

Pacific Lamprey
2021 Regional Implementation Plan
for the
Oregon Coast
Regional Management Unit
South Coast Sub-Region



Submitted to the Conservation Team August 11, 2021

Primary Authors

J. Poirier

U.S. Fish and Wildlife

Primary Editors

K. Coates

Service
Cow Creek Band of Umpqua
Tribe of Indians

This page left intentionally blank

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 km² (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).

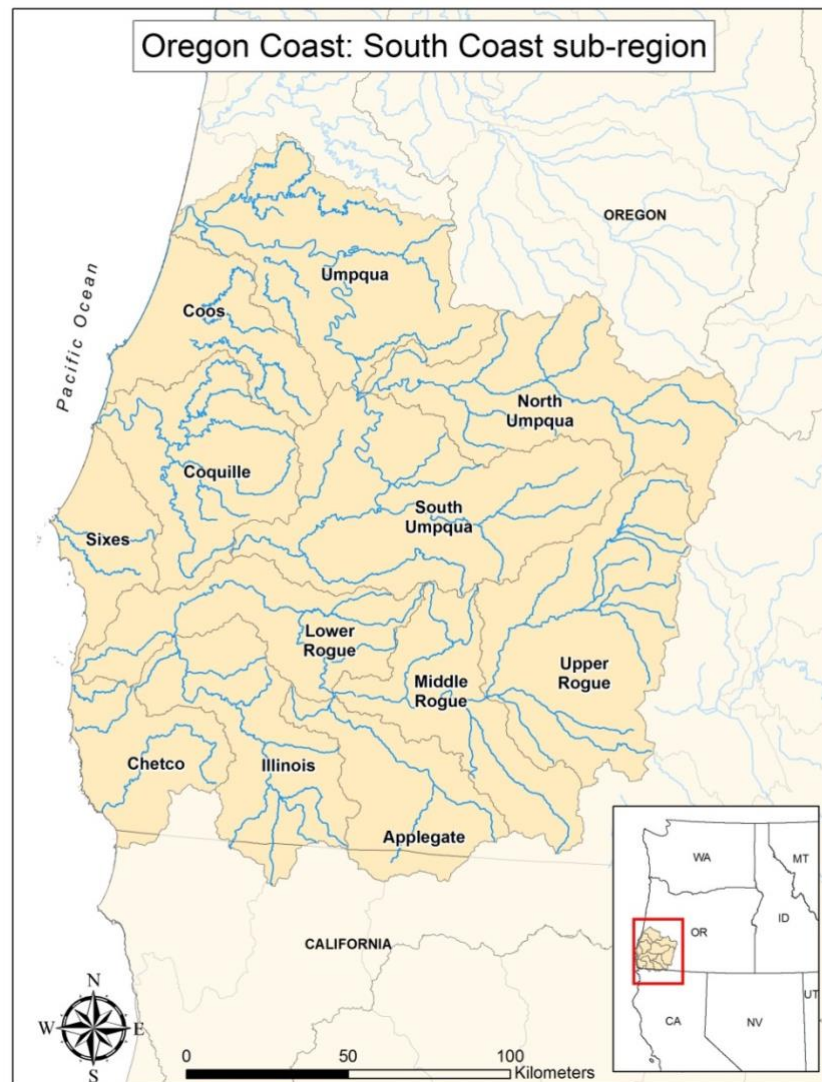


Figure 1. Map of watersheds within the Oregon Coast RMU, South Coast sub-region.

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 (km²)	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 lampreys passing over Winchester Dam has recently shown a slight increase since the lamprey ramp was employed during 2013 – 2020, with an average of 860 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

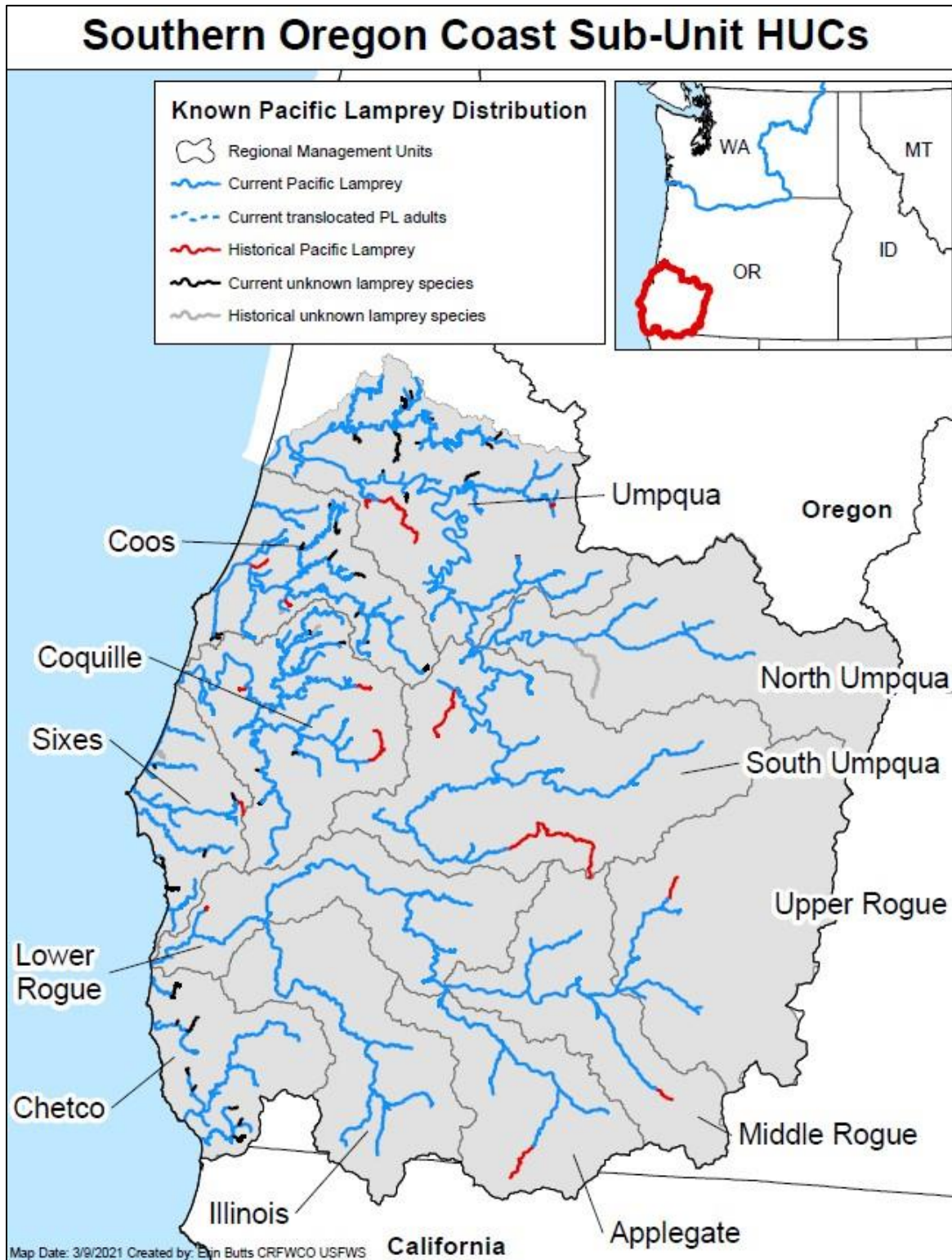


Figure 2. Current and historical known distribution for Pacific Lamprey: Oregon Coast Regional Management Unit, South Coast sub-region (USFWS Data Clearinghouse 2021). Historical Pacific Lamprey distribution depicted in map was obtained from published literature, tribal accounts and state and federal 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.

Smaller dams and water diversions for municipal, irrigation, livestock and other uses are abundant within the South Coast sub-region. Contemporary structures are required to provide passage for migratory fish and maintain screening or by-pass devices to protect fish from impingement or entrainment. Unfortunately, there are a large number of older structures that predate current screening and fish passage requirements. Additionally, active water rights associated with diversions make them difficult to upgrade or remove. Water diversion structures with inadequate screening or open irrigation canals can harm or entrap larval and juvenile lamprey while channel spanning concrete dams may delay or impede adult lamprey passage given their difficulty navigating over or around sharp edges (e.g., 90° angles), especially in areas with high velocity (e.g., dams crest; Pacific Lamprey Technical Workgroup 2017).

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.

Watershed	Dewatering and Flow Management		Stream and Floodplain Degradation		Water Quality		Lack of Awareness		Climate Change	
	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity
South Oregon Coast										
<i>North Umpqua</i>	4	3	2	3	3	2.5	4	2	4	3
<i>South Umpqua</i>	3	4	4	3	4	3	4	2	4	4
<i>Umpqua</i>	3	3	3	3	3	3	4	2	4	4
<i>Coos</i>	2	2	3	3	3	3	4	2	3	3
<i>Coquille</i>	2.2	2	3	3	3.5	3	4	2	3	3
<i>Sixes</i>	1	2	3	3	3	3	4	2	2	2
<i>Upper Rogue</i>	3	3	3	2.5	3	3	4	2	2.5	2.5
<i>Middle Rogue</i>	3	3	3	3	3	3	4	2	3	2.5
<i>Applegate</i>	3	3	3	2.5	3	3	4	2	3	2.5
<i>Lower Rogue</i>	1	1	1	1.5	1	1	4	2	2	2
<i>Illinois</i>	4	4	3	3	4	4	4	2	4	3.5
<i>Chetco</i>	1	2	1	2	1	2	4	2	2	2
<i>Average Scope/Severity</i>	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
<i>Mean</i>	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 was a popular recreational activity in the South Umpqua, Umpqua, Rogue, Chetco, and Illinois Rivers up until 2013. Suction dredge mining (i.e., vacuuming/excavating streambeds) can increase sedimentation and turbidity, alter stream channel morphology, disturb and destabilize spawning and rearing habitat, kill incubating eggs and larvae, and re-suspend contaminants such as mercury or other heavy metals in the water body (ORAFS 2015). In 2017 the Oregon Senate passed the Suction Dredge Reform Bill (SB 3) that prohibits all motorized suction dredge mining in rivers and streams that provide essential habitat for salmon and lamprey (see <https://chetco-new.dsl.state.or.us/esh2017/>).

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., $\geq 20^{\circ}\text{C}$) on the embryonic development, physiology, adult migrations, reproductive capability and evolutionary pressures can be multitudinous and substantial (Clemens et al. 2016).

Predation

Although predation was not ranked a ‘key threat’ during the 2017 Risk Assessment revision, predation of larval lamprey by non-native fish species is a known issue in at least six HUCs within the South Coast sub-region. Smallmouth bass predation on juvenile lamprey has been documented in the Umpqua Basin (Schultz et al. 2017) and is believed to be getting worse 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). In light of this information, the South Coast RMU group believes the rankings for Predation scope and severity in the 2018 Pacific Lamprey Assessment are lower than they should be.

Restoration Actions

Pacific Lamprey conservation work in the South Coast sub-region is currently focused on adult passage improvements, 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 2012-2020.

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	The Suction Dredge Reform Bill (SB 3) prohibits all motorized suction dredge mining in essential salmonid habitat.	Instream	Complete
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
RMU	Predation	Multi-RMU predation study to determine best methods for removal of nonnative fish	Assessment	Proposed
RMU	Population	Study to look at use of lakes for lamprey	Assessment	Proposed
RMU	Population	Study to look at estuary use by lamprey	Assessment	Proposed
RMU	Lack of Awareness	Making meaningful connections between the life histories of Pacific Lamprey and Pacific salmon to improve awareness and support for lamprey conservation	Other	Proposed
RMU	Passage	Evaluation of lamprey passage at culverts, small dams and fishways.	Assessment	Proposed
RMU	Lack of Awareness	Larval/juvenile lamprey ID workshop (2019 S. Coast RIP project proposal)	Coordination	Upcoming
North Umpqua	Passage	Passage improvement at Soda Springs Dam.	Instream	Complete
North	Passage	Pacific Lamprey spawning and rearing	Survey/	Complete

Umpqua		habitat suitability above Soda Springs Dam	Assessment	
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 basin.	Assessment	Complete
Rogue Basin	Passage	Several small barriers removed in 2020	Instream	Complete
Rogue Basin	Passage	Low cost passage retrofits at irrigation diversion dams.	Assessment/ Instream	Underway
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	Predation	Assessment of the nonnative smallmouth bass population in Coquille to determine feasibility of eradication – will include week long fishing blitz and bass suppression efforts	Assessment	Underway
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 May 18th, 2021 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 project was submitted by RMU partners for the South Coast sub-region in 2021:

Project Name	Project Proponent and Organization	Project Type(s)	Funding Requested	Brief Description
West Fork Smith River & Coon Creek Lamprey Passage & Channel Improvement	Brian Jenkins Smith River WC	Passage Improvement	\$50,000 (scalable)	Project will remove 3 concrete sills in West Fork Smith River (WFSR), place grade control structures in WFSR, & replace undersized culvert in Coon Creek with stream simulation culvert or bridge

III. Literature Cited

- American Fisheries Society, Oregon Chapter (ORAFS). 2013, Revised 2015. Effects of Suction Dredge Mining on Oregon Fishes and Aquatic Habitats. Portland, OR. 5p.
- 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.
- Pacific Lamprey Technical Workgroup. 2017. Practical guidelines for incorporating adult Pacific Lamprey passage at fishways. White Paper. 47pp + Appendix. Available online: <https://www.fws.gov/pacificlamprey/mainpage.cfm>
- 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.