



Klickitat Subbasin Larval Lamprey Monitoring Report, 2017



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

Project No. 2008-470-00

Report was completed under BPA Contract No. 56662 REL 123

Report covers work performed from: September, 2017

Tyler Beals and Ralph Lampman

**Confederated Tribes and Bands of the Yakama Nation
Yakama Nation Fisheries Resource Management Program, Pacific Lamprey Project
P.O. Box 151, Toppenish, Washington 98948, USA**

Report Created: March, 2018

This report was funded in part by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views in this report are the author's and do not necessarily represent the views of BPA.

ABSTRACT

Since 2009, the Yakama Nation Pacific Lamprey Project (YNPLP) has conducted larval lamprey electrofishing surveys to document the distribution and relative abundance of Pacific Lamprey (*Entosphenus tridentatus*) within the Klickitat Subbasin. In this report, we summarize our 2017 findings from larval lamprey habitat surveys in the Klickitat Subbasin. Both index sites (long term status and trend monitoring sites) and exploratory sites (sites to supplement knowledge of distribution throughout the subbasin) were surveyed. Larval Pacific Lamprey (*Entosphenus tridentatus*) was the primary target of the surveys. Western Brook Lamprey (*Lampetra richardsoni*), a predominately resident species, was also documented when encountered. Electrofishing surveys in 50 m reach sites were conducted in the mainstem Klickitat River and Little Klickitat River (a major tributary of the Klickitat River, confluence at river km 33.0). Throughout our survey, young of year (YOY) lampreys were separated from larger, older lampreys (non-YOY lampreys) to evaluate specific rearing preferences of young of year lampreys. We also monitored the temperature underneath the sediment where the highest densities of lampreys were found (in relation to the open water temperature above the sediment) to assess temperature preferences of larval lampreys between sites and the temperature relationship patterns and trends throughout the subbasin.

In the Klickitat River, a total of six sites were surveyed in September, 2017. Surveyed sites were spatially distributed from river km 1.9 to river km 99.8, consisting of five index sites (long-term status and trend sites) and one exploratory site (additional site to monitor distribution). Type I habitat was most abundant at river km 1.9 and river km 26.5 (105 m² and 210 m², respectively). Type I larval habitat was less than 10 m² in all sites surveyed upstream of river km 26.5. The maximum estimated lamprey density in Type I habitat for lampreys older than one year was 128.1 (#/m²) at river km 29.2. Similarly, the maximum estimated lamprey density in Type I habitat for YOY lampreys was 203.3 (#/m²), at the same river km site (river km 29.2). Pacific Lamprey were found at 4 of 6 (66%) surveyed sites. At the lower most site (river km 1.9), only Pacific Lamprey were found (100% of 77 identified lampreys). The ratio of Pacific Lamprey decreased with an increase in river kilometer (100%, 93%, 66%, and 64% at river km 1.9, 26.5, 52.5 and 69.4, respectively). The most upstream location where Pacific Lamprey were found was river km 69.4, located immediately upstream of the weir dam at the Klickitat Fish Hatchery, indicating that some Pacific Lamprey are able to navigate over the weir dam (although overall adult passage efficiency is still unknown). Only Western Brook Lamprey was found at river km 82.7, indicating that the upper distribution of Pacific Lamprey lies between river km 69.4 and 82.7. Out of all surveyed sites, the sediment was observed to be a maximum of 1.5°C warmer than the plot temperature (at river km 1.9) and a maximum of 1.1°C cooler than the plot temperature at river km 26.5.

One index site was also surveyed in the Little Klickitat River at river km 0.5. No Type I (preferred) larval lamprey habitat was present at the surveyed site. Type I habitat appears to be very limited in the lower reaches of the Little Klickitat River. Pacific Lamprey were found at the one index site

surveyed in the Little Klickitat River (83% of 46 identified). A total of six eyed Pacific Lamprey (macrophthalmia) were found in the Little Klickitat River during the September survey; none were found from surveys in the mainstem Klickitat River.

INTRODUCTION

Since 2009, the Yakama Nation Pacific Lamprey Project (YNPLP) has conducted larval lamprey electrofishing surveys to document the distribution and relative abundance of Pacific Lamprey (*Entosphenus tridentatus*) within the Klickitat Subbasin. Western Brook Lamprey (*Lampetra richardsoni*), a (predominantly) resident lamprey species, is also present in the subbasin in relatively high abundance. The primary monitoring objective in the Klickitat Subbasin is to monitor the distribution and status/ trend of wild Pacific Lamprey (and if present, Western Brook Lamprey). In this report, we have summarized key information that was collected as a result of our larval lamprey habitat survey in the Klickitat Subbasin in September, 2017.

METHODS

Site Choice and Field Survey

Throughout the Yakama Nation Ceded Lands, the YNPLP (Yakama Nation Pacific Lamprey Project) has conducted surveys for larval lampreys (beginning in 2009). Index sites, or long-term repeat monitoring sites, have been established throughout the Ceded Lands. The index sites are spatially distributed within watersheds with the potential to hold Pacific Lamprey. The primary goal of these index sites is to monitor the status and trend of Pacific Lamprey in the lower, middle, and upper reaches of interest watersheds. In addition to the index sites, exploratory sites are established each year to further our knowledge on Pacific Lamprey distribution and habitat availability within each watershed.

For all site types, survey sites were chosen based on aerial images from Google Earth and GIS software and site visits. Sites that had higher chances of being a Type I habitat [such as visibly recognizable areas on aerial image with slow water, shallow channel margin with dark tints (usually indicating fine sediment), backwater eddies, confluence of side channels, behind island bars, and tail end of deposition bars, etc.] were given priority. We determined that targeting the preferred habitat more effectually will provide us with a better framework for evaluating presence/absence, distribution, and relative abundance. Further, due to restricted survey time, the ease of access to a survey site (e.g. sites with public road access, short hikes, or near bridges, or private properties who permit access to the rivers/streams) was a critical issue and strongly considered when choosing sites. By prioritizing accessibility, more ground could be covered throughout the expansive area of interest. Chosen habitat sites were ultimately spatially distributed throughout individual watersheds.

Surveys were focused on Type I (preferred) and/or Type II (acceptable) habitat to provide optimal opportunity to capture the largest number of larval lamprey. Type I habitat primarily consists of fine sand, silt and/or clay and is absent of coarse substrate (gravel/cobble/boulder/bedrock). Type II habitat is coarse shifting sand or other fine substrate mixed with coarse substrate. Type III (unsuitable) habitat consists of no fine sediments and was not surveyed. Type I and II habitat is generally found in backwater areas, point bars, mainstem channel margins, and side channels.

At each electrofished site (index or exploratory), a 50 m reach was measured out which encompassed the most accessible and abundant Type I and Type II larval lamprey habitat. The total area (m²) of Type I and Type II larval lamprey habitat was estimated within the 50 m reach. Electrofishing surveys targeted representative areas of Type I habitat. Type II habitat was opportunistically surveyed (based on available time and survey purpose). At index sites, a minimum area of 5 m² of Type I habitat was surveyed. If Type II was surveyed, a minimum area of 5 m² was surveyed in addition to Type I habitat. At exploratory sites, a minimum area of 5 m² of either habitat type was surveyed, but varied depending on available time and survey purpose.

Throughout the course of the survey, young of year (YOY) larvae were kept separate from larger (older) lampreys. Larvae were considered YOY when their length was less than or equal to (\leq) 25 mm between June and August, and this threshold was increased to \leq 30 mm during the months of September and October.

Sediment type (sand, silt or clay) was recorded for the specific area (1 m²) where the most lampreys were observed (separate measurements for YOY and all other lampreys). The sediment depth (cm), water depth (cm), plot temperature (°C) and sediment temperature (a max of 10 cm below the sediment), were also recorded at this location (separate measurements were taken for YOY larvae). If no fish were observed, plot temperature was taken where the best available habitat was observed. Thalweg temperature was recorded to represent the main channel temperature.

Electrofishing surveys were conducted with an AbP-2 Backpack Electrofisher (ETS Electrofishing Systems Inc., Madison, WI), specially designed for the sampling of larval lampreys. Surveys targeted available (wetted) larval habitat using standard survey methods (slow tickle pulse of 3 pulses/sec and fast stunning pulse of 30 pulses/sec, 25% duty cycle, 3:1 burst pulse train, and 125 volts). Another person, equipped with a fine-mesh hand net was also present to help capture any electrofished larvae. Electrofishing time (seconds) and area (m²) covered (of each habitat type) was recorded. For YOY larvae, we recorded the total area where YOY larvae were observed during the course of the survey.

Captured lampreys were separated by habitat type, tallied by life stage, age class (YOY versus non-YOY), and identified to species (if of identifiable length > 50 mm). A minimum of 30 lampreys of identifiable length were identified to species.

For non-YOY lamprey, 15 representative lengths were taken (+/- 1 mm). Four of these lampreys were measured to the nearest 0.01 gram (length and weight was taken on the largest, smallest and two medium sized larvae relative to the site). The combined weight of all captured lampreys was also measured (nearest 0.01 g). Missed larvae were counted and tallied by size class (small <50 mm, medium 50-90 mm, and large > 90 mm).

Once a tally was obtained for each habitat type, all YOY larvae were placed together, and five lengths were recorded (largest, smallest, and three medium sizes relative to the collected sample [± 1 mm]). The total weight of the collected YOY larvae was also recorded to the nearest 0.01 gram.

Genetic samples were collected from Pacific Lamprey (> 50 mm) with scissors or 2 mm hole punch (top or bottom of the caudal fin). Lampreys less than 50 mm were generally collected as whole samples (by placement on a genetic sheet or preservation in 70% Ethanol), but efforts were made to take genetic clips from larger unidentifiable larvae (> 35 mm) rather than whole samples. Macrophthalmia were clipped on the back of the second (rear) dorsal fin with scissors or small (2mm) hole punch. Samples were primarily collected in areas where adult Pacific Lamprey translocation efforts are ongoing, or where the distribution of Pacific Lamprey is uncertain.

Additionally, genetic samples were collected from Western Brook Lamprey (> 50 mm) with scissors or 2 mm hole punch (top or bottom of the caudal fin). Photos were taken of the caudal fin prior to taking the genetic clip. In general, Western Brook Lamprey are separated into two classes, based on the pigment of their caudal fin; Class A (no pigment present) and Class B (pigment present). Genetic samples were collected from Western Brook Lamprey in each surveyed watershed when they were present (representative samples of Class A and Class B). The goal of these samples is 1) confirm the presence of Western Brook Lamprey in areas where Western Brook Lamprey are thought to be absent, or limited in number and 2) better understand the genetic variance between these two classes of Western Brook Lamprey throughout the Columbia River Basin.

Analysis

Captured and missed larvae were tallied together to determine the total number of observed lampreys from electrofishing for each habitat type. If the number of captured lampreys was less than half of the observed total, the number of captured lampreys was doubled, and used as the final observed total. If the number of captured lampreys was equal to or more than half, the recorded observed number was used as the final observed total (represented by “total number observed” in the following report).

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 (final observed total) was adjusted (increased) based on a 1-5 visibility scale. A separate adjustment value was given for non-YOY larvae, and YOY larvae (in an attempt to account for the small size of YOY larvae). For non-YOY larvae, the following 1-5 visibility scale was used: (1) poor (60%), (2) fair (70%), (3) good (80%), (4) very good (90%) and (5) excellent (100%). For YOY larvae, a more generous visibility adjustment scale was used: (1) poor (10%), (2) fair (20%), (3) good (30%), (4) very good (40%) and (5) excellent (50%).

For each survey, and each age class, the total number of observed lampreys was increased (by the percentage listed above) based on the survey’s visibility rank. The adjusted observed value is

represented as “Sampled Estimated Number” in the following report. Survey densities on non-YOY lampreys ($\#/m^2$) were calculated using the estimated sample number, and the total survey area. However, for YOY larvae, survey densities were calculated from the estimated sample number, and the survey area where YOY lamprey were observed during the survey. A mean condition factor was calculated for each site. The mean condition factor was calculated from the condition factor of each of the larvae measured by both length and weight.

RESULTS

Klickitat River

A total of six sites were electrofished in the Klickitat River in September, 2016. Electrofished sites were spatially distributed from river km 1.9 to river km 99.8 (Map 1). A total of five index sites and one exploratory site were surveyed. The discharge flow at the time of our electrofishing survey is shown in Figure 1.



Map 1. Overview of all surveyed sites in the Klickitat River (red line) in September, 2017, displaying Yakama Nation surveyed index sites (green arrows) and exploratory sites (white arrows) where electrofishing occurred. The location of a USGS Flow Station (near Pratt, WA; river km 12.0) is also labeled.

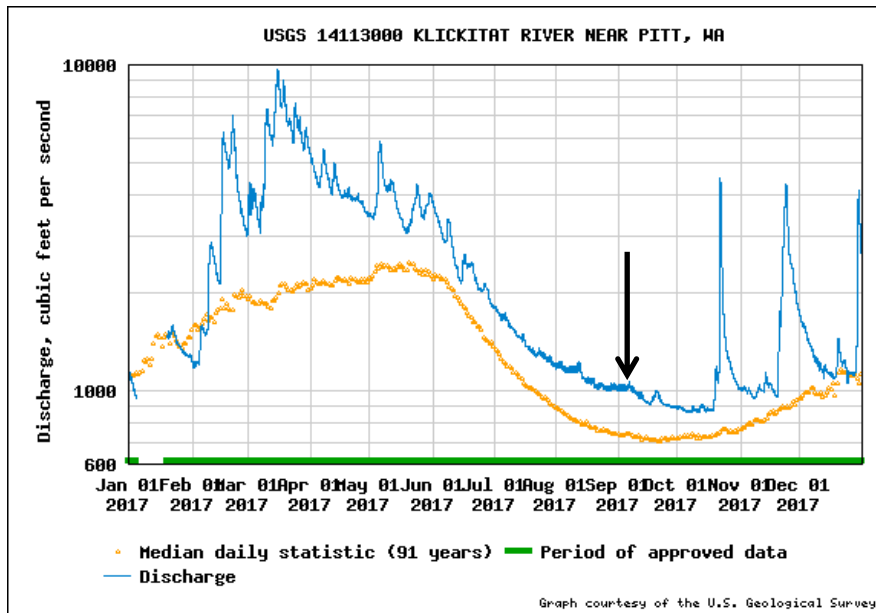


Figure 1. Discharge (cubic feet per second indicated by the narrow blue line) of the Klickitat River near Pratt, WA (river km 12.0) in 2017; black arrow indicates YN survey period (September, 2017).

Klickitat River Survey Highlights

- Type I habitat was most abundant at river km 1.9 and river km 26.5 (105 m² and 210 m², respectively). Type I larval habitat was less than 10 m² in a 50 m reach at each of the sites surveyed upstream of river km 26.5 (Table 1).
- The sediment temperature was a maximum of 1.5 C warmer than the plot temperature (directly above the sediment) in areas of high lamprey densities (river km 1.9; Table 1 and Table 2).
- The sediment temperature was a maximum of 1.1 C cooler than the plot temperature (directly above the sediment) in areas of high lamprey densities (river km 26.5; Table 1 and Table 2).
- Larval lamprey were not found at river km 99.8 (river km 82.7 was the most upstream distribution of larval lamprey; Table 1 and Table 2).
- The maximum estimated lamprey density in Type I habitat for lampreys older than one year was 128.1 (#/m²) at river km 29.2 (Table 3).
- The maximum estimated lamprey density in Type I habitat for young of year (YOY) lampreys was 203.3 (#/m²), at the same river km site as the older lampreys (river km 29.2; Table 4).
- The overall Pacific Lamprey ratio was high (82% of 229 lampreys identified; Table 7).
- The ratio of Pacific Lamprey decreased with an increase in river kilometer (100%, 93%, 66%, and 64% at river km 1.9, 26.5, 52.5 and 69.4, respectively).
- The most upstream location where Pacific Lamprey were found was river km 69.4, located immediately upstream of the weir dam at the Klickitat Fish Hatchery,]
- Only Western Brook Lamprey was found at river km 82.7, indicating that the upper distribution of Pacific Lamprey lies between river km 69.4 and 82.7.

Habitat Overview

Table 1. Larval lamprey habitat details for lampreys greater than one year of age from index sites surveyed in the Klickitat River. Under “Fish Age Class”, “> 1 Year” signifies that the displayed values are for lampreys assumed greater than one year old (> 30 mm for lampreys collected after September 1, 2017, and > 25 mm for lampreys collected prior to September 1, 2017). The total area (m²) of Type I and Type II habitat within the surveyed 50 m stream reach is shown. Under “Type I Habitat Type”, “Edge” indicates this took place on the edge of the main channel, and “Side Ch.” indicates the survey took place in a side channel. Plot temp was taken where the most lampreys were found. Sediment temp was taken where the most lampreys were found (a maximum of 10 cm under the sediment). “Sed. Temp Diff[erence].” was calculated by subtracting the plot temp from the sediment temp (a negative value indicates that the sediment temperature is cooler than the plot temperature). Thalweg temp was taken in the main channel flow.

Site Type	Stream	River KM	Date	50 m Type I Area (m2)	50 m Type II Area (m2)	50 m Type I/II Area (m2)	Fish Age Class	Primary Fine Sediment (Type I)	Primary Fine Sediment (Type II)	Type I Habitat Type	Plot Temp °C (Best)	Sed. Temp °C (Best)	Sed. Temp Diff. °C	Thalweg Temp °C
Index	Klickitat	1.9	9/26/2017	105	150	255	> 1 Year	Sand	-	Side Ch	12.6	14.1	1.5	12.6
Index	Klickitat	26.5	9/26/2017	210	35	245		Silt	-	Edge	11.7	10.6	-1.1	11.6
Index	Klickitat	52.5	9/26/2017	6	40	46		Sand	-	Side Ch	12.6	12.3	-0.3	12.6
Index	Klickitat	69.4	9/27/2017	5	18	23		Silt	-	Edge	9.2	9.4	0.2	9.2
Expl.	Klickitat	82.7	9/27/2017	0	5	5		-	Silt	-	9.3	8.9	-0.4	9.0
Index	Klickitat	99.8	9/27/2017	8	10	18		Sand	-	Edge	8.9	-	-	8.9

Table 2. Larval lamprey habitat details for young of year (YOY) lampreys collected from index sites surveyed in the Klickitat River. Under “Fish Age Class”, “YOY” signifies that the displayed values are for YOY lampreys (≤ 30 mm for lampreys collected after September 1, 2017 and ≤ 25 mm for lampreys collected prior to September 1, 2017). The total area (m2) of Type I and Type II habitat within the surveyed 50 m stream reach is shown. Under “Type I Habitat Type”, “Edge” indicates survey took place on the edge of the main channel, and “Side Ch.” indicates the survey took place in a side channel. Plot temp was taken where the most lampreys were found. Sediment temp was taken where the most lampreys were found (a maximum of 10 cm under the sediment). “Sed. Temp Diff[erence].” was calculated by subtracting the plot temp from the sediment temp (a negative value indicates that the sediment temperature is cooler than the plot temperature). Thalweg temp was taken in the main channel flow.

Site Type	Stream	River KM	Date	50 m Type I Area (m2)	50 m Type II Area (m2)	50 m Type I/II Area (m2)	Fish Age Class	Primary Fine Sediment (Type I)	Primary Fine Sediment (Type II)	Type I Habitat Type	Plot Temp °C (Best)	Sed. Temp °C (Best)	Sed. Temp Diff. °C	Thalweg Temp °C
Index	Klickitat	1.9	9/26/2017	105	150	255	YOY	Sand	-	Side Ch	12.6	14.1	1.5	12.6
Index	Klickitat	26.5	9/26/2017	210	35	245		Silt	-	Edge	11.7	10.6	-1.1	11.6
Index	Klickitat	52.5	9/26/2017	6	40	46		Sand	-	Side ch	12.6	12.3	-0.3	12.6
Index	Klickitat	69.4	9/27/2017	5	18	23		Silt	-	Edge	9.2	9.4	0.2	9.2
Expl.	Klickitat	82.7	9/27/2017	0	5	5		-	Silt	Edge	9.3	8.9	-0.4	9.0
Index	Klickitat	99.8	9/27/2017	8	10	18		-	-	-	8.9	-	-	8.9

Lamprey Capture Details and Estimated Density

Table 3. Lamprey capture details and estimated lamprey density for lampreys greater than one year of age in Type I and Type II habitat from index sites surveyed in the Klickitat River in September, 2017. Under “Fish Age Class”, “> 1 Year” signifies that the displayed values are for lampreys assumed greater than one year old (> 30 mm for lampreys collected after September 1, 2017, and > 25 mm for lampreys collected prior to September 1, 2017). The number of observed lampreys 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%). The adjusted number of observed lampreys is referred to as the “Sample Estimated Number [#]”. Survey densities (#/m²) were calculated using the sampled estimated number. In the “Habitat Summary” row, values are a sum of displayed values, except “Estimated Density” which is a weighted average.

Site Type	Stream	River KM	Fish Age Class	Habitat Type Surveyed	Shock Time (sec)	Shock Area (m ²)	# Captured	# Observed	Survey Visibility (1-5)	Sampled Estimated #	Estimated Density (#/m ²)
Index	Klickitat	1.9	> 1 Year	Type I	327	6	85	170	3	213	35.4
Index	Klickitat	26.5			222	6	246	615	3	769	128.1
Index	Klickitat	52.5			241	4	82	137	4	182	45.6
Index	Klickitat	69.4			252	5	53	68	3	133	29.4
Expl.	Klickitat	82.7			-	-	-	-	-	-	-
Index	Klickitat	99.8			478	8	0	0	5	-	-
Index	Klickitat	1.9	> 1 Year	Type II	0	-	-	-	-	-	-
Index	Klickitat	26.5			0	-	-	-	-	-	-
Index	Klickitat	52.5			0	-	-	-	-	-	-
Index	Klickitat	69.4			0	-	-	-	-	-	-
Expl.	Klickitat	82.7			314	5	13	13	5	26	5.2
Index	Klickitat	99.8			0	-	-	-	-	-	-
Habitat Summary			> 1 Year	Type I	1520	29	466	990	-	1296	59.6
				Type II	314	5	13	13	-	26	5.2

Table 4. Lamprey capture details and estimated lamprey density for young of year (YOY) lampreys in Type I and Type II habitat from index sites surveyed in the Klickitat River in September, 2017. Under “Fish Age Class”, “YOY” signifies that the displayed values are for YOY lampreys (≤ 30 mm for lampreys collected after September 1, 2017 and ≤ 25 mm for lampreys collected prior to September 1, 2017). The number of observed lampreys was adjusted (increased) based on the following 1-5 visibility scale (estimated % visibility in parenthesis): (1) poor (10%), (2) fair (20%), (3) good (30%), (4) very good (40%) and (5) excellent (50%). The adjusted number of observed lampreys is referred to as the “Sample Estimated Number [#]”. “YOY Area” is the area (within the overall survey area) where YOY lampreys were observed. Survey densities (#/m²) were calculated using the sampled estimated number and the “YOY Area”. In the “Habitat Summary” row, values are a sum of displayed values, except “Estimated Density” which is a weighted average.

Site Type	Stream	River KM	Fish Age Class	Habitat Type Surveyed	YOY Area (m ²)	# Captured	# Observed	Survey Visibility (1-5)	Sampled Estimated #	Estimated Density (#/m ²)
Index	Klickitat	1.9	YOY	Type I	3	32	64	2	320	106.7
Index	Klickitat	26.5			6	22	22	1	-	203.3
Index	Klickitat	52.5			4	0	20	3	67	16.7
Index	Klickitat	69.4			2	4	4	1	-	40.0
Expl.	Klickitat	82.7			0	-	-	-	-	-
Index	Klickitat	99.8			-	0	0	-	-	-
Index	Klickitat	1.9	YOY	Type II	0	-	-	-	-	-
Index	Klickitat	26.5			0	-	-	-	-	-
Index	Klickitat	52.5			0	-	-	-	-	-
Index	Klickitat	69.4			0	-	-	-	-	-
Expl.	Klickitat	82.7			2	35	155	5	155	78
Index	Klickitat	99.8			0	-	-	-	-	-
Habitat Summary			YOY	Type I	15	58	110	-	387	91.7
				Type II	2	35	155	-	155	77.5

Lamprey Measurement Details

Table 5. Measurement details of captured lampreys greater than one year old at index sites surveyed in the Klickitat River in Type I and Type II habitat in September, 2017. Under “Fish Age Class”, “> 1 Year” signifies that the displayed values are for lampreys assumed greater than one year old (> 25 mm for lampreys collected prior to September 1, 2017, and > 30 mm for lampreys collected after September 1, 2017). The “Mean Weight” was calculated by dividing the total weight of lampreys by the number of lampreys weighed. The “Min”, “Max” and “Mean” lengths are calculated from measured lampreys. In the “Habitat Summary” row, “Mean Weight” and “Mean Length” are averages of displayed values for the respective habitat type.

Site Type	Stream	River KM	Fish Age Class	Habitat Type Surveyed	# Weighed	Total Weight (g)	Mean Weight (g)	Min. Length (mm)	Max. Length (mm)	Mean Length (mm)
Index	Klickitat	1.9	> 1 Year	Type I	85	63.1	0.74	37	120	74
Index	Klickitat	26.5			246	175.2	0.71	45	130	76
Index	Klickitat	52.5			82	51.62	0.63	41	115	72
Index	Klickitat	69.4			53	31.85	0.60	44	145	74
Expl.	Klickitat	82.7			-	-	-	-	-	-
Index	Klickitat	1.9	> 1 Year	Type II	-	-	-	-	-	-
Index	Klickitat	26.5			-	-	-	-	-	-
Index	Klickitat	52.5			-	-	-	-	-	-
Index	Klickitat	69.4			-	-	-	-	-	-
Expl.	Klickitat	82.7			13	5.52	0.42	54	67	61
Habitat Summary		-	> 1 Year	Type I	466	322	0.67	37	145	74
				Type II	13	6	0.42	54	67	61

Table 6. Measurement details of captured young of year (YOY) larval lampreys at index sites surveyed in the Klickitat River in Type I and Type II habitat in September, 2017. Under “Fish Age Class”, “YOY” signifies that the displayed values are for YOY lampreys (≤ 30 mm for lampreys collected after September 1, 2017 and ≤ 25 mm for lampreys collected prior to September 1, 2017). The “Mean Weight” was calculated by dividing the total weight of lampreys by the number of lampreys weighed. The “Min”, “Max” and “Mean” lengths are calculated from measured lampreys.

Site Type	Stream	River KM	Fish Age Class	Habitat Type Surveyed	# Weighed	Total Weight (g)	Mean Weight (g)	Min. Length (mm)	Max. Length (mm)	Mean Length (mm)
Index	Klickitat	1.9	YOY	Type I	32	2.79	0.09	22	35	27
Index	Klickitat	26.5			22	1.67	0.08	25	35	29
Index	Klickitat	52.5			0	-	-	-	-	-
Index	Klickitat	69.4			0	-	-	14	19	16
Expl.	Klickitat	82.7			0	-	-	-	-	-
Index	Klickitat	1.9	YOY	Type II	-	-	-	-	-	-
Index	Klickitat	26.5			-	-	-	-	-	-
Index	Klickitat	52.5			-	-	-	-	-	-
Index	Klickitat	69.4			-	-	-	-	-	-
Expl.	Klickitat	82.7			12	0.47	0.04	16	23	20
Habitat Summary		-	YOY	Type I	54	4.46	0.08	14	35	24
				Type II	12	0.47	0.04	16	23	20

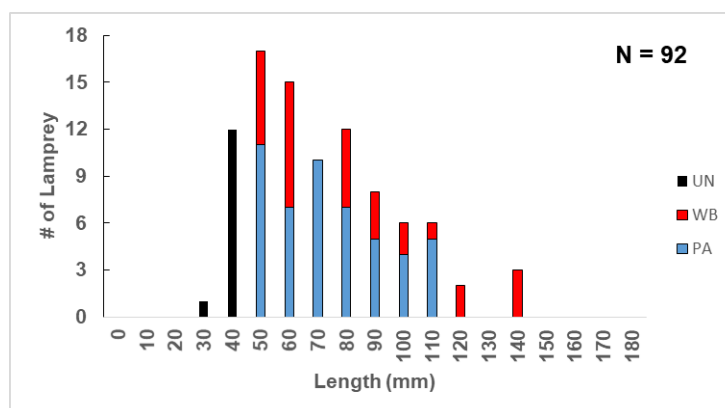


Figure 1. Histogram of all measured lampreys (excluding YOY lampreys) captured during electrofishing surveys, separated by species (“PA”= Pacific Lamprey (blue), “UN”=Unknown Lamprey <50 mm (green), “WB” Western Brook Lamprey (Red), in the Klickitat River in September, 2017.

Species Composition and Genetic Samples

Table 7. Species composition of captured lampreys from Klickitat River index sites surveyed in September, 2017. “Number (#) Captured” includes all captured lampreys (of all age classes). Under “Number (#) Pacific Lamprey Gen. Sampl.”, “Gen. Sampl.” stands for “Genetic Samples”.

Site Type	Stream	River KM	Habitat Type	# Captured	# Identified	# of Pacific	# Eyed Pacific Lamprey	# of Western Brook	% Pacific	% Western Brook	# Pacific Lamprey Gen. Sampl.
Index	Klickitat	1.9	Type I	117	77	77	0	0	100%	0%	0
Index	Klickitat	26.5		268	70	65	0	5	93%	7%	0
Index	Klickitat	52.5		82	44	29	0	15	66%	34%	0
Index	Klickitat	69.4		57	25	16	0	9	64%	36%	9
Expl.	Klickitat	82.7		-	-	-	-	-	-	-	-
Index	Klickitat	1.9	Type II	-	-	-	-	-	-	-	-
Index	Klickitat	26.5		-	-	-	-	-	-	-	-
Index	Klickitat	52.5		-	-	-	-	-	-	-	-
Index	Klickitat	69.4		-	-	-	-	-	-	-	-
Expl.	Klickitat	82.7		168	13	0	-	13	0%	100%	0
Habitat Summary			Type I		216	187		29	87%	13%	9
			Type II		13	0		13	0%	100%	

Klickitat River Tributary Streams

One index site was surveyed in the Little Klickitat River (Map 2).

Little Klickitat River (tributary of Klickitat River; confluence at river km 33.0)



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

Little Klickitat River Survey Highlights

- No Type I habitat was present at river km 0.5 in the Little Klickitat River (Table 8).
- The sediment temperature was 0.4 degrees cooler under the sediment, compared to the plot temperature (Table 8).
- A total of six eyed Pacific Lamprey (macrophthalmia) were captured at this location (Table 11). Genetic samples were collected from all six macrophthalmia.

Habitat Overview

Table 8. Larval lamprey habitat details for lampreys greater than one year of age from index sites surveyed in the Klickitat River. Under “Fish Age Class”, “> 1 Year” signifies that the displayed values are for lampreys assumed greater than one year old (> 30 mm for lampreys collected after September 1, 2017, and > 25 mm for lampreys collected prior to September 1, 2017). The total area (m²) of Type I and Type II habitat within the surveyed 50 m stream reach is shown. Under “Type II Habitat Type”, “Pool” indicates the survey took place primarily within a pool. Plot temp was taken where the most lampreys were found. Sediment temp was taken where the most lampreys were found (a maximum of 10 cm under the sediment). “Sed. Temp Diff[erence].” was calculated by subtracting the plot temp from the sediment temp (a negative value indicates that the sediment temperature is cooler than the plot temperature). Thalweg temp was taken in the main channel flow.

Site Type	Stream	River KM	Date	50 m Type I Area (m2)	50 m Type II Area (m2)	50 m Type I/II Area (m2)	Fish Age Class	Primary Fine Sediment (Type I)	Primary Fine Sediment (Type II)	Type II Habitat Type	Plot Temp °C (Best)	Sed. Temp °C (Best)	Sed. Temp Diff. °C	Thalweg Temp °C
Index	Little Klickitat	0.5	9/26/2017	0	100	100	> 1 Year	-	Silt	Pool	13.4	13.0	-0.4	13.4

Survey Details and Estimated Density

Table 9. Lamprey capture details and estimated lamprey density for lampreys greater than one year of age in Type II habitat from index sites surveyed in the Klickitat River in September, 2017. Under “Fish Age Class”, “> 1 Year” signifies that the displayed values are for lampreys assumed greater than one year old (> 30 mm for lampreys collected after September 1, 2017, and > 25 mm for lampreys collected prior to September 1, 2017). The number of observed lampreys 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%). The adjusted number of observed lampreys is referred to as the “Sample Estimated Number [#]”. Survey densities (#/m²) were calculated using the sampled estimated number.

Site Type	Stream	River KM	Fish Age Class	Habitat Type Surveyed	Shock Time (sec)	Shock Area (m2)	# Captured	# Observed	Survey Visibility (1-5)	Sampled Estimated #	Estimated Density (L/m2)
Index	Little Klickitat	0.5	> 1 Year	Type II	0	5	48	57	4	107	21.3

Lamprey Measurement Details

Table 10. Measurement details of captured lampreys greater than one year old at index sites surveyed in the Klickitat River in Type II habitat in September, 2017. Under “Fish Age Class”, “> 1 Year” signifies that the displayed values are for lampreys assumed greater than one year old (> 30 mm for lampreys collected after September 1, 2017, and > 25 mm for lampreys collected prior to September 1, 2017). The “Mean Weight” was calculated by dividing the total weight of lampreys by the number of lampreys weighed. The “Min”, “Max” and “Mean” lengths are calculated from measured lampreys.

Site Type	Stream	River KM	Fish Age Class	Habitat Type Surveyed	# Weighed	Total Weight (g)	Mean Weight (g)	Min. Length (mm)	Max. Length (mm)	Mean Length (mm)
Index	Little Klickitat	0.5	> 1 Year	Type II	48	85.06	1.77	54	137	89.4

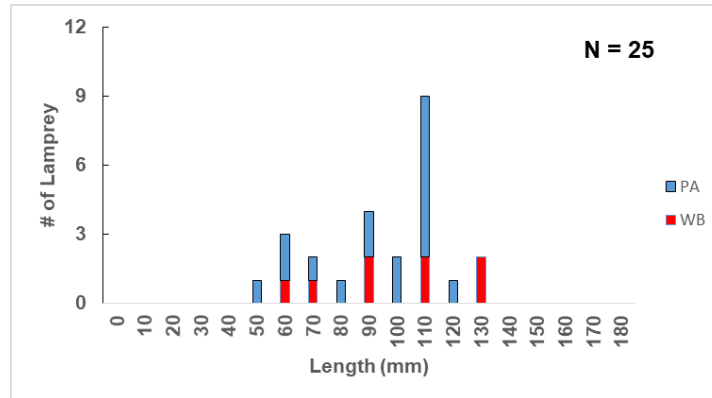


Figure 2. Histogram of all measured lampreys (excluding YOY lampreys) captured during electrofishing surveys, separated by species (“PA”= Pacific Lamprey (blue), “UN”=Unknown Lamprey <50 mm (green), “WB” Western Brook Lamprey (Red), in the Klickitat River in September, 2017.

Species Composition and Genetic Samples

Table 11. Species composition of captured lampreys from Klickitat River index sites surveyed in September, 2017. “Number (#) Captured” includes all captured lampreys (of all age classes). Under “Number (#) Pacific Lamprey Gen. Sampl.”, “Gen. Sampl.” stands for “Genetic Samples”.

Site Type	Stream	River KM	Habitat Type	# Captured	# Identified	# of Pacific	# Eyed Pacific Lamprey	# of Western Brook	% Pacific	% Western Brook	# Pacific Lamprey Gen. Sampl.
Index	Little Klickitat	0.5	Type II	48	46	38	6	8	83%	17%	6

APPENDIX: Additional Site Maps and Photos

Klickitat River



Map A1. Site map of Klickitat index site at river km 1.9 (surveyed in September, 2017); red balloon indicates presence of Pacific Lamprey.



Photo A1. Klickitat River index site at river km 1.9; overview of Type I habitat (left) and close-up of best Type I habitat sediment composed of sand/silt (right) from 2017 survey.



Map A2. Site map of Klickitat index site at river km 26.5 (surveyed in September, 2017); red balloon indicates presence of Pacific Lamprey.



Photo A2. Klickitat River index site at river km 26.5; overview of Type I habitat (left) and close-up of best Type I habitat sediment composed of sand/silt (right) from 2017 survey.



Map A3. Site map of Klickitat index site at river km 52.5 (surveyed in September, 2017); red balloon indicates presence of Pacific Lamprey.



Photo A3. Klickitat River index site at river km 52.5; overview of Type I habitat (left) and close-up of best Type I habitat sediment composed of sand/silt (right) from 2017 survey. The pencil in the left photo is pointing at the location (1 m²) with the highest density of larval lampreys.



Map A4. Site map of Klickitat index site at river km 69.4 (surveyed in September, 2017); red balloon indicates presence of Pacific Lamprey. The site is located immediately upstream of the Klickitat Fish Hatchery weir dam.

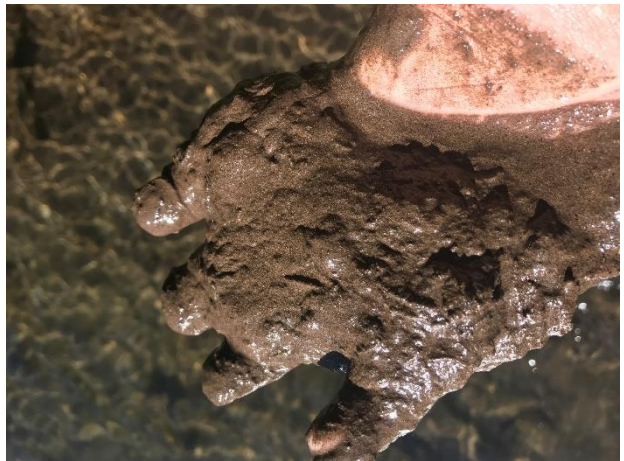


Photo A4. Klickitat River index site at river km 69.4; overview of the limited availability of Type I habitat (left) and close-up of best Type I habitat sediment composed of silt (right) from 2017 survey.



Map A5a. Site map of Klickitat index site at river km 82.7 (surveyed in September, 2017); yellow balloon indicates presence of larvae too small to identify (< 50 mm).



Map A5b. Site map of Klickitat index site at river km 99.8 (surveyed in September, 2017); white balloon indicates no lampreys were present.

Little Klickitat River



Map A6. Site map of Little Klickitat index site at river km 0.5 (surveyed in September, 2017); red balloon indicates presence of Pacific Lamprey.



Photo A6. Little Klickitat River index site at river km 0.5; overview of Type II habitat (left) and close-up of best Type II habitat sediment composed of silt/sand (right) from 2017 survey.