Pacific Lamprey
2020 Regional Implementation Plan
for the
Upper Columbia
Regional Management Unit

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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.

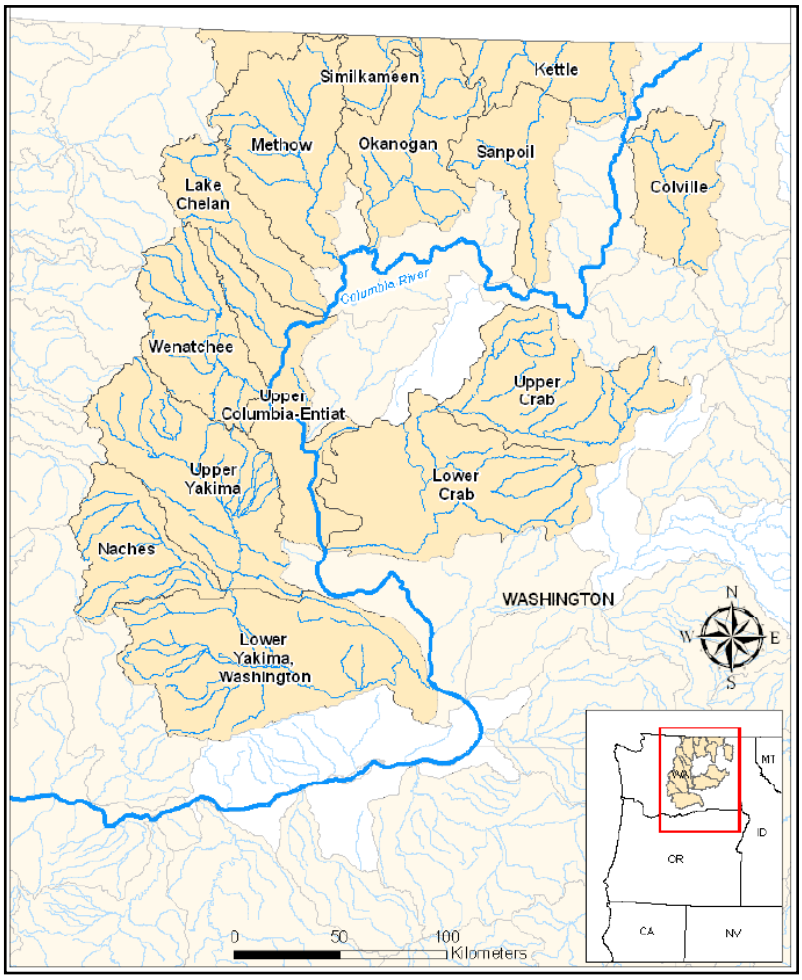

Figure 1: Map of the watersheds within the UCRMU.

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 2019 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 at 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 2019 (Table 3). The distribution map is expected to continue changing as new surveys and translocations are completed in the future.

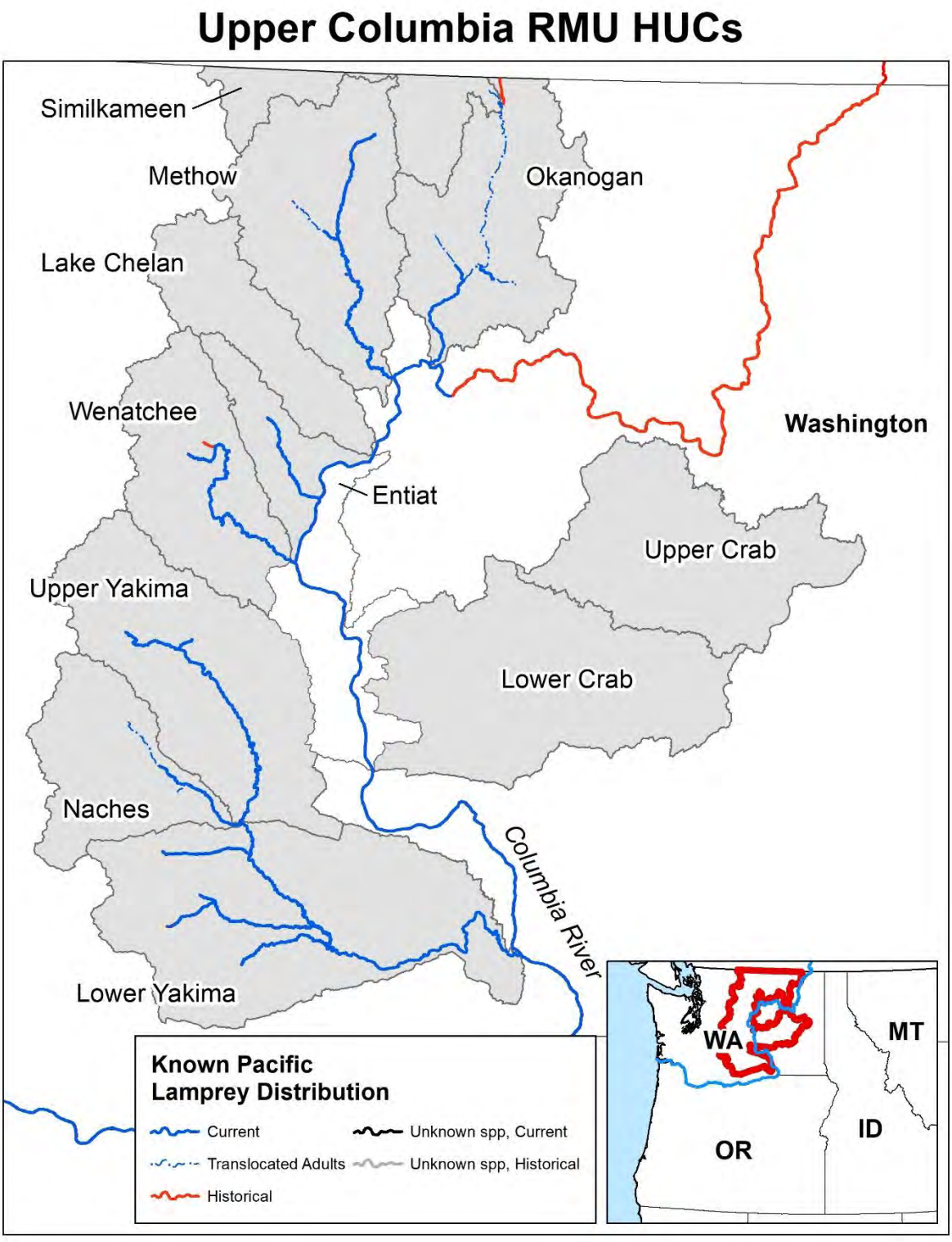

Figure 2: UCRMU Pacific Lamprey distribution and translocation streams as of July 16, 2020. HUCs where historic distribution is uncertain are identified with an (*).

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 HUCs within the UCRMU as of July 16, 2020.

Watershed	Years	YN Translocated Adults	USFWS Translocated Adults	CCT Translocated Adults	DCPUD Translocated Adults	GCPUD Translocated Adults	Totals
Wenatchee	2016 - 2020	1308	0	0	0	0	1308
Methow	2015 - 2020	954	0	0	507	0	1461
Upper Yakima	2013 - 2020	466	45	0	0	0	511
Naches	2013 - 2020	90	44	0	0	0	134
Lower Yakima	2011 - 2020	3152	164	0	0	0	3316
Columbia River	2017 - 2020	0	0	359	172	288	819
Okanogan	2018 – 2019	0	0	340	0	0	340
Similkameen	2017 – 2019	0	0	97	0	0	97

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 2020, the YN's translocations release sites included new locations in both the Upper Yakima and Naches River HUCs.

In 2020, YN and the Bureau of Reclamation (BOR) continued to operate lamprey-specific passage systems (LSP) at Prosser Dam. Video monitoring was installed 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. The YN, BOR, USFWS, and Natural Resources Conservation Service (NRCS) are in the process of designing and installing new LPS units at Sunnyside, Wapato, and Wanawish dams on the Lower Yakima. These new passage structures are will likely be installed in 2021.

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 one adult lamprey was observed during the USFWS 2020 Entiat River lamprey spawning surveys. Despite an abbreviated survey season, this number suggest a very low number of spawners were present in the Entiat River this year.

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. 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 River and Salmon and Omak creeks. No new translocations to the Similkameen River occurred in 2019, and no new eDNA sampling was conducted there. 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 April 28, 2020 (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 2018. The question of climate change as a priority threat was raised at the RMU meeting. However, based on additional consultation with other RMU leaders, this threat was not included in the RIP matrix because it is not tied directly to lamprey conservation and priority project actions. 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 20, 2019. High = 3.5-4.0, Medium = 2.5-3.4, Low = 1.5-2.4, Insignificant =≤ 1.4, Unknown = No value. Threat rankings highlighted in yellow indicate a change (↑ increased severity, ↓ decreased severity) in 2020 relative to the 2019 Regional Implementation Plan. Threat rankings in parentheses () have not be formally evaluated, were estimated, and not included in the mean score calculations.

2017	Tributary Passage		Dewatering and Flow Management		Stream and Floodplain Degradation		Water Quality		Predation		Small Population Size	
Watershed	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity	Scope	Severity
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 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 UCRMU in 2019. 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 in 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 macropthalmia, 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 initiated or completed in the UCRMU from 2012-2019.

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 initiated or completed in the UCRMU from 2012-2019.

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, YN, DCPUD)	Supplementation	Ongoing

Table 5 Continued: Conservation actions specifically for or substantially benefitting lampreys that were initiated or completed in the UCRMU from 2012-2019.

HUC	Threat	Action Description (Agency)	Type	Status
RMU	Population	BLIMP eDNA sampling and distribution model verification (USFS, YN, USFWS)	Assessment	Ongoing
RMU	Population	Artificial propagation and larval rearing (YN, Confederated Tribes of the Umatilla Indian Reservation (CTUIR) , CCPUD, BPA, USFWS)	Supplementation	Ongoing (in lab)
RMU	Population	Genetic evaluation of translocation success - (YN, USFWS, CRITFC, USFS)	Assessment	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 assessment of adult lamprey passage Roza Dam (USFWS)	Assessment	Complete
Naches	Passage	Radio telemetry assessment of adult lamprey passage Cowiche Dam (USFWS)	Assessment	Complete

Table 5 Continued: Conservation actions specifically for or substantially benefitting lampreys that were initiated or completed in the UCRMU from 2012-2019.

HUC	Threat	Action Description (Agency)	Type	Status
Lower Yakima	Passage	Coordinate funding and design of LPS passage structures at Sunnyside and Wapato dams (YN, BOR, NRCS)	Coordination	Underway
Lower Yakima	Passage	Coordinate funding and design of LPS passage structure at Wanawish Dam dams (USFWS, BOR, YN)	Coordination	Underway
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
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
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

Table 5 Continued: Conservation actions specifically for or substantially benefitting lampreys that were initiated or completed in the UCRMU from 2012-2019.

HUC	Threat	Action Description (Agency)	Type	Status
Naches	Dewatering/Flow Management	Monitor, salvage, and reduce larval/juvenile entrainment at irrigation diversions/canals (YN, BOR, WDFW, irrigation district)	Instream	Ongoing
Methow	Stream & Floodplain Degradation	Habitat restoration effectiveness monitoring for larval lamprey (MSRF, YN)		
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 outreach and provide educational opportunities (USFWS, YN)	Education	Ongoing
RMU	Lack of Awareness	Conduct lamprey identification training (YN, USFWS)	Education	Complete
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 (2020-2025) 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 & Enloe Dam	CCT	Telemetry, LPS
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

Table 6 Continued: Long-term (2020-2025) priority Pacific Lamprey conservation projects for the UCRMU.

HUC	Threat	Action Description	Agencies	Approach
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. **Prioritization Process**

Participating members of the UCRMU met in met in April 2020 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 2020. The complete applications for these projects attached as appendices:

Appendix A: Beyond Salmon: Lamprey Use of Salmonid-Focused Habitat Restoration Projects, and

Appendix B: eDNA & Lamprey Bile Acids Monitoring to Assess the Impacts of Adult Translocation in the Upper Columbia Basin Above Wells Dam

Appendix C: Okanogan River Basin Pacific Lamprey *(Entosphenus tridentatus*) Translocation and Monitoring

III. Literature Cited

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Appendix A: Priority Project Information for Beyond Salmon: Lamprey Use of Salmonid-Focused Habitat Restoration Projects

Project Title: Beyond Salmon: Lamprey Use of Salmonid-Focused Habitat Restoration Projects

Project Applicant/Organization: Methow Salmon Recovery Foundation
Contact Person: John Crandall
Email: john@methowsalmon.org
Phone: 509.341.4341

Project Type: Assessment

Lamprey RMU population(s): Upper-Columbia
Multi-RMU project? No. Please list RMUs

Watershed (5th HUC Field): Upper Chewuch River, Lower Chewuch River, Upper Methow River, Middle Methow River, Twisp River, Entiat River
NPCC Subbasin (4th HUC Field) name: Methow (17020008) and Entiat (17020010)
Project Location: 40 salmonid-focused restoration project locations in the Methow and Entiat plus non-restored reference sites in both watersheds
Project Coordinates (latitude and longitude, decimal degrees, NAD 1983): 40 sites (Fig.1-2)

Total Requested funds: $40,082

1. ***Short Project Summary (200 words or less):***
   - Provide a brief overview of your project including goals

   In the Upper Columbia region numerous salmonid-focused habitat restoration projects have been implemented in the past decade to address habitat limiting factors and improve the survival of ESA-listed salmonids. Pacific Lamprey (and Western Brook lamprey) are present in many of these project areas, but little information exists to determine whether or not these salmonid-focused projects are benefitting lamprey through the creation and/or enhancement of larval rearing habitat and its use by larval lamprey.

   Our project goals are:

   1) Quantify the availability and condition of lamprey rearing habitat at 40 salmonid-focused habitat restoration projects in the Methow and Entiat Subbasins.

   2) Quantify the use of this available habitat by larval lamprey.

   3) Assess salmonid-focused project types and features that promote development of (or enhance existing) larval rearing habitat.

   Project results will be disseminated through the Pacific Lamprey Conservation Initiative and Upper Columbia Salmon Recovery Board Watershed Action Teams. Results will inform the on-going salmon-focused habitat restoration efforts in order

to increase their effectiveness at providing habitat benefits to imperiled lampreys.

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

- Describe the proposed work including specific objectives

Objective #1. At 40 different salmonid-focused habitat restoration sites (20 each in the Methow and Entiat, Figures 1 and 2) within the observed distribution for Pacific Lamprey in these watersheds, we will quantify the amount of larval lamprey rearing habitat (i.e. Type 1, Hansen et al. 2003) present and quantify/classify associated habitat characteristics and features that may contribute to the formation, quality, and quantity of the Type 1 habitat at these sites (e.g. water column depth, sediment depth and type, channel type and location, restoration treatment type and orientation to channel, water velocity, bank type, water quality).

Numerous large wood installation (e.g. engineered log jams or "ELJs") projects have been implemented in both the Methow and Entiat subbasins, so our focus will be on assessing these structures, but we will also include several side and off channel habitat enhancement/reconnection and boulder installation projects. Many of the large wood installation sites include several structures and these will be assessed separately from one another.

Objective #2. Assess use of the restoration sites by lampreys (including Pacific and Western brook) by documenting presence/absence and relative abundance of larval lamprey in the Type 1 habitat patches observed. Larval sapling will follow the Yakama Nation methodology outlined in Lumley et al. (2020) and consist of single-pass electrofishing of a $10m^2$ sampling plot at each site to determine presence, as well as density and catch per unit effort to estimate abundance. If $10m^2$ of Type 1 habitat is not available at a given site, as many $1m^2$ plots as possible will be sampled. Captured lampreys will be identified (using Lampman 2017), measured, and weighed. All lampreys evading capture, but observed within the sampling plot, will also be counted for the abundance estimate. Sampling will occur during low water conditions in late July-August 2021.

To develop a general comparison of relative abundance between restored and non-restored sites, we will compare the larval abundance at restoration sites relative to separate reference sites that have been monitored for larval abundance in the Methow River (3 sites) and Chewuch River (3 sites) since 2008, and in the Entiat River (3 sites) since 2014. Monitoring of these sites will occur during the same timeframe as the restored sites. We recognize that other factors beyond restoration (e.g. stream flows, channel type, temperature, proximity to adult lamprey translocation releases) are likely to contribute to observed abundance at a given site, thus we will approach analysis/inference of our results with a respectful degree of caution.

Objective #3. Develop a final report detailing project sites, methods, results, and summary discussion. This report will include a list of recommendations on how to increase the effectiveness of salmonid-focused habitat restoration projects at increasing/improving habitat conditions for lamprey.

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

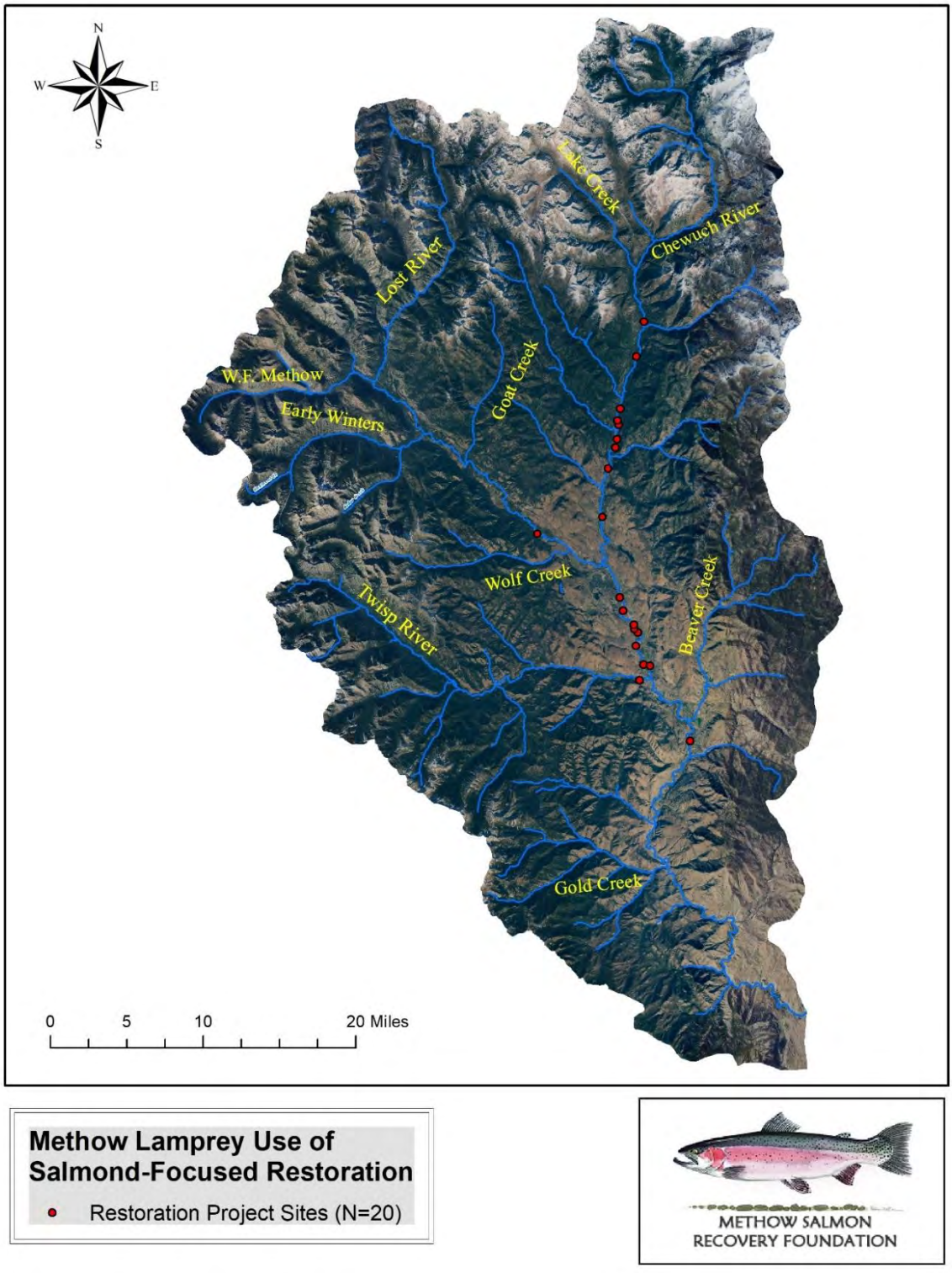

Figure 1. Salmond-focused restoration sites in the Methow River watershed that will be examined for larval lamprey and habitat.

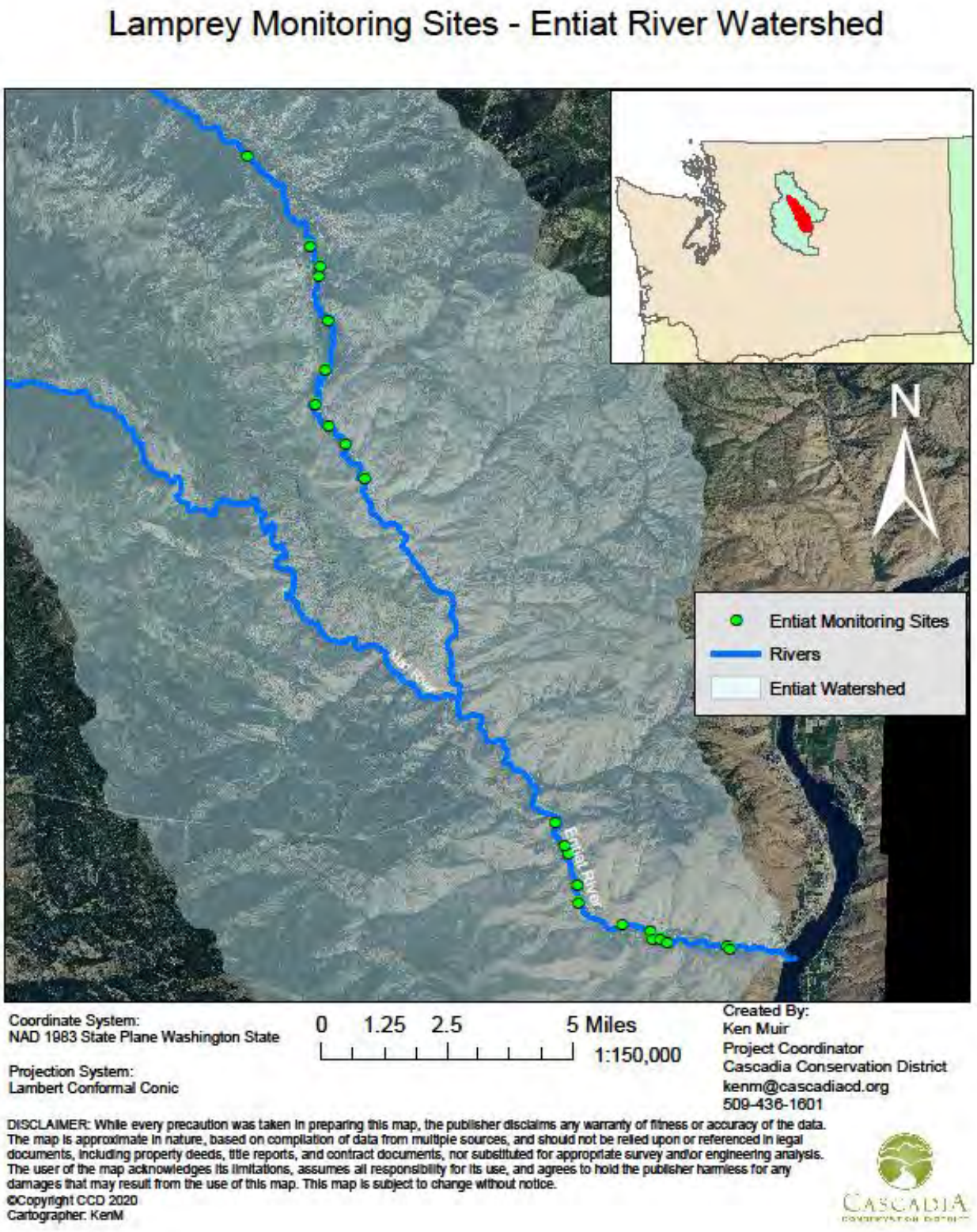

Figure 2. Salmond-focused restoration sites in the Entiat River watershed that will be examined for larval lamprey and habitat.

Figure 3. Example of Type 1 larval lamprey habitat formation downstream of a salmonid-focused large wood installation, Methow River.

4. ***Linkage of Actions to Identified Threats for Lampreys in RMU(s) (300 words or less):***

   - What threat(s) to lampreys does this project address? (See your RIP(s) for key threats) ***Stream and Floodplain Degradation***

   - Does this project address threat(s) to lampreys specific to this RMU only, or does the project address the threat(s) prevalent in multiple RMUs?
     Single RMU ☐, Multiple RMUs ☒ list additional RMUs: ***All RMUs where stream and floodplain degradation has been identified as a threat.***

   - Describe how this project addresses key threat(s) to lampreys within the HUC(s) where project is proposed.
     In all of our project HUCs, several specific forms of habitat degradation, including bed and channel form and instream structural complexity, have been identified as limiting factors for ESA-listed salmonids by the Biological Strategy developed by the Upper Columbia Regional Technical Team (UCSRB 2017). While not specifically focused on lampreys, the Biological Strategy provides guidance on current habitat limiting factors that are synonymous with the stream and floodplain degradation threat for lampreys cited in the Upper Columbia RIP.

By examining the development/enhancement of larval rearing habitat at salmonid-focused projects that were implemented to address identified limiting factors (threats), we can determine if these types of projects will have the added benefit of providing lamprey rearing habitat and observe if lamprey are indeed occupying this created/enhanced habitat.

5. ***Species/Habitat Benefits (200 words or less):***
    - Provide citation of literature, distribution maps, and/or surveys demonstrating lampreys are currently and/or were historically present in the project area.
      Pacific lamprey are currently present within all portions of our study area, see Crandall (2008), Beals and Lampman (2016), Lumley et al. (2020).

    - How will the project provide meaningful measurable results to improve lamprey populations and/or their habitat conditions?
      Quantitative data on lamprey presence and habitat characteristics at salmonid-focused restoration projects will be collected to determine if project location, type, size, or age have contributed to the formation/retention of larval rearing habitat.

      Project recommendations will provide valuable information that can be incorporated into the design of future, and adaptive management of past, salmonid-focused restoration projects. Implementation of "lamprey enhanced" salmonid-focused habitat restoration projects has the potential to greatly leverage the vast amounts of funding available for salmon restoration to also benefit lamprey.

    - What life stage or stages will benefit from action? How?
      By design, our project is focused on determining if and how past salmonid-focused restoration actions have created habitat for larval lamprey and, as such, this life stage will benefit the most from the assessment and recommendations derived from the project.

      However, it is possible that both adult lamprey holding and spawning habitat were created/retained/enhanced by the salmon-focused projects and we will be collecting habitat information during the assessment that can help determine if adult habitat is associated with the restoration site (i.e. observations of spawning gravel or holding areas).

    - What other species may benefit from action?
      Western brook lamprey are known to occur (likely at low levels) in both the Methow and Entiat watersheds, so our efforts will benefit this species in ways similar to Pacific Lamprey. Our project will inform the implementation and adaptive management habitat restoration actions which have the potential to benefit the entire freshwater food web which includes myriad aquatic and terrestrial species.

6. ***Priority Objectives and Goals:***
    - Indicate the strategies, and/or restoration/management plans are addressed by this project (when available relevant documents/websites are hyperlinked below for reference):
        - PLCI Conservation Agreement ☒
        - National Fish Habitat Partnership National Conservation Strategies ☐
        - USFWS Climate Change Strategies ☐
        - Bonneville Power Administration Northwest Power and Conservation Council Columbia River Basin Fish and Wildlife Program ☐
        - CRITFC Tribal Pacific Lamprey Restoration Plan for the Columbia River Basin ☒
        - US Army Corps of Engineers Pacific Lamprey Passage Improvement Implementation Plan ☐
        - PUD Management Plan (please name below) ☐
        - Other (please name below) ☒
    - Clearly describe how the project addresses the goals and objectives in the strategies, restoration/management plans indicated above (200 words or less).
      By assessing the effectiveness of habitat restoration project at creating/enhancing larval rearing habitat and it use by lampreys, our project informs multiple aspects of several plans including:
      1. Pacific Lamprey Conservation Initiative Objective 6 (implement projects to reduce threats) and Objective 4 (data sharing).
      2. CRITFC Plan Objective 2 (identify, protect, and restore tributary habitat, describe tributary habitat use).
      3. Methow Lamprey Inventory and Restoration Assessment (Crandall 2008) assess effectiveness of recommended restoration treatments.

7. ***Project Design / Feasibility:***
    - Have the designs for the project been completed already or will they be completed before planned project implementation? **Yes ☒ No☐**
    - Are the appropriate permits (e.g., ESA consultation, Scientific Collection, fish health/transport, etc.) in place already or will they be in place before planned project implementation? **Yes ☒ No☐**
    - Can the project be implemented within the defined timeframe? (*See BPA & NFHP requirements in the accompanying PLCI RIP Priority Project Guidance document*). **Yes ☒ No☐**
    - Please provide a brief description (200 words or less):
      The project is ready to proceed when funding becomes available with field work occurring in July-September 2021 and reporting shortly thereafter. Some private lands access remains to be finalized, but we do not expect any issues or delays arising from this as landowners have previously supported the restoration work on their property.

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

- What partners are supporting the project?

The project partnership is comprised of Methow Salmon Recovery Foundation, Confederated Tribes and Bands of the Yakama Nation, Cascadia Conservation District (CCD), and the U.S. Fish and Wildlife Service.

- What partners are active in implementing the project?

All partners listed above will be involved with implementation. Methow Salmon Recovery Foundation will lead field activities in the Methow and Cascadia Conservation District will lead field activities in the Entiat. Yakama Nation and USFWS will provide field support.

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

Matching/in-kind funding is being provided by Yakama Nation and Cascadia Conservation District.

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

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

A final report will be prepared and will document all aspects of the project including goals and objectives, study site description, methods, results, and recommendations for how future habitat restoration projects, and adaptive management of past projects, can be designed and constructed to benefit lampreys.

Project results will be disseminated through the Pacific Lamprey Conservation Initiative (Information Exchange), Upper Columbia Salmon Recovery Board Watershed Action Teams, and posted on MSRFs web page.

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

Additional monitoring will be necessary to track future projects that were implemented using the recommendations provided by our assessment.

10. ***Project Budget (including overhead):***
Budget presented on page 10 of Appendix A.

11. Timeline of major tasks and milestones:

Workflow	*Start Date/Month*	*End Date/Month*	*Responsible Party*
Project planning	*6/2021*	*7/2021*	*MSRF*
Landowner outreach	*6/2021*	*7/2021*	*MSRF, CCD*
Field assessment	*7//2021*	*9/2021*	*MSRF, CCD*
Data analysis	*10/2021*	*2/2022*	*MSRF*
Reporting	*2/2022*	*4/2022*	*MSRF*

12. References (if applicable):

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Project Budget:

	Items	# Hours or Units	Cost per Unit ($)	RIP Funds Requested ($)	Cost Share ($)	Total Cost ($)
A	***Personnel:***	-	-	-	-	-
	a. Project planning and outreach	50	$66	$3,300	$2,000 (CCD)	$5,300
	b. Field surveys – Methow/Entiat	350	$45	$15,750	$4,500 (YN)	$20,250
	c. Data analysis and reporting	80	$66	$5,280	$0	$5,280
	d. Project administration	10	$45	$ 450	$0	$ 450
B	***Equipment & Supplies:***	-	-	-	-	-
	a. ABP-2 Electrofisher	1	$8,500	$8,500	$ 0	$8,500
	b. Field supplies	1	$ 500	$ 500	$0	$ 500
C	***Travel:***	-	-	-	-	-
	a. Mileage	2000	$0.585	$1,170	$1,700 (YN)	$2,870
D	***Other:***	-	-	-	-	-
	a.					
E	***Administrative:***	-	-	-	-	-
	Indirect Costs (20.71%)	1	$24,780	$5,132	$0	$5,132
	Total (Sum of A - E)	-	-	$40,082	$8,200	$48,282

AppendixB: eDNA & Lamprey Bile Acids Monitoring to Assess the Impacts of Adult Translocation in the Upper Columbia Basin Above Wells Dam

Project Title: eDNA & lamprey bile acids monitoring to assess the impacts of adult translocation in the Upper Columbia Basin above Wells Dam

Project Applicant/Organization: Yakama Nation Fisheries (YNF)
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Project Applicant/Organization: Methow Salmon Recovery Foundation (MSRF)
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Project Applicant/Organization: Douglas County PUD
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Project Applicant/Organization: Chelan County PUD
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Project Applicant/Organization: Columbia River Inter-Tribal Fish Commission (CRITFC)
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Project Applicant/Organization: U.S. Forest Service Rocky Mountain Research Station (USFS RMRS)
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Project Type: Monitoring

Lamprey RMU population(s): Upper-Columbia
Multi-RMU project? Please list RMUs: Although some sampling for reference sites will occur in Lower Columbia and Mid-Columbia RMUs, the primary focus of the project is in the Upper Columbia, so we selected Upper Columbia for the RMU selection (however, could be moved to Multi-RMU as well).

Watershed (5th HUC Field): Various
NPCC Subbasin (4th HUC Field) name: Chief Joseph, Upper Columbia-Entiat, Methow, Okanogan, Middle Columbia-Lake Wallula, Lower Columbia-Sandy

Project Location: Sampling will be conducted at four hydroelectric dams (Wells, Rocky Reach, McNary, and Bonneville dams) as well as in the Columbia, Methow, and Okanogan rivers in the Upper Columbia upstream of Wells Dam. eDNA will be analyzed by the U.S. Forest Service Rocky Mountain Research Station (USFS RMRS) in Missoula, MT. Lamprey bile acids will be analyzed with the help of researchers from New Zealand and/or Michigan State University (Weiming Li Laboratory).

Total Requested funds: $25,925.40

1. ***Short Project Summary (200 words or less):***
    - Provide a brief overview of your project including goals
    - This information will be used to describe your project to potential funding entities

The Wells Aquatic Settlement Work Group reached a Statement of Agreement (SOA) in 2018 to commence adult Pacific Lamprey (PL) translocation work for a minimum of four years between 2018 and 2021 with the goal of translocating up to 1,000 adults per year. Environmental DNA (eDNA) monitoring was successfully conducted in 2018 to analyze the overall signals of PL within the Upper Columbia Wells Project Area in comparison with Lower and Mid-Columbia reference sites (Lampman and Lumley 2020). Thirty-one samples were collected in the Columbia River Basin (CRB) between river km 229.4 (Bonneville Dam tailrace) and 864.8 (downstream of Chief Joseph Dam) in fall 2018. The years 2021-2022 would mark 3-4 years after the start of the collaborative adult translocation project and we plan to revisit these sites to assess changes in PL distributions and DNA quantity (a course proxy for abundance) following translocation efforts. eDNA sampling will occur in fall 2021, spring 2022, and fall 2022 at the abovementioned sites in addition to 16 supplemental sites. To better understand the relationship between the lamprey pheromones (bile acids) and eDNA,lthe concentration of petromyzonol sulfate (a proven crucial lamprey bile acid for migration) will be assessed at a subset of the eDNA sites identified above.

2. ***Detailed Project Description (500 words or less):***
    - Describe the proposed work including specific objectives (subcomponents of your stated goals)

As PL abundance and associated biomass (of all life stages) increase in the Wells Project area

through adult translocation, the quantity of eDNA is anticipated to increase over time. We will measure PL eDNA presence/absence as well as quantities/concentrations. We will also make cross comparison of eDNA and lamprey bile acids data using a subset of sample sites to evaluate their association and potential relationship. Data from this study will help inform management decisions on whether the multi-year adult translocation program is helping achieve its original goal of increasing PL signals (via concentrations of eDNA and migratory pheromones) which are important not only for passage evaluations but also for the long-term goal of restoring self-sustaining populations upriver of Wells Dam.

Objective 1 –sampling and analysis of eDNA following 3-4 years of adult PL translocation

In 2018, Pacific Lamprey (PL) eDNA sampling was conducted in 10 areas on mainstem Columbia River and tributaries consisting of four major hydroelectric dams (Bonneville, McNary, Rocky Reach, and Wells dams) and eight additional areas upstream of Wells Dam (Lampman and Lumley 2020). A consortium of partners will collect eDNA samples from these same sites spanning Lower Columbia (Bonneville Dam, rkm 233.7) to Upper Columbia (upper reach, rkm 864.8) in fall 2021 (September-October), spring 2022 (March-April), and fall 2022 (September-October). Sampling from the three seasons will allow us to evaluate inter-seasonal and inter-annual variations. Eight additional sites will be established in the Methow and Okanogan subbasins (four sites each) to provide more information on PL distribution and signals within these two key subbasins. Furthermore, eight new sites will be established at the abovementioned four hydroelectric dams (two extra sites per dam) to increase the sample size at each of these dams. Samples will be taken according to Carim et al. (2016). Every sample will be analyzed in triplicate using quantitative PCR ("qPCR"), and samples will also be analyzed quantitatively to measure the number of Pacific Lamprey eDNA copies when present (e.g., eDNA concentrations and rates; Tillotson et al. 2018). All eDNA analysis for this project will be conducted by the USFS RMRS (see Carim et al. 2017).

Objective 2 – Sampling and analysis of lamprey bile acids

Water samples for lamprey bile acids analysis (primarily petromyzonol sulfate using sensitive mass spectrometry mehods) will also be collected at a subset of the eDNA sites focusing on Bonneville Dam, Rocky Reach Dam, and Methow and Okanogan subbasins (see Yun et al. 2003; Robinson et al. 2009). We plan to use "instream passive samplers" in collaboration with researchers from the National Institute of Water & Atmospheric Research Ltd., New Zealand (Stewart et al. 2011; Stewart and Baker 2012) and/or analysis using water grab samples in collaboration with researchers from Michigan State University Weiming Li Laboratory (Li et al. 2011). The concentrations and the overall estimated rates (concentration x discharge) of the petromyzonol sulfate will be directly compared with those of the eDNA. A final report analyzing both Objectives 1 and 2 will be submitted at the end of 2022.

*additional info (beyond the 500 word limit):

Late September and early October were identified as the optimal sampling season in the summer/fall due to the combination of 1) cessation of adult lamprey migration / movement and 2) low discharge conditions (prior to the fall rainy season). March and early April were identified as the optimal sampling season in the winter/spring due to the fact that adult PL are still primarily in "overwintering" mode and have not begun final spawning migration (i.e. minimal changes in adult PL distribution is anticipated between these fall and spring seasons) and discharge levels are still moderate (not at the highest levels).

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

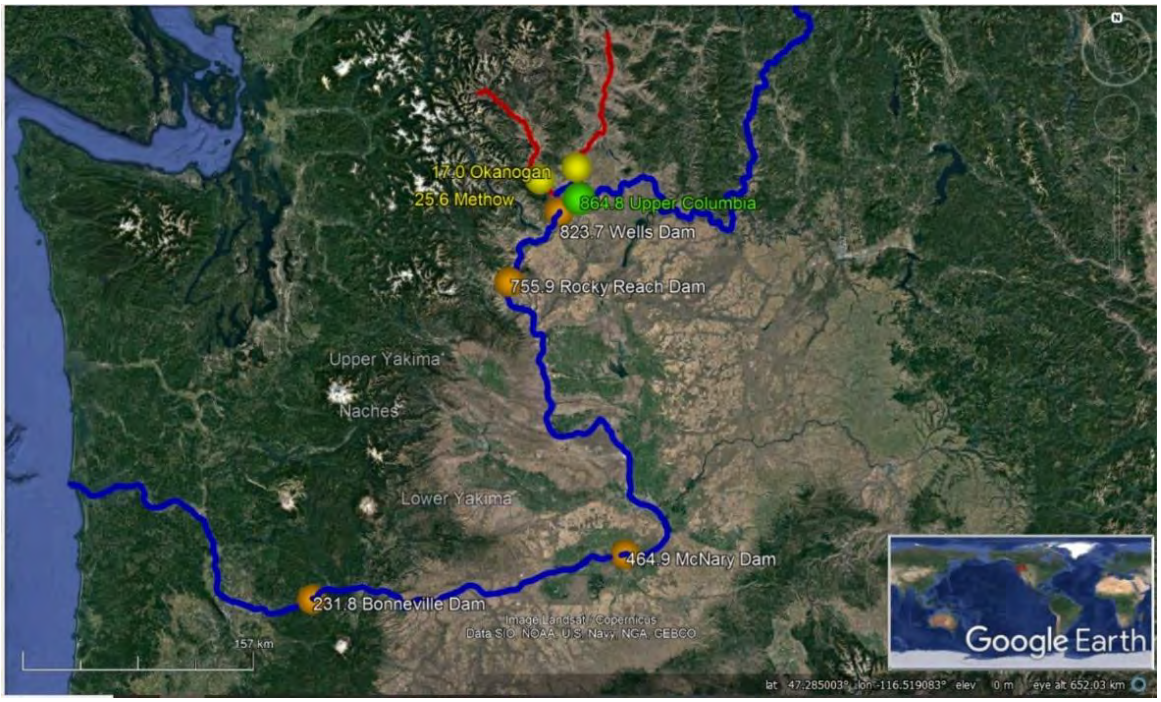


Figure 1. From Lampman and Lumley (2020). Overview of eDNA sample collection areas along Columbia (blue line) and Methow and Okanogan (both red lines) rivers. The four areas at hydroelectric dams (four sites each) are displayed with orange circles, the six areas in the Upper Columbia (9 sites total) is displayed by a green circle, and the Methow and Okanogan areas (two and four sites, respectively) are displayed by a yellow circle for each. The river km is also displayed for each grouping of sites (uppermost river km for the Upper Columbia, Methow, and Okanogan sites.

Figure 2. From Lampman and Lumley (2020). Overview of the Upper Columbia eDNA sample collection sites in 2018 and the color-coded abundance categories for the eDNA copies per second in millions. Each site name consists of the first three letters of the river name followed by the river km and bank side abbreviation.

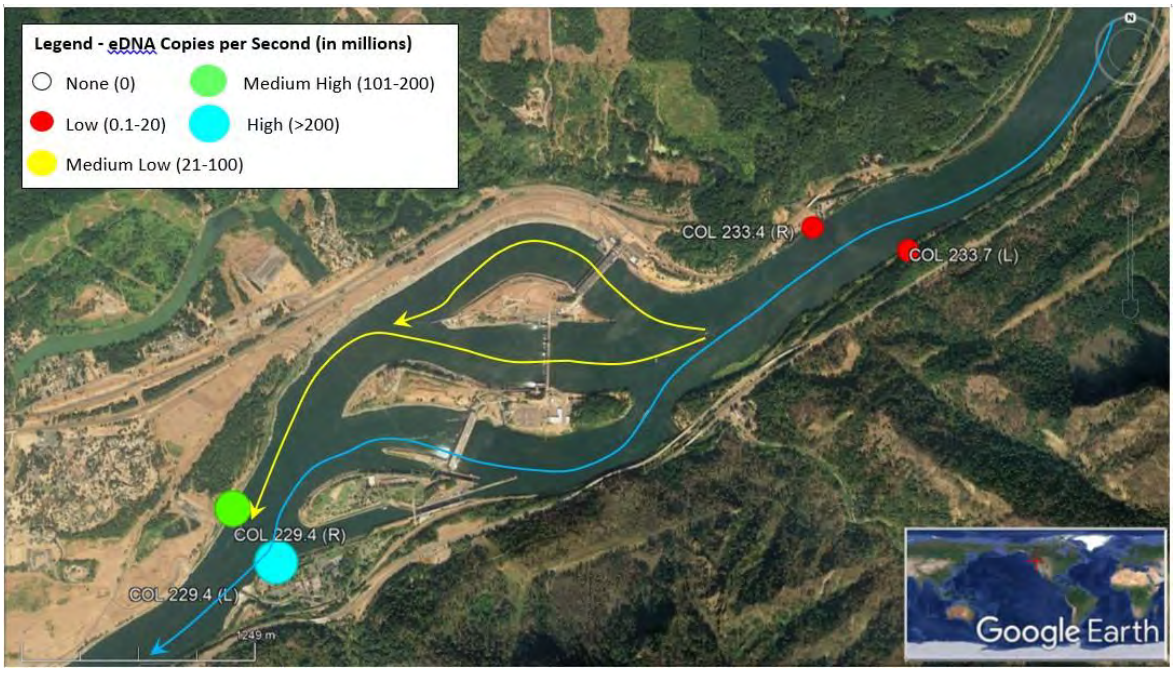


Figure 3. From Lampman and Lumley (2020). Overview of the Bonneville Dam eDNA sample collection sites in 2018 and the color-coded abundance categories for the eDNA copies per second in millions. Each site name consists of the first three letters of the river name followed by the river km and bank side abbreviation. The estimated route of the thalweg (light blue line) and secondary and tertiary thalwegs (yellow lines) are also displayed.

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

This project through monitoring focuses on small effective population size and the effectiveness of adult translocation to address this specific threat. Some recent telemetry data suggested that adult lamprey in the Upper Columbia are perhaps less motivated to reach and pass Wells Dam due to the lack of migratory cues originating upstream of the dam (due to the low overall abundance). As a result, adult translocation work began in 2018 to enhance the PL signal stemming upstream of Wells Dam. We will assess whether the distribution and signals of PL in the Upper Columbia Wells Project Area are both increasing after the collaborative adult translocation efforts began in 2018. If we can document the increase in eDNA rates (eDNA copies per second) at Wells Dam and key locations upstream of the dam, it will help confirm the potential wide-ranging impacts of adult translocation in a large water body (i.e. mainstem Columbia River) and can help provide more justification for re-examining adult passage at Wells Dam. We are particularly interested in whether eDNA sampling could be utilized successfully to assess the signal of PL over time and across seasons in this large water body and how it is particularly related to the lamprey migratory pheromones in the water. This monitoring will have wide applications for PL restoration, monitoring, and management and will provide a know-how in an unexplored field that currently lacks awareness. This project will be closely coordinated with the many partners and will take advantage of existing eDNA sites as well as collaborative sampling to cover the wide range of sampling sites spread across the Columbia Basin.

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

The previous study in 2018 successfully demonstrated that the highest PL eDNA rate (eDNA copy per second) was detected at Bonneville Dam and the rates gradually diminished moving upriver, culminating in no detection at the Wells Dam and the majority of the Columbia River sites upstream (Lampman and Lumley 2020). Furthermore, no *Lampetra* spp. were detected in any of the sites. In theory, the quantity of eDNA copies could hypothetically serve as an index for relative abundance and/or a surrogate for lamprey pheromone signals in the river (stemming from both adult and larval life stages), which are considered to be key attractants for actively

migrating adult lamprey. The goal of the collaborative adult translocation lead by ASWG was to supplement the abundance and associated pheromone signals in an effort to help improve adult passage above Wells Dam. The analysis of the new eDNA results in 2021-2022 in comparison to 2018 baseline data will help provide an objective assessment on whether the translocation program provided meaningful impact to adult PL migrating towards Wells Dam and further upriver. As many of the potential confounding variables (see Ostberg et al. 2018) will be controlled by standardizing the sampling protocols, season of sampling, and associated water temperature and discharge levels.

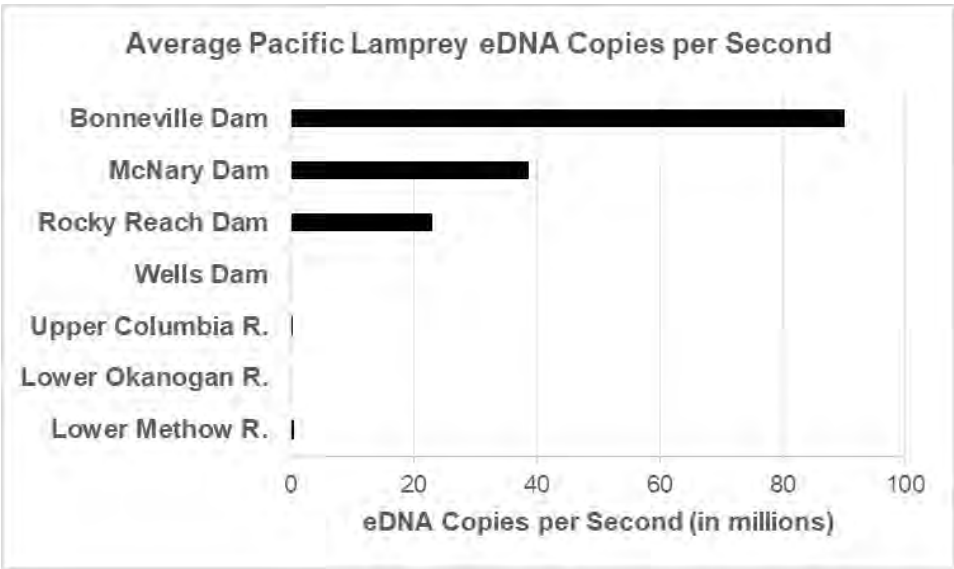


Figure 4. Average number of Pacific Lamprey eDNA copies per second among the seven groupings of 2018 eDNA collection sites.

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

This project, which entails both adult translocation and associated monitoring, addresses goals for multiple strategies and restoration/management plans, including the CRITFC TPLRP CRB (Objective 3 and 6), PLCI Conservation Agreement (Objective 5 and 6), BPA NPCC CRB FWP (Part 3 IV-C-6), US ACOE PL PIIP (in terms of improving "attraction" and our understanding of this behavior), and Douglas County PUD's Wells Hydroelectric Project PL Management Plan (Section 2.5.2, 4.1.7, and 4.2.4 and a 2018 SOA). The CRITFC plan, in section 4.1.6.b, addresses "Migratory Cues" as an important knowledge gap and states the importance of pursuing these types of studies using water samples. In the report "Critical Uncertainties for Lamprey in the CRB" (CRBLTWG 2005), "Lamprey Status" was identified as the highest and imminent priority for critical uncertainties and development of standardized sampling protocols and systematic basin-wide surveys to assess abundance and distribution was identified as a key strategy. This project addresses the goals of these various strategies/plans by providing an innovative yet objective means for evaluating the impact of adult translocation in a relatively large water body (i.e. the Upper Columbia River) and will help inform management decisions concerning the PL subpopulations upriver of Wells Dam.

7. Project Design / Feasibility:

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

A pilot study was already conducted in 2018 and the results from this study is reported in Lampman et al. (2020). The sampling sites used in 2018 will be resampled and some supplemental sites will be added to further our understanding of the status of PL subpopulations upriver of Wells Dam (see section 2 for more details). Due to the nature of this project with sampling and analysis conducted via water samples, permits will not be required. This project will be implemented within the defined timeframe owing to the collaborative nature of this project with many partners who will help cover the large geographic area via either existing concurrent or new sampling. Although the COVID-19 pandemic could still be a potential health hazard risk in 2021-2022, these water sampling for eDNA could be easily conducted with minimum staff (even one person) with minimal to no interaction with other people or staff. As a result, this project will be able to continue even if the current status quo with various COVID-19 related operation restrictions continued.

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

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

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

The project is supported by several partners including three tribal entities (YNF, CTFW, and CRITFC), two Public Utility Districts (Douglas and Chelan County PUDs), and one federal agency (U.S. Forest Service). The project was initiated by YNF in 2018 with matching funds from CRITFC and in-kind services from the Douglas and Chelan County PUDs, CTFW, and MSRF. The USFS RMRS assisted with the project design and development and conducted all of the laboratory analyses for this project. All of these partners will continue to support this new project in similar capacities. In-kind services will be provided by all partners, including salary, equipment and supplies and vehicle use and fuel. All project partners will be active in designing/refining the monitoring and will assist in reporting and sharing study results broadly. Project reporting will be executed primarily by YNF with input and feedback from all partners, in a highly collaborative setting. All partners have significant experience in eDNA procedures and most have concomitant eDNA sampling projects.

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

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

A report summarizing both the 2021-2022 new data in comparison with 2018 baseline data will be completed at the end of this project. All requirements associated with the funding agency (such as a BPA mid-term update in Nov-Dec 2021 and a final report in May-Dec 2022) will be followed per guidance. One of the specific benefits that this project will deliver include the development of a management decision tool to assess the recovery of PL subpopulations (using PL eDNA rates). This management decision tool could be useful not only for the ASWG for PL subpopulations upriver of Wells Dam but also for potentially a wide variety of stake holders interested in monitoring the status of local PL subpopulations (with continual improvement in standardization of methods and in our understanding of eDNA retention/shedding rates in local environments). The project partners will ensure that study findings are shared in an assortment of lamprey forums and venues (presentations, reports, publications, etc.) so that other stakeholders can best apply them for other lamprey conservation and restoration efforts.

10. Project Budget (including overhead):

- Budget table presented on page 12 of appendix B.

11. Timeline of major tasks and milestones:

Workflow	*Start Date/Month*	*End Date/Month*	*Responsible Party*
Finalization of study sampling design, sites, and dates	Jun 2021	Sep 2021	YNF & USFS RMRS (with input from all partners)
Objective 1 – Collect eDNA & lamprey bile acids samples in fall 2021	Sep 2021	Oct 2021	All partners
Objective 2 - Collect eDNA & lamprey bile acids samples in spring 2022	Mar 2022	Apr 2022	All partners
Objective 3 - Collect eDNA samples in fall 2022	Sep 2022	Oct 2022	All partners
Objective 4 – Analyze eDNA samples in the laboratory	Jan 2022	Dec 2022	USFS RMRS
Objective 5 – Analyze lamprey bile acids samples in the laboratory	Jan 2022	Dec 2022	MSU (Weiming Li) / NIWA (New Zealand)
Objective 6 - Reporting	Oct 2022	Dec 2022	All partners

12. References:

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

Carim, K.J., Dysthe, J.C., Michael, K.Y., McKelvey, K.S., & Schwartz, M.K. 2017. A noninvasive tool to assess the distribution of Pacific Lamprey (Entosphenus tridentatus) in the Columbia River Basin. PLoS ONE 12(1): e0169334, https://doi.org/10.1371/journal.pone.0169334.

CRBLTWG (Columbia River Basin Lamprey Technical Workgroup). 2005. Critical uncertainties for lampreyin the Columbia River basin: Results from a strategic planning retreat of the Columbia River Basin Lamprey Technical Workgroup.

Lampman, R, & Lumley, D. 2020. Using environmental DNA to detect Pacific Lamprey (*Entosphenus tridentatus*) within Yakama Nation ceded lands rivers and streams in 2018. In Yakama Nation Pacific Lamprey Project 2019 annual report (Appendix L2, Project No. 2008-470-00). Prepared for the U.S. Dept. of Energy, Bonneville Power Administration, Portland, OR, 40 pp.

Li, K, Wang, H., Brant, C.O., Ahn, S., & Li, W. 2011. Multiplex quantification of lamprey specific bile acid derivatives in environmental water using UHPLC-MS/MS. Journal of Chromatography B 879:3879-3886.

Ostberg, C.O., Chase, D.M., Hayes, M.C., & Duda, J.J. 2018. Distribution and seasonal differences in Pacific Lamprey and *Lampetra* spp. eDNA across 18 Puget Sound watersheds. PeerJ 6: e4496, https://doi.org/10.7717/peerj.4496.

Robinson, T.C., Sorensen, P.W., Bayer, J.M., & Seelye, J.G. 2009. Olfactory sensitivity of Pacific Lampreys to lamprey bile acids. Transactions of the American Fisheries Society 138:144-152, http://doi.org/10.1577/T07-233.1.

Stewart, M., & Baker, C.F. 2012. A sensitive analytical method for quantifying Petromyzonol sulfate in water as a potential tool for population monitoring of the southern pouched lamprey, *Geotria australis*, in New Zealand streams. J Chem Ecol 38:135-144.

Stewart, M., Baker, C.F., & Cooney, T. 2011. A rapid, sensitive, and selective method for quantitation of lamprey migratory pheromones in river water. J Chem Ecol 37:1203-1207. https://doi.org/10.1007/s10886-011-0029-y.

Tillotson, M.D., Kelly, R.P., Dud, J.J., Hoy, M., Kralj, J., & Quinn, T. 2018. Concentrations of environmental DNA (eDNA) reflect spawning salmon abundance at fine spatial and temporal scales. Biological Conservation 220:1-11.

Yun, S, Alexander, P.S., Bayer, J.M., Seelye, J.G., Close, D.A., & Li, W. 2003. HPLC and ELISA analyses of larval bile acids from Pacific and western brook lampreys. Steroids 68:515-523.

Project Budget:

	Items	# Hours or Units	Cost per Unit ($)	RIP Funds Requested ($)	Cost Share ($)	Total Cost ($)
A	***Personnel:***	-	-	-	-	-
	a. YNF staff	96	$60.00	-	$5,760.00	$5,760.00
	b. CTFW staff	48	$75.00	-	$3,600.00	$3,600.00
	c. CRITFC staff	48	$60.00	-	$2,880.00	$2,880.00
	d. MSRF staff	48	$75.00	-	$3,600.00	$3,600.00
	e. Douglas County PUD staff	96	$75.00	-	$7,200.00	$7,200.00
	f. Chelan County PUD staff	48	$75.00	-	$3,600.00	$3,600.00
B	***Equipment & Supplies:***	-	-	-	-	-
	N/A (included in analysis costs)			-	-	-
C	***Travel:***	-	-	-	-	-
	a. Field Trips	6 days (overnight)	$151/day	-	$906.00	$906.00
	b. Vehicle use/fuel	24 days	$120/day	-	$2,880.00	$2,880.00
D	***Other (Analysis):***	-	-	-	-	-
	a. USFS eDNA lab analysis (existing sites)	14 samples x 3 events	$35/sample	1,470.00	-	1,470.00
	b. USFS eDNA lab analysis (new sites)	29 samples x 3 events	$93.5/sample	8,134.50	-	8,134.50
	c. Michigan State University / NIWA lamprey bile acid derivatives lab analysis	20 samples x 2 events	$300/sample	12,000.00	-	12,000.00
E	***Administrative:***	-	-	-	-	-
	Overhead (20.00%)			$4,320.90	$3,042.60	$33,468.60
	Total (Sum of A - E)	-	-	$25,925.40	$30,426.00	$59,394.00

Appendix C: Okanogan River Basin Pacific Lamprey (Entosphenus tridentatus) Translocation and Monitoring

Project Title: Okanogan River Basin Pacific Lamprey (Entosphenus tridentatus) Translocation and Monitoring

Project Applicant/Organization: Colville Tribes Fish and Wildlife (CCT F&W)
Contact Person: John Rohrback
Email: john.rohrback@colvilletribes.com
Phone: (509) 634-1068

Project Type: Other

Lamprey RMU population: Upper-Columbia
Watershed (5th HUC Field): 1702000622 – Loup Loup Creek – Okanogan River; 1702000620 – Salmon Creek; 1702000619 – Omak Creek; 1702000615 – Antoine Creek – Okanogan River; 1702000720 – Snehumption Creek-Similkameen River
NPCC Subbasin (4th HUC Field) name: 17020006 – Okanogan; 17020007 – Similkameen
Project Location: **Various lamprey release and eDNA sampling sites within the Okanogan river basin in the aforementioned HUCs**

Total Requested funds: $11,180.60

Short Project Summary (200 words or less):

- Provide a brief overview of your project including goals
- This information will be used to describe your project to potential funding entities

Prior to the initiation of reintroduction efforts in 2017, Pacific lamprey (*Entosphenus tridentatus*) were last documented in the Okanogan river subbasin in 2010 (Wagner et al. 2018). This project proposal calls for the continuation of lamprey translocation efforts into the Okanogan river subbasin from mainstem Columbia collection sites, and solicits funding to create a monitoring framework, utilizing environmental DNA (eDNA) sampling, to evaluate and improve translocation efforts. Project goals include:

1. Employ eDNA sampling (n = 8 sites, two sampling occasions) in the Okanogan River and select tributaries to establish a baseline understanding current lamprey stream occupancy prior to 2021 translocation efforts to inform future release strategy and document lamprey stream presence/nondetection
2. Translocate lamprey sourced from a downstream Columbia river collection site to the Okanogan river basin in the spring and late summer/early fall of 2021
3. Monitor post-release lamprey movement using existing PIT tag infrastructure
4. Repeat eDNA sampling in March, 2022 for continued presence/nondetection monitoring

prior to lamprey translocation efforts later that same year

1. Detailed Project Description (500 words or less):

After construction of Chief Joseph Dam began in the early 1950s, the Okanogan became the terminal watershed to support Pacific lamprey production in the Columbia Basin. However, since macrophthalmia were collected in a main-stem Okanogan rotary screw trap in 2010, there had been no observations of lamprey in the Okanogan basin until adult translocation efforts began in 2017. Furthermore, in the decade prior translocation of adult lamprey in the Upper Columbia (2007-2016), only 92 lamprey were observed passing Wells Dam.

Lamprey translocation and supplementation allows for occupation of presumably underutilized habitat within the Okanogan basin, and larval lamprey have been observed in each tributary stream to the Okanogan into which translocated adults have been released (Salmon Creek, Omak Creek, and the Similkameen River). Translocation will continue to assist with establishing a lamprey pheromone signal in the Okanogan basin to naturally attract re-colonizing adults. The Pacific Lamprey Regional Implementation Plan for the Upper Columbia Regional Management Unit identifies both mainstem passage and small population sizes in the Okanogan and Similkameen watersheds as key threats to Pacific lamprey. Translocation and supplementation mitigate these threats, and appropriate monitoring enhances the effectiveness of these efforts.

Objective 1: Pre-release eDNA monitoring at all four previous lamprey release locations

In 2017, 2018, and 2019 Pacific lamprey were released into the Okanogan and Similkameen watersheds. Translocation is also scheduled to happen in 2020. However, apart from PTAGIS queries to monitor movement of PIT-tagged adults, no lamprey monitoring efforts have been implemented by CCT F&W. eDNA sampling and analysis will provide current lamprey presence/nondetection data in the Okanogan River and selected tributaries. These data can be used to inform release strategies for translocation efforts based on presence/nondetection results (e.g. lamprey presence in a select tributary may indicate suitable habitat, and result in higher numbers of adults released at that area). Samples (each of which consists of three field replicates and one negative control) will be collected at eight sites – one at each release location, and one at a location downstream.

Objective 2: Lamprey translocation and release into the Okanogan river basin

Subject to availability of adult lamprey at downstream collection sites (including Priest Rapids, John Day, The Dalles, and Bonneville dams), CCT F&W will receive adult lamprey at Wells Dam for translocation and release into the Okanogan basin. Translocation efforts should be similar to those conducted in past years – from one to five release occasions with a total number of released lamprey of up to 500 individuals, contingent on lamprey capture success, occurring in the spring and late summer/early fall.

Objective 3: Post-release PIT tag and eDNA monitoring

Following release, CCT F&W will periodically query the PTAGIS database to monitor the detected movements of released, PIT-tagged lamprey. After the overwintering period, eDNA samples will again be taken to monitor lamprey presence and distribution in the Okanogan river

basin. qPCR analysis will be used to document presence/nondetection of lamprey and starting quantities of lamprey DNA. Results of these monitoring efforts – along with translocation results – will be compiled, summarized, and analyzed in a final report. In future years, after the collection of a sufficient time-series of eDNA presence/nondetection data for substantive analysis, these results can be used to populate an Okanogan basin occupancy model that tracks the progress and evaluates the success of the translocation efforts.

2. Descriptive Photographs-illustrations-Maps (Limit to three total)**:**

Figures 1 and 2 are from the Okanogan Sub-basin adult Pacific lamprey translocation plan. They denote potential release locations for Pacific lamprey within the Okanogan river basin. Release locations will be chosen based on water temperature, habitat conditions and lamprey presence at the time of release. eDNA samples will be collected at release locations as well as sites located downstream. Historically, lamprey have been released in-basin in Salmon Creek, Omak Creek, the Similkameen River below Coyote Falls, and the Okanogan River near the mouth of Salmon Creek.

Figure 3

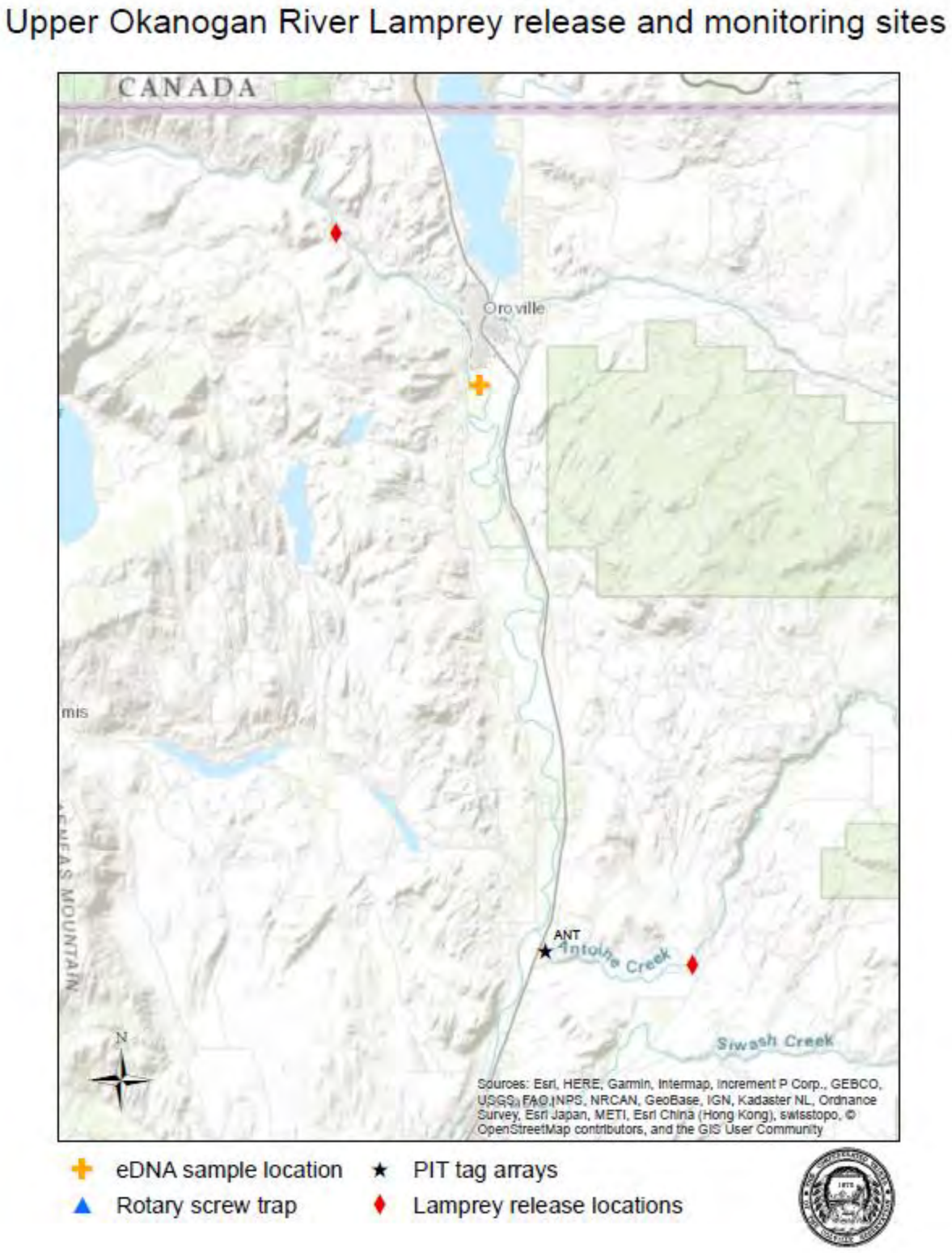
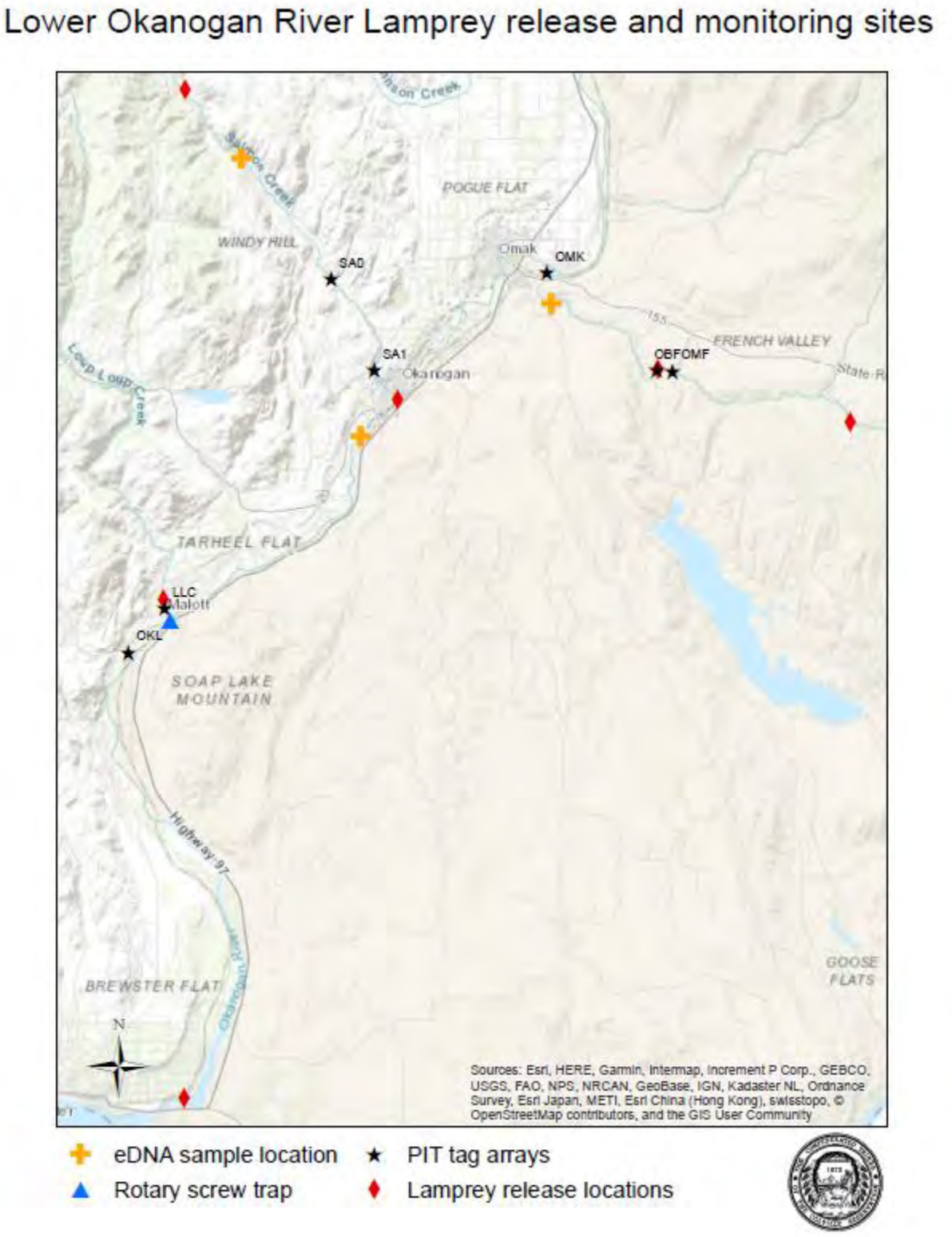

Upper Okanogan River Lamprey release and monitoring sites
CANADA
Oroville
mis
ANT
Antoine Creek
Siwash Creek
N
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community
eDNA sample location
PIT tag arrays
Rotary screw trap
Lamprey release locations

Figure 4


Lower Okanogan River Lamprey release and monitoring sites
POGUE FLAT
WINDY HILL
SAD
Omak
OMK
155
FRENCH VALLEY
OBFOMF
SA1
Okanogan
State R
Loup Loup Creek
TARHEEL FLAT
LLC
Malott
OKL
SOAP LAKE
MOUNTAIN
Highway 97
BREWSTER FLAT
GOOSE
FLATS
N
Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community
eDNA sample location
PIT tag arrays
Rotary screw trap
Lamprey release locations

3. ***Linkage of actions to Identified Threats in RMU (300 words or less):***
   - What threat(s) does this project address? ***See your RIP for key threats: Small Effective Population Size*** AND ***Passage*** AND ***Lack of Awareness***
   - Project scope: Does this project address threat(s) specific to this RMU only, or does the project address the threat(s) prevalent in multiple RMUs?
     Single RMU ☒, Multiple RMUs ☐ list additional RMUs:
   - How does this project address key threat(s) within the HUC where project is proposed?
     - *Translocating lamprey from the mid-Columbia to the Okanogan river basin mitigates the upstream passage burden on adults returning to spawn. Releasing lamprey in the proposed HUCs addresses the key threat of small effective population size. eDNA monitoring helps to evaluate the success of the translocation efforts and reduce the lack of awareness and understanding about lamprey distribution in the Okanogan river basin.*
     -
4. ***Species/Habitat Benefits (200 words or less):***
   - How will the project provide meaningful measureable results to improve lamprey populations and/or their habitat conditions?
     - *eDNA monitoring will provide data to monitor lamprey presence and distribution throughout the Okanogan river basin. Translocation of adults will provide a minimum known number of adults that are available to spawn within basin.*

   - What life stage or stages will benefit from action? How?
     - *Adult lamprey will be the primary beneficiaries through the translocation process. Since passage over Wells has been extremely limited in recent years, assisting with their upstream migration will help to ensure lamprey have the opportunity to reproduce in the Okanogan watershed. Secondarily, Juvenile lamprey will benefit from expanded range in underutilized habitat.*

   - What other species may benefit from action?
     - *Transferal of marine derived nutrients into the Okanogan River Basin in the form of spawned out lamprey carcasses will help to offset the nutrient deficit from historic levels, providing benefit to the riverine ecosystem and all naturally occurring species.*
     - *Re-establishment of larval lamprey (from translocated parents) will provide a food source for both native and non-native (prey-buffering) fish species, and may contribute to improved nutrient cycling and water quality in streams with high larval densities.*

5. ***Project Design / Feasibility (200 words or less):***
   - Have the designs for the project been completed already or will they be completed before planned project implementation? Yes ☒, No☐
     - *Coordination with project partners is ongoing*
   - Are the appropriate permits (e.g., ESA consultation, Scientific Collection, fish health/transport, etc.) in place already or will they be in place before planned project implementation? Yes ☒, No☐

- *CCT F&W maintains a fish transport permit for lamprey. It will be renewed to allow for these efforts*

- Can the project be implemented within the defined timeframe? ***See BPA and NFHP requirements above***. Yes ☒, No☐

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

- What partners are supporting the project?
  - *Yakama Nation, Grant PUD, Douglas PUD, and USGS*
- What partners are active in implementing the project?
  - *Yakama Nations and Douglas PUD will both participate in the adult lamprey translocation efforts, moving fish from Priest Rapids Dam to Wells Hatchery, and conducting PIT-tagging and biosampling activities. Grant PUD will conduct lamprey trapping and transferal activities. USGS will conduct the eDNA extraction and analysis. CCT F&W will transport and release lamprey into the Okanogan River Basin, PIT tag and biosample lamprey, and collect eDNA samples.*
- What partners are providing matching funds or in-kind services that directly contribute to the project?
  - *CCT F&W is providing vehicles, in-kind staff time that corresponds with planned eDNA sampling activities, and maintaining an extensive PIT array network in the Okanogan river basin that will allow for monitoring of released lamprey. Douglas PUD and Yakama Nations are providing staff time, lamprey transportation, and PIT tags to bring fish from Priest Rapids Dam to Wells, collect data, and PIT tag lamprey. USGS will provide use of nonconsumptive eDNA sampling supplies.*

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

- How is completion of the project going to be documented? ***See BPA and NFHP requirements above***.
  - *A written and photographed report of translocation events will be provided, which also includes post-release PIT tag monitoring through queries of the PTAGIS database, and the results of pre- and post-release eDNA sampling.*
- How will the projects' benefits to lamprey be monitored over time?
  - *The detection history of PIT-tagged lamprey will be monitored periodically through querying the publically available PTAGIS database. Collected and analyzed eDNA samples will provide additional insight into lamprey occupancy and habitat utilization in basin. Future activities to monitor the success of the lamprey translocation may include electroshocking and redd surveys, as funding allows.*

8. Project Budget (Including overhead):

- See budged on page 9 of Appendix C.

9. Timeline of major tasks and milestones:

Workflow	*Start Date/Month*	*End Date/Month*	*Responsible Party*
Pre-release eDNA sample collection	***July 2021***	***Aug. 2021***	***CCT F&W***
Lamprey translocation	***Aug. 2021***	***Sept. 2021***	***CCT F&W***
Post-release eDNA sample collection	***Mar. 2022***	***Mar. 2022***	***CCT F&W***
qPCR analysis of eDNA samples	***Mar. 2022***	***Apr. 2022***	***USGS***
Reporting	***Mar. 2022***	***Apr. 2022***	***CCT F&W***

10. References (If Applicable)

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

Project Budget:

Below is a budget for the funds requested for the proposed Pacific lamprey translocation and monitoring project

	Items	# Hours or Units	Cost per Unit ($)	RIP Funds Requested ($)	Cost Share ($)	Total Cost ($)
A	***Personnel:***	-	-	-	-	-
	a. CCT Biologist Salary	100	$30.01	$2400.80	$600.20	$3001.00
	b. CCT Biologist Fringe	1	$714.00	$714.00	$179.00	$893.00
	c. CCT Technician Salary	40	$22.19	$887.60		$887.60
	d. CCT Technician Fringe	1	$241.00	$241.00		$241.00
B	***Equipment & Supplies:***	-	-	-	-	-
	a. eDNA self-dessicating filters from Smith Root	64	$15.00	$960.00		$960.00
	b. eDNA filter shipping	1	$40.00	$40.00		$40.00
C	***Travel:***	-	-	-	-	-
	Translocation mileage from Omak to Wells, Similkameen release site, and back to Omak	748	$0.58/mile	$433.84		$433.84
D	***Other:***	-	-	-	-	-
	a. per sample qPCR Analysis for Pacific Lamprey	16	$265.56	$4248.96		$4248.96
	b. shipping filters to eDNA lab in Boise	2	$47.20	$94.40		$94.40
E	***Administrative:***	-	-	-	-	-
	Indirect Costs (35.29 %)	1	$1,160.00	$1,160.00		$1,160.00
	Total (Sum of A - E)	-	-	$11,180.60		$11,959.80