

Pacific Lamprey

2021 Regional Implementation Plan

for the

Upper Columbia

Regional Management Unit



Submitted to the Conservation Team September 2, 2021

Primary Author: Ann Grote, U.S. Fish and Wildlife Service

May 24, 2021 RMU Meeting Participants	
RD Nelle, Barb Kelly, Jake Blakeley, Ann Grote, Erin Butts – USFWS	Ralph Lampman – Yakama Nation Fisheries
Alicia Marrs – Pacific Lamprey Conservation Initiative	John Rohrback Matt Young – Colville Confederated Tribes
Kellie Carim – National Genomics Center	Andrew Gingerich, Chas Kyger – Douglas County PUD
Monica Blanchard, Patrick Verhey – WDFW	Mike Clement – Grant County PUD
John Crandall – Methow Salmon Recovery Foundation	Marty Liedtke – USGS

Projects proposed and discussed within this Regional Implementation Plan are in accordance with direction provided within the *Conservation Agreement for Pacific Lamprey in the States of Alaska, Washington, Idaho, Oregon and California, 2012*. Cooperative efforts through the Agreement intend to: a) develop regional implementation plans derived from existing information and plans; b) implement conservation actions; c) promote scientific research; and d) monitor and evaluate the effectiveness of those actions.

Projects identified in this Regional Implementation Plan do not imply or intend a funding obligation or any related activity from any of the government agencies, tribes or non-governmental entities discussed within this document.

I. Status and Distribution of Pacific Lamprey in the RMU

General Description of the RMU

The Upper Columbia Regional Management Unit (UCRMU) is defined as the tributaries to Columbia River from the Snake River to Chief Joseph Dam in which there are 15 4th Field Hydrologic Unit Codes (HUCs) (Figure 1). This Regional Implementation Plan (RIP) focuses on six subbasins of the Columbia River: Yakima, Wenatchee, Entiat, Methow, Okanogan, and Similkameen rivers. The priority 4th Field HUCs from these major tributaries include: Lower Yakima (#17030003), Naches (#17030002), Upper Yakima (#17030001), Wenatchee (#17020011), Entiat (#17020010), Methow (#17020008), Okanogan (#17020006), and Similkameen (#17020007). Crab Creek (#'s 17020013,17020015), the Chelan River (#17020009) and various smaller tributaries (Colockum-area streams and Foster Creek) are also included, but little information is available on lamprey presence in these subbasins (Table 1). Although historic Pacific Lamprey distribution likely extended into Sanpoil (#17020004), Colville (#17020003), and Kettle (#17020002) HUCs, these areas were excluded from consideration at this time due to existing anadromous passage barriers at Chief Joseph and Grand Coulee dams.

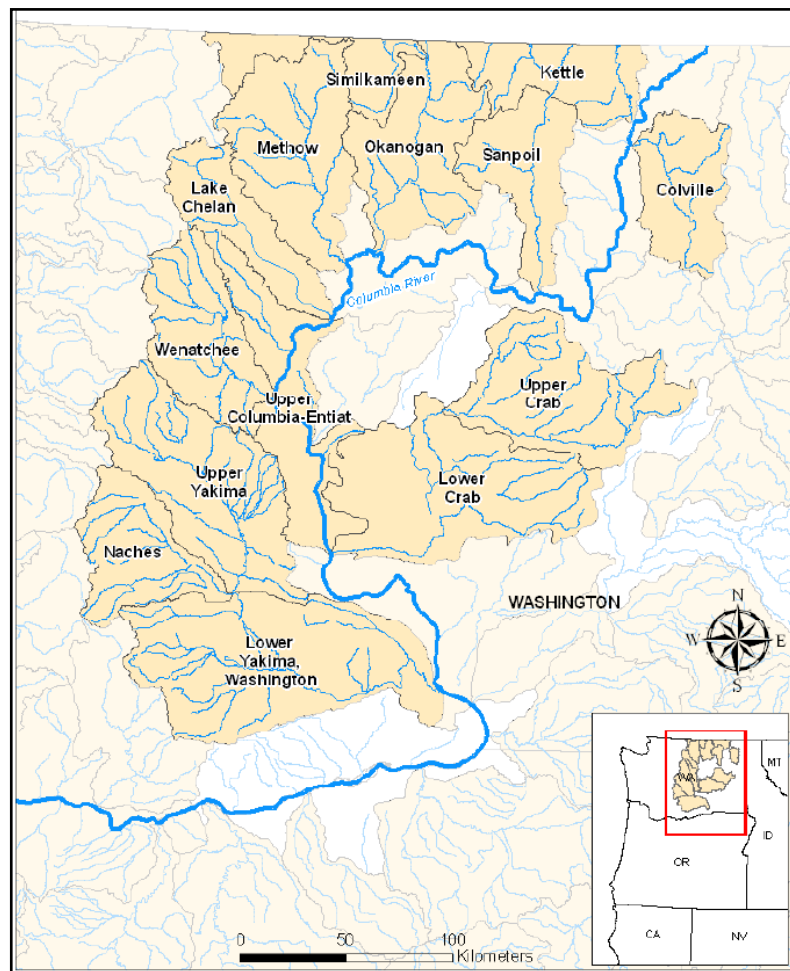


Figure 1: Map of the watersheds within the UCRMU.

Table 1: Drainage Size and Level III Ecoregions of the 4th Field HUC Watersheds located within the UCRMU.

Watershed	HUC Number	Drainage Size (km ²)	Level III Ecoregion(s)
Similkameen	17020007	1,735	Columbia Plateau, North Cascades
Okanogan	17020006	4,248	Columbia Plateau
Methow	17020008	4,714	Columbia Plateau, North Cascades
Chelan	17020009	2,473	Columbia Plateau
Entiat	17020010	3,937	Columbia Plateau, North Cascades
Wenatchee	17020011	3,648	Columbia Plateau, North Cascades
Crab Creek	17020013,17020015	11,318	Columbia Plateau
Upper Yakima	17030001	5,517	Columbia Plateau, Eastern Cascade Slopes and Foothills
Lower Yakima	17030003	7,640	Columbia Plateau, Eastern Cascade Slopes and Foothills
Naches	17030002	2,927	Columbia Plateau, Eastern Cascade Slopes and Foothills
Smaller Tributaries	--	2,512	Columbia Plateau

Status of Species

2017 Conservation Assessment and 2021 Updates

Pacific Lamprey *Entosphenus tridentatus* conservation status, distribution, and population information in the UCRMU were updated in the 2017 Pacific Lamprey Assessment (Table 2). Compared with the 2011 Assessment (Luzier et al. 2011), Conservation Status Ranks changed in five HUCs in 2017: two improved and three declined (Table 2). Pacific Lamprey are still believed to be either Critically Imperiled (S1) or Possibly Extinct (SH), in all UCRMU HUCs. Changes in status rankings from the 2011 to 2017 largely resulted from declines in some subbasins, adult translocations in others, and implementation of an improved and more accurate approach to calculating historical and current range extent using steelhead intrinsic potential as a surrogate for absent lamprey distribution data.

Table 2: Population, demographic, and Conservation Status Ranks of the 4th Field Hydrologic Unit Code (HUC) watersheds located within the UCRMU as of April, 2017. Steelhead intrinsic potential was used as a surrogate estimate of historical lamprey range extent in areas where historical occupancy information was not available. S1 = Critically Imperiled. SH = Possibly Extinct. Conservation Status rankings highlighted in yellow indicate a change (↑ improved, ↓ worsened) in 2017 relative to the 2011 Assessment

Watershed	HUC Number	Conservation Status Rank	Historic Occupancy (km ²)	2017 Occupancy (km ²)	2017 Population Size (adults)	Short-Term Trend (% change)
Similkameen	17020007	SH↓	<100	Zero*	Zero*	>70%
Okanogan	17020006	SH↓	1000-5000	20-100*	1-50*	>70%
Methow	17020008	S1	1000-5000	100-500	50-250	30-50%
Chelan	17020009	SH↓	Unknown	Zero	Zero	Unknown
Entiat	17020010	S1	1000-5000	100-500	250-1000	Stable
Wenatchee	17020011	S1	1000-5000	20-100	250-1000	Stable
Crab Creek	17020013, 17020015	SH	1000-5000	Zero	Zero	Unknown
Upper Yakima	17030001	S1↑	1000-5000	20-100	1-50	Increasing (+ >10%)
Lower Yakima	17030003	S1	1000-5000	100-500	250-1000	Increasing (+ >10%)
Naches	17030002	S1↑	1000-5000	20-100	1-50	Stable
Smaller Tributaries	--	--	Unknown	Zero	Zero	Unknown

* The information and rankings listed above were current as of April 2017 and do not reflect adult translocations that have occurred since the Assessment was completed

Since the completion of the 2017 Assessment, information on Pacific Lamprey distribution continues to improve due to additional sampling. Current Pacific Lamprey distribution in the UCRMU is displayed in Figure 2. For the purposes of this document, distribution of Pacific Lamprey is defined as the areas occupied by both adult and larval/juvenile lampreys. The UCRMU includes several subbasins (Upper Yakima, Okanogan, and Similkameen) where translocated adult lamprey have been released, but larvae/juveniles have not yet been detected. Radio tracking also located tagged translocated adults in reaches of the Naches and Tieton rivers where larvae were not detected (Grote et al. 2016). Adult translocation and larval monitoring are ongoing throughout the RMU, and translocation is resulting in expanded adult distribution and increased adult abundance in the Upper Yakima, Naches, Methow, Wenatchee, Okanogan, and Similkameen Rivers in 2021 (Table 3). The distribution map is expected to continue changing as new surveys and translocations are completed in the future.

Upper Columbia RMU HUCs

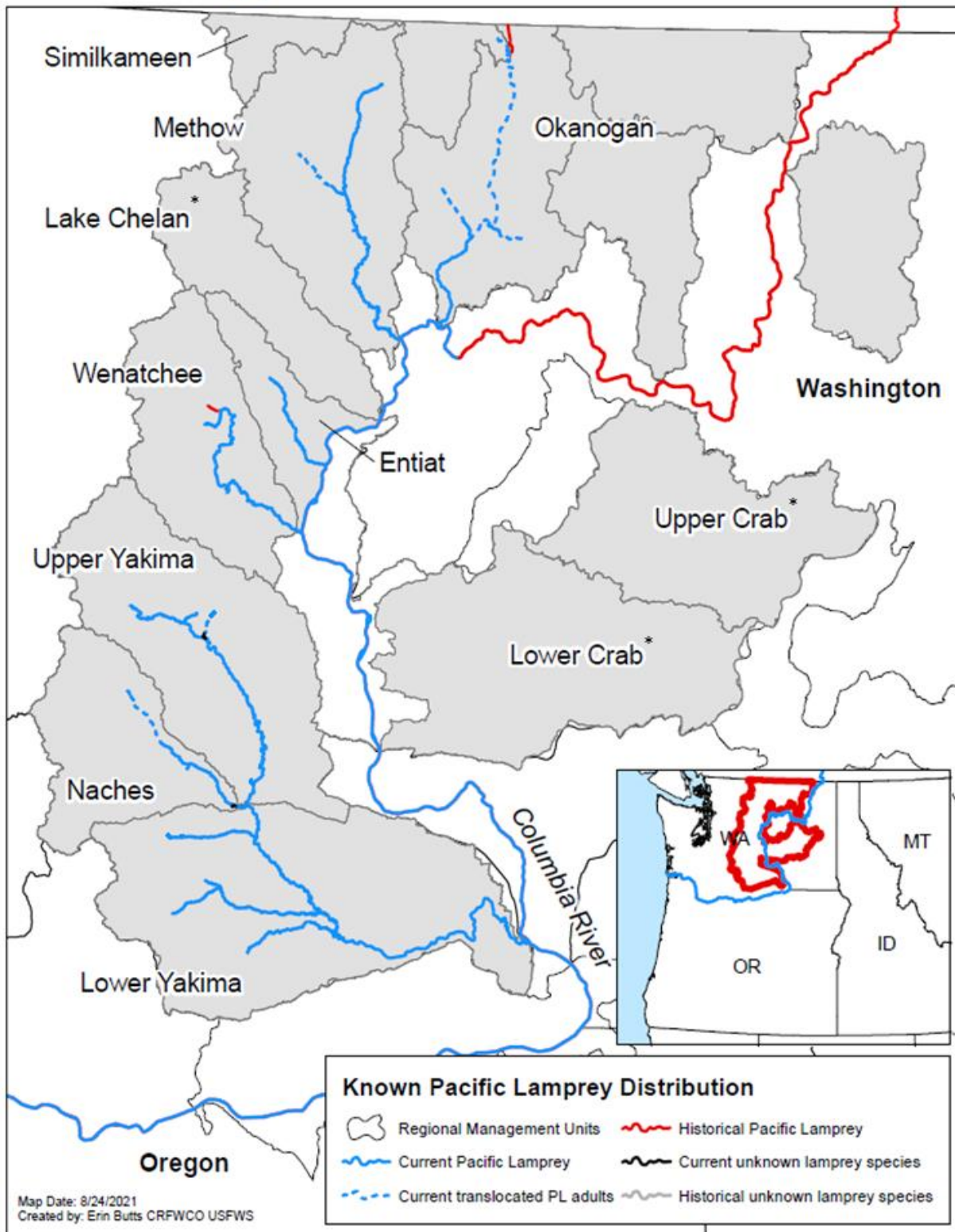


Figure 2: UCRMU Pacific Lamprey distribution and translocation streams as of July 16, 2021. Subbasins where historic distribution is uncertain are identified with an (*).

The current distribution map is informed by a variety of sources, including electrofishing, Environmental DNA (eDNA), and nesting surveys, and smolt trap, adult ladder, and translocation counts. Specific sources of information include: annual electrofishing surveys conducted by the Yakama Nation (YN) in the Lower Yakima (Beals and Lampman 2016a), Upper Yakima (Beals and Lampman 2016b), Naches (Beals and Lampman 2016c), Wenatchee (Beals and Lampman 2016d), Entiat (Beals and Lampman 2016e) and Methow (Beals and Lampman 2016f, Beals and Lampman 2018a), USFWS electrofishing data from the Wenatchee, Entiat, Chelan, Methow and Okanogan Rivers and smaller tributaries (USFWS, unpublished data), USFWS eDNA surveys (Grote and Carim 2017), and YN translocation reports (Lampman 2019a, 2019b, 2019c), and electrofishing surveys in Okanogan River tributaries by the Colville Confederated Tribes (CCT). Looking forward to 2021, new distribution information is expected as eDNA survey results from the USFS National Genomics Center Basin-Wide Lamprey Inventory and Monitoring Project (BLIMP) become available. BLIMP survey HUCs in the UCRMU include Upper and Lower Crab Creek, which are of special interest given the dearth of both historic and current lamprey information in this system.

Table 3: Summary of adult Pacific Lamprey Translocations to Subbasins within the UCRMU as of July 16, 2021.

Subbasin	Years	YN Translocated Adults	USFWS Translocated Adults	CCT Translocated Adults	DCPUD Translocated Adults	GCPUD Translocated Adults	Totals
Wenatchee	2016 - 2021	1564	0	0	0	0	1564
Methow	2015 - 2021	1082	0	0	507	0	1589
Upper Yakima	2013 - 2021	537	45	0	0	0	582
Naches	2013 - 2021	210	44	0	0	0	254
Lower Yakima	2011 - 2021	3337	164	0	0	0	3501
Columbia River	2017 - 2021	128	0	359	438	288	1213
Okanogan	2018 – 2021	0	0	409	0	0	409
Similkameen	2017 – 2021	0	0	117	0	0	117

NOTE: Many of these translocations involve multiple agency partners, but for clarity, only the releasing agency is listed here.

Distribution and Connectivity

There are five hydroelectric dams on the Columbia River within the UCRMU downstream of Chief Joseph Dam: Priest Rapids, Wanapum, Rock Island, Rocky Reach, and Wells dams. Although the mainstem dams are outside of the purview of this RIP, it is important to note that the combined impacts from Columbia River dams have greatly reduced the number of adults that can contribute to the tributary adult escapement. Within the subbasins, there are also many irrigation dams and diversions used for a variety of purposes including hydropower, irrigation, water storage and fisheries management. The impacts to connectivity of these smaller tributary dams vary by structure and subbasin.

The Yakima River has multiple diversion dams on the mainstem and many more on its tributary streams. Based on radio telemetry studies, mainstem Yakima River diversion dams impeded Pacific Lamprey upstream migration with passage rates ranging between 0% and 82% depending on time of year (Johnsen et al. 2013, Grote et al. 2014, Grote et al. 2016). Cumulative passage through successive

dams was very low, as less than 5% of adult lamprey successfully passed three or more of the lowermost diversion dams. No lamprey are known to have voluntarily passed Roza Dam (rkm 210.5). Prior to translocations, Pacific Lamprey were assumed to be functionally extirpated from the Upper Yakima HUC upstream of Roza Dam. In spring 2021, the YN's translocations release sites included locations in both the Upper Yakima and Naches River HUCs.

In 2021, YN and the Bureau of Reclamation (BOR) continued to operate lamprey-specific passage systems (LPS) at Prosser Dam. Video monitoring was installed in 2020 and operated at the two LPS traps at the Prosser left island with the goals of monitoring fallback (lower trap) and total passage time (upper to lower trap). However, very few adult Pacific Lamprey passed Prosser Dam in spring 2020, and a more robust assessment of the video system and LPS operation will require a larger run of migratory adults. YN and BOR continue to work together to modify the LPS structures and operations to allow for periods of trapping and volitional passage. The YN, BOR, USFWS, and Natural Resources Conservation Service (NRCS) are in the process installing new LPS units at Sunnyside, Wapato dams in the fall of 2021. Passage improvements at Wanawish Dam are still in development.

In the Wenatchee River, Pacific Lamprey were historically documented upstream of Tumwater Dam (49.6) in Lake Wenatchee and the upper mainstem, and likely occupied four large upper basin tributaries (Chiwawa, White, and Little Wenatchee rivers, and Nason Creek). Extensive electrofishing surveys conducted from 2011-2016 identified Tumwater Dam as the upper limit of lamprey distribution in the Wenatchee River (Johnsen and Nelson 2012, Beals and Lampman 2016d, Kelly-Ringel 2016, USFWS unpublished data). Adult lamprey passage at Tumwater Dam has not been formally evaluated, and incidental PIT detection data from the fishladder and upstream antennas indicate passage is rare. In 2017, for the first time in several decades, adult Pacific Lamprey were observed at the Tumwater Dam fish counting window (n =10). In response to low lamprey passage, Chelan County Public Utility District (PUD) modified trapping operations at Tumwater Dam beginning in 2018. For several weeks in August and September the fishladder exit is left open at night allowing fish to bypass the fish trapping system. These night operating conditions are intended to facilitate passage for nocturnal lampreys.

Following the 2016 adult translocations, electrofishing surveys detected larvae for the first time upstream of Tumwater Dam from both the mainstem Wenatchee River and Nason Creek (Beals and Lampman 2017a). Recolonization of Nason Creek continues, as larval lamprey are encountered further upstream in Nason Creek each survey year. Genetic parentage analysis of these larvae is ongoing, and they are assumed to be the progeny of translocated fish. Dryden Dam (rkm 28.3) on the Wenatchee River is passable by Pacific Lamprey, but has not been evaluated.

Distribution in the Entiat River is not limited by dams. Entiat River rotary screw trap counts of larval and juvenile lamprey have varied from close to 1,200 to just over 5,500 over the past 10 years (USFWS unpublished data). Larval lamprey are distributed widely from river mouth to rkm 46.4 (Beals and Lampman 2016e). USFWS lamprey spawning surveys conducted in 2018 and 2019 detected nests near, but not upstream of the larval distribution limit. Spawning survey results from both 2018 and 2019 indicated that the majority of lamprey spawning occurs in the lower 10 rkm of the Entiat River. Only two nests and one adult lamprey was observed during the USFWS 2021 Entiat River lamprey spawning surveys. This is the second year with minimal adult lamprey observed in the Entiat River: in 2020 with abbreviated surveys due to COVID, only a single adult lamprey was observed. These numbers suggest a very low number of spawners were present in the Entiat River the

past two years.

Migratory connectivity in the Methow HUC is generally better, although several structures have not been evaluated. Prior to adult translocation in the Methow subbasin, lamprey distribution was severely reduced and larval recruitment was absent or severely limited (Beals and Lampman 2016f, Crandall 2010). Since translocation began in 2016, larval lamprey have been detected at most mainstem survey sites from mouth to Chewuch River confluence, and up the Chewuch River to rkm 23.9 (Beals and Lampman 2016f). In spring 2018, larval lamprey were captured for the first time in the Twisp River screw trap, and recent electrofishing surveys are detecting increased numbers of larval lamprey at index sites (John Crandall, personal communication). Larval distribution and abundance in the Methow River and tributaries appears to be increasing.

In the Okanogan River watershed, larval lamprey were recently detected for the first time since 2010 (Wagner et al. 2018). In the fall of 2019, larval lamprey were captured during electrofishing surveys in Omak and Salmon creeks and in fall 2020 larvae were detected in Loup Loup Creek. Genetic samples were collected and submitted to CRITFC for parental-based-tagging analysis to determine if these larvae are the progeny of translocated parents. Although larval lamprey were detected in the tributary creeks, annual electrofishing efforts (2015-2019) have not detected any larvae in the mainstem Okanogan River (USFWS unpublished data). Meanwhile, results from 2018 and 2019 eDNA monitoring indicate Pacific Lamprey DNA is present at low concentrations at several locations throughout the mainstem Okanogan River (USFWS unpublished data). However these results are not able to differentiate between DNA from larvae versus adult lamprey, and adult translocations are ongoing in both the mainstem Okanogan and Similkameen rivers and Salmon, Omak, and Loup Loup creeks. The Okanogan translocation lampreys originate from two sources: fish are captured at the Lower Columbia River Dams (Bonneville, the Dalles, and John Day dams) and held at that YN Prosser Hatchery, or they are trapped in the Mid-Columbia at Priest Rapids Dam and hauled in partnership with Grant County PUD and Douglas County PUD.

The USFWS distribution surveys in the Chelan River, Colockum and L.T. Murray Wildlife Area creeks, and Foster Creek have not detected lamprey. Pacific Lamprey are believed to be absent in Crab Creek as recent electrofishing surveys detected no larvae (Timko et al. 2017).

Threats

Summary of Major Threats

Ranking of UCRMU threats was based on the 2017 Assessment and further developed through information and consensus of the participating UCRMU members during a conference call on May 24, 2021 (Table 4). No major changes to the threat rankings were suggested at the RMU meeting; so the overall rankings remain the same as they were in 2020. Recommendation of Priority Projects from the UCRMU is based upon and consistent with the highest-ranked threats indicated in Table 4.

Among the threats identified in the UCRMU, some showed a pervasive impact in the entire region (Small Population Size, Stream and Floodplain Degradation). Other threats were more location specific, but nevertheless cause severe impacts to the local populations, such as Tributary Passage, Dewatering & Flow Management and Predation. Although Mainstem Passage is a key threat for this region, it was not included in the priority actions because the RIP is focused on the tributaries. As of

Table 4: Threats to Pacific Lamprey within the UCRMU, as identified and ranked the at RIP conference call on May 24, 2021. High = 3.5-4.0, Medium = 2.5-3.4, Low = 1.5-2.4, Insignificant = ≤ 1.4, Unknown = No value. Threat rankings in parentheses () have not be formally evaluated, were estimated, and not included in the mean score calculations.

Watershed	Tributary Passage		Dewatering and Flow Management		Stream and Floodplain Degradation		Water Quality		Predation		Small Population Size	
	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity
2021												
U. Columbia Drainages												
Crab Creek	-	-	(2)	(2)	(3)	(3)	(4)	(4)	(2)	(3)	-	-
Smaller Tributaries	(1)	(1)	(3)	(2)	(1)	(2)	(1)	(2)	(1)	(1)	-	-
Wenatchee	3	3	3	2	3	3	2	2	1	1	3	3.5
Entiat	1	1	2	2	3	3	2	2	1	1	2	2
Chelan	-	-	-	-	1	1	1	1	1	1	-	-
Methow	1	1	2.5	1	3	3	1	1	2	2	3.5	4
Okanogan	1	3↑	3	3	3	3	3	3	2.5	3	4	4
Similkameen	4	4	3	3	2	2	2	2	2.5	3	4	4
Yakima Drainages												
Upper Yakima	4	4	4	3	2	2	2	2	2	2	4	4
Naches	3	3	2	2	2	2	2	2	2	2	4	4↑
Lower Yakima	4	3	3	4	2	2	4	4	4	4	3	3
UCRMU												
Mean Score	2.63	2.75	2.81	2.50	2.33	2.33	2.11	2.11	2.00	2.11	3.44	3.56
Mean Scope & Severity	2.69		2.66		2.33		2.11		2.06		3.5	
Drainage Rank	M		M		L		L		L		H	

∞

2020, there was a separate RMU for the Mainstem Columbia RMU, under which the ongoing mainstem passage impacts and improvements are addressed.

Small Population Size continues to be the highest-ranked threat in the UCRMU in 2021. Small Population Size is the cumulative effect from reduced mainstem dam passage and the other threats listed above. Small Population Size can result in a lack of pheromone attraction to migrating adults, inability of migrating adults to pass barriers en-masse, inability of spawning adults to find mates, the loss of functional ecological services provided by healthy larval populations, and potential for catastrophic loss of the local population from environmental perturbations. Current adult translocation programs throughout the UCRMU aim to combat this threat. However, conservation actions targeting the causal mechanisms behind diminished populations (poor adult passage, juvenile entrainment, etc.) will likely be needed to improve self-sustaining Upper Columbia Pacific Lamprey runs.

Tributary Passage is a key threat in the Yakima, and Wenatchee subbasins as evidenced by radio telemetry (Yakima) and juvenile distribution surveys (Yakima, Wenatchee). Adult passage issues in the lower subbasins severely limit distribution into the upper watersheds. Prior to translocation, larval lamprey distribution of Pacific Lamprey stopped immediately downstream of Tumwater Dam (Wenatchee River) and Roza Diversion Dam (Yakima River). Counts from both of these dams also support the hypothesis that few to no adult lamprey currently move past these structures; counts at Tumwater Dam viewing window in 2017 indicate that some (n = 10) Pacific Lamprey adults did pass the fishladder. How many attempts were made and the number of unsuccessful passage events is unknown, as lamprey passage efficiency at this facility has yet to be evaluated. The Okanogan River has several dams that have not been evaluated for Pacific Lamprey passage such as Zosel Dam and the Lake Osoyoos Control. The Enloe Dam on the Similkameen River has no fish passage structures and is impassable.

Dewatering & Flow Management was also identified as a key threat in the Yakima Basin but meaningful restoration actions will require large scale institutional changes involving water rights and salmonid management and is likely a long-term action. Many of these actions are being addressed within the Yakima Basin Integrated Water Resources Management Plan. Larval and juvenile entrainment is included in the Dewatering and Flow Management threat category. Larval entrainment has been examined extensively and intensively by the YN within the Yakima Basin and Wenatchee Subbasin (Beals and Lampman 2017b, 2017c, 2018b, Lampman 2018). Because of their small size, larval lamprey less than 80 mm in length were easily entrained past the existing fish screens which are designed exclusively for juvenile salmonids. Diversion waterways provide ample larval lamprey habitat during the irrigation season when these structures hold water. However, dewatering in the winter months severely impacts juvenile lamprey and their ability to survive or return back to the river. Annual fish salvage operations have been implemented at several UCRMU diversions each fall at the end of the irrigation season. These operations can be costly and extensive, and the efficacy of salvage techniques in reducing larval survival is largely unknown.

Stream and Floodplain Degradation is a low to moderate threat in most RMU subbasins as all of these systems have undergone extensive channel modifications. 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

mining and timber practices, agriculture, road construction, and urbanization have deforested or altered the function and diversity of riparian vegetation. Owing to their complex, multi-stage life history, Pacific Lamprey require varied freshwater habitats (spawning gravels, well oxygenated permeable fines, etc.) that are often absent or lacking in highly-modified rivers.

Water Quality is considered a threat in some watersheds within the RMU, particularly the Lower Yakima and Okanogan rivers, and Upper and Lower Crab Creek. Summer water temperatures are a concern in both these systems, where warm water “thermal barriers” may persist at the river mouths and prevent migratory adults from entering. Concentrations of a wide variety of contaminants in lamprey tissue as well as larval lamprey habitat (fine sediment) was found to be high in the Yakima Basin based according to collaborative research by the USGS, Columbia River Inter-Tribal Fish Commission (CRITFC), YN, and Pacific Northwest National Laboratory (PNNL) (Nilsen et al. 2015). Pesticide and herbicide loads from agricultural runoff and irrigation returns are a concern throughout the UCRMU.

Predation risk is likely higher than was initially estimated in the 2011, and was ranked higher in the 2017 Assessment. A 2017 experimental feeding study showed a that wide variety of native (Chinook Salmon *Oncorhynchus tshawytscha*, Coho Salmon *O. kisutch*, Rainbow Trout *O. Mykiss* Northern Pikeminnow *Ptychocheilus oregonensis*, White Sturgeon *Acipenser transmontanus*, Chiselmouth *Acrocheilus alutaceus*) and non-native (Smallmouth Bass *Micropterus dolomieu*, Common, Carp *Cyprinus carpio*, Yellow Bullhead *Ameiurus natalis*) fishes feed on larval lamprey under laboratory conditions (Arakawa and Lampman 2017). Northern Pikeminnow and Walleye *Sander vitreus* have been show to prey on larval and juvenile lamprey in the Lower Columbia (Carpenter et al. 2019) but the effects of these predators have not been investigated in the Upper Columbia. Predation is assumed to be especially problematic in areas where invasive species are more prevalent (as a result of stocking history, or altered hydrologic conditions) such as the Lower Yakima, Okanogan and Similkameen subbasins. Avian and mammalian are likewise yet to be investigated in the UCRMU.

Restoration Actions

Tributary restoration projects have been implemented by numerous stakeholders and cover a wide range of activities including: installation of lamprey-specific passage systems at Prosser Dam on the Yakima River, survival and outmigration monitoring of acoustic tagged macrophthalmia, distribution and abundance surveys throughout the RMU, juvenile rescue and salvage operations, adult translocations, and artificial propagation. For a list of lamprey-focused restoration projects and the agencies involved, see Table 5. Within the mainstem Columbia River, restoration actions continue to be implemented by Grant, Chelan, and Douglas County PUDs at their respective hydroelectric dams. The majority of these efforts are focused on increasing adult fishway passage and improving detectability at counting stations. Owing to their location on the mainstem and not the tributaries, these actions fall outside of the RIP.

Table 5: Conservation actions specifically for or substantially benefitting lampreys that were underway, ongoing, or completed in the UCRMU from 2012-2021.

HUC	Threat	Action Description (Agency)	Type	Status
Okanogan	Population	Distribution surveys to evaluate larval lamprey presence in the main stem Okanogan River (USFWS, CCT)	Survey	Ongoing
Methow	Population	Distribution surveys to evaluate the upper extent of larval lamprey presence in the main stem Methow, Chewuch, and Twisp rivers (YN, Methow Salmon Recovery Foundation (MSRF), USFWS)	Survey	Ongoing
Chelan	Population	Distribution surveys to evaluate larval lamprey presence in the lower Chelan River (USFWS)	Survey	Complete
Entiat	Population	Nest surveys to evaluate spawn timing and distribution (USFWS)	Survey	Ongoing
Entiat	Population	Distribution surveys to evaluate the upper extent of larval lamprey presence in the main stem Entiat River and Mad River (USFWS, YN)	Survey	Ongoing
Wenatchee	Population	Distribution surveys to evaluate larval lamprey presence in the main stem Wenatchee River and tributaries (Peshastin Creek, Icicle Creek)(USFWS, YN)	Survey	Ongoing
Smaller Tributaries	Population	Distribution surveys to evaluate larval lamprey presence in the Colockum Plateau Streams and Foster Creek (USFWS)	Survey	Complete

Table 5 Continued: Conservation actions specifically for or substantially benefitting lampreys that were underway, ongoing, or completed in the UCRMU from 2012-2021.

HUC	Threat	Action Description (Agency)	Type	Status
Lower Yakima	Population	Distribution surveys to evaluate larval lamprey presence in the main stem Yakima River and tributaries (YN)	Survey	Ongoing
Upper Yakima	Population	Distribution surveys to evaluate larval lamprey presence in the main stem Upper Yakima River and tributaries (Wenas Creek, Teanaway River) (YN)	Survey	Ongoing
Naches	Population	Distribution surveys to evaluate larval lamprey presence in the main stem Naches River (YN)	Survey	Ongoing
Methow	Population	Translocate & release adult lamprey (YN)	Supplementation	Ongoing
Wenatchee	Population	Translocate & release adult lamprey (YN)	Supplementation	Ongoing
Lower Yakima	Population	Translocate & release adult lamprey (YN)	Supplementation	Ongoing
Upper Yakima	Population	Translocate & release adult lamprey (YN)	Supplementation	Ongoing
Naches	Population	Translocate & release adult lamprey (USFWS)	Supplementation	Ongoing
Upper RMU	Population	Trap adults at Priest Rapids Dam for translocation (GCPUD, DCPUD)	Supplementation	Ongoing
Wenatchee	Population	Truck and release adult lamprey (GCPUD)	Supplementation	Ongoing
Methow	Population	Truck and release adult lamprey (YN, DCPUD)	Supplementation	Ongoing
Okanogan	Population	Truck and release adult lamprey (CCT, YN, DCPUD)	Supplementation	Ongoing
Similkameen	Population	Truck & release adult lamprey CCT, GCPUD, DCPUD)	Supplementation	Ongoing

Table 5 Continued: Conservation actions specifically for or substantially benefitting lampreys that were underway, ongoing, or completed in the UCRMU from 2012-2021.

HUC	Threat	Action Description (Agency)	Type	Status
Okanogan/ Similkameen	Population	eDNA assessment of translocation release locations (CCT, USGS)	Survey	Ongoing
Okanogan/ Similkameen	Population	Re-analyzing previously collected eDNA samples for Pacific Lamprey (CCT, USGS)	Assessment	Ongoing
RMU	Population	BLIMP eDNA sampling and distribution model verification (USFS, YN, USFWS)	Survey	Complete
RMU	Population	Artificial propagation and larval rearing (YN, Confederated Tribes of the Umatilla Indian Reservation (CTUIR) , CCPUD, BPA, USFWS)	Supplementation	Ongoing
RMU	Population	Genetic evaluation of translocation success - (YN, USFWS, CRITFC, USFS)	Research	Ongoing
Wenatchee	Passage	Fish trap/forebay bypass operations at Tumwater Dam (CCPUD, WDFW)	Instream	Ongoing
Wenatchee	Passage	Fishway, count window, hopper modifications at Tumwater Dam (CCPUD)	Instream	Underway
Lower Yakima	Passage	Construction, operation, and evaluation of LPS units at Prosser Dam (USBOR, YN, USFWS)	Assessment	Ongoing
Lower Yakima	Passage	Radio telemetry assessment of adult lamprey passage at Wanawish, Prosser, Sunnyside, and Wapato Dams (USFWS)	Assessment	Complete
Upper Yakima	Passage	Radio telemetry study of adult passage Roza Dam (USFWS)	Assessment	Complete

Table 5 Continued: Conservation actions specifically for or substantially benefitting lampreys that were underway, ongoing, or completed in the UCRMU from 2012-2021.

HUC	Threat	Action Description (Agency)	Type	Status
Naches	Passage	Radio telemetry assessment of adult lamprey passage Cowiche Dam (USFWS)	Coordination	Ongoing
Lower Yakima	Passage	Coordinate funding and design of LPS passage structure at Wanawish Dam dams (USFWS, BOR, YN)	Coordination	Underway
Lower Yakima	Passage	Design and install LPS passage structures at Sunnyside and Wapato dams (YN, BOR, NRCS)	Coordination	Ongoing
Wenatchee	Passage	Investigate Tumwater Dam lamprey passage constraints (CCPUD)	Assessment	Complete
Wenatchee	Dewatering/Flow Management	Monitor, salvage, and reduce larval/juvenile entrainment at the Dryden irrigation diversion (CCPUD, USFWS, YN, WDFW)	Instream	Ongoing
Wenatchee	Dewatering/Flow Management	Evaluate effects of slope on larval lamprey self-rescue during dewatering events (USGS, USFWS, CCPUD)	Instream	Underway
Lower Yakima	Dewatering/Flow Management	Monitor, salvage, and reduce larval/juvenile entrainment at irrigation diversions/canals (YN, BOR, WDFW, irrigation districts)	Instream	Ongoing
Lower Yakima	Dewatering /Flow Management	Acoustic telemetry assessment of juvenile lamprey downstream passage (YN, BOR, USGS, PNNL)	Assessment	Ongoing

Table 5 Continued: Conservation actions specifically for or substantially benefitting lampreys that were underway, ongoing, or completed in the UCRMU from 2012-2021.

HUC	Threat	Action Description (Agency)	Type	Status
Upper Yakima	Dewatering/Flow Management	Monitor, salvage, and reduce larval/juvenile entrainment at irrigation diversions/canals (YN, BOR, WDFW, irrigation districts)	Instream	Ongoing
Upper Yakima	Dewatering/Flow Management	Monitoring the impacts of “Flip-Flop” flow management in Yakima Basin	Assessment	Complete
Naches	Dewatering/Flow Management	Monitor, salvage, and reduce larval/juvenile entrainment at irrigation diversions/canals (YN, BOR, WDFW, irrigation district)	Instream	Ongoing
Methow & Entiat	Stream & Floodplain Degradation	Habitat restoration effectiveness monitoring for larval lamprey (MSRF, USFWS, YN, Cascadia Conservation)	Assessment	Underway
RMU	Water Quality	Toxicology/ Contaminant levels of larval, juvenile, and adult lamprey (CRITFC, USGS, PNNL, YN)	Assessment	Complete
Lower Yakima	Lack of Awareness	Role of lamprey carcasses in Lower Yakima River tributaries (University of Idaho, Heritage University, YN, CTUIR, CRITFC)	Assessment	Complete
RMU	Lack of Awareness	Elder interviews on Pacific Lamprey - Traditional Ecological Knowledge (YN, Heritage University)	Assessment	Ongoing
RMU	Lack of Awareness	Conduct lamprey identification training (YN, USFWS)	Education	Complete

Table 5 Continued: Conservation actions specifically for or substantially benefitting lampreys that were underway, ongoing, or completed in the UCRMU from 2012-2021.

HUC	Threat	Action Description (Agency)	Type	Status
RMU	Lack of Awareness	Conduct outreach and provide educational opportunities (USFWS, YN)	Education	Ongoing
RMU	Lack of Awareness	Developing lamprey tagging methods (USFWS, YN, USGS, PNNL)	Lack of Awareness	Complete
Lower Yakima	Predation	Lab study of larval lamprey susceptibility to fish predators (YN)	Research	Complete

Long-Term Priority Projects:

In addition to the Priority Projects detailed above, RMU participants developed a list of long-term projects that would ideally be funded and implemented by 2025 (Table 6). Like the Priority Projects, these long-term projects address the major threats identified through the RIP process. However, these projects are currently not “shovel-ready” and need to be further developed in the near term.

Table 6: Long-term (2022-2027) priority Pacific Lamprey conservation projects for the UCRMU.

HUC	Threat	Action Description	Agencies	Approach
Lower Yakima	Adult Passage	Passage improvements at Wanawish, Prosser, Sunnyside, Wapato dams	YN, BOR, USFWS	LPS, ladder modification
Upper Yakima	Adult Passage	Adult passage improvements Roza, Town Canal dams	YN, BOR, USFWS	LPS, ladder modification
Wenatchee	Adult Passage	Passage evaluation & improvement Tumwater, Dryden dams	CCPUD, USFWS, WDFW	LPS, ladder modification, telemetry
Okanogan	Adult Passage	Passage evaluation Zosel Dam	CCT	Telemetry
Similkameen	Adult Passage	Passage evaluation at Enloe Dam	CCT	Telemetry, LPS

Table 6 Continued: Long-term (2021-2025) priority Pacific Lamprey conservation projects for the UCRMU.

HUC	Threat	Action Description	Agencies	Approach
Upper RMU	Adult Passage	Evaluate adult passage through Rocky Reach Reservoir and Wells Dam	CCPUD, DCPUD	Research
RMU	Adult Passage	Standardize passage metrics used by U.S. Army Corps of Engineers and PUDs	GCPUD, CCPUD, DCPUD, ACOE	Research
Lower Yakima	Juvenile Passage	Acoustic Telemetry of juvenile lamprey passage	YN, BOR, USGS	Telemetry
Upper Yakima	Dewatering/Flow Management	Juvenile entrainment improvements at irrigation diversions & “Flip-Flop”	YN, BOR, irrigation districts	Operational, FVES, large sifter
Naches	Dewatering/Flow Management	Juvenile entrainment improvements at irrigation diversions	YN, BOR, irrigation districts	Operational, FVES, large sifter
Lower Yakima	Dewatering/Flow Management	Juvenile entrainment improvements at irrigation diversions	YN, BOR, irrigation districts	Operational, FVES, large sifter
Wenatchee	Dewatering/Flow Management	Juvenile entrainment improvement at Dryden Irrigation Canal	CCPUD, WDFW, USFWS, YN	Operational and sluice gates
Lower Yakima	Water Quality	Yakima Delta Restoration	YN, ACOE, DNR, MCRFEG	Bateman Island Causeway Modification
RMU	Water Quality	Toxicological Evaluations	YN, BOR, USGS.	Research

II. Selection of Priority Actions

A. 2017 Funded Projects

In 2017, Bonneville Power Agency funded a priority lamprey conservation project from the Upper Columbia RMU. Under this project, the dam owner (USBOR) collaborated with YN and USFWS to install two additional LPS units at Prosser Dam in the center island fishway. These units were installed in March 2019.

B. 2018 Funded Projects

In 2018, Bonneville Power Agency funded two priority lamprey conservation projects from the UCRMU. The first is a joint USGS/YN/PNNL acoustic telemetry project evaluating entrainment and survival of outmigrating juvenile lamprey in the Lower Yakima River. The second is an assessment of a flow barrier (Flow Velocity Enhancement System) to reduce larval entrainment at the Bachelor Hatten Diversion on Ahtanum Creek.

C. 2019 Funded Projects

In 2019, Bonneville Power Agency funded two priority lamprey conservation projects from the Colville Confederated Tribes in the Okanogan subbasin. The first proposal supported adult translocations activities and the second looked at historic lamprey distribution through eDNA analyses. Both the translocation work and eDNA analysis are ongoing as of August 2020.

D. 2020 Funded Projects

In 2020, Bonneville Power Agency funded two priority lamprey conservation projects from the UCRMU. The first proposal was a continuation of eDNA work by CCT to inform adult translocations. The second was an MSRF investigation of salmonid-focused habitat restoration structures in the Methow and Entiat rivers and whether they create habitat for larval lamprey . Both the translocation/eDNA work and the habitat evaluation are ongoing as of August 2021.

E. Prioritization Process

Participating members of the UCRMU met in met in May 2021 to discuss completed and ongoing conservation actions and identify specific projects and research needed to address threats and uncertainties within the region. Prioritization of projects is based on consensus by all participating members of the UCRMU. Criteria used in prioritization include: (1) action will provide significant and persistent benefit to the subbasin population, (2) action is supported by all affected parties, and (3) action can and will be implemented contingent upon securing funding.

Three Priority Project projects were submitted by RMU members for the Upper Columbia Regional Implementation Plan in 2021 (see below). The complete applications for these were submitted separately to the Conservation Team on August 17, 2021.

Project 1: Lamprey-Specific Electrofishing Techniques: impacts to target and non-target species

Project 2: Lethal Air Temperatures for Dewatered Lamprey: research to improve Best Management Guidance

Project 3: RNA distinguishes life stage and sex in relatives of Pacific Lamprey: the need for environmental RNA markers to monitor spawning and rearing

III. Literature Cited

- Arakawa, H. and R. Lampman. 2017. Assessment on the predation potential of various native and non-native fish species to Pacific Lamprey (*Entosphenus tridentatus*) and Western Brook Lamprey (*Lampetra richardsoni*) ammocoetes. Annual Report, BPA Project No. 2008-470-00. 30 pp.
- Beals, T., and R. Lampman. 2016a. Lower Yakima Subbasin larval lamprey monitoring report, 2016. Annual Report, BPA Project No. 2008-470-00. 70 pp.
- Beals, T., and R. Lampman. 2016b. Upper Yakima larval lamprey monitoring report, 2016. Annual Report, BPA Project No. 2008-470-00. 66 pp.
- Beals, T. and Lampman, R. 2016c. Naches larval lamprey monitoring report, 2016. Annual Report, BPA Project No. 2008-470-00. 29 pp.
- Beals, T., and R. Lampman. 2016d. Wenatchee Subbasin larval lamprey monitoring report, 2016. Annual Report, BPA Project No. 2008-470-00. 43 pp.
- Beals, T., and R. Lampman. 2016e. Entiat Subbasin larval lamprey monitoring report, 2016. Annual Report, BPA Project No. 2008-470-00. 27 pp.
- Beals, T., and R. Lampman. 2016f. Methow Subbasin larval lamprey monitoring report, 2016. Annual Report, BPA Project No. 2008-470-00. 37 pp.
- Beals, T., and R. Lampman. 2017a. Wenatchee Subbasin larval lamprey monitoring report, 2017. Annual Report, BPA Project No. 2008-470-00. 35 pp.
- Beals, T., and R. Lampman. 2017b. Intensive monitoring of larval/juvenile lamprey entrainment within the Yakima Subbasin, 2016. Annual Report, BPA Project No. 2008-470-00. 18 pp.
- Beals, T., and R. Lampman. 2017c. Intensive monitoring of larval/juvenile lamprey entrainment within Dryden Diversion, Wenatchee River, 2016. Annual Report, BPA Project No. 2008-470-00. 7 pp.
- Beals, T., and R. Lampman. 2018a. Distribution and occupancy of Pacific Lamprey in six major Columbia River subbasins within the Yakima Nation Ceded Lands: Summary from 2009-2017 surveys. Annual Report, BPA Project No. 2008-470-00. 27 pp.
- Beals, T., and R. Lampman. 2018b. Summary assessment of larval/juvenile lamprey entrainment in irrigation diversions within the Yakima Subbasin, 2017. Annual Report, BPA Project No. 2008-470-00. 7 pp.
- Carpenter, A. L., C. M. Barr, E. S. Anderson, and E. Tinus. 2019. Report C: System-wide Predator Control Program: Fisheries and Biological Evaluation. BPA Project No. Project No. 1990-077-00, 112 pp.
- Crandall, J. 2010. Methow Lamprey Inventory and Restoration Assessment: Draft Report. Wild Fish Conservancy. 44 pp.

- Grote, A.B. and K.J Carim. 2017. Using eDNA sampling to detect Pacific Lamprey in a large river: 2016 Wenatchee River Pilot Study. U.S. Fish and Wildlife Service, Leavenworth, WA. 23 pp.
- Grote, A.B., M. C. Nelson, C. Yonce, A. Johnsen, D. J. Sulak, and R. D. Nelle. 2014. Passage of radio-tagged adult Pacific lamprey at Yakima River diversion dams. 2013 Annual Report Phase : Sunnyside and Wapato Dams. U.S. Fish and Wildlife Service, Leavenworth, WA. 59 pp.
- Grote, A.B., M. C. Nelson, C. Yonce, K. Poczekaj, RD Nelle. 2016. Passage of radio-tagged adult Pacific lamprey at Yakima River diversion dams. 2014 Annual Report Phase 3: Roza and Cowiche Dams. U.S. Fish and Wildlife Service, Leavenworth, Washington. 59 pp.
- Johnsen, A., and M.C. Nelson. 2012. Surveys of Pacific Lamprey Distribution in the Wenatchee River Watershed 2010 – 2011. U.S. Fish and Wildlife Service, Leavenworth, WA. 15 pp.
- Johnsen, A., M. C. Nelson, C. Yonce, D. J. Sulak, and R. D. Nelle. 2013. Passage of radio-tagged adult Pacific lamprey at Yakima River diversion dams. 2012 Annual Report. U.S. Fish and Wildlife Service, Leavenworth, WA. 89 pp.
- Kelly-Ringel, B. 2016. Opportunistic surveys of Pacific Lamprey in the Wenatchee River. USFWS Memorandum, February 2, 2016. Leavenworth, WA. 6 pp.
- Lampman, R. 2018. Intensive monitoring of larval/juvenile lamprey entrainment within Dryden Diversion, Wenatchee River, 2017. Annual Report, BPA Project No. 2008-470-00. 21 pp.
- Lampman, R. 2019a. Translocation of Adult Pacific Lamprey within the Yakima Subbasin, 2017-2018 Broodstock. Annual Report, BPA Project No. 2008-470-00. 39 pp.
- Lampman, R. 2019b. Translocation of Adult Pacific Lamprey within the Wenatchee Subbasin, 2017-2018 Broodstock. Annual Report, BPA Project No. 2008-470-00. 34 pp.
- Lampman, R. 2019c. Translocation of Adult Pacific Lamprey within the Upper Columbia, 2017-2018 Broodstock. Annual Report, BPA Project No. 2008-470-00. 47 pp.
- Luzier, C.W, H.A. Schaller, J.K. Brostrom, C. Cook-Taber, D.H. Goodman, R.D. Nelle, K. Ostrand, and B. Streif. 2011. Pacific Lamprey (*Entosphenus tridentatus*) Assessment and Template for Conservation Measures. U.S. Fish and Wildlife Service, Portland, OR. 282 pp.
- Nilsen, E. B., Hapke, W. B., McIlraith, B., and D. Markovchick. (2015). Reconnaissance of contaminants in larval Pacific lamprey (*Entosphenus tridentatus*) tissues and habitats in the Columbia River Basin, Oregon and Washington, USA. *Environmental pollution*, 201, 121-130.
- Timko, M., Le, B., and Nass, B. 2017. Assessment of Juvenile Lamprey Presence/Absence, Habitat Use, and Relative Abundance in the Priest Rapids Project Area. 19 pp.

Wagner, P., M. Young, J. Rohrback, and C. Fisher. 2018 Fall Okanogan Sub-basin Adult Pacific Lamprey Translocation Plan. Colville Tribes Fish and Wildlife Program. August 20, 2018. 5 pp.

