Pacific Lamprey

2020 Regional Implementation Plan

for the

Oregon Coast

Regional Management Unit

South Coast Sub-Region

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Status and Distribution of Pacific Lamprey in the RMU

General Description of the RMU

South Oregon Coast Sub-Region

The Oregon Coast Regional Management Unit is separated into two sub-regions equivalent to the USGS hydrologic unit accounting units 171002 (Northern Oregon Coastal) and 171003 (Southern Oregon Coastal). The South Oregon Coast sub-region includes all rivers that drain into the Pacific Ocean from the Umpqua River basin south to the Smith River boundary in California. It is comprised of twelve 4th field HUCs ranging in size from 1,216 to 4,662 km^2 (Table 1). Watersheds within the South Oregon Coast sub-region include the North and South Umpqua, Umpqua, Coos, Coquille, Sixes, Upper, Middle and Lower Rogue, Applegate, Illinois and Chetco (Figure 1).

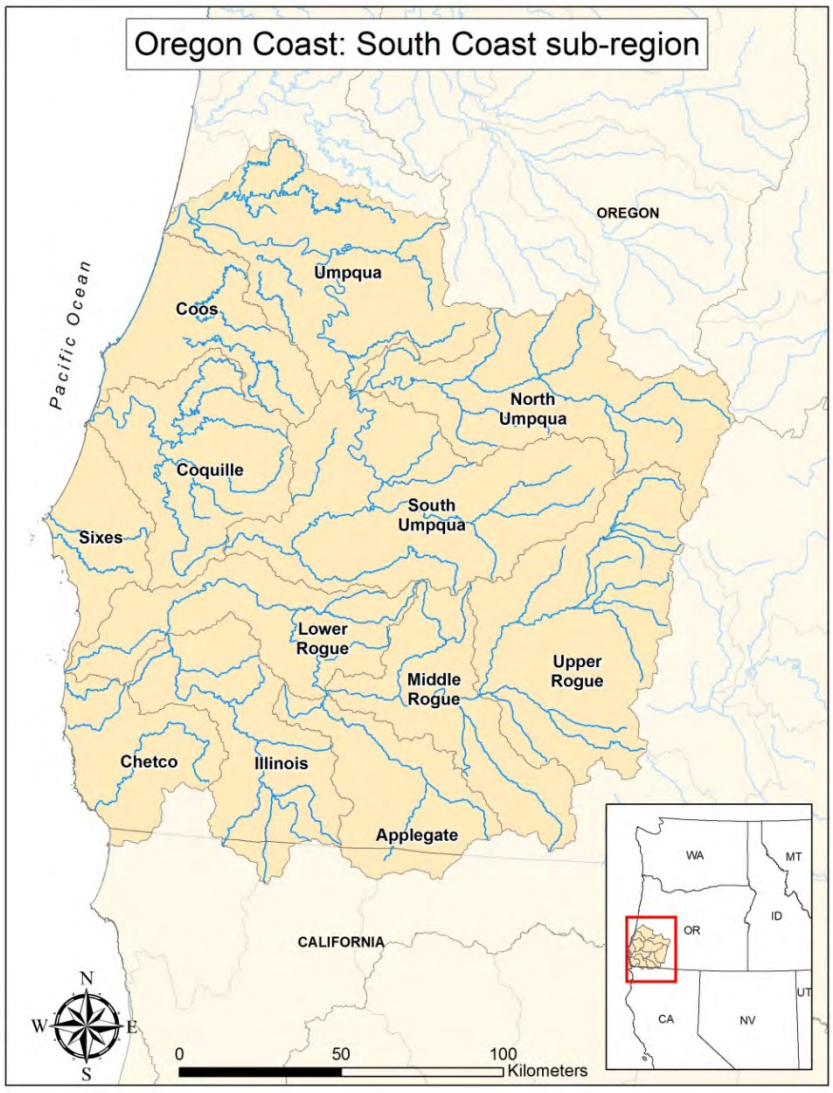


Figure 1. Map of watersheds within the Oregon Coast RMU, South Coast sub-region.

Table 1. Drainage Size and Level III Ecoregions of the 4th Field Hydrologic Unit Code (HUC) Watersheds located within the South Oregon Coast sub-region.

Watershed	HUC Number	Drainage Size (km^2)	Level III Ecoregion(s)
North Umpqua	17100301	3,544	Cascades, Klamath Mountains
South Umpqua	17100302	4,662	Coast Range, Cascades, Klamath Mountains
Umpqua	17100303	3,918	Coast Range, Cascades, Willamette Valley, Klamath Mountains
Coos	17100304	1,909	Coast Range
Coquille	17100305	2,736	Coast Range, Klamath Mountains
Sixes	17100306	1,216	Coast Range
Upper Rogue	17100307	4,180	Cascades, Klamath Mountains, Eastern Cascades Slopes and Foothills
Middle Rogue	17100308	2,283	Cascades, Klamath Mountains
Applegate	17100309	2,005	Klamath Mountains
Lower Rogue	17100310	2,347	Coast Range, Klamath Mountains
Illinois	17100311	2,580	Klamath Mountains
Chetco	17100312	1,654	Coast Range, Klamath Mountains

Status of Species

Conservation Assessment and New Updates

Current Pacific Lamprey distribution in the South Coast sub-region is greatly reduced from historical range (Table 2). The 2018 Assessment ranking of current distribution was reduced from 2011 rankings in all HUCs except the Umpqua, Coquille, and Middle Rogue. The decline of the rankings 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 (USFWS 2018). Overall, current understanding of Pacific Lamprey distribution has expanded in many watersheds due to increased sampling effort (e.g., smolt trapping, redd surveys, occupancy sampling), and improved recognition of lamprey redds. Distribution information is still limited in the Lower Rogue and Chetco River.

Population abundance was updated in the North Umpqua, Umpqua, Coos, Sixes, and Applegate River using new information from Oregon Department of Fish and Wildlife (ODFW) to estimate a range of Pacific Lamprey population 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). Adult Pacific Lamprey abundance is unknown in the Upper Rogue, Middle Rogue, Lower Rogue, Illinois, and Chetco Rivers

Short-term population trend (defined as the degree of change in population size over 3 lamprey generations or 27 years), was ranked as stable in most watersheds with available abundance information (see above). The only ongoing long-term record of lamprey counts in the South Coast is at Winchester Dam on the North Umpqua. The population has been monitored since 1965 and counts indicate a significant downward trend over time. For example, during 1965 – 1985, the average count of adult Pacific Lamprey at Winchester Dam was 12,343 fish (range: 877 – 46,785), compared with 1986 – 2012, when the average count was only 433 fish (range: 15 – 2,726). However, the number of lamprey passing over Winchester Dam has recently shown a slight increase since the lamprey ramp was employed during 2013 – 2019, with an average of 870 lamprey (range: 512 – 1,278) counted passing. It is unclear if the increase in lamprey in recent years is due to the installation of the lamprey ramp and more efficient counting methods, actual increases in the number of adults migrating upstream past the dam, or both. Many watersheds have 5-10 years of high quality data (~2009 – 2019), but information is inaccurate or undocumented before this time. The abundance of lamprey population(s) has generally increased over the last several years, but without a longer term data set it is unknown whether this apparent increase is simply an upswing in a larger cyclical trend.

Table 2. Population demographic and conservation status ranks (see Appendix 1) of the 4th Field Hydrologic Unit Code (HUC) watersheds located within the South Oregon Coast Sub-region. Note – coho salmon distribution 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)
North Umpqua	17100301	S2↑	1000-5000	100-500	1000-2500	Stable
South Umpqua	17100302	S1↓	1000-5000	100-500	250-2500	30-50%
Umpqua	17100303	S2	1000-5000	500-2000	250-1000	Stable
Coos	17100304	S2	1000-5000	100-500	1000-2500	Stable
Coquille	17100305	S2	1000-5000	500-2000	2500-10,000	Stable
Sixes	17100306	S2	1000-5000	100-500	250-1000	Stable
Upper Rogue	17100307	S1↓	1000-5000	100-500	Unknown	Unknown
Middle Rogue	17100308	S2↑	1000-5000	100-500	Unknown	Unknown
Applegate	17100309	S2	1000-5000	100-500	250-1000	Stable
Lower Rogue	17100310	S2	1000-5000	100-500	Unknown	Unknown
Illinois	17100311	S1↓	1000-5000	100-500	Unknown	Unknown
Chetco	17100312	S2↓	250-1000	100-500	Unknown	Unknown

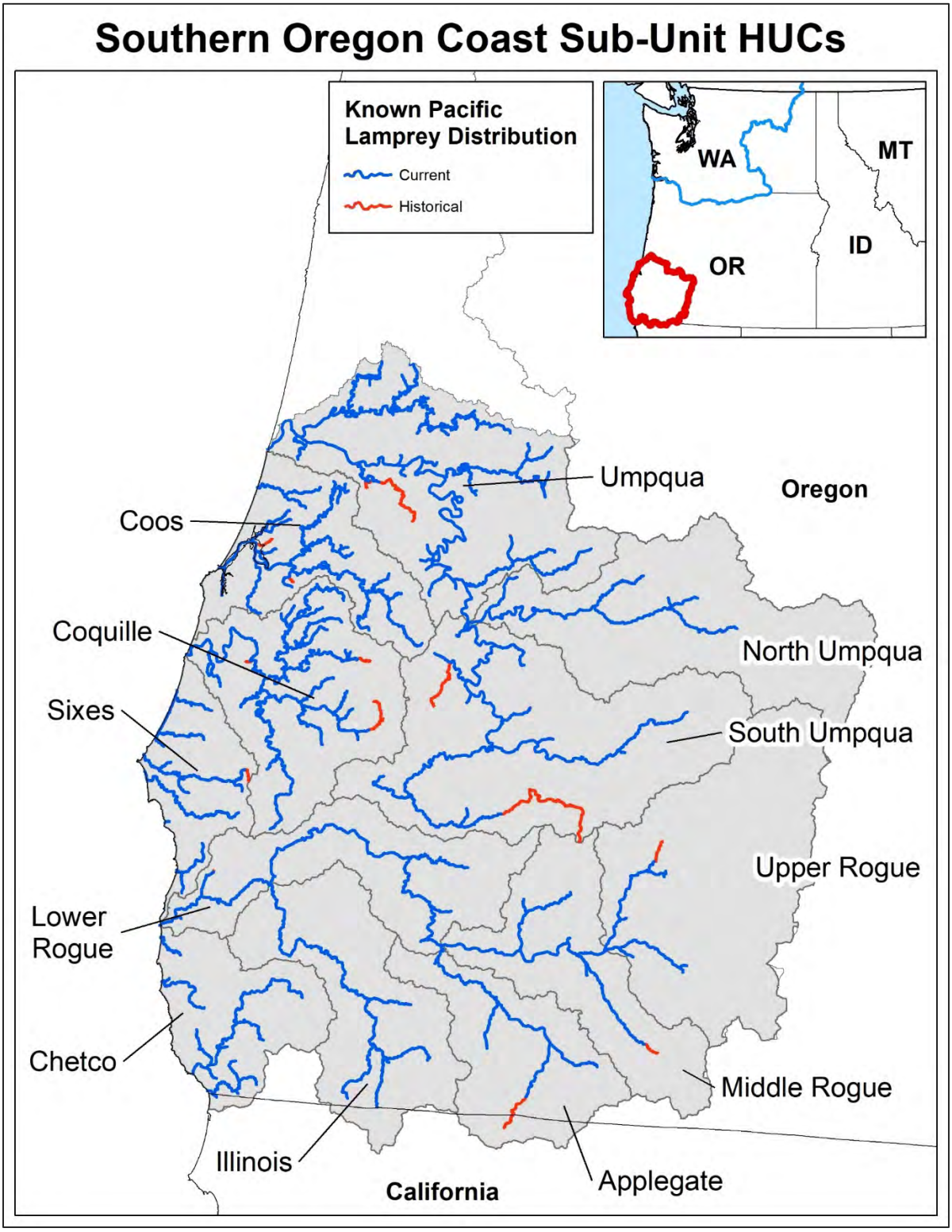


Figure 2. Current and historical known distribution for Pacific Lamprey: Oregon Coast Regional Management Unit, South Coast sub-region (USFWS Data Clearinghouse 2017). Historical Pacific Lamprey distribution depicted in map was obtained from published literature, tribal accounts and state and federal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

Distribution and Connectivity

Fish Passage was ranked a low to moderate threat in the majority of watersheds that were assessed in the South Coast sub-region (see USFWS 2018). A number of major passage issues have been addressed in the North Umpqua (e.g., Rock Creek Dam upstream of the hatchery, Soda Springs Dam, Winchester Dam) and an unprecedented four dams have been removed from the Middle Rogue since 2007 (i.e., Savage Rapids, Elk Creek, Gold Hill, and Gold Ray Dam). However, a number of existing structures continue to impede passage or alter the hydrograph to the detriment of fish and aquatic wildlife. Most notably, Applegate Dam and Murphy Dam on the Applegate River, Galesville Dam on Cow Creek (South Umpqua), Emigrant Dam on Bear Creek (Middle Rogue), and Lost Creek Dam on the Upper Rogue completely block upstream passage and access to historical spawning and rearing habitat.

Private and municipal water diversions are abundant within the South Coast sub-region. 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 aging or obsolete diversions with inadequate screening and open irrigation ditches that may harm or entrap fish.

Faulty tide gates are numerous in tidally-influenced areas of the Coos and Coquille Rivers. The Coquille Watershed Association completed a tide gate inventory in the Coquille watershed in 2015 and is working with The Nature Conservancy, ODFW, and landowners to prioritize the removal and/or replacement of failing structures. Barrier culverts were also identified as a threat in the South Umpqua, Coos and Coquille Rivers. Stakeholder groups are working to systematically remove or replace problem culverts to restore fish passage.

Threats

Summary of Major Threats

The following table summarizes the key threats within the South Coast sub-region as identified by RMU participants during the Risk Assessment revision meeting in March 2017.

Table 3. Summary of the Assessment results for the key threats of the South Oregon Coast sub-region.

	Dewatering and Flow Management		Stream and Floodplain Degradation		Water Quality		Lack of Awareness		Climate Change	
Watershed	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity
South Oregon Coast										
North Umpqua	4	3	2	3	3	2.5	4	2	4	3
South Umpqua	3	4	4	3	4	3	4	2	4	4
Umpqua	3	3	3	3	3	3	4	2	4	4
Coos	2	2	3	3	3	3	4	2	3	3
Coquille	2.2	2	3	3	3.5	3	4	2	3	3
Sixes	1	2	3	3	3	3	4	2	2	2
Upper Rogue	3	3	3	2.5	3	3	4	2	2.5	2.5
Middle Rogue	3	3	3	3	3	3	4	2	3	2.5
Applegate	3	3	3	2.5	3	3	4	2	3	2.5
Lower Rogue	1	1	1	1.5	1	1	4	2	2	2
Illinois	4	4	3	3	4	4	4	2	4	3.5
Chetco	1	2	1	2	1	2	4	2	2	2
Average Scope/Severity	2.54	2.67	2.67	2.71	2.88	2.79	4.00	2.00	3.04	2.83
Rank	**M**	**M**	**M**	**M**	**M**	**M**	**H**	**M**	**M**	**M**
Mean	2.60		2.69		2.83		3.00		2.94	
Drainage Rank	**M**		**M**		**M**		**M**		**M**	

Current Threats

Dewatering and Flow Management

Water withdrawals for irrigation, municipal, or residential purposes leave many watersheds in the South Coast sub-region dewatered or with inadequate flow during summer and fall months. Low flow conditions are most severe in the Illinois River and Umpqua Basin. In recent years early cessation of rains, below average snowpack, and above average air temperature have further contributed to reduced stream flows in much of the region. The proliferation of marijuana and hemp farms and potential impacts from climate change may exacerbate this situation in the future as well. Low flow conditions may reduce spawning habitat availability, prevent access to backwater or side channel habitats, create low water barriers, and may contribute to mortality if incubating eggs or burrowing larvae are dewatered or exposed to a high temperature or low oxygen environment.

Stream and Floodplain Degradation

Stream and floodplain degradation is widespread throughout the South Coast sub-region. Within lowlands, wetlands and side channels have been channelized, diked, diverted or drained to prevent flooding, create farmland or pastures, and provide land for commercial and residential development. In upland areas, historical and ongoing timber practices, agriculture, road construction, and urbanization have deforested or altered the function and diversity of riparian vegetation. Suction dredge mining is of particular concern in the South Umpqua, Umpqua, and Illinois River. This practice may increase sedimentation and turbidity, alter stream channel topography, disturb and destabilize spawning and rearing habitat, kill incubating eggs and larvae, and may re-suspend contaminants such as mercury or other heavy metals in the water body.

Water Quality

Current water quality conditions are impaired in many watersheds; and elevated water temperature remains a widespread issue throughout the South Coast sub-region (https://www.oregon.gov/deq/wq/tmdls/Pages/TMDLs-Approved-by-EPA.aspx). Excessive temperatures are likely associated with heavy water withdrawals and extensive floodplain degradation. Chemical and herbicide inputs from agriculture and industrial forest practices were also noted as problematic in the Umpqua Basin and Chetco River.

Lack of Awareness

Scientific understanding of Pacific Lamprey life history characteristics, habitat needs, physiological limitations, and awareness in terms of Best Management Practices when conducting instream work has improved over the last 5-10 years. Nevertheless, there is still a large portion of the human population that is not aware of lamprey, its importance to freshwater ecosystems, and how to avoid impacts to them. For more information about how to minimize impact to native lampreys during in-water work, please consult LTW (2020).

Climate Change

Some watersheds in the South Coast sub-region may be more resilient to impacts of climate

change (Upper Rogue, Applegate, Sixes, North Umpqua), while others may be at greater risk from potential change (Illinois, Umpqua, South Umpqua) based upon the underlying geology, impoundments, and other factors. Climate models predict increasing water temperatures, which may restrict habitat availability. Increased high intensity storm events and more precipitation falling as rain at higher elevations could cause flooding, which may lead to erosion and scouring of lamprey habitat. Earlier melting of snowpack due to warmer ambient temperatures may alter flow regimes during periods of lamprey spawning.

The impacts of relatively warm water temperatures (e.g., ≥20°C) on the embryonic development, physiology, adult migrations, reproductive capability and evolutionary pressures can be multitudinous and substantial (Clemens et al. 2016).

Predation

Although not considered a 'key threat', predation of larval lamprey by non-native fish species is a known issue in the South Coast sub-region. Smallmouth bass predation on juvenile lamprey has been documented in the Umpqua Basin (Schultz et al. 2017) and is also believed to occur in the Coquille River. Furthermore, the introduction of the non-native Umpqua pikeminnow to the Applegate, Illinois, Chetco, and Rogue Rivers has likely increased predation of larvae in these basins. Dams and diversions can increase habitat suitability for warm water fish species and may contribute to the decline of lamprey by delaying juvenile migration or exposing fish to increased predation. In addition, stream temperature increases predicted with climate models may impact regulated and non-regulated rivers as well, increasing the upstream extent of habitat for non-native species (Lawrence and Olden 2013; Lawrence et al. 2014).

Restoration Actions

Pacific Lamprey conservation work in the South Coast sub-region is currently focused on adult passage improvement, expansion of occupancy surveys, environmental DNA sampling, habitat assessments, predation studies, and numerous projects to restore degraded habitat. The following conservation actions were initiated or recently completed by RMU partners in the South Coast sub-region from 2012-2019.

HUC	Threat	Action Description	Type	Status
RMU	Stream Degradation	Implementation of instream and floodplain habitat restoration activities (e.g. large wood and boulder placement, side channel and floodplain reconnection, channel reconstruction, bank stabilization, gravel recruitment, etc.).	Instream	Ongoing
RMU	Population	Conduct spawning ground surveys in mainstem and principal tributaries to monitor Pacific Lamprey distribution, timing, and number of redds to develop relative abundance indexes.	Survey	Ongoing

RMU	Stream Degradation	Senate Bill 838 imposed 5-year moratorium of suction dredge mining on all Oregon streams with designated Essential Salmon Habitat (ESH). Also restrictions on specific USFS and BLM waterways (e.g. Rogue, Illinois)	Instream	Underway
RMU	Population	Environmental DNA sampling to fill distribution gaps on Rogue River Siskiyou National Forest Land.	Survey	Underway
RMU	Population	Oregon Department of Fish and Wildlife Conservation Plan for Lampreys in Oregon https://www.dfw.state.or.us/fish/CRP/coastal_columbia_snake_lamprey_plan.asp	Other	Complete
RMU	Other	Formation of South Coast Lamprey Working Group	Coordination	Ongoing
RMU	Stream Degradation	Science in Restoration Workshop and future whitepaper about restoration techniques for lampreys	Coordination	Upcoming
North Umpqua	Passage	Passage improvement at Soda Springs Dam.	Instream	Complete
North Umpqua	Passage	Pacific Lamprey spawning and rearing habitat suitability above Soda Springs Dam	Survey/ Assessment	Complete
North Umpqua	Passage	Passage improvement at Rock Creek Hatchery diversion dam fish ladder.	Instream	Complete
North Umpqua	Passage	Installation of Lamprey Passage Structure at Winchester Dam.	Instream	Complete
North Umpqua	Passage	Installation of video monitoring camera on Winchester Dam lamprey ramp	Instream	Complete
North Umpqua	Population	Conduct native fish inventory to establish baseline lamprey distribution dataset	Survey	Complete
Umpqua	Predation	Smallmouth bass predation evaluation in lower Elk Creek and Umpqua R.	Assessment	Complete
Umpqua	Other	Formation of Umpqua River Basin Lamprey Working Group.	Coordination	Ongoing
Umpqua & Rogue Basins	Population	Lamprey distribution mapping, occupancy and environmental DNA sampling.	Survey	Ongoing
Umpqua & Rogue Basins	Lack of Awareness	Provide education and outreach to stakeholders, resource managers and community members	Coordination	Ongoing
Rogue Basin	Passage	Rogue Basinwide Priority Barrier Removal Analysis - project characterized and prioritized 38 passage barriers in	Assessment	Complete

		basin.		
Rogue Basin	Passage	Low cost passage retrofits at irrigation diversion dams.	Assessment/ Instream	Proposed
Upper & Middle Rogue	Population	Distribution surveys in principal tributaries.	Survey	Complete
Middle Rogue	Passage	Removal of Fielder and Wimer dams on Evans Creek	Instream	Complete
Lower Rogue	Stream Degradation	Rogue River Estuary Strategic Plan and Lower Rogue Watershed Action Plan - to identify and prioritize conservation and restoration actions in lower Rogue and tributaries.	Assessment	Complete
Applegate & Illinois	Population	Distribution surveys in principal tributaries	Survey	Complete
Applegate & Illinois	Predation	Umpqua pikeminnow predation evaluation	Assessment	Proposed
Applegate	Passage	Removal of large gravel push-up dam on Williams Cr. (RM 0.5) opening 31 miles of habitat for native fish	Instream	Underway
Coos	Passage & Population	Evaluation of passage constraints and baseline presence/absence of lamprey within the Eel Lake basin	Assessment	Underway/ Complete
Coos	Passage	Installation of lamprey passage ramp/trap at Eel Creek Dam.	Instream	Complete
Coos	Passage	Installation of new trap box and camera monitoring system in Eel Lake ladder	Instream	Complete
Coos	Population	Telemetry to monitor movement, distribution and spawning of Pacific Lamprey through Tenmile Lakes system.	Assessment	Ongoing
Coos	Stream Degradation	Implementation of instream and floodplain habitat restoration activities (e.g. East Fork Millicoma Oxbow project, Ross Slough Project)	Instream	Complete
Coos	Population	Comparison of e-shocking and eDNA sampling (sediment & water samples) in the Coos Estuary (South Slough)	Assessment	Underway
Coos	Population	Development of eDNA citizen science network in greater Coos targeting Pacific and western brook lamprey	Assessment	Underway
Coos/ Coquille	Passage	Multiple culvert replacement or removal projects where lamprey salvage efforts occurred.	Instream	Ongoing
Coquille	Passage	Baker Creek culvert removal on SF Coquille – a regional stronghold for Pacific Lamprey	Instream	Complete

Coquille	Population	Lamprey spawning ground surveys in South Fork Coquille River.	Survey	Ongoing
Coquille	Population	Assessment to study entry timing of Pacific Lamprey into Coquille River	Survey	Proposed
Coquille	Climate Change	Water quality monitoring in lower Coquille River to identify cold water refuge.	Survey/ Assessment	Underway

Selection of Priority Actions

A. Prioritization Process

Participating members of the South Coast sub-region had a virtual meeting on April 21st, 2020 to discuss completed and ongoing conservation actions and identify specific projects and research needed to address threats and uncertainties within the region. Project proposals were submitted online and sent to RMU members for review. The following projects were submitted by RMU partners for the South Coast sub-region in 2020:

- GIS and eDNA Evaluation of Lamprey Barriers in the Southern Oregon Coast Range
- Twelvemile Creek Habitat Restoration

High Priority Proposed Project Information

Project Title: GIS and eDNA Evaluation of Lamprey Barriers in the Southern OR Coast Range

Project Applicant/Organization: Earth Design Consultants, Inc.
Contact Person: Dr. Ralph J. Garono
Email:rgarono@earthdesign.com
Phone:541.757.7896/ 541.829.9925

Project Type: **Passage Improvement**

Lamprey RMU population(s): South Oregon Coast Sub-Region
Multi-RMU project? Please list RMUs: North Oregon Coast Sub-Region

Watershed (5th HUC Field):17100206 & 17100205
NPCC Subbasin (4th HUC Field) name:
Project Location: Southern and Mid Oregon Coast Range
Project Coordinates (latitude and longitude, decimal degrees, NAD 1983): project spans several watersheds from Coquille to Yaquina.

Total Requested funds: **$20,704**

1. ***Short Project Summary (200 words or less):***

We are seeking funds to provide GIS analysis to develop a stratified sampling plan to identify high quality lamprey habitat that may be blocked by barriers in the southern Oregon Coast Range. We propose to use multivariate statistical techniques (e.g., cluster analysis, discriminant analysis, or nonmetric multidimensional scaling) to group stream segments and their associated watersheds into well-defined groups using environmental variables based on eBLIMP (eDNA Basinwide Lamprey Inventory & Monitoring Project) habitat suitability models (stream gradient, flow or flow accumulation, channel morphology, water temperature, etc…). Two lamprey species coexist in streams along the Oregon Coast, Pacific lamprey (*Entosphenus tridentatus*) and western brook lamprey (*Lampetra richardsonii*). Data from our 2019 eDNA surveys will be used to determine which classes of stream segments support lamprey populations. Stream segments will then be checked for accessibility (by field teams) and for barriers that may limit lamprey distribution and movement. Sites will then be randomly stratified and incorporated into a prioritized decision support system. This project enhances an existing project and will use volunteers trained and managed by the South Slough NERR.

2. ***Detailed Project Description (500 words or less):***

Pacific lamprey (*E. tridentatus*) and western brook lamprey (*L. richardsonii*) require streams with pockets of sediment and flowing water because they bury themselves in sediment during the day and extend their bodies into the water column during the night to feed. They feed by filtering

organic material from the water. Both species also require areas of pebble or sand for spawning. We are interested in how lamprey populations are doing in streams along the Oregon Mid and South Coast, a mosaic of State, Federal and Private property. Because lamprey are buried in stream sediments and are nocturnal, they are difficult to observe and to census. In addition, young lamprey of these two species (<6cm length) are difficult to distinguish from each other. A common method to study lamprey is to use electro-fishing techniques. However, this method is labor intensive, requiring specialized equipment and a team with technical lamprey identification experience. It also requires disturbing stream habitats and capturing and releasing lamprey, which may harm individuals. We are testing a new method to map lamprey distributions which uses environmental DNA (eDNA), collected from the water column, to identify lamprey species (Carim et al 2016). In 2019, field teams, comprised of SSNERR staff and volunteers (citizen scientists), sampled 71 locations in streams along the mid and southern Oregon coast for these two lamprey species. Funds from a USDA-USFS citizen science grant were used for the 2019 work and most of this previous sampling was on public land: Siuslaw and Rogue River-Siskiyou National Forests, plus state and county land. Sites were selected haphazardly, i.e., not part of any experimental sampling design; therefore, we are only able to draw limited conclusions.

We need to develop a more rigorous experimental design in order to conduct a formal analysis. **We are seeking funds to provide GIS analysis to develop a statistically-defensible sampling method, to derive landscape metrics, and identify impediments to lamprey passage**.

Our hypotheses, derived from our preliminary results, support the goals and objectives of this RFP and our study results will be used to better manage these important species. This project addresses the threats of **Stream and Floodplain Degradation** and **Lack of Awareness**, which are both key threats listed for both RMU's. This project uses lamprey presence data, collected by citizen scientists using eDNA analysis methods, to assess effects of lamprey movement barriers on reduction of suitable upstream habitat. A GIS analysis using 2019 eDNA Pacific and western brook lamprey presence data will assess habitat quality. Then, we will assess where barriers likely prevent lamprey movement using the existing fish barriers GIS database. We will then prioritize additional eDNA samples (collected by citizen scientists and analyzed under a 2020-2023 USDA-USFS Citizen Science grant) to assess whether lampreys are present above the barrier. The result will be a prioritized list of potential barrier removal sites based on the amount of suitable habitat upstream. It will also map distributions of the two lamprey species (each location will be entered into the publicly accessible USFS lamprey eDNA database). The project also increases awareness of lamprey through the citizen scientist eDNA training program.

3. Descriptive Photographs-Illustrations-Maps (limit to three total):

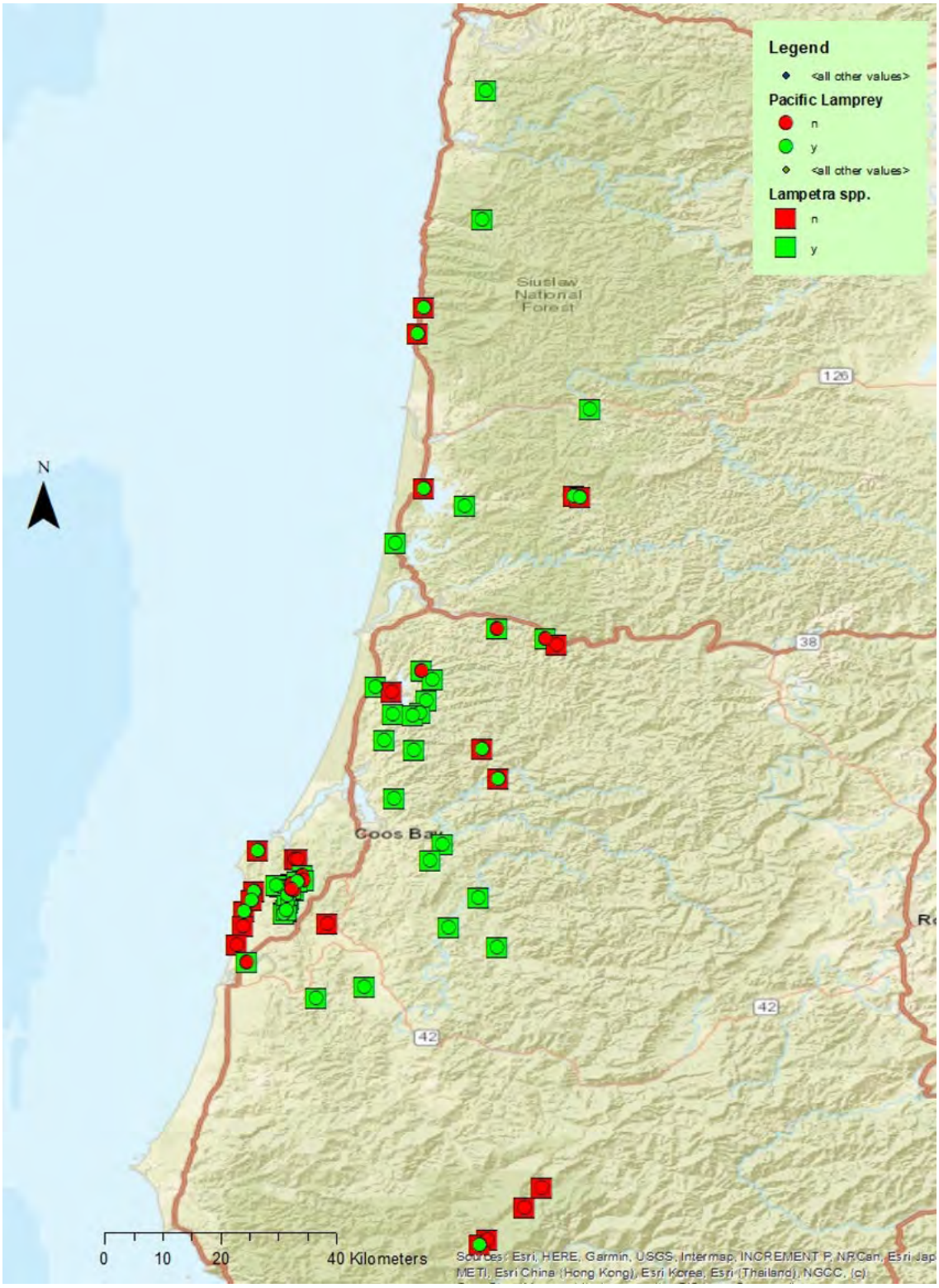


Figure 1. Area of current study and proposed project area showing distribution of 2019 eDNA results.

4. ***Linkage of Actions to Identified Threats for Lampreys in RMU(s) (300 words or less):***
    - *What threat(s) to lampreys does this project address? (See your RIP(s) for key threats)* **Stream Passage, Floodplain Degradation, Small Effective Population Size, Lack of Awareness**
    - *Does this project address threat(s) to lampreys specific to this RMU only, or does the project address the threat(s) prevalent in multiple RMUs?*
      Single RMU ☐, **Multiple RMUs** ☒ list additional RMUs:

The area of this project includes watersheds from Yaquina to Coquille and therefore spans two Regional Management Units, Oregon North Coast and Oregon South Coast.

- *Describe how this project addresses key threat(s) to lampreys within the HUC(s) where project is proposed.*

This project uses lamprey presence data, collected by citizen scientists using eDNA analysis methods, to assess effects of lamprey movement barriers on reduction of suitable upstream habitat. A GIS analysis using 2019 eDNA Pacific and western brook lamprey presence data will assess habitat quality in selected watersheds. Then, we will assess where barriers likely prevent lamprey movement using the existing fish barriers GIS database. We will then prioritize additional eDNA samples (collected by Citizen Scientists and analyzed under a 2020-2023 USDA-USFS Citizen Science grant) to assess whether lampreys are present below and above the barrier. The result will be a prioritized list of potential barrier removal sites based on the amount of suitable habitat upstream. This will help target the best sites for barrier removal. The project also increases awareness of lamprey through the citizen scientist eDNA training program and subsequent reports to stakeholders and the public through South Slough Education and Coastal Training programs.

5. ***Species/Habitat Benefits (200 words or less):***
    - *Provide citation of literature, distribution maps, and/or surveys demonstrating lampreys are currently and/or were historically present in the project area.*

Our 2019 eDNA results indicate that lamprey are present throughout our project area.

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

We will assess lamprey presence throughout the area (at least 80 sites) and assess presence above and below potential barriers in order to identify area that would benefit most from passage improvement projects.

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

All life stages will benefit from access to high quality habitat, identified by this project, that may be removed in the future.

- *What other species may benefit from action?*

Salmonid species with distributions limited by stream barriers.

6. ***Priority Objectives and Goals:***
    - *Indicate the strategies, and/or restoration/management plans are addressed by this project (when available relevant documents/websites are hyperlinked below for reference):*
        - PLCI Conservation Agreement ☐
        - National Fish Habitat Partnership National Conservation Strategies ☐
        - USFWS Climate Change Strategies ☐

- Bonneville Power Administration Northwest Power and Conservation Council Columbia River Basin Fish and Wildlife Program ☐
- CRITFC Tribal Pacific Lamprey Restoration Plan for the Columbia River Basin ☐
- US Army Corps of Engineers Pacific Lamprey Passage Improvement Implementation Plan ☐
- PUD Management Plan (please name below) ☐
- Other (please name below) ☐

- Clearly describe how the project addresses the goals and objectives in the strategies, restoration/management plans indicated above (200 words or less).

The outputs of this project will include assessing habitat suitability and prioritizing barriers for removal using eDNA, GIS, and citizen scientists. The expected outcome will be an increase of suitable habitat for lamprey species along the Oregon Coast. This proposal supports the PCLI Conservation Agreement Objective 5, Identifying and characterizing distributions of Pacific Lamprey; Objective 6, Enhancing watershed conditions; and Objective 7, Restoring Pacific Lamprey of the RMU's. It also supports Objective 3, Public Outreach through the use of citizen scientists and expected public reports and presentations.

A GIS analysis using 2019 eDNA Pacific and western brook lamprey presence data will assess habitat quality in selected watersheds. Then, we will assess where barriers likely prevent lamprey movement using the existing fish barriers GIS database. We will then prioritize additional eDNA samples (collected by citizen scientists and analyzed under a 2020-2023 USDA-USFS Citizen Science grant) to assess whether lampreys are present below and above the barrier. The result will be a prioritized list of potential barrier removal sites based on the amount of suitable habitat upstream. This will help target the best sites for barrier removal. The project also increases awareness of lamprey through the citizen scientist eDNA training program.

7. ***Project Design / Feasibility:***
   - *Have the designs for the project been completed already or will they be completed before planned project implementation?* **Yes X No☐**
   - *Are the appropriate permits (e.g., ESA consultation, Scientific Collection, fish health/transport, etc.) in place already or will they be in place before planned project implementation?* **Yes ☐ No☐ NA**
   - *Can the project be implemented within the defined timeframe? (See BPA & NFHP requirements in the accompanying PLCI RIP Priority Project Guidance document).* **Yes X No☐**
   - *Please provide a brief description (200 words or less):*

We will produce a prioritized list of potential barrier removal sites based on the amount of suitable habitat upstream and absence of lamprey above, but present below the barrier. All necessary data are available to conduct the GIS classification and barrier analysis. We have tested the eDNA methods in 2019 and have funds allocated for at least an additional 80 eDNA samples (possibly more depending on coordinator hours). This will help target the best sites for barrier removal. The project also increases awareness of lamprey through the citizen scientist eDNA training program. We will not be handling lamprey, so no permits are needed (although South Slough does have a ODFW-NOAA permit for electrofishing for lamprey in Winchester Creek, for our lamprey long-term abundance project)

8. Partner Engagement and Support (200 words or less):

- *What partners are supporting the project?*

South Slough National Estuarine Research Reserve Scientists, Staff, and Volunteers. Numerous other partners are interested in the eDNA distribution research and South Slough has been keeping them updated with annual reports.

- *What partners are active in implementing the project?*

South Slough National Estuarine Research Reserve Scientists, Staff and Volunteers.

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

South Slough National Estuarine Research Reserve Scientists, Staff ($20,000) and Volunteers ($12,600). The USDA-USFS is providing $30,000 for eDNA analysis.

9. Monitoring and Reporting (200 words or less):

- *How is completion of the project going to be documented?* (*See BPA and NFHP requirements in the accompanying PLCI RIP Project Proposal Guidance document).*)

The project will be complete after the eDNA samples are analyzed and a final report is produced.

- *How will the project's benefits to lampreys be monitored over time?*

We will track passage project that use the findings from the report to determine overall success of the project. The expected final outcome will be increased suitable habitat for the two lamprey species.

10. Project Budget (including overhead):

Project Budget:

	Items	# Hours or Units	Cost per Unit ($)	RIP Funds Requested ($)	Cost Share ($)	Total Cost ($)
A	***Personnel:***	-	-	-	-	-
	a. GIS Tech	125	60/hr	7,500		7,500
	b. GIS Analyst	40	90/hr	3,600		3,600
	c. Senior Ecologist	40	125/hr	5,000		5,000
	d. SSNERR Scientist	285	70/hr		19,950	19,950
	e. Volunteers	430	30/hr		12,900	12,900
B	***Equipment & Supplies:***	-	-	-	-	-
	a. Software & Hardware	150	30/hr	2,250	2,250	4,500
	b.					
	c.					
	d.					

C	***Travel:***	-	-	-	-	-
	a. Mileage	500	0.58	290		290
D	***Other:***	-	-	-	-	-
	a.					
	b.					
E	***Administrative:***	-	-	-	-	-
	Overhead (%)					
	Indirect Costs (10 %)			2,064		2,064
	Total (Sum of A - E)	-	-	20,704	35,100	55,804

11. Timeline of major tasks and milestones:

Workflow	*Start Date/Month*	*End Date/Month*	*Responsible Party*
Project Meeting	*Jan*	*Jan*	*EDC/SSNERR*
Acquire Spatial Data	*Jan*	*Mar*	*EDC*
Stream Classification	*Feb*	*May*	*EDC*
Sample Site Priorities	*May*	*Jun*	*EDC*
Sampling	*Jun*	*Aug*	*SSNERR*
Barrier Analysis	*Jun*	*Aug*	*EDC*
Reporting & Meeting	*Oct*	*Oct*	*EDC/SSNERR*

12. References (if applicable)

Carim, Kellie J.; McKelvey, Kevin S.; Young, Michael K.; Wilcox, Taylor M.; Schwartz, Michael K. 2016. **A protocol for collecting environmental DNA samples from streams.** Gen. Tech. Rep. RMRS-GTR-355. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station. 18 p.

eBLIMP Project: https://www.fs.fed.us/rm/boise/AWAE/projects/stream_temp/downloads/19-eBLIMP-lamprey-project-update_ORAFS_IDAFS.pdf

Project Title: Twelvemile Creek Habitat Restoration

Project Applicant/Organization: Coquille Watershed Association
Contact Person: Cyndi Park
Email: cpark@coquillewatershed.org
Phone: 918-720-7116

Project Type: **Habitat Restoration**

Lamprey RMU population(s): South Oregon Coast Sub-Region
Multi-RMU project? Please list RMUs

Watershed (5th HUC Field): Middle Fork Coquille River #1710030501 H*UC*
NPCC Subbasin (4th HUC Field) name: Coquille #17100305
Project Location: Twelvemile Creek
Project Coordinates (latitude and longitude, decimal degrees, NAD 1983):
42°55'42.2"N 123°43'27.8"W

Total Requested funds: **$39,047.80**

1. ***Short Project Summary (200 words or less):***

This project will restore channel complexity and floodplain connection in Twelvemile Creek, a 24,000-acre drainage to the Middle Fork Coquille River. Twelvemile Creek provides habitat for native salmonids and is an important spawning and rearing basin for Pacific Lamprey. Primary limiting factors in the sub-watershed include a lack of stream habitat complexity and poor water quality. Historically, Twelvemile Creek was clear-cut and subjected to stream cleaning, resulting in disconnected floodplains, large sections of bedrock substrate and lack sufficient large wood structures (LWD) and spawning gravel. To address these limiting factors, the Coquille Watershed Association, Roseburg BLM, ODFW and private timber companies are working towards a shared goal of improving spawning and rearing habitat for Pacific Lamprey in the Twelvemile basin. Ongoing project components include placing boulders and LWD into Twelvemile Creek and its tributaries and road improvements for sediment reduction and fish passage. Roseburg BLM and OWEB have funded wood placements on BLM and private timber property and road surveys, which have identified water quality issues. Funds from this solicitation will be used to compliment ongoing restoration by placing lamprey-focused boulders and LWD structures on private timber property, resulting in a holistic restoration project across an entire sub-watershed.

2. ***Detailed Project Description (500 words or less):***

Twelvemile Creek is an important sub-watershed for Pacific Lamprey within the Coquille River Basin. Due to past land management, large sections of Twelvemile Creek and its tributaries are lacking LWD, channel complexity and floodplain connection. Intensive logging and stream cleaning have led to down-cut channels with large sections of exposed bedrock and little capacity to sort and recruit spawning gravels and fine sediments; resulting in a lack of both spawning and ammocoete habitat (Photo 1).

CoqWA, Roseburg BLM, ODFW and private timber companies are addressing limiting factors for lamprey and other native fish by developing watershed level restoration actions in the Twelvemile Creek basin. CoqWA has performed road surveys and AQI analyses to address sediment loading and identify locations of limited habitat. We have received funding from OWEB to implement instream restoration (which this proposal seeks to build on) and are requesting additional funds from OWEB to address sediment loading and fish passage barriers. Currently funded instream restoration includes 10 log jams that were placed in Dice Creek in July 2020 and an additional 10 boulder and LWD structures that will be placed in Twelvemile Creek during the 2021 In-Water Work Period (IWWP). Roseburg BLM will also install LWD and boulder structures on adjacent BLM property in August 2020 to help recruit gravel and develop floodplain connection for native fish.

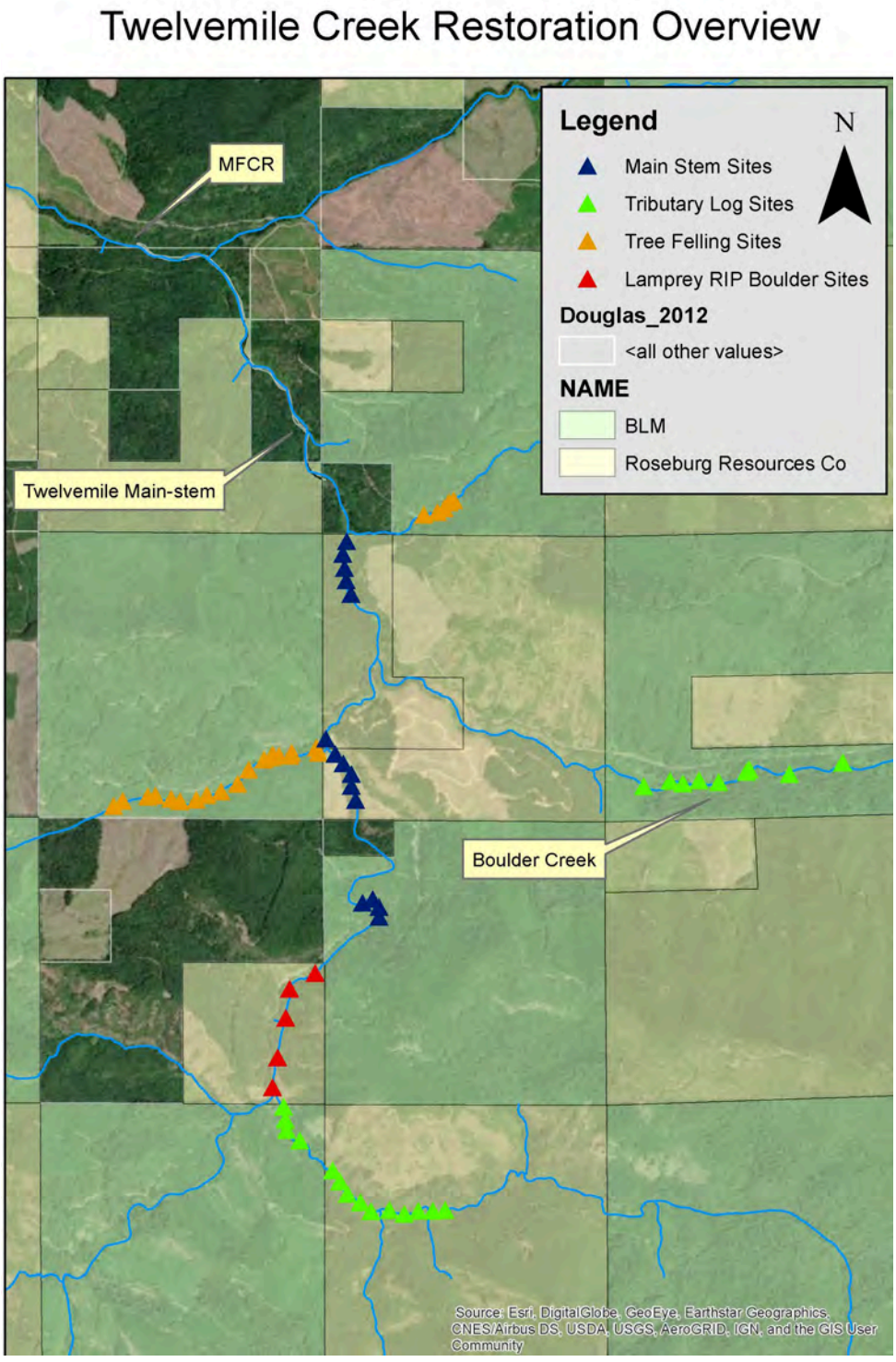
Funds from this solicitation will be used to place 5 structures for Pacific Lamprey within a reach of Twelvemile Creek that is dominated by bedrock (Photo 1, Map 1). Our time spent sighting Pacific Lamprey in the basin and surveying in adjacent stream reaches where there are rare segments of undisturbed habitat (Photo 2) give us confidence that placement of logs and boulders in the proposed restoration reach will aggrade gravel and finer substrate that will likely be used by larval lamprey to a high degree. The placed boulders and logs would also be used by adult lamprey for cover as they go through physiological processes preparing for spawning.

Specifically, this application will accomplish the following objectives:

- Deliver 100 boulders and 15 logs to the restoration site before July 1, 2021.
- Construct 5 boulder and log structures to sort gravels and fine sediments for lamprey habitat during the 2021 IWWP
- Coordinate with BLM and ODFW to ensure continuity between restoration sites and a cost efficient workflow throughout the IWWP.

Hazard trees on BLM property that burned in the 2017 Horse Prairie fire have been donated by the BLM for restoration logs. Felling and transport of logs will be done in conjunction with felling and delivery for concurrent restoration activities. Each site will contain 20 boulders and 3 logs constructed to maximize longevity, sort gravels and fines, and provide habitat complexity for all life stages of lamprey. Each site will be designed based on ODFW specifications, local knowledge and experience, and to maximize habitat benefits at each specific location. Additionally, sites will be designed and constructed to compliment restoration sites on BLM property directly upstream and downstream of the project location.

3. Descriptive Photographs-Illustrations-Maps (limit to three total):



Map 1: Location of instream restoration sites on BLM and Roseburg Resources Property. Restoration actions will be ongoing through the 2020 and 2021 IWWP.

Photo 1. Long section of exposed bedrock at the project site. This substrate is typical throughout the project site and across the Twelvemile basin.

Photo 2. Twelvemile Creek in an undisturbed reach about ¾ of a mile upstream of the proposed work that would be completed with requested funds.

4. ***Linkage of Actions to Identified Threats for Lampreys in RMU(s) (300 words or less):***
    - *What threat(s) to lampreys does this project address? (See your RIP(s) for key threats)* ***Stream and Floodplain Degradation*** Choose an item. Choose an item. Choose an item.
    - *Does this project address threat(s) to lampreys specific to this RMU only, or does the project address the threat(s) prevalent in multiple RMUs?*
      Single RMU ☒, Multiple RMUs ☐ list additional RMUs:
    - *Describe how this project addresses key threat(s) to lampreys within the HUC(s) where project is proposed.*

Stream and floodplain degradation is the most critical threat that needs to be addressed in the Twelvemile Creek basin. Past land use has created a lack of spawning gravel, fine sediments for larval lamprey and floodplain connection/complexity that are limiting the resilience of lamprey populations. Adopting learned metrics from PSUs Lamprey Ecology Course, and research studies (Stone and Barndt 2004), a qualitative lamprey habitat survey conducted by CoqWA staff and Roseburg BLM (11/8/2018) indicated that less than 25% of the habitat in the proposed stream reach was suitable for spawning or rearing by Pacific Lamprey. By creating boulder and log structures on a portion of Twelvemile Creek that is cut down to bedrock, this project will allow natural processes to address these threats. Specifically, these structures will slow down water to recruit gravel and fine sediments while facilitating stream complexity and floodplain connection.

5. ***Species/Habitat Benefits (200 words or less):***
    - *Provide citation of literature, distribution maps, and/or surveys demonstrating lampreys are currently and/or were historically present in the project area.*
    - *How will the project provide meaningful measureable results to improve lamprey populations and/or their habitat conditions?*
    - *What life stage or stages will benefit from action? How?*
    - *What other species may benefit from action?*

This project, along with other restoration activities being performed in the area, will provide measurable improvements to habitat conditions in the Twelvemile basin, which will translate into improvements in lamprey populations. Pacific Lamprey adults and lamprey redds are often seen in the basin through informal surveys (Clark, S., personal communication attached). Gravel and fine sediment recruitment will have positive benefits for both the adult and larval stages on lamprey by providing habitat that has been depleted for these life stages in the basin. The placed boulder and log structures will also be used by adult lamprey as cover as they go through physiological processes preparing for spawning. These structures will also provide habitat benefits for steelhead and cutthroat trout, and restoring the natural substrate stratification processes will benefit the healthy population of freshwater mussels that was recently documented in this reach of Twelvemile Creek.

6. ***Priority Objectives and Goals:***
    - *Indicate the strategies, and/or restoration/management plans are addressed by this project (when available relevant documents/websites are hyperlinked below for reference):*
        - PLCI Conservation Agreement ☒
        - National Fish Habitat Partnership National Conservation Strategies ☒
        - USFWS Climate Change Strategies ☒
        - Bonneville Power Administration Northwest Power and Conservation Council Columbia River Basin Fish and Wildlife Program ☐
        - CRITFC Tribal Pacific Lamprey Restoration Plan for the Columbia River Basin ☐
        - US Army Corps of Engineers Pacific Lamprey Passage Improvement Implementation Plan ☐
        - PUD Management Plan (please name below) ☐
        - Other (please name below) ☐
    - *Clearly describe how the project addresses the goals and objectives in the strategies, restoration/management plans indicated above (200 words or less).*

The proposed project aligns with the PLCI Conservation Agreement by implementing restoration actions that support the conservation goals identified for the Coastal Oregon RMU. The greatest threat to this RMU has been identified as the degradation of stream and floodplain habitat, which this project directly seeks to remedy. The stated restoration actions will also address climate change by providing instream diversity including scour pools and cover, both of which will lower stream temperatures in Twelvemile Creek—a main tributary to the Middle Fork Coquille River. This project also falls in line with the National Fish Habitat Partnership National Conservation Strategies as it restores hydrologic conditions for fish, reconnects fragmented habitats, and restores water quality.

7. Project Design / Feasibility:
- *Have the designs for the project been completed already or will they be completed before planned project implementation?* **Yes ☒** No☐
- *Are the appropriate permits (e.g., ESA consultation, Scientific Collection, fish health/transport, etc.) in place already or will they be in place before planned project implementation?* **Yes ☒** No☐
- *Can the project be implemented within the defined timeframe? (See BPA & NFHP requirements in the accompanying PLCI RIP Priority Project Guidance document).* **Yes ☒** No☐
- *Please provide a brief description (200 words or less):*

Project designs follow the Guide for Placement of Wood, Boulders and Gravel for Habitat Restoration published by OWEB and ODFW. Designs are also based on experience from a Roseburg BLM Fish Biologist who has implemented successful lamprey habitat projects in the Cow Creek basin. Past analyses from AQI surveys have determined that the reaches being treated in this project are of the highest priority for habitat restoration in Twelvemile Creek. AQI data and field surveys with project partners were used to design five sites with 20 boulders and 3 logs each. Boulder size was based on boulders naturally occurring in the stream and will be 1.5

cubic yards to withstand high flows. Logs are old –growth trees from the Horse Prairie fire and will be keyed into boulders and trees within the riparian area. Log and boulder placements will be completed by stream restoration specialists, Blue Ridge Timber Company, and implementation will be supervised by a CoqWA Restoration Program Coordinator and a BLM Fish Biologist.

8. ***Partner Engagement and Support (200 words or less):***
    - *What partners are supporting the project?*
    - *What partners are active in implementing the project?*
    - *What partners are providing matching funds or in-kind services that directly contribute to the project?*

CoqWA will partner with the Roseburg BLM and Roseburg Forest Products Co. to implement restoration. Roseburg BLM will be implementing habitat restoration for lamprey and steelhead on BLM property adjacent to the project site and will partner with CoqWA for efficient contracting, delivery, staging and implementation. Roseburg BLM is also donating all of the logs used for this project. An ODFW fish biologist will also be present during final structure design conversations with the contractor and implementation. Roseburg Forest Products is supportive of this project and is allowing restoration on their property as well as providing match and support for future projects in the basin.

9. ***Monitoring and Reporting (200 words or less):***
    - *How is completion of the project going to be documented?* (*See BPA and NFHP requirements in the accompanying PLCI RIP Project Proposal Guidance document).*)
    - *How will the project's benefits to lampreys be monitored over time?*

Photo points will be taken at each site before restoration, directly after restoration and once a year for 5 years after restoration. Additionally, a CoqWA Restoration Program Coordinator will visit each log and boulder placement site during high winter flows to ensure stability of the structures. In partnership with Roseburg BLM fish biologists, we will continue to perform spawning surveys and in addition to larval lamprey surveys before and after log and boulder installation in the basin. Laval lamprey surveys will be done using an LR-24 backpack electrofisher using appropriate lamprey "tickle settings". The surveys will help us determine presence/absence before and after restoration actions and help determine qualitative abundance of larval lamprey within the reach proposed for restoration. Together, these monitoring actions will provide a picture of the total benefits realized during this restoration project.

10. ***Project Budget (including overhead):***
    - See last page.

11. Timeline of major tasks and milestones:

Workflow	***Start Date/Month***	***End Date/Month***	***Responsible Party***
Environmental compliance/permits (completed)	Finished	Finished	BLM
Stream surveys and analysis	Finished	Finished	BLM, CoqWA, and ODFW
Pre-project lamprey surveys	9/2020	6/2021	BLM and CoqWA
Pre-project preparation	2/2021	6/2021	BLM and CoqWA
Implementation	7/2021	9/2021	CoqWA
Post-project lamprey surveys	9/2021	6/2022	BLM and CoqWA
Reporting	9/2021	12/2022	CoqWA

Project Budget:

	Items	# Hours or Units	Cost per Unit ($)	RIP Funds Requested ($)	Cost Share ($)	Total Cost ($)
A	Personnel:	-	-	-	-	-
	a. CoqWA Restoration Program Coordinator	400	$44.00	$8,000.00	$9,600.00	$17,600.00
	b. CoqWA Executive Director	60	$48.00	$1,600.00	$1,280.00	$2,880.00
	c. Roseburg Resources Forester	40	$30.00	$0.00	$1,200.00	$1,200.00
	d. BLM Fish Biologist	20	$40.00	$0.00	$800.00	$800.00
B	Equipment & Supplies:	-	-	-	-	-
	a. Boulders for BLM and CoqWA, delivered	100	$95.00	$9,500.00	$0.00	$9,500.00
	b. Trees with rootwads, delivered	15	$300.00	$0.00	$4,500.00	$4,500.00
C	Travel:	-	-	-	-	-
	a. CoqWA office to site, 82 miles round trip	4,100	$0.585	$2,398.00	$0.00	$2,398.00
D	Contracted Services	-	-	-	-	-
	a. Boulder and log placement	40	$350.00	$14,000.00	$0.00	$14,000.00
	b. Boulder and log placement on adjacent BLM property	1	$30,300.00	$0.00	$30,300.00	$30,300.00
E	Administrative:	-	-	-	-	-
	Overhead (10 %)			$3,549.80	$4,768.00	$8,317.85
	Indirect Costs (%)					
	Total (Sum of A - E)	-	-	$39,047.80	$52,448.00	$91,496.35

III. Literature Cited

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

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

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

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

Lamprey Technical Workgroup. 2020. Best management guidelines for native lampreys during in-water work. Original Version 1.0, May 4, 2020. 22pp. + Appendices. Available: https://www.fws.gov/pacificlamprey/LTWGMainpage.cfm.

Lawrence, D. J., J. D. Olden and C. E. Torgersen. 2012. Spatiotemporal patterns and habitat associations of smallmouth bass (Micropterus dolomieu) invading salmon-rearing habitat. *Freshwater Biology*, *57*(9), 1929-1946.

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

Schultz, L.D., M.P. Heck, B. M. Kowalski, C. A. Eagle-Smith, K. Coates and J.B. Dunham. Bioenergetics Models to Estimate Numbers of Larval Lampreys consumed by Smallmouth Bass in Elk Creek, Oregon. *North American Journal of Fisheries Management*, 37:4, 714-723, DOI: 10.1080/02755947.2017.1317677.

State of Oregon. https://www.oregon.gov/deq/wq/tmdls/Pages/TMDLs-Approved-by-EPA.aspx

USFWS (U.S. Fish and Wildlife Service). 2018. Pacific Lamprey Entosphenus tridentatus assessment. February 1, 2019. USFWS, Washington D.C.

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.