassembling of construction elements at the ladder facility.

A pilot PIT tag study will be conducted at Lyle Falls focusing on three release locations: 1) downstream of Lyle Falls, 2) within the Lyle Falls fish ladder, and 3) immediately upstream of Lyle Falls by the floating PIT array. The goal of 1) is to understand overall passage behavior at Lyle Falls (how much uses the fish ladder vs. LPS vs. the waterfall). The goal of 2) is to assess how lamprey pass within the fish ladder. The goal of 3) is to estimate the detection efficiency of the floating instream PIT array above Lyle Falls (which is critical for understanding #1).

Based on past larval surveys (2009-present), distribution of Pacific Lamprey largely ends at Klickitat Hatchery weir (river km 69.4). At least 36.5 river km is also available upstream of Klickitat Hatchery Weir up to Casteel Falls (river km 105.9), which is all low gradient habitat (<2.0%) with an abundance of both adult spawning and larval lamprey rearing habitat. In future years (2020-2025), we are planning to address the passage issues further upstream at Klickitat Hatchery weir. However, our consensus in 2018 was that further planning and research is needed to fully understand the issues surrounding Klickitat Hatchery weir (not only on how to improve the passage but also on how to effectively monitor adult passage). We plan to incorporate a step-by-step process by first assessing the passage conditions at this facility and incorporate the information and data to prescribe the most appropriate long-term solutions. This approach may take slightly longer to realize passage improvement, but we felt that this approach will provide more desirable results in the long run compared to a rushed plan (without fully understanding the potential issues at the facility).

2.0 Regional Priorities: Linkage of actions to Identified Threats

- What threat(s) does this project address?
  - "Tributary Passage", "Small Population Size"
- How does this project address this key threat(s)?
  - Lyle Falls fish ladder has some passage issues for Pacific Lamprey. The project will provide critical modifications to the LPS structure to allow it to function as originally designed and envisioned. These modifications will also allow staff at Klickitat Hatchery to enhance the monitoring and research at Lyle Falls (adult passage counts will be incorporated to the daily monitoring and some of the trapped lamprey could be used for PIT tagging studies), stimulating further improvement and development at the facility.
- Does this project address a threat(s) specific only to this RMU or does the project address the threat(s) for multiple RMUs?
  - The primary goal is to address the passage issues within Klickitat Subbasin, but the action and solutions certainly have applications for multiple RMUs

3.0 Project Goals/Objectives and Species/Habitat Benefits:

- What life stage or stages will benefit from action? How?
  - Adult lamprey – by increasing the passage efficiency through Lyle Falls Facility
- What other species may benefit from action?
  - N/A
- How will the project provide meaningful measureable results to improve lamprey populations and/or their habitat conditions?
  - Accessibility for adult lamprey to reach all their potential spawning grounds is vital for each subpopulation. This project will address the specific needs of adults at Lyle Falls to ensure they have full access to the Klickitat Subbasin during their entire run season.

4.0 Project Design / Feasibility

- Have the designs for the project been completed already or will they be completed before planned project implementation?
  - Conceptual designs have been completed.
- Are the appropriate permits (ESA and environmental compliance) in place already or will they be in place before planned project implementation?
  - Because this is a specific passage structure for Pacific Lamprey (that only lamprey can use), there will be no effect to ESA listed species. Most project work will occur inside the ladder when the ladder is scheduled to be dewatered.
- Can the project be implemented within the defined time frame?

o We will take a step-by-step approach to maximize the benefits. In 2019, the primary goals are to 1) improve the Lyle Falls lamprey passage structure to maximize the attraction at the downstream terminal and improve the trapping box / volitional outlet at the upstream terminal, and 2) release PIT tagged adult lamprey in the vicinity of Lyle Falls project area where two PIT array sites exist (one within the ladder and one upstream).

5.0 Partner Engagement and Support:

- What partners are supporting the project?
  - Yakama Nation, Yakima-Klickitat Fisheries Project, WDFW
- What partners are active in implementing the project?
  - Yakama Nation, Yakima-Klickitat Fisheries Project
- What partners are providing matching funds or in-kind services that directly contribute to the project?
  - Yakama Nation, Yakima-Klickitat Fisheries Project

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?
    - Yes, the primary focus for the first year (2019) is to improve the LPS while also enhancing our understanding of the passage conditions at Lyle Falls.
  - Does the monitoring framework provide clear objectives and measureable metrics that can be observed over time?
    - Measurable metrics for the first year (2019) is the increase in numbers passing Lyle Falls through the modification of the LPS. The other objective is an assessment of the year round passage at Lyle Falls, using the modified LPS and PIT array stations.
  - Does the framework provide a clear description of the expected outcome?
    - Expected outcomes for 2019 are to 1) enhance the passage of adult lamprey at Lyle Falls fish ladder (through LPS modification, 2) improve the tools available to learn about lamprey passage issues at Lyle Falls facility (through PIT tag monitoring), and 3) conduct a preliminary assessment of passage conditions at Lyle Falls using existing tools available.
    - Long-term goal (2-3 years) is to provide all-season passage for adult Pacific Lamprey (both summer/fall and spring migration runs) at Lyle Falls and Klickitat Hatchery weir. This 2019 project is a critical first step to achieve the long-term goal (in a timely manner).
- If this is an on the ground project without a monitoring or evaluation component:
  - How is completion of the project going to be documented?
    - N/A
  - Is the project's effectiveness linked to another M&E project?
    - N/A

7.0 Budget and Timelines

Budget:

Personnel cost will be cost shared by Yakama Nation and Yakima-Klickitat Fisheries Project staff, including the conceptual designs of the modification, daily monitoring, PIT tagging and research. A subcontract will be used to implement the modifications to the LPS structure.

		# Hours or Units	Cost per Unit ($)	Funds Requested ($)	Cost Share ($)	Total ($)
a	**Personnel**	-	-	-	-	-
	i. Project Leader (YKFP)	35	$70	-	$2,450	$2,450
	ii. Project Leader (YN)	60	$70	-	$4,200	$4,200
	iii. Technician (YKFP)	35	$50	-	$1,750	$1,750
	iv. Technician (YN)	60	$35	-	$2,100	$2,100
b	**Travel**	-	-	-	-	-
c	**Subtotal**	-	-	$0	$10,500	$10,500
d	**Subcontract**	-	-	$25,000	-	$25,000
e	**TOTALS**	-	-	$25,000	$10,500	$35,500

Timetable:

2019 Spring – release of PIT tagged lamprey (N=50) at Lyle Falls (downstream of the falls, within the ladder, and/or upstream of the falls [for upstream array detection efficiency]). Ideally, adults captured/trapped at Lyle Falls will be used, but some may be substituted using adults trapped from Bonneville Dam (through Yakama Nation tribal allocation).

2019 Summer –modifications to the LPS will be made primarily during the summer low flow period (a critical time, especially, for the outlet portion outside of the ladder). Each task should only require 1-2 days of deployment/implementation.

2019 Fall – release of PIT tagged lamprey (N=50) at Lyle Falls (downstream of the falls, within the ladder, and/or upstream of the falls [for upstream array detection efficiency]). Ideally, adults captured/trapped at Lyle Falls will be used, but some may be substituted using adults trapped from Bonneville Dam (through Yakama Nation tribal allocation).

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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.