

Pacific Lamprey
2022-2023 Regional Implementation Plan
for the
Upper Columbia
Regional Management Unit



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I. Status and Distribution of Pacific Lamprey in the RMU

General Description of the RMU

The Upper Columbia Regional Management Unit (RMU) includes watersheds that drain into the Columbia River from the Snake River confluence to Chief Joseph Dam (Table 1). It is comprised of fourteen 8th Field Hydrologic Unit Codes (HUC) watersheds (Figure 1), ranging in size from 1,735-7,640 km² (Table 1). This Regional Implementation Plan focuses on six subbasins of the Columbia River: Yakima, Wenatchee, Entiat, Methow, Okanogan, and Similkameen rivers. The priority 8th Field HUC watersheds from these major tributaries include: Lower Yakima (#17030003), Naches (#17030002), Upper Yakima (#17030001), Wenatchee (#17020011), Entiat (#17020010), Methow (#17020008), Okanogan (#17020006), and Similkameen (#17020007). Although the Okanogan and Similkameen subbasins extend into Canada, only the U.S. portion of these systems is included in our analysis. Crab Creek (#'s 17020013,17020015), Chelan River (#17020009) and various smaller tributaries (Colockum area streams and Foster Creek) are also included in the Assessment (Table 1), but little information is available on lamprey presence in these subbasins. While historic Pacific Lamprey (*Entosphenus tridentatus*) distribution likely extended into Sanpoil (#17020004), Colville (#17020003), and Kettle (#17020002) HUC watersheds, these areas were excluded from consideration at this time due to existing anadromous passage barriers at Chief Joseph and Grand Coulee dams. In future assessments, we recommend the inclusion of habitat consideration within these areas as well as in Canadian territories to help shed light on historic distribution and habitat within the Upper Columbia RMU.

Table 1: Drainage size and Level III Ecoregions of the 11 priority 4th Field Hydrologic Unit Code (HUC) watersheds and drainages within the Upper Columbia Region.

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, North Cascades
Methow	17020008	4,714	Columbia Plateau, North Cascades
Chelan	17020009	2,473	Columbia Plateau, North Cascades
Entiat	17020010	3,937	Columbia Plateau, North Cascades
Wenatchee	17020011	3,648	Columbia Plateau, North Cascades
Upper Crab Creek	17020013	4,810	Columbia Plateau
Lower Crab Creek	17020015	6,425	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

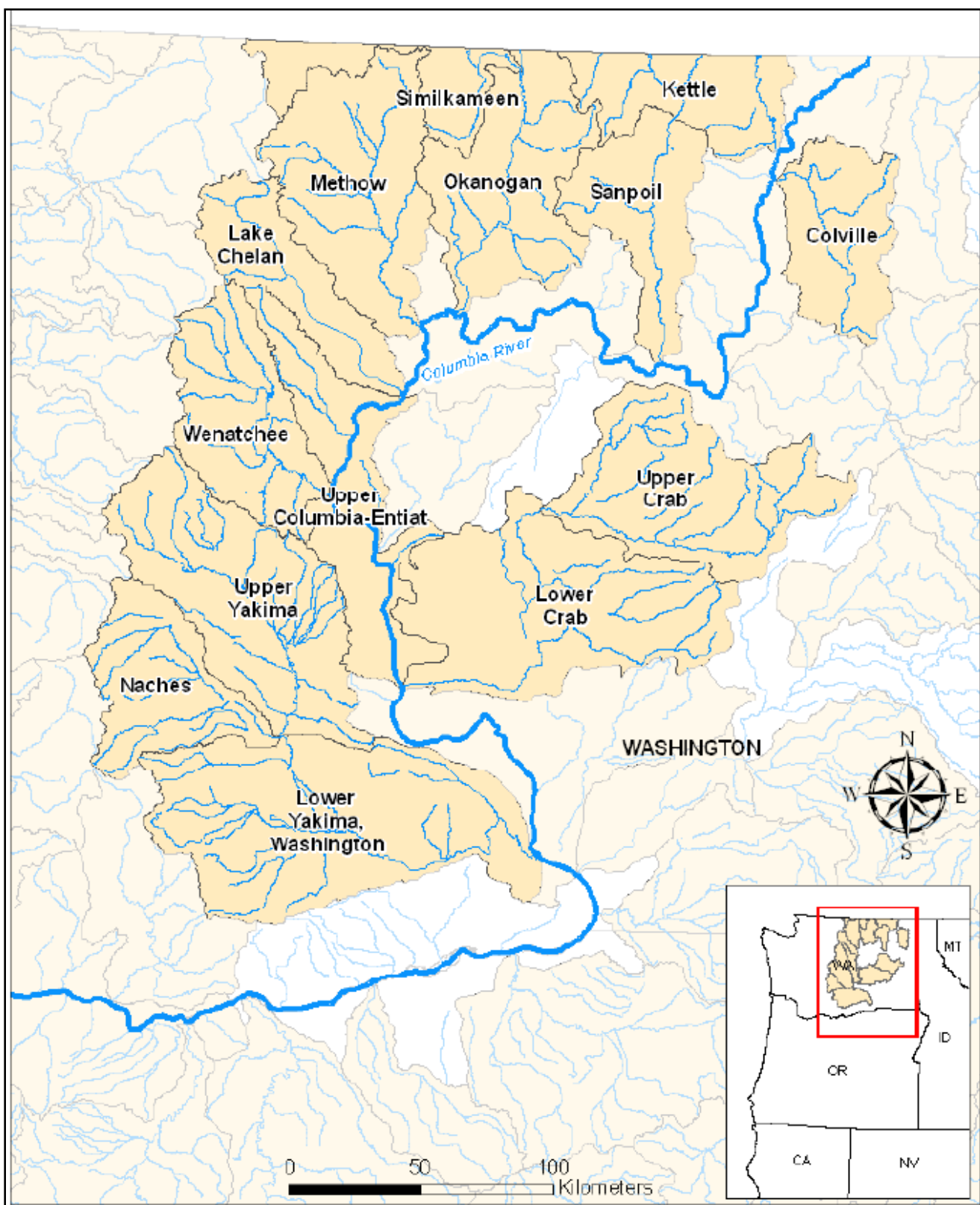


Figure 1: Map of the HUC4 watersheds within the Upper Columbia Regional Management Unit

Status of Species

2022 Conservation Assessment Summary and New Updates

Every five years the Pacific Lamprey Conservation Initiative (PLCI), through the RMUs, revise the Pacific Lamprey Assessment (USFWS 2019). 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 Upper Columbia RMU through an online Assessment questionnaire and virtual meeting held on March 11th, 2022. The following is a brief summary of key findings from the 2022 Upper Columbia RMU Pacific Lamprey Assessment.

To characterize the status impacts of adult translocation and associated changes, we calculated Upper Columbia RMU demographic and distribution metrics for the 2022 Assessment both with and without translocation. This approach differs from previous years, when translocations were less widespread, and the status ranks were calculated using only “volitional migrant” lampreys.

Pacific Lamprey are still considered to be either S1 (Critically Imperiled) or SH (Possibly Extirpated) in all Upper Columbia RMU HUC watersheds (Figure 2). Conservation Status Ranks changed in two of eleven HUC watersheds in 2022: status ranks improved to S1 (Critically Imperiled) from SH (Presumed Extirpated) in the Okanogan and Similkameen subbasins. These status improvements resulted from including translocated fish in the NatureServe analysis: when translocated fish were excluded, the rankings remained the same as they were in 2018.

Upper Columbia RMU NatureServe Rankings 2022

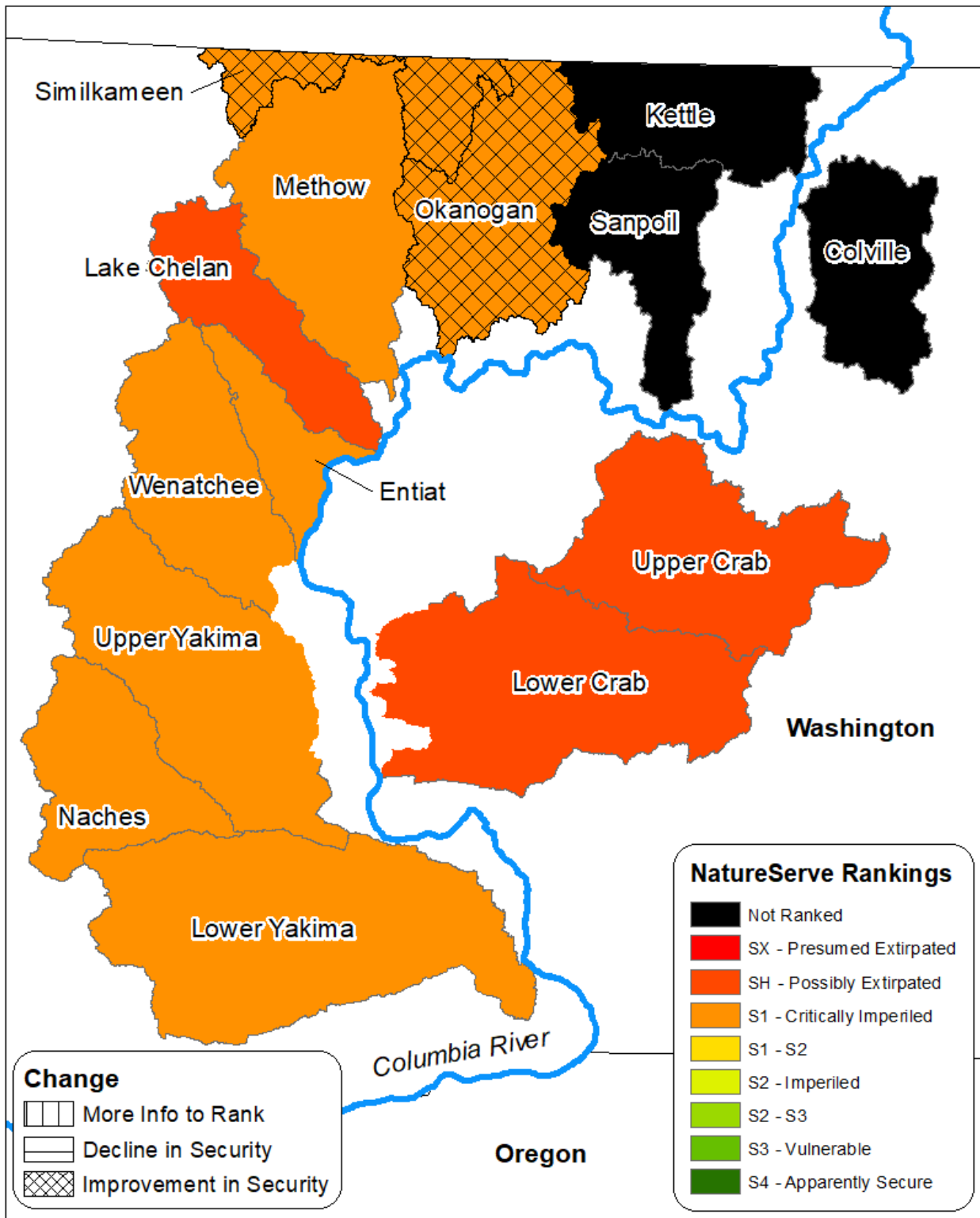


Figure 2: Upper Columbia RMU Pacific Lamprey distribution as of September 2022. When translocated adults are included in the ranking process, the status of The Similkameen and Okanogan both improve from Possibly Extirpated (SX) to Critically Imperiled (S1).

Background on Supplementation

Adult translocation first began in the Lower Yakima River in 2011 as a radio telemetry project lead by the USFWS and Yakama Nation (YN) (Table 2, Table 3 Figure 4). Over the last five years, multiple agencies including the YN, Colville Confederated Tribes (CCT), and Grant (GCPUD) and Douglas (DCPUD) County Public Utility Districts have conducted extensive translocations of adult Pacific lampreys within the Upper Columbia RMU (Table 3, Figure 3). Furthermore, in 2021, following the developed guidelines identified in the Lamprey “Master Plan” (CRITFC et al. 2018), the YN also began releasing hatchery propagated and reared early life stage lamprey (from fertilized eggs to juvenile life stages) into mainstem and tributaries of the Yakima River. Outplanting of early life stages currently occurs at four key locations: two sites in Upper Yakima River side channels, one site in a Naches River side channel, and one site in Lower Wenas Creek. The result of these supplementation efforts, but primarily stemming from long-term adult translocation programs, is an increase in functional adult population size and distribution in multiple Upper Columbia HUC watersheds along with increased larval and juvenile recruitment and distribution (Beals and Lampman 2020; Beals and Lampman 2022; Hess et al. 2023). In the Yakima Subbasin, where translocation has continued for over a decade, increases in volitional migrant adults are also being documented.

Table 2: Summary of Pacific Lamprey adult translocation release numbers by spawn years to eight subbasins within the Upper Columbia RMU by lead entity (and partnering entities) as of June 2023. USFSW and YN lampreys were sourced from Bonneville, The Dalles, and John Day dams, whereas CCT, DCPUD, and GCPUD translocation fish were collected at Priest Rapids Dam.

Subbasin	Adult Translocation Spawn Years	USFWS (& YN)	YN (& CRITFC)	CCT (& DCPUD, CCPUD)	DCPUD (& YN, CCT, GCPUD)	GCPUD	Totals
Lower Yakima	2011 - 2023	164	4960	0	0	0	5124
Upper Yakima	2014 - 2023	45	1123	0	0	0	1168
Naches	2014 - 2023	44	371	0	0	0	415
Wenatchee	2016 - 2023	0	2303	0	0	0	2303
Methow	2016 - 2023	0	1721	0	507	0	2228
Okanogan	2018 – 2023	0	329	362	0	0	691
Similkameen	2018 – 2023	0	97	158	0	0	255
Columbia (mainstem)	2018 - 2023	0	526	0	1693	1788	4007

Table 3: Detailed inventory of adult Pacific Lamprey adult translocation release numbers by migration/brood year to eight subbasins within the Upper Columbia RMU as of June 2023. The number of releases is listed and grouped by entity and summary subtotals (by watershed [blue], entity [orange], and grand total [green]) are displayed at the bottom.

Entity	Subbasin	Watersheds	River	2010- 2011	2011- 2012	2012- 2013	2013- 2014	2014- 2015	2015- 2016	2016- 2017	2017- 2018	2018- 2019	2019- 2020	2020- 2021	2021- 2022	2022- 2023	Total
US FWS (& YN)	Yakima	Lower YAK	L. Yakima	8	76	80	-	-	-	-	-	-	-	-	-	-	164
		Upper YAK	U. Yakima	-	-	-	45	-	-	-	-	-	-	-	-	-	45
		Naches	Naches	-	-	-	44	-	-	-	-	-	-	-	-	-	44
YN (& CRITFC, CCT)	Yakima	Lower YAK	L. Yakima	-	-	1	9	21	72	330	384	477	109	60	272	757	2,492
			Satus	-	15	46	92	209	117	30	23	22	26	40	47	129	796
			Toppenish	-	-	35	78	219	128	40	35	78	57	51	83	91	895
			Simcoe	-	-	10	-	-	-	-	-	-	-	-	-	-	10
		Upper YAK	Ahtanum	-	-	46	85	201	130	29	20	64	37	40	40	75	767
			U. Yakima	-	-	-	-	102	-	-	68	58	142	46	114	390	920
			Wilson	-	-	-	-	-	-	-	-	-	-	7	-	-	7
			Cherry	-	-	-	-	-	-	-	-	-	-	16	-	-	16
			Swauk	-	-	-	-	-	-	-	-	-	32	-	-	15	47
			Teanaway	-	-	-	-	-	-	-	-	-	41	-	25	22	88
			Cle Elum	-	-	-	-	-	-	-	-	-	20	-	-	25	45
		Naches	Naches	-	-	-	-	-	-	-	-	-	90	120	50	81	341
			American	-	-	-	-	-	-	-	-	-	-	-	30	-	30
	Wenatchee	Lower WEN	L. Wenatchee	-	-	-	-	-	110	120	119	151	-	-	-	-	500
			Icicle	-	-	-	-	-	-	-	26	-	-	-	-	-	26
		Upper WEN	U. Wenatchee	-	-	-	-	-	100	186	130	262	100	256	150	443	1,627
			Lake WEN	-	-	-	-	-	-	-	-	-	-	-	150	-	150
	Methow	Lower MET	L. Methow	-	-	-	-	-	249	120	240	150	100	128	231	408	1,626
			Twisp	-	-	-	-	-	-	20	-	-	-	-	-	-	20
		Upper MET	U. Methow	-	-	-	-	-	-	30	-	-	-	-	-	-	30
			Chewuch	-	-	-	-	-	-	-	45	-	-	-	-	-	45
	Okanogan (w/ CCT)	Okanogan	Okanogan	-	-	-	-	-	-	-	-	80	-	-	-	-	80
			Salmon	-	-	-	-	-	-	-	-	60	-	-	24	25	109
			Omak	-	-	-	-	-	-	-	-	60	-	-	25	30	115
			Loup Loup	-	-	-	-	-	-	-	-	-	-	-	-	25	25
	COL	Similkameen	Similkameen	-	-	-	-	-	-	-	-	48	-	-	-	49	97
		Lower COL	(Above MCN)	-	-	-	-	-	-	-	-	-	-	-	-	-	0
			(Below MET)	-	-	-	-	-	-	-	95	-	-	-	33	70	198
		Upper COL	(Below OKA)	-	-	-	-	-	-	-	-	-	-	109	169	50	328
CCT (& DCPUD, GCPUD)	OKA	Okanogan	Salmon	-	-	-	-	-	-	-	-	16	22	26	32	70	166
			Omak	-	-	-	-	-	-	-	-	15	26	22	31	-	94
			Loup Loup	-	-	-	-	-	-	-	-	-	-	21	25	56	102
		Similkameen	Similkameen	-	-	-	-	-	-	-	49	61	-	20	28	-	158
	DCPUD (& YN, CCT, GCPUD)	Lower MET	L. Methow	-	-	-	-	-	-	-	-	507	-	-	-	-	507
			(Above RRD)	-	-	-	-	-	-	-	-	-	-	-	-	454	454
		Upper COL	(Above Entiat)	-	-	-	-	-	-	-	-	-	-	-	-	191	191
			(Below MET)	-	-	-	-	-	-	-	136	-	102	266	345	-	849
	GCPUD	Upper COL	(Below OKA)	-	-	-	-	-	-	-	129	70	-	-	-	-	199
			(Below WEN)	-	-	-	-	-	-	-	-	177	111	-	-	1500	1,788
Subtotal By Watershed	YAK	Lower Yakima	-	8	91	218	264	650	447	429	462	641	229	191	442	1052	5,124
	YAK	Upper Yakima	-	0	0	0	45	102	0	0	68	58	235	69	139	452	1,168
	YAK	Naches	-	0	0	0	44	0	0	0	0	0	90	120	80	81	415
	WEN	Wenatchee	-	0	0	0	0	0	210	306	275	413	100	256	300	443	2,303
	MET	Methow	-	0	0	0	0	0	249	170	285	657	100	128	231	408	2,228
	OKA	Okanogan	-	0	0	0	0	0	0	0	0	231	48	69	137	206	691
	OKA	Similkameen	-	0	0	0	0	0	0	0	49	109	0	20	28	49	255
	COL	Columbia	-	0	0	0	0	0	0	0	360	247	213	375	547	2265	4,007
Subtotal By Lead Entity	YAK	USFWS	-	8	76	80	89	0	0	0	0	0	0	0	0	0	253
	multiple	YN	-	0	15	138	264	752	906	905	1185	1510	754	873	1443	2685	11,430
	OKA	CCT	-	0	0	0	0	0	0	0	49	92	48	89	116	126	520
	multiple	DCPUD	-	0	0	0	0	0	0	0	265	577	102	266	345	645	2,200
	COL	GCPUD	-	0	0	0	0	0	0	0	0	177	111	0	0	1500	1,788
-	-	GRAND TOTAL	-	8	91	218	353	752	906	905	1499	2356	1015	1228	1904	4956	16,191

Abbreviations: YAK=Yakima, WEN=Wenatchee, MET=Methow, COL=Columbia, OKA=Okanogan, L.=Lower, U.=Upper, RRD=Rocky Reach Dam.

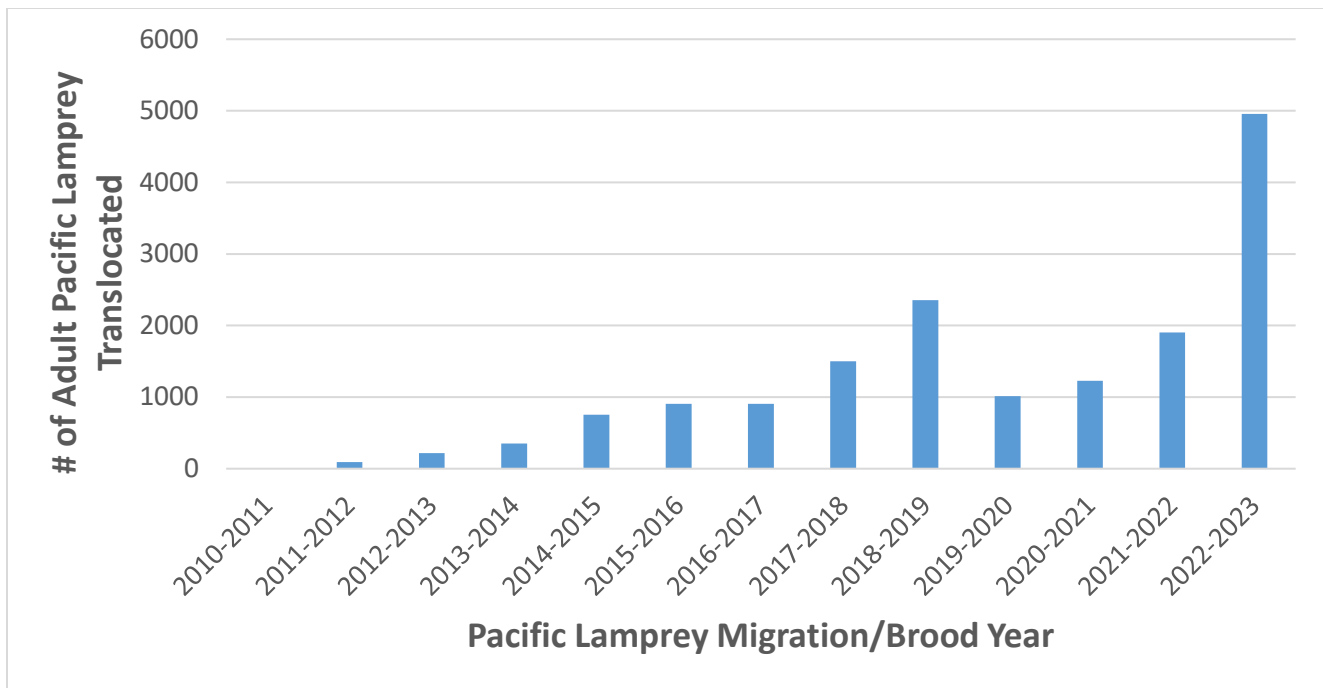


Figure 3: Adult Pacific Lamprey translocation release numbers in the Upper Columbia RMU (migration/brood year 2010-2011 to 2022-2023).

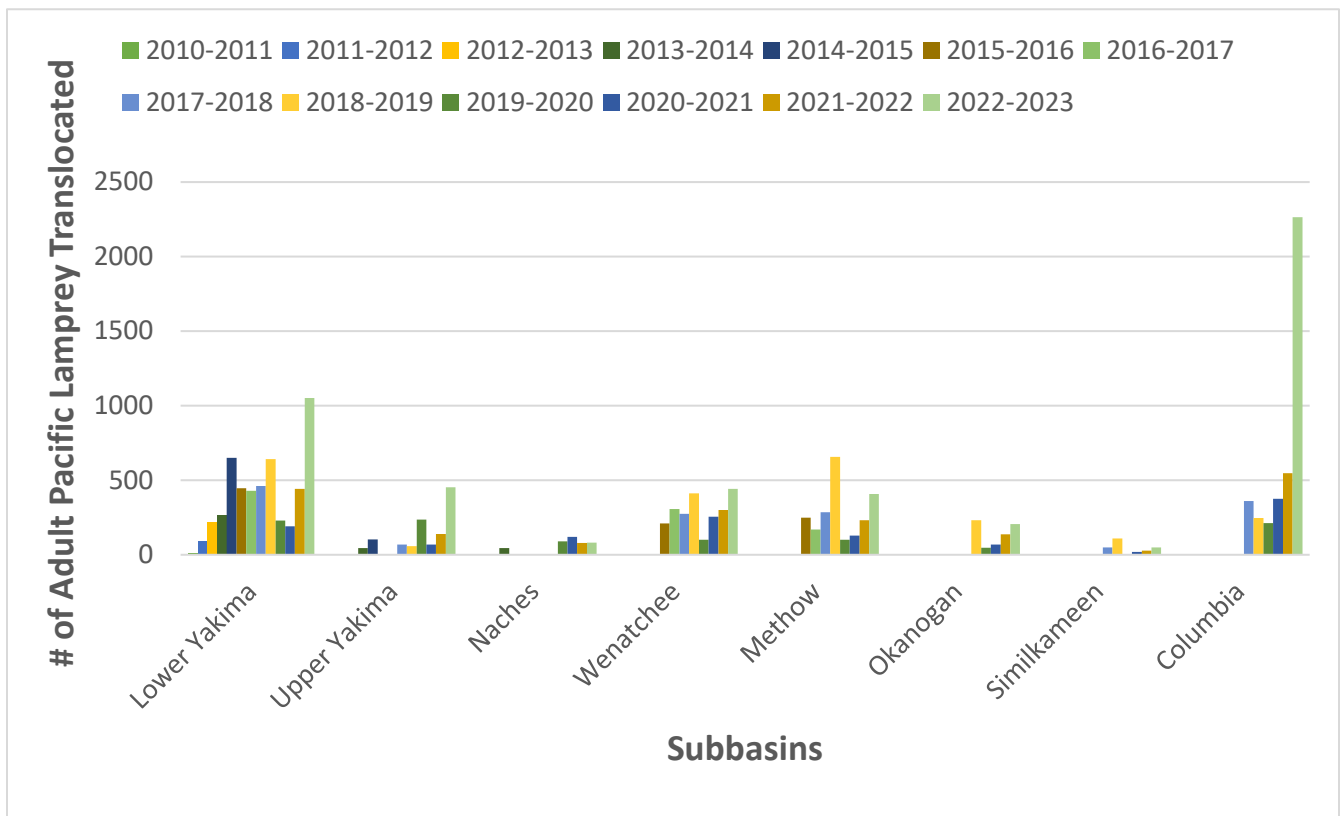


Figure 4: Adult Pacific Lamprey translocation release numbers in the Upper Columbia RMU by subbasin (migration/brood year 2010-2011 to 2022-2023).

Distribution

Since the completion of the 2018 Assessment (which was based on 2013-2017 data), information on Pacific Lamprey distribution continues to improve due to increased sampling efforts and application of new methodologies. Current Pacific Lamprey distribution in the Upper Columbia RMU is displayed in Figure 5. For the purposes of this document, distribution of Pacific Lamprey is defined as the areas occupied by either adult or larval/juvenile lampreys. Because we assume that larvae/juveniles do not move upstream (at least not over multiple river km), the uppermost distribution of spawning adults can be assessed conservatively using the presence of larval/juvenile Pacific Lamprey. However, in systems where larval presence has not been evaluated extensively or in migratory corridors, such as the mainstem Okanogan River, the uppermost release location of translocated adults was used to define distribution. Adult translocation and larval monitoring are ongoing throughout the RMU, and translocation is expanding adult distribution and increasing spawner and larval abundance in the Upper Yakima, Naches, Lower Yakima, Methow, Wenatchee, Okanogan, and Similkameen watersheds (Figures 4 and 5, Tables 3 and 4). We expect Pacific Lamprey distribution in the Upper Columbia RMU to continue changing as new surveys, translocations, and recolonizations occur in the future.

The current Upper Columbia distribution map is informed by a variety of sources, including electrofishing, environmental DNA (eDNA), and nesting survey, smolt trap, adult ladder, and translocation release counts. Specific sources include: annual and biennial electrofishing surveys conducted by the Yakama Nation (YN) (Beals and Lampman 2020) specifically in the Lower Yakima (Lumley and Lampman 2022a), Upper Yakima (Lumley and Lampman 2022a), Naches (Lumley and Lampman 2022a), Wenatchee (Lumley and Lampman 2022b), Entiat (Beals et al. 2019) Methow (Lumley and Lampman 2022c) and Crab (Lumley et al. 2021) subbasins; USFWS electrofishing surveys from the Wenatchee, Entiat, Chelan, Methow and Okanogan rivers and smaller tributaries (USFWS, unpublished data); YN eDNA surveys (Lampman and Lumley 2020; Lumley et al. 2020b); USFWS eDNA surveys (Grote and Carim 2017), USFS eDNA Basinwide Inventory and Monitoring Project (Carim et al. 2017; Young et al. 2022), electrofishing surveys and screw trap data in Okanogan River tributaries by the CCT (M. Young, CCT, personal communication), and translocation reports by the YN (Lampman 2019a, 2019b, 2019c), DCPUD (DCPUD 2023; M. Mayfield, DCPUD, personal communication), and GCPUD (GCPUD 2023; M. Clements, GCPUD, personal communication).

Current Pacific Lamprey distribution in the Upper Columbia RMU is greatly reduced from historical range: in all Upper Columbia HUC watersheds we estimate that between 0 – 50 % of historic habitat is currently occupied (Table 4), although the delineation of the historic habitat likely warrants some reevaluation and revisions in future assessments. Nevertheless, compared with previous assessments, distribution in the Upper Columbia RMU continues to expand, especially in systems where translocation releases circumvent existing passage barriers on the mainstem Columbia and its tributaries (Figure 5). Translocated adults are a major driver of occupancy expansion in the Okanogan, Similkameen, and Naches rivers, in the Wenatchee River upstream of Tumwater Dam, and in the Upper Yakima River upstream of Roza Dam, and several tributaries of the Lower Yakima. Without ongoing translocation activities and/or substantive passage improvements, lamprey distribution in these systems would likely contract to the diminished areas that were occupied prior to

translocations. In addition to direct supplementation of fish on the landscape, allowing Pacific Lamprey to once again serve their intrinsic ecological functions, translocation is also contributing to distribution gains directly through increased spawner numbers and resulting larval production in previously extirpated systems like Nason Creek (Upper Wenatchee), Salmon and Omak creeks (Okanogan), Toppenish Creek (Lower Yakima), and mainstem Upper Yakima River and many of its tributaries. Increased numbers of larval lamprey produce more larval bile acid in the stream system, which in turn acts as pheromones helping attract more adult lamprey, both translocated as well as volitional migrants, to spawn in previously inaccessible/unoccupied locations (CRITFC et al. 2018). Despite the clear delineation of newly expanded habitat via translocated adults (as displayed in Figure 5), the current range and distribution of the translocated adults in the Upper Columbia RMU is likely quite complex. Even streams that have not received any adult translocation to date, such as the Entiat River, likely are recipient of “strayed stocks,” and hold a combination of translocated and volitional migrant lamprey.

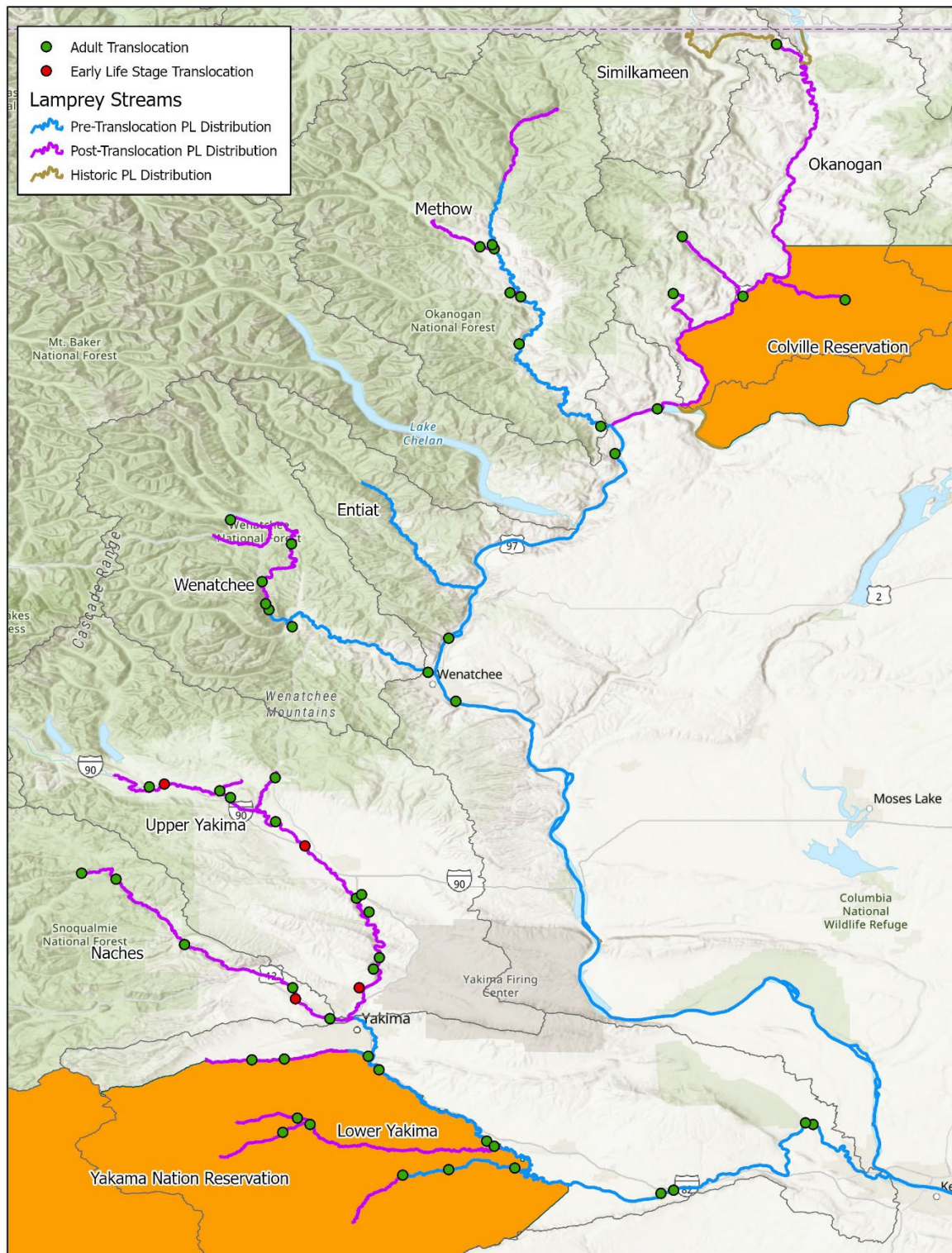


Figure 5: Distribution of Pacific Lamprey in the Upper Columbia RMU as of September 2022. Green circles (adults) and red circles (larvae, prolarvae), indicate release locations. Purple river segments indicate areas occupied predominantly by translocated and their progeny; blue segments indicate areas of mixed translocated and volitional migrants; brown segments indicate known historic areas that are currently unoccupied.

Table 4: 2022 population demographic and Conservation Status Ranks of the priority 4th Field Hydrologic Unit Code (HUC) watersheds located within the Upper Columbia RMU. S1 = Critically Imperiled. SH = Possibly Extinct. Rankings in yellow indicate deterioration (↓) whereas those in green indicate improvement (↑) between the 2022 and 2018 Assessment results. Rankings with an * indicate an improvement when translocation was included in the 2022 score calculations.

Watershed	HUC Number	Conservation Status Rank	Historic Occupancy (km ²)	Current Occupancy (km ²)	Population Size (adults)	Short-Term Trend (% decline)
Upper & Lower Crab	17020013 17020015	SH	1000-5000	Zero	Zero	Unknown
Wenatchee	17020011	S1	1000-5000	100-500↑	50-250↓	30-70%↓
<u>Wenatchee w/ Translocation</u>	<u>17020011</u>	<u>S1</u>	<u>1000-5000</u>	<u>100-500↑</u>	<u>250-1000*</u>	<u>10-50%↓*</u>
Entiat	17020010	S1	1000-5000	100-500	250-1000	10-50%↓
Lake Chelan	17020009	SH	Unknown	Zero	Zero	Unknown
Methow	17020008	S1	1000-5000	100-500	1-50↓	>70%↓
<u>Methow w/ Translocation</u>	<u>17020008</u>	<u>S1</u>	<u>1000-5000</u>	100-500	<u>250-1000↑*</u>	<u>50-70%↓*</u>
Okanogan	17020006	SH	1000-5000	Zero↓	1-50	>70%
<u>Okanogan w/ Translocation</u>	<u>17020006</u>	<u>S1↑*</u>	<u>1000-5000</u>	<u>100-500↑*</u>	<u>50-250↑*</u>	<u>50-70%↑*</u>
Similkameen	17020007	SH	<100	Zero	Zero	>70%
<u>Similkameen w/ Translocation</u>	<u>17020007</u>	<u>S1↑*</u>	<u><100</u>	<u>4-20↑*</u>	<u>1-50↑*</u>	<u>10-50%↑*</u>
Upper Yakima	17030001	S1	1000-5000	Zero↓	Zero↓	50-70%↓
<u>Upper Yakima w/ Translocation</u>	<u>17030001</u>	<u>S1</u>	<u>1000-5000</u>	<u>100-500↑*</u>	<u>50-250↑*</u>	<u>30-50%↓*</u>
Naches	17030002	S1	1000-5000	Zero↓	Zero↓	50-70%↓
<u>Naches w/ Translocation</u>	<u>17030002</u>	<u>S1</u>	<u>1000-5000</u>	<u>100-500↑*</u>	<u>50-250↑*</u>	<u>30-50%↓*</u>
Lower Yakima	17030003	S1	1000-5000	100-500	250-1000	30-50%↓
<u>Lower Yakima w/ Translocation</u>	<u>17030003</u>	<u>S1</u>	<u>1000-5000</u>	<u>100-500</u>	<u>250-1000</u>	<u>10-30%↓*</u>
Smaller Tributaries	--	--	Unknown	Zero	Zero	Unknown

Abundance

Population abundance of Pacific Lamprey ranged from zero to 250-1000 for each watershed (Table 4). When adult translocation numbers were excluded, four watersheds (namely Wenatchee, Methow, Upper Yakima, and Naches) displayed a decrease in abundance and no increases were observed in any of the watersheds compared to the previous Assessment. When translocation adults were included in the analysis, five watersheds (namely Methow, Okanogan, Similkameen, Upper Yakima, and Naches) displayed an increase in abundance and no decreases were observed in any of the watersheds compared to the previous Assessment. Furthermore, four watersheds (Entiat, Yakima, Wenatchee, and Methow) were estimated to be in the “C” category (250-1000 adults) compared to just one watershed (Entiat) being in the “C” category when translocation numbers were excluded. As the paired analysis demonstrates, adult translocation not only stopped the decline in many of the watersheds but also contributed to increasing the distribution and overall abundance in many of the Upper Columbia watersheds.

Figure 6 shows the combined low, middle, and high ranges of the estimated adult Pacific Lamprey population sizes from the Upper Columbia RMU during each of the three assessment 5-year periods (including the paired analysis with and without translocation numbers). When adult translocation numbers are included, we see a gradual increase in overall numbers, whereas when adult translocation numbers are excluded, the estimated number is considerably reduced. Adult translocation restoration work began in the Yakima Subbasin (Lower Yakima watershed specifically), which was part of the 2008-2012 Assessment period (Figure 7). Translocation then began in the Upper Yakima, Naches, Wenatchee, Methow, and Similkameen watersheds during the 2013-2017 Assessment period and increased considerably in the Lower Yakima watershed. During the 2018-2022 Assessment period, the numbers translocated increased across all seven watersheds.

Figure 8 shows the mean number of adult Pacific Lamprey counted between McNary Dam and Wells Dam during each of the assessment 5-year periods with translocation numbers included. Overall, the mean number during the 2018-2022 Assessment period was higher compared to that of the 2008-2012 Assessment period but was slightly less compared to that of the 2013-2017 Assessment period, except for Wells Dam which had higher conversion rates likely due to the consorted adult translocation efforts to bring more adults above this dam. Figure 9 displays the mean number of adult Pacific Lamprey counted between McNary Dam and Wells Dam during the 2022 Assessment period (2018-2022) with translocation numbers included and associated key tributaries in between these dams.

Finally, there is evidence that there are likely undercounting issues at some of the Upper Columbia River hydro dams, in addition to McNary Dam (Figure 10). For example, mean adult lamprey passage counts at Wanapum Dam (located upstream) were higher than at Priest Rapids Dam (located downstream) for the 2013-2017 Assessment period. This discrepancy indicates some undercounting of passing lamprey at Priest Rapids Dam. A similar undercounting trend was observed for Rock Island Dam (compared to Rocky Reach Dam counts), especially prior to improvements made at the Rock Island Dam fish counting station in 2018. Given that some of the adult lamprey passing Rock Island Dam move into the Wenatchee watershed to spawn, the adult counts at Rock Island Dam should be higher.

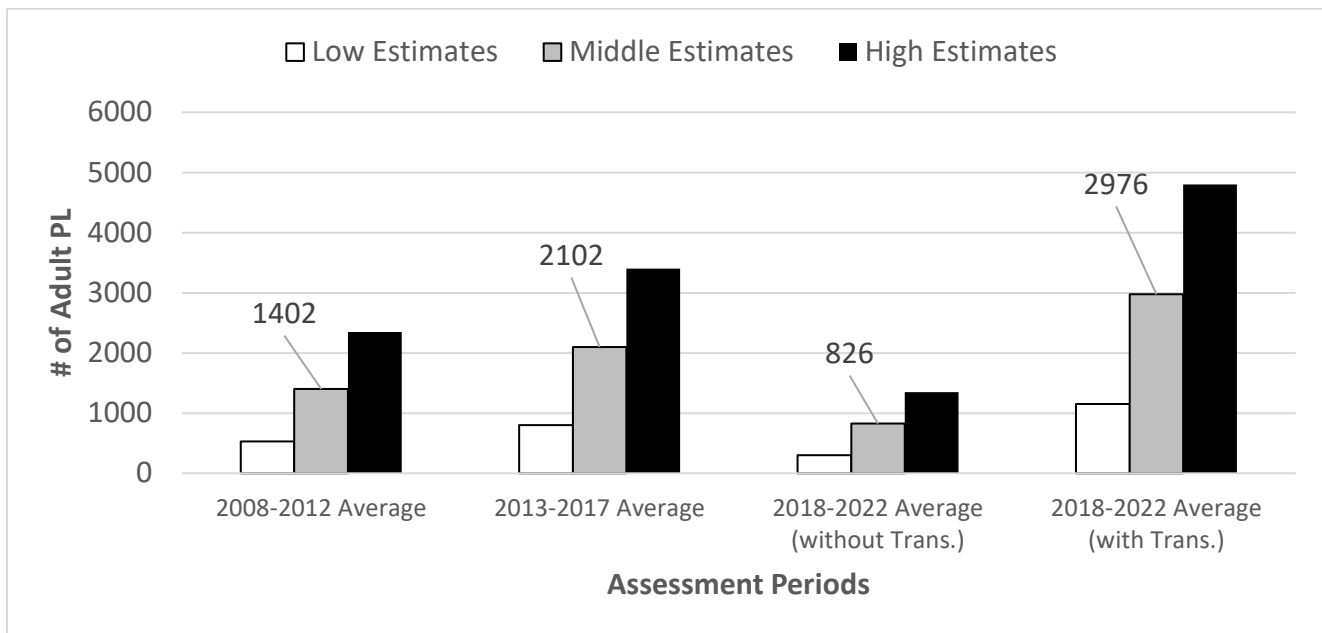


Figure 6. The combined low, middle, and high ranges of the estimated number of adult Pacific Lamprey from the Upper Columbia RMU during each of the three assessment 5-year periods. Two scenarios are shown for the 2018-2022 period; one without translocation (*Trans.*) and one with translocation included.

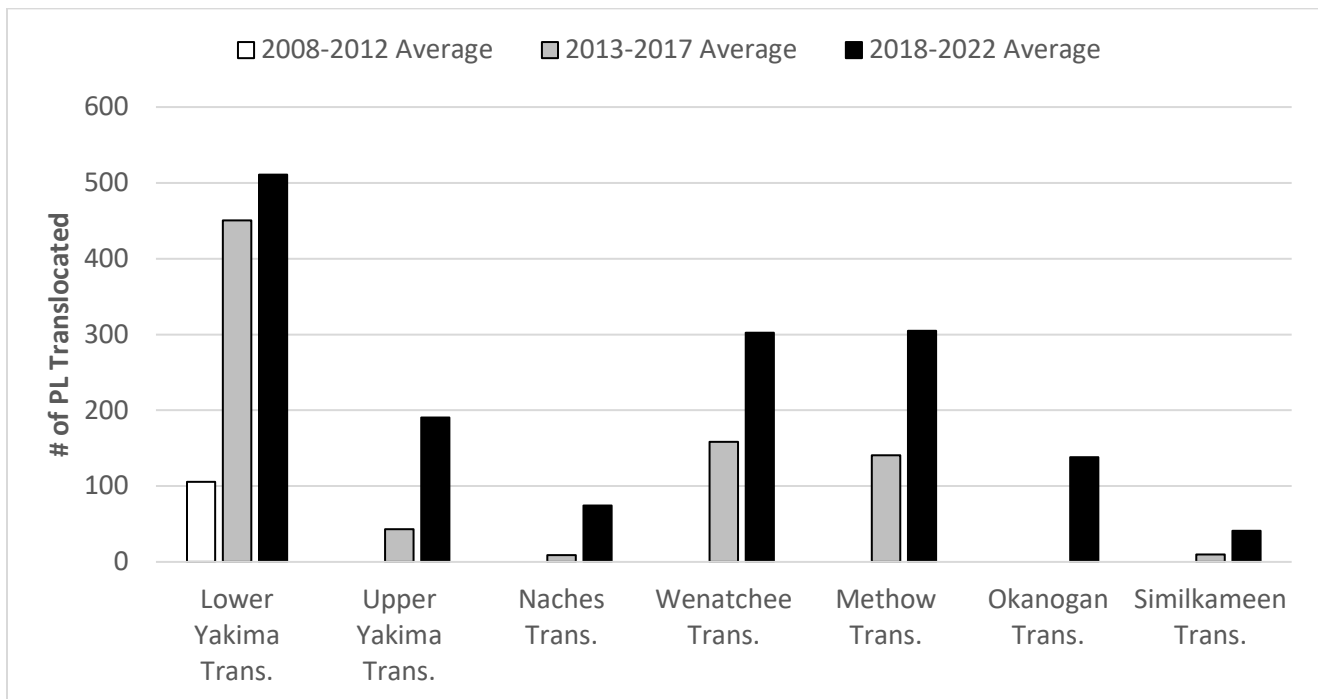


Figure 7: The average number of adult Pacific Lamprey translocated during each of the three assessment 5-year periods in each of the Upper Columbia RMU watersheds.

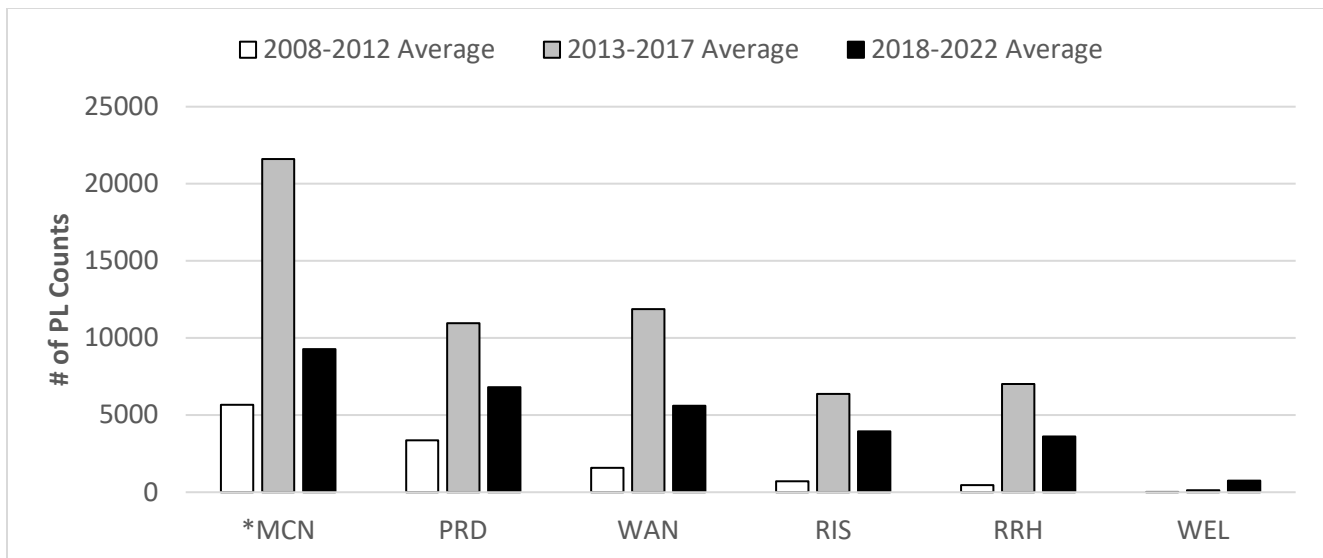


Figure 8: The mean number of adult Pacific Lamprey counted between McNary Dam and Wells Dam on the Columbia River during each of the assessment 5-year periods with translocation numbers included. *McNry Dam has undercounting issues, so an estimate was used instead (50% of the John Day Dam counts). Abbreviations: MCN = McNary Dam, PRD = Priest Rapid Dam, WAN = Wanapum Dam, RIS = Rock Island Dam, RRH = Rocky Reach Dam, WEL = Wells Dam.

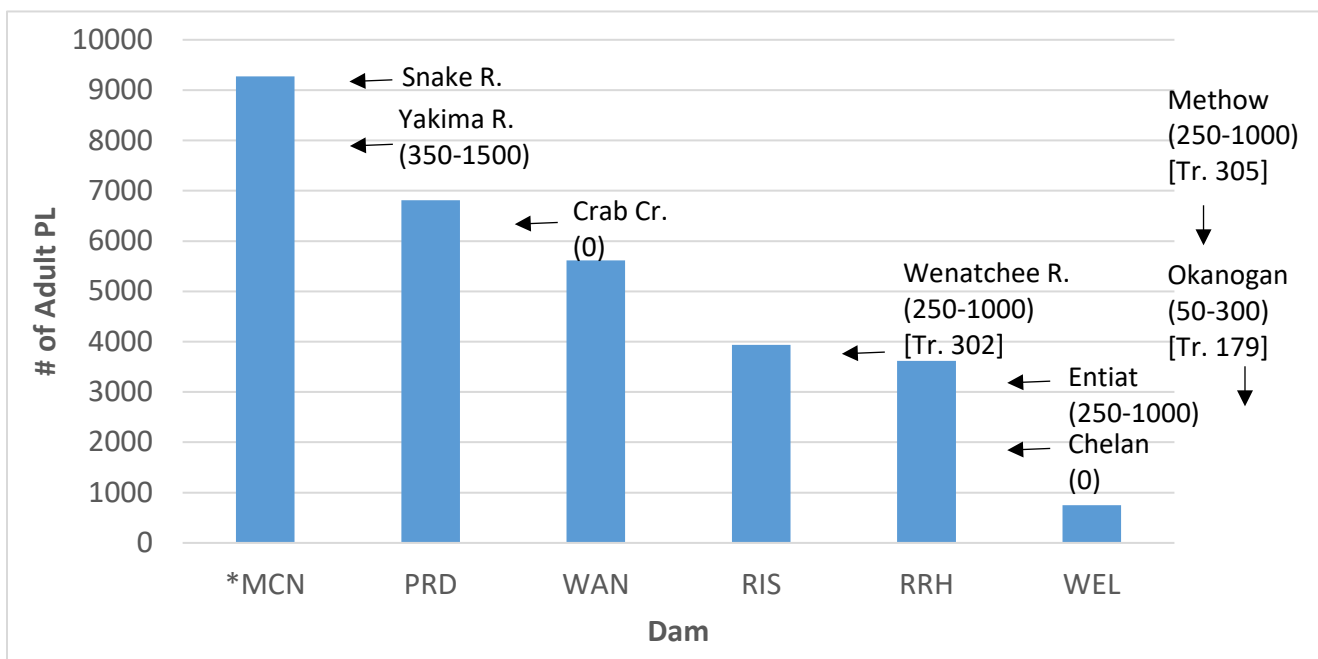


Figure 9: The mean number of adult Pacific Lamprey counted between McNary Dam and Wells Dam on the Columbia River during the 2022 Assessment period (2018-2022) with translocation numbers included and associated key tributaries in between these dams. The population categories of the tributaries are shown in parenthesis and the mean number of translocated adults between 2018 and 2022 are shown in square brackets [Tr.]. *McNry Dam has undercounting issues, so an estimate was used instead (50% of the John Day Dam counts). Abbreviations: MCN = McNary Dam, PRD = Priest Rapid Dam, WAN = Wanapum Dam, RIS = Rock Island Dam, RRH = Rocky Reach Dam, WEL = Wells Dam.

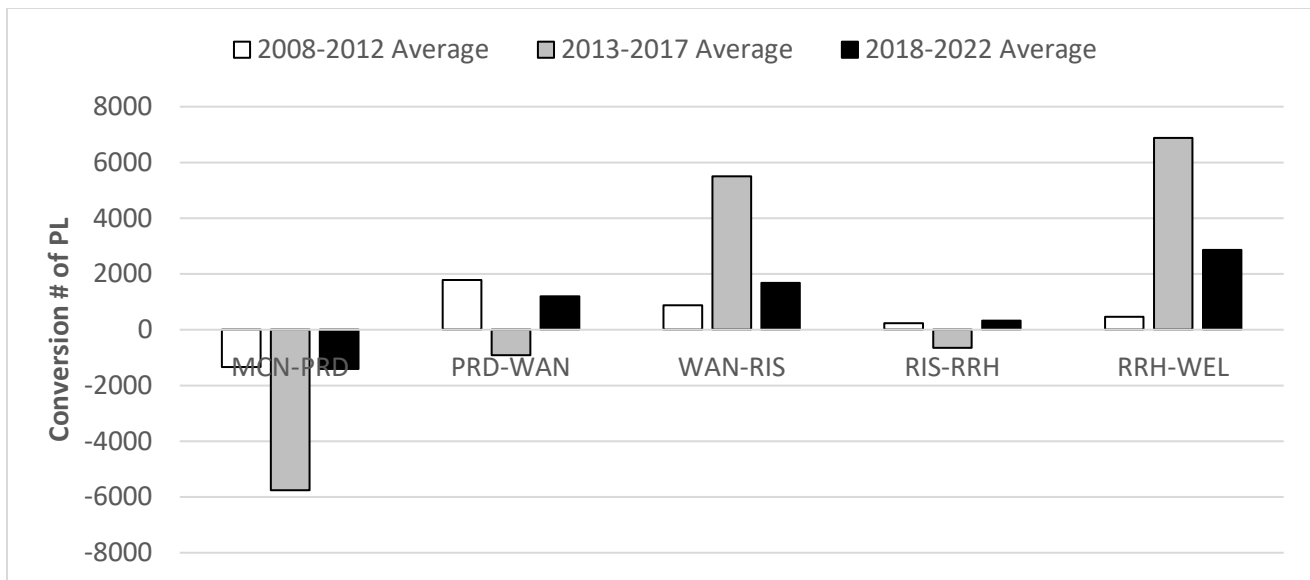


Figure 10: The difference in adult Pacific Lamprey counts between each of the adjacent pair of dams between McNary Dam and Wells Dam on the Columbia River (the conversion number). If negative, that indicates that there are more lamprey counted in the upstream dam compared to the downstream dam.

Short Term Population Trend was an ongoing point of discussion in the 2022 Assessment meeting. Based on new life history information (Hess et al. 2022, Hess et al. 2023), the baseline Pacific Lamprey generation time for this analysis increased from 9 to 10-15 years. The Short Term Population Trend metric is evaluated over 3 generations. Using a median generation time of 12 years, the interval we assessed for Short Term Population Trend was 36 years (1986 – 2022). Many RMU members agreed that reliable detailed demographic information extending that far back was very limited and it also coincides with a period when Bonneville Dam (1970-1996) as well as other hydroelectric dams discontinued lamprey counts temporarily. Our resulting Short Term Population Trend rankings are therefore based more on qualitative professional judgement using limited best information available rather than the more quantified appraisal of the Distribution and Abundance metrics.

One of the best available sources of information/trend data is Traditional Ecological Knowledge (TEK) from tribal elders. Many YN elders were interviewed by YN tribal and staff members regarding lamprey harvest in Upper Columbia starting in 2013 and a considerable number of the elders mentioned that late 1970s to early 1980s was when the numbers really began to decline sharply (Lampman and Luke 2015). Based on these observations, 1982-1986 (the period of comparison for short-term trend) was a period when a rapid shift was taking place in lamprey abundance. For example, if lamprey harvest between late 1960s and early 1970s was considered to represent the baseline level of harvest at 100% at Prosser Dam in Lower Yakima River (when the run was relatively abundant), harvest in mid-1970s was estimated to be only 8.3-9.1% of that baseline level, and harvest in mid-1980s was estimated to be 2.2-3.6% of that baseline level (which is immediately before harvest stopped due to lack of lamprey).

In occupied HUC watersheds, Pacific Lamprey subpopulations are estimated to have declined by 10% to >70% over the last 36 years (Table 2). For the currently unoccupied systems (including Upper and Lower Crab Creek, Lake Chelan, and the Smaller Tributaries), the Short-Term Trend was scored as “Unknown” due to lack of information. Compared with the 2018 Assessment results, the Short-Term Population Trend was worse (n=6) or stayed the same (n=2) from 2018-2022 for all ranked subbasins when translocation adults were excluded from the analysis. When translocation adults were included, the trend improved from the same to better in the Okanogan and Similkameen subbasins. The improvement in those two systems was due to the functional extirpation of Pacific Lamprey in these two subbasins (after 2010 in Okanogan), and their subsequent return and recolonization under translocation beginning in 2017 and continuing through 2023. The change in the baseline Pacific Lamprey generation time (and the resulting period of comparison for short-term trend) had an impact on this ranking, making the comparison with the 2018 Assessment results more nuanced and challenging.

Distribution and Connectivity

There are five hydroelectric dams on the Columbia River within the Upper Columbia RMU (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 Regional Implementation Plan, 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 of these smaller tributary dams to connectivity 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 the migration season / time of year (Johnsen et al. 2013, Grote et al. 2014, Grote et al. 2016). Cumulative passage through successive dams was very low with less than 5% of adult lamprey successfully passing three or more of the lowermost diversion dams. Prior to translocations, Pacific Lamprey were assumed to be functionally extirpated from the Upper Yakima HUC upstream of Roza Dam (rkm 210.5). In spring 2015, a total of 102 adult lamprey were translocated upstream of Roza Dam for the first time. Adult lamprey have been translocated annually each year to Upper Yakima River and its tributaries since 2018 and 2020, respectively. Although some passage improvements were implemented at Roza Dam by the YN and Bureau of Reclamation (enlargement of the drain holes in fish ladder weirs and installation of a lamprey exit from the adult collection facility) volitional passage still appears to be very limited based on results from PIT tag releases. Sixty seven to seventy five percent of PIT-tagged adults that enter Roza Dam exit the ladder downstream often after several days to a few months of moving back and forth within the ladder, and there is considerable uncertainty regarding the passage success of the remaining twenty five to thirty three percent of adults. Most of these fish are last detected at the uppermost PIT array in the fish ladder, but not in the adult collection facility, and it is unclear how many are indeed passing the dam as only a handful of detections at the adult collection facility has occurred to date (Lampman 2019a). We suspect that the passage rate is somewhere between 0-33%. In spring 2019, a total of 90 adult lamprey were released in Naches River

to ameliorate the declining abundance and distribution of larval Pacific Lamprey within the subbasin. Releases have occurred annually in the Naches River since then. Prior to 2019, translocation only occurred in the Naches River as part of a radio telemetry study lead by the USFWS in 2013-2014.

Starting in 2017, the YN, Bureau of Reclamation (BOR), and USFWS worked collaboratively to install the first vertical wetted wall structure (a type of a Lamprey Passage System [LPS]) at Prosser Dam right ladder. As of 2023, there are one or two LPS structure(s) at each of the three fish ladders at this dam, totaling five structures altogether as a result of a variety of funding sources. The two LPS structures on the left ladder have a volitional passage component using a combination of 4-inch plastic tubing and a video counting station. New funding from PLCI (BPA) was attained in 2024-2025 to convert all LPS trap boxes on the right and center ladders to volitional systems and incorporate optical sensor counters (also known as “lasers,” which have been tested by the U.S. Army Corps of Engineers [ACOE] to be highly effective at Bonneville Dam LPS systems). These changes will reduce both passage time for lamprey moving through LPS units and the staff time needed to operate the systems and process passage data. Some minor modifications to the trap box are also being proposed to reduce fine sediment accumulation (incorporating a design update used for the Lyle Falls [Klickitat River] LPS design). Adult lamprey passage through the LPS units at Prosser Dam varies considerably each year, but all of the LPS structures typically collect at least some lamprey and annual counts have ranged from 2 (in 2020) to 224 (in 2018). There is also a considerable number of lamprey (likely equal or slightly greater than the LPS passage) passing the ladder itself each year via the window count stations or through the picketed lead auxiliary water; however, the video system is only detecting a small portion of these adults (a new video counting system installed in 2018 at the fish ladders likely reduced the detection efficiency for lamprey considerably) and the number of lamprey passage is currently being estimated via annual PIT tag releases. A long-term solution is needed to help ensure all lamprey passing Prosser Dam is accurately accounted for.

Fully volitional LPS structures (vertical wetted walls) were installed at Sunnyside and Wapato diversion dams between 2021-2022 using funding from Natural Resources Conservation Service and USFWS. Wapato diversion dam structures (on the left and right ladders) require some minor modifications to once again operate smoothly (rerouting of some of the PVC pipes and relocation of the vertical wetted wall to a safer location from floating woody debris), but each of the Sunnyside diversion dam structures (on the right and center ladders) appear to have passed approximately 40-50 adults each. Although there are more detections to quality check, which could increase the count further, many of these could be false detections (e.g., insects, water flow reflections), and we have also discovered that the 6-inch PVC system allows adult lamprey to more readily switch directions. As a result, some of these detections may include lamprey heading downstream, rather than upstream (one of the downsides for the 6-inch PVC system, which was not observed with 4-inch tube systems). A final count, after error checking all the detections, will be provided in 2024.

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 2016a, Kelly-Ringel 2016, USFWS unpublished data). Although adult lamprey passage at Tumwater Dam has not been formally evaluated, release of PIT tagged lamprey indicated that at best only 12-17% of the

adults reach the upper PIT antenna located near the top of the main fish ladder (Lampman 2019c). Depending on dam operations, lamprey that navigate the main Tumwater fish ladder may not freely exit the dam, but instead be redirected to a second ladder and the fish counting and trapping stations. 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 counts, Chelan County Public Utility District (PUD) modified trapping operations at Tumwater Dam beginning in 2018. With this change, the fish ladder exit is left open at night for several weeks in August and September, allowing fish to bypass the fish trapping system. These night operating conditions are intended to facilitate passage for nocturnal lampreys. In 2022, a total of 6 adult lamprey passed the Tumwater Dam fish counting window, and in 2023 15 passed. These low numbers indicate that adult passage is still problematic, in spite of lamprey-friendly nighttime operations.

Following the 2016 adult translocation releases, 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, but preliminary results indicate that the majority of these larvae are the progeny of translocated fish (Hess et al. 2022 and 2023). Dryden Dam (rkm 28.3) on the Wenatchee River is passable by adult Pacific Lamprey but has not been formally evaluated.

Connectivity in the Entiat River is not limited by dams and larval lamprey are common and throughout much of this system. Larval lamprey are distributed widely from river mouth to rkm 46.4 (Beals and Lampman 2016b, Crandall 2022). Entiat River rotary screw trap counts of larval and juvenile lamprey vary from just under 1,200 to over 5,500 between 2007 and 2016 (USFWS unpublished data). Beginning in 2018, the USFWS has conducted spawning and nesting surveys for adult lamprey which have identified nests near, but not upstream of, the larval distribution limit. Spawning survey results indicate that the majority of lamprey spawning occurs in the lower 10 rkm of the Entiat River, and in the stillwater reach between Stormy Creek (rkm 31.1) and Brief, WA (rkm 40.2).

Migratory connectivity in the Methow HUC is largely intact with no identified mainstem impediments, although several structures including Foghorn Dam have not been formally evaluated. Prior to adult translocation in the Methow subbasin, lamprey distribution was substantially reduced and new larval recruitment appeared to be absent in most of the stream reaches for at least a few years; only large larval lamprey (> 100 mm) were being detected in all of the surveys (Beals and Lampman 2016c, Crandall 2008). Since translocation began in fall 2015, larval distribution, size classes, and abundance in the Methow River and tributaries have consistently increased. Larvae have been detected at all the mainstem Methow River index survey sites (Beals and Lampman 2016c), and as of 2023 are distributed upstream of the Chewuch River confluence to rkm 100.4 at Weeman Bridge. Larval lamprey have recolonized the Chewuch River past rkm 23.9 (Beals and Lampman 2016c) and up to rkm 49.5 in 2022-2023. In spring 2018, larval lamprey were captured for the first time in the Twisp River via the screw trap (rkm 2.0) and have been captured there continuously each year to date (increasing ~ 40 mm on average in body size for the first few years); in 2020, they were also detected via electrofishing surveys (Lumley et al. 2020a). Recent electrofishing surveys are detecting increased numbers and size classes of larval lamprey at index sites, indicating widespread successful reproduction (J. Crandall, Methow Salmon Recovery Foundation, personal communication).

In the Okanogan and Similkameen watersheds, adult translocations are ongoing since 2017 with active release sites in the mainstem Columbia, Okanogan, and Similkameen rivers, and Omak, Salmon, and Loup Loup creeks. 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 the YN Prosser hatchery, or they are trapped in the Mid-Columbia at Priest Rapids Dam and trucked in partnership with Grant County PUD and Douglas County PUD. Prior to translocation, the last lamprey detected in the Okanogan Subbasin was from a screw trap on the mainstem river in 2010 (Wagner et al. 2018), and Pacific Lamprey were presumed to be functionally extirpated from both the Okanogan and Similkameen systems after this year. Following translocation, electrofishing surveys have routinely captured larvae in Omak, Salmon, and Loup Loup creeks, and in the mainstem Similkameen River. Larval lamprey have also been captured at the Okanogan River rotary screw trap (CCT). Pacific Lamprey DNA has been detected at multiple sites throughout the mainstem Okanogan River and in the Similkameen River downstream of Enloe Dam. Distribution and abundance of larval lamprey in these systems is increasing under translocation, and these changes were reflected in the improved Nature Serve security rankings in 2022.

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; Lumley et al. 2021). Other watersheds within the Upper Columbia RMU where Pacific Lamprey are extirpated are located upstream of Chief Joseph and Grand Coulee Dams. Neither dam is equipped with fish passage systems and both are therefore complete barriers to migratory anadromous species including Pacific Lamprey. Historic information indicates that prior to construction of these two dams, lamprey more than likely occupied the Kootenai, Slocan, Pend Oreille, Kettle, Colville, Spokane, Little Spokane, Sanpoil and Nespelem rivers and Latah Creek in addition to the mainstem Columbia River (Dr. A. Scholz, Eastern Washington University, personal communication). Recent efforts by the Upper Columbia United Tribes (UCUT) to restore anadromous species (Chinook and Sockeye salmon) to the areas upstream of Grand Coulee Dam are driving feasibility evaluations for the design and implementation of fish collection and passage facilities at both Chief Joseph and Grand Coulee dam. Future passage systems or management actions aimed at restoring connectivity to the “Upper-Upper” Columbia River should include Pacific Lamprey as one of a suite of native anadromous fishes to be prioritized for reintroduction.

Western Brook Lamprey (*Lampetra richardsoni*) are pervasive and relatively abundant in the Naches and Upper Yakima in mainstem rivers as well as some of their larger tributaries (Beals and Lampman 2020). In the Lower Yakima River, Western Brook Lamprey are found in small, isolated patches in the lower and mid reaches of the mainstem and in many of the larger tributaries. The only other locations where Western Brook Lamprey have been documented and verified (via genetics) to date in the Upper Columbia are Entiat (rkm 46.5), Methow (rkm 59.3), and Chewuch (rkm 16.1) (Beals and Lampman 2020). These populations seem to be highly isolated and narrow in distribution. Prior to these detections, it was assumed that no *Lampetra* spp. existed in the Upper Columbia Basin upstream of the Yakima River confluence.

Threats

Summary of Major Threats

Ranking of Upper Columbia RMU threats was based on the 2018 Assessment and further developed through information and consensus of the participating UCRMU members during a conference call on May 22, 2023 (Table 5). No major changes to the threat rankings were suggested at the RMU meeting; so the overall rankings remain the same as they were in 2022. Recommendation of Priority Projects from the Upper Columbia RMU is based upon and consistent with the highest-ranked threats indicated in Table 5.

Among the threats identified in the Upper Columbia RMU, 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 subpopulations, 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 Regional Implementation Plan is focused on the tributaries. There is 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 Upper Columbia RMU. 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. Ongoing translocation activities throughout the Upper Columbia RMU aim to combat this major threat and have increased larval, juvenile, and adult abundance in translocation systems. However, conservation actions targeting the causal mechanisms behind diminished subpopulations (poor adult passage, juvenile entrainment, etc.) will be needed to improve self-sustaining Upper Columbia Pacific Lamprey subpopulations.

Within-HUC Passage is a key threat in most of the Upper Columbia RMU subbasins where adult passage barriers disrupt migratory connectivity. While translocation has expanded lamprey distribution and abundance above barriers, there is substantial work to be done (some of it currently underway, some of it in the planning process) to address the underlying mechanism of poor passage, especially in the Yakima and Wenatchee subbasins. In both these subbasins, poor adult passage in the lower part of the system severely limits distribution into the upper system. 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 a very limited number of adult lamprey currently move past these structures. Although LPS structures have been installed at multiple lower Yakima River dams, passage efficiency is likely still far from 90-100% and more work is needed to adequately address these passage issues. The mainstem Okanogan River has numerous dams that have not been evaluated for Pacific Lamprey passage, such as Zosel Dam on the U.S. portion of the river and the Lake Osoyoos control weirs in Canada.

Table 5: Summary of the 2022 Assessment results for the key threats of the Upper Columbia RMU. High = 3.5-4.0, Medium = 2.5-3.4, Low = 1.5-2.4, Insignificant = ≤ 1.4 , Unknown = No value. Rankings in yellow indicate deterioration (↓) whereas those in green indicate improvement (↑) in 2022 relative to the 2018 Assessment. Threat rankings in parentheses () were estimated not formally evaluated and are not included in the mean score and threat calculations. Rankings with an * indicate a threat that ranked for the first time in 2023.

2022:	Mainstem Passage		Within-HUC Passage		Dewatering and Flow Management		Stream and Floodplain Degradation		Water Quality		Small Population Size		Predation		Climate Change	
	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity
Yakima Subbasins																
Lower Yakima	4	4	3	3↑	3↑	4	2	3↓	4	4	3	3	4	4	4	4
Upper Yakima	4	4	4	4	4	4	2	3↓	3↓	3↓	4	4	2.5↓	2.5↓	3.5↑	3.5↑
Naches	4	4	2.5↑	2.5↑	3	3.5↓	2	3↓	2	2	4	4	2	2	3.5↓	3.5
Upper Col. Subbasins																
Crab Creek	4	4	4*	4*	4↓	4↓	3	3	4	4	()	()	2.5*	2.5*	4*	4*
Smaller Tributaries	4	4	4↓	4↓	3	2	1	2	4↓	4↓	()	()	2*	2*	4*	4*
Wenatchee	4	4	3	3	2↑	3↓	3	3	2.5↓	2.5↓	3	3	2*	2*	3.5*	3.5*
Entiat	4	4	1	1	2	2	2.5↑	2↑	2	2	2	2	2*	2*	3.5*	3.5*
Chelan	4	4	()	()	()	()	()	()	()	()	()	()	()	()	3.5*	3.5*
Methow	4	4	1	1	2.5	2↓	3	3	2↓	2↓	4↓	4	2*	2*	3.5↓	3.5↓
Okanogan	4	4	3↓	3↓	2.5↑	2.5↑	4↓	4↓	4↓	4↓	4	4	4↓	4↓	4	4
Similkameen	4	4	4↓	4↓	1↑	1↑	3	3	2↑	2↑	4	4	3↓	3	4	4
Mean Score	4.00	4.00	2.95↓	2.95↓	2.70	2.80↓	2.55↓	2.90↓	2.95	2.95↓	3.50	3.50↓	2.60	2.55↓	3.73	3.73
Mean Scope Severity	4.00		2.95↓		2.75		2.73↓		2.95↓		3.50↓		2.58		3.73↓	
Threat Rank	H		M↓		M		M↓		M↓		H↓		M		H	

In the Similkameen system, Enloe Dam at rkm 8.8 remains impassible to all fish and blocks Pacific Lamprey from migrating to spawning and rearing habitat in both the U.S. and Canadian portions of the river. Discussions about removing Enloe Dam have intensified after the Okanogan County PUD opted to stop pursuing re-electrification of the dam in 2018. Currently CCT and Trout Unlimited have been funded by NOAA to continue a removal feasibility study for Enloe Dam.

Dewatering & Flow Management is 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 subbasins (Beals and Lampman 2017b, 2017c, 2018b, Lampman 2018). Because of their small size, larval lamprey less than 80 mm in length are easily entrained past the existing fish screens which were originally designed exclusively for juvenile salmonids (LTWG 2022). Diversion waterways provide ample larval lamprey habitat during the irrigation season when these structures hold water. However, dewatering in the winter months severely impacts larval/juvenile lamprey and their ability to survive or return back to the river. Annual fish salvage operations have been implemented at several Upper Columbia RMU diversions each fall at the end of the irrigation season. These operations can be costly and time-consuming, and the efficacy of salvage techniques in reducing overall larval mortality rates stemming from irrigation canals is largely unknown. In the Okanogan Subbasin, larval entrainment is being addressed at the Salmon Creek irrigation diversion. This diversion screen is undergoing a fish-friendly redesign that will reduce entrainment and stranding of larval/juvenile lamprey in the canal, which is an important consideration now that adult lamprey are successfully reproducing in Salmon Creek.

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 a diversity of freshwater habitats (e.g., spawning habitat consisting of gravel and cobble in downwelling reaches; adult overwintering habitat consisting of deep swift water with boulder, bedrock, and/or large wood; juvenile habitat consisting of swift water, undercut banks, and/or coarse substrate; larval habitat consisting of off channel slow water fine sediment and organic matter) 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 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 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; Linley et al. 2014; Linley et al. 2016). Pesticide and herbicide loading from agricultural runoff and irrigation returns tend to be highest between spring and early summer months when Pacific Lamprey are making their final spawning migration and actively spawning (Lampman 2012) and are a concern throughout the Upper Columbia RMU for adults as well as early life stages (eggs, larvae, and juveniles).

Predation risk in 2022 ranked higher compared to both the 2011 and 2018 assessments. A 2017 experimental feeding study showed that a 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*, sculpin *Cottoidea* spp.) 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 shown to frequently 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. A recent molecular study (using metabarcoding and eDNA) in 2023 that examined predator fish species (primarily Northern Pikeminnow, Smallmouth Bass, Largemouth Bass, Walleye, and Channel Catfish) gut contents in the lower Yakima and Columbia rivers confirmed that a considerable portion of their prey was identified as lamprey from these two rivers (Bingham et al. 2024). Pacific Lamprey were detected at the highest rate in Walleye (28%), followed by Northern Pikeminnow (14%), and Smallmouth Bass (7%). The mean predation rates were higher in the Columbia River (21%) compared to the Lower Yakima River (8%). The predation rates essentially doubled in June (14%) compared to April (6%) and May (7%). Aside from anecdotal observations, avian and mammalian predation risks have not been formally investigated in the Upper Columbia RMU.

Climate Change was scored for all HUC watersheds for the first time in the latest Assessment and constitutes a high-ranking threat across the RMU. Pacific Lamprey in the Upper Columbia RMU are vulnerable to multiple climate related threats, including reduced snowpack, changes to the hydrograph, reduced summer stream flows, increased maximum water temperatures, increasingly variable spring freshets, etc. When discussing Climate Change, Upper Columbia RMU members emphasized that while this threat impacts the entire RMU, certain systems such as the Lower Yakima, Crab Creek, and Okanogan are at the greatest risk and were therefore

ranked higher accordingly. In future Assessments, Upper Columbia RMU members hoped to apply a standardized approach to ranking the Climate Change threat that recognizes how certain RMUs (e.g., interior regions, southern RMUs) are more vulnerable than others that have the potential to buffer climate effects (e.g., Coastal WA and OR). RMU members also agreed that while funding lamprey conservation activities that address climate change impacts and build ecosystem resilience to climate change is important for Pacific Lamprey recovery, mitigating these impacts at an ecosystem scale will more than likely require funding beyond what is available for Pacific Lamprey species alone.

Other Threats: Lack of Awareness was ranked in both the previous and latest assessments. However, in 2022 it did not score high enough (2.38) to rank as a priority threat. Several other potential hazards (Harvest, Disease, and Supplementation) originally included in the 2011 and 2018 Assessments are no longer considered threats and were therefore excluded from the 2022 process.

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 irrigation dams on the Yakima River, survival and outmigration monitoring of acoustic tagged juvenile lamprey, distribution and abundance surveys throughout the RMU, larval/juvenile rescue and salvage operations, adult translocations, and outplanting of early life stage lamprey. For a list of lamprey-focused restoration projects and the agencies involved, see Tables 6a – 6d. 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. However, owing to their location on the mainstem and not the tributaries, these actions fall outside of the Regional Implementation Plan.

Table 6a: Conservation actions addressing the threat of Small Population Size that were underway, ongoing, or completed in the Upper Columbia RMU from 2012-2023.

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	Complete
Methow	Population	Distribution surveys to evaluate the upper extent of larval lamprey presence in the mainstem 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 mainstem Entiat River and Mad River (USFWS, YN, MSRF)	Survey	Ongoing
Wenatchee	Population	Distribution surveys to evaluate larval lamprey presence in the mainstem Wenatchee River and tributaries (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
Lower Yakima	Population	Distribution surveys to evaluate larval lamprey presence in the mainstem Lower Yakima River and tributaries (YN)	Survey	Ongoing
Upper Yakima	Population	Distribution surveys to evaluate larval lamprey presence in the mainstem Upper Yakima River and tributaries (YN)	Survey	Ongoing
Naches	Population	Distribution surveys to evaluate larval lamprey presence in the mainstem Naches River and tributaries (YN)	Survey	Ongoing

Table 6a Continued: Conservation actions addressing the threat of Small Population Size that were underway, ongoing, or completed in the Upper Columbia RMU from 2012-2023.

HUC	Threat	Action Description (Agency)	Type	Status
Lower Crab	Population	Distribution surveys to evaluate larval lamprey presence in the mainstem Crab Creek and tributaries (YN)	Survey	Ongoing
Okanogan/ Similkameen	Population	eDNA sampling (CCT, USGS)	Survey	Ongoing
Multiple HUCs	Population	BLIMP eDNA sampling and distribution model verification (USFS, YN, USFWS)	Survey	Complete
Multiple HUCs	Population	eDNA and bile acid sampling (YN, USFS, CCT, MSRF, CCPUD, DCPUD, USGS, Michigan State University, NIWA)	Survey	Ongoing
Lower Yakima	Population	eRNA sampling to distinguish lamprey detection by life stages and sex	Research	Ongoing
Methow	Population	Translocate & release adult lamprey (YN, MSRF)	Supplementation	Ongoing
Wenatchee	Population	Translocate & release adult lamprey (YN, USFWS)	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 (YN)	Supplementation	Ongoing
Columbia	Population	Trap adults at Priest Rapids Dam (PRD) for translocation (GCPUD, DCPUD, CCT, YN)	Supplementation	Ongoing
Methow	Population	Truck & release PRD adult lamprey (YN, DCPUD)	Supplementation	Ongoing
Okanogan/ Similkameen	Population	Truck & release PRD adult lamprey (CCT, YN, DCPUD)	Supplementation	Ongoing
Upper Yakima/ Naches	Population	Artificial propagation and early life stage outplanting (YN, USFWS, Great Lakes Fish Commission)	Supplementation	Ongoing
Multiple HUCs	Population	Genetic & eDNA evaluation of translocation success (YN, USFWS, CRITFC, USFS)	Assessment	Ongoing

Table 6b: Conservation actions addressing the threat of Within-HUC Passage that were underway, ongoing, or completed in the Upper Columbia RMU from 2012-2023.

HUC	Threat	Action Description (Agency)	Type	Status
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	Complete
Upper Yakima	Passage	Coordinate funding and design of LPS passage structures at Roza Dam (BOR, USFWS, YN)	Instream	Underway
Lower Yakima	Passage	Install LPS passage structures at Prosser Dam (BOR, YN, YKFP)	Instream	Ongoing
Lower Yakima	Passage	Install LPS passage structures at Sunnyside and Wapato dams (BOR, YN, WDFW. irrigation districts)	Instream	Ongoing
Lower Yakima	Passage	Coordinate funding and design of LPS passage structures at Wanawish Dam (BOR, USFWS, YN)	Instream	Underway
Wenatchee	Passage	Investigate Tumwater Dam lamprey passage constraints (CCPUD)	Assessment	Complete
Naches	Passage	Radio telemetry assessment of adult lamprey passage Cowiche Dam (USFWS)	Assessment	Complete

Table 6c: Conservation actions addressing the threat of Dewatering and Flow Management that were underway, ongoing, or completed in the Upper Columbia RMU from 2012-2023.

HUC	Threat	Action Description (Agency)	Type	Status
Wenatchee	Dewatering/Flow Management	Monitor, salvage, and reduce larval/juvenile entrainment at the Dryden irrigation diversion (CCPUD, USFWS, YN, WDFW, irrigation districts)	Canal	Ongoing
Wenatchee	Dewatering/Flow Management	Evaluate effects of slope on larval lamprey self-rescue during dewatering events (USGS, USFWS, CCPUD, irrigation districts)	Canal	Complete
Lower Yakima/ Naches/ Upper Yakima	Dewatering/Flow Management	Monitor, salvage, and reduce larval/juvenile entrainment at irrigation diversions/canals (YN, BOR, WDFW, irrigation districts, North Yakima Conservation District, WA Conservation Corps, University of Idaho, USGS, PNNL)	Canal	Ongoing
Various HUCs	Dewatering/Flow Management	Counting and collection of genetic samples from screw trap and juvenile fish monitoring traps (YN, YKFP, CCT, WDFW, USFWS, MSRF, CCPUD, DCPUD)	Assessment	Ongoing
Various HUCs	Dewatering/Flow Management	PIT and VIE tagging of larval/juvenile lamprey to assess passage, migration, & entrainment rates (YN, YKFP, WDFW, CTUIR, BOR, irrigation districts)	Assessment	Ongoing
Upper Yakima/ Naches	Dewatering/Flow Management	Monitoring the impacts of “Flip-Flop” flow management in Yakima Basin (YN, BOR)	Assessment	Complete
Lower Yakima	Dewatering/Flow Management	Acoustic telemetry assessment of juvenile lamprey downstream passage (YN, BOR, USGS, PNNL, irrigation districts)	Assessment	Complete
Lower Yakima	Dewatering/Flow Management	Flow Velocity Enhancement System (FVES) at Bachelor Hatton Diversion (YN, YKFP, BOR, irrigation districts)	Assessment	Ongoing

Table 6d: Conservation actions addressing Other Threats that were underway, ongoing, or completed in the Upper Columbia RMU from 2012-2023.

HUC	Threat	Action Description (Agency)	Type	Status
Methow/ Entiat	Stream & Floodplain Degradation	Habitat restoration effectiveness monitoring for larval lamprey (MSRF, USFWS, YN, Cascadia Conservation)	Assessment	Underway
Multiple HUCs	Water Quality	Toxicology/ Contaminant levels of larval, juvenile, and adult lamprey (CRITFC, USGS, PNNL, YN)	Assessment	Ongoing
Lower Yakima	Water Quality	Yakima Delta Restoration: Bateman Island Causeway Modification (YN, YKFP, ACOE, WADNR, MCRFEG, etc)	Instream	Ongoing
Lower Yakima	Predation	Lab study of larval lamprey susceptibility to fish predators (YN, CRITFC, University of Ishikawa Prefecture)	Assessment	Complete
Lower Yakima/ Columbia	Predation	Molecular analysis of predation (YN, Cramer Fish Sciences, ODFW, YKFP, ACOE, WDFW, CRITFC, CTUIR, Warm Springs Tribe, Nez Perce Tribe)	Assessment	Ongoing
Multiple HUCs	Lack of Awareness	Elder interviews on Pacific Lamprey - Traditional Ecological Knowledge (YN, Heritage University, Central WA University, University of Idaho, CTUIR, CRITFC)	Assessment	Ongoing
Multiple HUCs	Lack of Awareness	Developing lamprey tagging methods (USFWS, YN, USGS, PNNL)	Research	Ongoing
Lower Yakima/ Upper Yakima	Lack of Awareness	Role of lamprey carcasses in Yakima Basin (University of Idaho, Heritage University, Central Washington University, YN, CTUIR, CRITFC)	Research	Complete
Multiple HUCs	Lack of Awareness	Conduct lamprey identification training (YN, USFWS, ODFW)	Education	Ongoing
Multiple HUCs	Lack of Awareness	Conduct outreach and provide educational opportunities (USFWS, YN, CRITFC, CTUIR, YKFP, GCPUD, Benton Conservation District, various NPOs & schools)	Education	Ongoing

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 7). Similar to the Priority Projects, these long-term projects address the major threats identified through the Regional Implementation Plan process. However, many of these projects are currently not “shovel-ready” and need to be further developed in the near term.

Table 7: Long-term (2022-2027) priority Pacific Lamprey conservation projects for the Upper Columbia RMU.

HUC	Threat	Action Description	Agencies	Approach
Lower Yakima	Adult Passage	Passage improvement at Wanawish Dam.	YN, BOR, USFWS, irrigation districts	LPS, ladder modification
Upper Yakima	Adult Passage	Implementation and evaluation of passage improvements at Roza, Town dams	YN, BOR, USFWS, irrigation districts	LPS, ladder modification, telemetry, PIT
/Lower Yakima	Adult Passage	Evaluation of Lamprey Passage Systems at Prosser, Sunnyside, and Wapato Dams	YN, BOR, irrigation districts	Telemetry, PIT
Wenatchee	Adult Passage	Passage evaluation & improvement at Tumwater and Dryden dams	CCPUD, USFWS, WDFW, YN, irrigation districts	LPS, ladder modification, telemetry
Okanogan	Adult Passage	Passage evaluation at Zosel Dam	CCT	Telemetry, ladder modification, LPS
Similkameen	Adult Passage	Provide passage at Enloe Dam	CCT, USFWS, ONA	Dam removal
Mainstem Columbia	Adult Passage	Evaluate adult passage from Priest Rapids Dam to Wells Dam	GCPUD, CCPUD, DCPUD	Assessment
Multiple HUCs	Adult Passage	Standardize passage metrics used by ACOE and PUDs	GCPUD, CCPUD, DCPUD, ACOE	Assessment
Upper Yakima/ Naches/ Lower Yakima	Dewatering/Flow Management	Juvenile entrainment improvement at irrigation diversions & “Flip-Flop”	YN, BOR, irrigation districts	Operational, FVES, large sifter, fish deterrent structures
Wenatchee	Dewatering/Flow Management	Juvenile entrainment improvement at Dryden Irrigation Canal	CCPUD, WDFW, USFWS, YN	Operational and sluice gates, fish deterrent structures

II. Selection of Priority Actions

A. 2018 Funded Projects

In 2018, Bonneville Power Administration funded one 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 and to modify existing passage structures on the left fishway to allow volitional passage (\$40,000). These units were installed in March 2019.

B. 2019 Funded Projects

In 2019, Bonneville Power Administration funded two priority lamprey conservation projects from the Upper Columbia RMU. The first was a joint USGS/YN/PNNL acoustic telemetry project evaluating entrainment and survival of outmigrating juvenile lamprey in the Lower Yakima River (\$48,394). The second proposal was an assessment on flow enhancing venturi pumps (Flow Velocity Enhancement System) to reduce larval/juvenile entrainment and increase bypass passage at the Bachelor-Hatten Diversion on Ahtanum Creek by YN (\$51,539).

C. 2020 Funded Projects

In 2020, Bonneville Power Administration funded two priority lamprey conservation projects from the Colville Confederated Tribes in the Okanogan and Similkameen watersheds. The first proposal supported adult translocations activities (\$11,280) and the second looked at historic lamprey distribution through eDNA analyses (\$35,596).

D. 2021 Funded Projects

In 2021, Bonneville Power Administration funded two priority lamprey conservation projects from the Upper Columbia RMU. The first proposal was a continuation of eDNA work by CCT to inform adult translocations (\$11,181). 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 (\$40,082).

E. 2022 Funded Projects

In 2022, Bonneville Power Administration funded three priority lamprey conservation projects from the Upper Columbia RMU. The first proposal was by USFWS to conduct three outreach multi-day workshops in the Upper Columbia to share information related to lamprey identification, habitat, and culture (\$35,000). The second proposal was by Cramer Fish Sciences to develop new eRNA markers based on genes known to distinguish phenotypes in other lamprey species in partnership with the YN (\$24,915).

F. 2023 Funded Projects

In 2023, there was no proposal associated specifically with the Upper Columbia RMU for the Bonneville Power Administration funding. However, a proposal to compare quantitative eDNA qPCR samples with lamprey bile acid concentration from water samples in the Upper Columbia River and tributaries was funded via National Fish Habitat Partnership funding (\$25,925).

G. 2024 Funded Projects

In 2024, Bonneville Power Agency is scheduled to fund two priority lamprey conservation projects from the Upper Columbia RMU. The first proposal was a phase II of the passage improvement at Prosser Dam, Yakima River, allowing volitional passage at all fishways, incorporating minor modification to reduce fine sediment build-up in the rest boxes, and converting the counting system to optical sensors (\$46,788). The second was an MSRF outreach project to create, update, and print a new version of the Pacific Lamprey Habitat Restoration Guide (\$27,498).

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