Yakama Nation Pacific Lamprey Project
Annual Progress Report

Project No. 2008-470-00

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Cover photo: Sean Goudy showing an adult lamprey to White Swan Headstart School students before releasing it into Toppenish Creek (river km 54.3) on May 12, 2016.

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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 Progress Report for the Yakama Nation Pacific Lamprey Project (YNPLP). This report outlines the most current activities undertaken by the YNPLP from January 1, 2016 through December 31, 2016.

A: WE165 - Environmental Compliance Documentation
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 - Collect/Generate/Validate Field and Lab Data
Seven reports are submitted in association with this milestone: Appendix C1 (Lower Yakima Subbasin Larval Lamprey Monitoring Report, 2016), Appendix C2 (Upper Yakima Subbasin Larval Lamprey Monitoring Report, 2016), Appendix C3 (Naches Subbasin Larval Lamprey Monitoring Report, 2016), Appendix C4 (Wenatchee Subbasin Larval Lamprey Larval Lamprey Monitoring Report, 2016), Appendix C5 (Entiat Subbasin Larval Lamprey Monitoring Report, 2016), Appendix C6 (Methow Subbasin Larval Lamprey Monitoring Report, 2016), Appendix C7 (Lower Columbia Tributaries Larval Lamprey Monitoring Report, 2016).

D: WE28 - Trap and Haul (Larval Survey and Salvage in Irrigation Diversions)
Three reports are submitted in association with this milestone: Appendix D1 (Summary Assessment of Larval/Juvenile Lamprey Entrainment in Irrigation Diversions within the Yakima Subbasin, 2016), Appendix D2 (Intensive Monitoring of Larval/Juvenile Lamprey Entrainment within the Yakama Subbasin, 2016), and Appendix D3 (Intensive Monitoring of Larval/Juvenile Lamprey Entrainment within Dryden Diversion, Wenatchee River, 2016).

E: WE99 - Outreach and Education
One report is submitted in association with this milestone: Appendix E1 (Yakama Nation Pacific Lamprey Project Outreach and Education, 2016).

F: WE161 - Disseminate Raw/Summary Data and Results
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, 2015-2016 Broodstock), Appendix G2

(Translocation of Adult Pacific Lamprey within the Wenatchee Subbasin, 2015-2016 Broodstock), and Appendix G3 (Translocation of Adult Pacific Lamprey within the Methow Subbasin, 2015-2016 Broodstock).

H: WE 158 – PIT Tag Juvenile Lamprey

One report is submitted in association with this milestone: Appendix H1 (Juvenile/Larval Lamprey Passage Monitoring in Chandler Diversion, Yakima River [Prosser, WA], 2016) and Appendix H2 (Juvenile/Larval Lamprey Passage Monitoring in the Middle Reach of the Yakima River, 2016).

I: WE196 – Council Step Process

No additional report is submitted in association with this milestone: see Section III.

J: WE176 - Produce Hatchery Fish

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, 2016).

L: WE162 – Analyze/Interpret Data

Four reports are submitted in association with this milestone: Appendix L1 (Assessment on the Predation Potential of Pacific Lamprey (*Entosphenus tridentatus*) and Western Brook Lamprey (*Lampetra richardsoni*) Ammocoetes by Various Native and Non-Native Species), Appendix L2 (Larval Lamprey Assessment at the Roza Dam Forebay and Yakima River Delta Region, 2015), Appendix L3 (Mercury Concentration in Adult Pacific Lamprey [*Entosphenus tridentatus*] Collected in the Mid-Columbia River and Fish Overwintered at the Prosser Fish Facility), and Appendix L4 (The Role of Pacific Lamprey in Yakima River Tributary Food Webs, 2016).

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 [2016]).

N: WE132 – (Annual) Progress Report

This report herein represents the annual progress report.

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 declines 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 (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.

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 Documentation

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.

B. Work Element 174 – Produce Propagation and Rearing Plan

Considerable planning has occurred in preparation of pilot propagation and outplanting research activities since 2012. In 2012 and 2013, the YNPLP worked closely with the CRITFC and the Umatilla Tribes in the development of a broad scale Research, Monitoring and Evaluation (RME) Framework document towards Pacific Lamprey supplementation generally and artificial propagation specifically. The 2013 draft of the framework document was shared with federal and state agencies involved in Pacific Lamprey management (USFWS, WDFW, ODFW, and IDFG) for review. The comments were then incorporated to the final draft, which was completed in March, 2014.

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

Photo B1. Extracting the eggs from a ripe female Pacific Lamprey on May 24, 2017.

The Columbia River Tribal Fish Commission (CRITFC), the Yakama Nation (YN), the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), and the Nez Perce Tribe (NPT) prepared a draft Master Plan to address Steps I and II 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 spring/summer 2017 to initiate experimental larvae outplanting in fall 2017 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 – Collect/Generate/Validate Field and Lab Data

Work Element Associated Appendix Reports:
Appendix C1 – Lower Yakima Subbasin Larval Lamprey Monitoring Report, 2016

Photo C1. Overview of a Yakima River index survey site (river km 191.8) immediately downstream of the Naches River confluence (October, 2016).

This report highlights our 2016 electrofishing efforts in the Lower Yakima Subbasin, which includes all watersheds downstream of the Naches River confluence on the Yakima River at river km 191.9 (Fig. C1-1). In 2016, a total of 13 previously established index sites (spatially distributed long-term monitoring sites) were surveyed (electrofished) in the Lower Yakima Subbasin (three in the mainstem, three in Satus Creek, three in Toppenish Creek, one in Simcoe Creek, and three in Ahtanum Creek). In addition, eight exploratory (supplemental) sites were surveyed (one in the mainstem, two in Satus, three in Toppenish, and two in Ahtanum creeks). Two sites (one exploratory and one index site) in Toppenish Creek were visited, but not surveyed, in order to better understand the distribution of larval habitat within the respective watershed.

Pacific Lamprey were found at 10 of the 13 electrofished index sites (76.9%), although lampreys (Western Brook Lamprey or Pacific Lamprey) were confirmed at 12 of the 13 sites (92.3%). For the mainstem Yakima River, Satus Creek, and Ahtanum Creek, Pacific Lamprey were confirmed at all of the index sites (100% of the nine sites). In the Toppenish Creek watershed, no Pacific Lamprey were found in the mainstem (0% of the four sites), and Western Brook Lamprey were found at two of the three sites (66.7%). In Simcoe Creek (a tributary of Toppenish Creek), Pacific Lamprey were confirmed at the one surveyed index site (100%). Three macrophthalmia (eyed Pacific Lamprey) were captured in Satus Creek at river km 12.9.

In the mainstem Yakima River, out of all of the surveyed sites, the area of larval habitat was greatest at river km 73.5 (250 m^2 of total Type I and Type II habitat). The highest estimated number of lampreys, and estimated biomass (g) within a 50 m reach, was at the index site at river km 149.8 (550 and 1,177 g, respectfully). However, at the lower site (index site at river km 73.5), fewer lampreys and biomass were estimated (278 and 286 g, respectfully). Despite a higher number of lampreys, the middle reach of the Yakima River (river km 149.8) had a lower percentage of Pacific Lamprey compared to the lower reach of the river (river km 73.5), which was 11% and 100%, respectively. A survey at river km 112.0 (exploratory site surveyed to supplement our knowledge of Pacific Lamprey distribution between the two index sites), yielded only Western Brook Lamprey and also had the lowest estimated number and biomass (22 and 30 g, respectfully). Detailed site data are missing for river km 191.8 (index site), so the information presented here only reflects two of the three surveyed index sites.

In Satus Creek, the largest area of available habitat (Type I and Type II) was at river km 29.2 (720 m^2), although similar areas of available habitat were also observed at index sites in the upper and lower reaches of the stream (350 m^2, 340 m^2, respectively). At the index sites, estimated numbers of lamprey (in a 50 m reach) showed an increasing trend, from downstream to upstream (1,909, 4,477, 13,785 at river km 12.9, 29.2, and 41.2, respectively). Estimated biomass (g) was greatest at the upstream most index site (river km 41.2, 8,453 g). The ratio of Pacific Lamprey was lowest at the lowest surveyed site (index site at river km 12.9; 36%, and exploratory site at river km 20.1, 40%). However, nearly all of the lampreys captured at the upper two sites (river km 29.6 and 41.2) were Pacific Lamprey (both 96%). No lampreys were found at the exploratory site at river km 5.1.

In Ahtanum Creek, the largest area of habitat was at the lowest site (river km 4.4). Habitat area decreased heading upstream at the index sites (river km 11.5, 102 m^2; river km 23.6, 69 m^2).

Exploratory sites conducted upstream showed the same decreasing trend of available larval habitat. The highest lamprey density was at river km 23.6 (73.6 #/m^2). However, the highest estimated number of lampreys and biomass was at river km 4.4 (3,649, 5,671 g, respectfully). At the index sites, the ratio of Pacific Lamprey were lowest at river km 4.4 (7%), and increased going upstream (71% and 89% at river km 11.5 and 23.6, respectively). Pacific Lamprey were found at the upstream most site (river km 34.1).

In Toppenish Creek, no Pacific Lamprey were found in 2016, despite lamprey presence at three of the six electrofished sites (river km 43.5, 59.9 and 73.2). Pacific Lamprey were present in Simcoe Creek (river km 9.0), however. In the Toppenish Creek watershed, lamprey habitat was greatest in the lower and middle reaches where low flow and widened channels allow for large areas of fine sediment to deposit. Despite large areas of larval habitat in the lower reach, no lampreys were found (electrofishing surveys conducted at river km 7.2, 17.8 and 20.9).

A total of 118 genetic samples were collected (5, 42, 19, 4, 48 from Yakima, Satus, Toppenish, Simcoe, and Ahtanum, respectively) from larval lampreys (both identified Pacific Lamprey and young-of-the-year lampreys) to analyze the success of translocated adult Pacific Lamprey into Satus Creek, Toppenish Creek, and Ahtanum Creek ongoing since 2012 / 2013. See **Appendix C1** for more information.

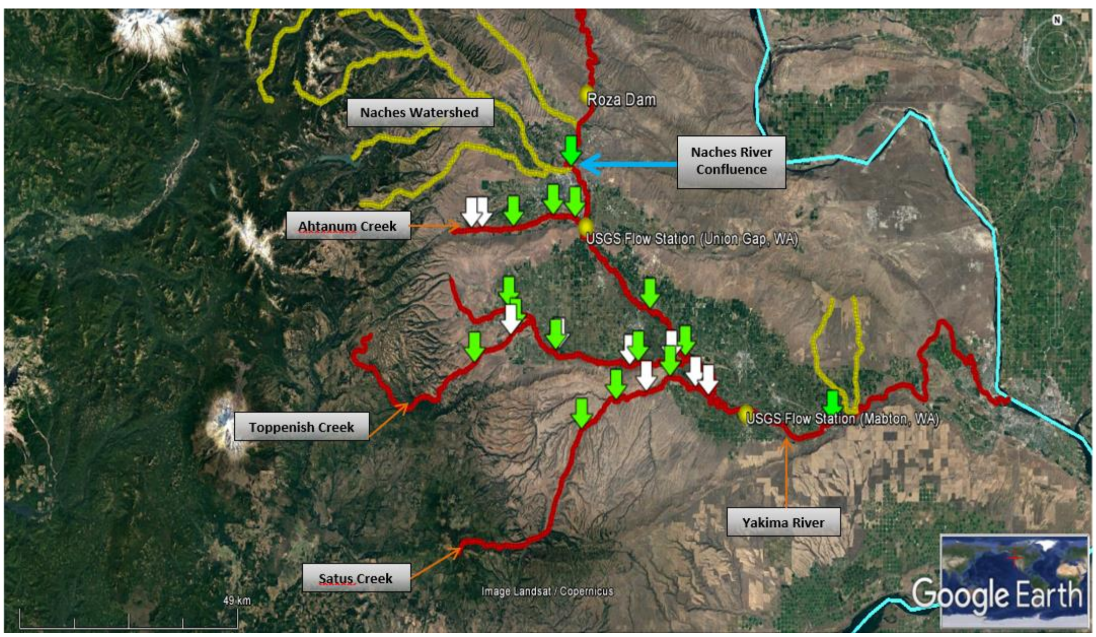


Figure C1-1. Overview of all sites surveyed in the Lower Yakima Subbasin, downstream of the Naches River confluence (river km 191.9, blue arrow). Streams of survey interest are highlighted by the red lines and other streams are highlighted in yellow. Index sites (green arrows) and exploratory sites (white arrows) where electrofishing occurred are shown. The location of two USGS Flow Stations 1) river km 177.6 (Union Gap, WA) and 2) river km 96.3 (Mabton, WA) and the location of Roza Dam (river km 210.5) are shown (yellow circles). Surveys occurred between July and October, 2016.

Appendix C2 – Upper Yakima Subbasin Larval Lamprey Monitoring Report, 2016

Photo C2. Overview of a Yakima River exploratory survey site (river km 288.5) immediately downstream of the Teanaway River confluence where Pacific Lamprey larvae were found in September, 2016.

This report highlights our 2016 electrofishing efforts in the Upper Yakima Subbasin, which includes all watersheds upstream of the Naches River confluence on the Yakima River at river km 191.9 (Fig. C2-1). Roza Dam (river km 210.5) is located near the downstream end of the Upper Yakima Subbasin, which was identified previously as a complete passage barrier for upstream migrating adult Pacific Lamprey. In Spring 2015, adult Pacific Lamprey were translocated upstream of Roza Dam, in an effort to rebuild the population of Pacific Lamprey upstream of the dam.

In 2016, a total of six previously established index sites (spatially distributed, long-term monitoring sites) were surveyed (electrofished) in the Upper Yakima Subbasin (three in the mainstem, two in Wenas Creek, and one in the Teanaway River). All three of the index sites in the mainstem Yakima River are upstream of Roza Dam. The Teanaway River is a tributary of the Yakima River upstream of Roza Dam. Wenas Creek is a tributary of the Yakima River downstream of Roza Dam. In addition, 15 exploratory (supplemental) sites were surveyed (seven in the mainstem, three in Wenas Creek, eight in Swauk Creek, and five in the Teanaway River). Of all of the surveyed exploratory sites, 9 of the 15 exploratory sites are upstream of the dam (60.0%). Four of the seven mainstem Yakima River exploratory sites are downstream of the dam. Eight exploratory sites were visited in Swauk Creek (a tributary upstream of Roza Dam), but not surveyed, in order to get a broad understanding of the distribution of larval habitat within the watershed.

At all of the surveyed index sites within the Upper Yakima Subbasin, Pacific Lamprey were found at two of the six index sites (33.3%), though lampreys (Western Brook Lamprey or Pacific

Lamprey) were present at all of the sites (100%). For the mainstem Yakima River, two of the three index sites had Pacific Lamprey (66.7%). Of the seven exploratory sites in the mainstem Yakima River, Pacific Lamprey were present at one of the four sites upstream of the dam (25%), but were not present in the three exploratory sites downstream of the dam (0%). No Pacific Lamprey were present at any of the index sites (or exploratory sites) in Weans Creek. In the Teanaway River, no Pacific Lamprey were found at the one index site, but Pacific Lamprey were found at two of the five exploratory sites (40.0%). No macrophthalmia (eyed Pacific Lamprey) were found during our surveys in the Upper Yakima River.

In the mainstem Yakima River above Roza Dam, the highest density of lampreys (in Type I habitat) was at river km 288.5 (48.2 #/m^2). However the highest estimated number of lampreys, for Type I habitat (to best compare to the exploratory sites which all focused on Type I habitat), in a 50 m reach was at river km 244.0 (6,686) with a relatively high density (37.1 #/m^2). Highest biomass (g) for Type I habitat was at river km 264.8 (2,075 g) due to a large area of Type I habitat (420 m^2), despite the relatively low density of lampreys (7.1 #/m^2). In the mainstem Yakima River downstream of Roza Dam, the estimated numbers of lampreys were lower (maximum of 360 at river km 192.2). The maximum density of lampreys was 4.0 #/m^2 at river km 193.2. Detailed survey data are missing for river km 201.7, so the above information (density and estimated lamprey numbers) applies to six of the seven exploratory sites.

In Wenas Creek, there are many beaver dams in the lower reach which help produce large areas of Type I habitat. The sites at river km 0.8 and 2.2 are each immediately upstream of a beaver dam with large areas of Type I habitat (135 and 220 m^2, respectively). However, the larvae densities at these sites are low (0.3 #/m^2 at both sites). In the main channel downstream of the beaver dams, river km 0.5 and 1.3, has much higher densities of larvae (8.5 and 14.7 #/m^2, respectively) and much lower areas of Type I habitat (30 m^2 and 5 m^2, respectively). No lampreys were found at the mouth of Wenas Creek. The YNPLP currently has plans to release artificially propagated lampreys within the lower reach of Wenas Creek in fall of 2017. Surveys conducted in 2016, and previously in 2015, were designed to understand the distribution, current lamprey densities, and relative abundance of Pacific Lamprey in Wenas Creek.

In Swauk Creek, the upper reaches are primarily Type III habitat, with patches of Type I and Type II habitat (Type II habitat being more abundant than Type I habitat). No Type I habitat was observed at the mouth of Swauk Creek. In the future, the reach near the Swauk Creek Ranch will be assessed for available habitat. In 2016, we plan to survey available habitat within Swauk Creek. In the Teanaway River, lamprey densities were highest at river km 5.3 (33.1 #/m^2). The largest area of Type I habitat, and additionally the highest number of lampreys within a 50 m reach was also at river km 5.3 (26.5 m^2, 877). Most of the lampreys observed at this site were young of the year larvae (generally < 36 mm), suggesting lamprey spawning occurs near this reach. Genetic samples were collected to confirm species. Pacific Lamprey (75-80 mm) was captured from the lower sites at river km 0.3 and 0.6.

A total of 62 genetic samples were collected (53 and 9 from Yakima and Teanaway rivers, respectively) from larval lampreys (both identified Pacific Lamprey and young of the year lampreys) to analyze the success of translocated adult Pacific Lamprey into the Upper Yakima Subbasin in spring of 2015. See **Appendix C2** for more information.

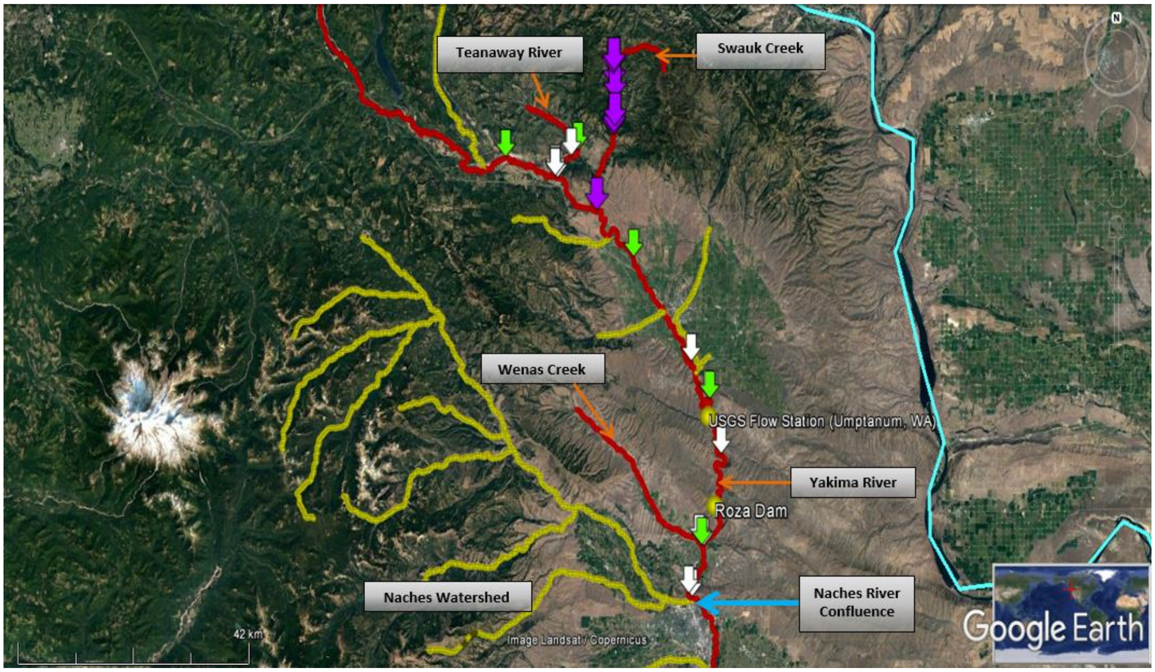


Figure C2-1. Overview of all sites surveyed in the Upper Yakima Subbasin, upstream of the Naches River confluence (river km 191.9, blue arrow). Streams of survey interest are highlighted by the red lines and other streams are highlighted yellow. Shown are index sites (green arrows), exploratory sites where electrofishing occurred (white arrows), and exploratory sites where no electrofishing occurred (purple arrows). The location of the USGS Flow Station (near Umptanum, WA; river km 230.6) and Roza Dam (rkm 210.5) are also shown (yellow circles). Surveys occurred between September and October, 2016.

Appendix C3 – Naches Subbasin Larval Lamprey Monitoring Report, 2016

Photo C3. Overview of river km 29.0 on the Naches River (immediately upstream of the Wapatox Diversion Inlet) where both Pacific Lamprey and Western Brook Lamprey were detected (August, 2016).

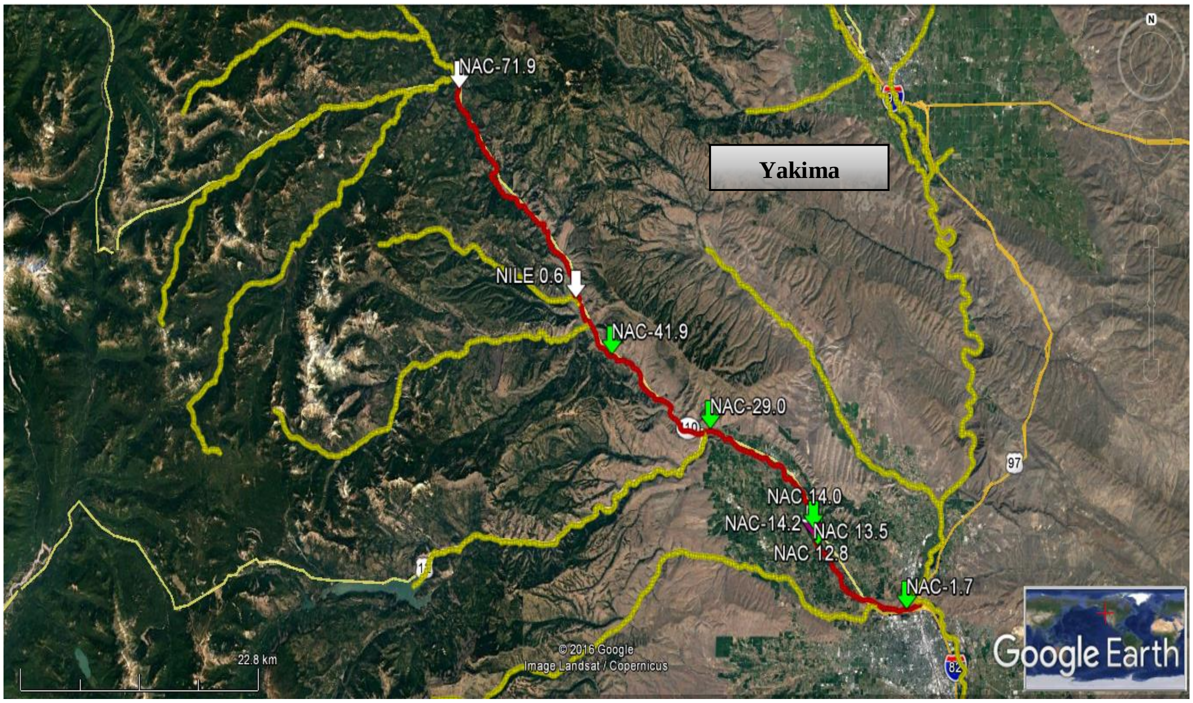
This report highlights our 2016 electrofishing efforts in the Naches Subbasin (Fig. C3-1). A total of seven established index sites were surveyed in the Naches River. Three of the seven sites are within the Eschbach Side Channel, a side channel of the Naches River used for irrigation (site river km 12.8, 13.8 and 14.0). In addition a total of three exploratory sites were surveyed within the Naches River (one sites within the Eschbach Side Channel), and one site in Nile Creek (a tributary of the Naches River). One site was visited in Eschbach Park (river km 13.5) to better understand the distribution of available habitat within the park. The confluence of the Naches River with the Yakima River is at river km 191.9.

Pacific Lamprey was present at four of the seven index sites (57.1%). Lampreys (either Western Brook Lamprey or Pacific Lamprey) were found at six of the seven sites (85.7%). Within the Eschbach Side Channel, Pacific Lamprey was found at one of the four surveyed sites (25.0%) and lampreys (of either species) were found at two of the four survey sites (50.0%). In the mainstem (not including sites surveyed in Eschbach Park), Pacific Lamprey was found at three of the four surveyed index sites (75%), but not at the exploratory site (river km 71.9). Interestingly, no Pacific Lamprey was found at the lower reach of the Naches River (river km 1.7). Western Brook Lamprey was found at both Naches river km 71.9 and Nile Creek at river km 0.6 (a tributary to Naches River); no Pacific Lamprey were confirmed in these two sites.

Out of all surveyed sites, lamprey densities in the Naches River were highest at river km 29.0 (23.0 #/m^2) immediately upstream of the inlet to Wapatox Diversion. The highest estimated biomass was at river km 29.0 as well (3,042 g). The largest area of Type I habitat in a 50 m reach was in Eschbach Park (river km 14.0; 600 m^2). This site also had the lowest density of any surveyed sites (0.7 #/m^2 within Type I habitat). Despite low densities at river km 14.0 in Eschbach Park, river km

12.8 (lower reach of the side channel) had the highest estimated number of lampreys of any site (5,013; only within Type I habitat) and a much higher density (12.5 #/m^2).

A total of five genetic samples were collected from young of the year larvae (< 36 mm) at river km 12.8 (within the Eschbach Side Channel). The larvae will be identified to species. If they are Pacific Lamprey, it will suggest that Pacific Lamprey may potentially be spawning within the side channel. See **Appendix C3** for more information.



Map 1. Overview of all surveyed sites in the Naches River (red line) in August, 2016 displaying index sites (green arrows) and surveyed exploratory sites where electrofishing occurred (white arrows). Exploratory sites where electrofishing did not occur are highlighted in purple.

Appendix C4 – Wenatchee Subbasin Larval Lamprey Monitoring Report, 2016

Photo C4: Overview of river km 56.8 of the Upper Wenatchee River (upstream of Tumwater Dam, and downstream of the Highway 2 Bridge) where larval lamprey (19-26 mm) were found in August, 2016.

This report highlights our 2016 electrofishing efforts in the Wenatchee Subbasin, both upstream and downstream of Tumwater Dam (river km 50.4), an assumed passage barrier to Pacific Lamprey (Fig. C4-1 and C4-2). In the spring and fall of 2016, adult Pacific Lamprey were released into the Wenatchee Subbasin (both upstream and downstream of Tumwater Dam) in an effort to rebuild the lamprey population upstream of the dam.

In the Lower Wenatchee River (downstream of Tumwater Dam), a total of two index sites, and two exploratory sites were surveyed. Pacific Lamprey were identified at all of the sites, and no Western Brook Lamprey were identified. At the index site at river km 40.4, the estimated number of lamprey was 188,940 within a 50 m reach; the highest of any of our survey sites within the lower, middle, or upper Columbia subbasins. Lamprey density was 54.7 times higher in Type I habitat compared to Type II habitat at the index site at river km 40.4. At the index sites, captured lamprey size ranged between 18 mm to 122 mm with a mean of 47 mm in Type I habitat and 63 mm in Type II habitat. No macrophthalmia (eyed Pacific Lamprey) were captured during our surveys in the Lower Wenatchee River.

Out of the four index sites surveyed in the Upper Wenatchee River, young of the year larval lamprey (19-29 mm) were found at one site (river km 56.8). The density of lamprey at this site was 1.3 $\#/m^2$, and 360 larvae were estimated to be within the 50 m reach. Jolanda Lake (river km 50.4) was surveyed along the edge of the lake, but no larvae were found. Surveys were conducted in a side channel at river km 52.3 (4.5 river km downstream of where larval lamprey were previously found), but no lamprey were present at this site (despite quality Type I habitat).

Electrofishing surveys were also conducted in four tributaries of the Upper Wenatchee River. No lamprey were found at four electrofished sites in the following rivers/streams: Chiwawa River (n=1), Nason Creek (n=2), and the White River (n=1). In brief, the lower reach of Chiwawa (river km 0.4 and 0.5) has Type I habitat ideal for the rearing of larval lamprey, but primarily limited to the channel margins. An exploratory site upstream (river km 3.5) revealed that Type I habitat becomes more patchy (limited to deposition behind large boulders or woody debris). In Nason Creek, two visited exploratory sites in the lower reach (river km 1.2 and 1.7) showed that available habitat in the mainstem is patchy and primarily composed of Type II habitat. However, Type I habitat was present in small quantities in a side channel. Further upstream in Nason Creek, at river km 12.7, Type I habitat was found in deep pools and along channel margins (in more abundant quantities that the lower reach). In the White River (tributary upstream of Lake Wenatchee) at river km 3.2, Type I habitat is abundant, and spans most of the channel width). See **Appendix C4** for more information.

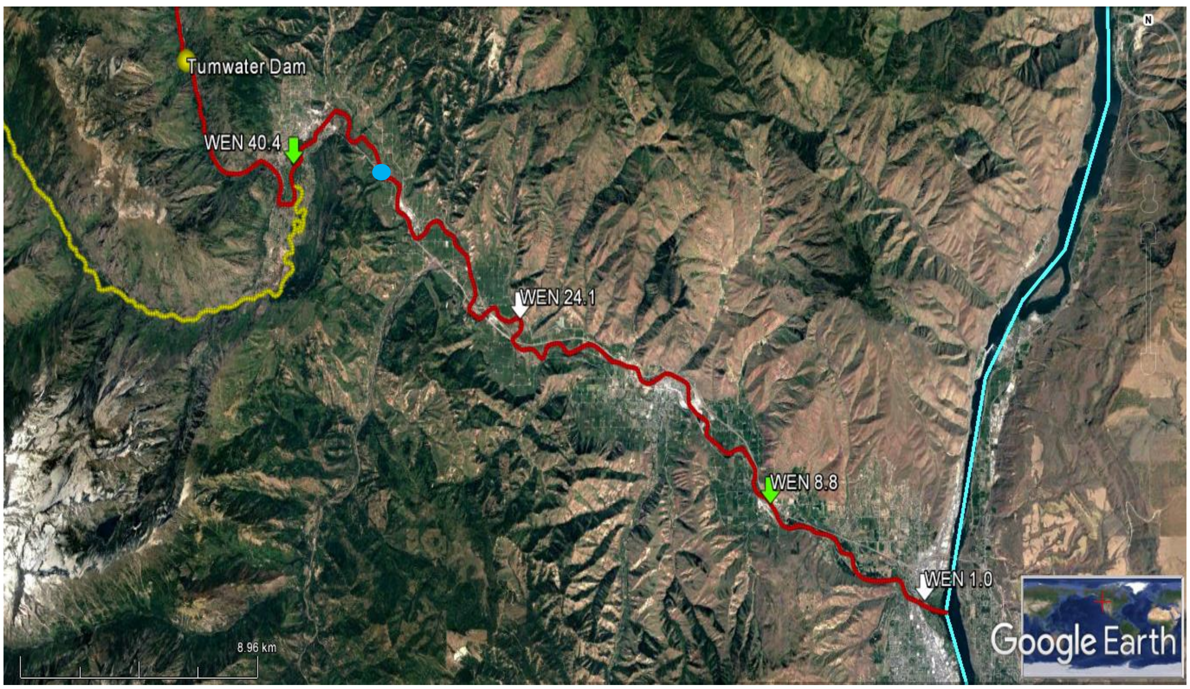


Figure C4-1. Overview of all surveyed sites in the Lower Wenatchee River (red line) in August, 2016, displaying index sites (green arrows) and surveyed exploratory sites (white arrows) where electrofishing occurred. The location of a USGS Flow Station (near Peshastin, WA; river km 34.1) is shown by the blue dot. Also shown is Tumwater Dam (river km 49.6).

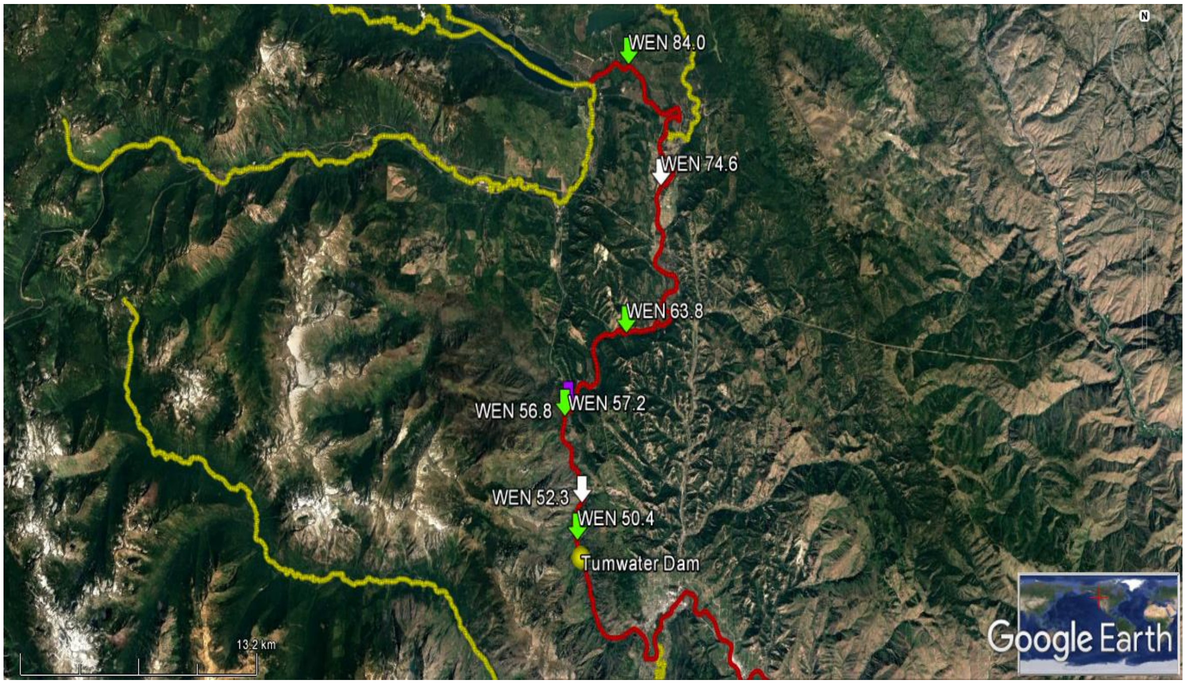


Figure C4-2. Overview of all surveyed sites in the Upper Wenatchee River (red line) in August, 2016 displaying index sites (green arrows) and surveyed exploratory sites (white arrows) where electrofishing occurred. Exploratory sites where electrofishing did not occur are highlighted in purple. Also shown is Tumwater Dam (yellow circle; river km 49.6).

Appendix C5 – Entiat Subbasin Larval Lamprey Monitoring Report, 2016

Photo C5. Overview of an Entiat River side channel (river km 46.5) where potential Western Brook Larvae (59-70 mm) were found in August, 2016.

This report highlights our 2016 electrofishing efforts in the Entiat Subbasin (Fig. C5-1). A total of eight sites (three index sites and five exploratory sites) were surveyed within the Entiat River. One additional site, river km 10.1, was visited (not electrofished) in order to better understand the distribution of available Type I and Type II habitat in the lower reach of the Entiat River. No electrofishing surveys were conducted in the Mad River, as there seems to be limited habitat for larval lamprey within the system.

Pacific Lamprey was found at all three of the index sites (100%), and at two out of the five exploratory sites (40%). Lamprey (n=6) with Western Brook Lamprey tail characteristics (43-70 mm) were discovered at an exploratory site at river km 46.5, and we are awaiting genetic analysis to confirm their species (Fig. C5-2). Lamprey were not found at river km 47.2 (3.2 river km downstream of Box Canyon at river km 50.4). No macrophthalmia (eyed Pacific Lamprey) were found during our surveys.

In Type I habitat, lamprey densities were highest at river km 30.4 (76.0 #/m^2), although densities near the river mouth (river km 1.1) were also high (59.0 #/m^2). The lowest density was river km 46.5 (1.5 #/m^2), where potential Western Brook Lamprey were found. The estimated number of lamprey and estimated biomass (g) within the 50 m reach were highest near the mouth at river km 1.1 (58,958 and 12,676 g, respectfully). The mouth also had the highest area of available habitat (1,000 m^2 in 50 m). At the index sites, estimated numbers of lamprey followed a decreasing trend from downstream to upstream (58,958, 20,032, and 1,396 at river km 1.1, 30.4 and 40.2, respectively).

A rapid drop in water level was noted in a side channel at river km 1.1 near the mouth of the Entiat River, and no lamprey were found during an exploratory electrofishing survey in this side channel (Fig. C5-3). The fluctuating water level is likely due to water control at Rocky Reach Dam. The water level in the side channel was observed to drop approximately 30 cm in two hours, or a rate of 15 cm per hour. The absence of lamprey could potentially be explained by a lack of attraction by larval lamprey to occupy recently dewatered fine sediment and/or because larval lamprey in this habitat simply cannot survive.

At river km 12.8 (0.5 km north of the intersection of Crum Canyon Road off of Entiat River Road), there is a man-made side channel which leads to an irrigation pump with no return flow to the river (Fig. C5-4). Larval lamprey will continue to move "downstream", or towards the irrigation pump, with no way back to the river. An estimated 7,726 larval lamprey reside in this side channel. Action needs to take place immediately to save the entrained lamprey. One recommendation is to salvage as many of the entrained lamprey as possible through electrofishing (and return them to the river). Alternatively, a connecting channel to the main river could be created near the downstream end of the side channel so entrained lamprey have an opportunity to return back to the river. Also, the screen on the pump needs to be replaced, as it has many small holes where larval lamprey could easily pass through.

A total of 85 larval lamprey genetic samples were collected from the Entiat River (34, 35, and 6 at river km 1.1, 40.2 and 46.5, respectively). The goals of these genetic samples are to 1) estimate the number of effective spawners by analyzing samples from the upper and lower reaches of the Entiat and 2) identify to species potential Western Brook Lamprey captured at river km 46.5. See **Appendix C5** for more information.

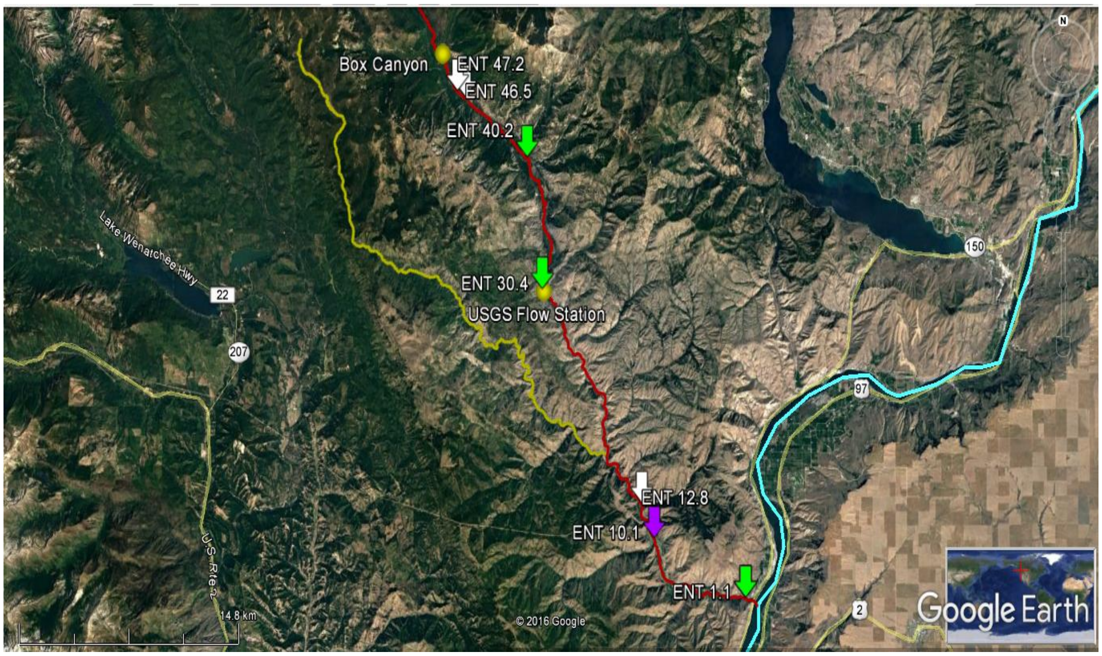


Figure C5-1. Overview of all surveyed sites in the Entiat River (red line) in August, 2016, displaying index sites (green arrows), exploratory sites (white arrows) where electrofishing occurred, and exploratory sites with no electrofishing (purple arrows). The locations of the USGS Flow Station (near Ardenvoir, WA; river km 30.3) and Box Canyon (rkm 50.4) are also shown (yellow circles).

Figure C5-2. Overview of a likely Western Brook Lamprey ~ 70 mm in total length captured in the Entiat River at river km 46.5 (left) and close-up of the same lamprey's tail (right). Species identification was based on tail characteristics, and genetic samples are awaiting analysis to confirm species.


Figure C5-3. Side channel at river km 1.1 where no lamprey were found in August, 2016. The photo on the left was taken at 9:00 am and the photo on the right was taken at 9:50 am on August 10, 2016.


Figure C5-4. Upstream view of the manmade side channel at river km 12.8 (left) and downstream view towards the irrigation pump (right).

<u>Appendix C6 – Methow Subbasin Larval Lamprey Monitoring Report, 2016</u>

Photo C6. Overview of river km 19.3 of the Chewuch River where larval lamprey (28-50 mm) were found in September, 2016.

This report highlights electrofishing efforts in the Methow Subbasin in 2016 by both the YNPLP (Fig. C6-1) and Jon Crandall / Methow Salmon Recovery (Fig. C6-2 and C6-3). A total of 10 sites were surveyed in the Methow Subbasin by Jon Crandall and the YNPLP (river km 25.6 to 100.9). Pacific Lamprey were found at four of the ten sites (40%). The YNPLP surveyed four index sites in the mainstem Methow River, and Pacific Lamprey was present at one of the sites (25%; river km 46.3). Three additional exploratory sites were surveyed in the Methow River, and lamprey were found at one site (33%; river km 79.6). Jon Crandall surveyed his three index sites within the mainstem, and Pacific Lamprey were present at two of the three sites (66%; river km 25.6 and 59.3). No Pacific Lamprey was confirmed upstream of river km 79.6 in the mainstem Methow (except in Chewuch River). Out of all sites surveyed in the Methow River, young of year larvae (< 36 mm) were found at each of the sites where larger larval lamprey were present (river km 25.6, 46.3, 59.3 and 79.6).

A total of two sites were electrofished by YNPLP in the Twisp River (primarily near the mouth, where larval habitat appears to be most abundant). Type I habitat was present at both electrofished sites, however, no lamprey were found. An additional three sites were visited, but were not electrofished. No lamprey habitat was observed at river km 16.5 and 26.1. A small amount of Type I and II habitat (behind a large boulder) was observed at river km 15.6.

A total of six sites were surveyed in the Chewuch River in 2016 by the YNPLP and Jon Crandall (river km 0.8 to river km 49.5). Pacific Lamprey was found at three out of the six sites (50%). The YNLP surveyed one index site in the Chewuch River and a total of six larval lamprey were captured at this site (100%). In addition, Jon Crandall surveyed his established index sites in the Chewuch River and Pacific Lamprey were present at three out of the five sites (60%). The furthest site upstream where Pacific Lamprey was found was at river km 26.1. The density of lamprey was highest at river km 16.1 (0.96 $\#/m^2$). Off all sites surveyed, young of year larvae were found at river km 16.1 and 19.3, but not at river km 0.8, 28.6, or 26.1.

Genetics are an important tool to monitor the spawning success of these released adults. In total, 62 genetic samples were collected from young lamprey (96.8% from larvae < 50 mm). In total, 35 samples were collected from mainstem Methow River and 27 samples from the Chewuch River. See **Appendix C6** for more information.

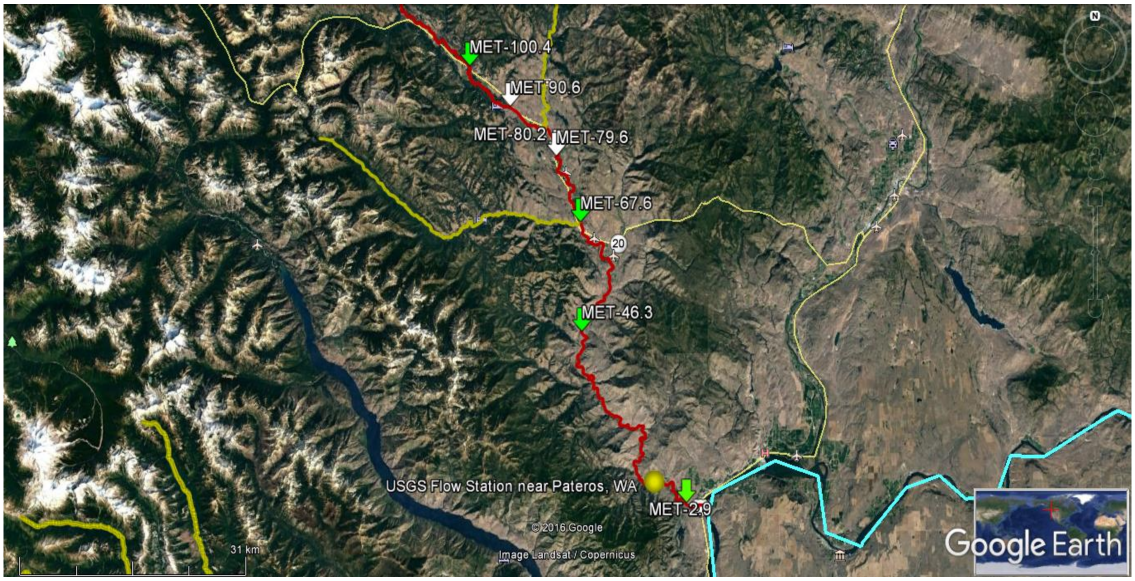


Figure C6-1. Overview of all surveyed sites in the Methow River (red line) in September, 2016, displaying Yakama Nation surveyed index sites (green arrows) and exploratory sites (white arrows) where electrofishing occurred. The location of a USGS Flow Station (near Peshastin, WA; river km 10.1) is shown by the yellow circle.

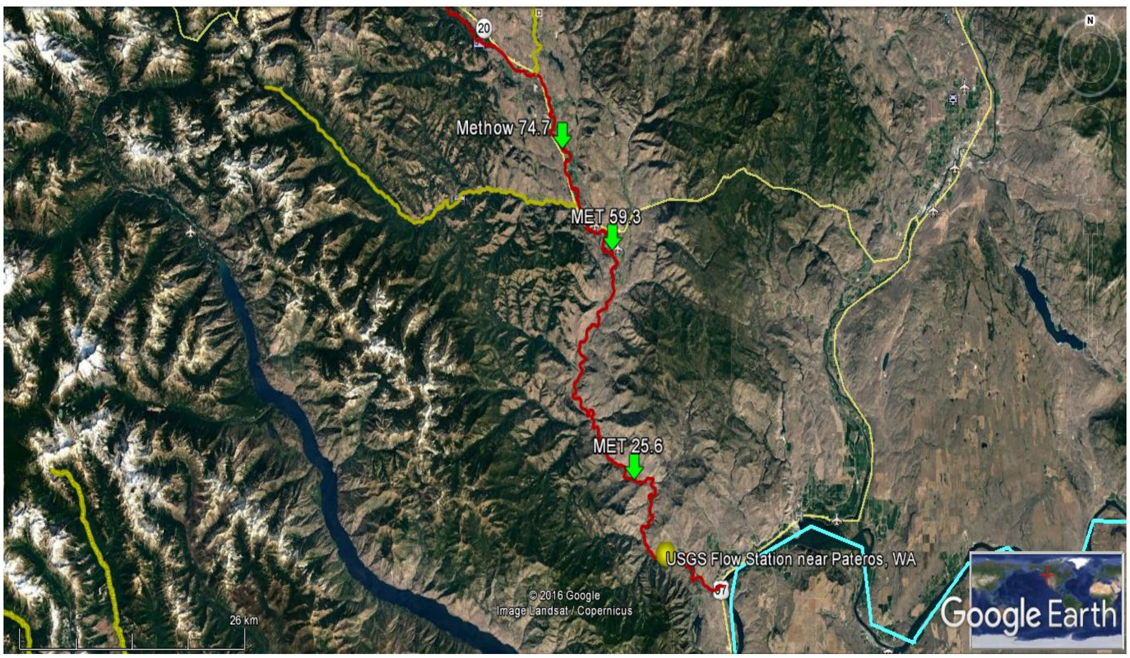


Figure C6-2. Overview of index sites (green arrows) established by Jon Crandall in the Methow River (red line) that were surveyed in August, 2016, with the help of Yakama Nation. The location of a USGS Flow Station (near Peshastin, WA; river km 10.1) is also shown (yellow circle).

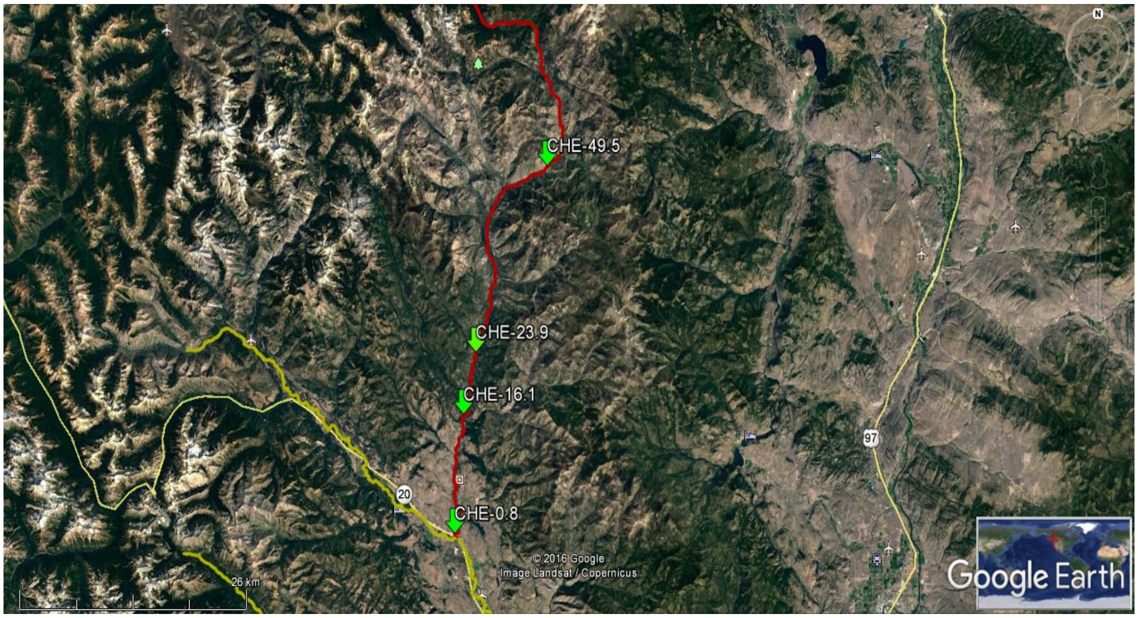


Figure C6-3. Overview of index sites (green arrows) established by Jon Crandall in the Chewuch River (red line) that were surveyed in August, 2016, with the help of Yakama Nation.

Appendix C7 – Lower Columbia Tributaries Larval Lamprey Monitoring Report, 2016

Photo C7. An overview of a Wind River exploratory survey site (river km 26.3) where Pacific Lamprey were found in September, 2016

This report highlights our 2016 electrofishing efforts in Rock (near Stevenson, WA) (Fig. C7-1), Wind (Fig. C7-2), and the White Salmon (Fig. C7-3) watersheds. A total of seven index sites were surveyed throughout the Lower Columbia tributary watersheds: Rock Creek (n=1), Wind River (n=2), White Salmon River (n=3), and Trout Lake Creek (n=1). Lampreys (either Western Brook or Pacific Lamprey) were present at all seven of the index sites (100%). Pacific Lamprey were confirmed at two of these seven index sites (28.6%).

In Rock Creek, a large area of available Type I (250 m^2) was present at the mouth of the creek. Larval lampreys were present at this site, but they were too small to identify (26-40 mm). Approximately 2,640 lampreys are estimated to occupy this site. One exploratory site was surveyed upstream of Rock Creek Falls, located at river km 2.3 (to assess if adult Pacific Lamprey are capable of passing over the falls, and if Western Brook Lamprey reside upstream of the falls). No lampreys were present, despite abundant Type I habitat and organic matter (see "Appendix: Additional Site Photos and Maps" for more photogenic details on the habitat here (excellent rearing location for lamprey).

Two index sites were surveyed in the Wind River. Pacific Lamprey were present at both of the sites (100%). Pacific Lamprey were found as far upstream as river km 26.3. Lamprey density was higher near the mouth (4.2 #/m^2), compared to the site at river km 26.3 (2.4 #/m^2).Of the identified lamprey, 100% were Pacific Lamprey at the upper site, compared to only 11% at the site near the mouth. One exploratory site was surveyed at river km 2.4 (tribal fish camp site). There is a large area of larval habitat at this site (all Type I habitat). This site had the highest survey density in the Wind River (5.8 #/m^2), as well as the highest estimated number of lampreys (10,500). The ratio of Pacific Lamprey was 36% (higher than the site at the mouth).

In the White Salmon River, we surveyed a total of three index sites. Larval lampreys were present at all three of the surveyed sites (100%), although no Pacific Lamprey were confirmed (0%). Larval densities were highest at river km 13.0 (50.6 #/m^2). Lamprey habitat was observed to be limited near the old Condit Dam Removal site (river km 5.9) based on observations at our index site at river km 8.8. Two exploratory sites were surveyed in the White Salmon River. Lampreys were present at both of the sites (100%), although no Pacific Lamprey were confirmed. Lamprey were found as far upstream at river km 40.5.

One index site was surveyed in Trout Lake Creek (a tributary of the White Salmon River). No Pacific Lamprey were confirmed. However, the estimated number of lampreys, and the biomass in that site, is the highest in the White Salmon Watershed (17,874, 6,473 g). The biomass density at this site is also relatively high, compared to the rest of the watershed, at 12.95 g/m^2. At the three exploratory sites in Trout Lake Creek, lampreys were present at all three sites (100%). Lampreys were found as far upstream as river km 13.3. The estimated number of lampreys in Type I habitat was highest (255) at river km 6.6 (1.7 km upstream of the index site with high lamprey densities).

Genetic samples were collected from lampreys in the White Salmon Watershed (25 and 12 from White Salmon River and Trout Lake Creek, respectively). All genetic samples were from smaller larvae (< 50 mm) and could not be identified to species visually. The goal of these genetic samples is to monitor the recolonization of Pacific Lamprey upstream of the Condit Dam removal site. See **Appendix C7** for more information.

Figure C7-1. An overview of all surveyed sites in the Rock Creek, north of Stevenson, WA (red line) in September, 2016, displaying index sites (green arrows) and surveyed exploratory sites (white arrows) where electrofishing occurred. Rock Creek Falls is at river km 2.3 (not shown on map).

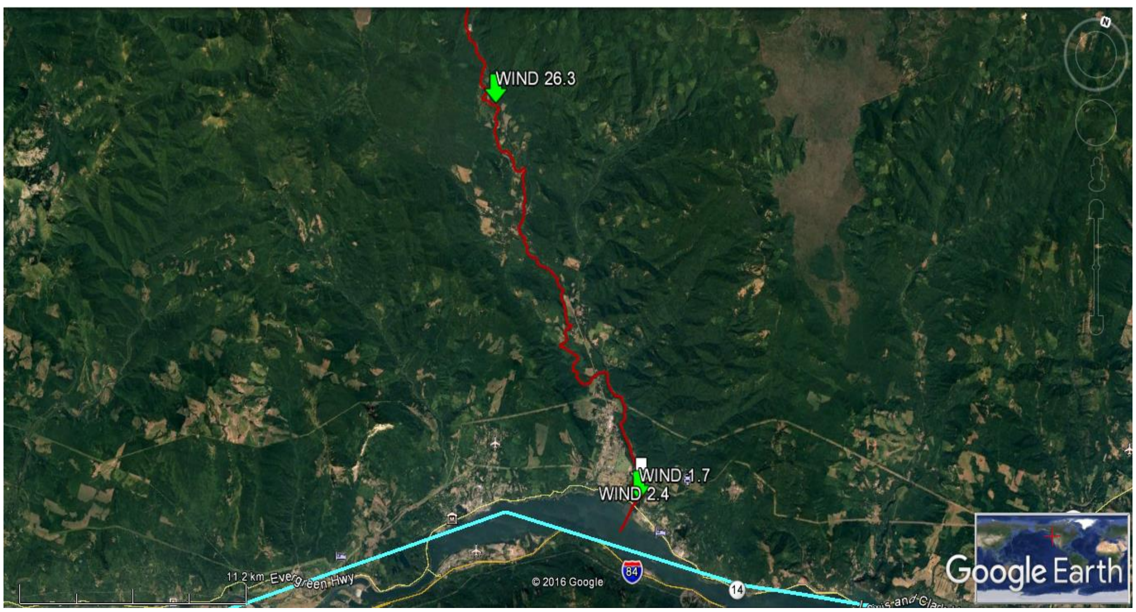


Figure C7-2. An overview of all surveyed sites in the Wind River (red line) in September, 2016 displaying index sites (green arrows) and surveyed exploratory sites where electrofishing occurred (white arrows). Rock Creek Falls is at river km 2.3 (not shown on map).

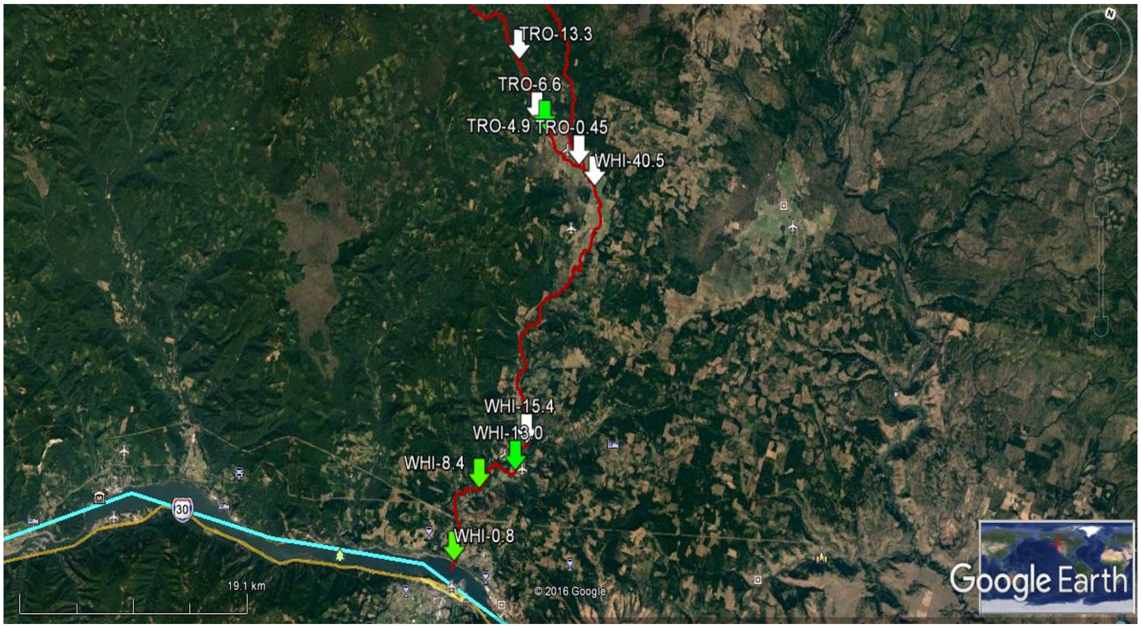


Figure C7-3. An overview of all surveyed sites in the White Salmon River Watershed (red line) in September, 2016, displaying index sites (green arrows) and surveyed exploratory sites (white arrows) where electrofishing occurred. Trout Lake Creek branches off to the left on the top of the map (red line also).

D. Work Element 28 – Trap and Haul (Larval/Juvenile Lamprey Salvage in Diversions)

Work Element Associated Appendix Report:

<u>Appendix D1 – Summary Assessment of Larval/Juvenile Lamprey Entrainment in Irrigation Diversions within the Yakama Basin, 2016</u>

Photo D1. Larval lampreys trapped on the dry bank after dewatering at Wapatox Diversion, Naches River (river km 28.9).

A total of 20 irrigation diversions were surveyed in 2016 irrigation season within the Yakima Subbasin (Table D1-1A and D1-1B); eight in Yakima River, one in Toppenish Creek, six in Ahtanum Creek, one in Taneum Creek, and four in Naches River. Irrigation diversions provide preferred, yet in effect misleading, refuge habitat to hundreds of thousands of larval/juvenile lampreys moving downstream. 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 translocated adult Pacific Lamprey.

In total, 39,114 larval/juvenile lampreys were captured and returned to the following respective rivers/streams; Yakima (n=32,064), Ahtanum (n=3,623), Naches (n=3,282), Taneum (n=85), and Toppenish (n=60). Captured lampreys constituted only 57.4% of all observed lampreys. More lampreys (84.0%) were captured upstream compared to downstream (16.0%) 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, Wapatox and Bachelor-Hatton diversions (26408, 2966 and 1668, respectively). 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 3.6 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 (234.3 $\#/m^2$). The maximum observed density downstream of the fish screens was at Sunnyside Diversion, located in an isolated pool of water (263.6 $\#/m^2$). From all the diversions, a total of 7,345 dead or nearly dead lampreys (13.5% of total lampreys observed) were found on dewatered banks or on top of partially wetted fine sediment. Bank-side salvage numbers were slightly higher downstream of the fish screens (57.1%) compared to upstream (42.9%).

A preliminary estimated number of lampreys residing in Type I habitat was calculated for each surveyed area based on the initial electrofishing density since dewatering. This preliminary estimated number of lampreys was calculated using 1) the daily max area of wetted Type I habitat since dewatering began (important for diversions surveyed over multiple days) and 2) the corresponding average lamprey density (using the adjusted observed total and total survey area) from Type I habitat for the same survey date. The area of wetted Type I habitat was calculated using a combination of polygon mapping on Google Earth 7 and on-site measurements. Preliminary estimated numbers of lampreys were calculated separately for locations upstream and downstream of the fish screens. The total preliminary number of lampreys residing in these 20 surveyed diversions was 116,809 (74.5% of this total was estimated to reside in Wapato and Sunnyside diversions alone.

Pacific Lamprey was present at 9 of the 20 surveyed diversions and on average (by facility) constituted approximately 27.7% of the lampreys that were identified (Table D1-2). The ratio of Pacific Lamprey (vs. Western Brook Lamprey) was high at Wapato Diversion (41.3%) in the Yakima River (river km 176.3) and at Bachelor-Hatton (77.1%) and Upper WIP (52.5%) diversions in Ahtanum Creek (river km 31.8 and 32.8, respectively). In the Yakima River, the ratio of Pacific Lamprey ranged from 12.3% (Selah-Moxee Diversion, river km 203.6) to 41.3% (Wapato Diversion, river km 176.3); the ratio at Sunnyside Diversion (river km 171.4) was lower at 23.9%. The ratio of Pacific Lamprey has been increasing steadily since 2010 at Sunnyside and Wapato diversions from approximately 0% between 2010-2013,~3% in 2013-2014, 7.0% in 2014-2015, to 15% in 2015-2016 and 33 % in 2016-2017. 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 began. A total of 81 genetic samples were collected from captured larval/juvenile Pacific Lamprey from diversions in the following rivers/streams: Yakima (n=27), Ahtanum (n=44), and Naches (n=10). The genetic samples collected from these larvae will help us understand the spawning success of translocated adult lampreys. See **Appendix D1** for more information.

Table 1A. Summary of larval-juvenile 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 # Dead (Wet)" is the number of lampreys found dead on wetted habitat. The "Total # Observed Adjusted (Wet)" is an adjustment (increase) in the number of lampreys based on water visibility (estimated % visibility). "Total # on Bank" is the number of dead, or nearly dead, lampreys found on dry dewatered banks. "Max E-Fish Density" is the maximum density of adjusted observed lampreys from all electrofishing surveys in the respective area. "Area of Wet Type I" is the area of Type I habitat observed on the first day of intensive salvage efforts. "Preliminary Estimated # in Type I" is an estimated number of lampreys residing only in Type I habitat in all surveyed areas either upstream or downstream of the fish screens. Summary totals (for all diversions) are shown at the bottom of Table 1B.

Watershed	Stream	Diversion Name	River km	Survey Location	# of Survey Days	Total Survey Area (m^2)	Total Shock Time (min)	Total # Captured (E-Fish)	Total # Dead (Wet)	Total # Observed (Wet)	Total # Observed Adjusted (Wet)	Total # on Bank	Max E-Fish Density (#/m2)	Area of Wet Type I (m2)	Preliminary Estimated # in Wet Type I
Lower Yakima	Yakima	Chandler	73.4	Upstream	1	16	8	4	0	4	4	3	0.3	98	**25**
				Downstream	0	-	-	-	-	-	-	-	-	-	**-**
Lower Yakima	Yakima	Snipes-Allen	159.9	Upstream	1	4	3	0	0	0	0	0	0.0	62	**0**
				Downstream	0	-	-	-	-	-	-	-	-	-	**-**
Lower Yakima	Yakima	Sunnyside	171.4	Upstream	2	9	10	142	0	162	201	50	32.1	64	**2057**
				Downstream	7	134	134	5313	308	9610	14619	4193	263.6	135	**7484**
Lower Yakima	Yakima	Wapato	176.3	Upstream	13	694	711	26408	0	47859	69086	188	234.3	1129	**75841**
				Downstream	1	8	8	36	0	42	60	0	7.5	273	**2050**
Lower Yakima	Yakima	Selah-Moxee	204.0	Upstream	1	7	8	19	0	23	33	0	4.7	554	**2602**
				Downstream	0	-	-	-	-	-	-	-	-	-	**-**
Upper Yakima	Yakima	Roza	210.6	Upstream	0	-	-	-	-	-	-	-	-	-	**-**
				Downstream	1	55	49	142	0	167	236	2	6.5	104	**676**
Upper Yakima	Yakima	New Cascade	264.7	Upstream	1	10	10	0	0	1	1	0	0.3	305	**40**
				Downstream	0	-	-	-	-	-	-	-	-	-	**-**
Upper Yakima	Yakima	Westside	272.1	Upstream	1	4	4	0	0	0	0	0	0.0	87	**0**
				Downstream	0	-	-	-	-	-	-	-	-	-	**-**
Lower Yakima	Toppenish	Olney	73.0	Upstream	1	27	26	60	0	90	113	0	4.8	30	**200**
				Downstream	0	-	-	-	-	-	-	-	-	-	**-**
Lower Yakima	Ahtanum	Lower WIP	16.5	Upstream	2	30	32	104	0	134	168	0	7.0	25	**172**
				Downstream	2	10	11	0	0	1	1	0	0.1	0	**1**
Lower Yakima	Ahtanum	Diversion 14	24.8	Upstream	4	68	99	1206	0	1614	2538	0	82.7	13	**351**
				Downstream	1	4	2	0	0	0	0	0	0.0	18	**0**
Lower Yakima	Ahtanum	Bachelor-Hatton[1]	31.8	Upstream	5	225	260	1668	2	2638	3933	0	0.0	46	**2237**
				Downstream	4	118	113	526	3	854	1219	0	0.0	39	**710**
Lower Yakima	Ahtanum	Upper WIP	32.8	Upstream	1	24	30	109	0	119	198	0	8.3	62	**509**
				Downstream	1	6	6	9	0	18	30	0	10.0	12	**118**
Lower Yakima	Ahtanum	Herke Ranch	35.0	Upstream	1	2	2	1	0	1	1	0	0.5	3	**1**
				Downstream	0	-	-	-	-	-	-	-	-	-	**-**
Lower Yakima	Ahtanum	John Cox	~ 45.0	Upstream	1	12	9	0	0	0	0	0	0.0	41	**0**
				Downstream	0	-	-	-	-	-	-	-	-	-	**-**

Table 1B. Summary of larval-juvenile salvage efforts in dewatered diversions in the Yakima Subbasin (continued). In the summary rows, "Upstream" and "Downstream" rows are a sum of presented values, except for "Max E-Fish Density", which is an equivalent value for the maximum density of all presented diversions for the respective surveyed area. "Total" is a sum of upstream and downstream values.

Watershed	Stream	Diversion Name	River km	Survey Location	# of Survey Days	Total Survey Area (m^2)	Total Shock Time (min)	Total # Captured (E-Fish)	Total # Dead (Wet)	Total # Observed (Wet)	Total # Observed Adjusted (Wet)	Total # on Bank	Max E-Fish Density (#/m2)	Area of Wet Type I (m2)	Preliminary Estimated # in Wet Type I
Upper Yakima	Taneum	Taneum	3.7	Upstream	1	20	20	85	0	91	101	0	5.1	76	**387**
				Downstream	1	3	3	0	0	0	0	0	0.0	38	**0**
Naches	Naches	City of Yakima	6.0	Upstream	1	6	19	112	0	149	213	43	35.5	14	**485**
				Downstream	1	4	6	30	0	30	30	0	7.5	20	**149**
Naches	Naches	Congdon	14.1	Upstream	1	10	12	2	0	2	3	0	0.6	21	**11**
				Downstream	1	10	9	1	0	1	1	0	0.1	76	**8**
Naches	Naches	Wapatox	29.0	Upstream	5	156	173	2966	6	4444	5663	2866	89.2	550	**15833**
				Downstream	0	-	-	-	-	-	-	-	-	-	**-**
Naches	Naches	Fruitvale	0.1	Upstream	1	5	4	0	0	0	0	0	0.0	19	**0**
				Downstream	2	14	18	171	0	541	901	0	134.3	114	**4326**
Summary	**-**	**-**	**-**	**Upstream**	**44**	**1,328.5**	**1,440.2**	**32,886**	**8**	**57,332**	**82,255**	**3,150**	**234.3**	**3,197**	**100,750**
				Downstream	**22**	**365.5**	**359.0**	**6,228**	**311**	**11,264**	**17,097**	**4,195**	**263.6**	**828.**	**15,521**
				Total	**66**	**1,694.0**	**1,799.3**	**39,114**	**319**	**68,595**	**99,352**	**7,345**	**-**	**4,026.**	**116,271**

Table D1-2. Overview of species composition of captured lampreys from dewatered irrigation diversions in the Yakima Subbasin in 2016-2017. "% 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 Days	# ID	# Western Brook Lamprey	# Pacific Lamprey	# of Eyed Pacific Lamprey	% Pacific Lamprey	# Gen. Samp. (Pacific Lamprey)
Lower Yakima	Yakima	Chandler	73.4	Upstream	1	5	5	0	0	**0.0%**	0
				Downstream	0	0	-	-	-	**-**	
Lower Yakima	Yakima	Snipes Allen	159.9	Upstream	1	0	0	0	0	**0.0%**	0
				Downstream	0	0	-	-	-	**-**	
Lower Yakima	Yakima	Sunnyside	171.4	Upstream	2	75	54	21	3	**28.0%**	3
				Downstream	7	55	45	10	0	**18.2%**	
Lower Yakima	Yakima	Wapato	176.2	Upstream	13	130	69	61	2	**46.9%**	23
				Downstream	1	20	19	1	0	**5.0%**	
Lower Yakima	Yakima	Selah-Moxee	203.6	Upstream	1	8	7	1	0	**12.5%**	1
				Downstream	0	0	-	-	-	**-**	
Upper Yakima	Yakima	Roza	210.6	Upstream	0	0	-	-	0	**-**	0
				Downstream	1	50	50	0	0	**0.0%**	
Upper Yakima	Yakima	New Cascade	264.7	Upstream	1	0	0	0	-	**-**	0
				Downstream	0	0	-	-	-	**-**	
Upper Yakima	Yakima	Westside	272.1	Upstream	1	0	0	0	0	**0.0%**	0
				Downstream	0	0	-	-	-	**-**	
Lower Yakima	Toppenish	Olney	73	Upstream	1	59	59	0	0	**0.0%**	0
				Downstream	0	0	-	-	-	**-**	
Lower Yakima	Ahtanum	Lower WIP	16.5	Upstream	2	101	95	6	0	**5.9%**	0
				Downstream	2	0	0	0	-	**-**	
Lower Yakima	Ahtanum	Diversion 14	24.8	Upstream	4	69	32	37	0	**53.6%**	0
				Downstream	1	0	0	0	-	**-**	
Lower Yakima	Ahtanum	Bachelor-Hatton	31.8	Upstream	5	25	4	21	0	**84.0%**	34
				Downstream	4	45	12	33	0	**73.3%**	
Lower Yakima	Ahtanum	Upper WIP	32.8	Upstream	1	31	10	21	0	**67.7%**	10
				Downstream	1	9	9	0	0	**0.0%**	
Lower Yakima	Ahtanum	Herke Ranch	35	Upstream	1	1	1	0	0	**0.0%**	0
				Downstream	0	0	-	-	-	**-**	
Lower Yakima	Ahtanum	John Cox	~ 45.0	Upstream	1	0	0	0	0	**-**	0
				Downstream	0	0	-	-	-	**-**	
Upper Yakima	Taneum	Taneum	3.7	Upstream	1	48	48	0	0	**0.0%**	0
				Downstream	1	0	0	0	-	**-**	
Naches	Naches	City of Yakima	6.0	Upstream	1	44	34	10	0	**22.7%**	10
				Downstream	1	1	1	0	0	**0.0%**	
Naches	Naches	Congdon	14.1	Upstream	1	2	2	0	0	**0.0%**	0
				Downstream	1	1	1	0	0	**0.0%**	
Naches	Naches	Wapatox	29	Upstream	5	69	52	17	0	**24.6%**	0
				Downstream	0	0	-	-	-	**-**	
Naches	Cowichee	Fruitvale	0.1	Upstream	1	0	0	0	0	**0.0%**	0
				Downstream	2	14	14	0	0	**0.0%**	
Summary	**-**	**-**	**-**	**Upstream**	**44**	**667**	**472**	**195**	**5**	**29.2%**	**81**
				Downstream	**22**	**195**	**151**	**44**	**0**	**22.6%**	
				Total	**66**	**862**	**623**	**239**	**5**	**27.7%**	

Appendix D2 - Intensive Monitoring of Larval/Juvenile Lamprey Entrainment within the Yakama Subbasin, 2016

Photo D2. A mesh basket of nearly 3,000 larval and juvenile lampreys captured from a one-day electrofishing salvage operation at Wapato Diversion (Yakima River, Rkm 176.3).

Irrigation diversions pose a major threat to Pacific Lamprey, primarily to their larval and juvenile life stages. There are many irrigation diversions scattered throughout the Yakima Subbasin. In 2016, four irrigation diversions within the Yakima Subbasin (with relatively high numbers of entrained lampreys) were intensively surveyed (by electrofishing wetted habitat and hand collection from dewatered banks) in high density areas. The following report is broken into three parts to summarize our 2016 intensive monitoring efforts; 1) Part I – Intensive Monitoring of Electrofishing Surveys in High Density Areas, 2) Part II – Effects of Dewatering Rates on Larval Lampreys, and 3) Part III – Monitoring Trends within High Density Areas (2012-2016).

Part I – Intensive Monitoring of Electrofishing Surveys in High Density Areas:
Total larval lamprey numbers were estimated at four diversions with considerably high lamprey entrainment. The area immediately downstream of the fish screens at Sunnyside Diversion (Yakima River, river km 171.4), the area immediately upstream of the fish screens at Wapato Diversion (Yakima River, river km 176.3), the area immediately upstream and downstream of the fish screens at Bachelor-Hatton Diversion (Ahtanum Creek, river km 31.8) and the area immediately downstream of the headgate (and upstream of the weir gate) at Wapatox Diversion (Naches River, river km 28.9) were our primary focus based on trends of past and current larval densities. At each location, surveys were conducted in individual plots covering representative areas of Type I and Type II habitat. Plots were surveyed by single-pass electrofishing. The resulting Type I and Type II densities were then extrapolated over the total area of the respective available wetted habitat to estimate the number of lamprey present based on single-pass electrofishing (termed alternatively as “the initial estimated number of lampreys”).

At Sunnyside Diversion, a total of 11 plots were surveyed in representative Type I and Type II habitat on two survey dates (November 8 and 9, 2016) (Fig. D2-1). The maximum observed density was observed in isolated pools of water on Type I habitat (208.6 #/m^2). The initial estimated number of lampreys in this area was 14,945 (Table D2-1).

At Wapato Diversion, a total of 11 plots were surveyed in representative portions of Type I and Type II habitat on three survey dates (October 15, 16, and 27, 2016) (Fig. D2-2). From these surveys, the initial estimated number of lampreys in this area was 69,736 (Table D2-2). The maximum electrofishing density in Type I habitat was relatively high and prevalent, and observed all along the bank of the main wetted area (109.0 #/m^2).

At Bachelor-Hatton Diversion, a total of four plots were surveyed upstream of the fish screens, and five plots were surveyed downstream of the fish screens (Fig. D2-3). The initial estimated number of lampreys upstream of the fish screens was 4.2 times higher than below the fish screens (3,157 and 761, respectively) (Table D2-3). The maximum density upstream of the fish screens in Type I habitat was 4.9 times higher than the maximum density in Type I habitat downstream of the fish screens (112.7 #/m^2 and 22.9 #/m^2, respectively).

At Wapatox Diversion, a total of eight surveys were conducted in representative portions of Type I habitat on three survey dates (November 1, 2 and 3, 2016) (Fig. D2-4). The initial estimated number of lampreys estimated to reside in Type I habitat is 9,843 (Table D2-4). The average density (for all Type I plots) is 17.0 #/m^2. Type II habitat was not surveyed. In order to calculate the number of lampreys in Type II, we used a density of 10% of the Type I density (based on Sea Lamprey studies). The resulting density (1.7 #/m^2), was extrapolated over the area of Type II habitat to arrive at a total of 1,166 lampreys. The initial estimated number of lampreys in this area was 11,009.

In reality, these estimated numbers are likely considerably larger, as it is uncertain how many lampreys remained unseen during the survey period either from survey inefficiency, predation, decomposition, or concealment in the dredged material. From our 2014 mark-recapture study in Wapato Diversion, we estimated only 19-45% capture efficiency using mark-recapture electrofishing surveys. In 2016, plots were surveyed multiple times at Sunnyside and Wapato diversions, and the resulting data from the pass-depletion surveys will be analyzed to provide more information towards the portion of lampreys we are not seeing from a single-pass electrofishing survey.

Part II – Effects of Dewatering Rates on Larval Lampreys:

The dewatering rate of irrigation diversions at the end of the irrigation season is a critical factor that influences the survival of entrained lampreys. At Wapato and Sunnyside diversions, we examined the impacts of dewatering rates on entrained lampreys. For this assessment, we estimated the past three years of dewatering rates (2014-2016) and compared those rates with the percent of lamprey captured from dry banks over all captured lamprey (including those electrofished from wetted habitat) for each respective year. At Sunnyside Diversion in 2015, the dewatering rate was estimated to be 18.3 cm/hr and the percent of lampreys collected on the bank was only 3%. However, in 2016, with a doubling of the dewatering rate (36.5 cm/hr), the percent of lampreys found on the bank increased to 76%. At Wapato Diversion, the dewatering rate was estimated to be virtually the same for 2014 and 2015 at 26.5 cm/hr, and the resulting ratio of lampreys found on the bank was 111% and 82%, respectively. In 2016, the Wapato Irrigation Project was willing to experimentally decrease the dewatering rate at Wapato Diversion, which resulted in a 10.2 cm/hr dewatering rate, a rate that was lower than any previous dewatering rates at Wapato Diversion or any of the other diversions in the subbasin (7.5 cm/hr was estimated to be a natural rate of drop in channel bank water elevations from Fraser River, a river without dams on the mainstem). The percent of lampreys from the dewatered banks, consequently, decreased to 1%. Although over 26,000 larvae were salvaged from electrofishing in Wapato Diversion this year, very few lampreys were captured from the dry banks this year due to this slow dewatering.

Part III – Monitoring Trends within High Density Areas (2012-2016):
The ratio of Pacific Lamprey (vs. Western Brook Lamprey) shows a considerable increasing trend since lamprey diversion surveys first began in 2010 (Fig. D2-5). Between 2010-2012, the ratios of Pacific Lamprey were near zero at all of these diversions. In 2013, a very small number of Pacific Lamprey were observed in some of these diversions (2~3%). At Wapato Diversion, the ratio of Pacific Lamprey was 7% in 2014 (the first year we began to observe a perceptible ratio of Pacific Lamprey). This ratio has since then increased to 41% in 2016. In tributaries, the ratio of Pacific Lamprey are even higher (75-94% in Bachelor-Hatton Diversion and 25-51% in Wapatox Diversion). Bachelor-Hatton Diversion is part of Ahtanum Creek, which is an YN adult lamprey translocation stream, and Wapatox Diversion is part of Naches River, which received some adult lamprey from a radio telemetry study but also has a small wild population.

The increasing trend is also observed clearly in the total captured number of lampreys from 2012 to 2016 irrigation seasons in all four diversions. At Wapato Diversion, for example, the capture number increased from 1,118 in 2012 to 26,444 in 2016. Translocation of adult lamprey began in 2012-2013 (initially only Satus Creek in 2012 and Toppenish and Ahtanum creeks in 2013). In 2015-2016, large increases in lamprey captures were observed in three of these diversions, which may be related to the increase in downstream migrating offspring from the initial years of adult lamprey translocation. Genetic analyses are pending to confirm the ratio of Pacific Lamprey that originated from the translocated lamprey. See **Appendix D2** for more information.

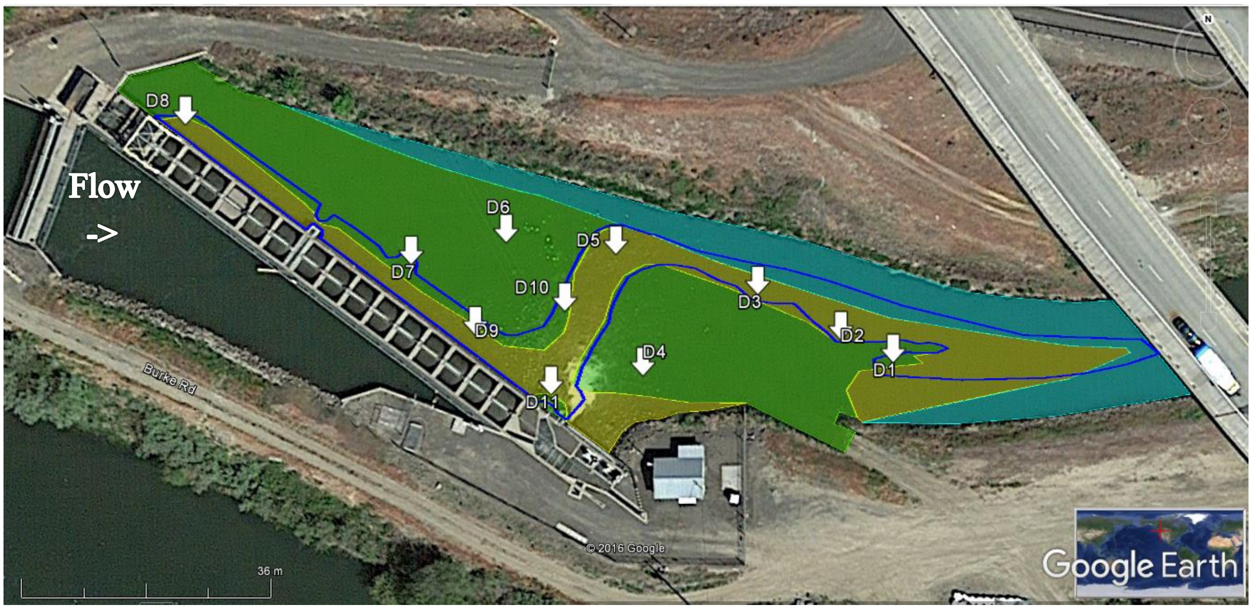


Figure D2-1. Sunnyside Diversion overview map showing the distribution of Type I, II, and III habitat (green, yellow and blue polygons, respectively) in the area immediately downstream of the fish screens. Also shown are the locations of the 11 surveyed plots (white arrows) in wetted Type I and Type II habitat on November 8 and 9, 2016. The blue line indicates the waterline on November 8, 2016. Plot D4 and D6 were conducted in isolated pools of water (away from the main body of water).

Table D2-1. Initial estimated number of lampreys (single-pass electrofishing estimates of lampreys) in the wetted habitat area immediately downstream of the fish screens at Sunnyside Diversion, separated by habitat type and habitat category, in November, 2016. Displayed values for "Total # of Plots", "Survey Area" and "Total # Observed (Adjusted)" are cumulative totals from all survey effort on both plot survey dates for each habitat type and habitat category. Electrofishing densities (#/m^2) are calculated using the adjusted observed number of lampreys. In the summary row, values are a sum of presented values, except electrofishing density, which is a weighted average.

Habitat Type Surveyed	Habitat Detail	Wetted Area (m2) 11/08/16	Total # of Plots	Survey Area (m2)	Total # Observed (Adjusted)	E-Fish Density (L/m2)	Initial Estimated # of Lamprey (E-Fish)
Type I	Isolated Pool	5	2	2.0	257	128.5	642
Type I	Bank	119	3	3.0	229	76.4	9080
Type I	Pump	11	1	1.0	2	2.2	24
Type II	Screens	193	2	2.0	6	3.1	590
Type II	Bank	142	2	2.0	47	23.5	3337
Type II	Open Water	339	1	1.0	4	3.8	1272
Summary		**809**	**11**	**11.0**	**545**	**49.6**	**14945**

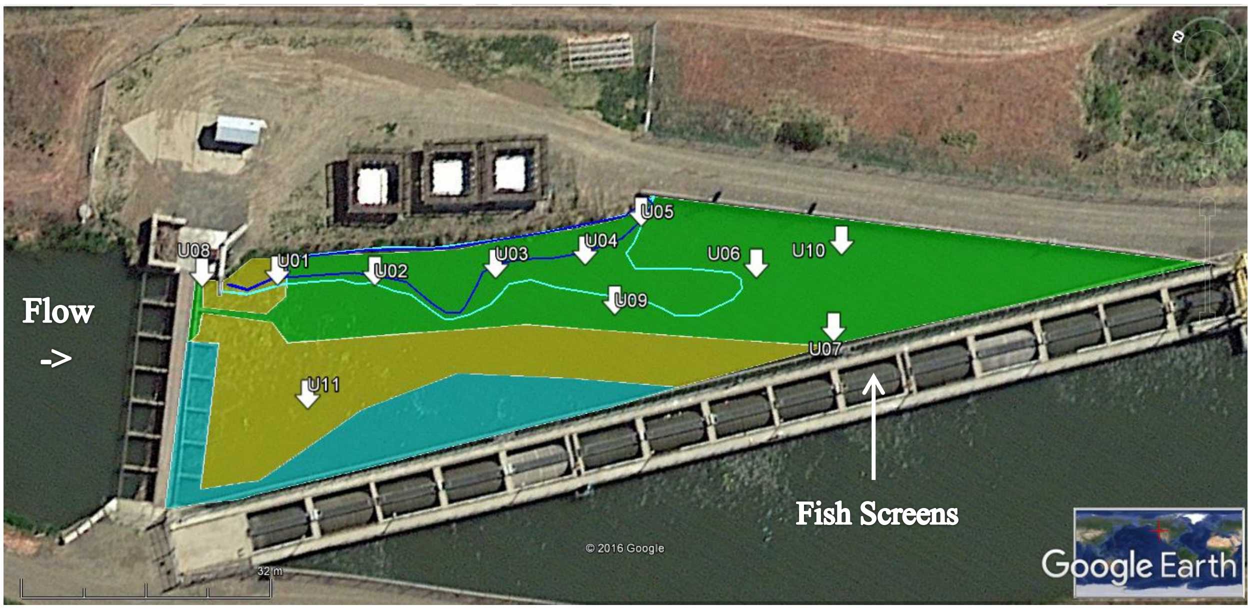


Figure D2-2. Wapato Diversion overview map showing the distribution of Type I, II, and III habitat (green, yellow and blue polygons, respectively) in the area immediately upstream of the fish screens. Also shown are the locations of the 11 surveyed plots (white arrows) in wetted Type I and Type II habitat surveyed on October 15, 16 and 27, 2016. The dark blue line indicates the waterline on October 16, 2016 and the light blue line indicates the waterline on October 27, 2016.

Table D2-2. Initial estimated number of lampreys (single-pass electrofishing estimates of lampreys) in the wetted habitat area immediately upstream of the fish screens at Wapato Diversion, separated by habitat type and habitat category, in October, 2016. Displayed values for "Total # of Plots", "Survey Area" and "Total # Observed (Adjusted)" are cumulative totals from all survey effort on all plot survey dates for each habitat type and habitat category. Electrofishing densities (#/m^2) are calculated using the adjusted observed number of lampreys. In the summary row, values are a sum of presented values, except electrofishing density, which is a weighted average.

Habitat Type Surveyed	Habitat Category	Wetted Area (m2) 10/15/16	Total # of Plots	Survey Area (m2)	Total # Observed (Adjusted)	E-Fish Density (#/m2)	Initial Estimated # of Lamprey (E-Fish)
Type I	Bank	169	4	12.0	956	79.6	13457
Type I	Open Water	905	3	9.0	546	60.7	54928
Type I	Trash Rack	10	1	3.5	35	10.0	100
Type I	Screens	45	1	2.0	22	10.8	488
Type II	Bank	9	1	3.0	72	23.9	215
Type II	Open Water	657	1	3.0	3	0.8	548
Summary		**1795**	**11**	**32.5**	**1633**	**50.2**	**69736**

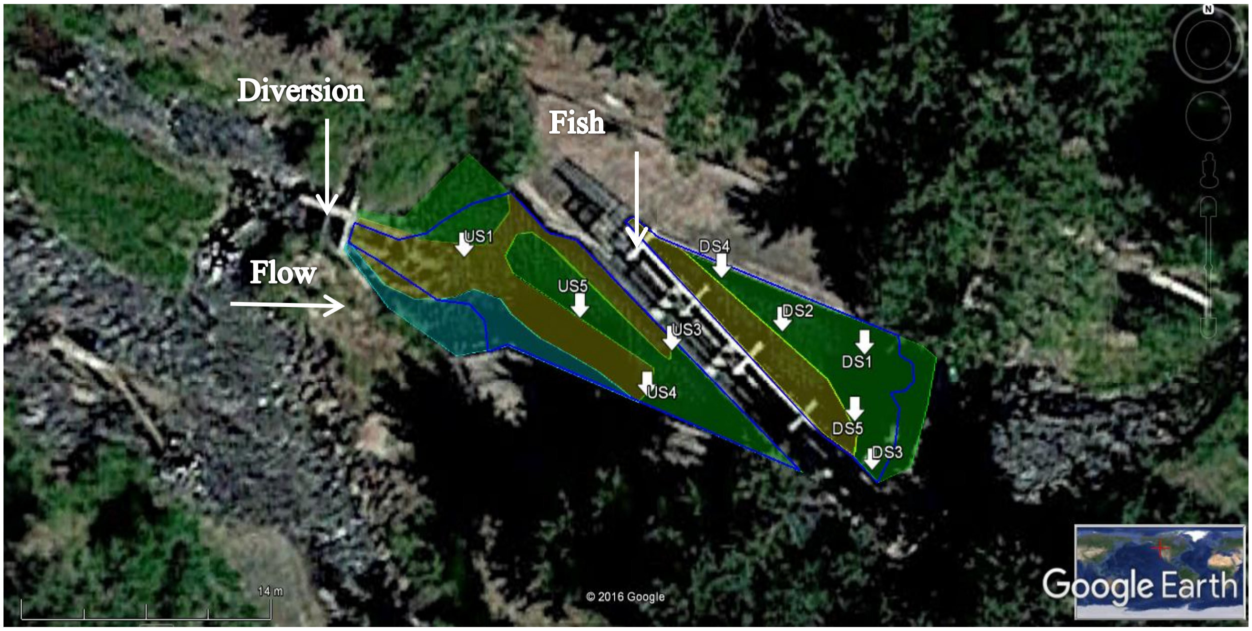


Figure D2-3. Bachelor-Hatton Diversion overview map showing the distribution of Type I, II, and III habitat (green, yellow and blue polygons, respectively) in the area immediately upstream and immediately downstream of the fish screens. Also shown are the locations of the nine surveyed plots (four upstream and five downstream) surveyed on July 11, 2016 (white arrows). The dark blue line indicates the waterline on July 11, 2016.

Table D2-3. Initial estimated number of lampreys (single-pass electrofishing estimates of lampreys) in the wetted habitat area at Bachelor-Hatton Diversion, separated by habitat type and habitat category, in July, 2016. Under "Screen Location", "Upstream" indicates the area immediately upstream of the fish screens and "Downstream" indicates the area immediately downstream side of the fish screens. Displayed values for "Total # of Plots", "Survey Area" and "Total # Observed (Adjusted)" are cumulative totals from all survey effort on July 11, 2016 for each screen location and habitat type. Electrofishing densities (#/m^2) are calculated using the adjusted observed number of lampreys. In the "total" rows, values are a sum of presented values, except electrofishing density, which is a weighted average. In the summary row, values are a sum of presented values for upstream and downstream surveys, except electrofishing density, which is a weighted average.

Screen Location	Habitat Type Surveyed	Wet Habitat Area (m2) 7/11/16	Total # of Plots	Survey Area (m2)	Total # Observed (Adjusted)	E-Fish Density (#/m2)	Initial Estimated # of Lamprey (E-Fish)
Upstream	Type I	46	3	21.0	1027	48.9	2237
Upstream	Type II	57	1	16.0	258	16.1	920
Downstream	Type I	39	5	38.0	688	18.1	710
Downstream	Type II*	28	0	-	-	1.8	51
Upstream Total		**103**	**4**	**37**	**1285**	**34.7**	**3157**
Downstream Total		**67**	**5**	**38**	**688**	**18.1**	**761**
Summary		**170**	**9**	**75**	**1973**	**26.3**	**3918**

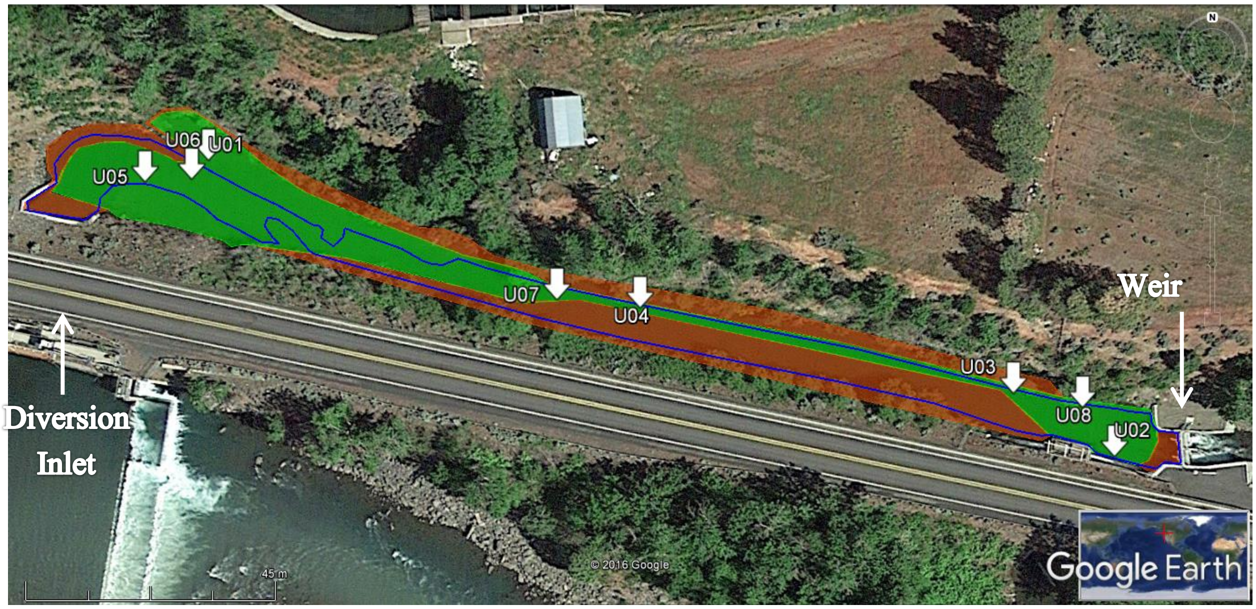


Figure D2-4. Wapatox Diversion overview map showing the distribution of Type I habitat (green polygon) and Type II and III habitat combined (orange polygon) in the canal area immediately downstream of the headgate. Also shown are the locations of the eight surveyed plots (white arrows) in wetted Type I habitat surveyed on November 1 and 3, 2016. The dark blue line indicates the waterline on November 1, 2016.

Table D2-4. Initial estimated number of lampreys (single-pass electrofishing estimates of lampreys) in the area immediately downstream of the headgate at Wapatox Diversion (separated by habitat type) in July, 2016. Displayed values for "Total # of Plots", "Survey Area" and "Total # Observed (Adjusted)" are cumulative totals from all survey effort on both plot survey dates for each habitat type and habitat category. Electrofishing densities (#/m^2) for Type I is calculated using the adjusted observed number of lampreys. In the "Total" rows (for Type I and Type II habitat) values are a sum of presented values, except survey density (#/m^2) which is a weighted average.*No surveys were conducted in Type II habitat; presented density is 10% of Type I density, and the resulting density is used to calculate the estimated number within Type II habitat.

Habitat Type Surveyed	Habitat Category	Wetted Area (m2) 11/1/16	Total # of Plots	Survey Area (m2)	Total # Observed (Adjusted)	E-Fish Density (#/m2)	Initial Estimated # of Lamprey (E-Fish)
Type I	Isolated Pool	4	1	2.5	323	129.3	517
Type I	Bank	235	4	7.0	260	37.1	8729
Type I	Open Water	315	3	6.0	11	1.9	597
Type II	Open Water	687	0.0	0.0	-	-	-
Type I	**Total**	**554**	**7**	**13**	**271**	**17.0**	**9843**
Type II*	**Total**	**687**	**0**	**-**	**-**	**1.7**	**1166**
Summary		**1237**	**7**	**13.0**	**271**	**-**	**11009**

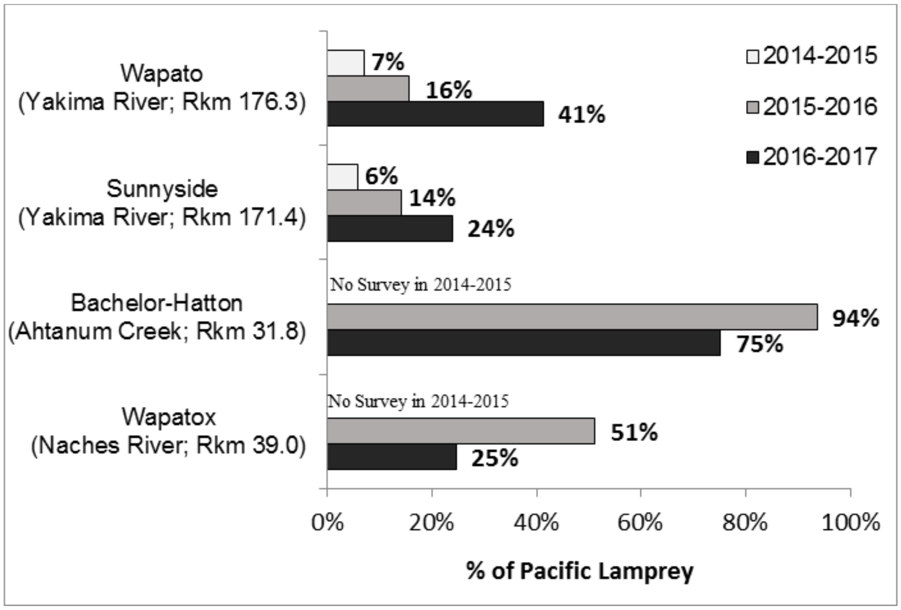


Figure D2-5. Ratio of Pacific Lamprey (to resident Western Brook Lamprey) from lamprey of identifiable length (generally > 50 mm) at Wapato Diversion, Sunnyside Diversion, Bachelor-Hatton Diversion, and Wapatox Diversion from the 2014-2015 irrigation season through the 2016-2017 irrigation season. Note no surveys were conducted at Bachelor-Hatton Diversion and Wapatox Diversion in the 2014-2015 irrigation season.

<u>Appendix G8 – Summary of Pacific Lamprey Salvage Efforts from Dryden Diversion Maintenance Operations (Wenatchee River, Dryden, WA)</u>

Photo G8. 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, 1.75 mm mesh-size vertical-bar fish screens) which entrains several thousands of larval/juvenile Pacific Lamprey each year. As in previous years, the Yakama Nation Pacific Lamprey Project (YNPLP) assisted with Pacific Lamprey salvage operations on October 11, 12 and 19, 2016, after the canal was dewatered.

Dryden Diversion was dewatered on October 11, 2015 and lamprey salvage efforts in the canal occurred on a total of four dates (October 11, 12, 19 and 24, 2016), primarily by Chelan County PUD (CCPUD), the YNPLP, and US Fish and Wildlife Service (USFWS). Through our collective efforts between October 11, 2015, and October 24, 2015, a total of 6,735 lamprey (6428 larvae and 307 macrophthalmia) were captured (Table D3-1) and released back to the Wenatchee River into a large eddy on the mainstem of the Wenatchee River (river km 24.1) with Type I and II habitat. Macrophthalmia composed 4.6% of the overall number salvaged. The total sample time (for a combination of bank collection and electrofishing efforts) was 17.4 hours, involving over 20 workers from various agencies. Of the total number of lampreys removed on October 11, 12, 19 and 24, the percentage of lampreys captured (by day) showed an overall decreasing trend. Catch per unit effort (CPUE; # captured per hour of effort), was highest from electrofishing and bank salvage efforts on October 11 (442 #/hr). For electrofishing efforts only, CPUE in the canal upstream of fish screens (focusing on the high density areas), maxed out at 359 #/hr on October 19. Although efforts were made to capture all lamprey we observed, a large number of the lamprey, especially smaller ones, escaped our nets due to high density and limited water quality (we estimated that we missed between 2~4 fish for every fish captured).

To estimate the number of entrained lamprey in Dryden Diversion, we used electrofishing densities from individual subsampling plots surveyed in representative sections of the areas upstream and downstream of the fish screens on October 11 and 12, 2015 (four sections upstream, and one section downstream of the fish screens) (Fig. D3-1). Subsampling surveys were conducted separately for Type I (optimal) and Type II (acceptable) larval lamprey habitat.

In many cases, survey visibility was less than ideal, and many lampreys went unseen. To account for unseen lamprey, the total number of lampreys observed (i.e. a combination of captured and missed lamprey) was adjusted (increased) based on the following 1-5 visibility scale: (1) poor (60%), (2) fair (70%), (3) good (80%), (4) very good (90%) and (5) excellent (100%). For each section of the diversion that was surveyed separately, the total number of observed lampreys was increased (by the percentage listed above) based on the survey visibility rank. Survey densities (#/m^2) were calculated using the adjusted observed number of lampreys. The resulting densities were used in extrapolating to the overall area, of each habitat type, within each section.

The total number of lampreys estimated to reside in Dryden Diversion based on adjusted observed lamprey was 13,139 (Table D3-2). The estimate downstream of the fish screen was low (246), though this only covered a small area downstream of the fish screens. In the canal upstream of the fish screens and downstream of the ecology blocks, the density of lampreys decreased from upstream to downstream (36.0, 11.0 and 6.0 in sections 2, 3, 4, respectively). Observed per unit effort (OPUE; # per minute of electrofishing time), was calculated for all surveys in the canal upstream of the fish screens on October 12, 19 and 24 (based on Yakama Nation electrofishing survey efforts). The OPUE showed a slight drop between October 12 and 19 (37.0 and 26.7, respectively). However, between October 19 and 24, the OPUE dropped significantly (26.7 and 2.6, respectively). The significant drop in OPUE suggests a large decrease in lamprey survival during this time period. After all salvage efforts were complete, we estimated that more than half (56.1%) of the lampreys within the diversion were never salvaged. In reality, these estimated numbers could be considerably larger, as we are entirely uncertain how many lampreys remained unseen during the survey period either from survey inefficiency, predation, decomposition, or concealment in the dredged material. From our 2014 mark-recapture study in Wapato Diversion (Yakima River, river km 176.3), we estimated only 19-45% capture efficiency using the standard electrofishing surveys.

In 2016, small plots (between 1-3 m^2 in size) were surveyed multiple times within two Yakima River diversions (Sunnyside and Wapato diversions), and the resulting pass-depletion data were analyzed to provide more information towards what we are not seeing from a single-pass electrofishing survey. Based on this analysis, the estimate from adjusted observed lamprey (which we used above) is likely a conservative estimate representing roughly only 60-70% of the actual number of lamprey. See **Appendix D3** for more information.

Table D3-1. Summary of larval/juvenile lamprey capture at Dryden Diversion between October 11 and 24, 2016.

Date	Fish Screen Location	Location Description	# of Days Post Dewater	Agency	Capture Method	# of Captured (Larvae)	# of Captured (Macro)	% Macro.	# of Captured Lamprey	% of Total Capture	Survey Time (Hours)	CPUE (#/hr)
10/11/16	Upstream	Below Ecology Blocks	0	YN	e-fishing	114	6	5.0%	120	1.8%	0.7	180
10/11/16	Upstream	Below Ecology Blocks	0	Chelan/FWS	bank salvage / e-fishing	2016	193	8.7%	2209	32.8%	~ 5.0	442
10/12/16	Upstream	Below Ecology Blocks	1	Chelan/FWS	bank salvage / e-fishing	182	45	19.8%	227	3.4%	~ 3.0	76
10/12/16	Upstream	Below Ecology Blocks	1	YN	bank salvage	102	1	1.0%	103	1.5%	0.5	206
10/12/16	Upstream	Below Ecology Blocks	1	YN/Chelan	e-fishing	1937	52	2.6%	1989	29.5%	6.5	306
10/19/16	Upstream	Above Ecology Blocks	8	YN/Chelan	e-fishing	111	8	6.7%	119	1.8%	0.8	159
10/19/16	Upstream	Below Ecology Blocks	8	YN/Chelan	e-fishing	1677	0	0.0%	1677	24.9%	4.7	359
10/19/16	Downstream	Below Fish Screens	8	YN/FWS	e-fishing	10	0	0.0%	10	0.1%	0.3	30
10/24/16	Upstream	Below Ecology Blocks	13	FWS	e-fishing	279	2	0.7%	281	4.2%	4.00	70
	Upstream	**Above Ecology Blocks**	**-**	**YN/Chelan**	**e-fishing**	**111**	**8**	**6.7%**	**119**	**6.6%**	**0.8**	**159**
-	**Upstream**	**Below Ecology Blocks**	**-**	**YN/Chelan/FWS**	**all**	**6307**	**299**	**17.8%**	**1677**	**92.9%**	**16.3**	**103**
	Downstream	**Below Fish Screens**	**-**	**YN**	**e-fishing**	**10**	**0**	**0.0%**	**10**	**0.6%**	**0.3**	**30**
Total	-	-	-	-	**all**	**6428**	**307**	**4.6%**	**6735**	**-**	**17.4**	**291**

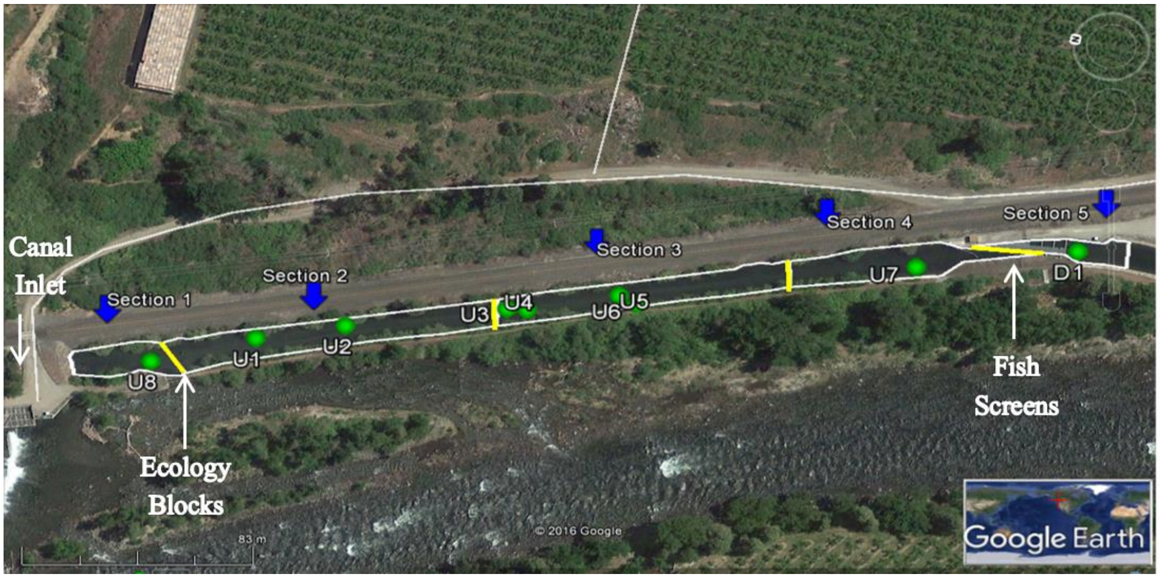


Figure D3-1. An overview map of Dryden Diversion, highlighting the delineated sections of the diversion (Section 1-4 are upstream of the fish screens and Section 5 is downstream of the fish screens).

Table D3-2. Initial estimated number of lamprey (single-pass estimates of lamprey) at Dryden Diversion, separated by habitat type and surveyed section. The total number of lampreys observed was adjusted (increased) based on the following 1-5 visibility scale (estimated % visibility in parenthesis): (1) poor (60%), (2) fair (70%), (3) good (80%), (4) very good (90%) and (5) excellent (100%). Electrofishing densities (#/m^2) were calculated using the adjusted observed number of lampreys. Under "Totals", presented values are a sum of presented values, except for "E-Fish Density", which is a weighted average. *In several sections, surveys were not conducted in Type II habitat; density in these Type II habitat areas were estimated to be 10% of Type I density, and extrapolated accordingly.

Screen Location	Location Description	Section #	Habitat Type Surveyed	Wetted Habitat Area (m2)	Total # of Plots	Survey Area (m2)	Total # Observed (Adjusted)	E-Fish Density (#/m2)	Initial Estimated # of Lamprey
Upstream	above ecology blocks	1	Type I	174	1	25.0	213	8.5	1476
Upstream	below ecology blocks	2	Type I	122	2	7.5	273	36.4	4427
Upstream	below ecology blocks	3	Type I	204	2	6.5	123	19.0	3870
Upstream	below ecology blocks	4	Type I	156	1	5.0	30	6.0	935
Downstream	below screens	5	Type I	201	1	9.0	10	1.1	223
Upstream	above ecology blocks	1	Type II*	122	-	-	-	1.3	161
Upstream	below ecology blocks	2	Type II*	14	-	-	-	5.7	77
Upstream	below ecology blocks	3	Type II	136	2	5.5	16	3.0	403
Upstream	below ecology blocks	4	Type II*	127	-	-	-	0.9	119
Downstream	below screens	5	Type II*	134	-	-	-	0.2	23
			Totals						
Upstream	**above ecology blocks**	**1**	**all**	**295**	**1**	**25.0**	**213**	**8.5**	**1476**
Upstream	**below ecology blocks**	**2**	**all**	**135**	**2**	**7.5**	**273**	**36.4**	**5486**
Upstream	**below ecology blocks**	**3**	**all**	**340**	**4**	**12.0**	**140**	**11.6**	**4796**
Upstream	**below ecology blocks**	**4**	**all**	**283**	**1**	**5.0**	**30**	**6.0**	**1158**
Downstream	**below screens**	**5**	**all**	**334**	**1**	**9.0**	**10**	**1.1**	**223**
-	**above ecology blocks**	**1**	**all**	**295**	**1**	**25.0**	**213**	**8.5**	**1476**
-	**below ecology blocks**	**2,3,4**	**all**	**758**	**7**	**24.5**	**442**	**18.1**	**11441**
-	**below screens**	**5**	**all**	**334**	**1**	**9.0**	**10**	**1.1**	**223**
Total	**all**	**all**	**all**	**1388**	**9**	**59**	**665**	**11.4**	**13139**

E. Work Element 99 – Outreach and Education

Work Element Associated Appendix Report:
<u>Appendix E1 – Yakama Nation Lamprey Outreach and Education, 2016</u>

Photo E1. One of our interactive displays showing lamprey eggs and larvae (left) and shed lamprey teeth that we give out to many of the outreach participants (right).

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. At release events, the visitor is able to hold a lamprey and release it into the river (Fig. E1-1). We also give most outreach participants a set of lamprey teeth (see cover photo) and a lamprey PIT code that they can look up on-line to follow the lamprey's movements. Last year, through our community events and hatchery tours, we reached out to over 4,000 children and 3,000 adults (Table 1A and Table 1B).

Fishery events (such as "Family Trout Fishing Event" and "Salmon Run"), the Treaty Day Parade, the Backpack Give Away, adult release events (such as the World Fish Migration Day), news media, and social media were opportunities to expose large numbers of people to the importance of Pacific Lamprey. The *Yakama Herald* published several stories about our project. More than 300,000 people visited the Central Washington State Fair where we had a Pacific Lamprey booth (Table 1A). We have introduced over half a million people to the Pacific Lamprey through these collection of events, newspapers, e-magazines, and social media (Table 1A and 1B).

Our team gives presentations to the scientific community, funding sources, and fisheries managers. In 2016, our biologists were presenters at eleven conferences and meetings, such as American Fisheries Society chapter meetings, Northwest Fish Culture Conference, and WDFW Habitat School Training, targeting the scientific and fisheries community. We also gave a tour with a team of representatives (NRCS and other government entities) from Washington D.C., whose support is crucial for future restoration activities. Ralph Lampman was able to give a presentation about Pacific Lamprey restoration work in Japan.

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. 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. For the Pacific Lamprey Project, 2016 was an outstanding year of good publicity with many opportunities to reach out to students, the general public, and our partners. We were chosen to represent the United States for the World Fish Migration Day website. This put Yakama Nation Fisheries in the spotlight, world-wide. Local news media continues to support our efforts and are promoting the need to restore Pacific Lamprey. 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 all means available. See **Appendix E1** for more information.

Photo 17. Tyler Beals with Toppenish Head Start students at Toppenish Creek release site on May 12, 2016.

Table 1A. Summary of Yakima Nation Pacific Lamprey Project outreach, educational events and activities, and media presence.

Date	Event	Location	Audience	# of Pre-School Students	# of Primary & Middle School Students	# of Youth (15-19 years)	# of College Students	# of Adults	# in Target Audience	# Total
1/16/16	Oyez Roslyn! Lamprey Presentation	Roslyn, WA	General Public	-	-	-	-	100	-	100
1/28/16	Upper Columbia Science Conference	Wenatchee, WA	Biologists / Managers	-	-	-	-	200	-	200
2/11/16	Presentation in the Classroom	Union Gap, WA	LaSalle High School	-	-	20	-	-	-	20
2/16/16	Wenatchee Environmental Film Festival	Wenatchee, WA	General Public	-	-	-	-	100	-	100
2/26/16	Heritage University Fisheries Class	Toppenish, WA	College Students	-	-	-	24	2	-	26
2/27/16	Prosser Hatchery Tours	Prosser, WA	Boy Scouts	-	10	-	-	2	-	12
2/27/16	Prosser Hatchery Tours	Prosser, WA	Family of 5	-	3	-	-	2	-	5
3/17/16	Wenatchee Adult Release	Jolanda Lake, WA	General Public	-	-	-	-	6	-	6
3/30/16	Prosser Hatchery Tours	Prosser, WA	Grandview McClure Elementary	-	40	-	-	-	-	40
3/31/16	Ahtanum Creek Adult Release	Prosser, WA	LaSalle High School	-	-	6	-	1	-	7
4/2/16	Prosser Hatchery Tours	Prosser, WA	Heritage University	-	-	-	30	-	-	30
4/12/16	Prosser Hatchery Tours	Prosser, WA	Harrah Elementary	-	36	-	-	4	-	40
4/13/16	Upper Columbia Lamprey Coordination Meeting	Yakima, WA	Biologists / Managers	-	-	-	-	15	-	15
4/20/16	Prosser Hatchery Tours	Prosser, WA	Prosser Business Leaders	-	-	-	-	6	-	6
4/23/16	Salmon Run	-	General Public	10	20	10	30	35	-	105
4/25/16	Pacific Lamprey Redd ID Workshop	Toppenish, WA	Biologists / Managers	-	-	-	-	10	-	10
4/27/16	Prosser Hatchery Tours	Prosser, WA	Mt. Hood CC	-	-	-	15	-	-	15
4/28/16	Museum After Hours	Fort Walla Walla Museum	General Public	10	20	10	10	30	-	80
5/3/16	USACOE Regulatory Meeting	Screen Sharing	Biologist / Managers	-	-	-	-	15	-	15
5/4/16	Prosser Hatchery Tours	Prosser, WA	Headstart Toppenish	12	-	-	-	-	-	12
5/4/16	Prosser Hatchery Tours	Prosser, WA	Administration Staff	-	-	-	-	8	-	8
5/4/16	Upper Satus Release		Yakama Nation Tribal School		-	20	-	6	-	26
5/5/16	Upper Toppenish Adult Release	-	General Public	2	-	2	-	3	-	7
5/5/16	Prosser Hatchery Tours	Prosser, WA	Harrah Elementary	-	32	-	-	4	-	36
5/6/16	Prosser Hatchery Tours	Prosser, WA	Harrah Elementary	-	40	-	-	5	-	45
5/9/16	Prosser Hatchery Tours	Prosser, WA	Headstart Wapato	16	-	-	-	8	-	24
5/9/16	Prosser Hatchery Tours	Prosser, WA	Headstart White Swan	15	-	-	-	4	-	19
5/10/16	Prosser Hatchery Tours	Prosser, WA	Headstart Wapato	16	-	-	-	6	-	22
5/10/16	WDFW Habitat School Training	Walla Walla, WA	Biologists / Managers	-	-	-	-	100	-	100
5/11/16	Prosser Hatchery Tours	Prosser, WA	Headstart Wapato	11	-	-	-	11	-	22
5/12/16	Toppenish Creek Adult Release	-	Headstart Toppenish	17	-	-	-	3	-	20
5/12/16	Prosser Hatchery Tours	Prosser, WA	Headstart Wapato	26	-	-	-	17	-	43
5/13/16	Prosser Hatchery Tours	Prosser, WA	Sunnyside Christian School	-	22	14	-	12	-	48
5/15/16	Satus Creek Adult Release	-	Toppenish Tribal School	-	-	16	-	2	-	18
5/21/16	World Fish Migration Day	Ahtanum, WA	General Public	5	6	2	-	43	-	56
5/24/16	Prosser Hatchery Tours	Prosser, WA	Pioneer Elementary	-	180	-	-	12	-	192
5/26/16	Prosser Hatchery Tours	Prosser, WA	Pioneer Elementary	-	150	-	-	12	-	162
5/30/16	School Coloring Contest	Sunnyside, WA	Pioneer Elementary 1st Grade	-	22	-	-	3	-	25
6/3/16	Prosser Hatchery Tours	Prosser, WA	Wapato Middle School	-	18	-	-	5	-	23
6/6/16	Pacific Lamprey Presentation (in Japanese)	-	Ishikawa Prefectural University	-	-	-	40	10	-	50
6/7/16	Prosser Hatchery Tours	Prosser, WA	Wapato Middle School	-	51	-	-	4	-	55
6/8/16	Prosser Hatchery Tours	Prosser, WA	Toppenish Middle School	-	275	-	-	10	-	285
6/8/16	Family Trout Fishing Event	Marion Drain Hatchery	General Public	25	100	25	-	250		400
6/9/16	Treaty Days Parade	Toppenish, WA	General Public	450	900	450	300	1,200	-	3,300
6/16/16	Yakima Basin Science & Management Conference	-	Biologists / Managers	-	-	-	-	150	-	150

Table 1B. Summary of Yakima Nation Pacific Lamprey Project outreach, educational events and activities, and media presence.

Date	Event	Location	Audience	# of Pre-School Students	# of Primary & Middle School Students	# of Youth (15-19 years)	# of College Students	# of Adults	# in Target Audience	# Total
7/12/16-10/14/16	Habitat Surveys7/12/2016, 7/18/2016, 7/25/2016, 8/3/2016, 8/17/2016, 8/24/2016, 9/16/2016, 9/28/2016	Multiple Sites	Homeowners	-	-	-	-	20	-	20
8/18/16	Yakama Nation Back-Pack Give Away	Toppenish, WA	General Public	150	300	150	100	400	-	1,100
9/1/16	BOR Funding Coordination Meeting	Yakima, WA	Biologists / Managers	-	-	-	-	10	-	10
9/1/16	Internship Presentation	Toppenish, WA	Job Applicants	-	-	-	20	10	-	30
9/13/16	Fish Screen Oversight Committee Training Conf.	Ellensburg, WA	Biologists / Managers / Vendors	-	-	-	-	50	-	50
9/--/2016	University of Washington	Seattle, WA	College Students	-	-	-	45	3	-	48
9/--/2016	Central Washington State Fair	Yakima, WA	General Public	-	-	-	-	-	312,191	312,191
10/7/16	AgForestsry Presentation	Vancouver, WA	Biologists/Managers	-	-	-	-	-	100	100
10/13/16	Upper Toppenish Restoration	Toppenish, WA	Washington DC Representatives	-	-	-	-	40	-	40
11/14/16	Prosser Hatchery Tour / Presentation	Prosser, WA	Kootenai Tribal Biologists	-	-	-	-	15	-	15
12/7/16	Northwest Fish Culture Conference	Centralia, WA	Biologists / Managers	-	-	-	-	350	-	350
(1/1/2016)	Yakama Nation Fisheries	Facebook	General Public	-	-	-	-	-	13,500	13,500
(1/14/2016)	**Oyez Roslyn! Featuring Local Presenters**	North Kittitas County Tribune	General Public	-	-	-	-	-	3500	3,500
(1/21/2016)	**The Bizarre Fish Biologists say our Rivers Need**	North Kittitas County Tribune	General Public	-	-	-	-	-	3,500	3,500
(3/12/2016)	**Lamprey found above Condit Dam site on White**	Yakima Herald	General Public	-	-	-	-	-	24,278	24,278
(3/15/2016)	Lamprey in the Classroom	Toppenish, WA	Yakama Nation Tribal School	-	-	200	-	10	-	210
(3/30/2016)	**Pacific lamprey return to White Salmon River**	The Columbian	General Public	-	-	-	-	-	8,000	8,000
(4/5/2016)	**On White Salmon River Pacific Lamprey Returning Upstream Of Condit Site**	The Enterprise	General Public	-	-	-	-	-	8,000	8,000
(5/17/2016)	**Lamprey release into Upper Ahtanum Creek will help mark World Fish Migration Day**	Yakima Herald	General Public	-	-	-	-	-	23,691	23,691
(5/21/2016)	worldfishmigrationday.com	Website	General Public	-	-	-	-	-	1,500	1,500
(5/21/2016)	World Fish Migration Day	Facebook	General Public	-	-	-	-	-	18,000	18,000
(5/21/2016)	**Yakama Nation Fisheries Release Lamprey in Ahtanum Creek**	yakamaherald.com	General Public	-	-	-	-	-	31,638	31,638
(5/28/2016)	**Yakama Nations Lamprey Education Event Appreciated**	Yakima Herald	General Public	-	-	-	-	-	23,691	23,691
(5/29/2016)	World Fish Migration Day Adult Release Video	Youtube	General Public	-	-	-	-	-	411	411
(6/9/2016)	EcoConnect: an online magazine	Website	General Public	-	-	-	-	-	309	309
(6/18/2016)	The Oregonian/OregonLive	Willamette Falls, OR	-	-	-	-	-	-	20,000	20,000
(6/22/2016)	**A prehistoric delicacy**	Willamette Falls, OR	-	-	-	-	-	-	20,000	20,000
(9/15/2016)	Lamprey in the Classroom	Toppenish, WA	CATS: Toppenish	-	-	163	10	5	-	178
(9/29/2016)	**Stabilizing Ahtanum Creek good for fish, homeowners**	Yakima Herald	General Public	-	-	-	-	-	23,234	23,234
	Totals			765	2,225	1,088	624	3,329	535,543	543,574

Credits:

YNF: Emily Washines (Outreach Coordinator)

YNF: Bill Fiander and Oliver Davis (Prosser Hatchery)

Yakima Herald: Tammy Fahsholtz (Circulation Department)

Subtotals:	
Hatchery Tours	1,159
Public Release Events	180
Community Events	317,301
Presentations	1,682
Newspapers	149,532
E-magazines/Social Media	73,720
TOTAL	543,574

F. Work Element 161 – Disseminate Raw/Summary Data and Results and Participation in Regional Efforts

Work Element Associated Appendix Report:
Not Applicable

Throughout 2016, the YNPLP has continued to maintain a strong presence in supporting and guiding Pacific Lamprey recovery in the Yakima Subbasin and in the Columbia River Basin. The following outlines some of the key activities YNPLP staff is involved with:

<u>Coordination with the Bureau of Reclamation in the Yakima Subbasin</u>
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, and (2) intensive monitoring associated with larval/juvenile entrainment in select diversions. 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 and Horn Rapids dams (the two lowermost dams in the Yakima Subbasin) using primarily a USFWS fish passage grant. A pilot lamprey passage devise has recently been added to the Prosser Dam and is being tested in the spring months of 2017. "Project Alternative Solution Study (PASS)" through Bureau of Reclamation and partners assessed alternative solutions for improving adult lamprey passage in other parts of the Yakima Subbasin. These discussions will continue over the next couple years with the intent to implement several structures between 2017 - 2018, including Sunnyside and Wapato diversion dams (funded through NRCS).

<u>Coordination with the Irrigation Districts in the Yakima Subbasin</u>
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, we worked closely with Wapato Irrigation Project to discuss the possibility of implementing some of the short term solutions for mitigating larval entrainment and mortalities. The 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 and provided a great example of the positive outcome from collaboration.

<u>Coordination with the USACE in the Columbia River Basin</u>

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 in the development of a new 5-10 year planning document 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 the John Day reservoir 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).

<u>Coordination with the CRITFC in the Columbia River Basin</u>

A considerable amount of planning and coordination continues with the CRITFC in the development of the "Framework for Pacific Lamprey Supplementation Research in the Columbia River Basin" and "Master Plan for Pacific Lamprey Supplementation, Aquaculture, Restoration, and Research." The former document was completed in 2015 and the latter document (Master Plan) is nearly complete and will be submitted to the NPCC in 2017. 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 we are going to accelerate implementation of solutions (such as passage structures)?

<u>Coordination with the USFWS: Regional Conservation Team (CT)</u>

In June, 2011 the USFWS initiated a Pacific Lamprey Conservation Agreement in which both the Reclamation and YN are signatories. 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. With respect to the

Yakima Subbasin, the YN recognizes that multiple threats exist that limit abundance, productivity and spatial distribution throughout the basin and that multiple agencies, jurisdictions and publics are needed to realize recovery objectives. The YN anticipates working closely with the Reclamation and other relevant partnerships to accelerate implementation of various actions at the subbasin scale, within the context of the Conservation Agreement. We anticipate celebrating the forth Lamprey Summit next December, 2017 – which is also timed with the re-initiation of the 2012 Pacific Lamprey Conservation Agreement.

<u>Coordination with the Lamprey Technical Work Group (LTWG)</u>

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.

<u>Coordination with the Mid-Columbia Public Utility Districts</u>

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). 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 2016.

G. Work Element 158 – PIT Tag Adult Lamprey

Work Element Associated Appendix Report:
Appendix G1 – Translocation of Adult Pacific Lamprey within the Yakima Subbasin, 2015-2016 Broodstock)

Photo G1. Sean Goudy showing an adult lamprey to White Swan Headstart School students before releasing it into Toppenish Creek (river km 54.3) on May 12, 2016.

This report is composed of two parts: 1) summary of all 2015-2016 broodstock adult Pacific Lamprey releases during the spring 2016 migration season within the Wenatchee Subbasin and 2) analysis of migration data from those adults that were PIT tagged (all adults were PIT tagged). From the 2015-2016 broodstock (adults collected in summer 2015 that primarily mature in 2016), a total of 447 adult Pacific Lamprey were released within the Yakima Subbasin. A total of 117 lamprey were released in Satus Creek, 128 lamprey were released in Toppenish Creek, 130 lamprey were released in Ahtanum Creek, and 72 lamprey were released in Lower Yakima River between March 25, 2016, and May 21, 2016. Female ratio was estimated to be 43.4%, PIT tag ratio was 34.2%, and genetic tag ratio was 95.5%. This is the fifth year that adult Pacific Lamprey were translocated into the Yakima Subbasin. Translocation occurs primarily in Lower Yakima tributaries, with some release in Lower and Upper Yakima River. 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 36 lamprey (23.8%) out of 151 total PIT tagged lamprey released were detected in at least one PIT array site. The highlights from the 2015-2016 broodstock adult Pacific Lamprey translocation monitoring in the Yakima Subbasin are the following:

- Detection rates of lamprey passing through the lower Satus and lower Toppenish PIT arrays were extremely low this year (31.4% and 6.6%, respectfully), compared to the very high detection from previous years (generally 75-95%).
- Nine lamprey were detected moving downstream initially. One was detected moving downstream all the way to the Lower Columbia River to enter the lower array at Deschutes River. One was detected moving past Prosser Dam Diversion in the Yakima River.
- Of the nine lamprey that initially moved downstream, seven lamprey were detected moving upstream within the Yakima River (after initially moving downstream in the tributary stream). Four of these lamprey were detected in the middle reach of Yakima River at Sunnyside Instream Array (river km 171.1) and the other three lamprey were detected at Roza Diversion Dam (river km 210.5).
- The three lamprey detected at Roza Diversion Dam spent 5-54 days at the dam with total detections ranging between 1,588 and 53,734 (indicating extensive holding).
- Upstream migration was observed primarily in April with episodic movements in May, and June.
- Downstream migration was observed primarily in June and early July potentially indicating the post-spawn drifting.
- The fastest upstream traveling lamprey detected was 7.35 km/day (lamprey detected at Lower Satus Array).

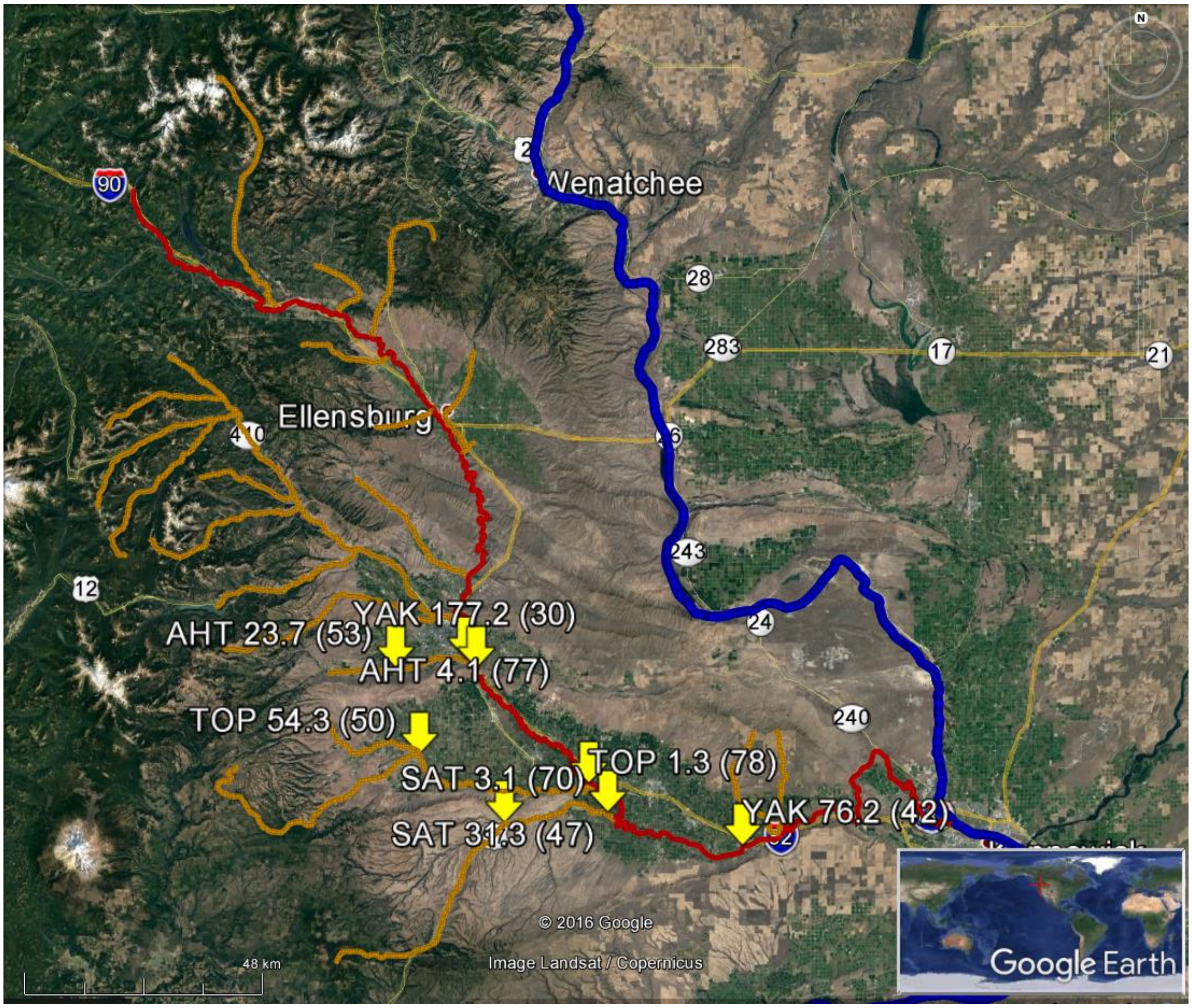


Figure G1-1. Overall aerial map of 2015-2016 broodstock Pacific Lamprey translocation release sites in the Yakima River ("YAK" = Yakima, "SAT" = Satus, "TOP" = Toppenish, "AHT" = Ahtanum, the number next to the stream name is the river km, and the number in parenthesis is the total number of lamprey released). The red line represents mainstem Yakima River, the orange lines represent its tributaries, and the blue line represents the Columbia River.

Table G1-1. Summary of 2015-2016 broodstock Pacific Lamprey translocation release in the Yakima Subbasin. "F" stands for female, "M" stands for male, and "UN" stands for unknown sex. "(?)" denotes slightly lower certainty with the sex ID. Female Ratio (Est. 1) is based solely on "# F" and "# M", whereas "Female Ratio (Est. 2)" includes "# F (?)" and "# M (?)" in the estimation.

Stream	# Total	# F	# M	# F (?)	# M (?)	# UN	# with Pit Tags	# with Genetic Tags	Female Ratio (Est. 1)	Female Ratio (Est. 2)	Pit Tag Ratio	Genetic Tag Ratio
Satus	117	33	59	10	12	15	71	100	35.9%	37.7%	60.7%	85.5%
Toppenish	128	57	47	13	9	24	82	125	54.8%	55.6%	64.1%	97.7%
Ahtanum	130	50	71	7	0	9	0	130	41.3%	44.5%	0.0%	100.0%
Lower Yakima	72	21	51	0	0	0	0	72	29.2%	29.2%	0.0%	100.0%
Overall	**447**	**161**	**228**	**30**	**21**	**48**	**153**	**427**	**41.4%**	**43.4%**	**34.2%**	**95.5%**

Appendix G2 – Translocation of Adult Pacific Lamprey within the Wenatchee Subbasin, 2015-2016 Broodstock

Photo G2. April Hull releasing an adult lamprey into Wenatchee River above Tumwater Dam (river km 50.4) on March 17, 2016.

This report is composed of two parts: 1) summary of all 2015-2016 broodstock adult Pacific Lamprey releases during the spring 2016 migration season within the Wenatchee Subbasin and 2) analysis of migration data from those adults that were PIT tagged (all adults were PIT tagged). From the 2015-2016 broodstock (adults collected in summer 2015 that primarily mature in 2016), a total of 210 adult Pacific Lamprey were released in the lower to upper reaches of the Wenatchee River. Initially, 180 adults were released at four sites on March 17, 2016: 1) 0.7 km upstream of North Wenatchee Avenue (Highway 285) bridge at river km 2.1 (n=50), 2) 1.0 km downstream of Tumwater Dam at river km 48.6 (n=30), 3) 0.8 km upstream from Tumwater Dam in Jolanda Lake at river km 50.4 (n=50), and 4) just downstream of US Route 2 Highway bridge crossing at river km 56.9 (n=50). Subsequently, 30 adults were released on May 3, 2016, within three sections of the Tumwater Dam fish ladder at river km 49.6: 1) Weir 2 Pool (n=10), 2) Weir 9 Pool (n=10), and 3) Weir 18 Pool (n=10). Female ratio was estimated to be 42.9%, PIT tag ratio was 100.0%, and genetic tag ratio was 95.7%. This is the first year that adult Pacific Lamprey were translocated into the Wenatchee Subbasin. Larval or adult lamprey have not been documented upstream of Tumwater Dam on the Wenatchee River since the early 1990s. 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 210 PIT tagged lamprey, 31 lamprey (14.8%) were detected in at least one PIT array site within the Columbia Basin. The highlights from the 2015-2016 broodstock Pacific Lamprey translocation monitoring in the Wenatchee Subbasin are the following:

- None of the 30 lamprey released immediately downstream of Tumwater Dam were detected within the Tumwater fish ladder arrays.

- Two lamprey (20.0%) from both Weir Pool 2 and Weir Pool 9 were detected moving upstream to the lower array (Weir Pool 13/14) within the Tumwater Dam fish ladder.
- No lamprey were detected at the upper array (Weir Pool 17/18) despite the release of 30 PIT tagged lamprey.
- Two lamprey (4.0%) were detected moving upstream from the upper release at river km 56.9) – one was detected in the White River (river km 10.9) past Lake Wenatchee and another was detected in the Chiwawa River (river km 11.5) in June/July period.
- Upstream migration was observed primarily in April and June through early July, with episodic movements in August and September.
- Downstream migration was observed primarily in May- July, and early August, potentially indicating the timing of post-spawn drifting.

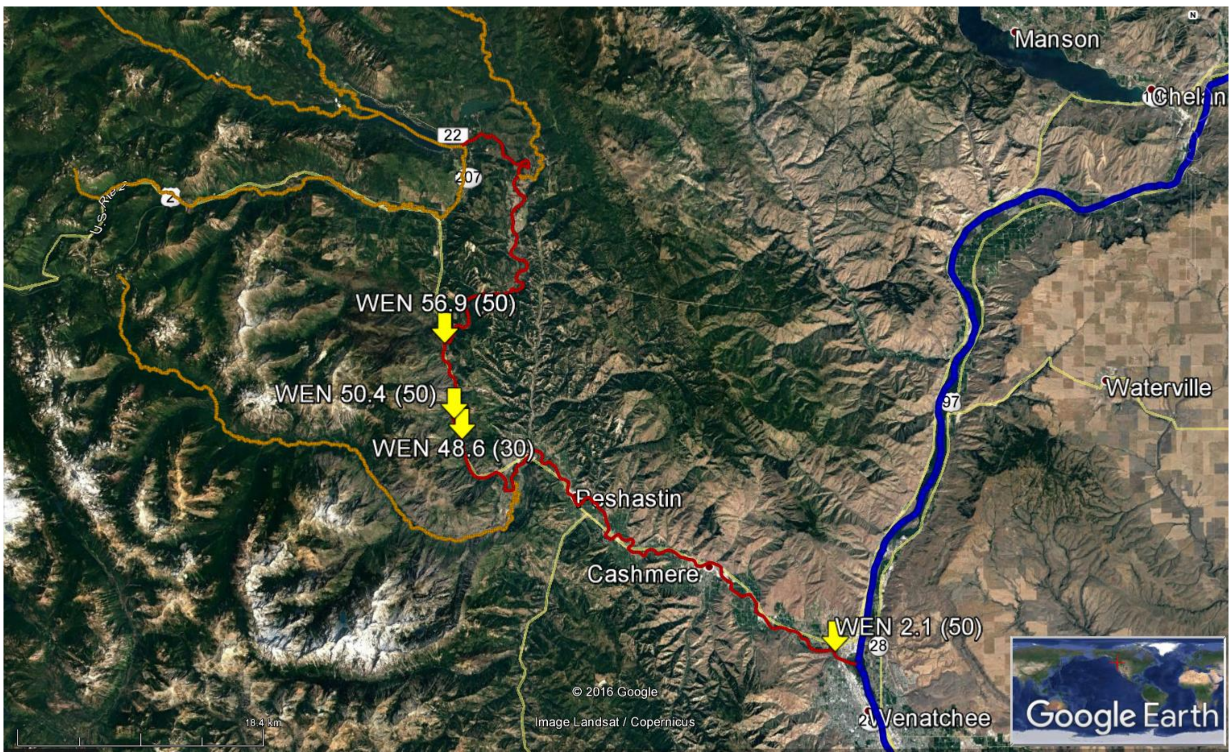


Figure G2-1. Overall aerial map of 2015-2016 broodstock Pacific Lamprey translocation release sites in the Wenatchee River. "WEN" stands for Wenatchee, the number next to the stream name is the river km, and the number in parenthesis is the total number of lamprey released. The red line represents mainstem Wenatchee River, the orange lines represent its tributaries (Icicle, Chiwawa, and Nason creeks from downstream to upstream), and the blue line represents the Columbia River.

Table G2-1. Summary of 2015-2016 broodstock Pacific Lamprey translocation release in the Wenatchee Subbasin. "F" stands for female, "M" stands for male, and "UN" stands for unknown sex. "(?)" denotes slightly lower certainty with the sex ID. Female Ratio (Est. 1) is based solely on "# F" and "# M", whereas "Female Ratio (Est. 2)" includes "# F (?)" and "# M (?)" in the estimation.

Stream	River km	Date	Time	Water Temp (Cº)	# Total	# F	# M	# F (?)	# M (?)	# UN	# with Pit Tags	# with Genetic Tags	Female Ratio (Est. 1)	Female Ratio (Est. 2)	Pit Tag Ratio	Genetic Tag Ratio
Wenatchee	2.1	3/17/2016	14:00	5.9	50	8	24	7	9	2	50	48	25.0%	31.3%	100.0%	96.0%
Wenatchee	48.6	3/17/2016	13:00	4.0	30	9	9	7	3	2	30	29	50.0%	57.1%	100.0%	96.7%
Wenatchee	49.6	5/3/2016	15:46	9.0	30	11	18	1	0	1	30	30	37.9%	40.0%	100.0%	100.0%
Wenatchee	50.4	3/17/2016	11:00	3.7	50	15	17	4	11	3	50	47	46.9%	40.4%	100.0%	94.0%
Wenatchee	56.9	3/17/2016	12:00	3.9	50	10	20	15	5	0	50	47	33.3%	50.0%	100.0%	94.0%
Total	**-**	**-**	**-**	**-**	**210**	**53**	**88**	**34**	**28**	**69**	**210**	**201**	**37.6%**	**42.9%**	**100.0%**	**95.7%**

Appendix G3 – Translocation of Adult Pacific Lamprey within the Methow Subbasin, 2015-2016 Broodstock

Photo G3-1. Bernadine Phillips, Colville Tribe Wenatchi Aboriginal Rights Coordinator, transfers an adult lamprey for release into the Methow River (river km 83.8) on September 23, 2015.

This report is composed of two parts: 1) summary of all 2015-2016 broodstock adult Pacific Lamprey releases within the Methow Subbasin and 2) analysis of migration data from PIT tagged adults. From the 2015-2016 broodstock (adults collected in summer 2015 that primarily mature in 2016), a total of 249 adult Pacific Lamprey were released in the lower to mid reaches of the Methow River. Adults were released at three locations between September 17 and 23, 2016; 1) by Methow Valley Highway bridge in Carlton, WA, at river km 46.3 (n=100), 2) downstream of Twisp River confluence at river km 66.4 (n=75), and 3) downstream of Chewuch River confluence at river km 83.8 (n=74). Female ratio was estimated to be 39.3%, PIT tag ratio was 100.0%, and genetic tag ratio was 98.0%. This is the first year that adult Pacific Lamprey were translocated into the Methow Subbasin. Larval numbers and distribution have steadily been decreasing in recent years and the younger age classes appear to be mostly absent, likely as a result of depressed numbers of adults moving into the subbasin (see Wells Dam passage data). 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 249 PIT tagged lamprey, 145 lamprey (58.2%) were detected in at least one PIT array site within the Columbia Basin. The highlights from the 2015-2016 broodstock Pacific Lamprey translocation monitoring in the Methow Subbasin are the following:

- Detection efficiency of some of the arrays are quite low for adult Pacific Lamprey (and some sites were likely not fully operational during the release).
- None of the lamprey were detected moving into Twisp River and only one lamprey (0.4%) was detected moving into Upper Methow River (98.9% of the detected adults moved into Chewuch River [n=91]).
- Three lamprey (1.2%) moved back down into the Columbia River; one migrated up the Entiat River; one migrated up the Okanogan River; and one migrated back into the Methow River and moved all the way into the Chewuch River (after being detected at Wells Dam).
- Seven lamprey (2.8%) were detected traveling through the Whitefish side channel during the spring migration (likely during high flow periods).
- Active upstream migration was observed in both fall (mid-September till early November) and spring (mid-March till early August) seasons.
- Downstream migration was observed only in the spring season between early March and end of July.
- The fastest upstream moving lamprey (n=3) traveled at a rate between 15.13 and 15.66 km/day [three lamprey that moved into the Chewuch River (river km 1.6) immediately after release from the lower release site].

Table 1. Summary of 2015-2016 broodstock Pacific Lamprey translocation release in the Methow Subbasin. "F" stands for female, "M" stands for male, and "UN" stands for unknown sex. "(?)" denotes slightly lower certainty with the sex ID. Female Ratio (Est. 1) is based solely on "# F" and "# M", whereas "Female Ratio (Est. 2)" includes "# F (?)" and "# M (?)" in the estimation.

Stream	River km	Date	Time	Water Temp (Cº)	# Total	# F	# M	# F (?)	# M (?)	# UN	# with Pit Tags	# with Genetic Tags	Female Ratio (Est. 1)	Female Ratio (Est. 2)	Pit Tag Ratio	Genetic Tag Ratio
Methow	46.3	9/17/2015	14:25	13.4	100	3	15	29	34	19	100	99	16.7%	39.5%	100.0%	99.0%
Methow	66.4	9/17/2015	16:05	14.1	75	3	9	15	30	18	75	72	25.0%	31.6%	100.0%	96.0%
Methow	83.8	9/23/2015	12:45	11.5	74	7	12	22	22	11	74	73	36.8%	46.0%	100.0%	98.6%
Total	**-**	**-**	**-**	**-**	**249**	**13**	**36**	**66**	**86**	**200**	**249**	**244**	**26.5%**	**39.3%**	**100.0%**	**98.0%**

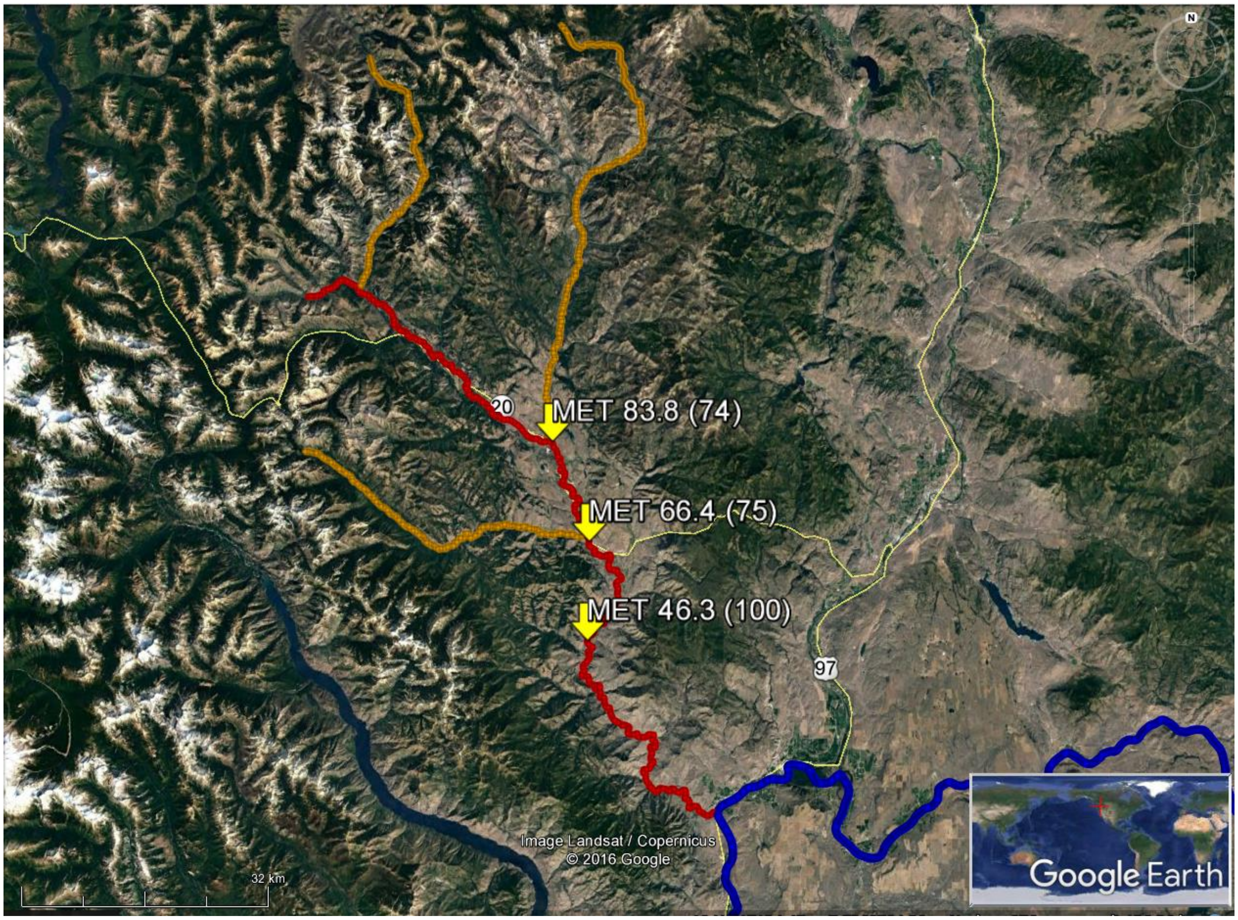


Figure G3-1. Overall aerial map of 2015-2016 broodstock Pacific Lamprey translocation release sites in the Methow River. "MET" stands for Methow, the number next to the stream name is the river km, and the number in parenthesis is the total number of lamprey released. The red line represents mainstem Methow River, the yellow lines represent its tributaries (Twisp, Chewuch, and Lost rivers from downstream to upstream), and the blue line represents the Columbia River.

H. Work Element 158 – PIT Tag Juvenile Lamprey

Work Element Associated Appendix Report:
Appendix H1 – Juvenile/Larval Pacific Lamprey Passage Monitoring in Chandler Diversion, Yakima River (Prosser, WA), 2016

Photo H1. PIT tagged larval/juvenile lamprey released within the fish bypass channel within Chandler Diversion.

Chandler Diversion is a known migration corridor for out-migrating larval/juvenile Pacific Lamprey. On December 30, 2015 (n=21), and January 20, 2016 (n=52), we PIT tagged 73 juvenile/larval lamprey using 8.4 mm Pico Full Duplex tags at Prosser Hatchery. Of the total 73 tagged lamprey, 23 (31.5%) were Pacific Lamprey transformer (i.e. macrophthalmia), 25 (34.2%) were Western Brook Lamprey transformer, and 25 (34.2%) were Pacific Lamprey larvae.

On January 26, 2016, between 10:53 am and 11:03 am, all tagged lamprey were released in four locations between the trash rack and fish screens. There were five PIT tag arrays located within the Chandler Juvenile Fish Monitoring Facility (located within the bypass route) to evaluate downstream passage. Three arrays are located upstream of the sample tank where all fish in the bypass have to move through and two are located in the exit for the sample room.

For those lamprey that were detected at the fish bypass arrays, the majority (82.7%) were detected at some or all three arrays at the Chandler Juvenile Monitoring Facility (A1, A2, and A3). Of the 23 Pacific Lamprey transformers released, 19 (82.6%) were detected. Of the 25 Pacific Lamprey larvae released, 20 (80.0%) were detected. Of the 25 Western Brook Lamprey transformers released, only 13 (52.0%) were detected. Western Brook Lamprey transformers not only had the least detection rates, but almost half of the detection occurred 7 days or longer after the release date; they may be more inclined to fight the current and try to swim upstream compared to the Pacific Lamprey transformers and larvae.

Our results indicated that the detection rates of lamprey increases considerably when they are released in front of the fish bypass channel (average of 83.3% detection rates compared to the 0.0-12.5% detection rates when released further upstream in the diversion canal in previous years). It is uncertain what is attributing to the remaining 16.7%. The detection rate of lamprey when they were released further upstream by the trash rack decreased considerably to 36.8% (44.2% loss compared to those released directly within the bypass inlet channels). This is likely related to predation or entrainment through the fish screens.

Although sampling was conducted one third of the time (33%) within the bypass channel, only 11.1% of those that were detected were captured from the sample pool (theoretically, it should be closer to 33%). Capture rates (of those detected) were highest for those released in Bypass #1 (31.3%) and secondly just downstream of the trash rack (14.3%); none were captured from the Bypass #2 and #3. Of those that were detected, Pacific Lamprey macrophthalmia had the highest capture rates (15.8%), while Western Brook transformers and Pacific Lamprey larvae had only 7.7% and 5.0% capture rates, respectfully.

We also observed considerable difference in their travel time within the three Bypass channels and by the trash rack. Bypass #2 had the shortest median travel time (2.82 mins), Bypass #3 was second (6.53 mins), and trash rack release location had the longest median travel time (103.4 hrs) followed by Bypass #1 (4.08 hrs).

A future study with a larger sample size (or alternatively a release closer to the bypass entrance) is needed to further assess passage rates for juvenile/larval lamprey. If the return rates are less than 10-20%, irrigation diversions, such as Chandler Diversion, may pose a serious threat to downstream migrating juvenile/larval Pacific Lamprey in the Lower Yakima River.

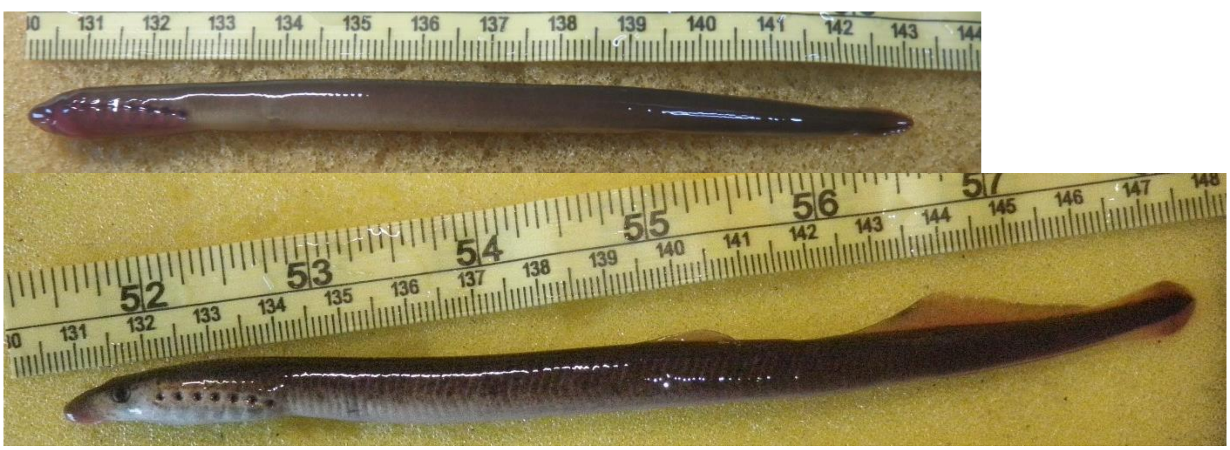


Figure H1-1. Examples of the PIT tagged lamprey used in this study - larval Pacific Lamprey (above) and Western Brook Lamprey transformer (below).

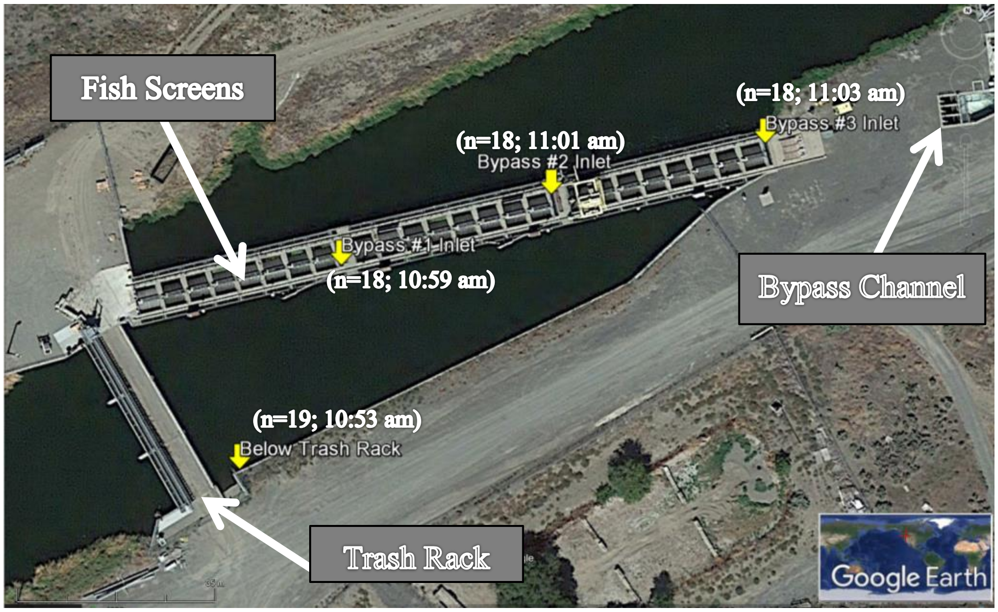


Figure H1-2. Overview map of Chandler Diversion and the four release sites relative to the trash rack, fish screens, and the fish bypass channel. Release sample size and time of day are shown within the parenthesis next to the release location.

<u>Appendix H2 – Juvenile/Larval Pacific Lamprey Passage Monitoring in the Middle Reach of the Yakima River, 2016</u>

Photo H2. Release site above Sunnyside Diversion Dam on the left bank for PIT tagged larval/juvenile lamprey.

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, summer, and fall of 2016, we released juvenile/larval lamprey above and below Sunnyside Diversion Dam with the goal of assessing 1) the ratio of juvenile/larval lamprey entering Sunnyside Diversion and 2) the detection efficiency of the mainstem Yakima River PIT array located just downstream of Sunnyside Diversion Dam at three different migration periods.

We released PIT tagged juvenile/larval lampreys (N=375) upstream and downstream of Sunnyside Diversion Dam (river km 171.4) on three separate events during spring, summer, and fall of 2016. During each release event, PIT tagged lamprey were released in four separate locations. All the lampreys used in this study were either from the Yakima River (n=133; salvaged lamprey from various Yakima Basin diversions – primarily Sunnyside and Wapato diversions) or from the Wenatchee River (n=242; salvaged lamprey from Dryden Diversion).

The first release was on April 15, 2016. The second release was on July 28 and 29, 2016. The third release was on October 7, 2016. All lampreys for these releases were tagged between January 20, 2016, and October 5, 2016, using a Pico Full Duplex PIT tags (8.4 mm). The number of detected lamprey at Sunnyside Dam mainstem array was very low.

None of the 98 released lamprey from April 15, 2016, were detected at the Sunnyside Dam mainstem array. One of the tags (1.0%) released below the dam on the right bank, however, was detected at Chandler Diversion 95.5 km downstream; detection was 10 months after the release on February 13, 2017 (downstream travel speed of 0.48 km/day). Only 1 of the 131 released lamprey (0.8%) from July 28 and 29, 2016, were detected at the Sunnyside Dam mainstem array. The detection date was on October 20, 2016, which is 2.5 months after the release date (downstream travel speed of -0.001 km/day or -1.0 m/day). Only 4 of the 146 released lamprey (2.7%) from October 7, 2016, were detected at the Sunnyside Dam mainstem array. Detection dates ranged between October 13, 2016, and October 21, 2016 (an 8-day period). All four of the detected lampreys came from the group that were released below the dam on the right bank (16.7% detection rate from this particular release site). Duration of detection lasted from 0 to 4 days for these four lampreys (median 0.54 days); the one lamprey that was detected over a 4-day period was detected 255 times total. The discharge during release ranged between 2,000 cfs (October, 2016) and 9,500 cfs (April 15, 2016). The higher the flow rates, the lower the detection rates were. If the return rates for entrained larval/juvenile lamprey are less than 10-20%, irrigation diversions, such as Sunnyside Diversion, may pose a serious threat to downstream migrating juvenile/larval Pacific Lamprey in the Lower Yakima River.

Table H2-1. Summary of the release information (by date, location, origin, species, and life stages).

		Release Location				# Total	Origin		Species		Life Stage	
#	Release Date	# Above LB	# Above RB	# Below LB	# Below RB		# Yakima	# Wenatchee	PA	WB	LA	TR
1	4/15/2016	33	33	16	16	98	51	47	50	48	96	2
2	7/28/2016, 7/29/2016	33	33	33	32	131	42	89	113	18	131	0
3	10/7/2016	47	50	25	24	146	40	106	114	32	146	0
	All	**113**	**116**	**74**	**72**	**375**	**133**	**242**	**277**	**98**	**373**	**2**

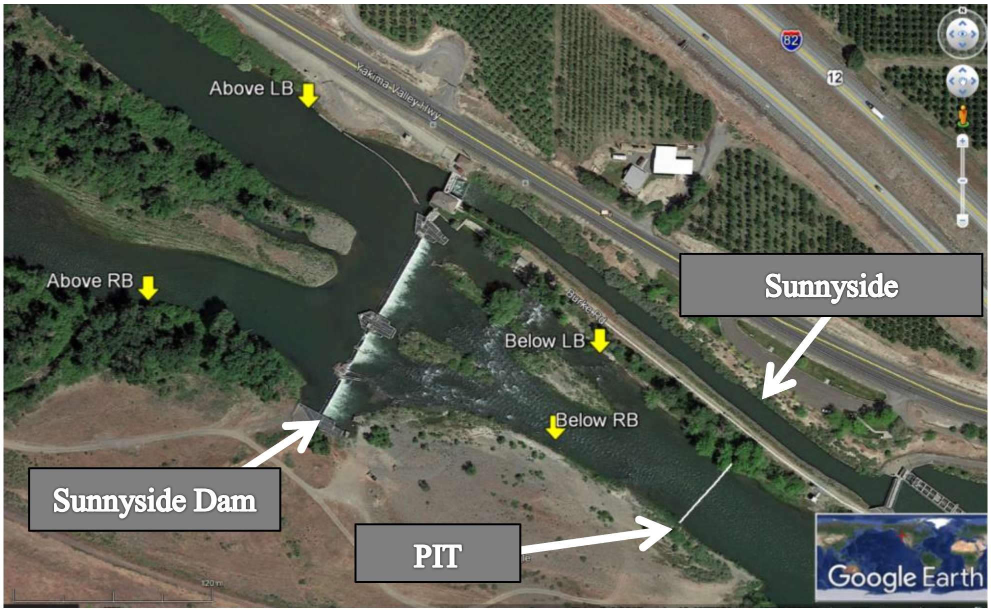


Figure H2-1. Overview map of the study area relative to the trash rack, fish screens, and the fish bypass channel. Release sample size and time of day are shown within the parenthesis next to the release location.

Figure H2-2. Examples of the PIT tagged lamprey used in this study – close up (upper photo) and whole body (lower photo) of larval Pacific Lamprey. Incision cuts can be seen for both larvae.

Table H2-1. Summary data for PIT tag detection by date and location.

		# Detected by Release Location				% Detected by Release Location			
#	Release Date	# Above LB	# Above RB	# Below LB	# Below RB	Above LB	Above RB	Below LB	Below RB
1	4/15/2016	0	0	0	0	0%	0%	0%	0%
2	7/28/2016, 7/29/2016	0	0	0	1	0%	0%	0%	3.1%
3	10/7/2016	0	0	0	4	0%	0%	0%	16.7%
	All	**0**	**0**	**0**	**5**	**0%**	**0%**	**0%**	**6.9%**

I. Work Element 196 – Council Step Process

Work Element Associated Appendix Report:
Not Applicable

For 2016, Yakama Nation and other CRB tribes will continue 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.

J. Work Element 176 – Produce Hatchery Fish / Research into Juvenile

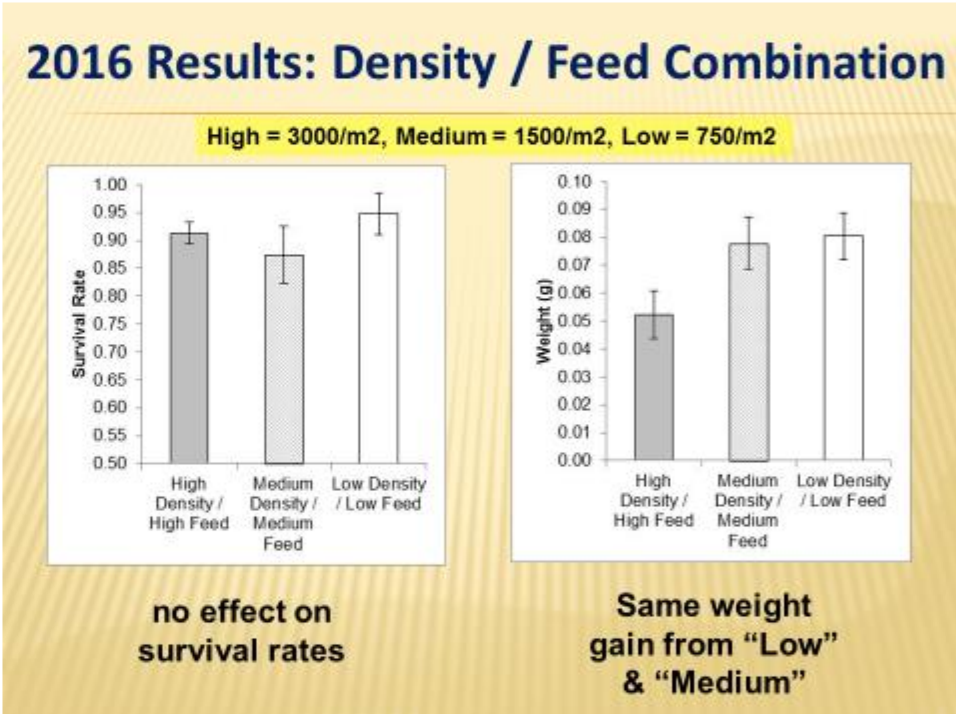
Work Element Associated Appendix Report:
Not Applicable

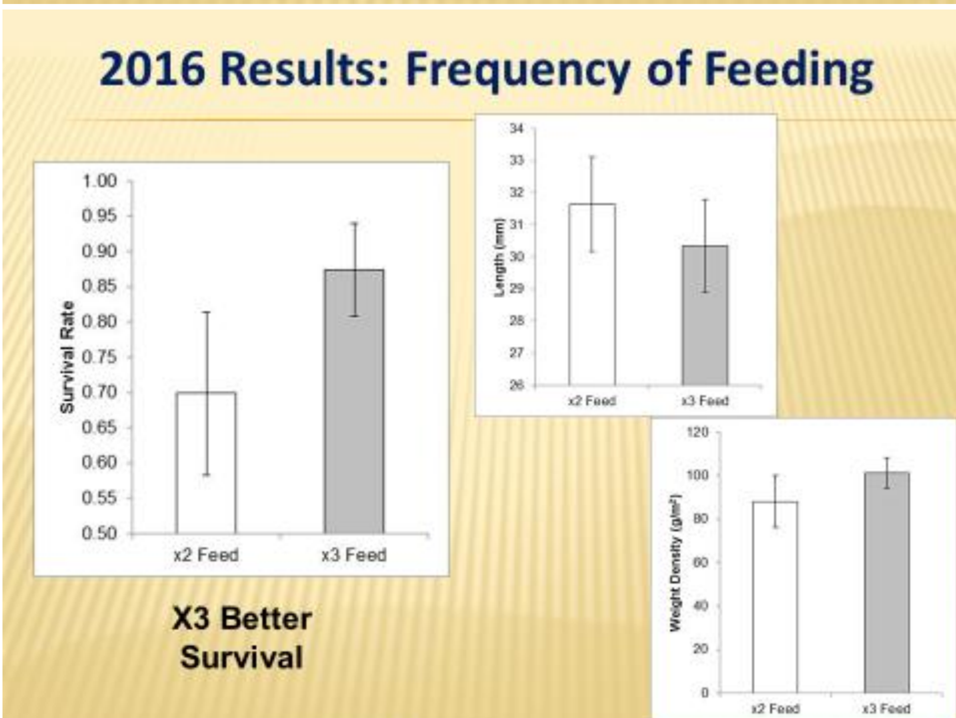
By October 2016, the Yakama Nation finished the key experiments for the first year of the three year study. Coordination meetings were held frequently among the Yakama Nation, USFWS, Confederated Tribes of the Umatilla Indian Reservation / NOAA Fisheries to ensure that our studies were well coordinated and planned for the season. This year we examined the following questions:

1. Can high density of larvae (3000/m^2) grow as much as the medium (1500/m^2) and low density (750/m^2) of larvae if we increase the feed levels?
2. Is it better to gradually increase the feed amount or keep the feed constant during the 8 week period?
3. Does the presence of spawning mat increase survival and growth of larvae?
4. Is a feeding frequency of 3 times per week better than 2 times per week?
5. Does turning off the water during feeding help larvae grow (without affecting survival rates)?
6. What is the effect of mixed leaves and lamprey carcass on the growth and survival of larvae?

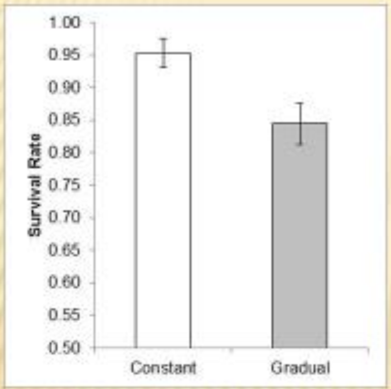
Survival rates in each aquarium tank ranged from 0 – 98.9% and the average was 76.4% (if we exclude the two tanks with 0% survival due to a water flow accident, the average survival rates was 84.9%). Mean size at the end of the 2-month experiment for all the aquarium tanks was 29.3 mm, showing a growth of approximately 22 mm (mean size ranged from 23.4 to 33.3 mm for all the individual aquarium tanks). More data and results are being analyzed currently and will be presented at the Northwest Fish Culture Conference on December 7, 2016, in Ground Mound, WA.

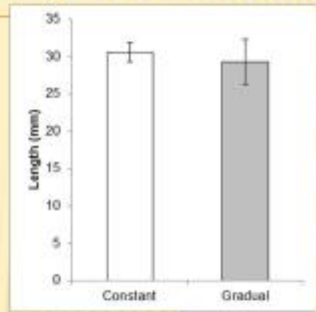
Shown below are some preliminary graphs highlighting the results (detailed results will be shared in the final report):

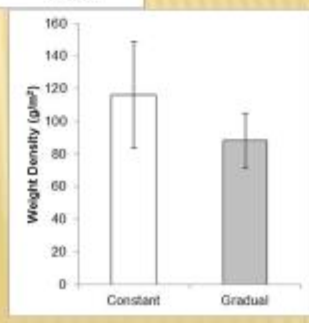




2016 Results: Ramping of Feeding

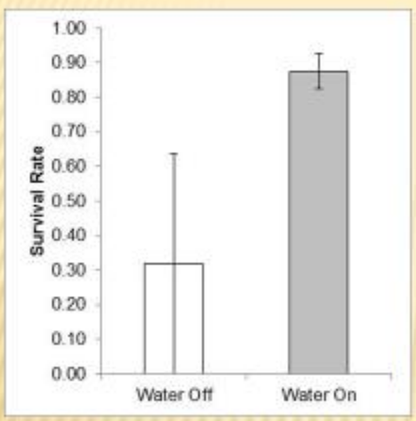


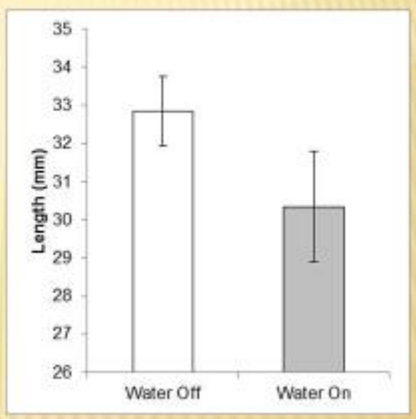




Constant had better survival

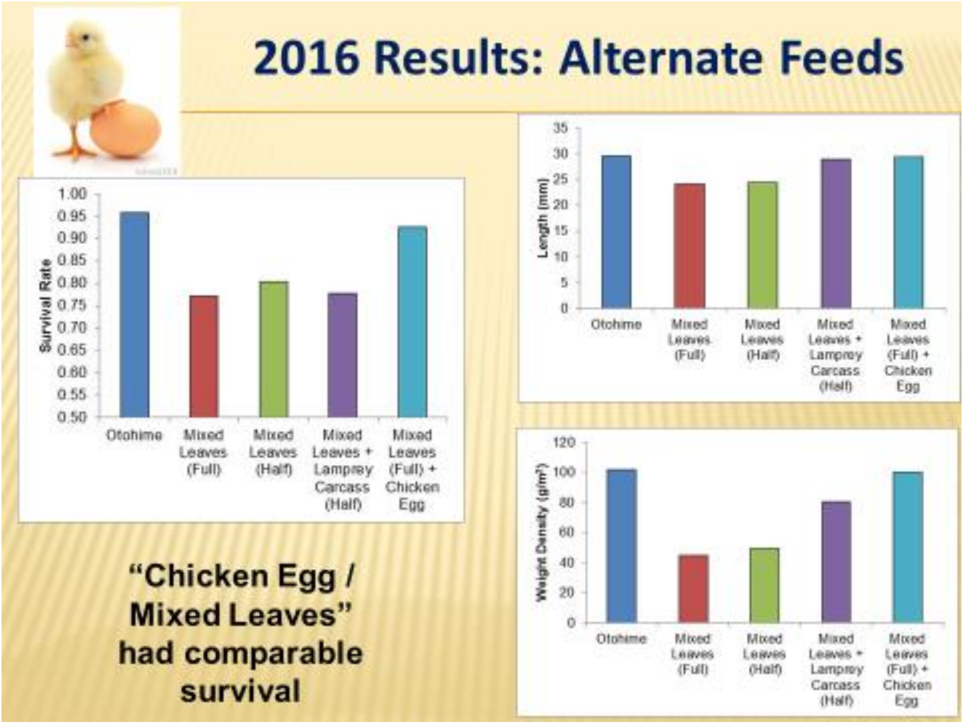
2016 Results: Water Off During Feeding





Water Off: 0% Survival in 2 tanks; 96% in 1

Growth Rate Promising



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

Work Element Associated Appendix Report:
Appendix K1 – Yakama Nation Adult Pacific Lamprey Collection in the Columbia River Basin, 2016

Photo K1. Overview of John Day Dam from the North Ladder on June 19, 2016.

This report is composed of two parts. The purpose of Part I is to report the summary of events from the adult Pacific Lamprey collection (trapping and transporting) in 2016 from the Lower Columbia River hydroelectric projects, specifically Bonneville, The Dalles, and John Day dams. Adult collection for the YNPLP in 2016 began on June 6, 2016, at Bonneville Dam and was completed on September 16, 2016, at John Day Dam. In total, 858 adult lamprey (215 from Bonneville Dam, 219 from The Dalles Dam, and 424 from John Day Dam) were collected, which was 382 short of the 2016 allocation guideline number. We collected 100% of our allocation guideline numbers from both Bonneville and John Day dams (215 and 424, respectfully), but the collection efficiency at The Dalles Dam was conspicuously low this year, possibly due to lower proportion of lamprey using the East Ladder than the North Ladder compared to previous years (Table 4). We had a total of 34 mortalities in 2016 with a mortality rate of 4.0%. One mortality event on August 15, 2016, added 15 mortalities from that day, increasing the overall mortality rate considerably (was likely due to oxygen super saturation from excessive dissolved oxygen flow rates). Part III describes the project area and fish traps used in 2016 to collect lamprey at each of the three facilities (Bonneville, The Dalles, and John Day dams). See **Appendix K1** for more information.

Table K1-1. Total allocation per tribe for 2015 based on Tribal Restoration Plan guidelines.

Project	# of Adults
Bonneville Dam	215
The Dalles	601
John Day	424
Total	**1240**

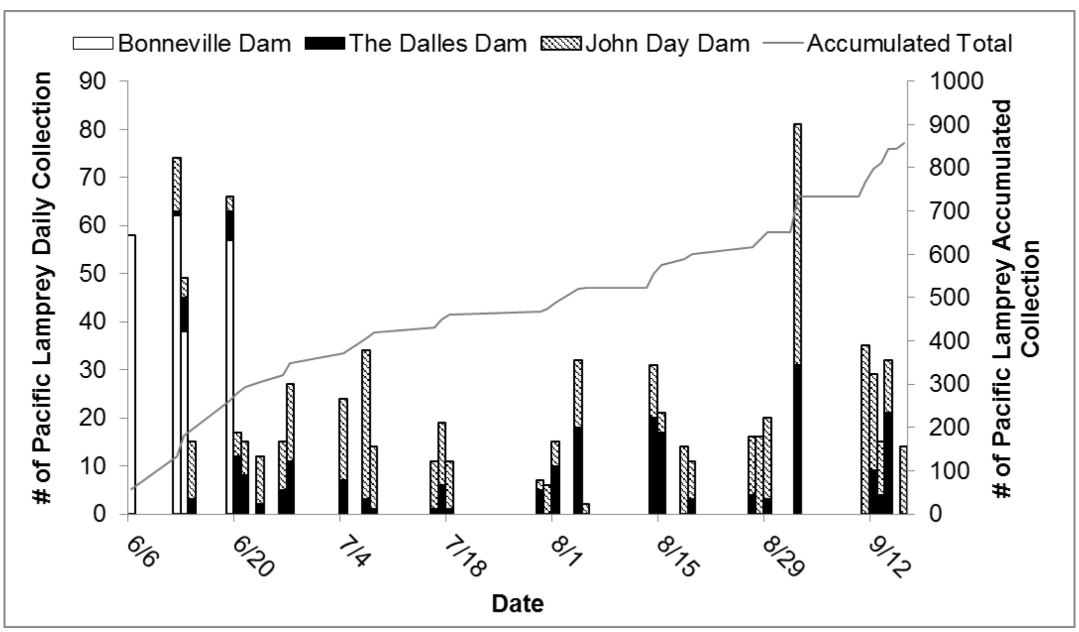


Figure K1-1. Summary of adult Pacific Lamprey collection numbers (daily and accumulated numbers) from 2016 collection.

Table K1-2. Summary of adult Pacific Lamprey collection data from Columbia River hydro dams (John Day, The Dalles and Bonneville dams) in 2016. All collections from Bonneville Dam was from the Adult Fish Facility.

	John Day Dam			The Dalles Dam			Bonneville Dam	Accumulated
Date	North Ladder	South Trap	Total	North Ladder	East Ladder	Total	Total	Total
6/6/2016	-	-	-	-	-	-	58	58
6/12/2016	7	4	11	-	1	1	62	132
6/13/2016	4	-	4	-	7	7	38	181
6/14/2016	4	8	12	-	3	3	-	196
6/19/2016	0	3	3	-	6	6	57	262
6/20/2016	2	3	5	-	12	12	-	279
6/21/2016	1	6	7	-	8	8	-	294
6/23/2016	0	10	10	-	2	2	-	306
6/26/2016	0	10	10	-	5	5	-	321
6/27/2016	6	10	16	-	11	11	-	348
7/4/2016	12	5	17	-	7	7	-	372
7/7/2016	12	19	31	-	3	3	-	406
7/8/2016	1	12	13	-	1	1	-	420
7/16/2016	2	8	10	-	1	1	-	431
7/17/2016	6	7	13	-	6	6	-	450
7/18/2016	2	8	10	-	1	1	-	461
7/30/2016	1	1	2	-	5	5	-	468
7/31/2016	0	6	6	-	0	0	-	474
8/1/2016	0	5	5	-	10	10	-	489
8/4/2016	12	2	14	-	18	18	-	521
8/5/2016	2	0	2	-	0	0	-	523
8/13/2016	0	0	0	0	0	0	-	523
8/14/2016	11	0	11	0	20	20	-	554
8/15/2016	4	0	4	0	17	17	-	575
8/18/2016	12	2	14	0	0	0	-	589
8/19/2016	8	0	8	0	3	3	-	600
8/27/2016	12	0	12	0	4	4	-	616
8/28/2016	12	4	16	0	0	0	-	632
8/29/2016	12	5	17	0	3	3	-	652
9/1/2016	0	0	0	0	0	0	-	652
9/2/2016	24	26	50	0	31	31	-	733
9/10/2016	0	0	0	0	0	0	-	733
9/11/2016	2	33	35	0	0	0	-	768
9/12/2016	0	20	20	0	9	9	-	797
9/13/2016	0	11	11	0	4	4	-	812
9/14/2016	0	11	11	0	21	21	-	844
9/15/2016	0	0	0	0	0	0	-	844
9/16/2016	5	9	14	0	0	0	-	858
TOTALS	**176**	**248**	**424**	**0**	**219**	**219**	**215**	**858**

L. Work Element 162 – Data Input, Analysis and Interpretation

To accomplish the goal of restoring natural production, YNPLP has focused activities on five general objectives: 1) establishing baseline information for the presence and absence of Pacific Lamprey, 2) understand 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) continue research, development into adult supplementation practice and reintroduce by translocation where local populations have been extirpated or functionally extirpated and 5) establish long term status and trend monitoring with index sites. Since initiation of the YNPLP in 2008, we have gained a better understanding on program development and prioritizing action plans based upon our Three Phase approach for the last few years.

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 two types of data together so that they can be stored on a data depository, such as StreamNet, and/or shared with other entities. We are also in the process of scanning all field data sheets to make all hard copy data available in an electronic form. 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 2017-2018. 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 is available upon request.

Work Element Associated Appendix Reports:

Appendix L1 – Assessment on the Predation Potential of Pacific Lamprey (*Entosphenus tridentatus*) and Western Brook Lamprey *(Lampetra richardsoni*) Ammocoetes by Various Native and Non-Native Species

Photo L1. Newly consumed ammocoete by a small Smallmouth Bass immediately after removal from the short-term experimental feeding study.

One of the most primitive vertebrate species of the world, Pacific Lamprey, *Entosphenus tridentatus*, is distributed widely along the West Coast of North America, including the Columbia River Basin. It is a very important species ecologically for the stream ecosystems and culturally for the Pacific Northwest tribes. Pacific Lamprey populations have decreased rapidly in the past three to six decades in the Columbia River Basin, and recent research has attributed a variety of causes and threats that contributed to this decline. Predation of juvenile salmon by invasive fish species has become a serious problem in many of the rivers and streams in the Northwestern USA, including Columbia River Basin, yet the degree of predation of ammocoetes by fishes (both native and non-native) is not well known.

We conducted two confined, experimental feeding studies (a short- and long-term study) to estimate the predation potential of Pacific Lamprey ammocoetes by various native and non-native fishes collected from the Yakama River Subbasin. We held ammocoetes and predator fish together inside a tank and monitored the number of ammocoetes that survived four nights for the short-term study and 14 nights for the long-term study. For both the short- and long-term studies, the first half of the experiment (two and seven nights, respectively) were conducted with fine sediment present and the second half were conducted without any fine sediment available. For the short-term study, we examined the following seven native predator species: Northern Pikeminnow (*Ptychocheilus oregonensis*), Chiselmouth (*Acrocheilus alutaceus*), Chinook Salmon (*Oncorhynchus tshawytscha*), Coho Salmon (*Oncorhynchus kisutch*), rainbow trout (*Oncorhynchus mykiss*), sculpin (*Cottus* spp.) and White Sturgeon (*Acipenser transmontanus*). Correspondingly, the following three non-native species were assessed: Smallmouth Bass (*Micropterus dolomieu*), Common Carp (*Cyprinus carpio*) and Yellow Bullhead (*Ameiurus natalis*). For the long-term study, we examined two native and two non-native species: Northern Pikeminnow, White Sturgeon, Smallmouth Bass, and Common Carp. In the short-term study, we used both Pacific Lamprey and Western Brook Lamprey ammocoetes and evaluated: 1) predation rates of live and dead ammocoetes, 2) mass of preyed ammocoetes, and 3) maximum size of preyed ammocoetes. In the long-term study, we used PIT and VIE tagged ammocoetes as well as untagged ammocoetes (control treatment) and examined the predation rates.

Various predator fishes, both native and non-native, preyed heavily on ammocoetes when fine sediment was absent (ave. predation rate of 47%) as opposed to present (ave. predation rate of 5%), indicating the importance of fine sediment habitat for ammocoetes. Small ammocoetes (YOY and small) were preyed primarily when fine sediment was present while wider range of ammocoetes length was preyed when fine sediment was absent. Salmonids had a preference of preying on dead ammocoetes and ate very few live ammocoetes. This avoidance of live ammocoetes might relate to the feeding behavior of predator fish and the noxious substances from the ammocoetes. A positive relationship was observed between the predation rates of ammocoetes and the fork length of the predator fishes. Smallmouth Bass was capable of consuming ammmocoetes that was at least 97% of its fork length. Similarly, sculpin and Yellow Bullhead consumed ammocoetes that were at least 91% and 77% of their length, respectfully. Based on direct observations from this study, the high level of ammocoete predation can be attributed to the slim and supple body of ammocoetes devoid of bones. The predation rates with fine sediment present increased considerably for White Sturgeon and Common Carp in the long-term study compared to the short-term study. These benthic feeders, displayed adeptness in preying on ammocoetes even when they had cover available. Although existing predation studies within the Columbia River Basin primarily focus only on a select group of invasive predators, such as Smallmouth Bass, Northern Pikeminnow, and Channel Catfish, our study suggested that other non-native and invasive species, such as Common Carp and Yellow Bullhead, have a high predation potential for ammocoetes and warrants further research and review.

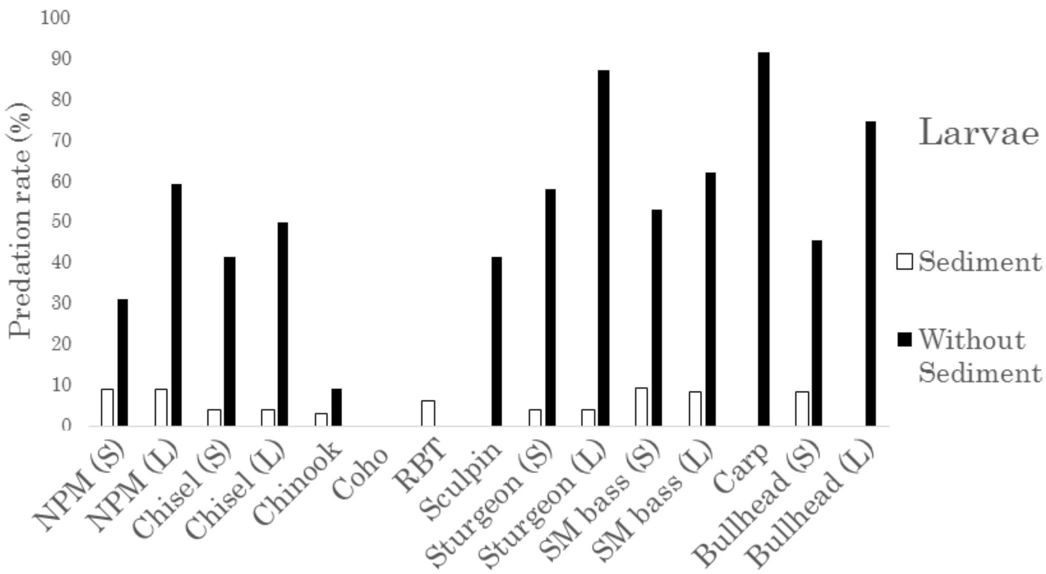


Figure L1-1. Predation rates of live ammocoetes during the short term study

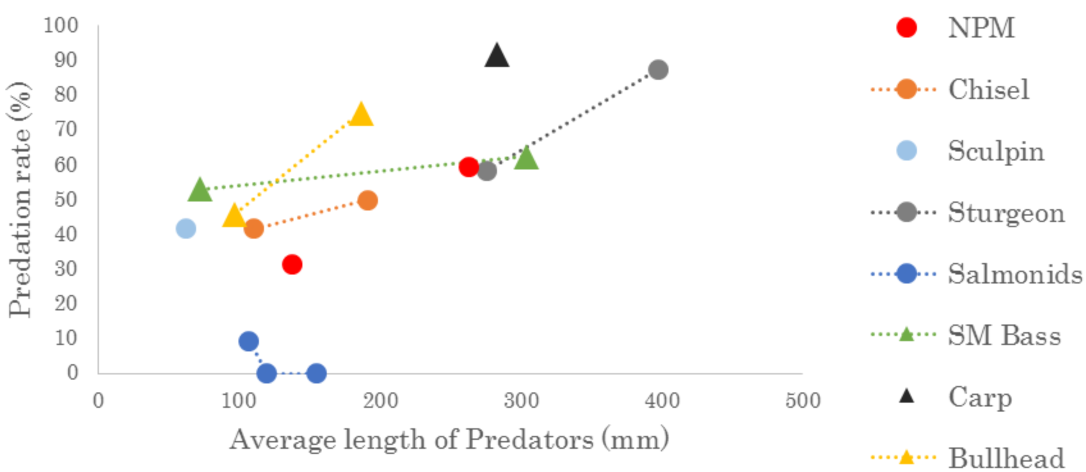


Figure L1-2. Relationship between predation rate and average length of predator fishes.

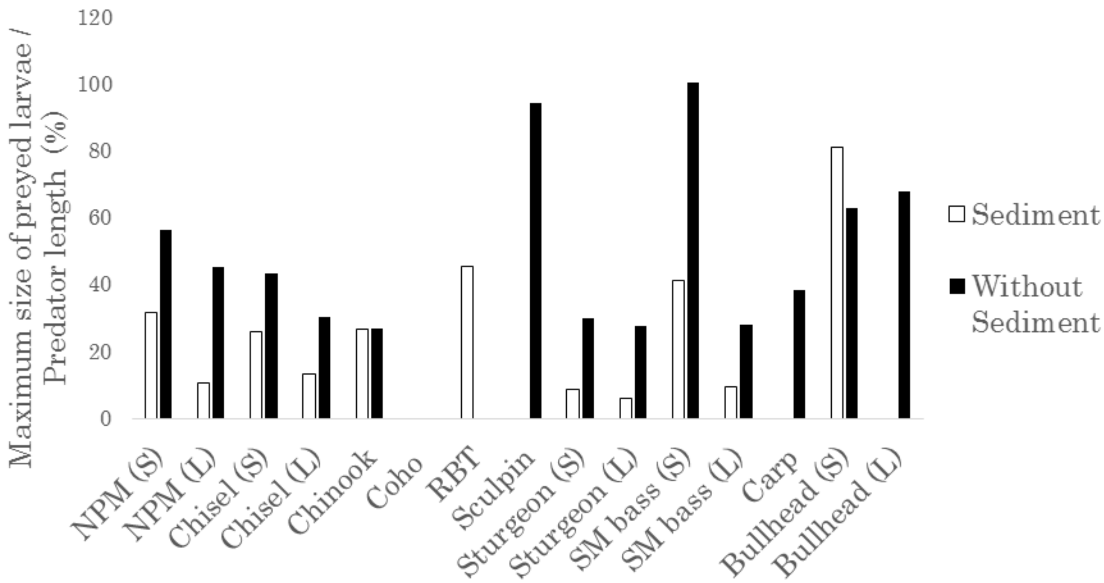


Figure L1-3. Maximum size of the consumed ammocoetes over the average predator length during the short term study.

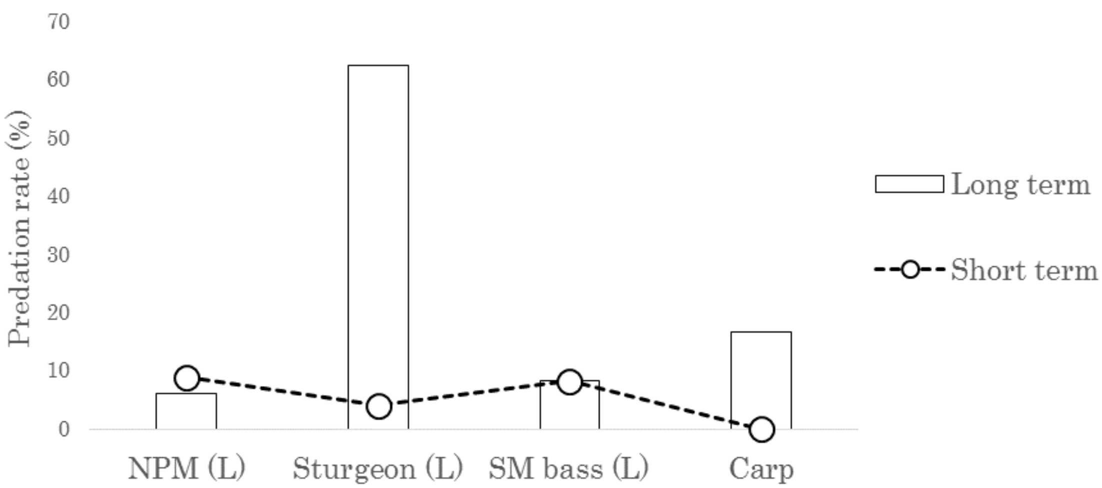


Figure L1-4. Predation rates of ammocoetes with fine sediment present during the short term and the long-term studies.

Appendix L2 - Larval Lamprey Assessment at Roza Dam Forebay and Yakima River Delta Region, 2015

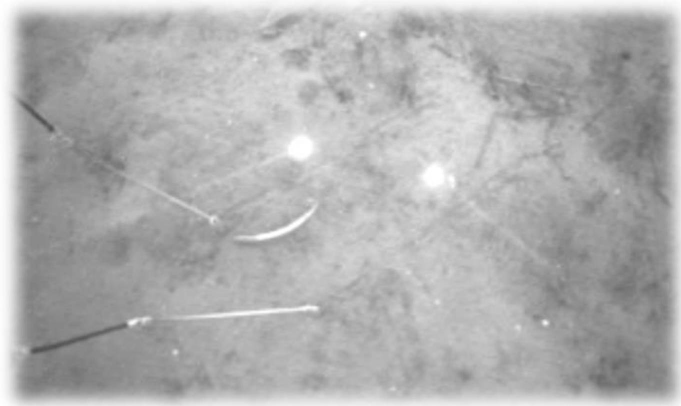


Photo L2. Image of a larval lamprey during shocking event at the Yakima River delta (distance between laser points is 13.9cm).

In 2015, Pacific Northwest National Laboratory (PNNL) and staff from the Yakama Nation conducted deep water larval lamprey surveys near the Roza Dam Diversion Fish Screening Facility and at the Yakima River delta region to determine lamprey occurrence and provide a general assessment of substrate composition in depths ranging from 0.9-9.1 m. We used a deep-water electrofishing platform (DEP) developed by PNNL and deployed it from a motorboat (Fig. L2-1 and Fig. L2-2). At the Roza Dam forebay, lamprey densities are unknown and only limited sampling has been conducted in shallow dewatered channel margins. At the Yakima River delta, limited data is available on the occurrence or density of larval lamprey and past surveys by USFWS have resulted in no lamprey detections 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 deepwater larval lamprey surveys conducted at Roza Dam Screening Facility forebay were the first known to occur there. Results from surveys indicated that very few larval lamprey are inhabiting regions just upstream of the Roza Diversion facility although suitable substrates are present and abundant. At the Roza Dam forebay, a total of four larval lamprey were observed in Type I and II substrates. Three of the four lamprey were found near the trash racks upstream from Screening Bay 5 at a water depth of 5.3 m, and the other was found ~515 m upstream from the facility at a water depth of 2.9 m. Based on our limited survey we do not believe there are high densities of larval lamprey occurring in the immediate vicinity of the forebay region although lamprey may be utilizing the shallow water habitat near the east side of the forebay region which becomes dewatered during the late fall period.

Our surveys at the Yakima River delta region were also one of the first to use sampling methods which allowed sampling in deeper water habitats. At the Yakima River delta, larval lamprey searches were conducted at three general areas consisting of the main river channel and delta regions to the north of the mouth. Most of the substrates in this region had significant macrophyte growth over soft sand/silt sediments. A total of three larval lamprey were observed in a relatively small region along the north section of the delta region in water depths of approximately 6 m in Type I and II substrates. This is the first known occurrence of larval lamprey inhabiting the Yakima River delta region. Lamprey may be utilizing this area due to a combination of stable water temperatures, suitable substrates and a general lack of dense aquatic vegetation. The specific location where these larvae were found suggests that these larvae may have come from the Columbia River rather than the Yakima River. See **Appendix L2** for more information.

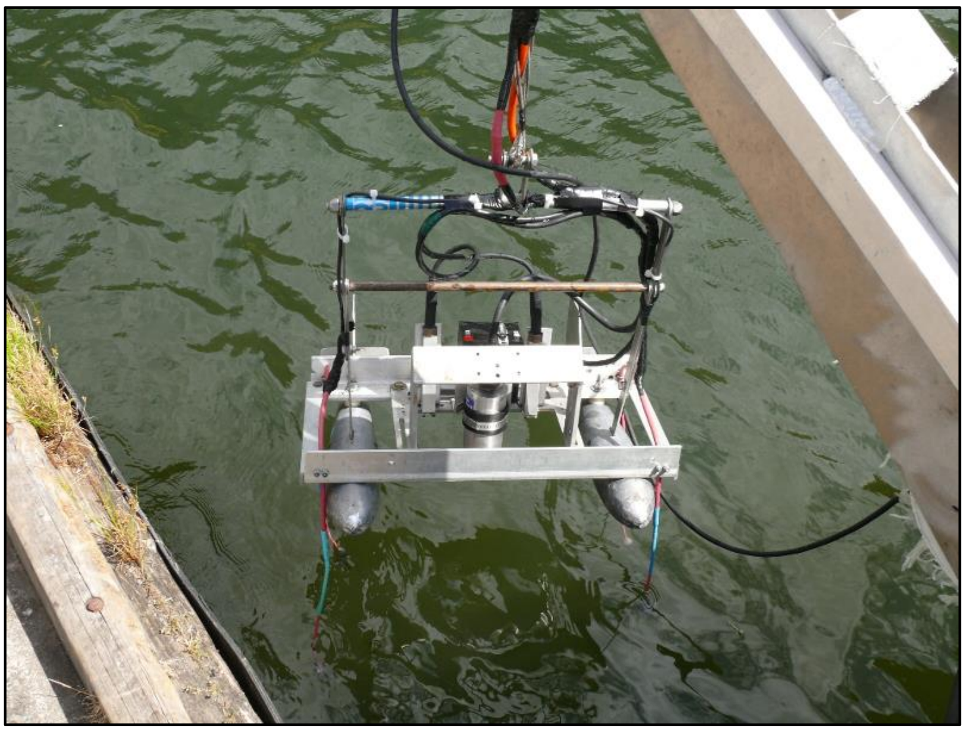


Figure L2-1. **Deepwater Electrofishing Platform (DEP) prior to being deployed from boat.**

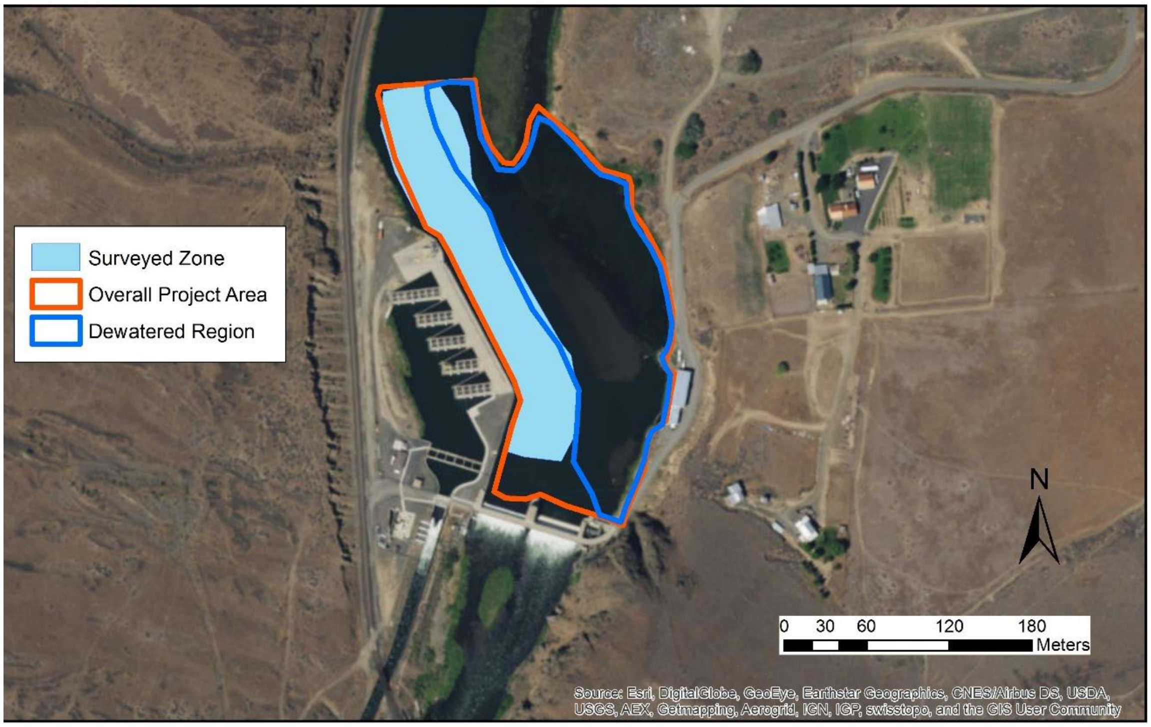


Figure L2-2. Roza Project area. Orange line delineates the overall project area, light blue region delineates the zone that was surveyed and remains wetted year round, and blue line delineates the area that dries up during dewatering.

Table L2-1. General sizes of the sampling areas near the Roza Dam forebay.

Location	Sq. Meter
Surveyed Zone	13,370
Overall Project Area	37,844
De-watered Region	23,126

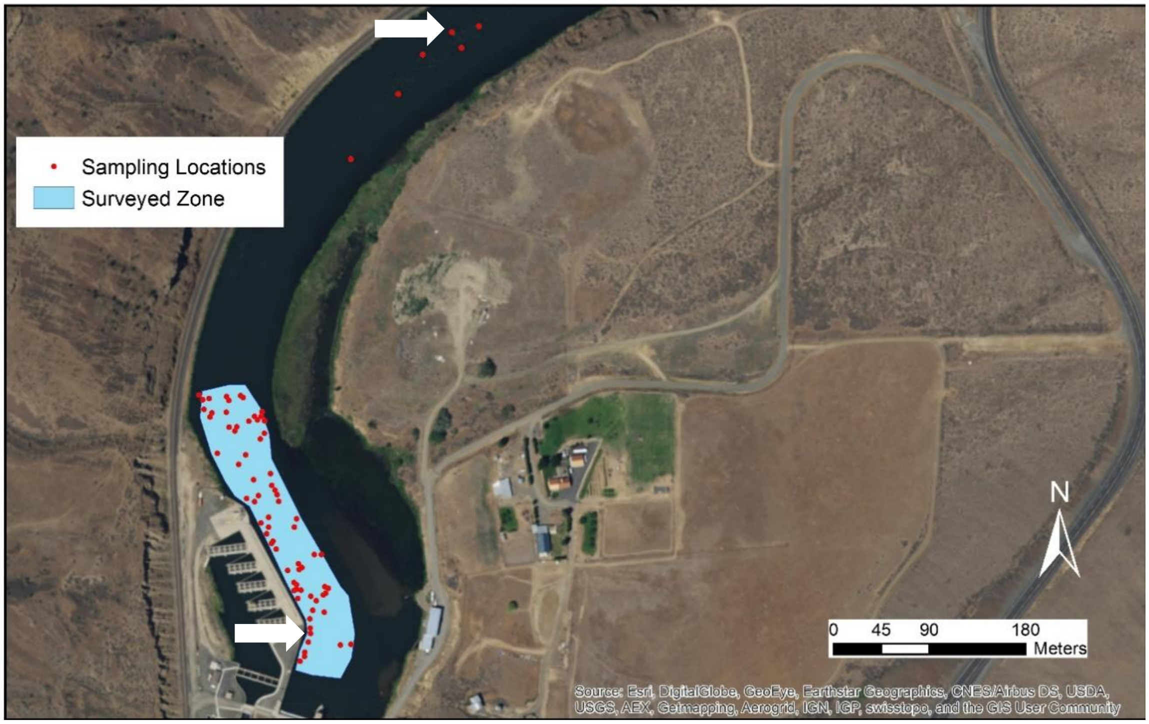


Figure L2-3. Roza Dam forebay region illustrating sampling locations (red dots), larval lamprey locations (white arrows), and total survey region (blue polygon) from surveys conducted on October 14 2015. Larval lamprey were found at upper portion of image and upstream of Screening Bay 5.

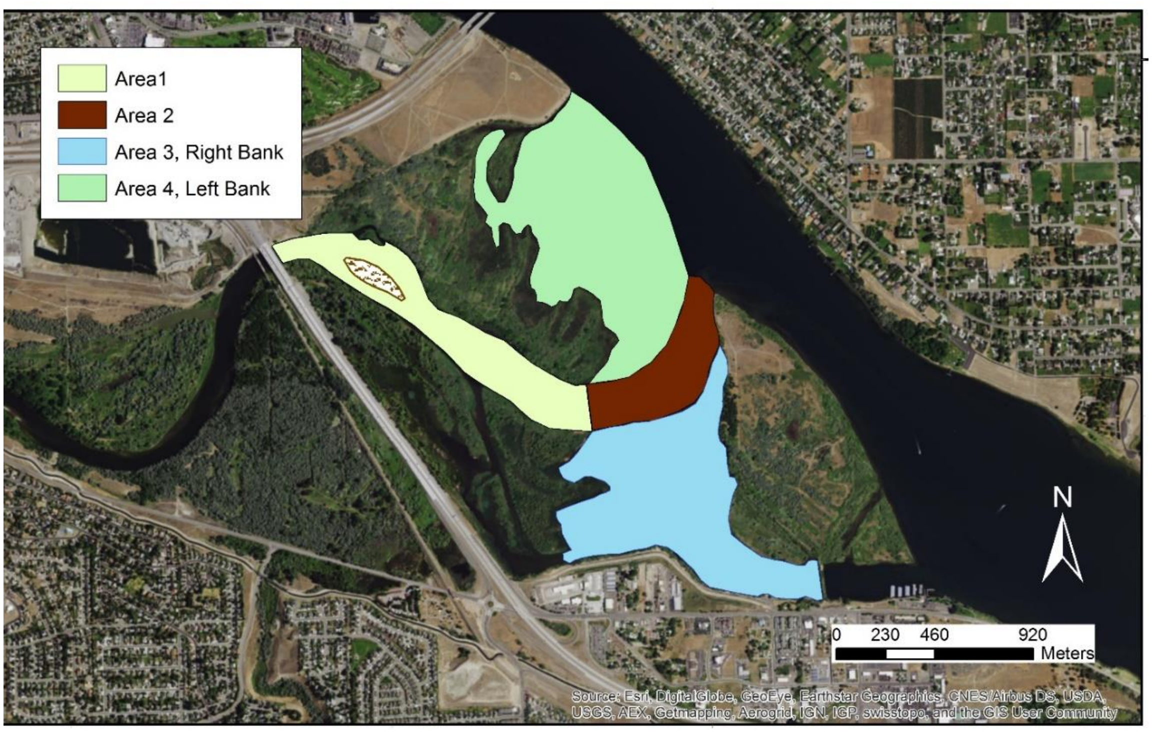


Figure L2-4. General survey regions near the Yakima River Delta.

Table L2-2. General size of the survey zones near the Yakima River Delta Region

Location	Sq. Meter
Area 1	327,315
Area 2	194,610
Area 3, Right Bank	575,413
Area 4, Left Bank	702,577

Figure L2-4. Yakima River Delta region with survey locations from survey conducted on December 4, 2015. Location of larval lamprey (white arrow) is in the northwest corner of the Yakima River delta.

<u>Appendix L3 – Mercury Concentration in Adult Pacific Lamprey (Entosphenus tridentatus) Collected in the Mid-Columbia River and Fish Overwintered at the Prosser Fish Facility</u>

Photo L3. Some of the dead adult lamprey (female) that were evaluated in this study.

When compared with other species where mercury (Hg) effects have been well studied, the concentrations in larval Pacific Lamprey (*Entosphenus tridentatus*) from Columbia River tributaries, such as Klickitat River, Fifteen Mile Creek, Rock Creek and the Wind River, suggest that many of these fish may have experienced and (or) continue to experience lethal and sub-lethal adverse effects from Hg that constrain population recruitment. The present study extends the analyses conducted in 2013 and 2014 to determine Hg levels in larval and adult lamprey as well as stream sediments. The analyses include samples collected from 1) the ocean prior to freshwater migration 2) at several main stem dams after limited freshwater residence and 3) adults held at the Prosser Hatchery until spawning. We also compared Hg concentrations in tissue from two females and their mature eggs to determine transgenerational risk.

There was a wide variation in THg concentrations in adult lamprey, particularly in mature females, which ranged from 0.26 – 7.98 ug/g wet weight (Fig. 1). The mean ± SD for the fresh migrants was significantly lower (0.34 ± 0.25 ug/g wet) than those held up to 322 days until spawning at the Prosser Hatchery (2.14 ± 2.75 ug/g wet). Females generally had higher THg concentrations (0.43 ± 0.27 ug/g wet) than males (0.26 ± 0.22 ug/g wet) for the fresh migrants, as did mature females (2.35 ± 3.47 ug/g wet) compared to mature males (1.8 ± 1.17 ug/g wet), but there was no significant difference between sexes for either fresh migrants or mature fish. A mature female adult captured in the Chandler Diversion had a similar THg concentration as the fresh migrants (0.30 ug/g wet) and an immature male mortality in the spring of 2016 had a concentration of 1.50 ug/g wet, which was higher than the mean THg for the fresh migrant males and approximately equal to the mean for mature males held at the Prosser Hatchery.

Total Hg concentrations from two females and their eggs collected at Bonneville and John Day dams and held at the Prosser Hatchery until ripe also showed evidence of generational Hg transmission (Table 1). For the larger (530 mm) adult female collected at Bonneville Dam, the THg tissue concentration was 7.91 ug/g wet, whereas the concentration in the eggs was 1.02 ug/g wet, or a 12.8% transmission. For the smaller female (456 mm), collected at John Day Dam, the tissue THg concentration was 1.13ug/g wet compared to 0.053 ug/g wet, or a 4.7% transmission.

At tissue concentrations of Hg above ~ 0.5 μg/g, the EPA recommends no more than one meal per month (6 oz. cooked) for fish. Pacific lamprey have been harvested by Columbia River tribes for thousands of years and if efforts currently underway to aid recovery are successful tribal consumption can be expected to increase above current levels. This may place tribal lamprey consumers at increased risk of Hg exposure. Additional monitoring of Hg concentrations in adult lamprey will improve understanding of the risks to population recovery and tribal consumers. See **Appendix L3** for more information.

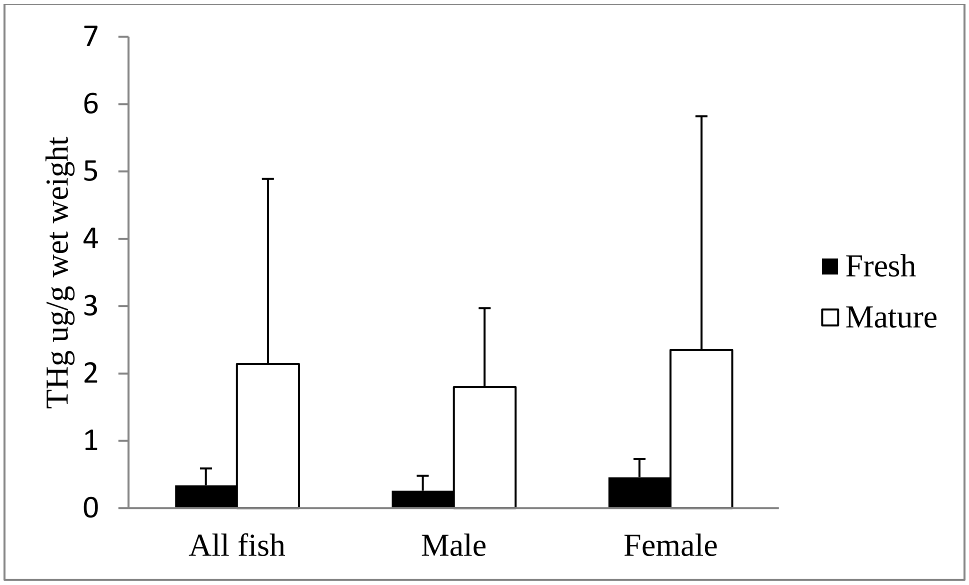


Figure L3-1. The mean ± SD THg concentration for fresh migrant and mature adult lamprey.

Table L3-1. Adult Pacific lamprey summary comparing THg and MeHg concentrations from mature female and eggs, immature male and a juvenile collected from the Pacific Ocean.

No	Life Stage	Migrant Type	Sex	Source	Mort Date	Length (mm)	Weight (g)	Comments	Days at Prosser	THg (ug/g wet)	MeHg (ug/g wet)
1	Adult	Mature	Female	Yakima	6/25/15	457	172.6	Captured in Chandler Diversion	0	0.303	NA
2	Adult	Mature	Female	BON	4/16/16	456	253.5	spawned out (1 day) - 103.3g of eggs	289	1.13	NA
3	Eggs	-	-	BON	4/16/16	-	103.3	eggs from above fish	289	0.0531	NA
4	Adult	Mature	Female	JDA	4/16/16	530	305.5	spawned out (3-4 days max died) - 84.8g of eggs	276	7.91	8.37
5	Eggs	-	-	JDA	4/16/16	-	84.8	eggs from above fish	276	1.02	NA
6	Adult	Immature	Male	BON	4/14/16	615	315.6	immature mort in spring	287	1.50	NA
8	Juvenile	Ocean	?	Ocean	7/7/05			juvenile from the ocean	0	0.119	0.0754

Appendix L4 - The Role of Pacific Lamprey in Yakima River Tributary Food Webs, 2016

Photo L4. One of the spawned out Pacific Lamprey carcass used in this experiment.

Carcasses of post-spawn anadromous fish have been shown to influence stream and riparian food webs. Most work has focused on fall spawning Pacific salmon; relatively little work has focused on other species with differing body chemistry, distribution, or spawn phenology. We explored the response of benthic macroinvertebrates and resident fish species to the presence of carcasses from an early-summer spawning species: Pacific lamprey (*Entosphenus tridentatus*). Invertebrate colonization was assessed using artificial substrate tiles immediately downstream to carcasses placed in a potential spawning reach under various accessibility conditions (Fig. L4-1): fine mesh within a fish-exclosure, course mesh within a fish exclosure, and course mesh in an open channel. Mesh enclosures were placed in Simcoe Creek near the intersection of Branch Road and Stephenson Road near White Swan, WA on June 21, 2016 (Fig. L4-2). Eight transects were selected in visually similar pool macro habitats, measured for flow, depth, and substrate diameter. Artificial substrate samplers at a carcass-free locations were used as controls. Resident fish were assessed using in-situ video observation of carcasses during decomposition. Overall, carcasses lost ~75% of their original wet weight during the four week study (Fig. L4-3). Video observation is ongoing, but is limited by water clarity. At both week two and week four, the highest concentration of invertebrates across taxa were found downstream of carcasses placed in course mesh in the open channel (Fig. L4-4). Invertebrate response was variable, but suggests that certain taxa are able to sense and colonize historically widespread resources from post-spawn Pacific lamprey. Particularly strong responses were seen in the families *Chironomidae* and *Baetidae*, which comprised >85% of samples and showed significant differences due to accessibility treatments (Fig. L4-5). Results from this study suggest that lamprey carcasses may provide resource “hot spot" effects in spawning systems and lamprey-derived nutrients may enter the aquatic food web via direct or indirect macroinvertebrate consumption. See **Appendix G6** for more information.

Figure L4-1. Example of one transect including an exclosure as well as cameras and invertebrate samplers.

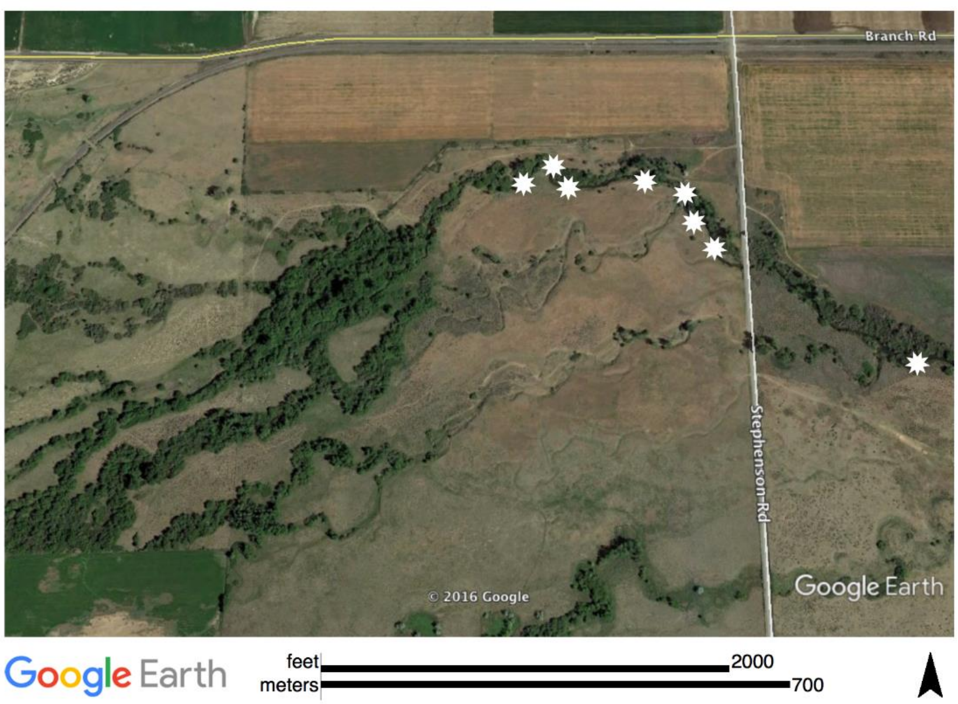


Figure L4-2. Map of study location with approximate locations of transects marked by white stars.

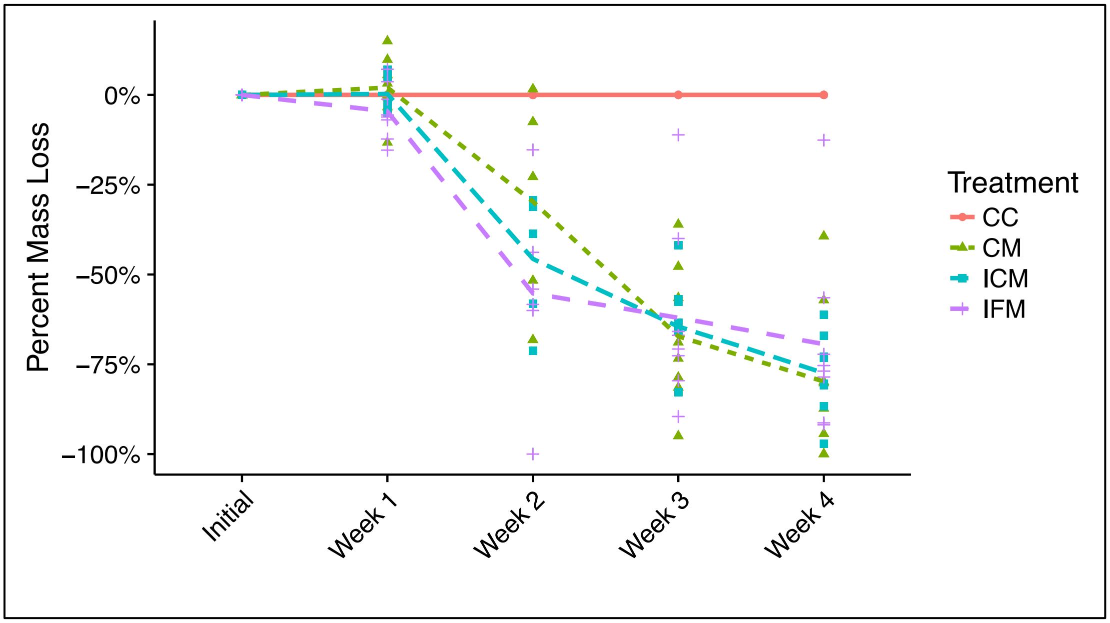


Figure L4-3. Carcass breakdown rates over the course of the experiment by treatment scenario (CC = carcass control, CM = course mesh outside of exclosures, ICM = course mesh inside exclosures, IFM = fine mesh inside exclosure).

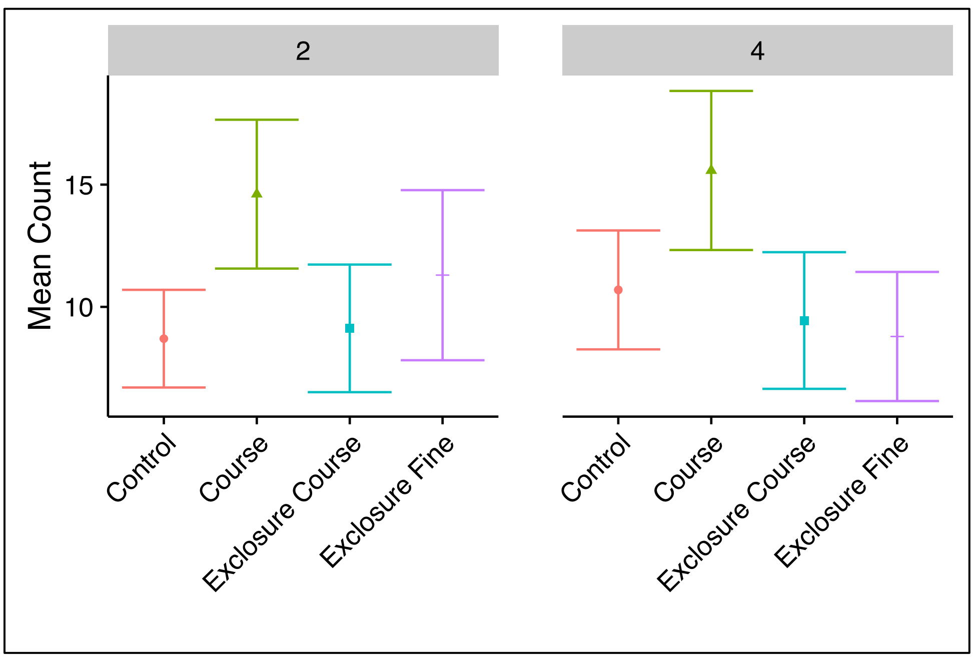


Figure L4-4. Overall differences in macroinvertebrate abundances in week 2 and week 4 of the study.

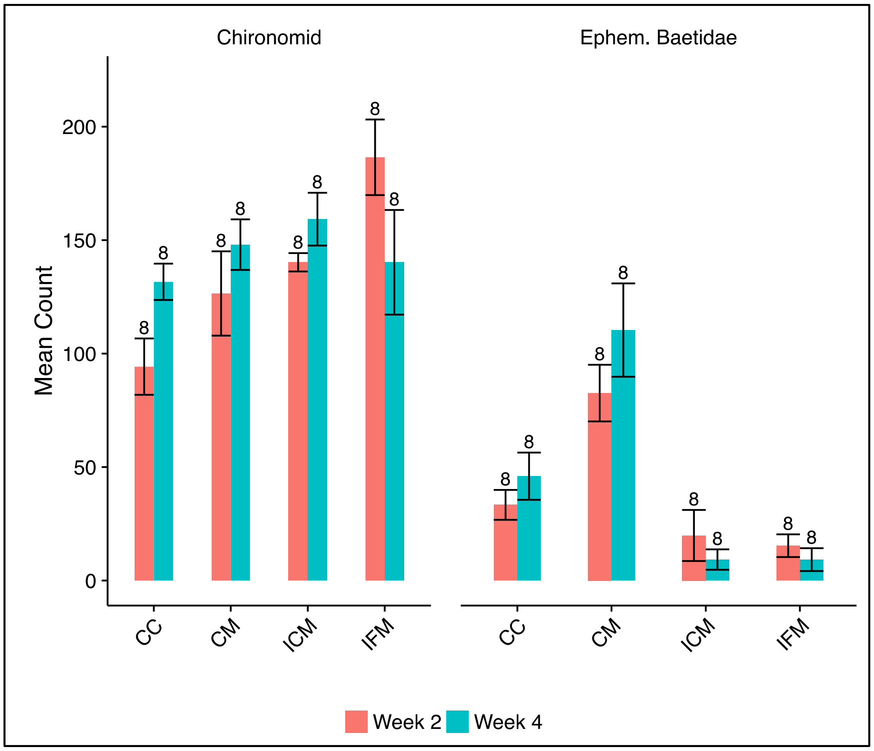


Figure L4-5. Differences in abundances of Chironomid midges and Baetid mayflies in samples taken at week two and week four of carcass decomposition.

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

Work Element Associated Appendix Report:

Appendix L1 – Yakama Nation Cultural Oral Interviews on Asum (Lamprey Eels): Summary Part II (2016)

Photo L1. 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.

Wilbur Slockish and Johnny Jackson, 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. Growing up in primarily Wahkiacus and Celilo area, Mr. Slockish and Jackson shared their tradition of eel harvest at Celilo Falls and many sites within the Klickitat River (Lyle Falls and Wahkiacus) and its tributaries (Little Klickitat River by Centerville and Swale Creek by Wahkiacus). They also harvested eels in Fifteenmile Creek, Rock Creek, Sherars Falls (Deschutes River) and Tygh Valley (White River, a tributary to Deschutes River). To them, the best years they can recall for eel harvest was in the 1950s and early 1960s, during which 25-30 sacks of eels were harvested per season. However, since the middle 1980s, eel numbers appeared to decline sharply (primarily 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 Cellilo 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.

In addition, a poster presentation was created through CRITFC TRAIL summer project funding. A Heritage University undergraduate student, Michael Buck, who is an enrolled Yakama Nation tribal member, worked closely with the YNPLP staff as an intern during the summer of 2016 to present and communicate key information from the elder interviews (see Appendix). He presented the poster at the American Indian Science and Engineering Society National Conference in Minneapolis, MN, in November, 2016. See **Appendix L1** for more information.

Table L1-1. List of interviewees, background information, and critical threats (human impacts) that they identified as responsible for the decline of Pacific Lamprey populations.

Name	Gender	General Area Raised	Year Born	Age (At Interview)	# of Threats Identified	Critical Threats Identified: Irrigation & Canal	Passage	Water Quality	Habitat Loss	Water Quantity	Predation	Disease	Ocean Condition	Other
Johnny Jackson	Male	Wahkiacus, WA	1931	83	4	√	√	√	√					
Johnson Mininick	Male	Satus, WA	1933	80	4	√	√	√		√				
Russell Jim	Male	Yakima Reservation	1935	79	1									√
Lester Umtuch	Male	Priest Rapids, WA	1938	76	2	√		√						
Mel Sampson	Male	White Swan, WA	1938	76	2						√			√
Elmer Schuster	Male	White Swan, WA	1940	74	5	√	√	√	√	√				
Wilbur Slockish	Male	Wapato/Wahkiacus, WA	1944	70	4	√	√	√	√					
Tony Washines	Male	Yakima Reservation	1945	69	3	√	√	√						
Lindsey Selam	Male	Yakima Reservation	1951	63	2		√			√				
Leroy Senator	Male	Prosser/Parker, WA	1951	62	3	√	√			√				
Steve Hoptowit	Male	Wapato, WA	1952	61	3	√			√	√				
Veronica Wallulatum	Female	Yakima Reservation	1960	54	1									√
Pam Miller	Female	Yakima Reservation	1962	52	4	√	√	√	√					
Lowell Miller	Male	Yakima Reservation	1969	45	3			√	√			√		
Average	-	-	**1953**	**67**	**2.9**	**64%**	**57%**	**57%**	**43%**	**36%**	**7%**	**7%**	**0%**	**21%**

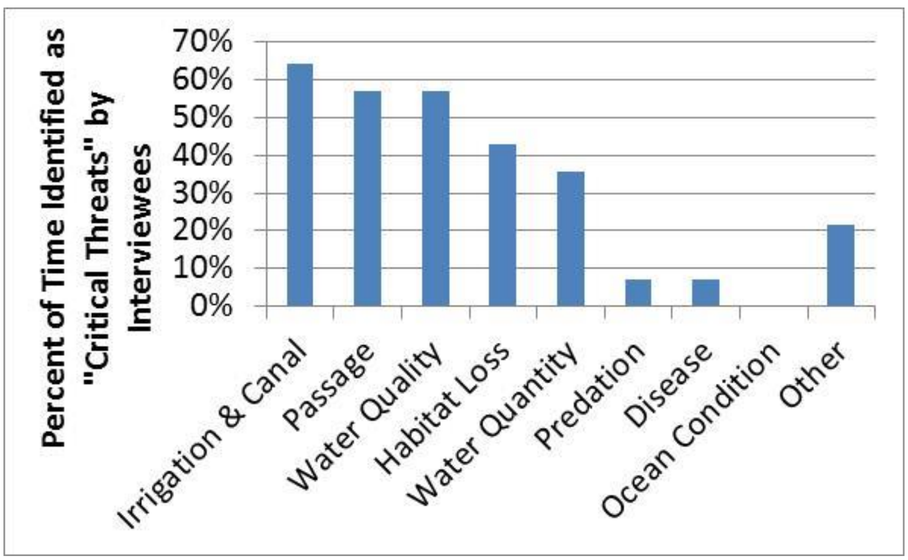


Figure L1-1. Potential threats (human impacts) and the percent of time they were identified by interviewees as "critical threats" leading to the decline of Pacific Lamprey.

Traditional Ecological Knowledge of *Asum* (Pacific Lamprey *Entosphenus tridentatus*) in Central/Eastern Washington and Oregon from Indigenous Peoples of the Confederated Tribes and Bands of the Yakama Nation

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Heritage University

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Introduction

Asum and *ksuyas* are the traditional words that refer to Pacific Lamprey (*Entosphenus tridentatus*) in *Sahaptin* and *Ichishkíin Sínwit* languages (Luke 2015). Pacific Lamprey (commonly referred to as "eels" by tribal members) in the Northwestern USA has historically been managed by federal and state fisheries agencies as non-game "rough fish" or "trash fish," despite its ecological and cultural significance for indigenous peoples. As Pacific Lamprey populations have declined precipitously in the mid and late 20th century (Figure 1; Rose et al. 2012), recovery efforts have been hampered by the paucity of knowledge regarding their life history, biology, and ecology. As a result of the limited scientific data available, Traditional Ecological Knowledge on Pacific Lamprey is vital in understanding this species with a historical and bio-centric context. Yakama Nation tribal members with ties to traditional lamprey fishing and practices were interviewed and asked to describe their personal relationship with Pacific Lamprey.

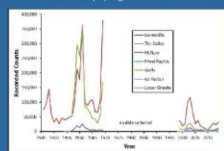

Figure 1. Adult Pacific Lamprey annual counts at Columbia and Snake River dams from 1946 to 2014. Data based on Fish Passage Center annual counts. (Source: Fish Passage Center http://www.fpc.org/)

Photo 1. Spawning Adult Pacific Lamprey (female) in a stream. Photo credit: Freshwaters Illustrated and U.S. Fish and Wildlife Service.

Methods

A total of 27 Yakama tribal members were initially sought for interviews based on their connection and involvement with fishing and cultural activities. Of this group, 14 were formally interviewed in March 2013 (n=2) and in March 2014 (n=12) using 15 interview questions, focusing on biography, harvest/abundance, biology, ecology, culture, and human impacts (Supplemental Information: A). Elders and family members were initially contacted by phone or were asked in person if they would be interested in sharing their stories on lamprey. Purposes of the interviews were explained in advance, and for interviews conducted in 2014, we also asked if they would allow us to film the interview. Before the interview, we provided each interviewee ample time to examine the interview questions, restated our goals and objectives for the interview, and inquired once more whether they would allow us to film the interview (given strict limitation in distribution). Most of the filmed interviews have been transcribed into Microsoft Word and key information was summarized using Microsoft Excel.

Wilbur Slockish (left), Johnny Jackson (right)

Johnson Meninick (left)

Russell Jim (left)

Lester Umtuch (left)

Mel Sampson (left)

Elmer Schuster (left)

Tony Washines (left)

Lindsey Selam (left)

Veronica Wallulatum (left), Pam Miller (center), Lowell Miller (right)

Results

Age of the tribal members interviewed ranged from 45 to 83 (average 67; Table 1). Through this interview process, many insights and revelations were attained in relation to historical distribution, abundance, run timing, and harvest sites (Figure 2), potential threats and impacts, and tradition associated with harvest, preparation, and consumption. In this poster, we focus primarily on critical human impacts and cultural significance.

Photo 2. Adult Pacific Lamprey being harvested at Willamette Falls (Oregon City, Oregon) by Columbia Basin tribal members.

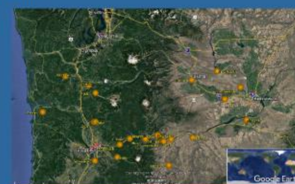

Figure 2. General location of historical and current Pacific Lamprey harvest sites in Washington and Oregon states that were discussed by interviewed tribal members.

Critical Human Impacts

Interviewees identified the most critical threat(s) that caused the decline in Pacific Lamprey populations from nine categories (see Table 1). The majority of interviewees (86%) described at least two or more critical threats (Table 1 and Figure 3). "Irrigation and Canal", "Passage", "Water Quality" were the most frequently chosen answers (57-64% answer rates), while "Habitat Loss" and "Water Quantity" were also a popular answer (36-43% answer rates). Among the three interviewees that chose "Other" for their answer, one (Veronica Wallulatum) stressed uncertainty, while the other two (Russell Jim and Mel Sampson) described the lack of education and cultural understanding on lamprey importance as the root cause of the decline. Russell Jim called this "the logic of the uninformed," meaning if you do not fully understand what you are missing, you will not be able to make the "right" decisions to fix the underlying problems.

Table 1. List of interviewees, background information, and critical threats (human impacts) that they identified as responsible for the decline of Pacific Lamprey populations.

						Critical Threats Identified								
Name	Gender	General Area Raised	Year Born	Age (At Interview)	# of Threats Identified	Irrigation & Canal	Passage	Water Quality	Habitat Loss	Water Quantity	Predation	Disease	Ocean Condition	Other
Johnny Jackson	Male	Wahkiacus, WA	1931	83	4	√	√	√	√					
Johnson Meninick	Male	Satus, WA	1933	80	4	√	√	√		√				
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Elmer Schuster	Male	White Swan, WA	1940	74	5	√	√	√	√	√				
Wilbur Slockish	Male	Wapato/Wahkiacus, WA	1944	70	4	√	√	√	√					
Tony Washines	Male	Yakima Reservation	1945	69	3	√	√	√						
Lindsey Selam	Male	Yakima Reservation	1951	63	2		√			√				
Leroy Senator	Male	Prosser/Parker, WA	1951	62	3	√	√			√				
Steve Hoptowit	Male	Wapato, WA	1952	61	3	√			√	√				
Veronica Wallulatum	Female	Yakima Reservation	1960	54	1									√
Pam Miller	Female	Yakima Reservation	1962	52	4	√	√	√	√					
Lowell Miller	Male	Yakima Reservation	1969	45	3			√	√			√		
Average	-	-	1953	67	2.9	64%	57%	57%	43%	36%	7%	7%	0%	21%

Figure 3. Potential threats (human impacts) and the percent of time they were identified by interviewees as "critical threats" leading to the decline of Pacific Lamprey.

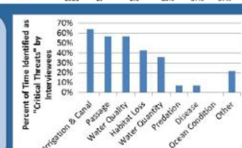

Photo 3. Pacific Lamprey that was dried using traditional methods (holes created to dry them more efficiently).

Cultural Significance

The dissipation or loss of "eel" harvest was filled with mixed emotions and many experienced culture shock, which also affected them physiologically. Mel Sampson and Russell Jim mentioned people getting physically sick from being deprived of the nutritional and medicinal content found in lamprey. Tony Washines and Lowell Miller, amongst other interviewees, highlighted the positive "spirits" and high energy bequeathed from the eel (spiritual medicine). They described how cooking lamprey over the fire while fishing was one of the most lighthearted memories. Traditional fishing for "eels" was not the same experience as today, as mentioned by Lester Umtuch and Elmer Schuster; it was what had to be done to survive. Fishing was certainly not recreational and traveling was not as easy and expeditious as it is today. Bartering was common and a lot more sharing amongst families, relatives, and guests took place along the river in the older days.

Photo 4. Collage of historical (upper right, lower right, lower left) and current (upper left) photos displaying lamprey preparation, preservation, and consumption.

Photo 5. Collage of historical (upper left, lower right, lower left) and current (upper right) photos displaying traditional cultural items and lamprey preservation.

Conclusion

For many of the tribal elders, "*asum*" have been not only a key food source and medicine but also an integral element of their culture and tradition, without which there is an indubitable "void" in their very existence. The language is one element of the culture that all elders hold sacred. In tribal elder interviews, there is inherent difficulty in analyzing what is being said from a strictly analytical perspective and interpreting those stories and thoughts into the English language. Lester Umtuch would often speak to me in our native language, stating "The story I am sharing today will continue the next time we talk" by which he means that all stories are connected and never ending. It is vital to continue interviewing tribal elders and with that, a more holistic composition of "knowledge" about the interaction of the life cycles of humans and Pacific Lamprey will hopefully become evident and attainable.

"...English is very tricky and you can't say anything correctly if you say it in English, but if you use the Native language, you can understand the nature." ~Johnson Meninick~

Acknowledgements

Deepest thanks goes to all the elders that participated in this interview process and the following list of people: Patrick Luke, Gaylord Mink, Jessica Black, Alexander Alexiades, Tana Atchley, Jacob Billy and Aric Washines.

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N. Work Element 132 – Annual Progress Report

Work Element Associated Appendix Report:
Not Applicable

The Annual Progress Report for the period January 2016 through December 2016 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.

O. 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 2016.

P. Work Element 185 – Pisces Status Report

Work Element Associated Appendix Report:
Not Applicable

All quarterly Pisces Status Report for the Year 2016 were completed successfully.

IV. References

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V. Appendices

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

Appendix C1 – Lower Yakima Subbasin Larval Lamprey Monitoring Report, 2016

Appendix C2 – Upper Yakima Subbasin Larval Lamprey Monitoring Report, 2016

Appendix C3 – Naches Subbasin Larval Lamprey Monitoring Report, 2016

Appendix C4 – Wenatchee Subbasin Larval Lamprey Monitoring Report, 2016

Appendix C5 – Entiat Subbasin Larval Lamprey Monitoring Report, 2016

Appendix C6 – Methow Subbasin Larval Lamprey Monitoring Report, 2016

Appendix C7 – Lower Columbia Tributaries Larval Lamprey Monitoring Report, 2016

Appendix D1 –Summary Assessment of Larval/Juvenile Lamprey Entrainment in Irrigation Diversions within the Yakima Subbasin, 2016

Appendix D2 – Intensive Monitoring of Larval/Juvenile Lamprey Entrainment within the Yakama Subbasin, 2016

Appendix D3 – Intensive Monitoring of Larval/Juvenile Lamprey Entrainment within Dryden Diversion, Wenatchee River (Dryden, WA), 2016

Appendix E1 – Yakama Nation Pacific Lamprey Project Outreach and Education, 2016

Appendix G1 – Translocation of Adult Pacific Lamprey within the Yakima Subbasin, 2015-2016 Broodstock

Appendix G2 – Translocation of Adult Pacific Lamprey within the Wenatchee Subbasin, 2015-2016 Broodstock

Appendix G3 – Translocation of Adult Pacific Lamprey within the Methow Subbasin, 2015-2016 Broodstock

Appendix H1 - Juvenile/Larval Lamprey Passage Monitoring in Chandler Diversion, Yakima River (Prosser, WA), 2016

Appendix H2 - Juvenile/Larval Lamprey Passage Monitoring in the Middle Reach of the Yakima River, 2016

Appendix K1 – Yakama Nation Adult Pacific Lamprey Collection in the Columbia River Basin, 2016

Appendix L1 – Assessment on the Predation Potential of Pacific Lamprey (*Entosphenus tridentatus*) and Western Brook Lamprey (*Lampetra richardsoni*) Ammocoetes by Various Native and Non-Native Species

Appendix L2 – Larval Lamprey Assessment at the Roza Dam Forebay and Yakima River Delta Region, 2015

Appendix L3 – Mercury Concentration in Adult Pacific Lamprey (*Entosphenus tridentatus*) Collected in the Mid-Columbia River and Fish Overwintered at the Prosser Fish Facility

Appendix L4 – The Role of Pacific Lamprey in Yakima River Tributary Food Webs, 2016

Appendix M1 – Yakama Nation Cultural Oral Interviews on Asum (Lamprey Eels): Summary and Review Part II (2016)