Pacific Lamprey
2022 Regional Implementation Plan
for the
Mid-Columbia
Regional Management Unit

Submitted to the Conservation Team August 31st, 2022

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Status and Distribution of Pacific Lamprey in the RMU

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).

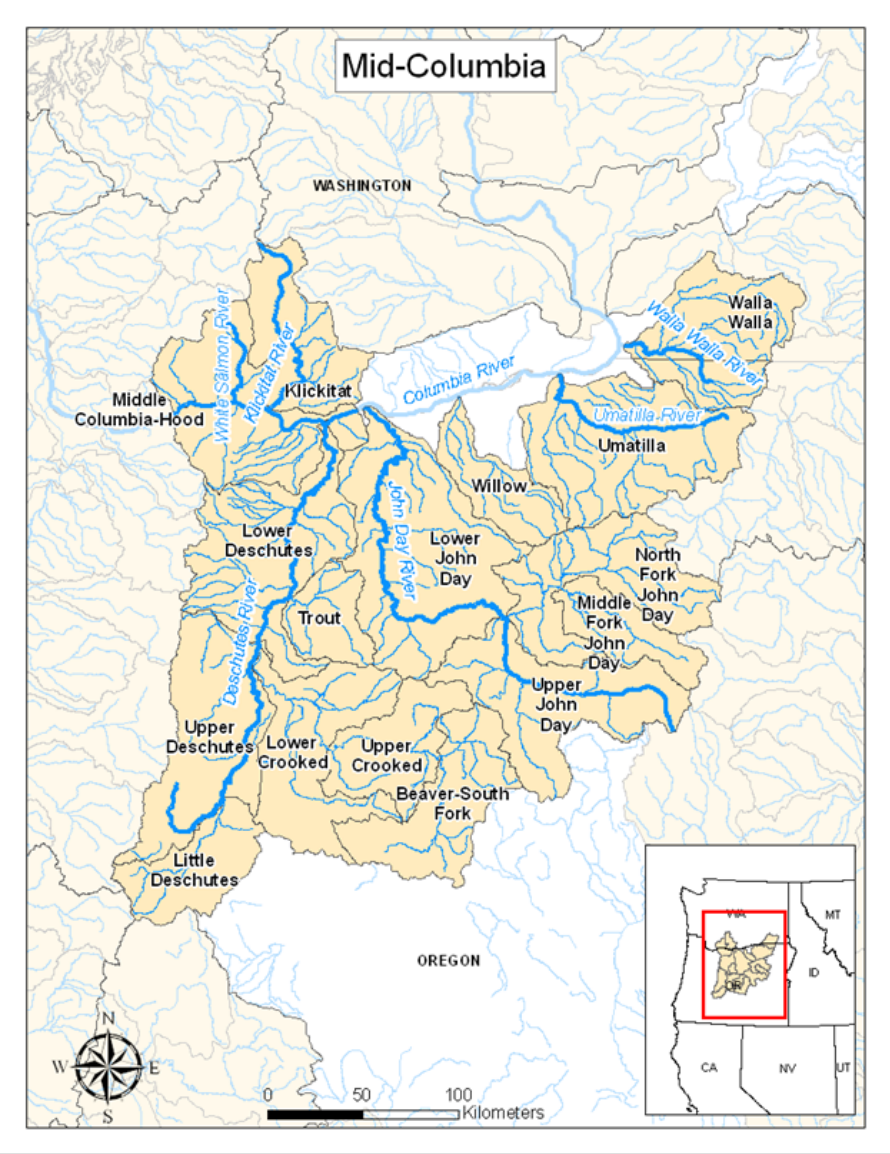

Figure 1. Map of watersheds within the Mid-Columbia Regional Management Unit.

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

Status of Species

Conservation Assessment and New Updates

Every five years the Pacific Lamprey Conservation Initiative (PLCI), through the Regional Management Units (RMUs), revise the Pacific Lamprey Assessment (USFWS 2018). The Assessment utilizes local stakeholder knowledge and expertise to evaluate Pacific Lamprey distribution, population demographics and threats at the 4th field HUC watershed level. This information is used to inform NatureServe, a diagnostic tool that characterizes the conservation risks of Pacific Lamprey across their historical range. Information about current Pacific lamprey distribution, population size, trends, and watershed threats were collected from stakeholders in the Mid-Columbia RMU through an online Assessment questionnaire and virtual meeting held on March 10th 2022. The following is a brief summary of key findings from the 2022 Pacific Lamprey Assessment.

NatureServe Conservation status ranks changed in two of 16 HUCs in 2022. Status ranks increased from S1 (Critically Imperiled) to S2 (Imperiled) in the Mid-Columbia-Hood and Lower Deschutes. Changes in these areas are attributable to an expansion in current occupancy

(Mid-Columbia-Hood) and high estimated population abundance (Lower Deschutes).

Distribution

Current Pacific Lamprey distribution in the Mid-Columbia RMU is still greatly reduced from historical range (Table 2). The ratio of current to historical distribution was estimated to be small in the majority of watersheds, ranging from 4% (Klickitat) to 16% (Mid-Columbia-Hood) in areas with known Pacific Lamprey occupancy. Although current distribution of lamprey has remained the same in most watersheds since the completion of the 2018 Assessment, distribution expanded slightly in both the Klickitat (+17 km^2) and Mid-Columbia-Hood (+81 km^2) due to increased sampling effort (i.e., occupancy sampling, PIT-tagging). 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.

Abundance

Population abundance of Pacific Lamprey increased in six watersheds, with estimates ranging from zero to over 10,000 fish (Table 2). The increase in abundance in these watersheds is due to a better understanding of the proportion of adults potentially entering mid-Columbia tributaries, rather than a true increase in population abundance. Pacific Lamprey abundance was estimated in seven watersheds (i.e., Mid-Columbia-Hood, Klickitat, Upper John Day, North fork John Day, Middle fork John Day, Lower John Day, and Lower Deschutes) using annual counts at the three lowest mainstem Columbia River dams and the publication by Noyes et al. (2015) which estimated adult lamprey entrance in mid-Columbia tributaries from multiple years of acoustic telemetry and PIT tagging information (2011-2014). To estimate tributary abundance, average tributary entry rates (0.1% - 5.9%) were multiplied by the total number of adult Pacific Lamprey passing Bonneville, The Dalles, and John Day dams annually. Although estimates are based on a limited duration study and not all potential spawning tributaries were monitoring for tagged lamprey, this information still provided a good foundation for estimating population size in mid-Columbia tributaries. Population abundance in the Umatilla was estimated from adult counts at Three Mile Falls Dam near Umatilla, OR. The Confederated Tribes of the Umatilla Indian Reservation (CTUIR) also has an active Pacific Lamprey translocation program, ongoing for the last 20 years, though no translocation efforts occurred in 2018 and 2019 in the Umatilla River due to good volitional return numbers. However, there have been some occasional trap-and-haul efforts due to low flow and high water temperatures and lamprey passage system (LPS) rest box overcrowding.

Short-term Population Trend

Mainstem dam counts provide one of the few 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. The 10-year median day time count of adult Pacific Lamprey prior to 1970 was over 106,000 fish (1960-1969), while the recent 10-year median is just over 30,000 fish (Columbia River DART 2022). Short-term population trend which is defined as the degree of change in population size over three lamprey generations (≈36 years), was ranked as ‘Unknown’ in all but four mid-Columbia watersheds due to the lack of continuous long-term adult counts in these tributaries. The Umatilla, Mid-Columbia-Hood, Klickitat, and Lower Columbia have

approximately 10-22 years of consistent adult count information that was used to estimate short-term population trend for the 2022 Assessment. Based on the overall decline of counts at Bonneville Dam, mark-recapture information and TEK from CTUIR tribal members in the Umatilla (Close et al. 2004), Pacific Lamprey populations are estimated to be declined by 10-70% over the last 36 years (Table 2).

Pacific Lamprey are in very low abundance or possibly extirpated from Willow Creek. Electrofishing 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). In 2021, the CTUIR conducted environmental DNA (eDNA) sampling within the subbasin and had no detections for Pacific Lamprey but did detect *Lampetra* spp. Habitat in mid-lower Willow Creek is poor and several small passage barriers (i.e., private diversions for irrigation) likely limit potential distribution. Pacific Lamprey are still believed to be extirpated from the Walla Walla River. Although present in the subbasin historically, Pacific Lamprey have not been observed during ongoing electrofishing, screw trap and spawning survey efforts (Moser and Close 2003). Environmental DNA sampling was conducted throughout the Walla Walla River in 2021 and results will be available in late summer 2022. Pacific Lamprey are also believed to be extirpated in Trout Creek as well as the Deschutes River basin upstream from Pelton Dam. In fall 2020 and spring 2021, the Middle Deschutes Watershed Council in partnership with the Confederated Tribes of Warm Springs, Cramer Fish Sciences and Jefferson County SWCD conducted eDNA sampling on the lower Deschutes River and first three miles of Trout Creek to assess Pacific Lamprey presence and distribution. Environmental DNA sampling did not detect Pacific Lamprey in Trout Creek and surveyors noted the poor quality of habitat in the lower subbasin. There are no Pacific Lamprey upstream of the Pelton Round-Butte Dam. Pelton is currently impassable to lamprey and translocation is not occurring.

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 2018 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	SH	1000-5000	Zero	Zero to 1-50	Unknown
Umatilla	17060103	S1	1000-5000	100-500	1000-2500	10-30%
Willow	17060104	SH	1000-5000	Not ranked	Zero	Unknown
Mid-Columbia – Hood	17060105	S2↑	1000-5000	500-2,000	1000-10,000	10-50%
Klickitat	17060106	S1	1000-5000	20-100	1000-10,000	50-70%
Upper John Day	17070201	S1	1000-5000	100-500	250-1000	Unknown
North Fork John Day	17070202	S1	1000-5000	100-500	250-2500	Unknown
Middle Fork John Day	17070203	S1	1000-5000	100-500	250-2500	Unknown
Lower John Day	17070204	S1	5000-20,000	100-500	250-1000	Unknown
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	S2↑	1000-5000	100-500	2500-10,000	10-30%
Trout	17070307	SH	1000-5000	Zero	Zero	Unknown

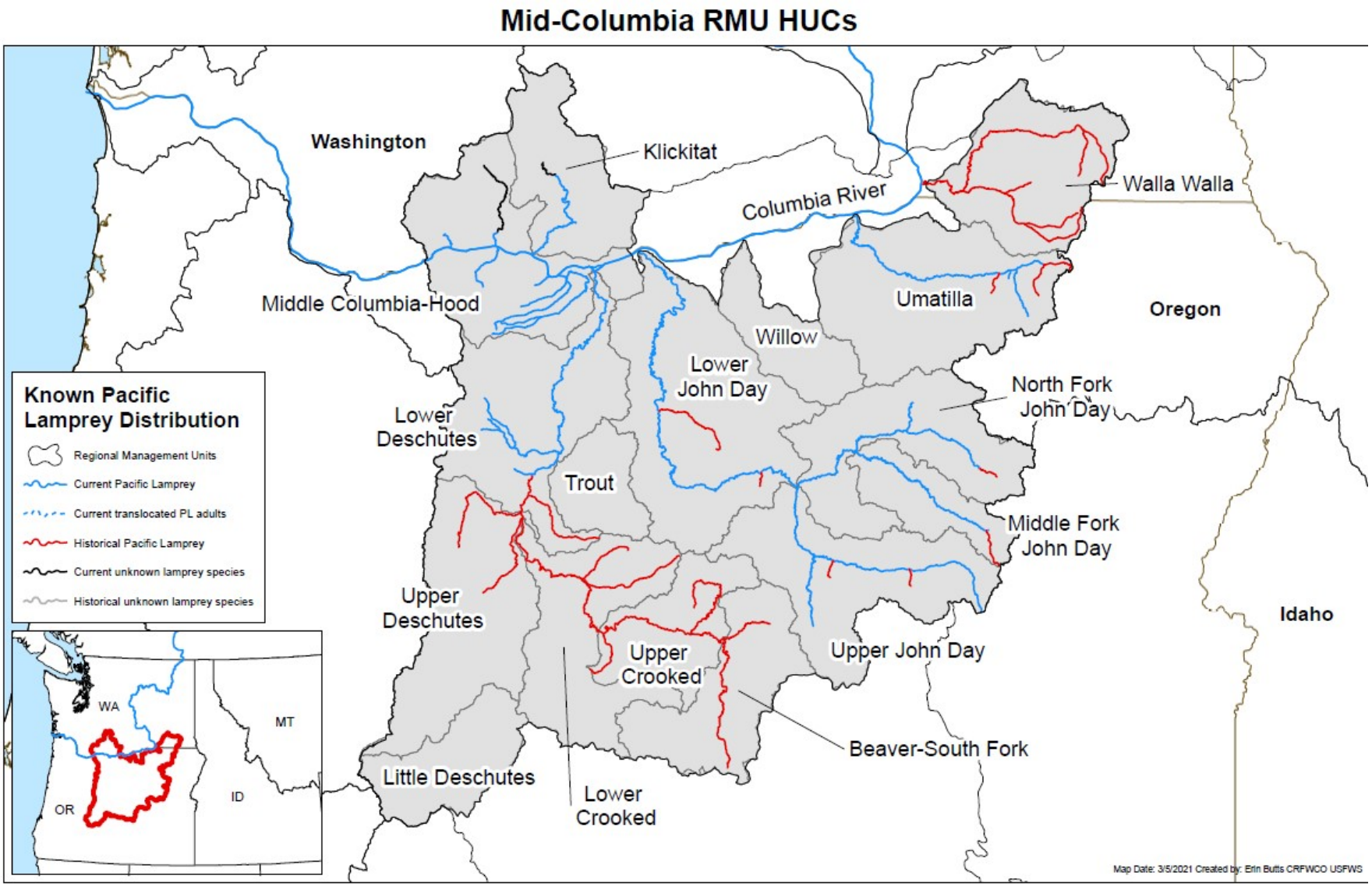

Figure 2. Current and historical known distribution for Pacific Lamprey: Mid-Columbia RMU (USFWS Data Clearinghouse 2021). Historical Pacific Lamprey distribution depicted in map was obtained from published literature, tribal accounts and state and federal agency records.

Distribution and Connectivity (Passage)

Mainstem passage for adult and juvenile Pacific Lamprey 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 2015; LTWG 2017). Passage within tributaries was ranked a moderate overall threat in the Mid-Columbia RMU (Table 3). 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). Within the Umatilla subbasin, tributary passage was reduced from a high (Mean Scope/Severity 3.5) to a moderate (Mead Scope/Severity 3.25) threat in 2022. Four diversions have been breached or completely removed from the subbasin in the last five years (i.e., Boyd's, Dillon, Brownell and Taylor diversion dams). Additionally, adult lamprey passage structures (i.e. LPS or flat plates with video monitoring and PIT detection) have been installed at Three Mile Falls diversion dam, Maxwell diversion dam, and Feed Diversion Dam to enhance passage. The Severity rank of tributary passage was also reduced (from moderate to low) in the Lower Deschutes. A LPS and video monitoring system were recently installed at the Warm Springs National Fish Hatchery fishway to improve passage conditions for adult Pacific Lamprey in the Warm Springs River.

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, Pelton Round Butte Hydroelectric Project) and low elevation water diversions. Irrigation diversions for crops and 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 bypass devices to protect fish from impingement or entrainment, though most screens are designed to protect/exclude salmonids and not lamprey. A recent study in the Umatilla River found a large proportion of PIT tagged juvenile Pacific Lamprey released upstream of the Feed Diversion headgate were entrained into the diversion canal in 2020 (54%; Simpson 2022). Similarly, high levels of entrainment have also been observed at Westland and Three Mile Falls diversions (Aaron Jackson, CTUIR, personal comm.). A large number of irrigation diversions still do not meet NOAA criteria for screening or are completely unscreened and may entrap or impinge larval and juvenile lamprey to an unknown extent. The structural design of diversion dam fishways 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 (LTWG 2017). Additionally, it has been observed in the Umatilla River that the angle that diversion canals are in relation to the river channel can impact how severe larval and juvenile entrainment is at that facility. Facilities that have less of an angle tend to entrain more lamprey (Aaron Jackson, CTUIR, personal comm.).

In the Klickitat subbasin, tributary passage was increased from a moderate (Mean Scope/Severity 3.0) to high threat (Mean Scope/Severity 3.50) in 2022. The Lyle Falls passage structure can significantly delay adult lamprey passage during low water conditions and the low head weir at Klickitat Hatchery likely hinders adult passage based on the low number of Pacific Lamprey larvae observed during electrofishing surveys upstream from the hatchery. 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 comm.).

Threats

Summary of Major Threats

The following table summarizes the key threats (Mean Scope/Severity ≥ 2.5) within the Mid-Columbia RMU tributaries as identified by RMU participants during the Assessment revision meeting in March 2022.

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

	Mainstem Passage		Climate Change		Water Quality		Stream and Floodplain Degradation		Dewatering and Flow Management		Tributary Passage		Lack of Awareness		Small Population Size	
Watershed	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity
Walla Walla	4	4	4	4	3.5	3.5	4	4	4	4	4	4	3	2	4	4
Umatilla	4	4	4	4	3.5	3	4	4	3	3.5	3.5	3	3	3	2	2.5
Willow	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Mid-Columbia/Hood	4	3.5	4	5	3.5	3.5	3	3	3	4	2	2	2	2	2	2
Klickitat	4	3.5	3.5	3.5	4	3.5	2	2	2.5	3.5	3.5	3	3	2.5	2	2.5
Upper John Day	4	4	4	4	4	4	3.5	4	3.5	3.5	3	3.5	3	3		
North Fork John Day	4	4	4	4	3	3	2.5	2.5	2.5	2.5	2	2	3	3		
Middle Fork John Day	4	4	4	4	3.5	3.5	3.5	3.5	2.5	2.5	2	2	3	3		
Lower John Day	4	4	4	4	4	4	3.5	3.5	4	4	3	3	3	3	2	2
Lower Deschutes	4	4	4	4	2.5	2.5	2.5	2.5	1.5	1.5	2	2	2	2	2	2
Mean	4.00	3.90	3.95	3.95	3.55	3.45	3.25	3.30	3.05	3.30	2.90	2.85	2.90	2.75	2.57	2.71
Rank	M	M	M	M	H	M	M	M	M	M	M	M	M	M	M	M
Mean Scope & Severity	3.95		3.95		3.50		3.28		3.18		2.88		2.83		2.64	
Drainage Rank	**H**		**H**		**H**		**M**		**M**		**M**		**M**		**M**	

Current Threats

The highest ranked threats in the Mid-Columbia RMU are described below. Mainstem passage, climate change and water quality were ranked a high threat in the Mid-Columbia, while stream and floodplain degradation, dewatering and flow management, tributary passage, lack of awareness and small population size were ranked a moderate threat in 2022.

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 2011 Pacific Lamprey Assessment (Luzier et al. 2011).

Climate change

Climate change was one of the highest ranking threats in the Mid-Columbia RMU with Assessment Scope/Severity scores increasing in eight watersheds (Table 3). Climate change is happening faster and more intensely than anticipated and the combined effects of climate change (e.g., changes to ambient temperature, precipitation, and streamflow patterns) and predicted rise in human population will likely exacerbate other threats in the RMU. Climate change is likely to alter the amount, timing, and type of precipitation with decreases in snowpack, earlier snow melt, and more winter precipitation as rain. This will contribute to earlier peak streamflows and lower summer baseflows. In a region heavily dominated by agricultural crop production, rising ambient temperatures will likely increase demand for water for irrigation that will further 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 juveniles are exposed to 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 and some areas at greater risk from potential change based upon the underlying geology, impoundments, land use, or other factors (EPA 2021). Climate change is identified as a critical threat across the range of Pacific Lamprey, but the feasibility of making tangible changes will be challenging and require large scale institutional changes. Within the Lower Deschutes and Walla Walla subbasins, one of the strategies to combat climate change is the acquisition and subsequent protection of habitat. In the John Day subbasin, 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.

Water quality

Water quality rose from a moderate to high threat in the Mid-Columbia RMU. Assessment Scope/Severity scores increased in Willow, the Middle Fork John Day, and lower Deschutes (Table 3). Elevated water temperature is still the primary concern in most Mid-Columbia watersheds. Lower and mainstem reaches regularly experience prolonged warming often starting in late spring, extending into fall. Factors contributing to excessive water temperatures generally include increased air temperature, lack of riparian cover, widening of stream channels, or reduced instream flows associated with water withdrawals. The impacts of warm water temperatures (e.g., ≥20°C) on Pacific

Lamprey embryonic development, physiology, adult migrations, reproductive capability and evolutionary pressures can be multitudinous and substantial (Clemens et al. 2016). Other water quality concerns in Mid-Columbia watersheds include low dissolved oxygen levels, pH extremes, sedimentation, and presence of bacteria (e.g., fecal coliform), heavy metals, or toxic pollutants (e.g., insecticides, PCBs). High mercury concentrations in larval lamprey was noted as a specific concern in the Klickitat subbasin. Direct exposure to heavy metals and toxins in water, sediment, or through dietary intake may result in high concentrations of contaminants accumulating in the fatty tissues of lamprey that may compromise development, reproduction and survival (Nilsen et al. 2015; Clemens et al. 2017; Madenjian et al. 2021).

Stream & floodplain degradation

Stream and floodplain degradation was ranked a moderate threat in the Mid-Columbia RMU. 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, historical and current land use practices have contributed to large scale losses in stream habitat complexity. Unmanaged livestock grazing, road building, and timber harvest have altered Mid-Columbia watersheds by widening or entrenching stream channels, intensifying bank erosion, compacting soils, reducing water infiltration and storage potential, increasing runoff, and reducing riparian vegetation cover. Many watersheds in the RMU lack 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), reducing flow velocities and facilitating the deposition of fine substrate and organic matter important for larval lamprey rearing and feeding (Gonzalez et al. 2017). Within lowlands, 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. The cumulative loss of aquatic and riparian habitat has contributed to increased stream temperatures and reduced or eliminated important spawning and rearing habitat for Pacific Lamprey within many watersheds. RMU partners continue to work hard to implement restoration projects aimed at addressing habitat degradation, water quality issues and impaired floodplain function throughout the Mid-Columbia region.

Dewatering & flow management

Dewatering and flow management was also ranked a moderate threat in the Mid-Columbia RMU. 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, Willow 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.

Lack of Awareness

Lack of Awareness was ranked a moderate threat, though the severity of this threat was reduced in three Mid-Columbia watersheds in 2022 (Umatilla, Mid-Columbia-Hood, and Klickitat). Pacific Lamprey awareness is slowly becoming more widespread among stakeholders and the public. Tribes, state and federal agencies, watershed councils and others have played a significant role in improving awareness through targeted outreach, youth education events, informational brochures and webinars. Nevertheless, it's unclear how improved awareness translates to on-the-ground actions that incorporate or benefit lamprey such as lamprey specific fish salvage, design of fish screens, passage improvements, habitat restoration, permitting (e.g., Section 404 permits), etc. For example, instream water work, whether for restoration activities or maintenance of diversions, can dewater areas or remove sediments in which larval lamprey are burrowed. Such actions without first salvaging lamprey may result in the death of hundreds to thousands of larvae and juveniles. Increasing public and agency awareness about the presence of larval lamprey in the sediments, adult lamprey spawning habitats and timing during in-water work, and education on actions to minimize these impacts, could greatly decrease localized mortality and injury to lamprey populations. For more information about how to minimize impact to native lampreys during in-water work, please consult LTWG (2020).

Small Population Size

Small population size was ranked a moderate threat, but is primarily a concern in the Walla Walla, Willow, and watersheds upstream of the Pelton Round-Butte Dam. There is the potential that adult lamprey could recolonize the Walla Walla and Willow from larger, adjacent populations, but this has not yet occurred in these subbasins. Although larval lamprey pheromones may increase the attraction of adults to a watershed (e.g., Umatilla translocation/reintroduction efforts), lamprey have recolonized areas without larval lamprey pheromone attraction (e.g., Condit dam removal). It is difficult to parse out the factors that may affect recolonization (i.e., pheromones, habitat quality, flow, water temperature, etc.) and how to interpret small population size as an impact.

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 2012-2021.

HUC	Threat	Action Description	Status
RMU	Population	Environmental DNA, spawning ground surveys, smolt trapping and occupancy sampling to better understand lamprey distribution.	Ongoing
RMU	Stream Degradation	Implementation of instream and floodplain habitat restoration activities.	Ongoing
RMU	Passage	Evaluation of juvenile entrainment mechanisms and preventative measures.	Ongoing
RMU	Population	Development of protocols and techniques for artificial propagation and larval rearing of Pacific Lamprey	Ongoing
RMU	Dewatering/ flow	Water savings through Columbia Basin Water Transactions Program	Ongoing
RMU	Population	Conservation Plan for Lampreys in Oregon (ODFW) *https://www.dfw.state.or.us/fish/CRP/coastal_columbia_snake_lamprey_plan.asp*	Complete
RMU	Population	Artificial propagation and larval rearing (YN, CTUIR, USFWS)	Ongoing
RMU	Population	Mesocosm experiment to investigate performance of artificially propagated larvae and juveniles vs wild fish	Proposed
RMU	Population	eDNA sampling in lower Umatilla River, John Day River, Walla Walla River and Willow Creek	Ongoing
RMU	Population	Large-scale PIT tagging of larval and juvenile Pacific Lamprey in mid-upper Columbia tributaries	Proposed
RMU	Dewatering/ flow	Study to evaluate fate of salvaged larval lamprey during dewatering events https://doi.org/10.3133/ofr20201026	Complete
RMU	Dewatering/ flow	Larval lamprey movement study to understand how far lamprey can move over dewatered surfaces	Ongoing
RMU	Dewatering/ flow	Study to test efficacy of portable backpack suction dredge to sample for	Complete

		larval lamprey during salvage	
RMU	Dewatering/ flow/Passage	Study testing use of venturi pump to prevent/reduce entrainment into irrigation diversion canals	Ongoing
RMU	Dewatering/ flow	Lamprey salvage at irrigation diversion canals and hatchery ponds	Ongoing
RMU	Disease	New lamprey pathogen publication (Jackson et al. 2019)	Complete
Columbia River	Population	Seasonal abundance of larval lamprey at confluence of 3 tributaries in Bonneville Dam reservoir and 3 tributaries below Bonneville Dam (5 year study)	Ongoing
Columbia River	Stream Degradation/ Water Quality	Riparian plantings at mouths/deltas of mid-Columbia tributaries to reduce water temperature in shallow water habitat	Proposed
Columbia River	Population	eDNA sampling at Bonneville, McNary, Wells and Rocky Reach to determine number of PCL DNA copies/second.	Complete
Walla Walla–Umatilla–John Day	Population	Master Plan for Pacific Lamprey Artificial Propagation, Translocation, Restoration, and Research (CRITFC, YN, CTUIR, NPT)	Complete
Walla Walla	Population	Release of artificially propagated lamprey as part of Master Supplementation Plan	Proposed
Umatilla	Population	Translocation/reintroduction of adult Pacific Lamprey.	Ongoing
Umatilla	Population	Monitoring larval density trends and adult passage success to spawning areas.	Ongoing
Umatilla	Population	Collection of genetic samples to contribute to ongoing work by John Hess (CRITFC)	Ongoing
Umatilla	Population/ Passage	Ongoing larval and juvenile lamprey PIT tagging study	Ongoing
Umatilla	Passage	Installation of Lamprey Passage Systems to enhance passage for Pacific Lamprey at three water diversion dams.	Complete
Umatilla	Passage	Telemetry to assess use of Lamprey Passage Systems at diversion dams.	Complete

Umatilla	Passage	Sampling of Bureau of Reclamation canals to estimate extent of juvenile entrainment into diversions.	Ongoing
Umatilla	Passage	Removal of Boyd, Dillon and Brownell diversion dams.	Complete
Mid-Col. Hood	Passage	Monitoring natural recolonization above former site of Powerdale Dam on Hood River and Condit Dam on White Salmon River.	Ongoing
Mid-Col Hood	Population	Larval occupancy/density surveys in principal tributaries.	Ongoing
Mid-Col Hood	Population	Electrofishing in White Salmon and Wind Rivers to assess distribution and abundance of larval lamprey	Ongoing
Mid-Col Hood	Population	Course scale eDNA sampling on White Salmon River and tributaries	Complete
Mid-Col Hood	Population	Survey to assess Pacific Lamprey recolonization of White Salmon River following Condit Dam removal	Proposed
Mid-Col Hood	Population	Translocation of adult Pacific Lamprey above former Condit Dam location on White Salmon River	Proposed
Klickitat	Population	Distribution surveys of mainstems and principal tributaries.	Ongoing
Klickitat	Passage	Modification/improvements to Lamprey Passage Structure at Lyle Falls fish ladder.	Complete
Klickitat	Passage	Passage improvement for adult Pacific Lamprey at Klickitat Hatchery weir	Proposed
Klickitat	Population	Electrofishing in tributaries to assess distribution and abundance of larval lamprey	Ongoing
Klickitat	Population	Course scale eDNA sampling on mainstem and confluence of all tributaries	Complete
John Day Basins	Population	Collected genetic samples and PIT tagged ≈400 PCL (>100 mm) in NF John Day	Complete
John Day Basins	Stream Degradation	Large channel restoration project in core area for lamprey (Middle Fork John Day)	Complete
John Day Basins	Passage	Removal of over 100 push-up diversion dams	Ongoing

John Day Basins	Passage	Fish screening improvements	Ongoing
Lower Deschutes	Passage	Installation of LPS and video monitoring system at Warm Springs National Fish Hatchery fishway	Complete
Lower Deschutes	Water Quality	Collection of larval lamprey and sediment samples to characterize contaminants in tributaries on the Warm Springs Reservation	Complete
Lower Deschutes	Water Quality	Study to look at contaminants in adult Pacific Lamprey tissue near suspected point sources on Warm Springs Reservation	Ongoing
Lower Deschutes-Trout	Population	Environmental DNA sampling on lower Deschutes, Shitike Creek and Trout Creek to assess distribution of Pacific Lamprey	Complete

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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.