Yakama Nation Pacific Lamprey Project
2017 Annual Report

Project No. 2008-470-00

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Cover Photo: Yakama Nation Tribal School (Toppenish, WA) and Christian Brothers High School (Sacramento, CA) students jointly releasing adult Pacific Lamprey in Satus Creek on March 30, 2017.

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I. Executive Summary

In accordance with Bonneville Power Administration (BPA) Contract 2008-470-00, the Confederated Tribes and Bands of the Yakama Nation (YN) have prepared this Annual Report for the Yakama Nation Pacific Lamprey Project (YNPLP). This report outlines the most current activities undertaken by the YNPLP from January 1, 2017 through December 31, 2017.

A: WE165 - Environmental Compliance
No additional report is submitted in association with this milestone: see Section III.

B: WE174 – Propagation, Rearing, and Outplanting Plan
One report is submitted in association with this milestone: Appendix B1 (Updated Draft Master Plan for Pacific Lamprey Supplementation, Aquaculture, Restoration, and Research).

C: WE157 – Larval/Juvenile Lamprey Surveys in the Yakima and Mid and Upper Columbia subbasins
Eight reports are submitted in association with this milestone: Appendix C1 (Lower Yakima Subbasin Larval Lamprey Monitoring Report, 2017), Appendix C2 (Upper Yakima Subbasin Larval Lamprey Monitoring Report, 2017), Appendix C3 (Naches Subbasin Larval Lamprey Monitoring Report, 2017), Appendix C4 (Wenatchee Subbasin Larval Lamprey Larval Lamprey Monitoring Report, 2017), Appendix C5 (Methow Subbasin Larval Lamprey Monitoring Report, 2016), Appendix C6 (Klickitat Subbasin Larval Lamprey Monitoring Report, 2017), Appendix C7 (Distribution and Occupancy of Pacific Lamprey in Six Major Columbia River Subbasins within the Yakama Nation Ceded Lands: Summary from 2009-2017 Surveys), and Appendix C8 (Yakama Nation Ceded Lands Larval Lamprey Synthesis Report, 2017).

D: WE28 – Lamprey Survey and Salvage in Irrigation Diversions
Two reports are submitted in association with this milestone: Appendix D1 (Summary Assessment of Larval/Juvenile Lamprey Entrainment in Irrigation Diversions within the Yakima Subbasin, 2017) and Appendix D2 (Intensive Monitoring of Larval/Juvenile Lamprey Entrainment within Dryden Diversion, Wenatchee River, 2017).

E: WE99 – Public Outreach and Education
Two reports are submitted in association with this milestone: Appendix E1 (Yakama Nation Pacific Lamprey Project Outreach and Education, 2017) and Appendix E2 (Participation in the Outplanting of Artificial Propagated Arctic Lamprey Larvae in Noto, Ishikawa, Japan).

F: WE161 – Local and Regional Participation
No additional report is submitted in association with this milestone: see Section III.

G: WE 158 – PIT Tag Adult Lamprey
Three reports are submitted in association with this milestone: Appendix G1 (Translocation of Adult Pacific Lamprey within the Yakima Subbasin, 2016-2017 Broodstock), Appendix G2 (Translocation of Adult Pacific Lamprey within the Wenatchee Subbasin, 2016-2017 Broodstock), and Appendix G3 (Translocation of Adult Pacific Lamprey within the Methow Subbasin, 2016-2017 Broodstock).

H: WE 158 – PIT Tag Juvenile Lamprey
No additional report is submitted in association with this milestone: see Section III.

I: WE196 – Council Step Process for Lamprey Artificial Propagation Activities
No additional report is submitted in association with this milestone: see Section III.

J: WE176 – Research into Artificial Propagation and Juvenile Propagation
No additional report is submitted in association with this milestone: see Section III.

K: WE28 - Trap and Haul Adult Lamprey from Columbia River
One report is submitted in association with this milestone: Appendix K1 (Yakama Nation Adult Pacific Lamprey Collection in the Columbia River Basin, 2017).

L: WE162 – Data Input and Analysis
Three reports are submitted in association with this milestone: Appendix L1 (Columbia Basin Lamprey Identification Guide), Appendix L2 (Larval Lamprey Assessment at the Sunnyside Fish Screening Facility, 2017), Appendix L3 (Summary of Larval Lamprey Hook-and-Line Predator Fish Removal in Chandler Irrigation Diversion [Yakima River, Prosser, WA], 2017), and Appendix L4 (Summary of Freshwater Mussel Observations within the Yakama Nation Ceded Lands from Larval Lamprey Surveys, 2017).

M: WE141 – Other Reports (Cultural Report)
One report is submitted in association with this milestone: Appendix M1 (Yakama Nation Cultural Oral Interviews on Asum [Lamprey Eels]: Summary and Review Part II [2017]).

N: WE132 – Final Annual Report for CY2016
This report was submitted successfully in spring 2017.

O: WE132 – Annual Report for CY2017
This report herein represents the annual report for CY2017.

O: WE119 - Manage and Administer Projects
No additional report is submitted in association with this milestone: see Section III.

P: WE185 - Pisces Status Report
No additional report is submitted in association with this milestone: see Section III.

II. Introduction

The Goal of the Yakama Nation is to restore natural production of Pacific Lamprey to a level that will provide robust species abundance, significant ecological contributions and meaningful harvest throughout the Yakama Nation's Ceded Lands and in the Usual and Accustomed areas (Fig. 1).

Pacific Lamprey (*Entosphenus tridentatus*) has always been important to Native Americans throughout the Pacific Northwest. Since time immemorial, the Fourteen Bands (Palouse, Pisquose, Yakama, Wenatchapam, Klinquit, Oche Chotes, Kow way saye ee, Sk'in-pah, Kah-miltpah, Klickitat, Wish ham, See ap Cat, Li ay was, and Shyiks) who make up the YN, have shared a commonality treating lampreys as a medicine, food source, and cultural icon. These fish are native to the Columbia River Basin, spawning hundreds of kilometers inland within the states of Washington, Oregon, and Idaho (Kan 1975; Hammond 1979; Hamilton et al. 2005).

Over the past three decades the tribes of the Columbia River Basin have noticed drastic declines from the previous era. These trends are now well known and documented within most current literature about Pacific Lamprey throughout their range. In the present day, remnant populations of Pacific Lamprey still migrate up the Columbia River at a fraction of their historical numbers; daytime counts of adult Pacific Lamprey at Bonneville Dam have declined from an estimated 1,000,000 in the 1960's and 1970's to lows of approximately 20,000 in 2009 and 2010 (CRITFC 2011). Pacific Lamprey have been extirpated from many subbasins in the interior Columbia River Basin (Beamish and Northcote 1989; Close et al. 1995; Luzier et al. 2011).

Studies on this disturbing downward trend of Pacific Lamprey populations to date cite various contributors for the decline, including but not limited to hydroelectric / flood control dams, irrigation and municipal water diversions, degraded habitat, water quantity and quality (contamination), increased predation, targeted eradication through the use of rotenone, and host species abundance in the ocean (Close et al. 2005; CRITFC 2011; Luzier et al. 2011; Murauskas et al. 2013). The ecological consequences associated with the decline of these fish in both marine and freshwater environments are also largely unknown. Despite the implementation of various long-term actions intended to address large-scale limiting factors, adult returns remain low in comparison to historical baseline and abundance (CRITFC 2011a; Luzier et al. 2011; Ward et al. 2012).

The purpose of the YNPLP is to 1) collect and report critical information to evaluate status, trends and other biologic characteristics, 2) identify known and potential limiting factors for Pacific Lamprey within Columbia River tributaries, and 3) develop, implement and evaluate the effects of Pacific Lamprey restoration actions within the YN Ceded Lands. All of the Work Elements described herein (WE165, WE174, WE157, WE28, WE99, WE161, WE158, WE196, WE176, WE162, WE141, WE132, WE119, and WE185) are oriented toward meeting one of these three project goals.

The primary goals in 2017 were the followings:

- Proceed with the submission of and planning related to the "Master Plan for Pacific Lamprey Supplementation, Aquaculture, Restoration, and Research."
- Continue larval lamprey surveys in Yakama Nation Ceded Lands, focusing on the Yakima Wenatchee, Methow, and Klickitat subbasins.
- Provide synthesis data and information related to larval lamprey distribution, occupancy, and relative abundance.
- Continue salvage and surveys of larval/juvenile lamprey in high priority irrigation diversions, focusing on Wapato, Sunnyside, Wapatox, Bachelor-Hatton diversions in the Yakima Subbasin and Dryden Diversion in the Wenatchee Subbasin.
- Continue adult trap and haul collection from lower Columbia River hydroelectric dams (Bonneville, The Dalles, and John Day dams) as well as upper Columbia River (Priest Rapids Dam).
- Continue adult translocation in the Yakima, Wenatchee, and Methow subbasins as well as mainstem Upper Columbia River and monitor its effectiveness through PIT tagging (migration success), index reach spawning surveys (spawning success), and parentage based genetic tagging (offspring success).
- Expand monitoring on larval/juvenile lamprey passage in the Lower Yakima Subbasin, focusing on Wapato, Sunnyside, and Chandler diversions and tributary monitoring using PIT tagging and acoustic telemetry.
- Develop and refine the science and techniques for the artificial propagation and larval rearing of Pacific Lamprey along with collaborating partners (primarily Confederated Tribes of the Umatilla Indian Reservation, NOAA Fisheries, and USFWS).
- Assess life stage specific limiting factors, critical threats, and knowledge gaps important for the restoration of Pacific Lamprey and test and refine the applicable solutions that are logical and practical, including adult and juvenile passage, flow management, toxicology, and predation.
- Initiate and expand new research related to 1) the development of an improved lamprey identification guide, 2) the temporal changes of larval/juvenile lamprey abundance in irrigation diversions using deep water electrofishing and eDNA, 3) assessment of larval lamprey predation in Chandler Diversion through hook and line methods, and 4) the distribution and siting of freshwater mussels within the Ceded Lands.

- Improve our understanding of Pacific Lamprey in its historical context through Traditional Ecological Knowledge (TEK) by interviewing and pursuing dialogue with tribal elders that grew up harvesting, preparing, and consuming "asum" (Pacific Lamprey in Sahaptin language).
- Engage federal, state, and local partners to further their commitment for Pacific Lamprey restoration and conservation by 1) sharing relevant information related to lamprey biology and monitoring data, 2) proposing new approaches/venues for administering projects to help lamprey or reduce negative impacts, and 3) developing long-term plans with the partners to ensure the commitment for restoration and conservation by all entities is long-lasting.
- Continue rigorous outreach and education for youth/students, teachers, general public, as well as agency biologists and managers to instill a "true" understanding of Pacific Lamprey and its ecological and cultural roles.

Figure 1. Overview of Ceded Lands and Reservation boundaries of the Confederated Tribes and Bands of the Yakama Nation.

III. Deliverables

A. Work Element 165 – Environmental Compliance

Work Element Associated Appendix Report:
Not Applicable

This work element is part of this project's deliverables in relation to environmental laws. This project requires environmental review and compliance assurance prior to contract implementation and we work in close coordination with the BPA Environmental Compliance Officer for this work element and deliverables. This compliance was related to 1) obtaining/renewing applicable local, state, federal, and tribal environmental permits, 2) reporting lamprey observation and catch data to USFWS, 3) documenting public involvement process activities, 4) participating in ESA consultation, and 5) inspection of gear for aquatic invasive species. These milestones were completed successfully in 2017.

B. Work Element 174 – Propagation, Rearing, and Outplanting Plan

Considerable planning has occurred in preparation of pilot propagation and outplanting research activities. The "Framework for Pacific Lamprey Supplementation Research in the Columbia River Basin" was completed in 2014 and the "Synthesis of Threats, Critical Uncertainties, and Limiting Factors in Relation to Past, Present, and Future Priority Restoration Actions for Pacific Lamprey in the Columbia River Basin" was completed in 2017. The 2017 draft of the "Master Plan: Pacific Lamprey Artificial Propagation, Translocation, Restoration, and Research" was shared with federal and state agencies involved in Pacific Lamprey management (USFWS, NOAA Fisheries, WDFW, ODFW, and IDFG) for review. The comments were then incorporated to the final draft, which will be submitted to both BPA and the Independent Scientific Review Panel of the Northwest Power and Conservation Council for review in March, 2018.

Work Element Associated Appendix Report:
Appendix B1 – (Updated Draft) Master Plan: Pacific Lamprey Artificial Propagation, Translocation, Restoration, and Research

Photo B1. Dave'y Lumley and Shekinah Saluskin collecting eggs from a ripe female adult Pacific Lamprey on June 13, 2017.

The Columbia River Tribal Fish Commission (CRITFC), the Confederated Tribes and Bands of the Yakama Nation (YN), the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), and the Nez Perce Tribe (NPT) prepared this Master Plan to conceptually address Step 1 review elements of the Northwest Power and Conservation Council's review requirements for artificial propagation projects involving new construction and/or programs that will produce fish for reintroduction. This plan describes ongoing and proposed adult translocation and artificial propagation activities, as well as existing and proposed facilities needed to meet artificial propagation objectives. The plan focuses on activities of the YN and the CTUIR; however, to provide a comprehensive description of supplementation activities in the Columbia River Basin, the plan also describes ongoing adult translocation activities being conducted by the NPT. Actions described herein will work together and provide synergy with other actions such as improvements to passage, habitat, and water quality to help meet restoration goals for Pacific Lamprey in the Columbia River Basin.

This draft Master Plan is scheduled to be completed and submitted to the Independent Scientific Review Panel in March 2018 to initiate experimental larvae/juvenile outplanting in 2018/2019 and will be the basis from which the tribes move forward for additional research and funding towards potential future supplementation and lamprey recovery efforts.

See **Appendix B1** for more information.

C. Work Element 157 – Larval/Juvenile Lamprey Surveys in the Yakima and Mid and Upper Columbia subbasins

Work Element Associated Appendix Reports:
Appendix C1 – Lower Yakima Subbasin Larval Lamprey Monitoring Report, 2017

Photo C1. Overview of a larval lamprey survey site on the Yakima River (river km 13.0 near Richland, WA), where larval lampreys were captured in October, 2017.

In this report, we summarize our 2017 findings from larval lamprey habitat surveys in the lower Yakima Subbasin (Yakima River and all tributaries downstream of the Naches River confluence, river km 191.9). Both index sites (long term status and trend monitoring sites) and exploratory sites (sites to supplement knowledge of distribution throughout the subbasin) were surveyed. Larval Pacific Lamprey (*Entosphenus tridentatus*) was the primary target of the surveys. Western Brook Lamprey (*Lampetra richardsoni*), a predominately resident species, was also documented when encountered. Electrofishing surveys in 50 m reach sites were conducted in the mainstem of the lower Yakima River, and three major tributary streams; Satus Creek, Toppenish Creek and Ahtanum Creek. Throughout our survey, young of year (YOY) lampreys were separated from larger, older lampreys (non-YOY lampreys) to evaluate specific rearing preferences of young of year lampreys. We also monitored the temperature underneath the sediment where the highest densities of lampreys were found (in relation to the open water temperature above the sediment) to assess temperature preferences of larval lampreys between sites and the temperature relationship patterns and trends throughout the subbasin.

In the mainstem of the lower Yakima River (downstream of the Naches River confluence at river km 191.9), a total of four index sites were surveyed (river km 13.0, 74.1, 134.3 and 171.1; Fig. C1-1). Pacific Lamprey were found at 3 of 4 (75%) sites. Pacific Lamprey were not present at river km 134.3, despite being present at surrounding sites (river km 74.3 and 171.1). In October of 2017, both larval Pacific Lamprey and Western Brook Lamprey were found at river km 13.0. Prior to

2017, the lowest distribution of larval lampreys (all species) was river km 73.5. Interestingly, river km 13.0 also had the highest estimated density of lampreys in Type I (preferred) habitat (26.5 #/m^2). The lowest estimated lamprey density in Type I habitat was at river km 74.1 (0.7 #/m^2), despite this site having the largest area of Type I habitat (900 m^2). Similarly, the estimated lamprey density at river km 134.3 was also low (1.0 #/m^2). Young of year (YOY) lampreys were found at 1 of 4 (25%) sites (river km 171.1). The density of young of year lampreys at this site was estimated at 10 #/m^2 in Type I habitat. The temperature under the sediment in Type I habitat (measured at a maximum of 10 cm under the sediment) was higher than the plot temperature (measured directly above the sediment), ranging from 0.5 to 1.0˚C warmer).

In Satus Creek, three index sites (river km 12.9, 29.2 and 43.8) and one exploratory site (river km 50.2) were surveyed (Fig. C1-2). Pacific Lamprey were found at 3 of 3 (100%) index sites. No lampreys were present at the exploratory site at river km 50.2. Upstream sites had a higher ratio of Pacific Lamprey than more downstream sites (67%, 90%, and 93%, at river km 12.9, 29.2 and 43.8, respectively). The highest estimated lamprey density was at river km 29.2 in Type I habitat (36.5 #/m^2). Despite having the largest area of Type I habitat (175 m^2), river km 12.9 had the lowest estimated lamprey density (3.7 #/m^2). Young of year lampreys were found at 2 of 3 (66%) sites where lampreys were found. Estimated densities of YOY lampreys ranged from 75.0 #/m^2 (river km 12.9) to 245.0 #m^2 (river km 29.2). At the most upstream site (river km 43.8), the sediment temperature in Type I habitat was 3.0˚C cooler than the plot temperature; the highest observed temperature difference between the sediment and plot temperatures in Satus Creek.

A total of three index sites were electrofished in Toppenish Creek (river km 7.1, 43.5, 59.9), and one index site in Simcoe Creek (tributary of Toppenish Creek; river km 9.0) (Fig. C1-3). Lampreys were present at 2 of 3 (66%) index sites in Toppenish Creek and 1 of 1 (100%) sites in Simcoe Creek. Despite having the largest area of Type I habitat, no lampreys were found at river km 7.1 in Toppenish Creek. Pacific Lamprey were found at all the sites where lamprey was present in Toppenish and Simcoe Creek. At the two sites in Toppenish Creek, the ratio of Pacific Lamprey was similar (52% and 48% at river km 43.5 and 59.9, respectively). In Simcoe Creek, the ratio of Pacific Lamprey was much lower (18%). The highest estimated density of lampreys was in Simcoe Creek (25.3 #/m^2). In Toppenish Creek, estimated densities of lampreys (excluding YOY lampreys) was higher at the upper most survey site at river km 59.9 (6.7 #/m^2) compared to river km 43.5 (0.5 #/m^2). Young of year (YOY) lampreys were found at 1 of 2 (50%) index sites with lampreys in Toppenish Creek (river km 59.9), and 1 of 1 (100%) sites in Simcoe Creek (river km 9.0). The YOY density was estimated to be 2.0 #/m^2 in Toppenish Creek and 25.7 #/m^2 in Simcoe Creek. Overall, the sediment temperature was cooler than the plot temperature (ranging between 0.2 and 1.1˚C cooler at Toppenish Creek, river km 7.1 and Simcoe Creek, river km 9.0, respectively).

A total of four index sites were electrofished in Ahtanum Creek (river km 1.1, 11.5, 22.8 and 34.8; Fig. C1-4). Pacific Lamprey were found at 4 of 4 (100%) sites. Similar to Satus Creek, the ratio of Pacific Lamprey generally increased with site distance upstream (11%, 86%, 79% and 94% at river km 1.1, 11.5, 22.8 and 34.8, respectively). Pacific Lamprey macrophthalmia (smolt stage with eyes) were captured at river km 1.1, 11.5 and 22.8 in September, 2017 (captured 2, 1, and 1, respectively). Despite having the largest area of Type I habitat, river km 11.5 had the lowest estimated lamprey density in Type I habitat, excluding YOY lampreys (10.5 #/m^2). Young of year lampreys were found at 4 of 4 (100%) sites. At river km 11.5, the estimated density of YOY lampreys was highest (66.7 #/m^2), despite this site having the lowest estimated density of larger (older) lampreys. At all sites, the sediment temperature was less than 1.0 C cooler than the plot temperature (sediment temperature 0.6, 0.5, 0.5 and 0.1˚C cooler than the plot temperature at river km 1.1, 11.5, 22.8 and 34.8, respectively).

See **Appendix C1** for more information.

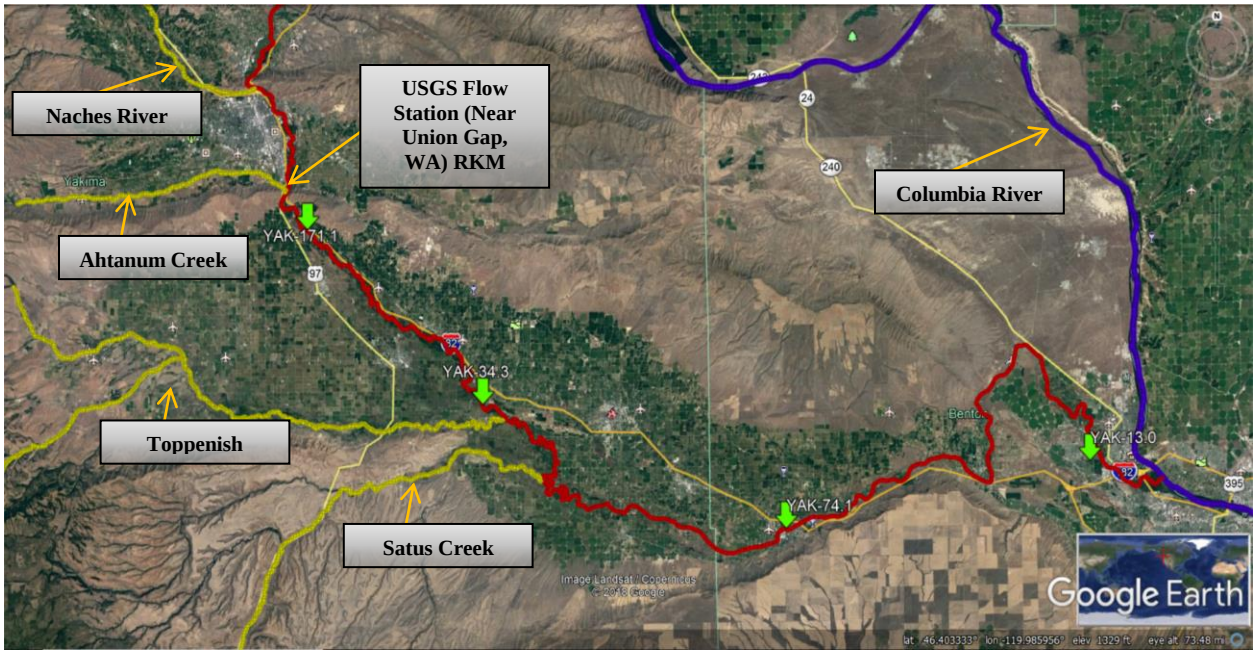


Figure C1-1. Overview of 2017 survey sites in the lower mainstem of the Yakima River (red line) downstream of the Naches River confluence (river km 191.9), displaying surveyed index sites (green arrows) where electrofishing occurred. The location of a USGS Flow Station (near Union Gap, WA; river km 177.3) is also labeled. Tributary streams are also labeled accordingly.

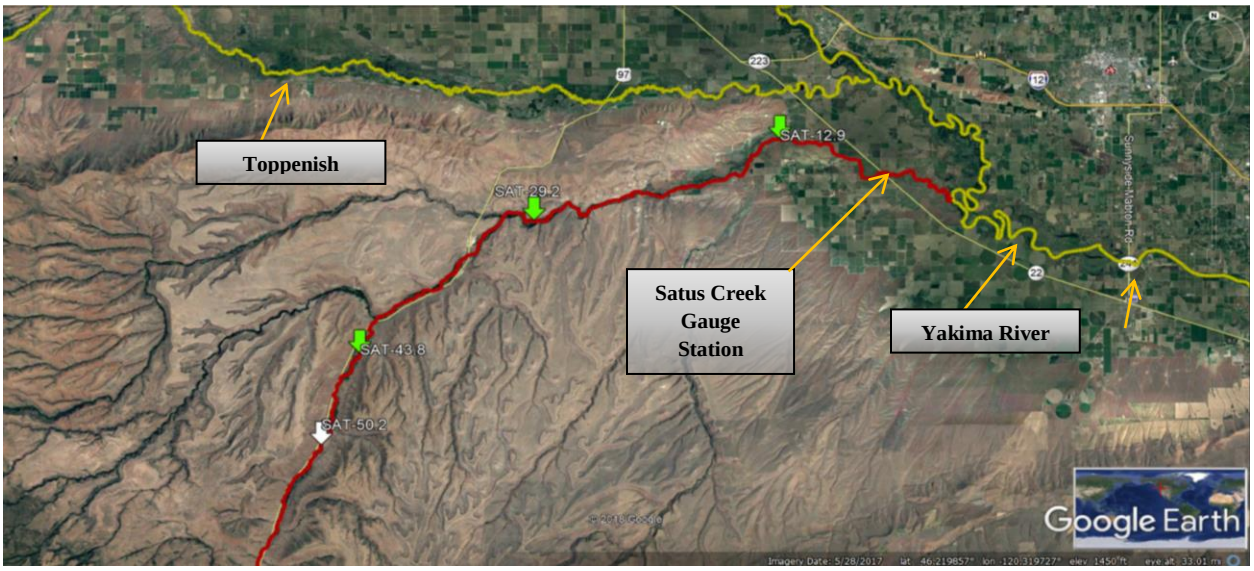


Figure C1-2. Overview of 2017 survey sites in Satus Creek (red line; confluence with the Yakima River at river km 112.2). Surveyed index sites (green arrows) and exploratory sites (white arrows) are shown. The location of the gauge station (monitored by Yakama Nation; river km 5.0) is also shown. Streams in close proximity to Satus Creek are also labeled.

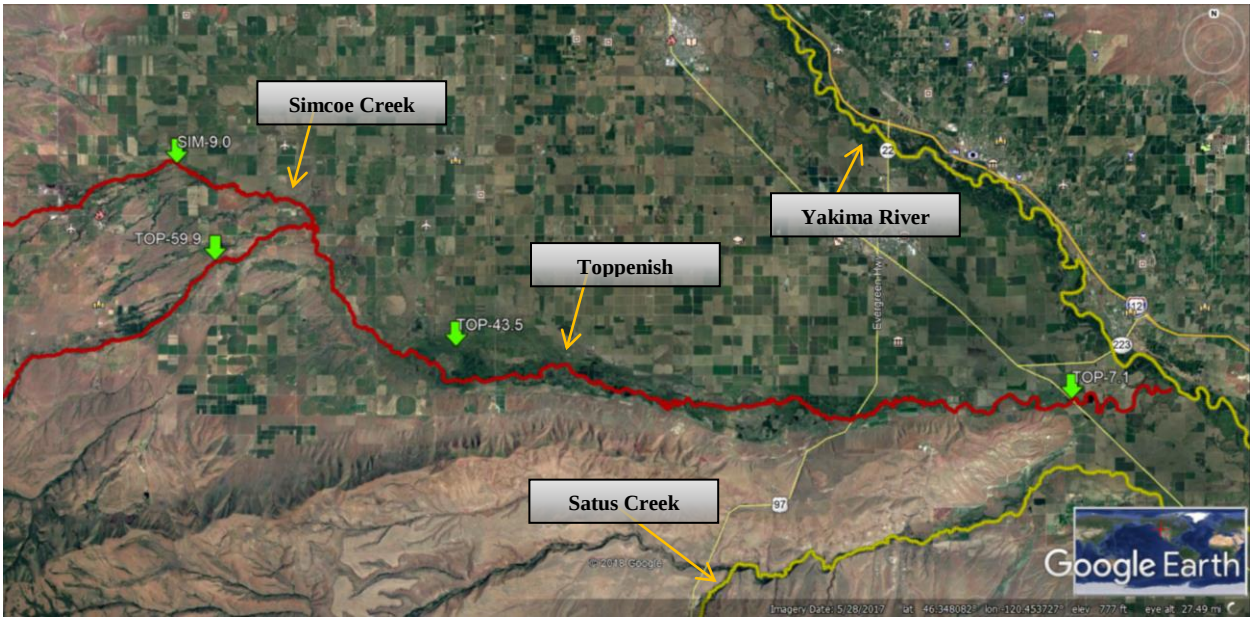


Figure C1-3. Overview of 2017 survey sites in Toppenish Creek and Simcoe Creek (red lines; Toppenish Creek confluence with the Yakima River at river km 130.8). Surveyed index sites (green arrows) are shown. Streams in close proximity are labeled accordingly.

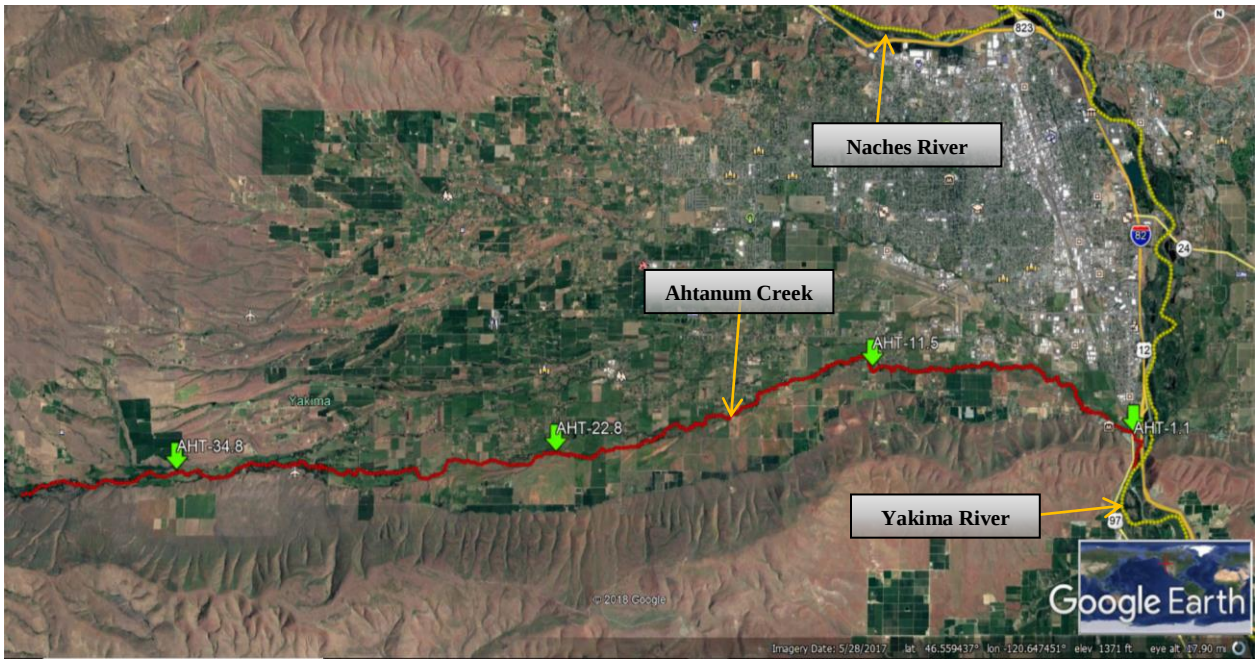


Figure C1-4. Overview of 2017 survey sites in Ahtanum Creek (red lines; confluence with the Yakima River at river km 176.8). Surveyed index sites (green arrows) are shown. Streams in close proximity to Ahtanum Creek are labeled accordingly.

Appendix C2 – Upper Yakima Subbasin Larval Lamprey Monitoring Report, 2017

Photo C2. Overview of a larval lamprey survey site on the Yakima River (river km 318.3) where Pacific Lamprey were identified in September, 2017.

In this report, we summarize our 2017 findings from larval lamprey habitat surveys in the Upper Yakima Subbasin (Yakima River and all tributaries upstream of the Naches River confluence, river km 191.9). Only index sites (long term status and trend monitoring sites) were surveyed. Larval Pacific Lamprey (*Entosphenus tridentatus*) was the primary target of the surveys. Western Brook Lamprey (*Lampetra richarsoni*), a predominately resident species, were also documented when encountered. Electrofishing surveys in 50 m reach sites were conducted in the upper mainstem of the Yakima River

(upstream and downstream of Roza Dam, river km 210.5), and two major tributary streams; Swauk Creek and the Teanaway River. Throughout our survey, young of year (YOY) lampreys were separated from larger, older lampreys (non-YOY lampreys) to evaluate specific rearing preferences of young of year lampreys. We also monitored the temperature underneath the sediment where the highest densities of lampreys were found (in relation to the open water temperature above the sediment) to assess temperature preferences of larval lampreys between sites and the temperature relationship patterns and trends throughout the subbasin.

Five index sites were surveyed in the upper mainstem of the Yakima River (upstream of the Naches River confluence, river km 191.9) in September, 2017 (Fig. C2-1). One index site (river km 192.6) was located downstream of Roza Dam and four index sites upstream of Roza Dam (river km 235.7, 264.8, 300.9 and 318.3). Pacific Lamprey were present at 4 of 5 (80%) index sites. Pacific Lamprey were not present at river km 235.7 (located 25.2 river km upstream of Roza Dam). The highest estimated density of lampreys (excluding YOY lampreys) was 18.0 #/m^2 (river km 300.9). Further upstream at river km 318.3, the density dropped off to 6.2 #/m^2. The lowest estimated density was at river km 192.6 (5.2 #/m^2), located downstream of Roza Dam. YOY lampreys were found at 4 of 5 (80%) index sites. No YOY lampreys were found at river km 318.3 (the most upstream surveyed site). The highest estimated density of YOY lampreys was 76.7 #/m^2. The highest water temperature was 20.6 C at river km 192.6 in September, 2017. At river km 192.6, the sediment temperature (measured at a maximum of 10 cm below the sediment) was 2.1˚C cooler than the plot temperature in areas with high densities of lampreys. Only 1 of 5 (20%) sites had a sediment temperature that was warmer than the plot temperature, taken directly above the sediment (0.2˚C warmer at river km 235.7).

Two index sites were surveyed in Swauk Creek in July, 2017 (river km 1.2 and 3.4; Fig. C2-2). No Pacific Lamprey were found in Swauk Creek. The estimated density of lampreys at river km 1.2 was nearly three times higher than river km 3.4 (24.3 #/m^2 and 8.5 #/m^2, respectively). Also, the mean length of lampreys was larger at river km 3.4 (107 mm) than at river km 1.2 (71 mm). The maximum temperature observed was 20.3˚C at river km 1.2 in July, 2017. At river km 3.4, the sediment temperature was 6.2˚C cooler than the plot temperature.

Two index sites were surveyed in the Teanaway River in July, 2017 (river km 1.2 and 7.1; Fig. C2-3). Pacific Lamprey were present at 2 of 2 (100%) index sites. At river km 1.2, the ratio of Pacific Lamprey was 67% and was much lower at river km 7.1 (10%). The highest estimated density in Type I habitat was at river km 1.2 (29.7 #/m^2). At river km 7.1, the estimated density in Type I habitat was much lower (11.3 #/m^2). Similar to Swauk Creek, river km 7.1 (the site with the lower density), had an average lamprey length larger than river km 1.2 (103 mm and 72 mm at river km 7.1 and 1.2, respectively). The maximum temperature observed was 25.9˚C at river km 7.1 in July, 2017. At the upper most site (river km 7.1), the sediment temperature was 8.9˚C cooler than the plot temperature (the highest temperature difference observed in the Yakima Subbasin during our larval lamprey surveys). At the lower most site (river km 1.2), the sediment temperature was 1.5˚C cooler than the plot temperature.

See **Appendix C2** for more information.

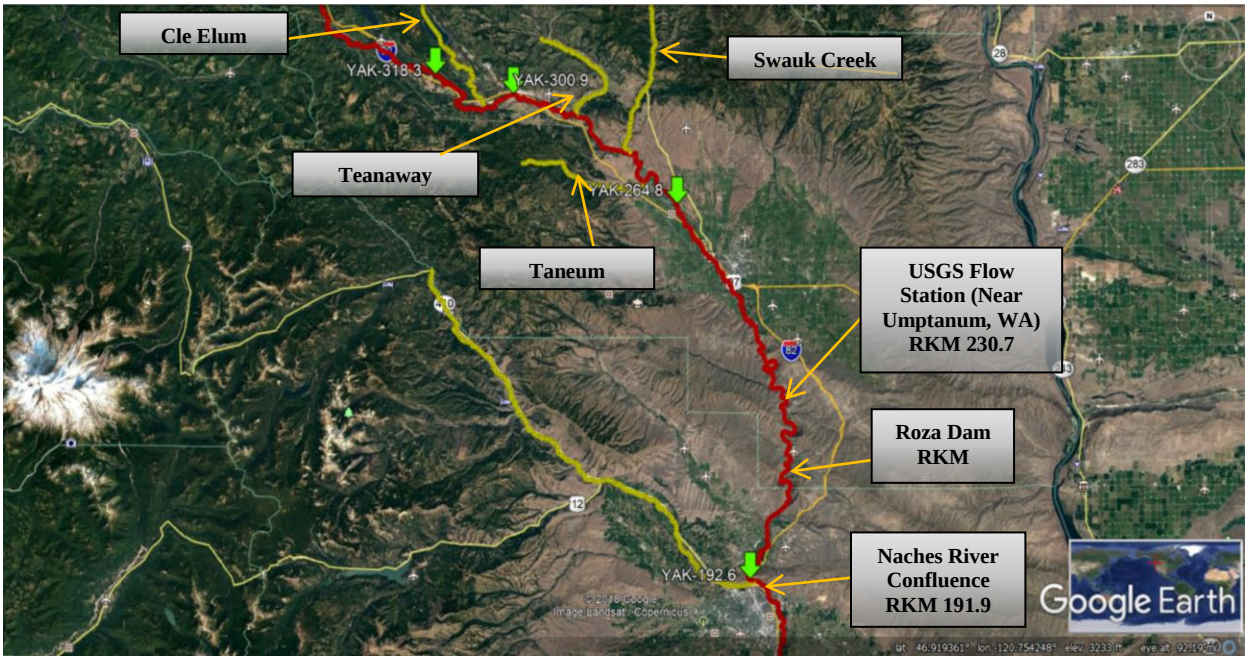


Figure C2-1. Overview of all surveyed sites in the upper mainstem of the Yakima River (red line) upstream of the Naches River confluence (river km 191.9) in September, 2017, displaying Yakama Nation surveyed index sites (green arrows) where electrofishing occurred. The location of Roza Dam (river km 210.5) is shown. The location of a USGS Flow Station (near Umptanum, WA; river km 230.7) is also labeled. Relevant tributary streams are also labeled accordingly.

Figure C2-2. Overview of surveyed index sites (green arrows) in Swauk Creek (red dotted line), confluence with the Yakima River at river km 278.8 in July, 2017. The Yakima River is highlighted by the yellow dotted line.

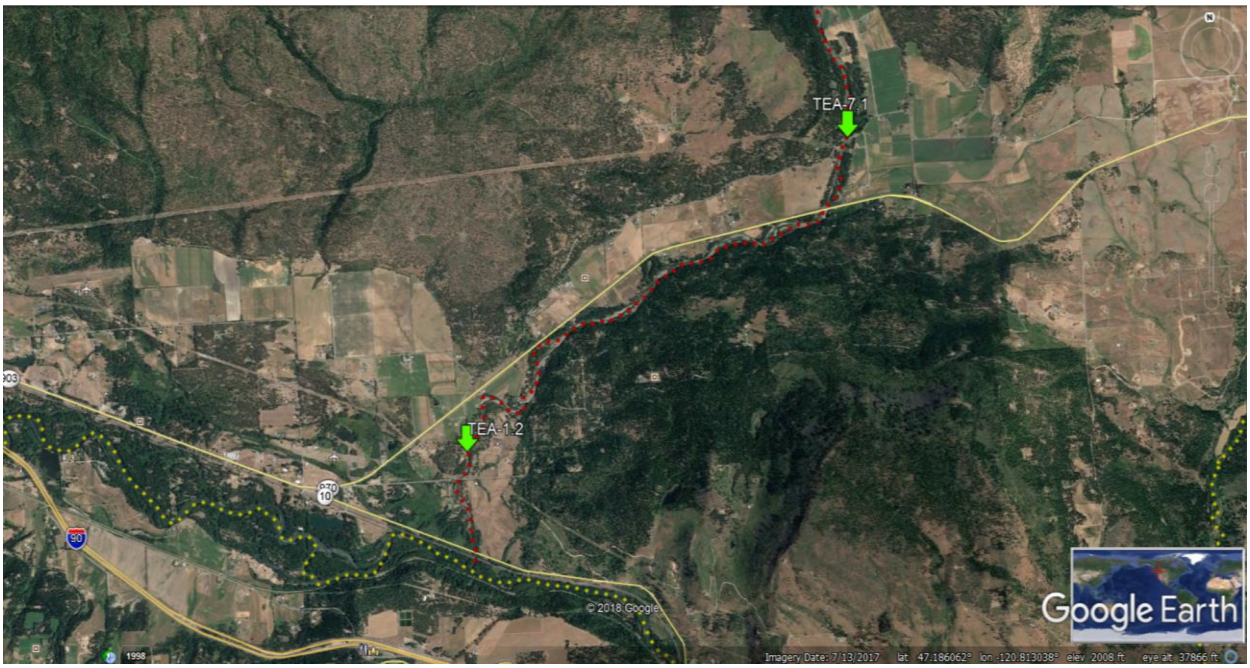


Figure C2-3. Overview of surveyed index sites (green arrows) in Swauk Creek (red dotted line), confluence with the Yakima River at river km 278.8 in July, 2017. The Yakima River is highlighted by the yellow dotted line.

Appendix C3 – Naches Subbasin Larval Lamprey Monitoring Report, 2017

Photo C3. Overview of a larval lamprey survey site on the Naches River (river km 29.1) where Pacific Lamprey were identified in August, 2017.

In this report, we summarize our 2017 findings from larval lamprey habitat surveys in the Naches Subbasin (Naches River confluence with the Yakima River at river km 191.9). Both index sites (long term status and trend monitoring sites) and exploratory sites (sites to supplement knowledge of distribution throughout the subbasin) were surveyed. Larval Pacific Lamprey (*Entosphenus tridentatus*) was the primary target of the surveys. Western Brook Lamprey (*Lampetra richardsoni*), a predominately resident species, were also documented when encountered.

Electrofishing surveys in 50 m reach sites were conducted in the Naches River and five tributary streams; Cowichee, Tieton, Oak (Tieton tributary), Rattlesnake, and Nile. Throughout our survey, young of year (YOY) lampreys were separated from larger, older lampreys (non-YOY lampreys) to evaluate specific rearing preferences of young of year lampreys. We also monitored the temperature underneath the sediment where the highest densities of lampreys were found (in relation to the open water temperature above the sediment) to assess temperature preferences of larval lampreys between sites and the temperature relationship patterns and trends throughout the subbasin.

A total of four index sites (river km 0.0, 14.2, 29.1 and 41.9) were surveyed in the mainstem Naches River in August, 2017 (Fig. C3-1). Overall, surveys were primarily conducted in side channel habitats, where Type I habitat was most abundant. Pacific Lamprey were found at 2 of 4 (50%) sites. Pacific Lamprey were not found at river km 41.9 (the upper most site), nor river km 0.0 (the lower most site). Two Pacific Lamprey macrophthalmia (smolt stage with eyes) were found at river km 29.1 (August, 2017). Type I habitat was limited at the mouth (9 m^2 at river km 0.0). Type I habitat was most abundant at river km 14.2 and 29.1 (120 m^2 and 100 m^2, respectively). The highest estimated densities of lampreys (excluding YOY lampreys) were at river km 41.9 and 14.2 (22.6 and 21.3 #/m^2, respectively). The site near the mouth (river km 0.0) had the lowest density (4.1 #/m^2) as well as available Type I habitat. YOY lampreys were found only near the mouth (river km 0.0) with an estimated density of 4.0 #/m^2, similar to the density of the larger (older) lampreys. The sediment temperature (measured at a maximum of 10 cm below the sediment where the most lampreys were found), was 4.0˚C cooler than the plot temperature (taken directly above the sediment) at river km 14.2 and 29.1. At the mouth (river km 0.0), and at the upper most site (river km 41.9), the sediment temperature was cooler than the plot temperature, but to a lesser degree (1.4 and 0.1˚C, respectively).

One index site (river km 1.6) was surveyed in Cowichee Creek (Fig. C3-2). No Pacific Lamprey was found in Cowichee Creek, despite the identification of 25 lampreys. The estimated density of lampreys (excluding YOY lampreys) was 17.1 #/m^2. The estimated density of YOY lampreys was higher (45.0 #/m^2). The sediment temperature was 1.4˚C cooler than the plot temperature where the most lampreys were found, excluding YOY lampreys. The location with the highest density of YOY lampreys was 2.2˚C cooler under the sediment, than the plot temperature.

One exploratory site (river km 5.0) was surveyed in the Tieton River (Fig. C3-3). A large area of Type I habitat was found in the Tieton River at river km 5.0 located in a side channel (300 m^2). Overall, however, Type I habitat appears to be limited throughout the Tieton River. The water temperature in the side channel was 18.1˚C. The sediment temperature was 2.3˚C cooler than the plot temperature. No larval lampreys were found in the Tieton River despite preferred habitat being present. In Oak Creek (tributary of the Tieton River), a total of three exploratory sites were surveyed to see if larval lampreys were present (Fig. C3-4). The lower reach was surveyed, where

a total of 3 m^2 of larval habitat was present, but no larval lampreys were found in Oak Creek. Aerial images taken in 2015, showed Oak Creek to have many small log/beaver dams. However, during our visit in 2017, we noticed most of these beaver/log jams were washed away. There was very limited larval lamprey habitat (Type I or Type II habitat) distributed throughout the surveyed sites in Oak Creek.

A total of four exploratory sites were surveyed in a side channel in Rattlesnake Creek (Fig. C3-5). This side channel serves the dual purpose of improving salmonid habitat and providing reliable irrigation water supply (originally built in the early 2000's). The sites were spatially distributed from the inlet (river km 2.1) to the outlet (river km 1.0). Bob Inouye (the landowner that monitors the side channel and the headgate for the irrigation water) was also present and shared his knowledge of the side channel and sites. A total of 28 m^2 of Type I (preferred) larval lamprey habitat was surveyed in total between the four sites. No larval lampreys were found in the surveyed side channel in Rattlesnake Creek. There was abundant fine sediment throughout the visited sites (approximately 100 m^2 of Type I habitat in total). The fine sediment was mostly composed of silt and fine sand.

In Nile Creek, one index site (river km 0.6) and one exploratory site (river km 6.8) were surveyed (Fig. C3-6). Lampreys were found at 1 of 2 (50%) sites (found only at river km 0.6). No Pacific Lamprey were found in Nile Creek, despite the identification of 29 lampreys. The density of lampreys (excluding YOY lampreys) was 11.0 #/m^2 at river km 0.6. The density of YOY lampreys was similar (13.3 #/m^2). In Nile Creek, Type I habitat was more abundant than Type II habitat (35 m^2 Type I habitat and 15 m^2 Type II habitat in total for both surveyed sites). At the upper most site (river km 6.8) the sediment temperature was 6.1˚C cooler than the plot temperature. At river km 0.6, the sediment temperature was 3.1˚C cooler than the plot temperature.

See **Appendix C3** for more information.

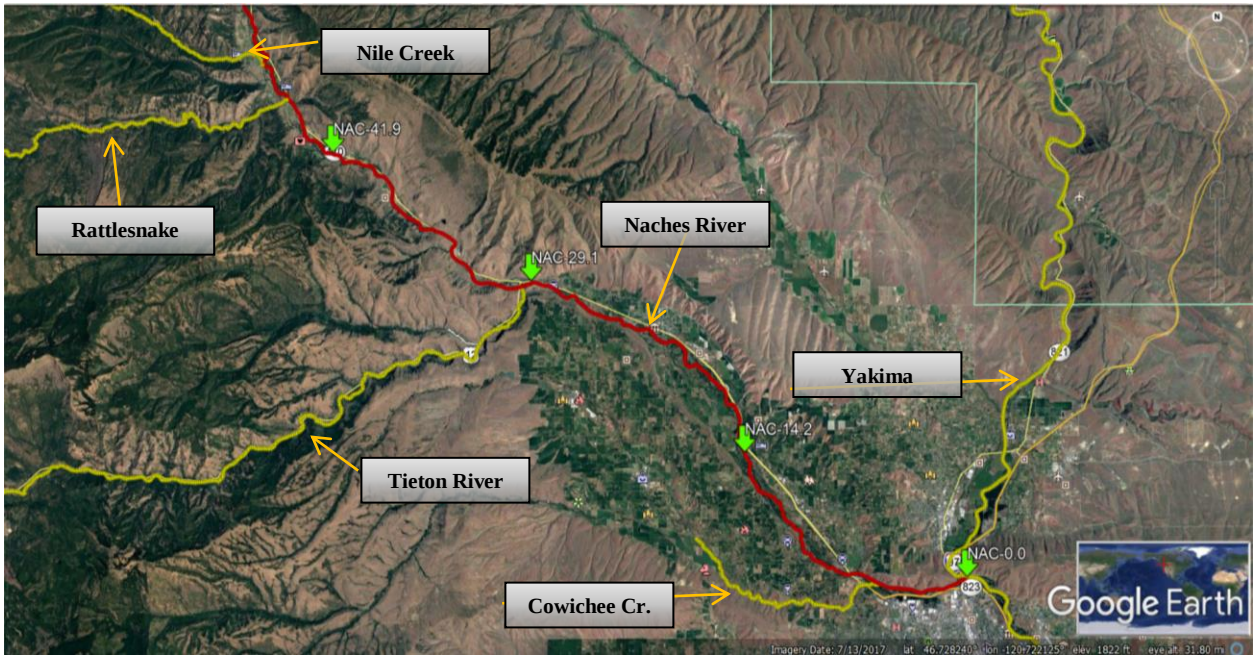


Figure C3-1. Overview of all surveyed sites in the Naches River (red line) in August, 2017, displaying Yakama Nation surveyed index sites (green arrows) where electrofishing occurred. Relevant tributary streams are also labeled accordingly.

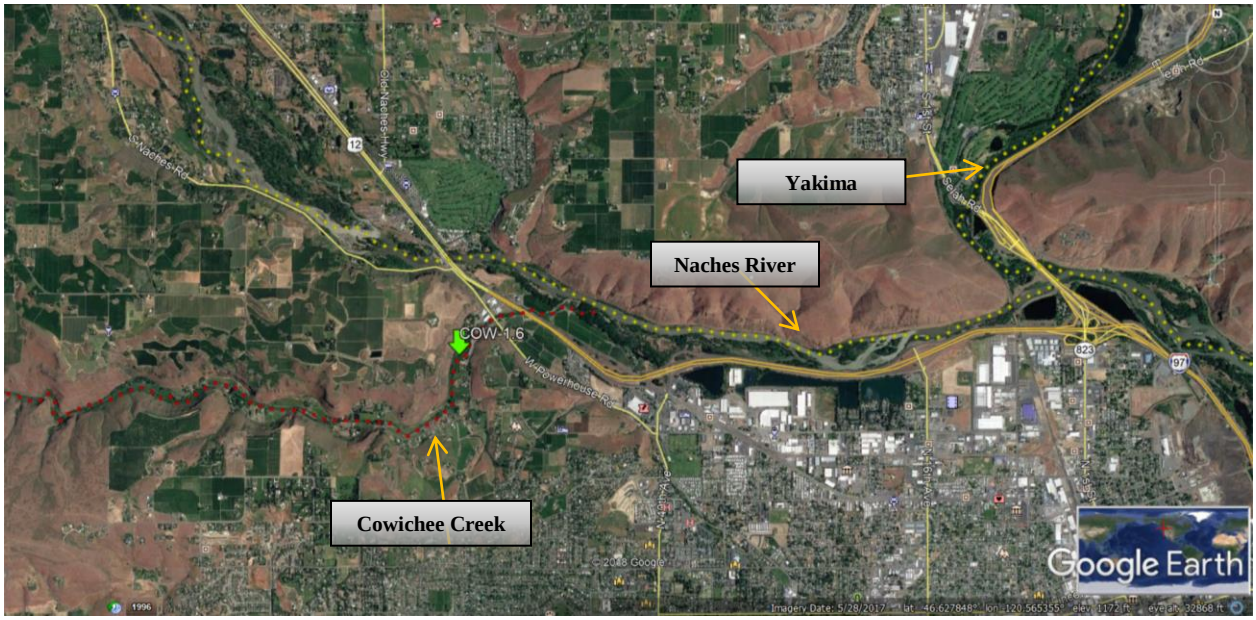


Figure C3-2. Overview of all surveyed sites in Cowichee Creek (red dotted line) in August, 2017, displaying the Yakama Nation surveyed index site (green arrow) where electrofishing occurred. The Naches River and Yakima River are labeled accordingly (also shown by the yellow dotted lines).

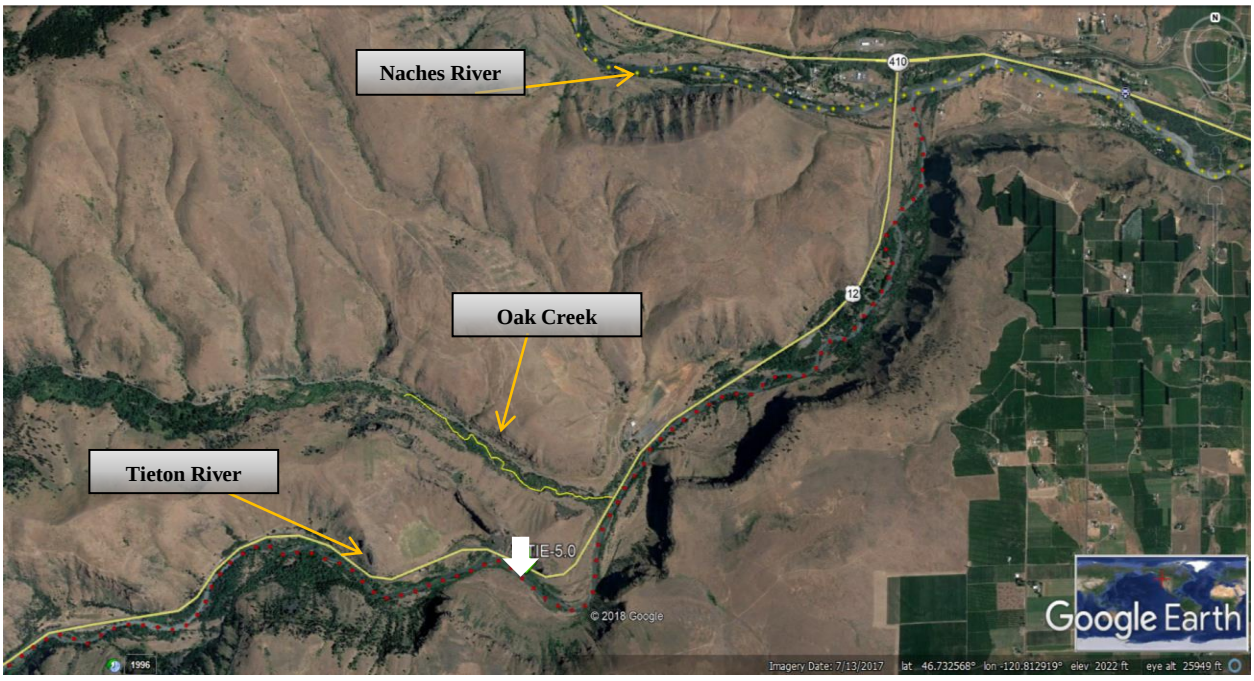


Figure C3-3. Overview of all surveyed sites in the Tieton River (red dotted line) August, 2017, displaying the exploratory site surveyed at river km 5.0 (white arrow) where electrofishing occurred. The Naches River (yellow dotted line), and the location of Oak Creek (a Tieton River tributary; solid yellow line) are also shown.

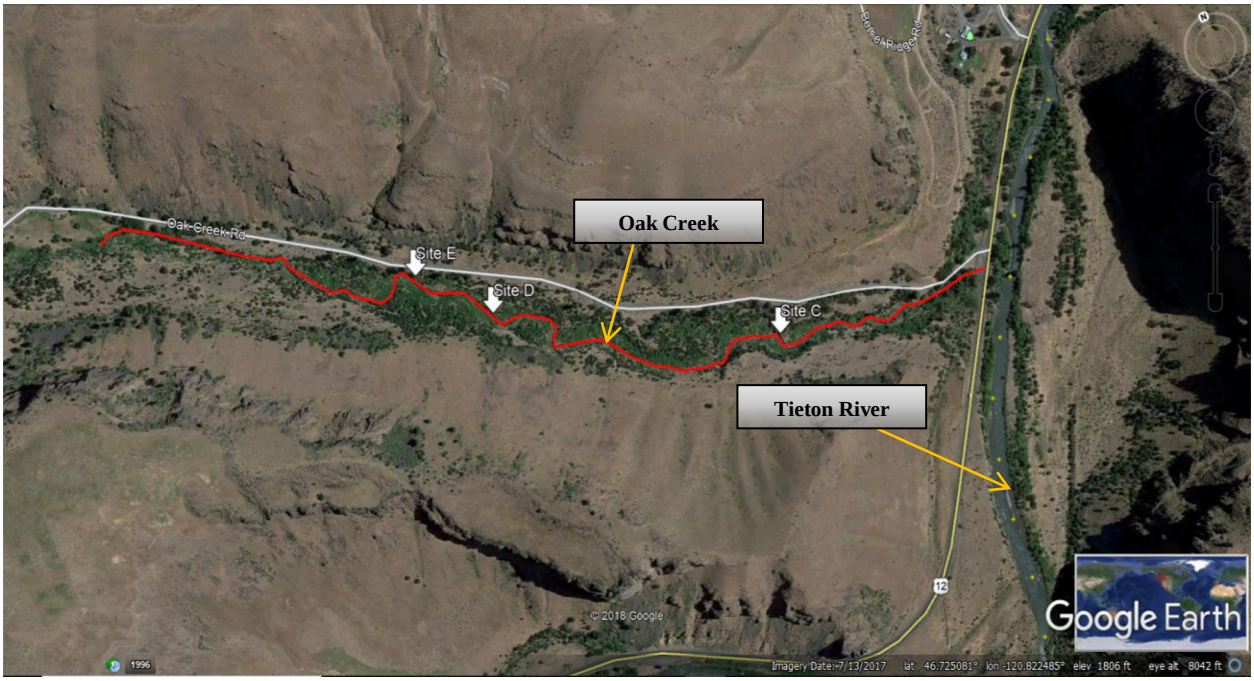


Figure C3-4. Overview of all surveyed sites Oak Creek (red line) in August, 2017, displaying the exploratory site surveyed (Site C, D and E; white arrows) where electrofishing occurred. The Tieton River (yellow dotted line) is shown.

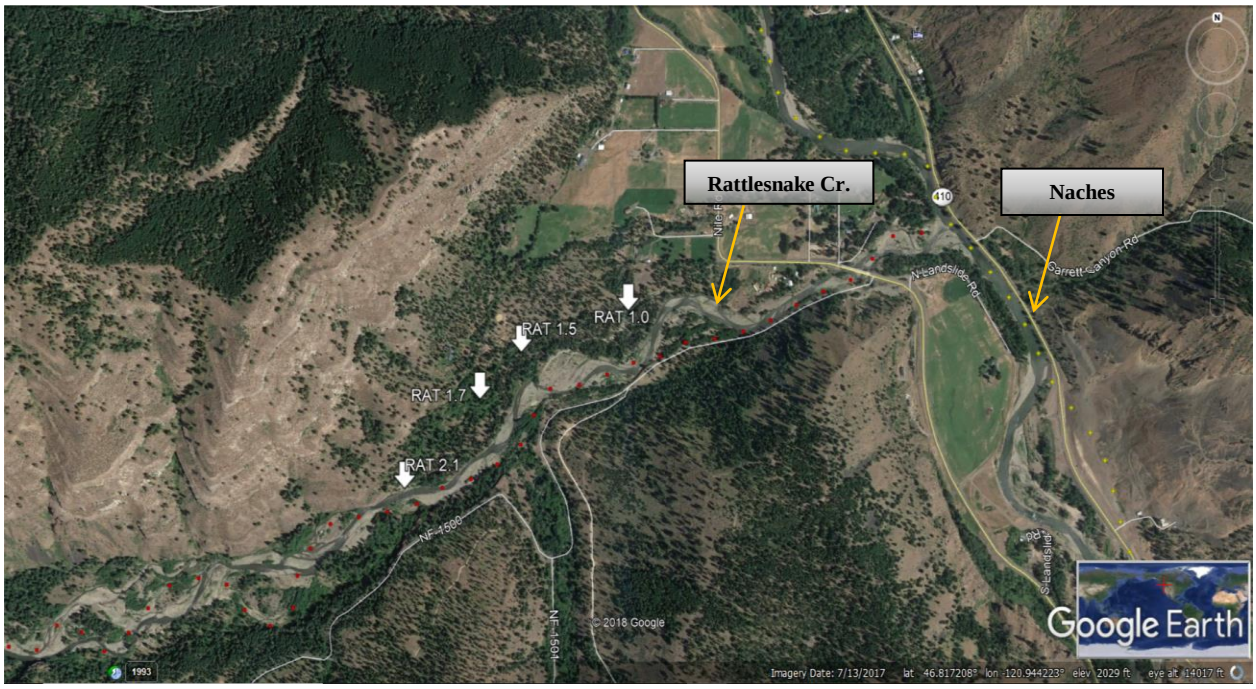


Figure C3-5. Overview of all surveyed sites Rattlesnake Creek (red dotted line) in August, 2017, displaying the exploratory sites surveyed (white arrows) where electrofishing occurred. The Naches River (yellow dotted line) is shown.

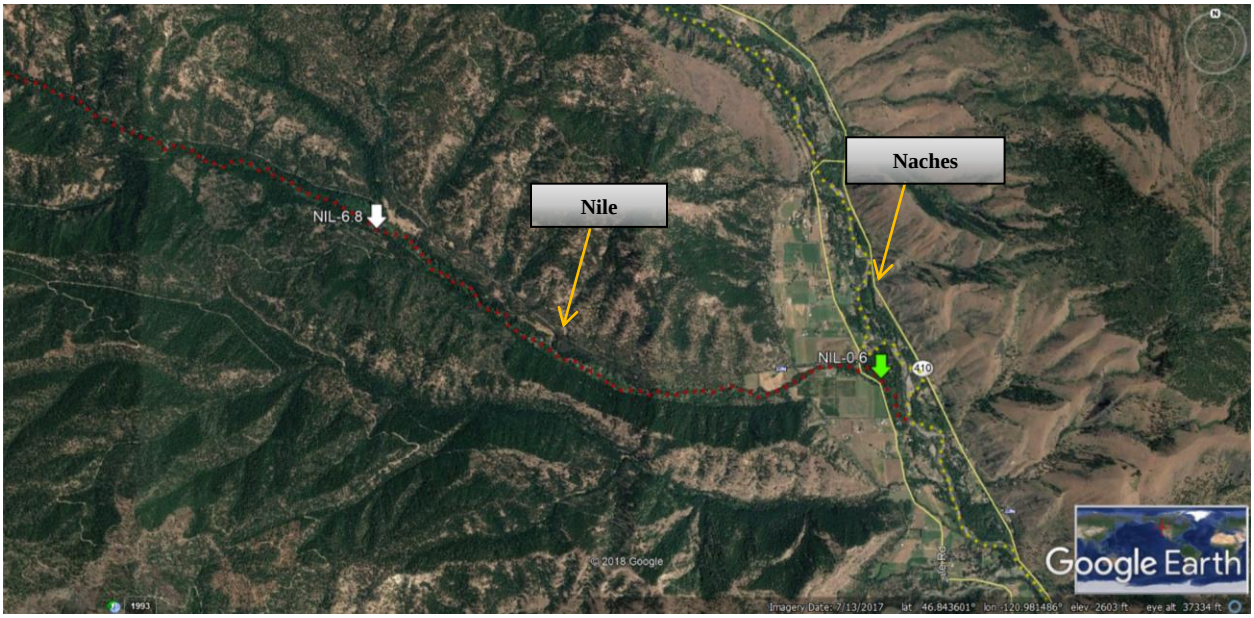


Figure C3-61. Overview of all surveyed sites Nile Creek (red dotted line) in August, 2017, displaying the index site (green arrow; river km 0.6) and exploratory site (river km 6.8) where electrofishing occurred. The Naches River (yellow dotted line) is shown.

Appendix C4 – Wenatchee Subbasin Larval Lamprey Monitoring Report, 2017

Photo C4. Overview of a larval lamprey survey site on the Wenatchee (river km 84.0, 3.3 river km downstream of Lake Wenatchee), where Pacific Lamprey were identified in August, 2017.

In this report, we summarize our 2017 findings from larval lamprey habitat surveys in the Wenatchee Subbasin. Both index sites (long term status and trend monitoring sites) and exploratory sites (sites to supplement knowledge of distribution throughout the subbasin) were surveyed. Larval Pacific Lamprey (*Entosphenus tridentatus*) was the primary target of the surveys. Western Brook Lamprey (*Lampetra richardsoni*), a predominately resident species, has not been documented specifically in the Wenatchee Subbasin through habitat surveys; however, genetic analysis from 2014 Dryden Diversion samples indicated that there were some *Lampetra* species present. Electrofishing surveys in 50 m reach sites were conducted in the lower Wenatchee River (downstream of Tumwater Dam, river km 49.6), upper Wenatchee River (upstream of Tumwater Dam) and two major tributary streams; Icicle Creek (tributary of the lower Wenatchee River) and Nason Creek (tributary of the upper Wenatchee River). Throughout our survey, young of year (YOY) lampreys were separated from larger, older lampreys (non-YOY lampreys) to evaluate specific rearing preferences of young of year lampreys. We also monitored the temperature underneath the sediment where the highest densities of lampreys were found (in relation to the open water temperature above the sediment) to assess temperature preferences of larval lampreys between sites and the temperature relationship patterns and trends throughout the subbasin.

In the lower Wenatchee River, two index sites (river km 8.8 and 40.3), and one exploratory site (river km 10.8) were surveyed in late August, 2017 (Fig. C4-1). Larval Pacific Lamprey were present at 3 of 3 (100%) sites. No Type I habitat was observed at river km 8.8 (the most downstream survey site). However, a total of 500 m^2 of Type II habitat was present at this site. The area of Type I habitat at river km 10.8 and 40.3 was similar (56 m^2 and 50 m^2, respectively). The estimated density (excluding YOY lampreys) at river km 10.8 and 40.3 was also similar (9.5 and 10.2 #/m^2, respectively). The estimated density of lampreys at river km 8.8 (14.3 #/m^2) in Type II habitat was higher than both of these index sites in Type I habitat. Young of year (YOY)

lampreys were present at 2 of 3 (66%) sites. YOY lampreys were absent from river km 10.8. The estimated density of YOY lampreys was higher at river km 40.3 (62.2 #/m^2), than river km 8.8 (15.6 #/m^2). The sediment temperature was cooler than the plot temperature at all surveyed sites (0.8 to 3.9˚C cooler).

In Icicle Creek, a total of two index sites (river km 4.0 and 5.3) were surveyed in late August, 2017 (Fig. C4-2). No lampreys were found in Icicle Creek. Type I habitat was abundant at both index sites (240 m^2 and 400 m^2 at river km 4.0 and 5.3, respectively). A total of 28 m^2 of Type I habitat was electrofished. Subsequently, adult Pacific Lamprey were released into Icicle Creek in late August 2017 to monitor spawning activity and migration patterns within the system.

In the upper mainstem of the Wenatchee River, adult Pacific Lamprey were first translocated upstream of the dam in spring of 2016 (Fig. C4-3). Adult lamprey were also released in the fall of 2016, and spring of 2017. In August of 2017, we surveyed a total of five index sites (river km 50.4, 56.8, 65.8, 74.1 and 84.0). Pacific Lamprey were found at 5 of 5 (100%) sites. Type I habitat was most abundant in Jolanda Lake (river km 50.4) immediately upstream of Tumwater Dam (1000 m^2). Type I habitat was also abundant at river km 56.8 and 84.0 (400 m^2 and 600 m^2, respectively). The estimated density of larval lampreys (excluding YOY lampreys) was highest at the two downstream index sites, river km 50.4 and 56.8 (5.2 #/m^2 and 2.9 #/m^2, respectively). The lowest estimated densities were documented at river km 65.8 and 84.0 (0.2 and 0.3 #/m^2, respectively). The density at river km 74.1 was higher than both river km 65.8 and 84.0 (2.0 #/m^2). Young of year (YOY) lampreys were found at river km 56.8 and 84.0 with a density of 4.0 #/m^2 and 8.8 #/m^2, respectively. YOY lampreys ranged from 13 to 26 mm in total length. The average length of larvae (excluding YOY lampreys) ranged from 60-79 mm. The maximum length observed was 108 mm (river km 56.8), a growth of approximately 100 mm between the spring of 2016 (assumed spawning time of the first released adults) and the summer of 2017 (approximately 13 months). At all sites (except for river km 50.4), the sediment temperature was cooler than the plot temperature (1.8 to 5.1˚C cooler).

A total of five index sites were surveyed in Nason Creek in August, 2017 (Fig. C4-4). The index sites are located at river km 2.7, 6.5, 12.8. 14.7 and 20.0. Young of year (YOY) lampreys were found at 1 of 5 (20%) sites. YOY lampreys were found in a side channel of Nason Creek at river km 6.5. These YOY lampreys are likely progeny from the 2016 (fall) or 2017 (spring) adult release (adult lampreys that would likely spawn in the spring/summer of 2017.

See **Appendix C4** for more information.

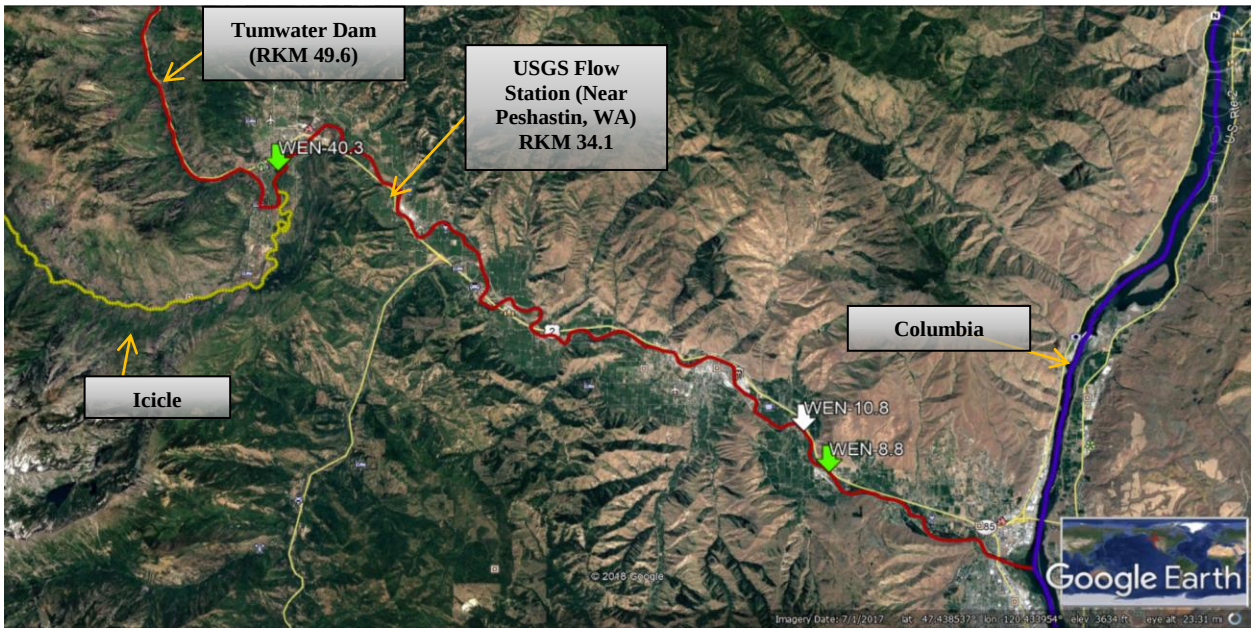


Figure C4-2. Overview of all surveyed sites in the lower mainstem of the Wenatchee River (red line) downstream of Tumwater Dam (river km 49.6) in August, 2017. Yakama Nation surveyed index sites (green arrows) and exploratory sites (white arrow) where electrofishing occurred are shown. The location of a USGS Flow Station (near Peshastin, WA; river km 34.1) is also labeled. Relevant streams are also labeled accordingly (Icicle Creek is the yellow line and the Columbia River is the blue line).

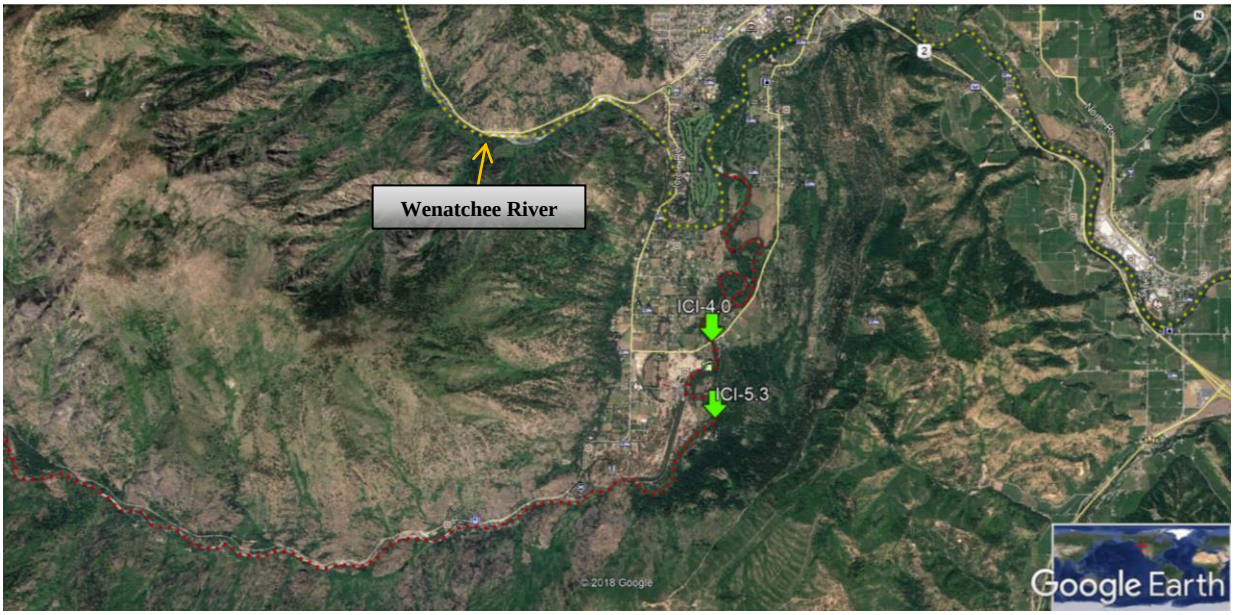


Figure C4-2. Overview of all surveyed sites in Icicle Creek (red dotted line) in August, 2017. The confluence of Icicle Creek with the Wenatchee River is at river km 41.0. Yakama Nation surveyed index sites (green arrows) where electrofishing occurred are shown. Relevant streams are also labeled accordingly (Wenatchee River is the yellow dotted line).

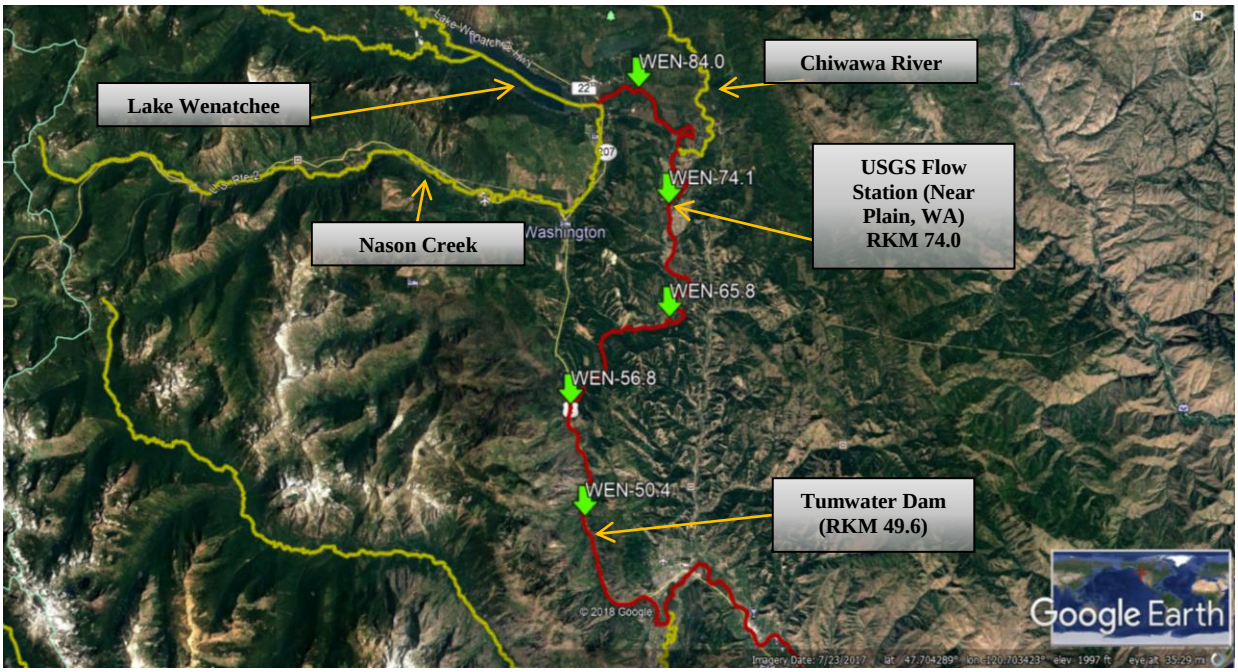


Figure C4-3. Overview of all surveyed sites in the upper mainstem of the Wenatchee River (red line) upstream of Tumwater Dam (river km 49.6) in August, 2017. Yakama Nation surveyed index sites (green arrows) where electrofishing occurred are shown. The location of a USGS Flow Station (near Plain, WA; river km 74.0) is also labeled. Relevant streams, and the location of Lake Wenatchee, are also labeled accordingly.

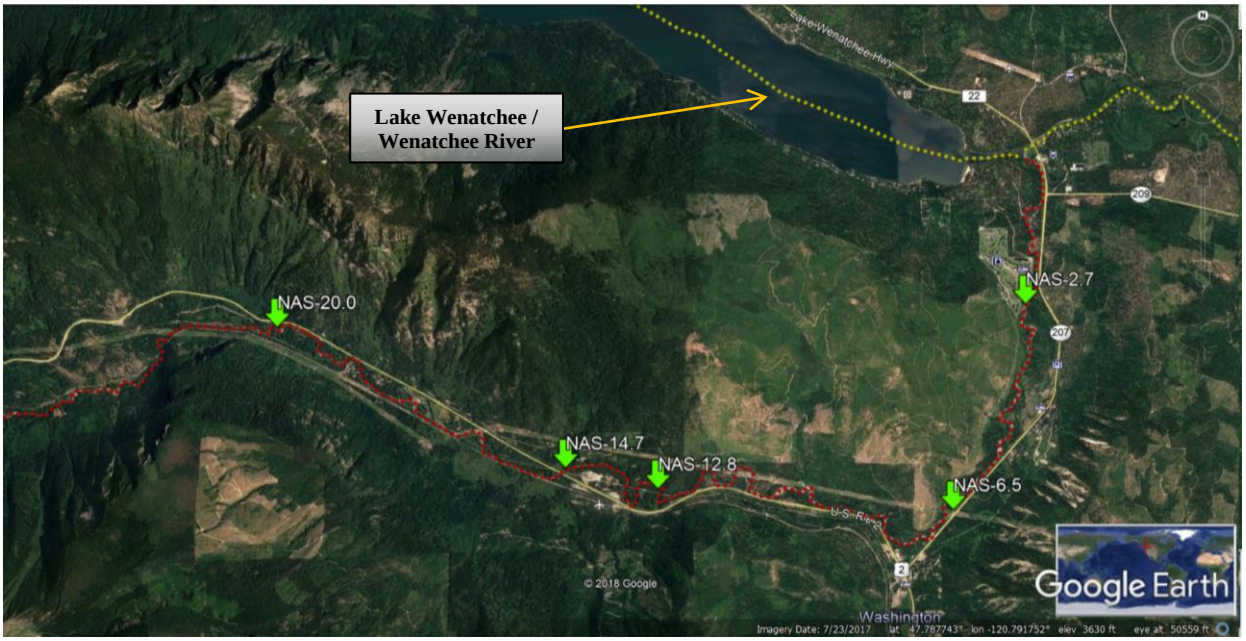


Figure C4-4. Overview of all surveyed sites in Nason Creek (red dotted line) in August, 2017. Yakama Nation surveyed index sites (green arrows) where electrofishing occurred are shown. The location of Lake Wenatchee and the Wenatchee River mainstem, are also labeled accordingly (highlighted by the yellow dotted line).

Appendix C5 – Methow Subbasin Larval Lamprey Monitoring Report, 2017

Photo C5. Overview of a larval lamprey survey site on the Methow River (river km 59.3) where Western Brook Lamprey were identified in September, 2017.

John Crandall (Methow Salmon Recovery) first established some long-term monitoring sites within the Methow and Chewuch rivers in 2008. Since then, Crandall has surveyed these sites each year. Since 2013, the Yakama Nation Pacific Lamprey Project has aided John Crandall with these surveys. The following is a summary of John Crandall's information he collected in 2017. Some of his survey methods are different from that of the Yakama Nation Fisheries, but the common information collected between Yakama Nation and John Crandall are presented in this report.

In the Methow River, a total of three index sites were surveyed by John Crandall and Yakama Nation Fisheries in August and September, 2017 (Fig. C5-1). The sites are located at river km 25.6, 59.3 and 74.7. Overall electrofishing densities were low, though highest at the most upstream survey site (0.5, 0.9 and 1.2 #/m^2 at river km 25.6, 59.3 and 74.7, respectively). The average length decreased as river km increased (64 mm, 45 mm, 32 mm, at river km 25.6, 59.3 and 74.7, respectively). No young of year (YOY) larvae were found at the surveyed sites. Western Brook Lamprey were morphologically identified at river km 59.3, although these samples are awaiting genetic confirmation. The warmest water temperature measured was at river km 25.6 (19.2˚C). At river km 25.6, the sediment temperature (measured a maximum of 10 cm below the sediment) was 6.3˚C cooler than the plot temperature (measured directly above the sediment). At all of the surveyed sites, the sediment temperature was cooler than the plot temperature (1.7 to 1.9˚C cooler).

In the Chewuch River, a total of five index sites were surveyed by John Crandall and Yakama Nation Fisheries in August and September, 2017 (Fig. C5-2). The sites are located at river km 0.8, 16.1, 23.9, 28.6 and 49.6. Lamprey were present at 3 of 5 (60%) surveyed sites. No lamprey were found upstream of river km 23.9. Electrofishing densities increased slightly from downstream to upstream sites (0.8, 2.6, and 3.5 #/m^2 at river km 0.8, 16.1 and 23.9, respectively). Young of year

(YOY) larvae were only found at river km 16.1. The warmest temperature measured in the Chewuch River was 19.8˚C at river km 0.8. The sediment temperature was lower than the plot temperature at all surveyed sites in August, 2017. The differences in temperature under the sediment compared to the plot increased as river km increased (1.9 C, 2.7 and 4.7˚C cooler, at river km 0.8, 16.1 and 49.5, respectively).

See **Appendix C5** for more information.

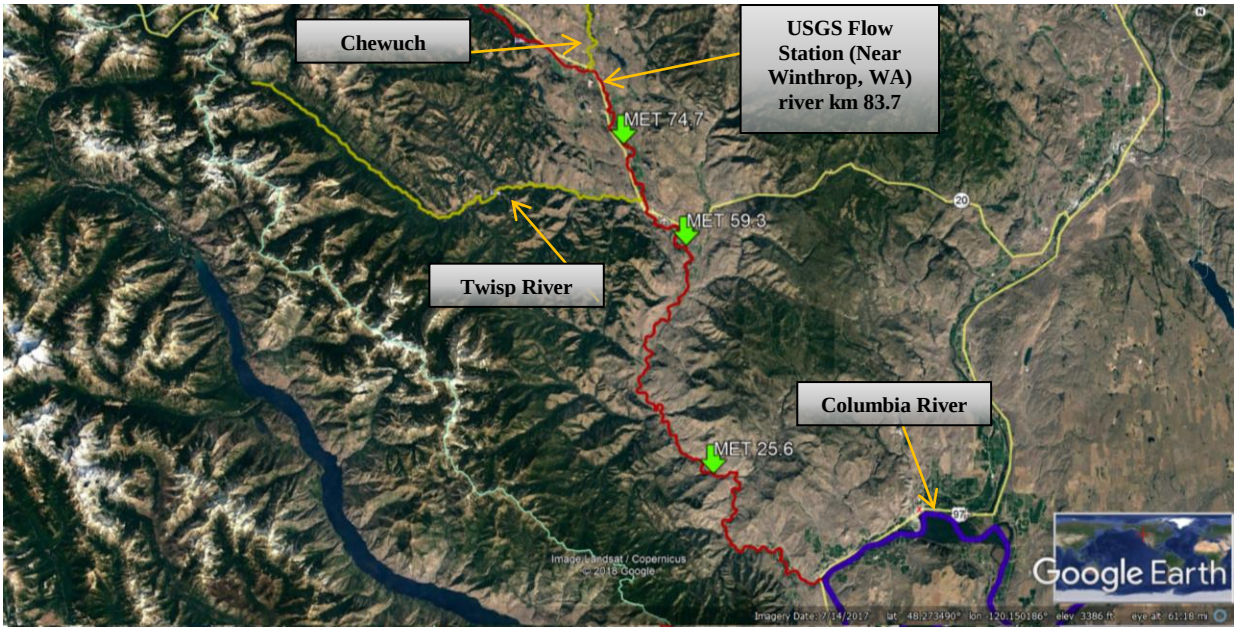


Figure C5-1. Overview of all surveyed sites in the Methow River (red line) in 2017, displaying surveyed index sites (green arrows) where electrofishing occurred. The location of a USGS Flow Station (near Winthrop, WA; river km 83.7) is also labeled. Tributaries (yellow lines) and Columbia River (blue line) are labeled accordingly.

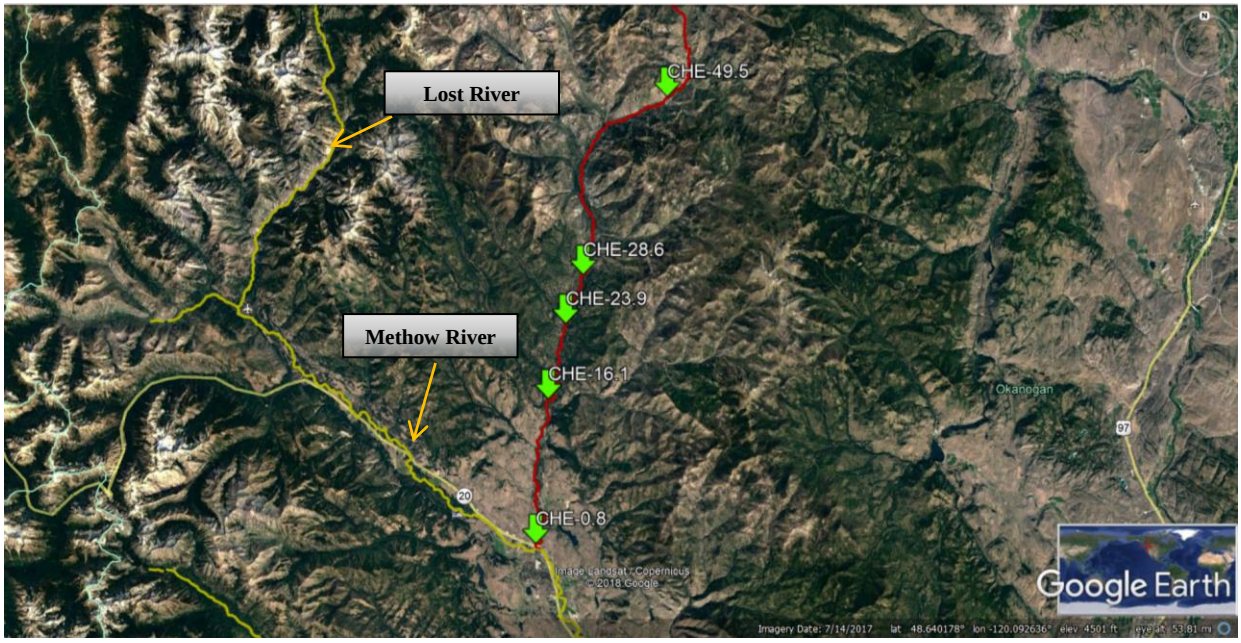


Figure C5-2. Overview of all surveyed sites in the Chewuch River (red line) in August and September, 2017, displaying surveyed index sites (green arrows) where electrofishing occurred. Nearby streams are labeled accordingly (yellow lines).

Appendix C6 – Klickitat Subbasin Larval Lamprey Monitoring Report, 2017

Photo C6. Overview of a larval lamprey survey site on the Klickitat River (river km 69.5) upstream of the Klickitat Hatchery Dam, where Pacific Lamprey were identified in October, 2017.

Since 2009, the Yakama Nation Pacific Lamprey Project (YNPLP) has conducted larval lamprey electrofishing surveys to document the distribution and relative abundance of Pacific Lamprey (*Entosphenus tridentatus*) within the Klickitat Subbasin. In this report, we summarize our 2017 findings from larval lamprey habitat surveys in the Klickitat Subbasin. Both index sites (long term status and trend monitoring sites) and exploratory sites (sites to supplement knowledge of distribution throughout the subbasin) were surveyed. Larval Pacific Lamprey (*Entosphenus tridentatus*) was the primary target of the surveys. Western Brook Lamprey (*Lampetra*

richardsoni), a predominately resident species, was also documented when encountered. Electrofishing surveys in 50 m reach sites were conducted in the mainstem Klicitat River and Little Klickitat River (a major tributary of the Klickitat River, confluence at river km 33.0). Throughout our survey, young of year (YOY) lampreys were separated from larger, older lampreys (non-YOY lampreys) to evaluate specific rearing preferences of young of year lampreys. We also monitored the temperature underneath the sediment where the highest densities of lampreys were found (in relation to the open water temperature above the sediment) to assess temperature preferences of larval lampreys between sites and the temperature relationship patterns and trends throughout the subbasin.

In the Klickitat River, a total of six sites were surveyed in September, 2017 (Fig. C6-1). Surveyed sites were spatially distributed from river km 1.9 to river km 99.8, consisting of five index sites (long-term status and trend sites) and one exploratory site (additional site to monitor distribution). Type I habitat was most abundant at river km 1.9 and river km 26.5 (105 m^2 and 210 m^2, respectively). Type I larval habitat was less than 10 m^2 in all sites surveyed upstream of river km 26.5. The maximum estimated lamprey density in Type I habitat for lampreys older than one year was 128.1 (#/m^2) at river km 29.2. Similarly, the maximum estimated lamprey density in Type I habitat for YOY lampreys was 203.3 (#/m^2), at the same river km site (river km 29.2). Pacific Lamprey were found at 4 of 6 (66%) surveyed sites. At the lower most site (river km 1.9), only Pacific Lamprey were found (100% of 77 identified lampreys). The ratio of Pacific Lamprey decreased with an increase in river kilometer (100%, 93%, 66%, and 64% at river km 1.9, 26.5, 52.5 and 69.4, respectively). The most upstream location where Pacific Lamprey were found was river km 69.4, located immediately upstream of the weir dam at the Klickitat Fish Hatchery, indicating that some Pacific Lamprey are able to navigate over the weir dam (although overall adult passage efficiency is still unknown). Only Western Brook Lamprey was found at river km 82.7, indicating that the upper distribution of Pacific Lamprey lies between river km 69.4 and 82.7. Out of all surveyed sites, the sediment was observed to be a maximum of 1.5˚C warmer than the plot temperature (at river km 1.9) and a maximum of 1.1˚C cooler than the plot temperature at river km 26.5.

One index site was also surveyed in the Little Klickitat River at river km 0.5 (Fig. C6-2). No Type I (preferred) larval lamprey habitat was present at the surveyed site. Type I habitat appears to be very limited in the lower reaches of the Little Klickitat River. Pacific Lamprey were found at the one index site surveyed in the Little Klickitat River (83% of 46 identified). A total of six eyed Pacific Lamprey (macrophthalmia) were found in the Little Klickitat River during the September survey; none were found from surveys in the mainstem Klickitat River.

See **Appendix C6** for more information.

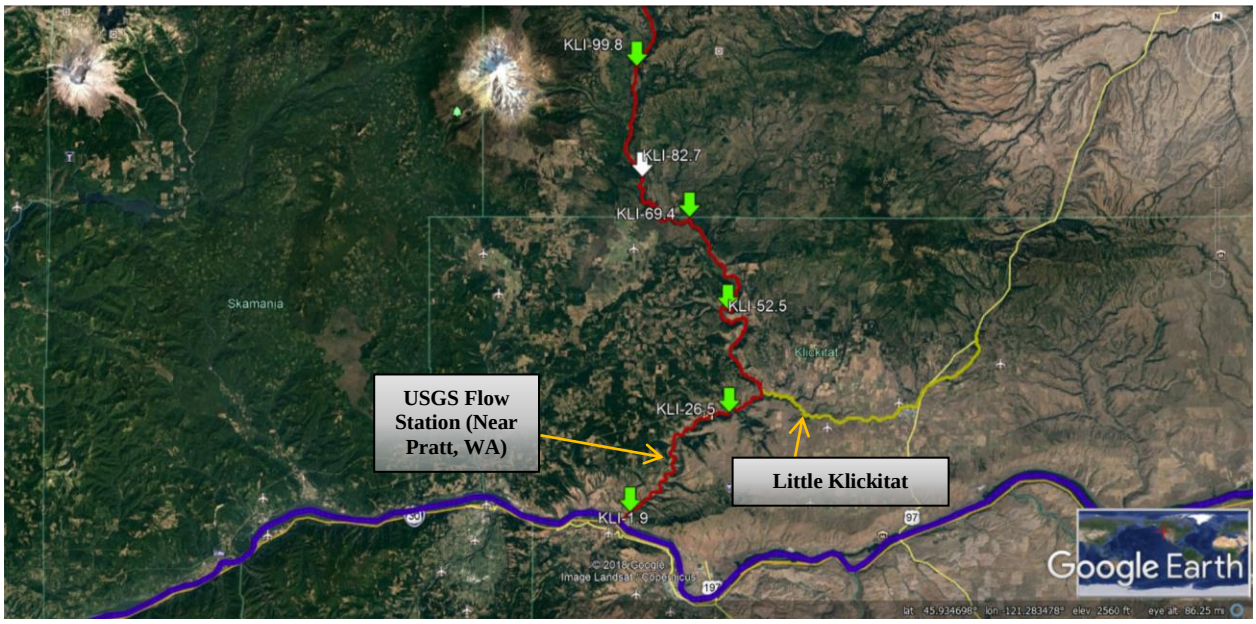


Figure C6-3. Overview of all surveyed sites in the Klickitat River (red line) in September, 2017, displaying Yakama Nation surveyed index sites (green arrows) and exploratory sites (white arrows) where electrofishing occurred. The location of a USGS Flow Station (near Pratt, WA; river km 12.0) is also labeled.

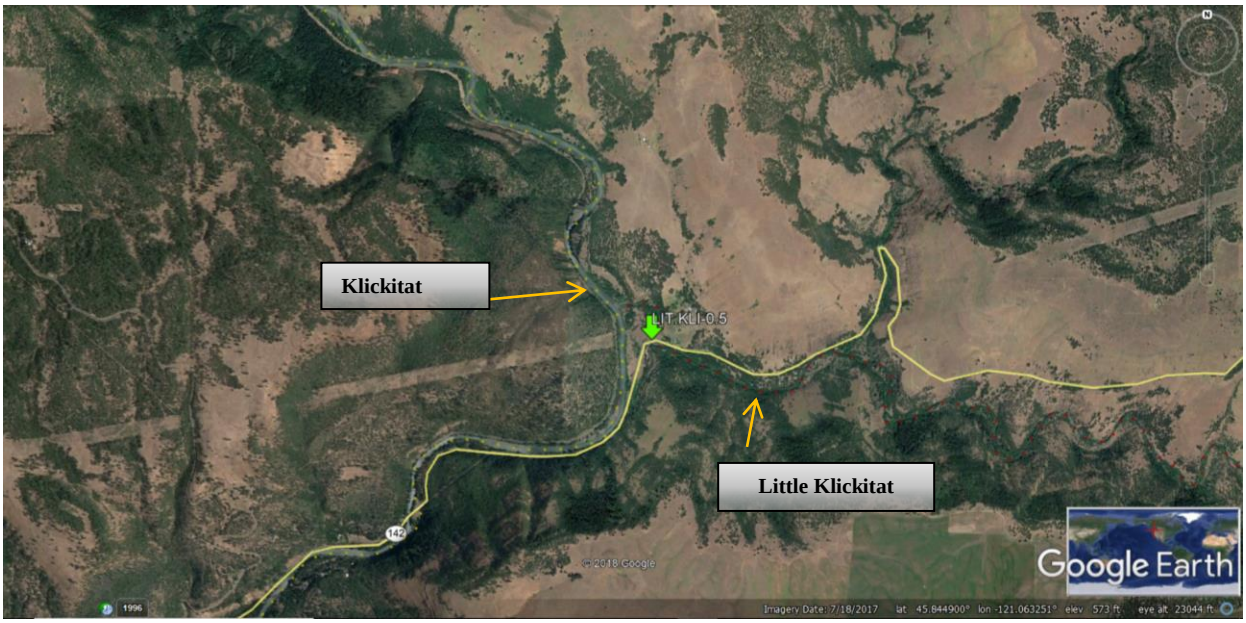


Figure C6-2. Overview of all surveyed site (river km 0.5) in the Little Klickitat River (red line) in September, 2017, displaying Yakama Nation surveyed index sites (green arrow).

Appendix C7 – Distribution and Occupancy of Pacific Lamprey in Six Major Columbia River Subbasins within the Yakama Nation Ceded Lands: Summary from 2009-2017 Surveys

Photo C7. Overview of a larval lamprey survey site on the Wenatchee (river km 84.0, 3.3 river km downstream of Lake Wenatchee), where Pacific Lamprey were identified in August, 2017.

This report covers the most up-to-date information related to Pacific Lamprey (*Entosphenus tridentatus*) and Western Brook Lamprey (*Lampetra richardsoni*) distribution and site occupancy within the White Salmon, Klickitat, Yakima, Wenatchee, Entiat, and Methow subbasins. Information was compiled from Yakama Nation Fisheries larval lamprey electrofishing surveys between 2009 and 2017, as well as available data from partnering agencies. In the following report, we refer to all Lampetra spp. as Western Brook Lamprey for simplification purposes.

White Salmon Subbasin – In 2016 (the most recent survey year), no Pacific Lamprey (0%) were found in the White Salmon River between river km 0.0 and 41.5. Genetic samples were collected (and are currently awaiting analysis) from lampreys too small to identify (less than 50 mm in total length).

Klickitat Subbasin – In 2017, Pacific Lamprey were captured at 4 of 4 (100%) sites in the Klickitat River within the known distribution (river km 1.9-69.4). Larval Pacific Lamprey were confirmed immediately upstream of the weir dam at the Klickitat Fish Hatchery (river km 69.4). This finding confirms that some adult Pacific Lamprey are able to pass the weir dam (albeit unknown passage efficiency).

Yakima Subbasin – In 2017, Pacific Lamprey were found at river km 13.0 (in Richland, WA); 60.5 river km downstream of the previous known lower distribution (river km 73.5) in the Lower Yakima River. In 2016 and 2017, Pacific Lamprey occupancy in the Lower Yakima River was 75% (present at 6 of 8 sites) (Fig. C7-1). Adult translocation began in all three lower Yakima River tributaries (Satus Creek, Toppenish Creek and Ahtanum Creek) in 2013. As a result, between 2013 and 2017, Pacific Lamprey occupancy in these streams increased extensively, with 13 of 18

(72.2%) sites in Satus Creek (river km 12.9-43.8), 4 of 4 (100%) sites in Toppenish Creek (river km 43.5-73.0), and 14 of 19 (73.4%) sites in Ahtanum Creek (river km 0.9-34.9) occupied by Pacific Lamprey within the updated and extended Pacific Lamprey distribution (Fig. C7-2). Adult Pacific Lamprey were translocated upstream of Roza Dam by YN in the spring of 2015. In the Upper Yakima River, between 2016 and 2017, 8 of 18 (44.4%) sites within the updated Pacific Lamprey distribution (river km 191.8-318.3) had Pacific Lamprey. In the Teanaway River, Pacific Lamprey were found at 4 of 7 (57.1%) sites surveyed between 2016 and 2017 within the updated Pacific Lamprey distribution (river km 0.3-7.1).

Wenatchee Subbasin – Between 2015 and 2017, Pacific Lamprey were present at 10 of 10 (100%) sites downstream of Tumwater Dam (river km 49.6). No larval lampreys have been found in Icicle Creek. Pacific Lamprey adult translocation in Wenatchee Subbasin, including upstream of Tumwater Dam, began in spring of 2016. In the summer of 2016, larval Pacific Lamprey were found at only 1 of 6 (17%) sites upstream of Tumwater Dam (at river km 56.2 near the Highway 2 Bridge; surveyed sites ranged from river km 50.4-84.0). Then, in 2017, Pacific Lamprey were found at 5 of 5 (100%) sites upstream of the dam, stretching from Jolanda Lake (river km 50.4) upstream to river km 84.0 (a site 3.3 river km downstream of Lake Wenatchee) (Fig. C7-3). In 2017, young of year (< 30 mm in length) larval lampreys were found at river km 6.5 in Nason Creek. The captured lampreys were too small to identify to species (less than 50 mm in total length), but they are likely progeny from adult Pacific Lamprey released into the upper Wenatchee River (currently awaiting genetic confirmation).

Entitat Subbasin – In 2016, Pacific Lamprey were confirmed at 4 of 4 (100%) sites within the known Pacific Lamprey distribution **(**river km 1.2-46.4). In 2016, Yakama Nation morphologically and genetically confirmed the presence of Western Brook Lamprey in the Entiat River at river km 46.5 (3.9 river km downstream of Box Canyon).

Methow Subbasin – Adult translocation began in the fall of 2015 in the lower Methow Subbasin In 2016 (first year for YOY offspring from translocation to show up), Pacific Lamprey occupancy did not increase, with Pacific Lamprey found at only 2 of 6 (33.3%) sites. However, in 2017, Pacific Lamprey were found at 3 of 3 (100%) sites (Fig. C7-4). In 2017, Western Brook Lamprey was morphologically identified at river km 59.3 (shortly upstream of the confluence of Beaver Creek). These samples are awaiting genetic confirmation. In 2016, YN confirmed (through genetic analysis) the presence of Western Brook Lamprey in the Chewuch River at river km 16.1. In the Chewuch River in 2016 and 2017, Pacific Lamprey were found at 7 of 10 (70.0%) sites. No Pacific Lamprey have been found in the Twisp River or the upper Methow River to date.

See **Appendix C7** for more information.

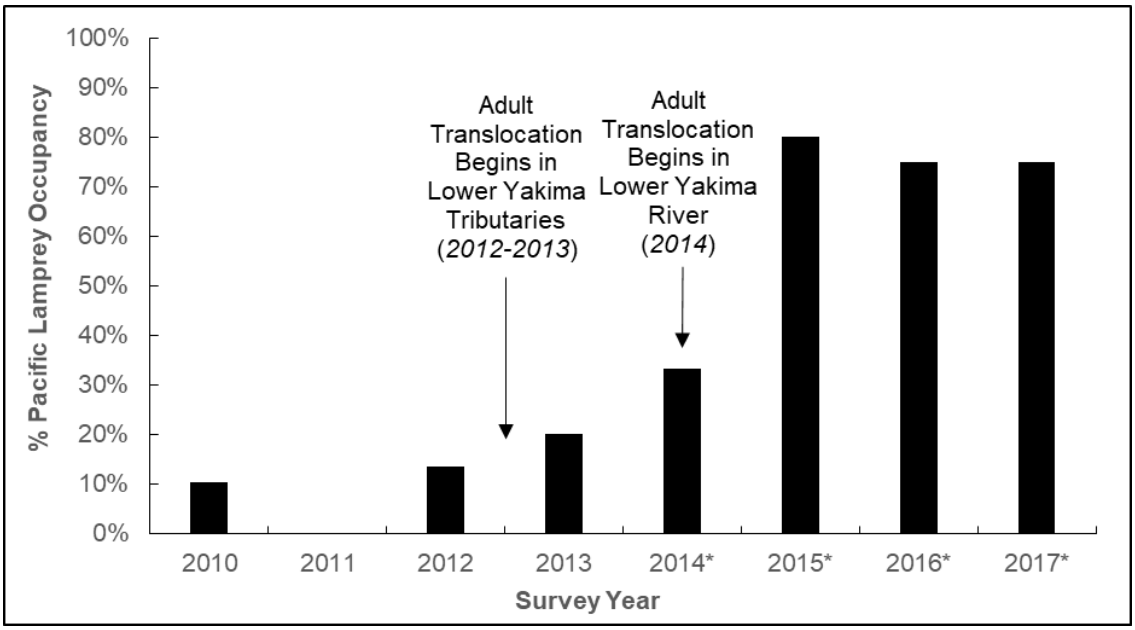


Figure C7-1. Pacific Lamprey site occupancy in the Lower Yakima River (downstream of the Naches River confluence, river km 191.9). "Percent [%] Pacific Lamprey Occupancy" was calculated by dividing the number of sites occupied by Pacific Lamprey by the number of sites surveyed within the Pacific Lamprey distribution. An asterisk (*) next to a survey year indicates a year where adult Pacific Lamprey were actively translocated into the river.

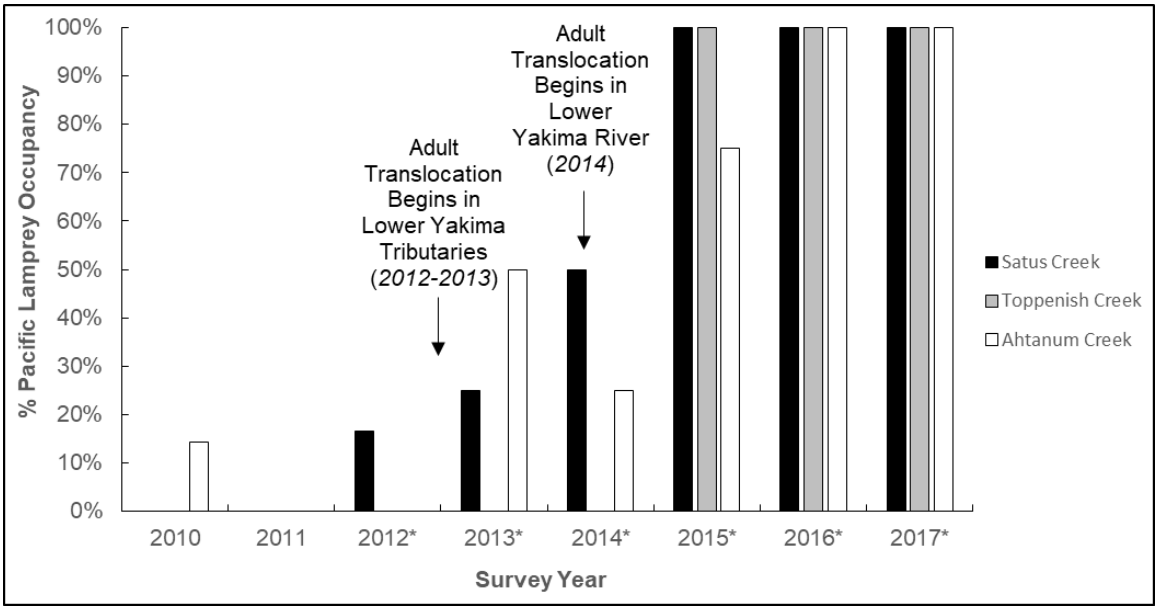


Figure C7-2. Pacific Lamprey site occupancy in Lower Yakima River tributaries (Satus, Toppenish and Ahtanum streams). "Percent [%] Pacific Lamprey Occupancy" was calculated by dividing the number of sites occupied by Pacific Lamprey by the number of sites surveyed within the Pacific Lamprey distribution. An asterisk (*) next to a survey year indicates a year where adult Pacific Lamprey were actively translocated into the respective streams. Adult Pacific Lamprey were translocated into Satus Creek in 2012 and into Toppenish and Ahtanum creeks starting in 2013.

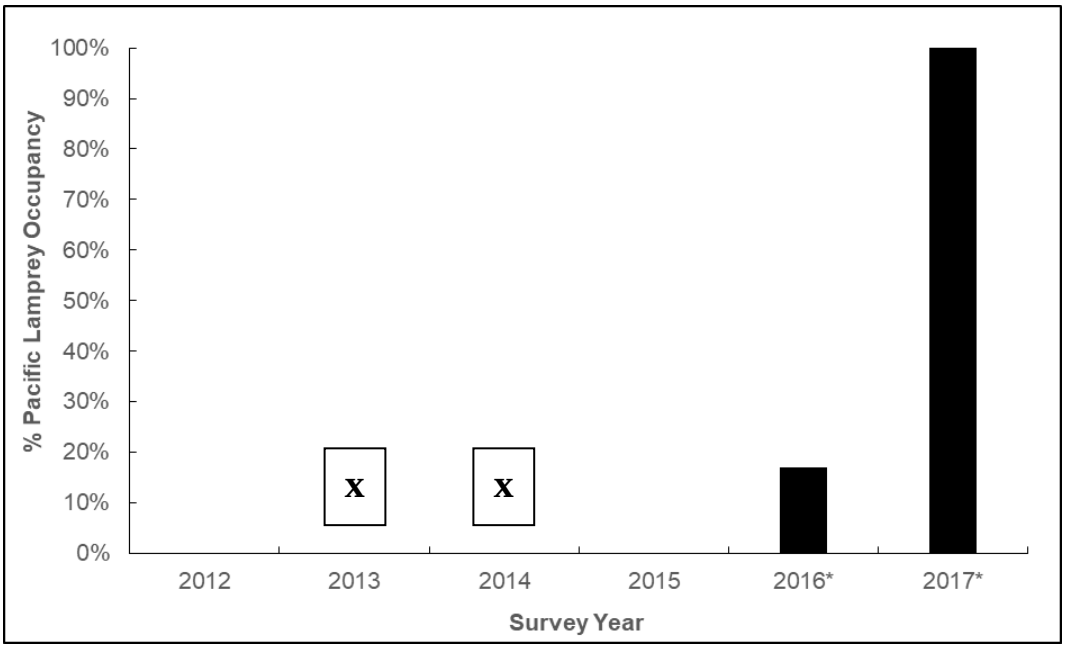


Figure C7-3. Pacific Lamprey site occupancy in the Upper Wenatchee River (upstream of Tumwater Dam, river km 49.6). "Percent [%] Pacific Lamprey Occupancy" was calculated by dividing the number of sites occupied by Pacific Lamprey by the number of sites surveyed within the Pacific Lamprey distribution. An asterisk (*) next to a survey year indicates a year where adult Pacific Lamprey were actively translocated into the river. See Table 9 for more details. No electrofishing surveys were conducted in 2013 and 2014 (indicated by the "x").

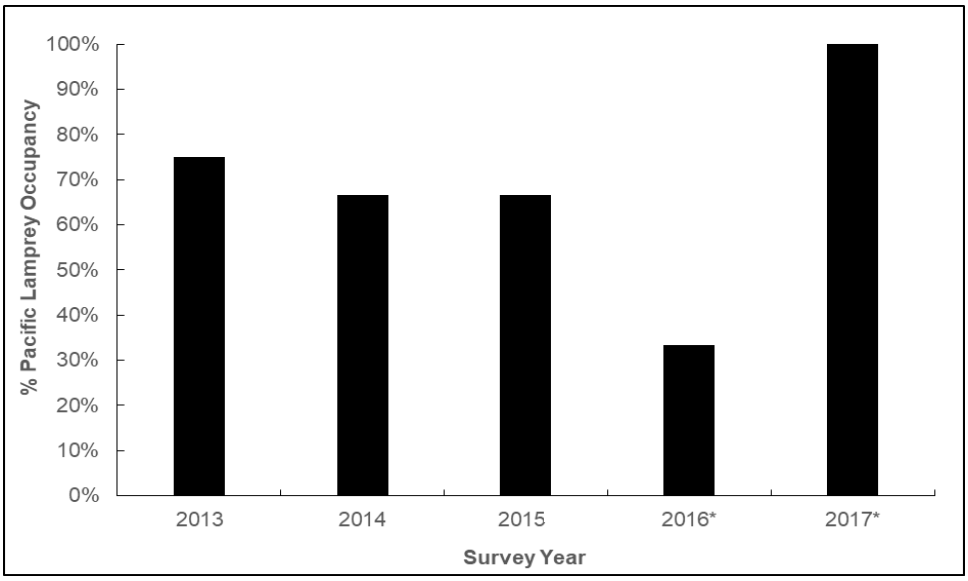


Figure C7-4. Pacific Lamprey site occupancy in the Lower Methow River (downstream of the Chewuch River confluence, river km 84.1). "Percent [%] Pacific Lamprey Occupancy" was calculated by dividing the number of sites occupied by Pacific Lamprey by the number of sites surveyed within the Pacific Lamprey distribution. An asterisk (*) next to a survey year indicates a year where adult Pacific Lamprey were actively translocated into the river. See Table 13 for more details.

D. Work Element 28 – Lamprey Survey and Salvage in Irrigation Diversions

Work Element Associated Appendix Report:
Appendix D1 – Summary Assessment of Larval/Juvenile Lamprey Entrainment in Irrigation Diversions within the Yakama Basin, 2017

Photo D1. A Pacific Lamprey macrophthalmia (eyed smolt) trapped on a dewatered bank at Wapatox Diversion, Naches River on November 1, 2017.

A total of 14 irrigation diversions were surveyed within the 2017 irrigation season in the Yakima Subbasin; six in Yakima River, one in Toppenish Creek, five in Ahtanum Creek, two in Naches River (Table D1-1). Irrigation diversions often provide preferred refuge habitat to hundreds of thousands of larval/juvenile lampreys moving downstream, until dewatering takes place in summer or fall season. When the diversions are dewatered after the irrigation season, the entrained lampreys are left to desiccate in or on top of dried fine sediment unless salvage occurs in a timely fashion. Larval lamprey salvage surveys were conducted with the following objectives; 1) efficiently salvage as many larval/juvenile lampreys as possible and return them to their respective stream downstream of the diversion, 2) check dried banks closely for desiccated lampreys, and 3) understand lamprey distribution and densities upstream and downstream of the fish screens. In addition, we evaluated the ratio of entrained Pacific Lamprey versus Western Brook Lamprey within each of the surveyed irrigation diversion facilities. Genetic samples were opportunistically collected from Pacific Lamprey with the primary objective of monitoring the success of adult Pacific Lamprey translocation projects and from Western Brook Lamprey with the primary objective of evaluating the genetic diversity and its relationship to morphological traits.

In total, 8,234 larval/juvenile lampreys were captured and returned to the following respective rivers/streams from electrofishing surveys (Table D1-1); Yakima (n=6,291), Ahtanum (n=1,719), Naches (n=94), and Toppenish (n=65). Captured lampreys constituted only 50.5% of all observed lampreys (i.e. approximately 49.5% of lampreys were missed). More lampreys (82.5%) were

captured upstream compared to downstream (17.5%) of fish screens. However, the high ratio of captured lampreys upstream of the fish screens is primarily driven by the high numbers of captured lampreys from Wapato Diversion in 2017 (4,885). Also, surveys were focused in areas upstream of the fish screens (in areas with the highest densities of lampreys) and the total area surveyed was 2.8 times higher upstream than downstream. The maximum observed density upstream of the fish screens was at Wapato Diversion, located along the bank of the dewatered sediment (110.0 #/m^2). The maximum observed density downstream of the fish screens was at Sunnyside Diversion, located in an isolated pool of water (55.0 #/m^2). A total of 8,733 dead or nearly dead lampreys (51.5% of total lampreys captured) were found on dewatered banks or on top of partially wetted fine sediment from all salvage surveys.

Larval lamprey were found at 13 of 14 (92.9%) of the visited irrigation diversions. Of the diversion where lampreys were found, Pacific Lamprey was present at 11 of 13 (84.6%) diversions (Table D1-2). The ratio of Pacific Lamprey (vs. Western Brook Lamprey) was high at Diversion 14 (80%), Bachelor-Hatton (100%), and Upper WIP (83%) diversions in Ahtanum Creek (river km 24.8, 31.8 and 32.8, respectively). In the Yakima River, the ratio of Pacific Lamprey ranged from 4% (Selah-Moxee Diversion, river km 203.6) to 30% (Wapato Diversion, river km 176.3); the ratio at Sunnyside Diversion was also high (27%). Pacific Lamprey were also found in a high ratio (25%) at Town Diversion (located at river km 264.7, upstream of Roza Dam). The ratio of Pacific Lamprey has been increasing steadily since 2010 at Sunnyside and Wapato diversions from approximately 0% from 2010-2013, ~3% in 2013-2014, 7.0% in 2014-2015, 15% in 2015-2016, 33% in 2016-2017 to 29% in 2017-2018. Adult lamprey translocation began in 2013 in Ahtanum Creek (which flows into Yakima River upstream of Wapato and Sunnyside diversions) and the ratio of Pacific Lamprey appears to roughly double each consecutive year since this restoration program began. A total of 6 Pacific Lamprey macrophthalmia (smolt stage with eyes) were collected from the following irrigation diversions; four from Sunnyside (Yakima River), one from Wapato (Yakima River), two from Bachelor-Hatton (Ahtanum Creek), three from Upper WIP (Ahtanum Creek), and two from Wapatox (Naches River). A total of 99 genetic samples were collected from captured larval/juvenile lamprey from diversions.

See **Appendix D1** for more information.

Table D1-1. Summary of larval/juvenile lamprey salvage efforts in dewatered diversions in the Yakima Subbasin. Under survey location, "Upstream" and "Downstream" includes all areas surveyed upstream or downstream of the fish screens, including respective canal areas further away, if surveyed. "Total # Observed" includes not only lampreys that were captured but also those that were observed but not captured. "Total # Dead on Bank" is the number of dead lampreys collected from dry, dewatered banks. "Total # Live on Bank" is the number of live lampreys collected from dry, dewatered banks. "Max E-Fish Density" is the maximum density of adjusted observed lampreys from all electrofishing surveys in the respective area. "Max CPUE" is the maximum CPUE (Catch Per Unit Effort) from all surveys conducted at the respective location (calculated from the number of captured lampreys and the shock time in minutes).

Watershed	Stream	Diversion Name	River km	Survey Location	# of Survey Visits	Total Survey Area (m^2)	Total Shock Time (min)	Total # Captured (E-Fish)	Total # Observed	Total # Live on Bank	Total # Dead on Bank	Total # on Bank	Max E-Fish Density (#/m2)	Max CPUE (L/min)
Lower Yakima	Yakima	Sunnyside	173.4	Upstream	2	19	18	63	77	98	41	139	7.1	7.1
				Downstream	2	93	105	977	1213	875	3736	4611	55.0	39.2
Lower Yakima	Yakima	Wapato	176.3	Upstream	9	262	227	4885	10431	1291	2101	3392	110.0	71.2
				Downstream	1	8	8	27	43	0	0	0	11.0	9.4
Lower Yakima	Yakima	Union Gap	189.8	Upstream	1	10	8	7	10	0	0	0	0.7	0.8
				Downstream	0	-	-	-	-	-	-	-	-	0.0
Lower Yakima	Yakima	Selah-Moxee	204.0	Upstream	1	55	51	124	144	0	0	0	2.4	2.6
				Downstream	1	20	15	48	55	0	0	0	2.4	3.1
Upper Yakima	Yakima	Roza	210.6	Upstream	0	-	-	-	-	-	-	-	-	0.0
				Downstream	1	28	26	117	159	0	0	0	7.8	7.9
Upper Yakima	Yakima	Town	264.7	Upstream	1	22	23	38	59	0	0	0	2.0	1.9
				Downstream	1	5	5	5	5	0	0	0	1.0	1.0
Lower Yakima	Toppenish	Olney	176.3	Upstream	2	22	22	64	96	0	0	0	6.2	6.5
				Downstream	1	2	2	1	1	0	0	0	0.5	0.5
Lower Yakima	Ahtanum	Lower WIP	16.4	Upstream	1	5	5	7	13	0	0	0	1.4	1.5
				Downstream	0	-	-	-	-	-	-	-	-	0.0
Lower Yakima	Ahtanum	Diversion 14	24.8	Upstream	1	43	34	843	2306	0	0	0	27.7	35.8
				Downstream	1	9	10	44	54	0	0	0	4.9	4.5
Lower Yakima	Ahtanum	Bachelor-Hatton	31.8	Upstream	3	83	65	450	826	0	2	2	13.7	16.6
				Downstream	2	30	23	174	279	0	0	0	10.0	12.5
Lower Yakima	Ahtanum	Upper WIP	32.8	Upstream	2	22	21	183	258	64	0	64	8.9	8.9
				Downstream	1	5	12	18	38	115	10	125	3.6	1.5
Lower Yakima	Ahtanum	John Cox	~ 45.0	Upstream	1	18	12	0	0	0	0	0	0.0	0.0
				Downstream	0	-	-	-	-	-	-	-	-	0.0
Upper Yakima	Naches	City of Yakima	6.0	Upstream	1	19	15	31	43	0	0	0	1.7	2.8
				Downstream	1	8	8	34	39	0	0	0	4.3	4.1
Upper Yakima	Naches	Wapatox	29.0	Upstream	3 *	3	3	94	159	400	0	400	48.0	42.4
				Downstream	0	-	-	-	-	-	-	-	-	0.0
Total (14 Diversions Surveyed)				**Upstream**	**28**	**583**	**504**	**6789**	**14422**	**1852**	**2144**	**3996**	**24.7**	**13.5**
				Downstream	**12**	**208**	**214**	**1445**	**1886**	**990**	**3746**	**4736**	**9.1**	**6.7**
Grand Total				**-**	**40**	**791**	**719**	**8234**	**16308**	**2842**	**5890**	**8733**	**20.6**	**11.5**

Table D1-2. Overview of species composition of captured lampreys from dewatered irrigation diversions in the Yakima Subbasin in 2017-2018. "% Pacific Lamprey" is a ratio of identified Pacific Lamprey to the total number of lampreys identified. "Gen. Samp. (Pacific Lamprey)" is the number of genetic samples that were collected from Pacific Lamprey and it is not separated by screen location. The summary rows are a sum of presented values (for each respective area), except for "% Pacific Lamprey", which is a weighted average.

Watershed	Stream	Diversion Name	River km	Survey Location	# of Survey Visits	# Identified	# Western Brook Lamprey	# Pacific Lamprey	# of Eyed Pacific Lamprey	% Pacific Lamprey	# Gen. Samp. (Pacific Lamprey)
Lower Yakima	Yakima	Sunnyside	173.4	Upstream	2	70	51	19	4	27%	27
				Downstream	2	72	57	15	0	21%	
Lower Yakima	Yakima	Wapato	176.3	Upstream	9	240	167	73	1	30%	12
				Downstream	1	20	17	3	0	15%	
Lower Yakima	Yakima	Union Gap	189.8	Upstream	1	4	4	0	0	0%	-
				Downstream	0	0	0	0	0	-	
Lower Yakima	Yakima	Selah-Moxee	204.0	Upstream	1	55	53	2	0	4%	2
				Downstream	1	1	1	0	0	0%	
Upper Yakima	Yakima	Roza	210.6	Upstream	0	-	-	-	-	-	-
				Downstream	1	0	0	0	0	-	
Upper Yakima	Yakima	Town	264.7	Upstream	1	20	15	5	0	25%	5
				Downstream	1	1	1	0	0	0%	
Lower Yakima	Toppenish	Olney	176.3	Upstream	2	49	46	3	0	6%	3
				Downstream	1	0	-	-	-	-	
Lower Yakima	Ahtanum	Lower WIP	16.4	Upstream	1	3	2	1	0	33%	0
				Downstream	0	-	-	-	-	-	
Lower Yakima	Ahtanum	Diversion 14	24.8	Upstream	1	30	6	24	0	0.8	22
				Downstream	1						
Lower Yakima	Ahtanum	Bachelor-Hatton	31.8	Upstream	3	24	0	24	1	100%	24
				Downstream	2	15	0	15	0	100%	
Lower Yakima	Ahtanum	Upper WIP	32.8	Upstream	2	54	9	45	3	83%	3
				Downstream	1	7	4	3	0	43%	
Lower Yakima	Ahtanum	John Cox	~ 45.0	Upstream	1	0	-	-	-	-	-
				Downstream	0	-					
Upper Yakima	Naches	City of Yakima	6.0	Upstream	1	25	21	4	0	16%	0
				Downstream	1	0	0	0	0	-	
Upper Yakima	Naches	Wapatox	29.0	Upstream	3 *	43	32	11	2	26%	1
				Downstream	0	0	0	0	0	-	
Total (14 Diversions Surveyed)				**Upstream**	**28**	**617**	**406**	**211**	**11**	**34%**	**99**
				Downstream	**12**	**116**	**80**	**36**	**0**	**31%**	
Grand Total				**-**	**40**	**733**	**486**	**247**	**11**	**34%**	**-**

Appendix D2 – Intensive Monitoring of Larval/Juvenile Lamprey Entrainment within Dryden Diversion, Wenatchee River, 2017

Photo D2. An overview of the canal upstream of the fish screens at Dryden Diversion, Wenatchee River, known to entrain several thousands of Pacific Lamprey each year.

Dryden Diversion is an irrigation diversion on the Wenatchee River (river km 27.8) which entrains several to tens of thousands of larval/juvenile Pacific Lamprey (*Entospheus tridentatus*) each year. As in previous years, Chelan County PUD, US Fish and Wildlife Service (USFWS), Washington Department of Fish and Wildlife (WDFW), and the Yakama Nation Fisheries assisted with the Pacific Lamprey salvage operations on October 16, 17 and 18, 2017, soon after the canal was dewatered. In addition, one final salvage was conducted on October 20, 2017, by WDFW focusing on salmonids.

Through our collective efforts between October 16, 2017, and October 20, 2017, a total of 15,035 lamprey (13,797 larvae and 1,238 macrophthalmia) were captured and the majority were released in Jolanda Lake (river km 50.4) upstream of Tumwater Dam on Wenatchee River with Type I habitat (Table D3-1, Fig. D3-1). This was a large increase compared to previous years (totaling < 9,000 lamprey). Several factors likely contributed to this increase in salvage numbers in 2017, including 1) the larger number of people, including volunteers, that assisted in the salvage, 2) more electrofishers (up to four) used by separate teams covering more ground simultaneously, 3) three (instead of two) consecutive days of electrofishing immediately after the dewatering, 4) reduced dewatering rate at the beginning that minimized stranding and desiccation, and 5) maintenance of water levels in the evening hours between survey days.

Juvenile lamprey (macrophthalmia) comprised 8.2% of the overall number salvaged (which is roughly twice as high as previous years' rates). The total team salvage time (a combination of electrofishing and bank collection efforts by individual groups) was 60.9 hours, involving over 20 people from various agencies. At least 11.3% of the salvaged lamprey were captured from drying banks and fine sediment heaps, but there were likely more if we recorded them more consistently.

Catch per unit effort (CPUE; # captured / hour of effort) was highest (408.9 #/hr) in Section 1 (the upstream most section) and lowest (32.8 #/hr) in Section 7 (the area just upstream of fish screens). A combination of electrofishing densities and wetted area from each section was used to estimate the number of entrained lamprey in Dryden Diversion (Fig. D3-2 and D3-3). The simple estimate was 15,111 lamprey and the cumulative estimate was 21,936 lamprey for the entire diversion. This estimate is likely an underestimate due to the fact that electrofishing efficiency is unlikely to be 100% (the presumed assumption), and is more likely to be ~50% when the density levels are high. Due to other supporting data, the most realistic lamprey estimate in Dryden Diversion may be close to 30,000 – 40,000 lamprey.

See **Appendix D3** for more information.

Table D3-1. Summary of daily larval/juvenile lamprey capture data at Dryden Diversion (Dryden, WA) between October 16 and 20, 2017. Columns that are in blue font represent mean values, whereas others are total values.

Date	Sections Covered	# of Larvae	# of Macro	# of Lamprey	% of Macro	Density (m^2)	% from Drying Bank	# from Drying Bank	Section Estimate #	Section Estimate # + Daily Salvage #	Section Estimate # + All Salvage #
10/16/2017	1,2,3,4	4121	525	4646	12.7%	5.0	27%	1257	8817	9640	9640
10/17/2017	1,2,3,4,5,6,7,8	4903	421	5324	9.0%	7.0	8%	432	9258	9679	14325
10/18/2017	1,2,3,4,5,6,7	4700	282	4982	6.0%	6.1	-	-	**11097**	**11594**	**21551**
10/20/2017	2,3,4	73	10	83	13.6%	0.9	-	-	458	458	7400
Overall	-	**13797**	**1238**	**15035**	**8.2%**	**5.8**	-	-	-	-	-

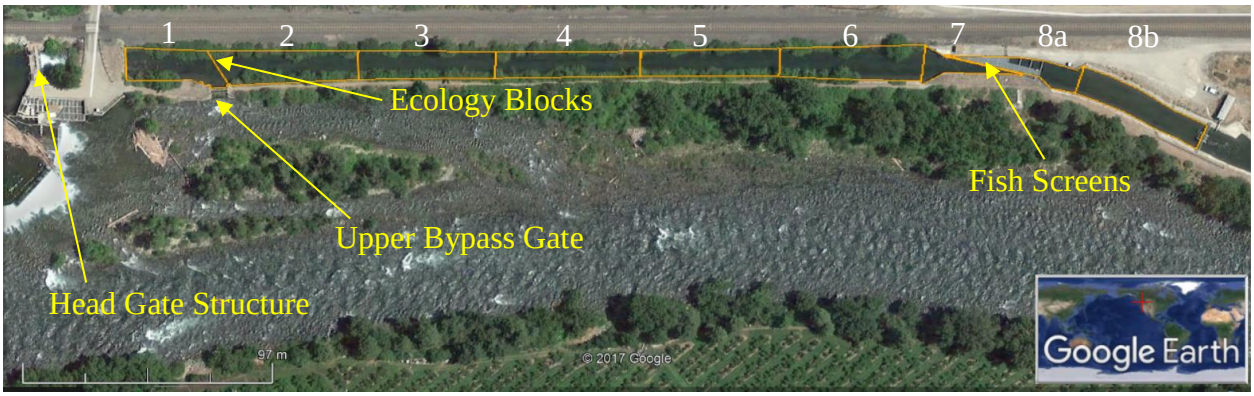


Figure D3-1. Aerial map of Dryden Diversion (Dryden, WA) from headgate structure to just downstream of the fish screens. Sections are delineated by orange lines and section ID numbers are shown in white font at the top of the map.

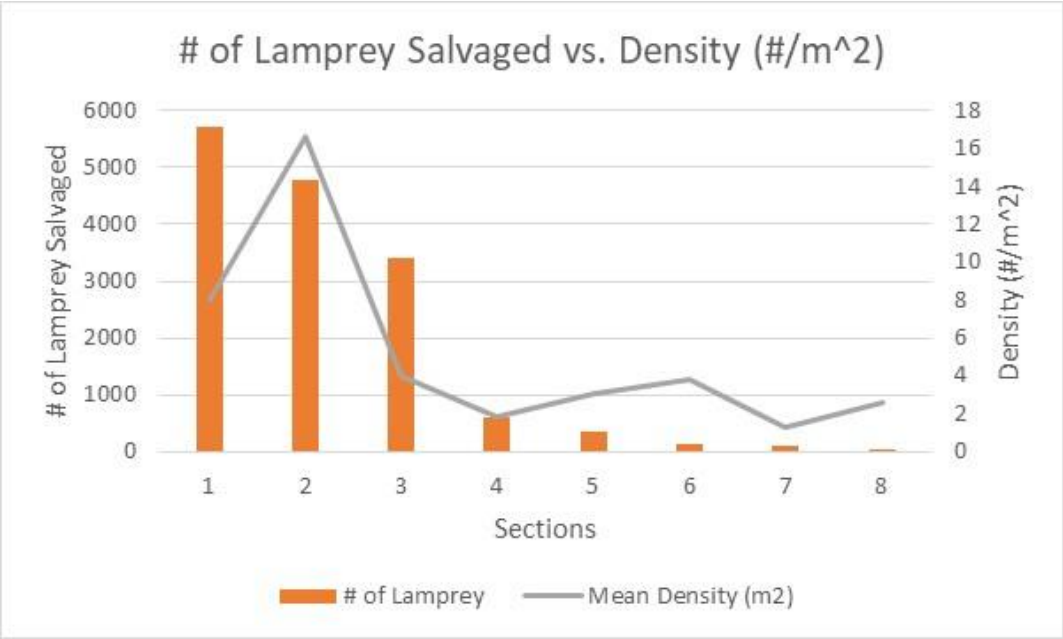


Figure D3-2. Total number of lamprey salvaged and mean survey density by sections at Dryden Diversion (Dryden, WA).

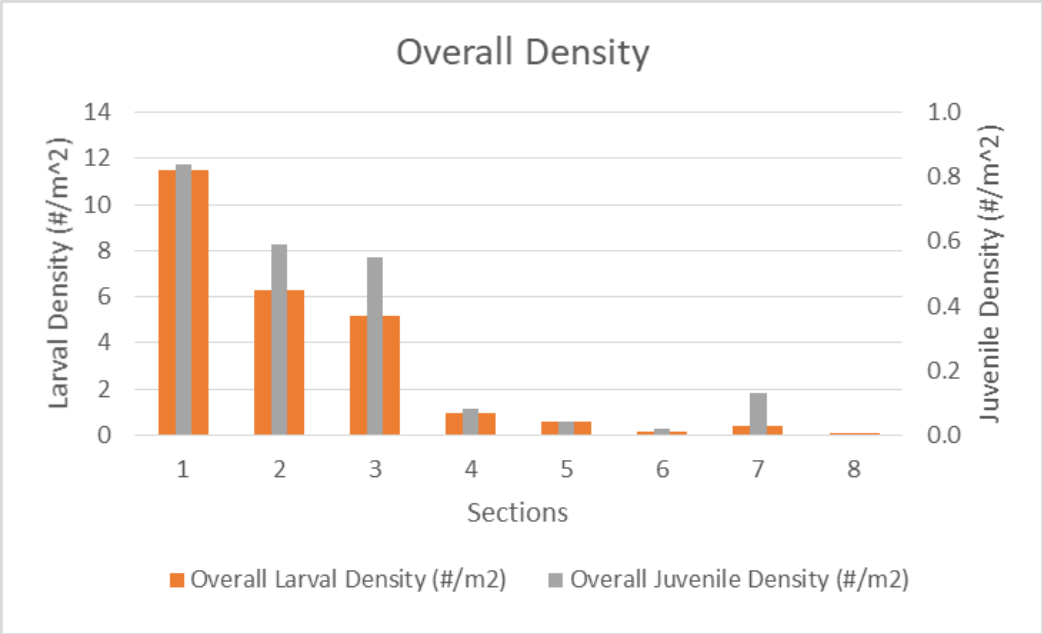


Figure D3-3. Density of larval and juvenile lamprey from Dryden Diversion (overall number of lamprey salvaged divided by overall section area at full water level) by sections at Dryden Diversion (Dryden, WA).

E. Work Element 99 – Public Outreach and Education

Work Element Associated Appendix Report:
Appendix E1 – Yakama Nation Lamprey Outreach and Education, 2017

Photo E1. Yakama Nation Tribal School (Toppenish, WA) students releasing adult Pacific Lamprey in Satus Creek on March 30, 2017

Yakama Nation Fisheries Resource Management Program Pacific Lamprey Project (YN PLP) has a duty to educate the public about Pacific Lamprey. Pacific Lamprey has become infamous, in part, to the notoriety of the Sea Lamprey in the Great Lakes. The ecological and cultural significance has become lost among youth and the new generations. Conservation of this species is critical, and if the public is not educated about the importance of Pacific Lamprey, there will be no focus on their restoration.

For the YN PLP, our primary concern is to restore the Pacific Lamprey to its rightful place in the culture of the Columbia Basin Native Americans. From a tribal perspective, the decline of lamprey equals a loss of a family member, a close friend, and a loss of an important culture. Many young tribal members do not know how to catch and prepare lamprey for drying, while myths and legends associated with lamprey are being forgotten or lost. We need to dissuade the public of the "River Monster" view of Pacific Lamprey. When we open our hatchery for tours and invite schools, organizations, and the general public to our release events, we have an opportunity to educate them. We have created a variety of visual displays and interactive exhibits. Our team members give presentations about the life cycle, history, cultural significance, medicinal uses of lamprey, and the problems they face. Gaining the support of the public is a vital part of restoring Pacific Lamprey to their rightful place.

We must continue to educate through school presentations, lamprey in the classroom programs, hands-on tours for college students, and reach out to other biologists and fishery managers. At release events, the visitors are able to hold a lamprey and release it into the river. Providing a

hands-on experience for people to hold and touch the lamprey is a memorable event for visitors. It can dispel their image of the monstrous lamprey and many come to find this an incredible creature.

Last year, through our community events and hatchery tours, totaling 32 events, we reached out to over 1,650 students, 102 teachers, 259 agency workers, and 1,239 people from the general public, reaching over 3,250 people combined (Table E1-1). Ralph Lampman also gave a presentation about Pacific Lamprey restoration work in Ishikawa, Japan, and participated in the release of artificially propagated Arctic larval lamprey (see Appendix E2 for more information).

Our team gives presentations to the scientific community, funding sources, and fisheries managers frequently. In 2017, our biologists and partners sharing YN PLP work gave over 22 presentations at a variety of conferences and meetings, including American Fisheries Society chapter meetings, California Lamprey Passage Workshop, and Lamprey Summit III, targeting the scientific and fisheries community, ranging in locations from Eureka, California, to Ghent, Belgium. Through scientific presentations, we reached out to over 650 students, 131 teachers, 1,285 agency workers, reaching over 2,066 people combined.

Local news and social network media, and various educational blogs continue to support our outreach efforts and are helping to promote the need to restore Pacific Lamprey. We take the initiative to announce various outreach events through the local news media and we take the time to provide feedback to reporters and bloggers to ensure they get their stories on Pacific Lamprey written as accurately and correctly as possible. Through these various media outreach, totaling 13 sources, we estimated that we reached out to over 101,336 people from the general public, based on a very conservative estimate.

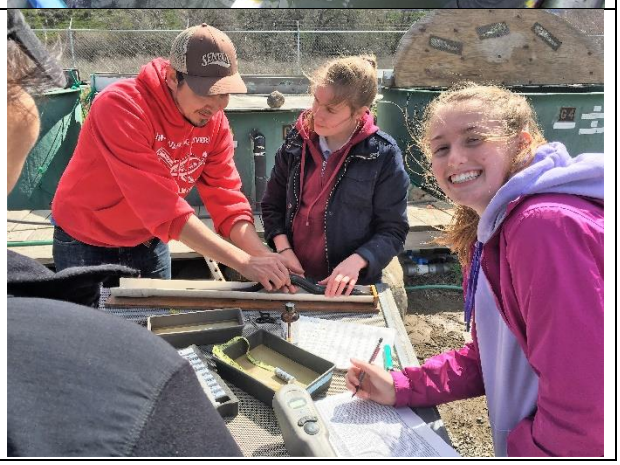
For the Pacific Lamprey Project, 2017 was an outstanding year of good publicity with many opportunities to reach out to students, teachers, partners, and the general public. All together, we reached out to over 2,300 students, 233 teachers, 1,544 agency workers, and 102,575 people from the general public, totaling over 106,652 people (Table E1-2, Fig. E1-1). We have many opportunities to continue to reach out to the public and all of us on our team will continue to do our best to be the rightful spokesperson and messenger for the Pacific Lamprey, using various means available. See **Appendix E1** and **E2** for more information.

Table E1-1. Summary of 2017 Yakama Nation Fisheries Pacific Lamprey Project outreach and education activities audience.

Type of Event	# of Students	# of Teachers	# of Agency Workers	# of General Public	# of People (Total)
Outreach	1650	102	259	1239	3250
Science Pres.	650	131	1285	0	2066
Media	0	0	0	101336	101336
Total	**2300**	**233**	**1544**	**102575**	**106652**

Table E1-2. List of 2017 Yakama Nation Pacific Lamprey Project outreach and education activities.

Date	Event	Location	Type of Event	# of Students	# of Teachers	# of Agency Workers	# of General Public	# of People (Total)
3/24/2017	Lower Satus Adult Translocation Release	Satus, WA	Outreach	10	1	0	0	11
3/28/2017	La Salle High School In-Class Lamprey Presentation	Union Gap, WA	Outreach	19	1	0	0	20
3/29/2017	Lower Ahtanum Adult Translocation Release	Union Gap, WA	Outreach	31	3	0	0	34
3/30/2017	Lower Satus Adult Translocation Release	Satus, WA	Outreach	22	3	0	0	25
3/30/2017	Christian Brothers High School Lamprey Workday	Prosser, WA	Outreach	12	2	0	0	14
4/8/2017	Lower Yakima Adult Translocation Release	Prosser, WA	Outreach	60	3	3	60	126
4/12/2017	Methow Adult Translocation Release	Winthrop, WA	Outreach	10	1	3	0	14
4/13/2017	Prosser Hatchery Tour – Heritage University Lab Class	Prosser, WA	Outreach	5	1	1	0	7
4/17/2017	Methow Adult Translocation Release	Winthrop, WA	Outreach	0	0	3	4	7
4/19/2017	Wenatchee Adult Translocation Release	Levenworth, WA	Outreach	47	8	0	2	57
4/22/2017	Central Washington University Salmon Run	Ellensburg, WA	Outreach	50	5	0	30	85
4/22/2017	Prosser Science Expo	Prosser, WA	Outreach	70	5	5	140	220
4/27/2017	Lower Yakima Adult Translocation Release	Prosser, WA	Outreach	10	3	0	1	14
5/4/2017	Prosser Hatchery Tour – Toppenish Middle School	Prosser, WA	Outreach	148	5	1	5	159
5/9/2017	Upper Toppenish Adult Translocation Release	White Swan, WA	Outreach	20	2	0	0	22
5/11/2017	Lower Yakima Adult Translocation Release & Prosser Hatchery Tour	Prosser, WA	Outreach	100	5	1	5	111
5/16/2017	Prosser Hatchery Tour – Pioneer Elementary School	Prosser, WA	Outreach	132	5	0	5	142
5/18/2017	Prosser Hatchery Tour – Sunnyside Christian School	Prosser, WA	Outreach	33	3	0	3	39
5/18/2017	Prosser Hatchery Tour – Northwest High School	Prosser, WA	Outreach	60	4	0	4	68
5/23/2017	Prosser Hatchery Tour – Smith Elementary School	Prosser, WA	Outreach	48	2	0	2	52
5/24/2017	Prosser Hatchery Tour – Pioneer Elementary School	Prosser, WA	Outreach	140	5	0	5	150
5/24/2017	Benton County Soil and Water Conservation District Salmon Release	Prosser, WA	Outreach	40	4	2	2	48
5/31/2017	Prosser Hatchery Tour - Wapato Middle School	Prosser, WA	Outreach	58	2	0	2	62
6/9/2017	Treaty Day Parade	Toppenish, WA	Outreach	300	10	100	500	910
6/19/2017	Arctic Lamprey larvae release in Ishikawa, Japan	Ishikawa, Japan	Outreach	15	2	5	20	42
6/28/2017	Intertribal Timber Council Tour at Toppenish Creek	White Swan, WA	Outreach	15	0	100	15	130
8/15/2017	Campbell Farm Summer Camp	Wapato, WA	Outreach	30	2	2	2	36
8/31/2017	Wenatchee Adult Translocation Release	Levenworth, WA	Outreach	5	0	10	10	25
9/14/2017	Methow Adult Translocation Release	Winthrop, WA	Outreach	0	0	8	2	10
9/22/2017	Central Washington State Fair	Yakima, WA	Outreach	100	10	0	300	410
10/25/2017	NRCS - WA County Conservation District Tour	Prosser, WA	Outreach	0	0	10	0	10
11/11/2017	Native American Month Celebration – Arts, Crafts, & Culture Day	Richland, WA	Outreach	60	5	5	120	190
1/26/2017	Yakima Basin Irrigation Board Meeting	Yakima, WA	Science Pres.	0	0	30	0	30
1/30/2017	California Lamprey Passage Workshop	Eureka, CA	Science Pres.	15	0	50	0	65
3/1/2017	Idaho Chapter of AFS (American Fisheries Society) Annual Meeting	Boise, ID	Science Pres.	50	10	150	0	210
3/2/2017	Oregon Chapter of AFS (American Fisheries Society) Annual Meeting	Bend, OR	Science Pres.	20	5	30	0	55
3/2/2017	Oregon Chapter of AFS (American Fisheries Society) Annual Meeting	Bend, OR	Science Pres.	15	5	35	0	55
4/11/2017	Washington/BC Chapter of AFS (American Fisheries Society) Annual Meeting	Spokane, WA	Science Pres.	15	5	35	0	55
4/11/2017	Washington/BC Chapter of AFS (American Fisheries Society) Annual Meeting	Spokane, WA	Science Pres.	30	5	115	0	150
4/12/2017	Matthew Dunkle, Master of Science Thesis Presentation, University of Idaho	Moscow, ID	Science Pres.	40	10	10	0	60
4/18/2017	10th Annual Columbia Gorge Fisheries and Watershed Science Conference	The Dalles, OR	Science Pres.	10	0	60	0	70
4/26/2017	CRITFC Lamprey Task Force Meeting	Portland, OR	Science Pres.	0	0	30	0	30
6/15/2017	Annual Yakima Basin Science and Management Conference	Ellensburg, WA	Science Pres.	20	5	55	0	80
6/15/2017	Annual Yakima Basin Science and Management Conference	Ellensburg, WA	Science Pres.	20	5	55	0	80
7/10/2017	Lamprey Identification and Tagging Training	Wenatchee, WA	Science Pres.	0	1	50	0	51
9/4/2017	LARVI 2017: 7th Fish & Shellfish Larviculture Symposium	Ghent, Belgium	Science Pres.	100	20	100	0	220
9/21/2017	American Indian Science and Engineering Society	Denver, CO	Science Pres.	150	30	50	0	230
10/18/2017	Corps-Tribal Lamprey Passage Workgroup: Lamprey Information Session	Pendleton, OR	Science Pres.	0	0	40	0	40
12/6/2017	Lamprey Summit III (Once Every 5-Year Event)	Portland, OR	Science Pres.	30	5	70	0	105
12/6/2017	Lamprey Summit III (Once Every 5-Year Event)	Portland, OR	Science Pres.	30	5	70	0	105
12/6/2017	Lamprey Summit III (Once Every 5-Year Event)	Portland, OR	Science Pres.	30	5	70	0	105
12/6/2017	Lamprey Summit III (Once Every 5-Year Event)	Portland, OR	Science Pres.	30	5	70	0	105
12/6/2017	Lamprey Summit III (Once Every 5-Year Event)	Portland, OR	Science Pres.	30	5	70	0	105
12/7/2017	Lamprey Summit III (Once Every 5-Year Event)	Portland, OR	Science Pres.	15	5	40	0	60
2017	Facebook – "Luna the Lamprey"	Website	Media	-	-	-	1827	1827
2017	Facebook - "Yakima Nation Fisheries"	Website	Media	-	-	-	1674	1674
4/5/2017	Tri-City Herald – "Public can watch lamprey released on Saturday in Prosser"	Newspaper & Website	Media	-	-	-	5700	5700
4/6/2017	Daily Sun News – "Tribe to release lampreys"	Newspaper & Website	Media	-	-	-	490	490
4/8/2017	Tri-City Herald – "Learning to love the (Pacific) lamprey"	Newspaper & Website	Media	-	-	-	5700	5700
4/10/2017	Daily Sun News – "Ancient Fish – Restoration event focuses on lamprey"	Newspaper & Website	Media	-	-	-	490	490
4/10/2017	YakTriNews.com / KAPP, KVEW TV – "Pacific Lamprey save local woman's life"	TV & Website	Media	-	-	-	8400	8400
4/24/2017	Methow Valley News – "Lampreys released in Methow Valley to help restore population"	Newspaper & Website	Media	-	-	-	180	180
6/19/2017	Artificially propagated Arctic Lamprey larvae released in Noto, Ishikawa, Japan	Newspaper & Website	Media	-	-	-	35000	35000
8/21/2017	American Fisheries Society Science Blog – "Conservation efforts for an unlikely hero"	Website	Media	-	-	-	1200	1200
8/29/2017	USFWS Blog – "The #Filter that makes Pacific Lamprey pretty (in the eyes of biologists)"	Website	Media	-	-	-	600	600
9/8/2017	Tribal Tribune – "CTFW releases lampreys at Okanogan, Similkameen rivers"	Newspaper & Website	Media	-	-	-	75	75
11/2/2017	OPB – "The hidden world of Oregon's overlooked falls"	TV & Website	Media	-	-	-	40000	40000



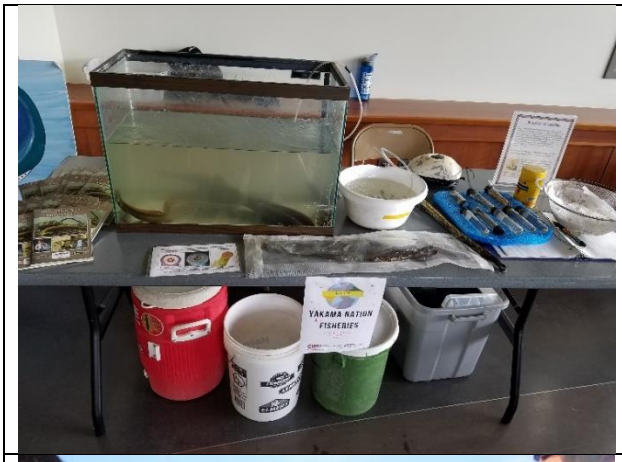

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Figure E1-1. A collection of photos from Yakama Nation Fisheries Pacific Lamprey Project outreach and education activities in 2017.

F. Work Element 161 – Local and Regional Participation

Work Element Associated Appendix Report:
Not Applicable

Throughout 2017, the YNPLP has continued to maintain a strong presence in supporting and guiding Pacific Lamprey recovery efforts in the Yakima Subbasin and in the Upper and Mid Columbia River basins. The following outlines some of the key activities YNPLP staff are involved with:

Coordination with the Bureau of Reclamation in the Yakima Subbasin
Technical representative for both the YNPLP and Reclamation continue to meet regularly on an "as-needed" basis to coordinate studies and findings on Reclamation facilities, primarily in the lower Yakima River. These meetings have focused primarily on 1) larval/juvenile lamprey salvage/collection in irrigation diversions, 2) intensive monitoring associated with larval/juvenile entrainment in select diversions, and 3) adult passage improvement planning and implementation. Discussions continue with the Reclamation and irrigation districts about logistics for implementing various components of larval/juvenile lamprey monitoring, salvage, and passage improvement using funds from Reclamation (Science and Technology Funds) and Natural Resources Conservation Service (NRCS) 2015-2019 5-year grant funding.

In collaboration with Reclamation and USFWS, the YNPLP continues to work towards implementation of adult Pacific Lamprey passage improvement at Prosser Dam and other lower Yakima River irrigation diversion dams. Progress over the past year has been slower than expected, but we are implementing a multi-year passage improvement project targeted at Prosser, Sunnyside, and Wapato dams and will also focus on Horn Rapids and Roza dams in the near future. A pilot lamprey passage devise (vertical wetted wall) has recently been added to the Prosser Dam

and was tested between spring – fall 2017. These discussions will continue over the next couple years with the intent to implement several structures between 2018 - 2019, including Prosser, Sunnyside and Wapato diversion dams (funded through NRCS).

Coordination with the Irrigation Districts in the Yakima Subbasin

Due to the need to monitor and salvage larval/juvenile lamprey from irrigation diversions, there is a strong need to build a good relationship with the local irrigation districts. Over the years, we have worked with multiple irrigation districts, including managers and personnel from Sunnyside, Wapato, and Congdon diversions. We also present and share our research results and updates with the irrigation district managers through the Yakima Basin Joint Board meeting periodically. For coordination, we work closely with David Child (DC Consulting) who acts as a liaison between Yakama Nation Fisheries and irrigation districts. In 2016-2017, we worked closely with Wapato Irrigation Project (WIP) and Sunnyside Valley Irrigation District to discuss the possibility of implementing some of the short term solutions for mitigating larval entrainment and mortalities. The WIP managers were willing to reduce the dewatering rate in mid-October (shutting down fewer gates at a time and extending the dewatering duration) to reduce the desiccation of lamprey on dry banks; this helped reduce the bank mortality of lamprey significantly in 2016 and provided a great example of the positive outcome from collaboration.

Coordination with the USACE in the Columbia River Basin

Technical representatives of the YN continue to meet quarterly with technical representatives of the USACE with the primary intent to improve juvenile and adult passage conditions through the FCRPS hydro-electric facilities on the mainstem Columbia River. Over the past year the emphasis has been the prioritization of adult passage improvement and juvenile monitoring projects which will incorporate (1) monitoring newly constructed passage structures at Bonneville, John Day and McNary dams, (2) design and development of a micro-tag for future juvenile research and (3) prioritization of research for both juvenile and adult passage interests. The micro-tag has recently been developed and we are now initiating a basic study in Lower Yakima to test the efficacy of these tags inserted into juvenile lamprey (macrophthalmia). Longer-term planning continues with important priority considerations: implementation vs additional needed research, adult vs juvenile, lower Columbia Projects vs Snake River projects. Many of these considerations are also well coordinated with the USACE sponsored Study Review Work Group (SRWG).

Coordination with the CRITFC in the Columbia River Basin

A considerable amount of planning and coordination continues with the CRITFC in the development of the "Master Plan for Pacific Lamprey Supplementation, Aquaculture, Restoration, and Research," which will be submitted to the NPCC in March 2018. There is extensive coordination work associated with genetic sampling for adults and juvenile/larvae, including collection, prioritization, and analysis. The YN policy and technical representatives also continue to meet with the CRITFC Pacific Lamprey Tribal Task Force frequently. Typical agenda items

associated with these meetings include the USFWS Conservation Agreement, progress in passage at the FCRPS facilities, progress in adult and juvenile supplementation, and progress among the YNPLP and various member tribes. Of primary importance to CRITFC and tribal policy representatives is the ever-present question: When are we going to accelerate the implementation of solutions (instead of short-term stop gap measures)?

Coordination with the USFWS: Regional Conservation Team (CT)

In June, 2011 the USFWS initiated a Pacific Lamprey Conservation Agreement in which the YN is a signatory. Both technical and policy representatives are communicating with the USFWS at multiple administrative levels to strengthen the commitment of this agreement. The Yakama Nation representative also serves as the Co-Chair to this CT. The YN recognizes that multiple threats exist that limit abundance, productivity and spatial distribution throughout the Ceded Lands subbasins and that multiple agencies, jurisdictions and publics are needed to realize recovery objectives. The YN anticipates working closely with all relevant partnerships to accelerate implementation of various actions at each subbasin scale, within the context of the Conservation Agreement. The forth Lamprey Summit was successfully held in December, 2017, which was also timed with the re-initiation of the 2012 Pacific Lamprey Conservation Agreement. The YN presented five separate topics of presentations at the Information Exchange Workshop on the 2nd and 3rd day of the summit: 1) adult passage, 2) artificial propagation, 3) larval/juvenile entrainment, 4) *Lampetra* genetics and identification, and 5) lamprey predation.

Coordination with the Lamprey Technical Work Group (LTWG)

Technical representatives continue to meet periodically with the LTWG, whose meetings are held biannually focusing on regionally important lamprey coordination / conservation projects. There are also several subgroups that convene meetings more regularly to develop answers and solutions to various specific topics, including Adult Engineering (Passage), Juvenile Engineering (Passage), Dredging, Ocean Phase, Genetics, Passage Metrics, Tagging, etc. Our technical lead (Ralph Lampman) is leading some of these subgroups and is a participating member in most of the other subgroups.

Coordination with the Mid-Columbia Public Utility Districts

Both YN policy and technical representatives participate and provide significant leadership in implementation of PUD mitigation associated with their FERC licenses. Each of the three Public Utility Districts (Grant, Chelan and Douglas counties) have Pacific Lamprey Management Plans as a component of their FERC licenses. The YN technical representatives regularly attend monthly meetings associated with the implementation of each of the PUD's Pacific Lamprey Management Plans. In collaboration with partners (the Confederated Tribes of the Umatilla Indian Reservation, NOAA Fisheries, and USFWS), we continue to conduct a three year (2016-2018) study to investigate the best management practices for rearing larvae/juvenile from artificial propagation, using Chelan County PUD funding allocated for Pacific Lamprey Management.

For activities related to disseminating raw/summary data and results stemming from this project, see Work Element 99 (Outreach and Education) and **Appendix E1**. Each of our team members have taken the time to present our latest findings and results in many local, state, and regional conferences throughout the year in 2017.

G. Work Element 158 – PIT Tag Adult Lamprey

Work Element Associated Appendix Report:
Appendix G1 – Translocation of Adult Pacific Lamprey within the Yakima Subbasin, 2016-2017 Broodstock)

Photo G1. Adult Pacific Lamprey being released above Prosser Dam on Yakima River (river km 76.1) by the general public during an open house release event on April 8, 2017.

This report is composed of two parts: 1) summary of all 2016-2017 broodstock adult Pacific Lamprey releases during the spring 2017 migration season within the Yakima Subbasin and 2) analysis of migration data from those adults that were PIT tagged (all adults were PIT tagged). From the 2016-2017 broodstock (adults collected in summer 2016 that primarily mature in 2017), a total of 429 adult Pacific Lamprey were released within the Yakima Subbasin between October 13, 2016, and May 18, 2017 (Fig. G1-1). Overall female ratio was estimated to be 47.8%, PIT tag ratio was 96.5% (9 and 12 mm tags 48.0% and 48.5%, respectively), and genetic tag ratio was 98.8%. This is the sixth year that adult Pacific Lamprey were translocated into the Yakima Subbasin. This was the first year we incorporated wild natural run Pacific Lamprey from the Yakima River (Prosser Dam) into the translocation. Larval Pacific Lamprey have not been documented upstream of Roza Diversion Dam (river km 210.5) until recently in 2016 (adult translocation in Upper Yakima occured in 2015).

From the PITAGIS regional data base (http://www.ptagis.org/), using Query Builder2 Reports, the interrogation data of PIT tagged lamprey were summarized. A total of 158 lamprey (38.2%) out of 414 total PIT tagged lamprey released were detected in at least one PIT array site. The highlights from the 2016-2017 broodstock adult Pacific Lamprey translocation monitoring in the Yakima Subbasin are the following:

- The site with the most detection was at PRO (Prosser Dam; 60.4%), SAT (Lower Satus Creek; 21.9%), AHT (Lower Ahtanum Creek; 7.1%), and SIM (Simcoe Creek; 4.7%) (Table G1-1). There were some detections from ROZ (Roza Dam; 4.1%) and SUN (Sunnyside Instream Array; 1.8%) as well.
- Detection of movement was the highest during the month of May and attenuated in June and July, with the last detection in mid-July. One movement was detected in late November, likely associated with an increase in discharge (Fig. G1-2).
- Detection from the three releases downstream of Prosser Dam resulted in an overall 64.9% detection. For some of these (22.1% overall), the last detection was at a lower array, indicating potential fallback within the ladder. However, 1 of the 6 lamprey (16.7%) that entered Satus Creek from these releases was not detected at Prosser Dam, indicating some level of passage without detection.
- From the 151 adults released downstream of Prosser Dam, six lamprey (4.0%) were detected at Satus Creek. Ten of the 155 adults (6.5%) released immediately upstream of Prosser Dam were detected at Satus Creek; providing an estimate of 61.6% Prosser Dam passage.
- From the 151 adults released downstream of Prosser Dam, three lamprey (2.0%) were detected at Roza Dam (one of which were last detected at the upper array, potentially indicating fish ladder passage). Four of the 155 lamprey (2.6%) released immediately upstream of Prosser Dam were detected at Roza Dam; providing an estimate of 77% Prosser Dam passage.
- Lamprey used the left and right ladder the most (44.8% each), while only several used center ladder (10.4%). However, the average time spent in left ladder ranged from 0.91 to 3.35 days, whereas the time spent in the right and center ladders ranged from 0.00 to 0.39 days, indicating that lamprey consistently spent more time in passing the left ladder.
- There was a seasonal tendency - more lamprey approached the right ladder during the early spring high flow season, whereas during the late spring lower flow conditions, more lamprey approached the left ladder.
- The fastest upstream traveling lamprey detected was 48.3 and 41.8 km/day (lamprey detected at Lower Satus Array), which may be the fastest migration speed ever recorded for Pacific Lamprey upstream migration.
- Downstream post spawn drifting was observed primarily between mid-June and mid-July.

- Lamprey continuous holding by PIT arrays were detected at Prosser and Roza diversion dams and will be closely examined in future years (focusing on issues and potential solutions).

See **Appendix G1** for more information.

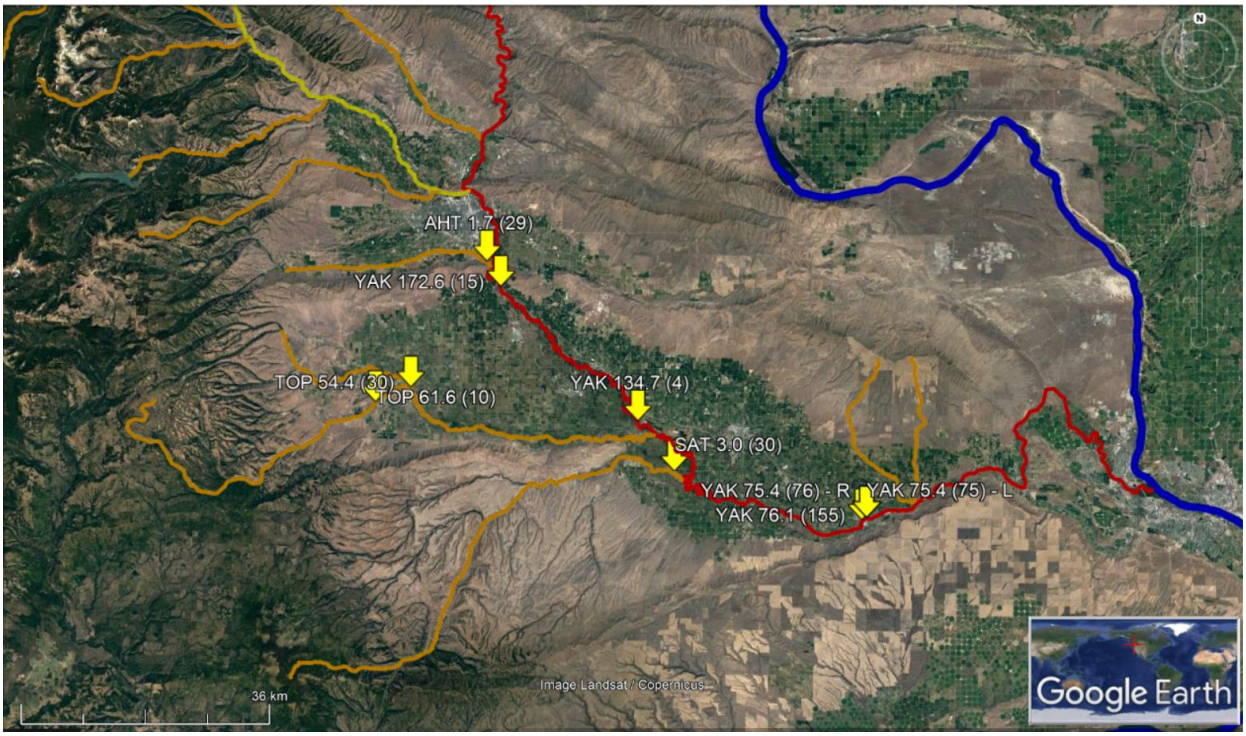


Figure G1-1. Overall aerial map of 2016-2017 broodstock Pacific Lamprey translocation release sites in the Yakima Subbasin. "YAK" stands for Yakima, "SAT" stands for Satus, "TOP" stands for Toppenish, "AHT" stands for Ahtanum, the number next to the stream name is the river km, and the number in parenthesis is the total number of lamprey released. The red line represents mainstem Yakima River, the orange lines represent key tributaries, and the blue line represents the Columbia River.

Table G1-1. Summary of 2016-2017 broodstock Pacific Lamprey translocation detection sites from the Yakima Subbasin releases.

River	River KM	Site ID	Site Name	# of Lamprey Detected	% Detected
Yakima	75.7	PRO	Prosser Diversion Dam Combined	107	61.5%
Yakima	171.1	SUN	Sunnyside Instream Array	3	1.7%
Yakima	210.5	ROZ	Roza Diversion Dam (Combined)	7	4.0%
Satus	4.3	SAT	Lower Satus Creek	37	21.3%
Simcoe	8.9	SIM	Simcoe Creek	8	4.6%
Ahtanum	4.0	AHT	Ahtanum	12	6.9%

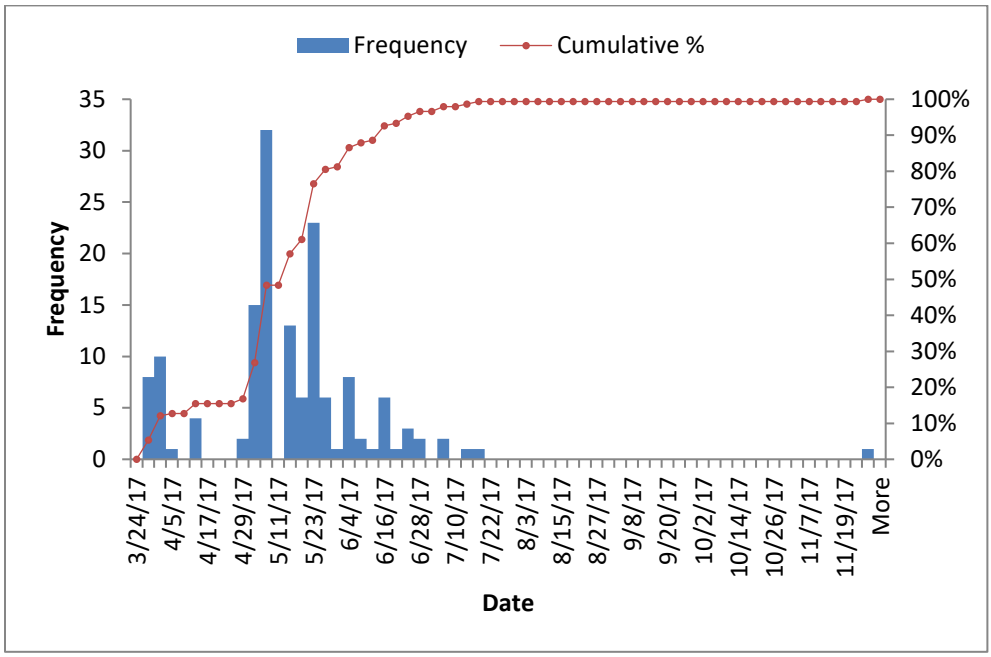


Figure G1-2. Frequency of movement displayed by Pacific Lamprey from the 2017 Spring release in the Yakima Subbasin based on PIT tag detection data.

Appendix G2 – Translocation of Adult Pacific Lamprey within the Wenatchee Subbasin, 2016-2017 Broodstock

Photo G2. Releasing adult lamprey with Beaver Valley School Elementary School students into Wenatchee River at Jolanda Lake (river km 50.4) on April 19, 2017.

This report is composed of two parts: 1) summary of all 2016-2017 broodstock adult Pacific Lamprey releases within the Wenatchee Subbasin and 2) analysis of migration data from PIT tagged adults. From the 2016-2017 broodstock (adults collected in summer 2016 that primarily mature in 2017), a total of 306 adult Pacific Lamprey were released in the Wenatchee Subbasin. Adults were released at nine locations between August 23, 2016, and April 19, 2017. This is the second year that adult Pacific Lamprey were translocated into the Wenatchee Subbasin. Until the

recent adult translocation began in 2016 spring, no lamprey have been detected in the Wenatchee River upstream of Tumwater Dam for over two decades despite intensive monitoring efforts conducting larval lamprey electrofishing surveys by Yakama Nation Fisheries and USFWS. Translocation was implemented in 2016 out of concern for the species extinction observed upstream of Tumwater Dam and also to enhance the larval pheromone signal from Upper Wenatchee River to improve adult lamprey attraction.

From the PITAGIS regional data base (http://www.ptagis.org/), using Query Builder2 Reports, the interrogation data of PIT tagged lamprey were summarized. Out of 306 PIT tagged lamprey, 71 lamprey (23.2%) were detected in at least one PIT array site within the Columbia Basin. The highlights from the 2016-2017 broodstock Pacific Lamprey translocation monitoring in the Wenatchee Subbasin are the following:

- Within Tumwater Dam, estimated area-specific detection rates ranged from 21.3 – 75.0% (lower portion of the ladder had lower detection rates), resulting in estimated cumulative detection rates of 6.7-19.9% (within the existing PIT array sections) (Fig. G2-2).
- The overall detection rate of PIT tagged lamprey was 23.2% within the Wenatchee Subbasin.
- Sites that detected lamprey the most were TUF (Wenatchee river km 49.6; 36.6%), UWE (Wenatchee river km 80.9; 29.6%), and LWE (Wenatchee river km 2.7; 21.1%) (Table G2-1).
- Estimated detection efficiencies at some of the instream arrays were considerably low (especially UWE <11.1%, LWE = 45-50%, NAL <50.0), but likely higher compared to detection rates during spring high flow conditions.
- Among the lamprey detected, the percent of lamprey that initially migrated upstream was considerably lower for lamprey released within Tumwater Dam (42.5%) compared to the other releases (average of 84.6%).
- Only the uppermost release (at Wenatchee river km 74.6) resulted in some portion of lamprey being detected within Nason Creek.
- Although fall migration is the primary migration timing observed at major hydro dams, many lamprey migrate considerable distances (e.g. 30-50 km) during the spring final migration within this type of tributary environments (Fig. G2-3).

See **Appendix G2** for more information.

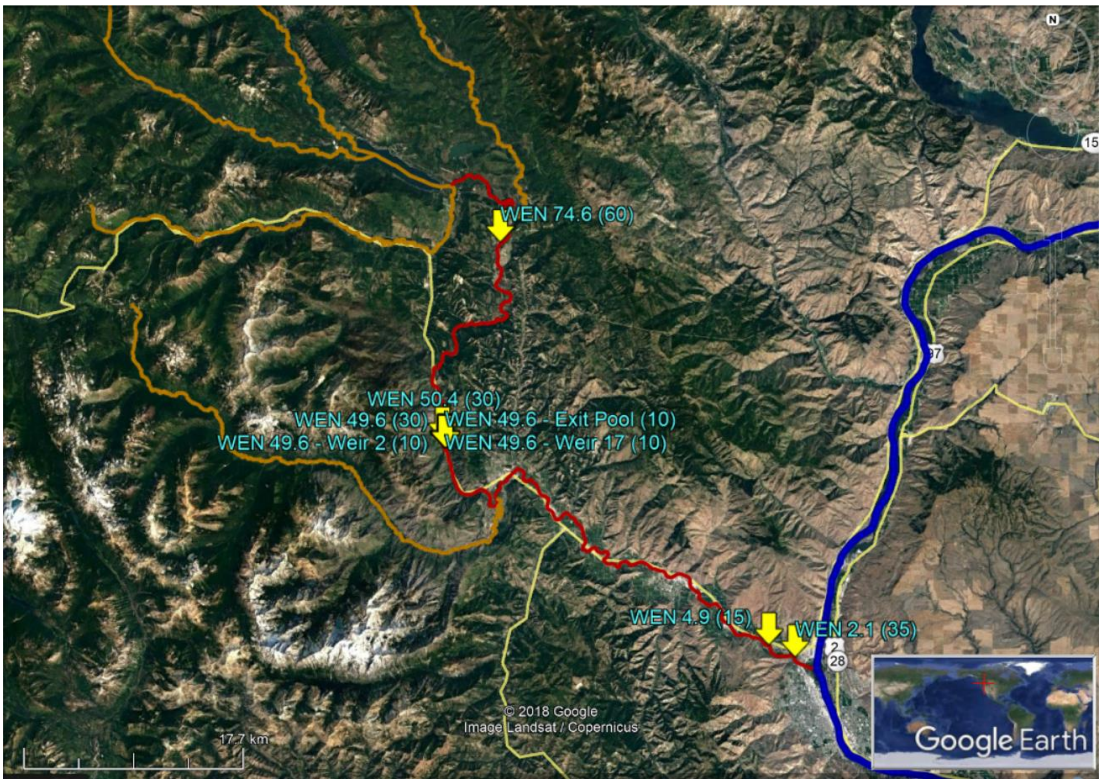


Figure G2-1. Overall aerial map of 2016-2017 broodstock Pacific Lamprey translocation release sites in the Wenatchee River. "WEN" stands for Wenatchee, the number next to the stream name is the river km, and the number in parenthesis is the total number of lamprey released. The red line represents mainstem Wenatchee River, the orange lines represent its tributaries (Icicle, Chiwawa, Nason, White, Little Wenatchee rivers/creeks from downstream to upstream), and the blue line represents the Columbia River.

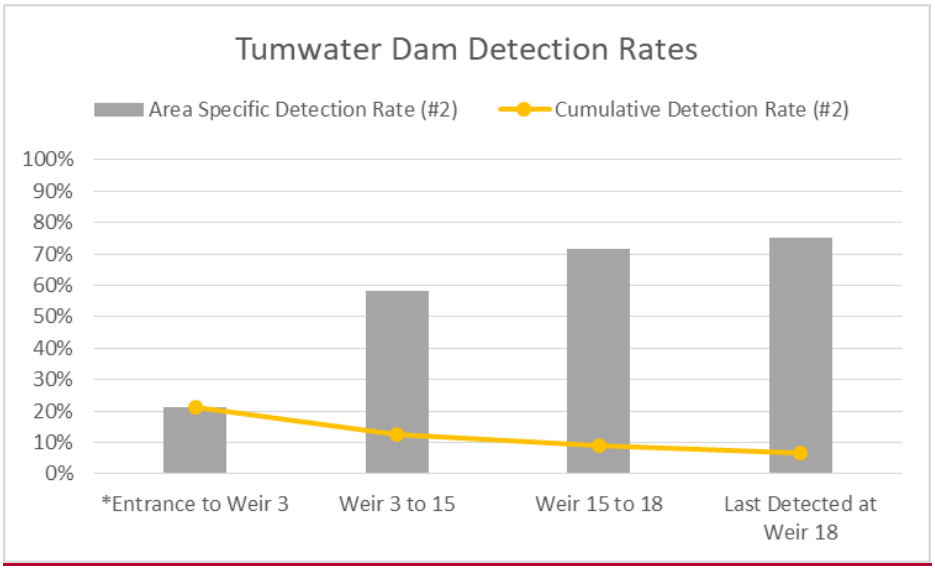


Figure G2-2. Estimated area-specific and cumulative detection rates based on PIT tag detection within Tumwater Dam arrays (TUF). "Entrance to Weir 3" detection rate was calculated based on the number of lamprey released immediately below the dam that passed the dam. It is uncertain if those "Last Detected at Weir 18" successfully passed the dam.

Table G2-1. Summary of 2016-2017 broodstock Pacific Lamprey translocation detection sites from the Wenatchee Subbasin releases.

River	River KM	Site ID	# of Lamprey Detected	% Detected	Estimated Detection Efficiency
Wenatchee	2.7	LWE	15	21.1%	45-50%
Wenatchee	49.6	TUF	26	36.6%	N/A
Wenatchee	80.9	UWE	21	29.6%	<11.1%
Nason	0.8	NAL	7	9.9%	<50.0%
Nason	19.5	NAU	1	1.4%	N/A
Columbia	755.9	RRF	1	1.4%	N/A

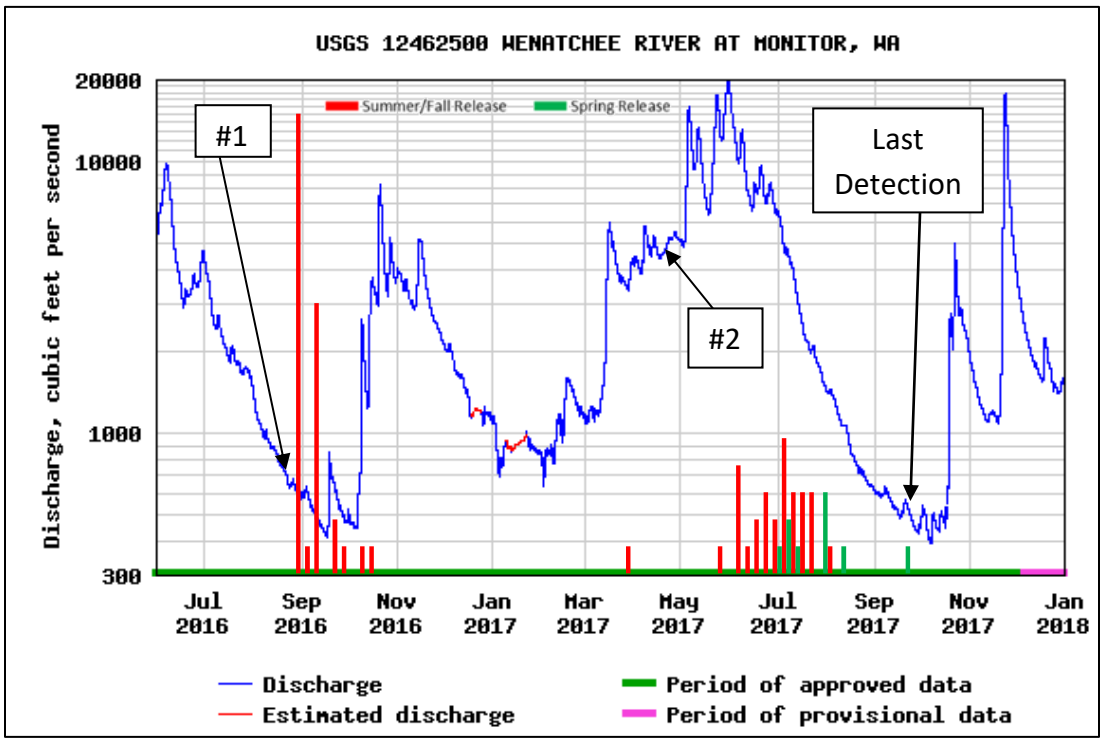


Figure G2-3. Frequency of movement by adult Pacific Lamprey from 2016 summer/fall (#1 release; red bars) and 2017 spring (#2 release; green bars) translocation release in the Wenatchee Subbasin, displayed together with the discharge data.

Appendix G3 – Translocation of Adult Pacific Lamprey within the Methow Subbasin, 2016-2017 Broodstock

Photo G3-1. Outreach event with Methow Valley Independent Learning Center students prior to releasing the adult Pacific Lamprey into Upper Methow River on April 12, 2017.

This report is composed of two parts: 1) summary of all 2016-2017 broodstock adult Pacific Lamprey releases within the Methow Subbasin and 2) analysis of migration data from PIT tagged adults. From the 2016-2017 broodstock (adults collected in summer 2016 that primarily mature in 2017), a total of 170 adult Pacific Lamprey were released in the Methow Subbasin (Fig. G3-1). Adults were released at nine locations between April 12 and 17, 2017. This is the second year that adult Pacific Lamprey were translocated into the Methow Subbasin. Prior to translocation, larval numbers and distribution have steadily decreased in the recent years and the younger age classes were mostly absent, likely as a result of depressed numbers of adults moving into the subbasin. Translocation was implemented in 2015 out of concern for the possibility of species extinction in the near future within the entire subbasin.

From the PITAGIS regional data base (http://www.ptagis.org/), using Query Builder2 Reports, the interrogation data of PIT tagged lamprey were summarized. Out of 170 PIT tagged lamprey, 69 lamprey (40.6%) were detected in at least one PIT array site within the Columbia Basin. The highlights from the 2016-2017 broodstock Pacific Lamprey translocation monitoring in the Methow Subbasin are the following:

- Sites that detected lamprey the most were CRW (Chewuch river km 1.6; 32.5%), MRC (Methow river km 46.4; 14.3%), and CRU (Chewuch river km 28.1; 13.0%) (Table G3-1).
- Estimated detection efficiencies at instream arrays were considerably lower compared to low flow fall season releases (especially MWF <8.3%, CRW = 10.0%, LMR = 11.1%, and MRC = 16.7%).
- Among the lamprey detected, the percent of lamprey that initially migrated upstream was nearly 100% for all release sites on the Methow River below Chewuch River confluence; however, those released further upstream or in tributary environment (Twisp R.) mostly

migrated downstream initially, potentially indicating the role of lamprey pheromone on attraction and migration behavior.

- Among the lamprey detected, the percent of lamprey that migrated to Chewuch River was highest for the release sites most close to the Chewuch River confluence indicating release proximity to the river confluence may influence attraction.
- The most movements were detected between mid-April and early May ("final migration") and mid-June and mid-August ("spawning"), followed by limited detections later in September and October (potential "twice overwintering lamprey?") (Fig. G3-2).
- When these movements are compared and contrasted with the associated discharge data, it becomes apparent that lamprey either avoid movement during the high flow period (mid May to mid June) or their detection efficiency becomes extremely low.
- Although fall migration is the primary migration timing observed at major hydro dams, many lamprey migrate considerable distances (e.g. >80 km) during the spring final migration within the tributary environments.

See **Appendix G3** for more information.

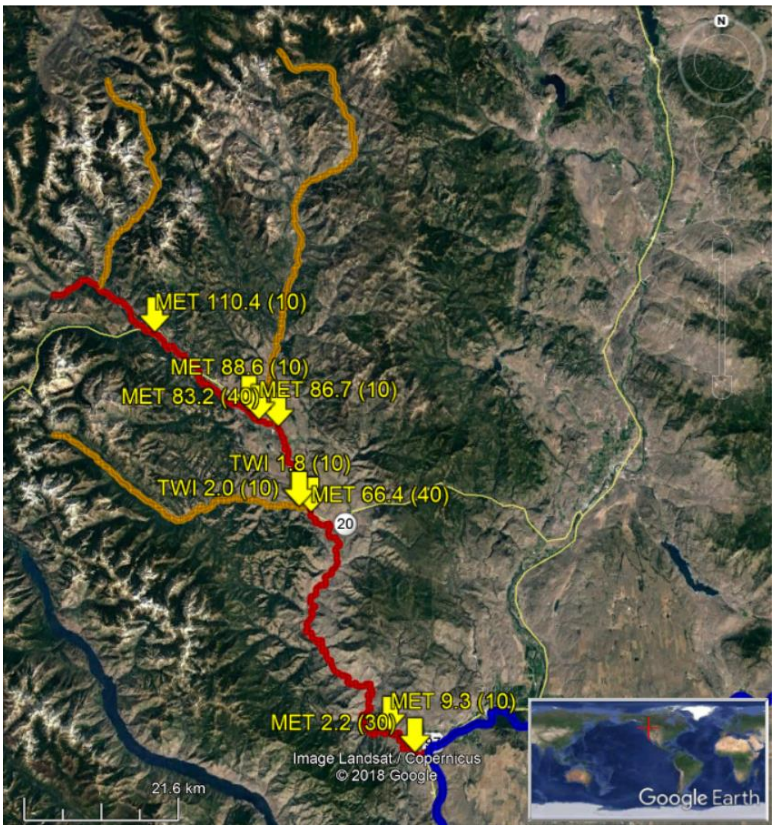


Figure G3-1. Overall aerial map of 2016-2017 broodstock Pacific Lamprey translocation release sites in the Methow and Twisp rivers. "MET" stands for Methow, "TWI" stands for Twisp, the number next to the stream name is the river km, and the number in parenthesis is the total number of lamprey released. The red line represents mainstem Methow River, the orange lines represent its tributaries (Twisp, Chewuch, and Lost rivers from downstream to upstream), and the blue line represents the Columbia River.

Table G3-1. Summary of 2016-2017 broodstock Pacific Lamprey translocation detection sites from the Methow Subbasin releases.

River	River KM	Site ID	Site Description	# of Lamprey Detected	% of Detection	Estimated Detection Efficiency
Methow	3.1	LMR	Lower Methow River at Pateros	6	7.8%	11.1%
Methow	46.4	MRC	Methow River at Carlton	11	14.3%	16.7%
Methow	80.2	MWF	Whitefish SC in Methow River	7	9.1%	<8.3%
Methow	84.4	SCP	Spring Creek Acclimation Pond	2	2.6%	N/A
Methow	88.3	MRW	Methow River at Winthrop	8	10.4%	75.0%
Twisp	1.9	TWR	Lower Twisp River near MSRF Ponds	8	10.4%	50-100%
Chewuch	1.6	CRW	Chewuch River above Winthrop	25	32.5%	10.0%
Chewuch	28.1	CRU	Upper Chewuch Instream Array	10	13.0%	50-100%
Total	-	-	-	**77**	**100%**	-

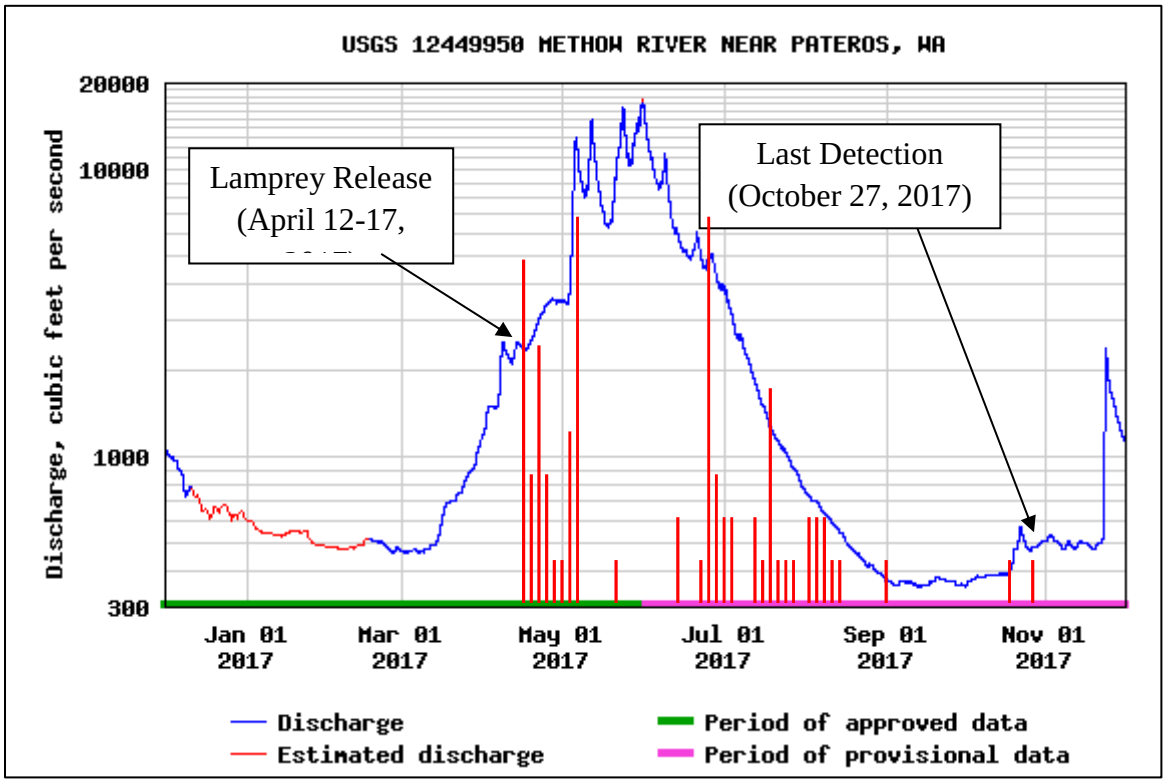


Figure G3-2. Frequency of movement (red bar) by adult Pacific Lamprey from the 2017 spring translocation release in the Methow Subbasin, displayed together with the discharge data.

H. Work Element 158 – PIT Tag Juvenile Lamprey

Work Element Associated Appendix Report:
Not Applicable (Primarily Bureau of Reclamation funding)

As a result of multiple years of surveys in dewatered irrigation diversions within the Yakima Basin, Yakama Nation Fisheries Pacific Lamprey Project (YNFPLP) has discovered that Wapato and Sunnyside diversions entrain the largest number of larval/juvenile lampreys each year. For larval lamprey, these diversions act as a migration corridor as well as an intermittent temporary rearing habitat (due to the slow water and fine sediment habitat). In the spring and fall of 2017, we released PIT tagged juvenile/larval lamprey in mainstem Yakima River downstream of Sunnyside Diversion Dam and within the diversion with the goal of assessing 1) the detection efficiencies of the mainstem Yakima River PIT array immediately downstream of Sunnyside Diversion Dam as well as the newly installed bypass arrays and 2) the rate of return to mainstem Yakima River migration through the bypass channel from releases in various locations within Sunnyside Diversion. Pico Full Duplex PIT tags (8.4 mm) were used for this study.

During the spring season (April 25, 2017), we released PIT tagged juvenile lamprey (N=126; all Pacific Lamprey macrophthalmia life stage except two Pacific Lamprey larvae) downstream of Sunnyside Diversion Dam (river km 171.4) immediately upstream of the PIT array (Fig. H1-1 and H1-2). These natural wild run juvenile Pacific Lamprey were all captured at Chandler Juvenile Monitoring Facility (Prosser, WA) between March 28, 2017, and April 20, 2017.

During the fall season (October 13, 2017), we released PIT tagged larval lamprey (N=124) within Sunnyside Diversion to assess PIT array detection efficiencies and migration behavior up to the dewatering season. These lamprey were released in five separate locations. All the lampreys used in this study were either from the Yakima or Naches River (salvaged lamprey from various Yakima / Naches subbasin diversions – primarily Sunnyside, Wapato, and Wapatox diversions).

Details of this juvenile/larva lamprey PIT tag study will be discussed in more details in the 2017 Annual Progress Report for the Bureau of Reclamation (the primary funding source for this project).

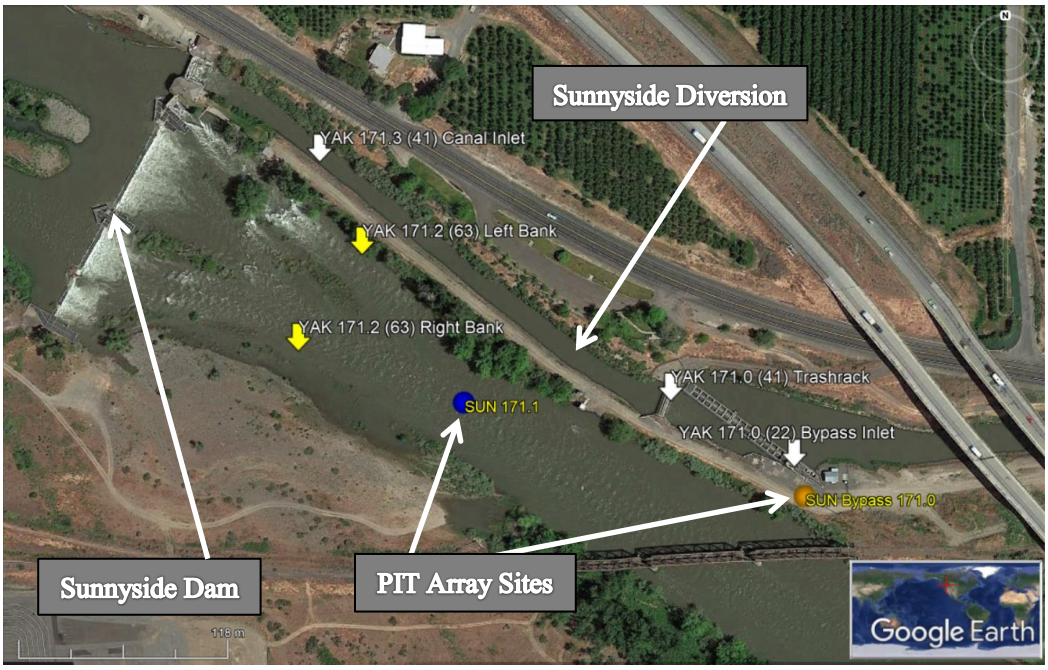


Figure H1-1. Overview map of the 2017 PIT tagged juvenile/larva lamprey study at Sunnyside Diversion Dam. The yellow downward facing arrows are the spring release sites (mainstem Yakima River), and the white downward facing arrows are the fall release sites (Sunnyside Diversion). For each release site, the number next to the river abbreviation (Yakima) is the river km and the number inside the parenthesis is the number of lamprey released, followed by a general description of the release site. Also, the PIT array locations are displayed by the blue and orange circles. See Figure H1-2 for the release site locations within the bypass outlet.

Figure H1-2. Close up map of the 2017 PIT tagged juvenile/larva lamprey study at Sunnyside Diversion Dam within the bypass outlet. The white downward facing arrows are the fall release sites (Sunnyside Diversion). For each release site, the number next to the river abbreviation (Yakima) is the river km and the number inside the parenthesis is the number of lamprey released, followed by a general description of the release site.

I. Work Element 196 – Council Step Process for Lamprey Artificial Propagation Activities (with CRITFC)

Work Element Associated Appendix Report:
Not Applicable

In 2017, Yakama Nation and other CRB tribes continued working though the 3-step process and learning what aspects of this process will be/is relevant to our proposed artificial propagation actions for lamprey. We have been in contact with BPA COTR's and all parties agree that this is a new undertaking and may require a modified strategy to complete this work. We will work closely and collaboratively to insure that this process is completed in a timely manner. See Work Element 174 above for more information. The final draft of the "Master Plan for Pacific Lamprey Supplementation, Aquaculture, Restoration, and Research" will be submitted in March 2018.

J. Work Element 176 – Research into Artificial Propagation and Juvenile Propagation

Work Element Associated Appendix Report:
Not Applicable (Chelan County Public Utility District funding)

By October 2017, the Yakama Nation finished the key experiments for the first year of the three year study. Coordination meetings were held frequently among the Yakama Nation, USFWS, Confederated Tribes of the Umatilla Indian Reservation / NOAA Fisheries to ensure that our studies were well coordinated and planned for the season. This year we focused on the following topics:

- Refine incubation methods to maximize survival rates from fertilization to prolarvae.
- Evaluate sensitivity and vulnerability of eggs, prolarvae, and early life stage of larvae to transportation from simulated transportation experiments
- Test alternative feed ingredients for rearing larval lamprey in medium to high density conditions.
- Continue to rear ammocoetes for long term objective of metamorphosed juvenile production.

Experiments in support of artificial propagation and larval rearing was conducted at YN Prosser Hatchery located in Prosser, WA. The facility has a plentiful supply of both river water and well water throughout the year. Inside the lamprey incubation room are six columns (16 tray each) of heath trays, two 75-gallon incubation troughs, and twenty 10-gallon aquarium tanks for larval feeding and there is space available to potentially set up more tanks.

For the incubation study, we experimented with various flow rates to determine the best rate for egg incubation. Past studies have indicated that lamprey eggs require very low flow at the early stages, but we would like to test whether the low flow has any positive or negative effects in the later stages of egg development.

For the transportation experiments, larvae (from 0-60 days post hatching) were placed in a container that underwent vibration (through the use of a vibration machine or other means) for a set duration (1-4 hours). When the time comes to outplant the early life stages of lamprey, it would be important to assess the level of sensitivity at each stage so that we have a better understanding of the inherent risks involved in transportation for each of these life stages. Temperature conditions will be controlled to the extent possible to remove variables associated with high temperature or rapid changes in temperature.

For the rearing study, hatchlings were subsampled for length and weight, counted, and installed in each replicate chamber. At the YN Prosser Hatchery, these units were 25-L aquarium tanks supplied with flow through well water (1.0 L/min) at 14ºC ± 1ºC. A sand substrate (2.5 cm deep for newly hatched larvae) was provided in each tank and light was moderated using light timers simulating natural light regime. On week eight, all larvae were counted, and a subsample of larvae (15-30 per tank) were measured and weighed.

Active dry yeast is one of the primary feeds that have been used widely for rearing larval lamprey. We also included treatments with alternative feeds including Otohime A1 (Reed Mariculture), alfalfa pellets, salmonid carcasses, various types of flour meals (wheat, soy, mixed, etc.), and chicken eggs. The primary objective was to find a cost effective natural alternative feed that is able to sustain high survival and growth rates even under high density conditions. The starting density were 188-375 fish per tank (between 3.8-7.5 g/m^2 based on an average start weight of 0.0025 g). The end density will be 105-210 g /m^2, based on 100% survival and an average end weight of 0.07 g. Approximately 125 g/m^2 is considered the maximum recommended fish density for rearing larval lamprey above which larval survival and/or growth is limited. Each treatment included three replicates. Additional tanks were used to measure the impact of other types of variables. These treatments continued for eight weeks, after which larval lamprey survival increases considerably.

Details of this juvenile/larva lamprey PIT tag study will be discussed in more details in the 2017 Annual Progress Report for the Chelan County Public Utility District and Bureau of Reclamation (the primary funding sources for this project) (Fig. J1-1 through J1-7).

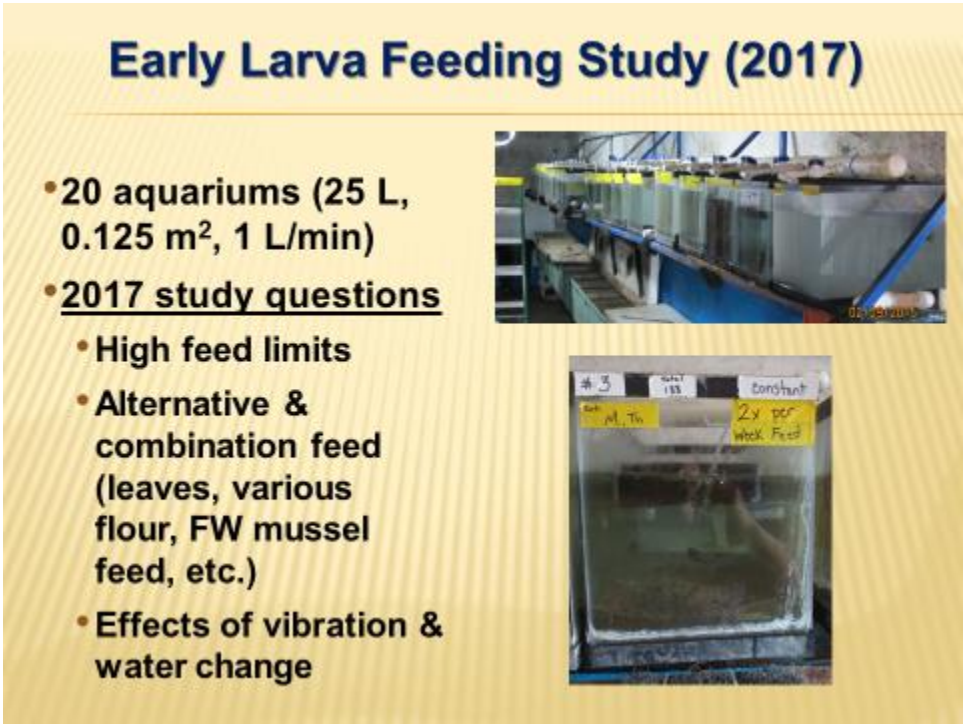


Figure J1-1. A collection of PowerPoint slides highlighting the 2017 artificial propagation and larval rearing results (page 1).

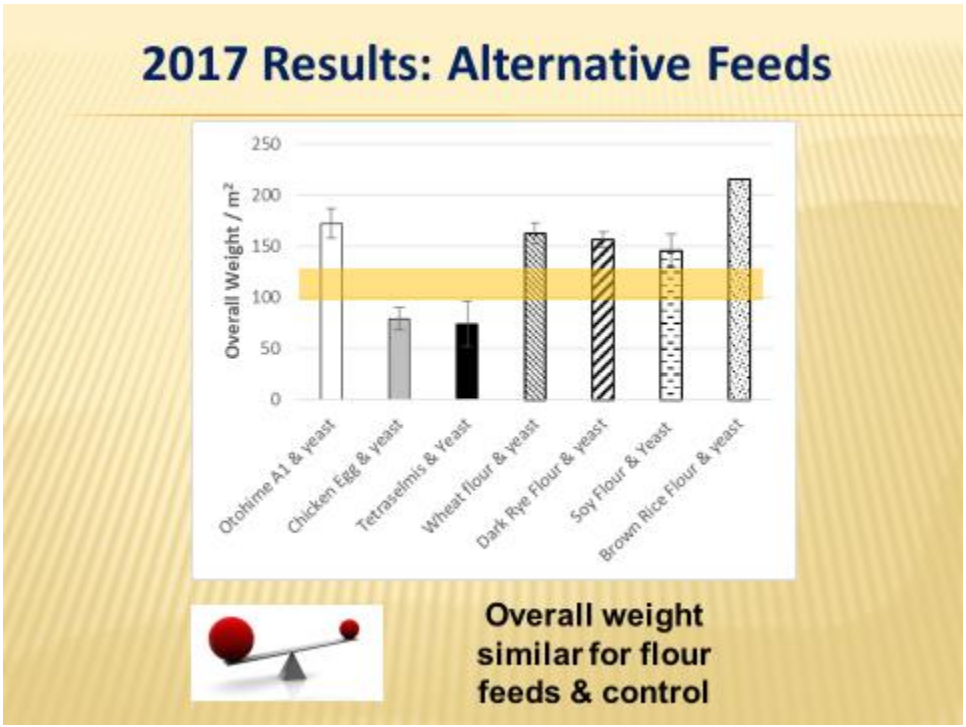


Figure J1-2. A collection of PowerPoint slides highlighting the 2017 artificial propagation and larval rearing results (page 2).

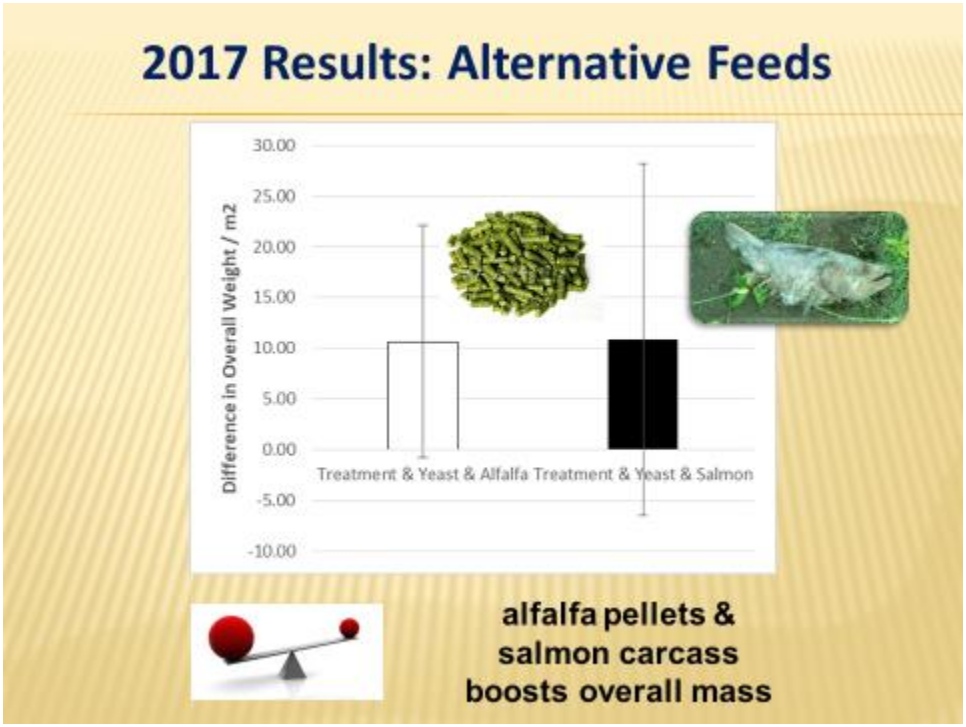


Figure J1-3. A collection of PowerPoint slides highlighting the 2017 artificial propagation and larval rearing results (page 3).

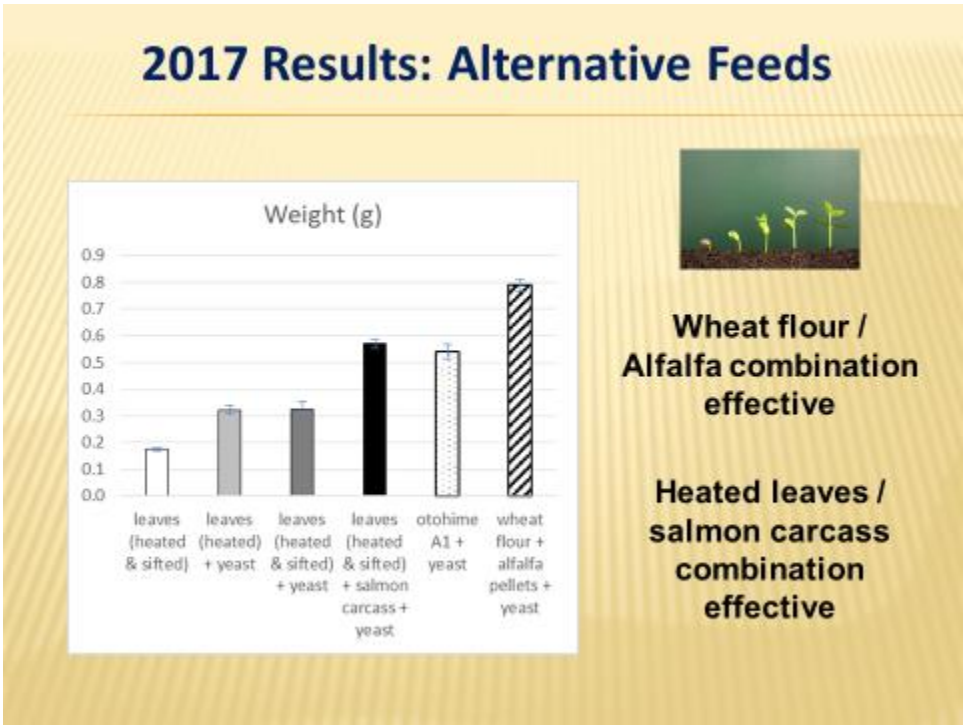


Figure J1-4. A collection of PowerPoint slides highlighting the 2017 artificial propagation and larval rearing results (page 4).

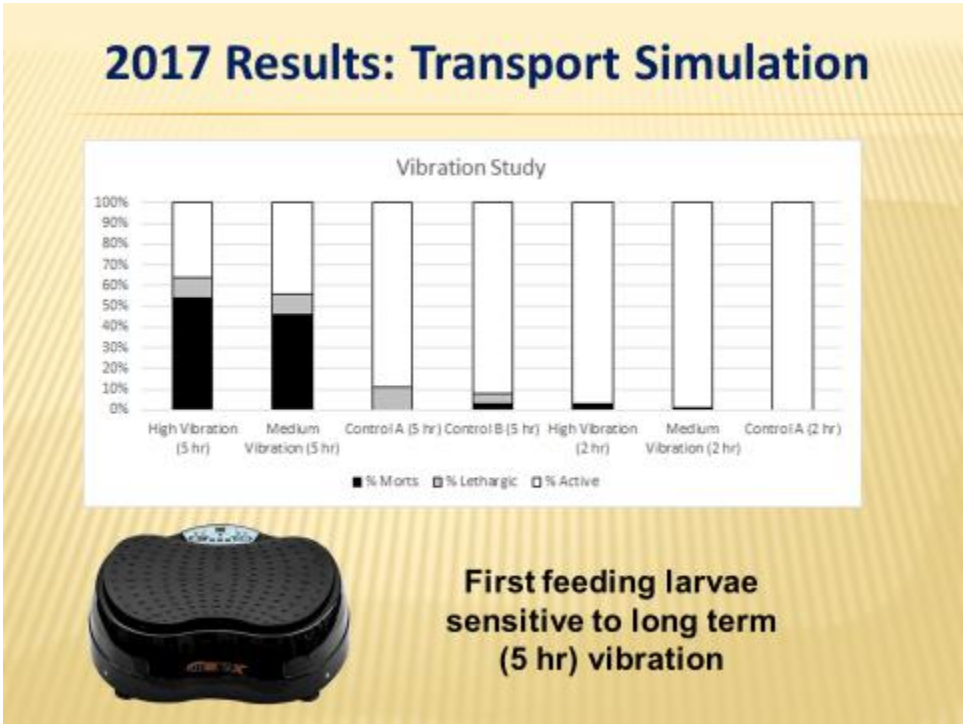


Figure J1-5. A collection of PowerPoint slides highlighting the 2017 artificial propagation and larval rearing results (page 5).

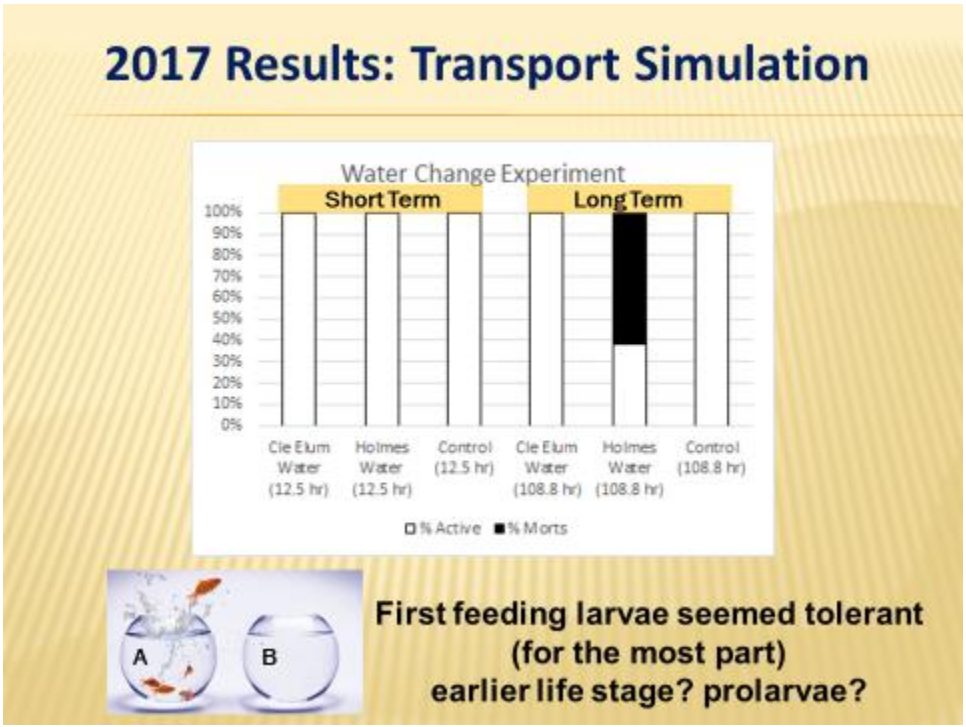


Figure J1-6. A collection of PowerPoint slides highlighting the 2017 artificial propagation and larval rearing results (page 6).

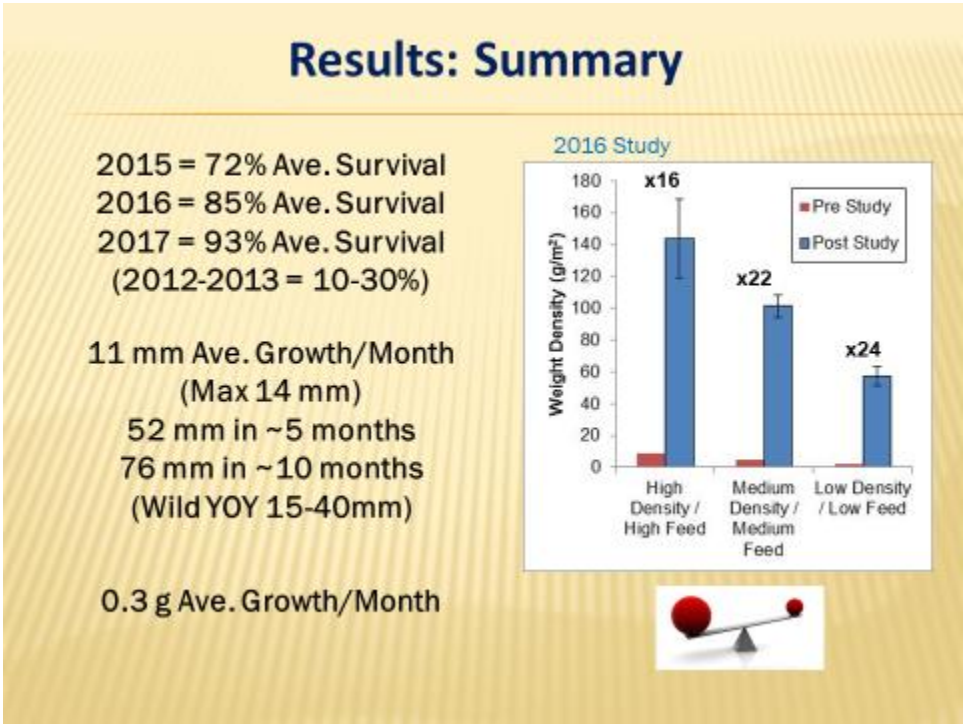


Figure J1-7. A collection of PowerPoint slides highlighting the 2017 artificial propagation and larval rearing results (page 7).

K. Work Element 28 – Trap and Haul Adult Lamprey from Columbia River

Work Element Associated Appendix Report:

Appendix K1 – Yakama Nation Adult Pacific Lamprey Collection in the Columbia River Basin, 2017

Photo K1. Bonneville Dam LPS on Washington Shore on May 23, 2017.

A total of 1,248 adult lamprey were requested for allocation based on Tribal Restoration Plan guideline, which was recently updated in 2017 (Table K1-1). Adult collection for the YNPLP in 2017 began on June 17, 2017, at Bonneville Dam and was completed on August 15, 2017, at The Dalles and John Day dams. In total, 1248 adult lamprey (331 from Bonneville Dam, 525 from The Dalles Dam, and 392 from John Day Dam) were collected (Fig. K1-1 and Table K1-2). We had a total of 113 mortalities in 2017 with a mortality rate of 9.1%. The high mortality rate is partly due to the high occurrences of furunculosis in the Lower Columbia during the summer of 2017 as well as a large mortality event on July 6, 2017, when 46 adults from the previous day collection on July 5, 2017, died. An additional 24 adults from this collection day died during or after transport, totaling 67 (almost 20% of the 348 adults collected this day).

Some of the lessons from this large mortality event were: 1) ensure we arrive and leave as early as possible to avoid handling lamprey during the warmest period of the day; 2) minimize the time that lamprey stay in the transport totes (if they can be left in tanks with flowing water, best to leave them there and pick them up on your return trip); 3) avoid filling up the water too high in transport totes as the repetitive extra vibration caused by excess water bouncing off the lid and corners can be stressful to the lamprey (starting with a half full tote will contain it to within 3 quarters full even after we add additional river ice); 4) remove separator buckets if there are no need to separate the lamprey by source (extra source of stress); 5) ensure temperature is lowered adequately during the transport (the goal is to get it near 15-16˚C in a timely fashion); and 6) reduce the oxygen supply from 1.0 ml/L to 0.25 to 0.5 ml/L after 1-2 hours (otherwise oxygen supersaturation can occur, potentially harming lamprey). In addition, we communicated the need for our crew as well as the Columbia Intertribal Fish Commission (CRITFC) crew to reject lamprey that have any signs of weakness (white belly, sluggish movement, cloudy eyes, etc.). The rejected lamprey were then released immediately upstream of the collection dam to reduce the long transport time and physiological stress, thereby enhancing their chances of survival.

See **Appendix K1** for more information.

Table K1-1. Total allocation per tribe for 2017 based on updated Tribal Restoration Plan guidelines (*guideline was updated in 2017). **The total number is a set number based on previous Bonneville Dam counts and does not equate to the sum of all the individual project numbers, which connote the maximum numbers allowed from each project.

Project	*Allocation #	# Requested
Bonneville Dam	1248	392
The Dalles Dam	599	599
John Day Dam	453	453
Total	**2496	**1248

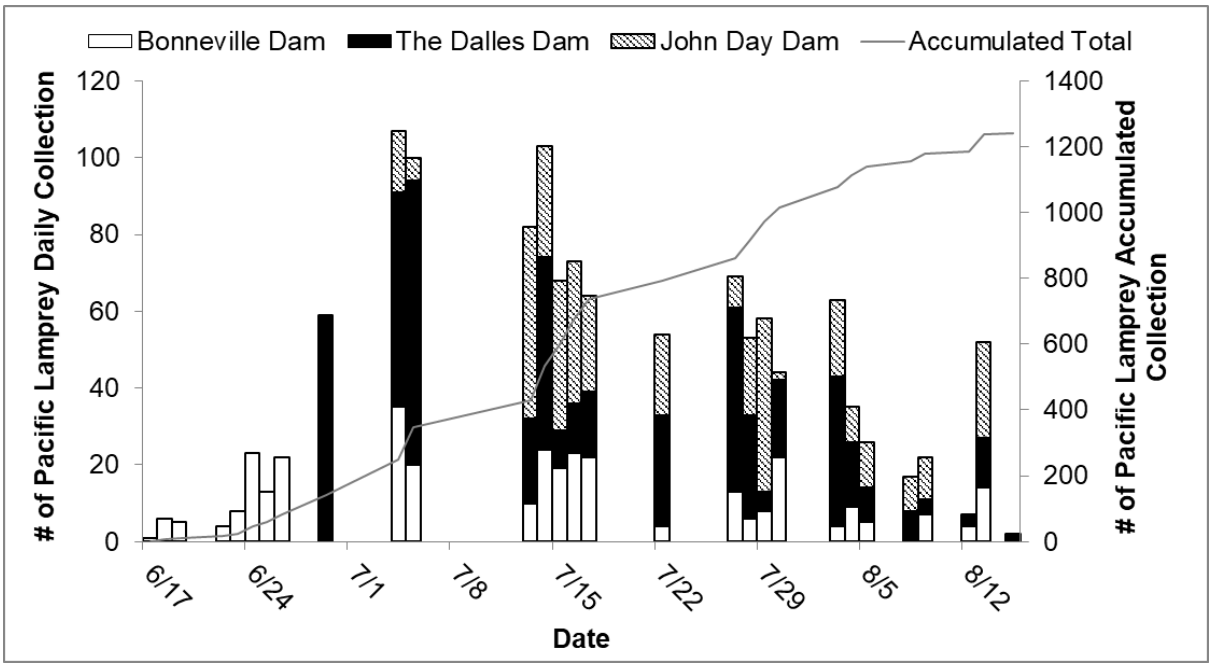


Figure K1-1. Summary of adult Pacific Lamprey collection numbers (daily and accumulated numbers) from 2016 collection.

Table K1-2. Summary of adult Pacific Lamprey collection data from Columbia River hydro dams (John Day, The Dalles and Bonneville dams) in 2017. (N Ladder = North Ladder, S Trap = South Trap, E Ladder = East Ladder, CI = Cascade Island, AFF = Adult Fish Facility, BI = Bradford Island, LFS = Lamprey Flume System). Bold dates denotes the dates that Yakama Nation actually physically picked up the lamprey. Hyphen in the trap collection sections indicates no trapping (as opposed to capturing zero lamprey).

Date	John Day Dam			The Dalles Dam			Bonneville Dam					Daily Total	Accumulated Total
	N Ladder	S Trap	Total	N Ladder	E Ladder	Total	CI	AFF	BI	LFS	Total		
6/17/2017	-	-	0	-	-	0	-	-	1	-	1	1	1
6/18/2017	-	-	0	-	-	0	-	-	6	-	6	6	7
6/19/2017	-	-	0	-	-	0	-	-	5	-	5	5	12
6/22/2017	-	-	0	-	-	0	-	-	4	-	4	4	16
6/23/2017	-	-	0	-	-	0	-	4	3	1	8	8	24
6/24/2017	-	-	0	-	-	0	-	4	18	1	23	23	47
6/25/2017	-	-	0	-	-	0	-	5	8	0	13	13	60
6/26/2017	-	-	0	-	-	0	-	9	13	0	22	22	82
6/29/2017	-	-	0	-	59	59	-	-	-	-	0	59	141
7/4/2017	16	-	16	-	56	56	-	6	29	0	35	107	248
7/5/2017	6	-	6	-	74	74	-	1	14	5	20	100	348
7/13/2017	50	-	50	-	22	22	-	6	4	0	10	82	430
7/14/2017	29	-	29	-	50	50	-	7	17	0	24	103	533
7/15/2017	19	20	39	-	10	10	-	8	11	0	19	68	601
7/16/2017	24	13	37	-	13	13	-	0	14	9	23	73	674
7/17/2017	14	11	25	-	17	17	-	3	14	5	22	64	738
7/22/2017	7	14	21	-	29	29	-	2	2	0	4	54	792
7/27/2017	4	4	8	-	48	48	-	13	0	0	13	69	861
7/28/2017	10	10	20	-	27	27	-	0	6	0	6	53	914
7/29/2017	29	16	45	-	5	5	-	4	4	0	8	58	972
7/30/2017	2	0	2	-	20	20	-	1	21	0	22	44	1016
8/3/2017	20	0	20	-	39	39	-	1	3	0	4	63	1079
8/4/2017	8	1	9	-	17	17	-	1	8	0	9	35	1114
8/5/2017	11	1	12	-	9	9	-	5	0	0	5	26	1140
8/8/2017	1	8	9	-	8	8	-	0	0	0	0	17	1157
8/9/2017	7	4	11	-	4	4	-	1	6	0	7	22	1179
8/12/2017	-	-	0	-	3	3	-	1	3	0	4	7	1186
8/13/2017	13	12	25	-	13	13	-	0	14	0	14	52	1238
8/15/2017	7	1	8	-	2	2						10	1248
Total	**277**	**115**	**392**	**0**	**525**	**525**	**0**	**82**	**228**	**21**	**331**	**1248**	**1248**

L. Work Element 162 – Data Input and Analysis

To accomplish the goal of restoring natural production, YNPLP has focused activities on five general objectives: 1) establishing baseline and long term status and trend monitoring data for the presence/absence and relative abundance of Pacific Lamprey, 2) understanding primary limiting factors affecting abundance of local populations, 3) continuously updating subbasin "Action Plans" that identify key activities to promote Pacific Lamprey recovery, and 4) continuing research and development into adult supplementation practice and reintroduce by translocation where local populations have been extirpated or functionally extirpated. Since initiation of the YNPLP in 2008,

we have gained a better understanding on program development and prioritizing action plans based upon these objectives. Additional research topics each year have focused on furthering these specific objectives.

Data Depository

All mapping data are currently stored in the Google Earth program and all quantitative data are stored in Microsoft Excel, and all reports are stored in Microsoft Word. All files are backed up on the YN share drive as well as external hard drive regularly. The YNPLP will merge these data together so that they can be stored on a data depository, such as StreamNet, Pacific States Marine Fisheries Commission, and/or other entities (including internal Yakama Nation data depository). We have also scanned all field data sheets from the beginning of the project (2008) to make all hard copy data available in electronic forms. Data depository options were previously discussed with YN GIS specialists (Leon Ganuelas) and StreamNet staff (Van Hare and Michael Banach), and these options will be pursued further in 2018-2019. The USFWS has also set up a data archival recently for ArcGIS map related data as well as other types of documents for lamprey, and this database has the potential to serve as a shared archive for all Pacific Lamprey related data range wide and information contributed by an assortment of collaborating agencies. All of this data / information are available upon request.

Work Element Associated Appendix Reports:

Appendix L1 – Columbia Basin Lamprey Identification Guide

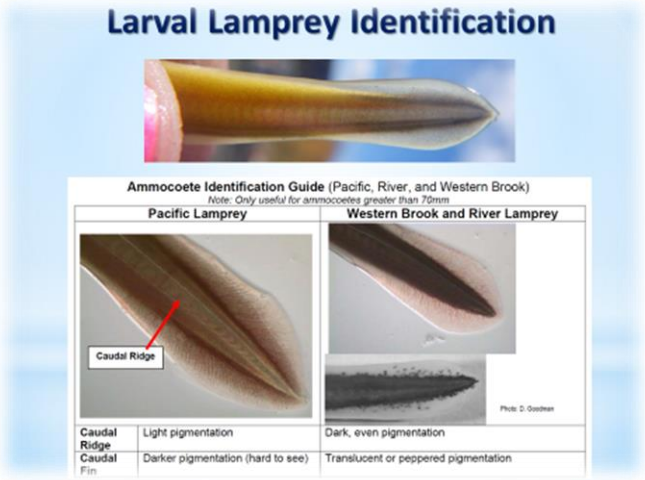


Photo L2. Identification of larval lamprey can be very confusing for beginners as well as experienced biologists and the original identification guide did not provide adequate explanation for what to specifically observe and examine in the larval lamprey tail.

Entosphenus and Lampetra species are diverse in some regions of the Pacific Northwest (in particular, Klamath River Basin) with many unique endemic species of lamprey. This guide will not provide enough detail to identify all those species, but it was drafted with the intention to help

those that work primarily with Pacific Lamprey (Entosphenus tridentatus), Western River Lamprey (Lampetra ayresii), Western Brook Lamprey (L. richardsoni) and/or Pacific Brook Lamprey (L. pacifica) within the Columbia River Basin or other basins with primarily those target species present (Fig. L1-1 and L1-2).

Description for Columbia Basin Lamprey Identification Guide (Adults / Juvenile):
The dentition guide on the lower right highlights three areas: supraoral lamina (A), lateral circumorals or endolaterals (B), and infraoral lamina (C) and the number of teeth within. The (2-3-2) represents the number of cusps within each teeth (from top to bottom). The secondary sexual characteristics highlighted and displayed in the guide typically only show up immediately prior to the spawning season (a few months to a few days prior to spawning, depending on the trait), and sexing of adults prior to this period is very difficult.

Description for Columbia Basin Lamprey Identification Guide (Larvae):
The larvae guide focuses primarily on distinguishing Pacific Lamprey from Lampetra species (primarily Lampetra ayresii, L. richardsoni, and L. pacifica). However, the morphological difference between L. richardsoni and L. pacifica is limited (primary difference is myomere counts, which includes some overlap). Also, no obvious genetic difference between L. ayresii and L. richardsoni has been identified at a local scale, suggesting that these two species may actually be one species with two life history (similar to steelhead and rainbow trout).

As a result, it is difficult to accurately distinguish the various species of Lampetra larvae using a guide based on morphology, but through genetic analyses conducted by Columbia River Intertribal Fish Commission, we have identified two distinct groups of Lampetra species (Class A and B). All larvae shown here in photos were genetically analyzed and confirmed. Class A has a clear caudal fin and no “wide” triangle-shaped translucent (technically, not completely translucent, but lighter-colored) area in the caudal ridge (usually pigmented or only has narrow translucent area). Class B has a speckled and/or mottled caudal fin (in some ways similar to Pacific Lamprey) and usually no or only a small “wide” triangle-shaped translucent area in the caudal ridge. Pacific Lamprey has a pigmented and/or speckled caudal fin and a “wide” triangle-shaped translucent area (red highlighted area; this triangle gradually gets larger and extends further as larvae grow larger). All three groups of lamprey may have a “narrow” translucent area (green highlighted area) especially when they are smaller (<100 mm), which needs to be distinguished from the “wide” translucent area. The guide makes an attempt to show these differences among the three groups of lamprey and by size (not to forget individual variation).

Although there is some color and size based differences at the egg stage, there is very little difference among the three groups of lamprey until they reach 45-60 mm. Experienced biologist can ID Pacific Lamprey features as early as 40-50mm (but identifying Lampetra at 40-50mm is not recommended as it may be simply be a Pacific Lamprey that has not manifested its species

specific features quite yet). Biologists with intermediate experience can identify lamprey down to 50-70 mm sizes. We recommend beginners (with limited experience) to start identification with larger larvae (>70 mm). These tail differences can also be used for transformer and to some extent adult life stages (in addition to other features such as dentition).

Other sources:

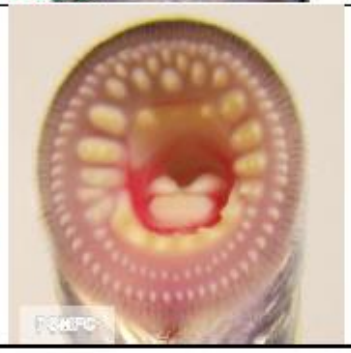
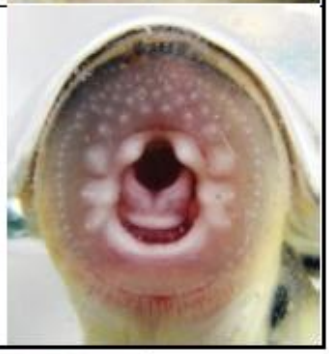
Goodman, D. H., A. P. Kinziger, S. B. Reid, and M. F. Docker. 2009. Morphological diagnosis of Entosphenus and Lampetra ammocoetes (Petromyzontidae) in Washington, Oregon, and California. In L. R. Brown, S. D. Chase, M. G. Mesa, R. J. Beamish and P. B. Moyle (editors), Biology, Management, and Conservation of Lampreys in North America, American Fisheries Society, Bethesda, MD. Pp. 223–232.

Renaud, C.B. 2011. Lampreys of the world: An annotated and illustrated catalogue of lamprey species known to date. FAO Species Catalogue for Fishery Purposes No. 5., Rome, FAO. 109 pp.

Columbia Basin Lamprey Identification Guide (Adults / Juvenile)

*last updated 11/22/2017

Prepared by Ralph Lampman (lamr@yakamafish-nsn.gov), Yakama Nation Fisheries

Species Name	Pacific Lamprey (*Entosphenus tridentatus*)	Western River Lamprey (*Lampetra ayresii*); anadromous *Lampetra*	Western & Pacific Brook Lamprey (*Lampetra richardsoni & pacifica*); resident *Lampetra*
Adult Length	330-840 mm (13-33 inch) (coastal dwarf type 200-330mm)	200-330 mm (8-13 inch)	90-200 mm (3.5-8 inch)
Juvenile Length	Typically 90-200 mm (3.5-8 inch)	Typically 90-200 mm (3.5-8 inch)	Typically 90-200 mm (3.5-8 inch)
Dentition Pattern	A: 3 (juvenile initially 2), B: 4 (typically 2-3-3-2), C: 5-6	A: 2, B: 3 (typically 2-3-2 or 2-2-2), C: 7-10	A: 2, B: 3 (typically 1-2-1, 2-2-1, or 2-2-2), C: 7-10
Adult Dentition *see Dentition Pattern & Dentition Guide (bottom right)			
Juvenile (Trans-former) Dentition *see Dentition Pattern & Dentition Guide (bottom right)			

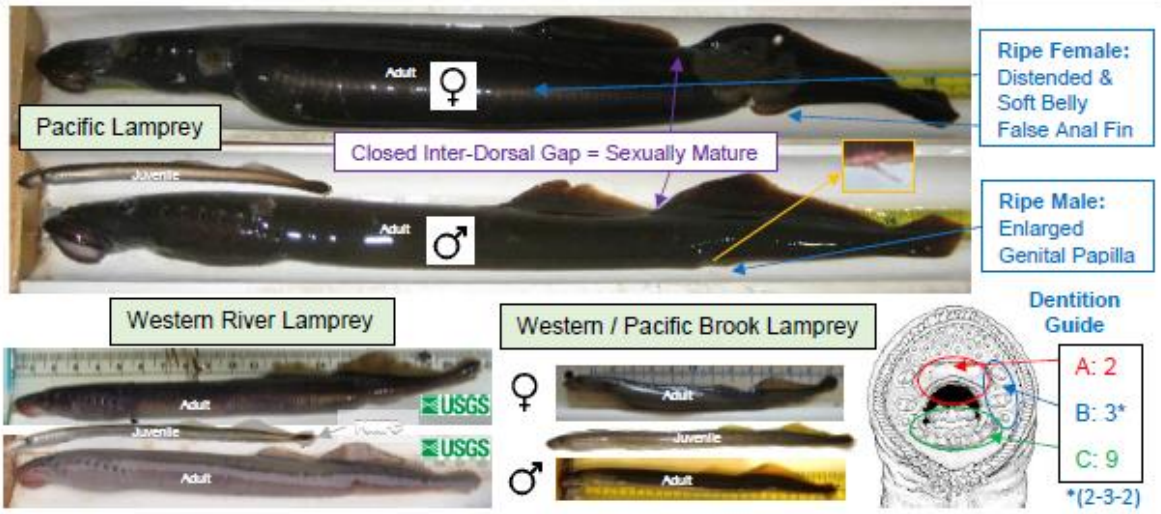


Figure L1-1. Columbia Basin Lamprey Identification Guide (Adults / Juvenile) page.

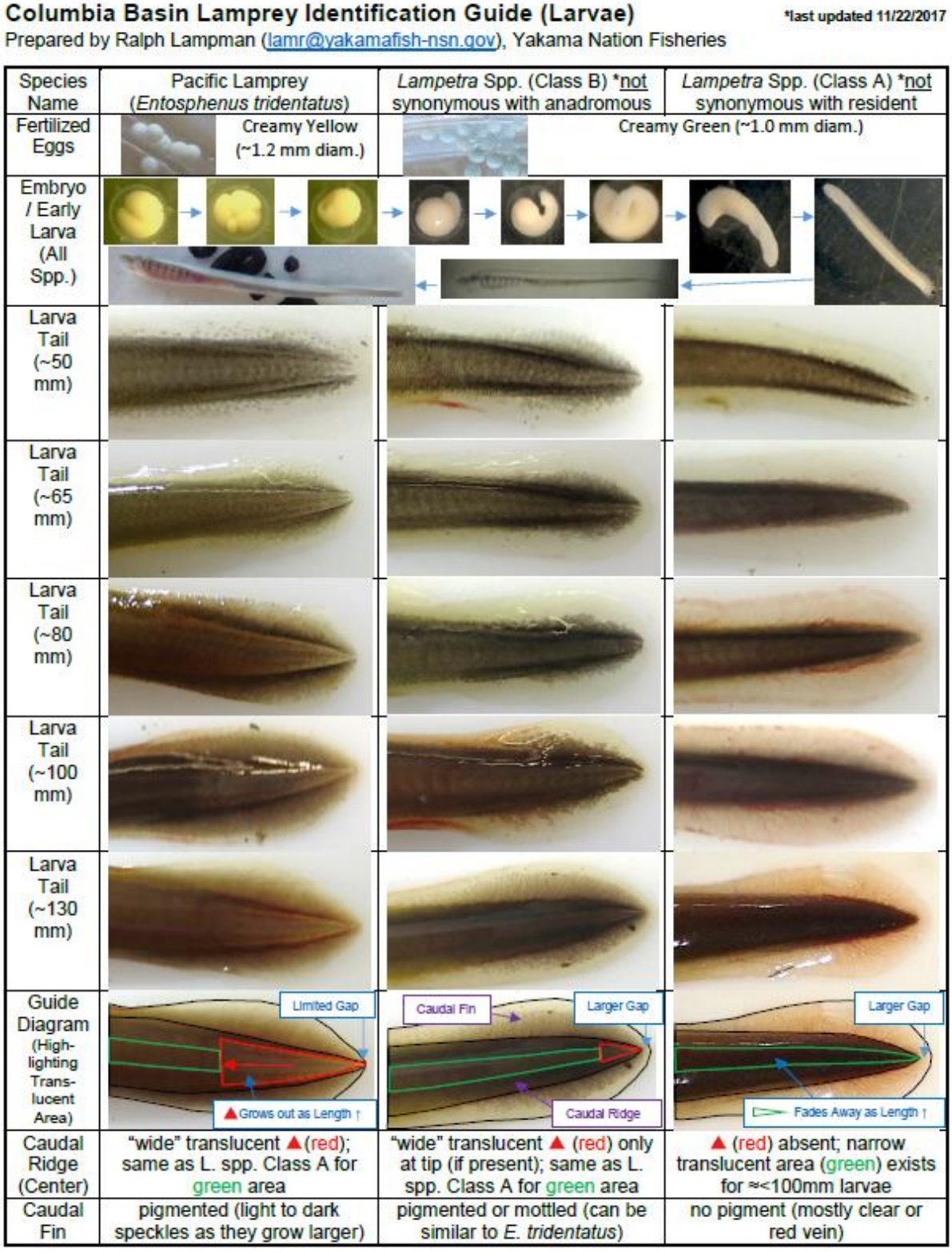


Figure L1-2. Columbia Basin Lamprey Identification Guide (Larvae) page.

Appendix L2 - Larval Lamprey Assessment at the Sunnyside Fish Screening Facility, 2017

Photo L2. Survey boat (4 m V-hulled fishing boat) used to deploy the deepwater electrofishing platform at Sunnyside Screens.

In 2017, Pacific Northwest National Laboratory (PNNL), DC Consulting LLC and staff from the Yakama Nation conducted deep water larval lamprey surveys within Sunnyside Diversion Fish Screening Facility to determine lamprey relative abundance and temporal changes in abundance over time (Fig. L2-1). We used a deep-water electrofishing platform (DEP) designed and built by PNNL and deployed it from a survey boat (4 m V-hulled fishing boat; Photo L2). Currently, no other method exists to survey these regions and determine the presence/absence, density, and size classes of larvae that are rearing in deep water regions of river deltas or near screening facilities in diversion channels while in operation. The DEP has been laboratory and field tested, and shown to be an extremely effective tool at determining the presence/absence of larval lamprey as well as characterizing the physical habitat parameters encountered during the surveys.

The Sunnyside Diversion Dam is located at Rkm 165.7 of the Yakima River. Water is diverted from the river at flow rates up to 37 m^3/sec during the irrigation season which starts in mid-March. The canal is normally dewatered mid to late October. The facility consists of a headgate, 15 drum screens, trash rack, and fish return bypass systems. The survey location included the region immediately downstream of the drum screens in the canal (Figure 2).

Two surveys were conducted on August 16 and September 25, 2017 (Table L2-1). On the first survey, a total of 70 locations were electroshocked within the region of interest in water depths ranging from 1.4 to 4 m. Water clarity was conducive to electrofishing with ~1 m visibility. The majority of the substrates were Type 1 or Type II. Hard and rocky bottom was observed along the immediate downstream portions of the screens and along the north canal bank. A total of 18 lamprey ammocoetes were observed across all size ranges. The total area surveyed using a 0.33 m^2 average was 23.1 m^2 and the overall density was estimated to be 0.74 fish per m^2.

The second survey was conducted on September 25, 2017 and a total of 60 locations were surveyed. A total of 47 lamprey ammocoetes were observed across all size ranges. The total area surveyed using a 0.33 m^2 average, was 19.8 m^2 and the overall density was estimated to be 2.4 fish per m^2.

Based on our survey in 2017, larval lamprey densities tended to increase from less than 1 lamprey per m^2 to 2.3 m^2 over a 40-day period. The September survey density estimate was skewed in large part due to a total 25 lamprey that were found at one location which had significant impact on the density estimate. These lamprey were all very small and estimated to have lengths of ~25 mm. If this location was omitted, the average density estimate is reduced from 2.4 to 1.1 lamprey per m^2 resulting in an estimate of 1,551 lamprey inhabiting the suitable region which is similar to the August estimate of 1,128 lamprey. In October 2015 a similar survey was conducted by PNNL in the same general region as the current survey (Mueller 2016). An average density was estimated at 8.8 lamprey per m^2 at 46 sampling points. It is apparent that large fluctuation do occur from year to year as lamprey entraining rates may be impacted by population fluctuations, annual fluctuations in discharge, local changes in channel hydrology and river bottom configurations, and mortalities associated with dewatering operations.

See **Appendix L2** for more information.

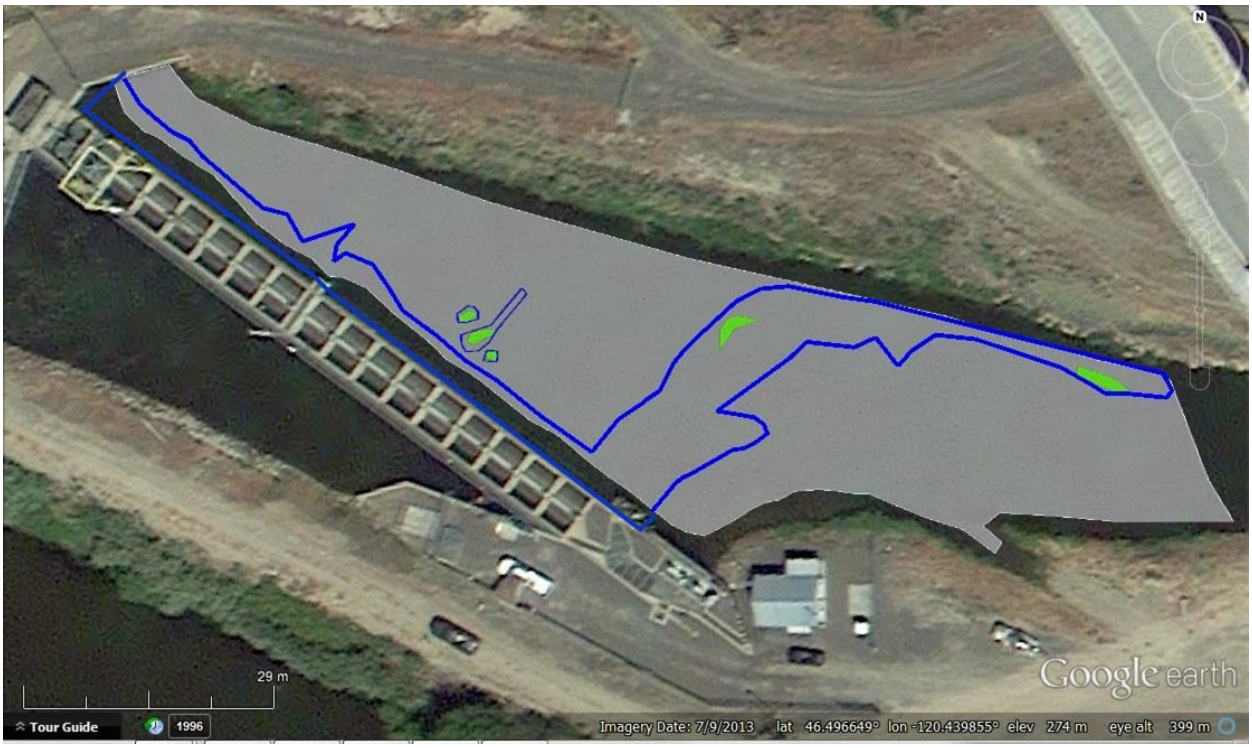


Figure L2-1. Survey region downstream from the fish screens at Sunnyside Diversion. The priority survey region includes the area that dries up after dewatering (grey area outside of blue polygon), as well as the area that stays wet after dewatering (blue polygons). Green regions indicate locations surveyed by Yakama Nation in 2014.

Table L2-1. Sampling parameters and lamprey densities observed downstream of Sunnyside Screening Facility on August 16 and September 25, 2017.

	Survey 1	Survey 2
Overall Size (m^2)	2,870	2,870
Suitable Region (m^2)[1]	1,410	1,410
Number of Lamprey Observed	18	47
Density (average)	0.80	2.4
Estimated Number	1,128	3,384

[1] Includes Type I and Type II substrate types

Appendix L3 – Summary of Larval Lamprey Hook-and-Line Predator Fish Removal in Chandler Irrigation Diversion (Yakima River, Prosser), WA, 2017

Photo L3. Smallmouth Bass, Northern Pikeminnow and Channel Catfish captured by hook and line methods from Chandler Canal on August 2, 2017.

One passage bottleneck that larval lampreys likely face in the lower Yakima River is the large numbers of native and non-native predator fishes in the 800 m long canal upstream of the fish screens in the Chandler Irrigation Canal (Prosser, WA). During the summer months (July-September) in 2016 and 2017, conventional hook and line methodology (earthworms, larval Western Brook Lamprey, and artificial baits) was used to assess the diversity of predator fishes in the Chandler Canal. A total of 338 predator fishes were removed from Chandler Canal in 59.8 hours of angling (Table L3-1 and L3-2). In total, five invasive species were captured during this study (number removed shown in parenthesis); 1) Smallmouth Bass (235 total), 2) Brown Bullhead (12 total), 3) Channel Catfish (9 total), 4) Common Carp (2 total) and 5) Bluegill Sunfish (1 total). One native species was captured during this study (number removed shown in parenthesis); Northern Pikeminnow (79 total). During the day time, the most commonly captured species was Smallmouth Bass, followed by Northern Pikeminnow. During a short period of night time fishing with earthworms in 2016, the most commonly caught species was Brown Bullhead, followed by

Smallmouth Bass and Northern Pikeminnow. Live larval Western Brook Lamprey (90-100 mm) were attached to a hook, and captured predator fish were measured and enumerated by species. In 2016, Total CPUE (# of fish/hour) was highest for earthworms at 7.4 fish/hour, although larval lamprey was close behind (6.4 fish/hour) and artificial baits had the lowest CPUE (4.5 fish/hour). Future steps to monitor predation on lampreys in the canal include 1) perform hook and line study (with larval lampreys) during different seasons, 2) time of day when predators are most active (morning, afternoon, evening, or night time) with larval lamprey as bait and 3) size classes of larval lamprey and corresponding predation (predator size vs. size of predated lamprey).

See **Appendix L3** for more information.

Table L3-1. Daytime summary of predator fish removal from the Chandler Canal from hook and line efforts in years 2016 and 2017. "Rem." In the table heading stands for "Removed". "NPM" stands for Northern Pikeminnow; "SM Bass" stands for "Smallmouth Bass", "WB Lamprey" stands for "Western Brook Lamprey". "Total CPUE" is the total number of fish captured divided by the total time fishing, and "Angler CPUE" is the total number of fish captured divided by the total number of angler hours; the total number of hours fished multiplied by the number of anglers fishing.

Year	Month	Day or Night	Bait Used	# of Anglers	Total Time Fishing (Hrs)	Total Angler Time (Hrs)	# NPM Rem.	# SM Bass Rem.	# Chan. Catfish Rem.	# Bluegill Rem.	# Brown Bullhead Rem.	# Common Carp Rem.	Total # of Fish Rem.	Total CPUE (# Fish / hr)	Angler CPUE (# Fish/ Anglr. hr)
2016	Jul.	Day	WB Lamprey	1-3	1.4	1.8	7	2	0	0	0	0	9	6.4	5.1
			Earthworm		3.0	9.0	3	18	0	0	1	0	22	7.3	2.4
			Artificial		0.6	0.6	0	1	0	0	0	0	1	1.7	1.7
2016	Aug.	Day	WB Lamprey	1-2	0.0						-				
			Earthworm		17.0	31.5	55	62	5	1	1	2	126	7.4	4.0
			Artificial		10.5	16.5	0	45	2	0	0	0	47	4.5	2.8
2016	Sep.	Day	WB Lamprey	1-2	0.0						-				
			Earthworm												
			Artificial		11.5	17.0	2	52	0	0	0	0	54	4.7	3.2
2017	Aug.	Day	WB Lamprey	1	0.0						-				
			Earthworm												
			Artificial		20.3	20.3	9	49	2	0	0	0	60	3.0	3.0
2016 Total		**Day**	**WB Lamprey**	**1-3**	**1.4**	**1.8**	**7**	**2**	**0**	**0**	**0**	**0**	**9**	**6.4**	**5.1**
			Earthworm		**20.0**	**40.5**	**58**	**80**	**5**	**1**	**2**	**2**	**148**	**7.4**	**3.7**
			Artificial		**22.6**	**34.1**	**2**	**98**	**2**	**0**	**0**	**0**	**102**	**4.5**	**3.0**
2017 Total		**Day**	**WB Lamprey**	**1**	**0.0**						**-**				
			Earthworm												
			Artificial		**8.2**	**8.2**	**9**	**49**	**2**	**0**	**0**	**0**	**60**	**7.3**	**7.3**
Total		**Day**	**ALL**	**1-3**	**52.3**	**84.6**	**76**	**229**	**9**	**1**	**2**	**2**	**319**	**6.1**	**3.8**

Table L3-2. Nighttime summary of predator fish removal from the Chandler Canal from hook and line efforts in years 2016 and 2017. "Rem." In the table heading stand for "Removed". "NPM" stands for Northern Pikeminnow; "SM Bass" stands for "Smallmouth Bass", "WB Lamprey" stands for "Western Brook Lamprey". "Total CPUE" is the total number of fish captured divided by the total time fishing, and "Angler CPUE" is the total number of fish captured divided by the total number of angler hours; the total number of hours fished multiplied by the number of anglers fishing.

Year	Month	Day or Night	Bait Used	# of Anglers	Total Time Fishing (Hrs)	Total Angler Time (Hrs)	# NPM Rem.	# SM Bass Rem.	# Chan. Catfish Rem.	# Bluegill Rem.	# Brown Bullhead Rem.	# Common Carp Rem.	Total # of Fish Rem.	Total CPUE (# Fish / hr)	Angler CPUE (# Fish/ Ang. hr)
2016	Jul.	Night	WB Lamprey Earthworm Artificial	-	0.0						-				
2016	Aug.	Night	WB Lamprey Earthworm Artificial	2	0.0 7.5 0.0	15.0	3	6	0	0	- 10 -	0	19	2.5	1.3
2016	Sep.	Night	WB Lamprey Earthworm Artificial	-	0.0						-				
2017	Aug.	Night	WB Lamprey Earthworm Artificial	-	0.0						-				
2016 Total		**Night**	**WB Lamprey Earthworm Artificial**	**2**	**7.5**	**15.0**	**3**	**6**	**0**	**0**	**- 10 -**	**0**	**19**	**2.5**	**1.3**
2017 Total		**Night**	**WB Lamprey Earthworm Artificial**	**-**	**0.0**						**-**				
Total		**Night**	**ALL**	**2**	**7.5**	**15.0**	**3**	**6**	**0**	**0**	**10**	**0**	**19**	**2.5**	**1.3**

Appendix L4 – Summary of Freshwater Mussel Observations within the Yakama Nation Ceded Lands from Larval Lamprey Surveys, 2017

Photo L4. A freshwater mussel (Western Pearlshell, *Margaritifera falcate*) collected from downstream of the fish screens at Sunnyside Diversion; an irrigation diversion of the lower Yakima River at river km 171.1.

Freshwater mussels are an underappreciated species that plays an irreplaceable ecological role in the rivers and streams of the Columbia River Basin. The Yakama Nation Pacific Lamprey

Project (YNPLP) documented the presence of freshwater mussels during electrofishing surveys targeting larval lamprey. Freshwater mussels have been documented by the YNPLP in both the Yakima Subbasin (Table L4-1) and the Wenatchee Subbasin (Table L4-2). In the Yakima Subbasin, freshwater mussels were found in two large scale irrigation diversions (Sunnyside Diversion and Wapato Diversion, Yakima River, river km 171.1 and 175.3, respectively). In 2017, 63 live and 49 dead freshwater mussels were removed from the area downstream of the fish screens at Sunnyside Diversion. The freshwater mussels collected downstream of the fish screens at Sunnyside Diversion (1.5 inches to 5 inches in longest length) are too large to have drifted downstream through the fish screens, suggesting that they entered the diversion as larvae, and reared in this location for many years. The variance of size classes suggest larval mussels have entered the diversion over a multitude of years. In future years, the YNPLP will make a more concerted effort to salvage the freshwater mussels prior to their habitat drying up (priority given to the areas downstream of the fish screens).

Further in the Yakima Subbasin, freshwater mussels were found in natural stream environments while surveying for larval lamprey. Mussels were found in Toppenish Creek (tributary of the lower Yakima River), Simcoe Creek (tributary of Toppenish Creek), and in Cowichee Creek (tributary of the Naches River). Mussels found in the stream environment (natural setting), were often found in a mix of sandy and gravel/cobble substrates. Larval lamprey were also often found in the same location as freshwater mussels. Although larval lampreys prefer the deeper fine sediment, as opposed to areas with gravel and cobble, larval lamprey often utilize these gravel/cobble/fine sediment areas (Type II habitat) as well, potentially engaging in a symbiotic relationship with the freshwater mussels.

In the Wenatchee Subbasin, freshwater mussels were observed at 3.3 river km downstream of Lake Wenatchee in the mainstem Wenatchee River. At this site, only dead mussels (shells only) have been observed along the bank (trapped in woody debris). There are large areas with a mix of coarse and fine substrate, which appears to be ideal freshwater mussel habitat (based on what we have seen in other locations with freshwater mussels present).

Through photo identification by experts, and general knowledge of the locations where these freshwater mussels were found, the most dominant freshwater mussel species we encounter is Western Pearlshell (*Margaritifera falcate*). However, it is quite possible other mussel species are also present. In the future, we will add a designated space to our lamprey datasheet to collect information related to species, photos taken to confirm our identification of species, size (longest diameter length), general description of habitat, and the mussels condition (live or dead), and mortality condition (fresh mort or shells only). Our data will be submitted yearly to the Xerces Society, which documents freshwater mussel findings throughout the Northwestern United States.

See **Appendix L4** for more information.

Table L4-1. Freshwater mussel observations by the YNPLP in the Yakima Subbasin.

Subbasin	HUC4	Watershed	Stream	RKM	GPS Coordinate	Site Description	Date of Most Recent FW Mussel Sighting	Years FW Mussels Were Sighted
Yakima	Lower Yakima	Lower Yakima	Yakima	171.1	46.518724 -120.478940	Sunnyside Diversion; Canal Downstream of Fish Screens	11/2/2017	2015, 2016, 2017
				175.7	46.496552 -120.438836	Wapato Diverison; Canal Upstream of Fish Screens	3/3/2018	2015, 2016, 2017
		Toppensih	Toppenish	59.9	46.365937 -120.671330	Upstream of Shaker Church Road, White Swan, WA	7/19/2017	2017
			Simcoe	9.0	46.400997 -120.691819	Upstream of Stephenson Road, White Swan, WA	7/19/2017	2015, 2016, 2017
Yakima	Naches	Cowichee	Cowichee	1.1	46.627178 -120.581045	Bridge on Powerhouse Road Yakima, WA	2014	-

Table L4-2. Freshwater mussel observations by the YNPLP in the Wenatchee Subbasin.

Subbasin	HUC4	Watershed	Stream	RKM	GPS Coordinate	Site Description	Date of Most Recent FW Mussel Sighting	Years FW Mussels Were Sighted
Wenatchee	Upper Wenatchee	Upper Wenatchee	Wenatchee	84.0	47.815610 -120.687880	3.3 RKM downstream of Lake Wenatchee	8/23/2017	2016, 2017

M. Work Element 141 – Other Reports (Cultural Information)

Work Element Associated Appendix Report:

Appendix M1 – Yakama Nation Cultural Oral Interviews on Asum (Lamprey Eels): Summary Part III (2017)

Photo M1. Zach Penney (right) grabbing eels while Bobby Begay (center) and Russell Jackson (left) assist with the transferring and netting at Willamette Falls, OR, on June 17, 2016.

Within the past several years, the Yakama Nation Pacific Lamprey Project (YNPLP) has interviewed many tribal members, most of whom are tribal elders, to inquire questions related to Pacific Lamprey. We also interviewed some of the young and middle aged tribal members who have strong connections to lamprey related customs, traditional culture, and tribal elder family members. For many of the tribal elders, lamprey have been not only a key food source and medicine but also an integral piece of their culture and tradition, without which there is an indubitable "void" in their very existence.

Between March 2013 and March 2014, an oral interview was conducted with sixteen tribal members (all but two were recorded in full length videos), and 15 key questions were asked related to lamprey status, biology, ecology, culture, as well as human impact. Through this interview process, many insights and revelations were attained related to historical distribution, abundance, run timing, potential threats and impacts, and tradition associated with harvest, preparation, and consumption by Yakama Nation tribal members across the wide-ranging Ceded Lands.

Johnson Meninick and Tony Washines, the two interviewees for which a summary and review was completed in this report, provided unique and intriguing information related to lamprey customs and tradition within the Yakama Nation Ceded Lands. Mr. Meninick and Mr. Washines are Yakama elders born on the Yakama Reservation. They shared their tradition of eel harvest at Celilo Falls (Columbia River), White Salmon, Klickitat River, Rock Creek, and Pine Creek. On the Oregon side, they shared their experience at Willamette Falls (Willamette River), Fivemile Creek, Fifteenmile Creek, Eightmile in The Dalles, and John Day and Deschutes rivers. On the Yakima River, they discussed places such as Horn Rapids Dam, Tup-Tut (Prosser Dam area), and Wapato Dam, and tributaries including Satus and Logy creeks. They also discussed about lamprey in the upper reaches in Snake River at Ice Harbor up to Palouse River. Most of these areas and many other sites are considered Usual and Accustomed areas according to our Treaty.

To them, the best years they can recall for eel harvest was in the 1950s and early 1960s, during which many sacks of eels were harvested per season. However, since the middle 1980s, eel numbers appeared to decline sharply (notably in the Klickitat Subbasin). Information related to biology, ecology, and harvest and cooking methods were also discussed. Irrigation/Canals, dams (passage), water quality, habitat loss were considered as the leading factors contributing to the decline of Pacific Lamprey. Especially, the construction of The Dalles Dam, which inundated Celilo Falls took away a crucial harvest site and as a result many of the Yakama Nation tribal members were forced to travel longer distances to harvest eels.

See **Appendix M1** for more information.

N. Work Element 132 – Final Annual Report for CY2016 (Jan 2016 to Dec 2016)

Work Element Associated Appendix Report:
Not Applicable

The Final Annual Report (along with associated appendix reports) for the period January 2016 through December 2016 was submitted in spring 2017.

O. Work Element 132 – Annual Report for CY2017 (Jan 2017 to Dec 2017)

Work Element Associated Appendix Report:
Not Applicable

The Annual Report for the period January 2017 through December 2017 refers to this summary report and covers all the work elements that are part of the contract. This report summarizes project goals, objectives, complete and incomplete deliverables, problems encountered, lessons learned, and the information gathered, synthesized, and updated to assist in long term planning.

P. Work Element 119 – Manage and Administer Projects

Work Element Associated Appendix Report:
Not Applicable

This work element is part of this project's deliverables in relation to project administration and management. It covers milestones, such as 1) Federal Information Security Management Act law compliance, 2) final invoice submission for contract closeout, 3) estimate for end of fiscal year accrual, 4) drafting and submission of contract renewal documents, and 5) entry of cost share information. These milestones were completed successfully in 2017.

Q. Work Element 185 – Pisces Status Report

Work Element Associated Appendix Report:
Not Applicable

All quarterly Pisces Status Report for the Year 2017 were completed successfully.

IV. References

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V. Appendices

Appendix B1 – Final Draft Master Plan for Pacific Lamprey Supplementation, Aquaculture, Restoration, and Research

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Appendix C2 – Upper Yakima Subbasin Larval Lamprey Monitoring Report, 2017

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