



Upper Yakima Larval Lamprey Monitoring Report, 2016



[Cover Photo: 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]

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ABSTRACT

Pacific Lamprey is an invaluable cultural and ecological species that is declining in abundance and distribution throughout their range, including the Yakima Basin. In an effort to monitor, manage and restore the species, the Yakama Nation Pacific Lamprey Program (YNPLP) has led electrofishing surveys for larval Pacific Lamprey throughout the Yakima Basin since 2009. This report highlights our 2016 electrofishing efforts in the Upper Yakima Subbasin (all watersheds upstream of the Naches River confluence, Yakima River river km 191.9).

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 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 Wenas 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 #/m²). 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 #/m²). 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 m²), despite the relatively low density of lampreys (7.1 #/m²). 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 #/m² 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 m², respectively). However, the larvae densities at these sites are low (0.3 #/m² 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 #/m², respectively) and much lower areas of Type I habitat (30 m² and 5 m², 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 #/m²). 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 m², 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.

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.

Site surveys were categorized as “Full”, “Short” or “Visit”. During a full survey, both Type I and Type II habitat were surveyed. At short surveys only Type I habitat (or Type II habitat, in the case of no Type I habitat available) was surveyed. At visited sites, no electrofishing occurred, and were primarily designed to further assess available lamprey habitat in different reaches of a river/stream. In general, a full survey was performed at each index site (to gain the most knowledge possible). A short survey (in general) was conducted at exploratory sites, designed to focus on the best habitat and get a quick assessment of lampreys at the site (habitat availability, density, and presence/absence).

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 were conducted separately over Type I and Type II habitat, and covered representative areas of each habitat type. At full survey sites, a minimum area of Type I and Type II habitat was surveyed (10 m² and 5 m², respectively). At short survey sites, a minimum area of 5 m² of either habitat type was surveyed. Sediment type (sand, silt or clay) was recorded for the specific area (1 m²) where the most lampreys were observed. The sediment depth (cm), water depth (cm), and plot temperature (°C) were also recorded at this location. If no fish were observed, plot temperature was taken where the best available habitat was observed. Thalweg temperature was also 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, was used to survey 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.

Captured lampreys were separated by habitat type, and tallied by life stage and identified to species (if of identifiable length > 50 mm). For each group of captured lampreys, 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 weights of all captured lampreys were also measured (nearest 0.01 g). Missed larvae were also counted and tallied.

Genetic samples were collected from Pacific Lamprey (> 50 mm) with scissors or 2 mm whole 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 (> 35mm) rather than whole samples. Samples were primarily collected in areas where adult Pacific Lamprey translocation efforts are ongoing, or where the distribution of Pacific Lamprey is uncertain.

Analysis

Captured and missed larvae were tallied together and added to the number captured, 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 “observed total” in the following report).

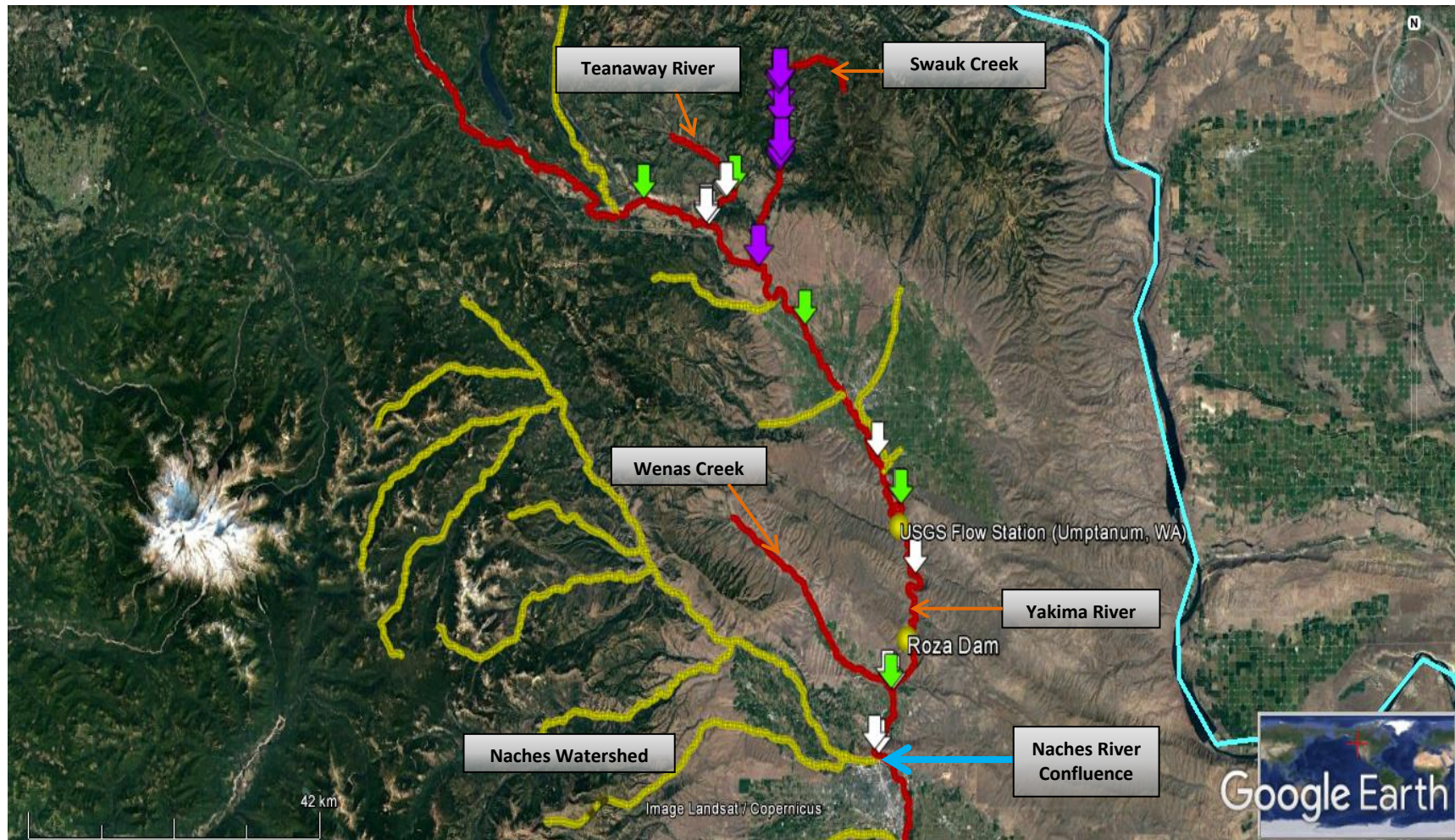
In many cases, survey visibility was less than ideal, and many lampreys went unseen. To account for unseen lamprey, the total number of lampreys observed (final observed total) was adjusted (increased) based on the following 1-5 visibility scale: (1) poor (60%), (2) fair (70%) , (3) good (80%), (4) very good (90%) and (5) excellent (100%). For each survey, the total number of observed lampreys was increased (by the percentage listed above) based on the survey's visibility rank. Survey densities ($\#/m^2$) were calculated using the adjusted observed number of lampreys.

To calculate the number of lampreys within each 50 m reach, survey densities were extrapolated over their respective habitat type (estimated area within the 50 m reach) to arrive at the total number of lampreys for each habitat type. The estimated number from both habitat types was then summed together for an estimated total number of lampreys by site. The number of Pacific Lamprey within a 50 m reach was calculated from the Pacific Lamprey ratio (from identified lampreys) multiplied by the total number of lampreys estimated to reside within the reach.

A condition factor for each site was calculated by averaging the condition factor for each of the fish measured by both length and weight. The average weight of the captured lamprey (total weight $g/\#$ weighed) was calculated for each site. In the event, that not all of the captured lampreys were weighed together, the average capture weight was multiplied by the total number of captured lampreys.

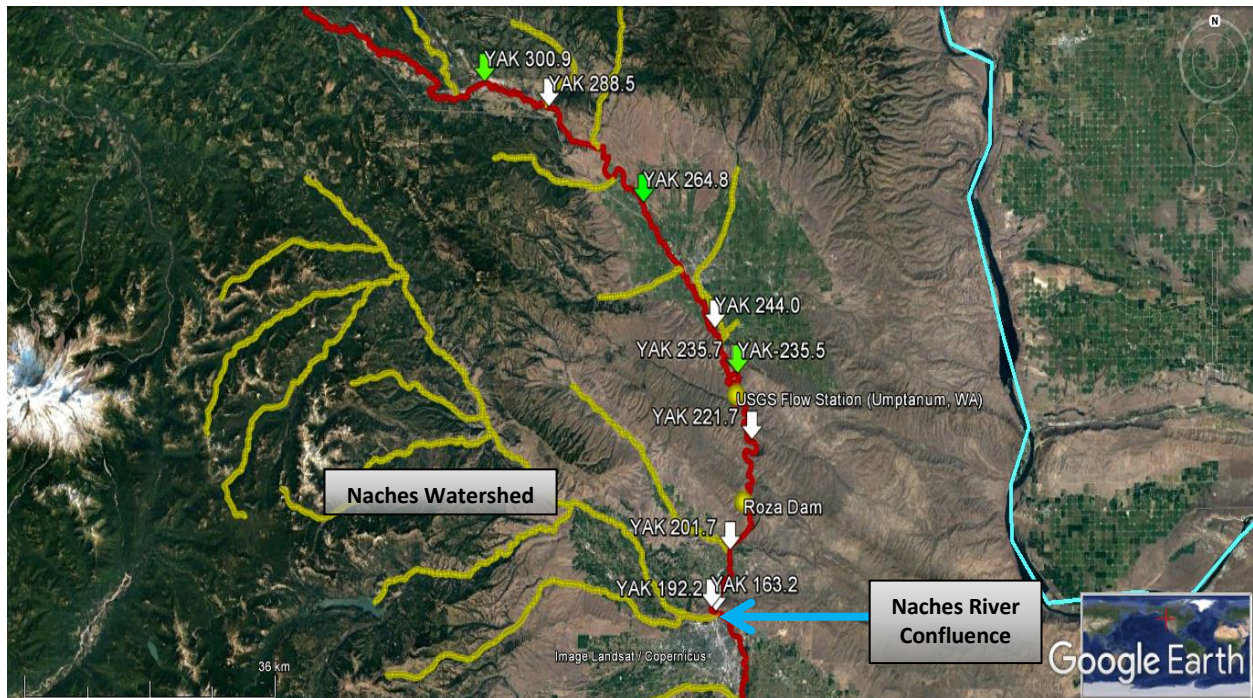
To arrive at an estimated biomass within a 50 m reach, the electrofishing density (by mass) was calculated separately for captured and missed lampreys. The biomass densities for captured and missed lampreys was summed together to get the total biomass density for the survey. The estimated final biomass density was then extrapolated over the respective habitat type. The estimated biomass for each habitat type was then summed together to arrive at a total site biomass (g).

RESULTS



Map 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. Surveys occurred between September and October, 2016. 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).

Upper Yakima River Mainstem



Map 2. Overview of all surveyed sites in the Upper Yakima River (red line) in September and October, 2016 displaying index sites (green arrows) and surveyed exploratory sites where electrofishing occurred (white arrows). The location of an USGS Flow Station (river km 230.6) and Roza Dam (river km 210.5) are shown (yellow circles).

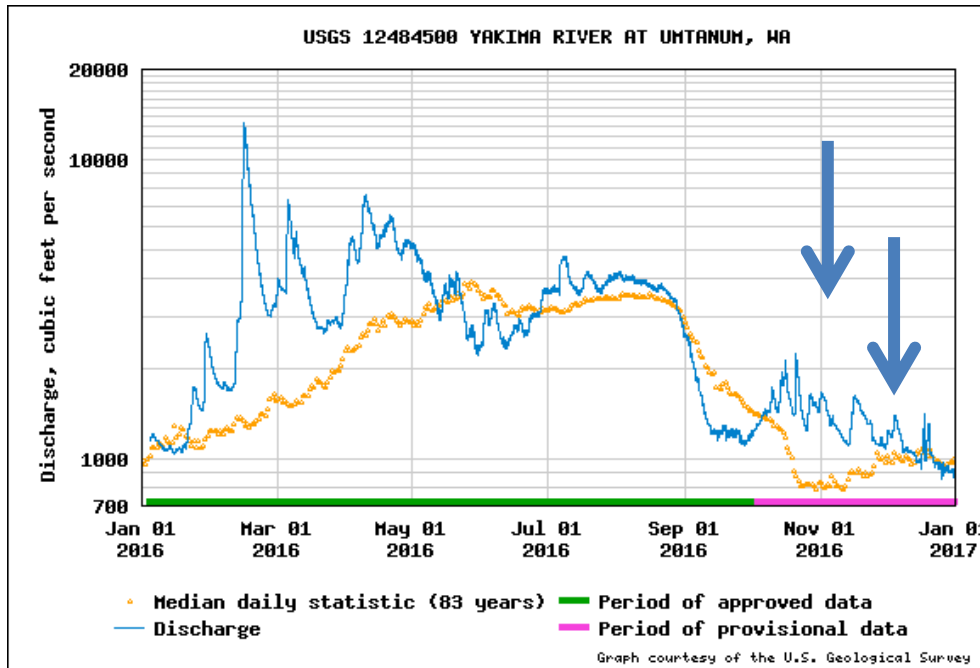


Figure 1. Discharge (cubic feet per second indicated by the narrow blue line) of the Yakima River near Umptanum, WA (river km 230.6) in 2016; blue arrow indicates YN survey period (September/October, 2016).

Index Sites – Upper Yakima River Mainstem

- A total of three index sites were surveyed in the Upper Yakima mainstem (all upstream of Roza Dam, river km 201.5).
- Lamprey densities were highest at river km 300.9 (24.2 #/m²). Highest biomass (g) for Type I habitat was at river km 264.8 (2,075 g), despite a relatively low density of lampreys (7.1 #/m²), but large area of Type I habitat (420 m²).

Table 1. Larval lamprey habitat details from index sites surveyed in the Yakima River. Under “Survey Type”, a “Full” survey indicates that both Type I and Type II habitat were electrofished (when available). The percent of larval habitat shown is the ratio between available Type I and Type II habitat, and excludes Type III (unusable) habitat within the 50 m survey reach. Under “Type I Habitat Type”, “Edge” indicates that the primary survey location (for Type I habitat) was on the edge of the main channel; “Side Chan.” indicates this occurred in a side channel. Plot temp was taken where the most lampreys were found, and thalweg temp was taken in the main channel flow.

Site Type	Stream	River KM	Date	Survey Type	% Type I in 50 m	% Type II in 50 m	Type I Habitat Type	Primary Fine Sediment (Type I)	Primary Fine Sediment (Type II)	Plot Temp °C (Best)	Thalweg Temp °C
Index	Yakima	235.5	9/15/16	Full	53%	47%	Edge	Silt	-	15.4	15.4
Index	Yakima	264.8	9/14/16	Full	55%	45%	Edge	Sand	Sand	18.2	18.0
Index	Yakima	300.9	9/14/16	Full	40%	60%	Side Chan.	Sand	Sand	13.0	12.0

Table 2. Survey details, separated by habitat type, for Upper Yakima River index sites surveyed in September, 2016. The total number of lampreys observed was adjusted (increased) based on the following 1-5 visibility scale (with estimated % visibility in parenthesis): (1) poor (60%), (2) fair (70%), (3) good (80%), (4) very good (90%) and (5) excellent (100%). Survey densities (#/m²) were calculated using the adjusted observed number of lampreys. The summary rows are a sum of presented values, except for e-fish density which is a mean of presented values.

Site Type	Stream	River KM	Habitat Type Surveyed	Shock Time (sec)	Shock Area (m2)	# Captured	# Observed	Survey Visibility (1-5)	Total # Observed (Adjusted)	E-Fish Density (#/m ²)
Index	Yakima	235.5	Type I	738	13	32	64	2	91	7.0
Index	Yakima	264.8	Type I	1315	25	79	158	3	198	7.9
Index	Yakima	300.9	Type I	595	10	121	242	5	242	24.2
Index	Yakima	235.5	Type II	256	5	6	12	2	12	2.4
Index	Yakima	264.8	Type II	715	7	7	14	3	18	2.5
Index	Yakima	300.9	Type II	640	11	4	8	4	8	0.7
Site Summary		235.5		994	18	38	76		103	4.7
		264.8	-	2030	32	86	172	-	215	5.2
		300.9		1235	21	125	250		250	12.5
Habitat Summary			Type I	2648	48	232	464	-	531	13.0
			Type II	1611	23	17	34		38	1.9

Table 3. Measurement details of captured lampreys, separated by habitat type, for Upper Yakima River index sites surveyed in September, 2016 (sites without lamprey are excluded). The summary rows are a sum of presented values, except for mean weight, mean length and mean condition factor, which are a mean of presented values, and min and max length, which are the lowest and highest value, respectively.

Site Type	Stream	River KM	Habitat Type Surveyed	# Weighed	Total Weight of Captured (g)	Mean Weight of Captured (g)	Min. Length (mm)	Max. Length (mm)	Mean Length (mm)	Mean Condition Factor
Index	Yakima	235.5	Type I	32	36.8	1.15	29	153	76	1.043
Index	Yakima	264.8	Type I	25	75.2	0.95	40	170	114	0.952
Index	Yakima	300.9	Type I	121	157.6	1.30	19	165	89	1.092
Index	Yakima	235.5	Type II	6	32.0	5.34	72	170	137	1.268
Index	Yakima	264.8	Type II	7	22.1	3.15	54	163	117	1.045
Index	Yakima	300.9	Type II	4	7.7	1.92	37	128	91	1.120
Site Summary		235.5		38	68.8	3.24	29	170	106	1.156
		264.8	-	32	97.3	2.05	40	170	116	0.998
		300.9		125	165.3	1.61	19	165	90	1.106
Habitat Summary			Type I	178	269.6	1.14	19	170	93	1.029
			Type II	17	61.8	3.47	37	170	115	1.144

Table 4. Lamprey identification details, separated by habitat type, for Yakima River index sites surveyed in September and October, 2016. The summary rows are a sum of presented values except for % values, which are a weighted average.

Site Type	Stream	River KM	Habitat Type	# Identified	# of Pacific	# of Western Brook	% Pacific	% Western Brook	% of Cap. Identified	
Index	Yakima	235.5	Type I	11	0	11	0%	100%	34%	
Index	Yakima	264.8	Type I	56	12	44	21%	79%	71%	
Index	Yakima	300.9	Type I	75	3	72	4%	96%	62%	
Index	Yakima	235.5	Type II	6	0	6	0%	100%	-	
Index	Yakima	264.8	Type II	7	0	7	0%	100%	100%	
Index	Yakima	300.9	Type II	3	0	3	0%	100%	75%	
Site Summary		235.5		17	0	17	0%	100%	45%	
		264.8	-	63	12	51	19%	81%	73%	
		300.9		78	3	75	4%	96%	62%	
Habitat Summary			-	Type I	142	15	127	11%	89%	61%
				Type II	16	0	16	0%	100%	94%

Table 5. Lamprey population and biomass estimates within a 50 m reach, separated by habitat type, for Yakima River index sites surveyed in September, 2016. “Estimated # of Pacific Lamprey” is calculated based on the identified ratio of Pacific Lamprey (to Western Brook Lamprey) generally > 50 mm in length. Summary rows are a sum of presented values, except for e-fish density and mean weight of captured, which are a mean of presented values.

Site Type	Stream	River KM	Habitat Type	50 m Habitat Area (m ²)	E-Fish Density (#/m ²)	Estimated # in 50 m	Estimated # of Pacific Lamprey in 50 m	Mean Weight of Cap. (g)	Estimated Mass Density (g/m ²)	Estimated Mass (g) in 50 m	
Index	Yakima	235.5	Type I	200	7.0	1407	0	1.15	5.09	1017	
Index	Yakima	264.8	Type I	420	7.9	3318	711	0.95	4.94	2075	
Index	Yakima	300.9	Type I	27	24.2	653	26	1.30	22.52	608	
Index	Yakima	235.5	Type II	175	2.4	420	0	5.34	9.15	1601	
Index	Yakima	264.8	Type II	340	2.5	425	0	3.15	5.18	1762	
Index	Yakima	300.9	Type II	40	0.7	29	0	1.92	1.00	40	
Site Summary		235.5		375	4.7	1827	0	3.24	7.12	2618	
		264.8	-	760	5.2	3743	711	2.05	5.06	3837	
		300.9		67	12.5	682	26	1.61	11.76	648	
Habitat Summary			-	Type I	647	13.0	5378	737	1.14	10.85	3700
				Type II	555	1.9	874	0	3.47	5.11	3403

Additional Index Site Observations:

- **River km 235.5** – This site is located in the Yakima River Canyon (easily accessed from Canyon Road). A large rock outcrop/rock pile creates a large backwater area during high water where the sediment deposits. We visited the site during when the river was at low flow ~ 1 week after the “Flip-Flop”. Approximately 85 m² of Type I habitat was dewatered (~ 30% of the Type I habitat at this site within a 50 m reach).

- **River km 264.8** – This site is located 0.1 km upstream of Town Diversion. During high flow, this is a large back-water area with abundant Type I habitat, located at the mouth of a small stream or side channel. This site was visited during low flow (after the “Flip-Flop”). Approximately 1000 m² (or more) of Type I habitat was dry. Young of the year larvae were found in drying pools throughout the dewatered habitat (isolated pool densities and salvage are not included in the presented tables).
- **River km 300.9** – This site is located upstream of the S. Cle Elum Way Bridge in Cle Elum, WA in a small side channel (~ 15 m wide and ~100 m long). Type I habitat is located in a narrow strip on the left bank of the side channel. In the mainstem, dredging was occurring downstream of survey site at water district intake (mostly Type III habitat).

Exploratory – Upper Yakima River Mainstem

- 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%).
- 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 #/m²).

Table 6. Larval lamprey habitat details from the exploratory site surveyed in the Yakima River in September and October, 2016. Under “Survey Type”, a “Short” survey indicates that either Type I or Type II habitat was electrofished. The percent of larval habitat shown is the ratio between available Type I and Type II habitat, and excludes Type III (unusable) habitat within the 50 m survey reach. Under “Type I Habitat Type”, “Edge” indicates that the primary survey location (for Type I habitat) was on the edge of the main channel; “Side Chan.” indicates this occurred in a side channel. Plot temp was taken where the most lampreys were found, and thalwag temp was taken in the main channel flow. * Data for river km 201.7 is missing, and limited only to brief field notes.

Site Type	Stream	River KM	Date	Survey Type	% Type I in 50 m	% Type II in 50 m	Type I Habitat Type	Primary Fine Sediment (Type I)	Primary Fine Sediment (Type II)	Plot Temp (Best) °C	Thalwag Temp °C
Expl.	Yakima	192.2	9/16/16	Short	35%	65%	Edge	Sand	-	18.2	-
Expl.	Yakima	193.2	9/16/16	Short	11%	89%	Edge	Silt	-	16.1	-
Expl.	Yakima	201.7*	10/14/16	Short	-	-	-	-	-	-	-
Expl.	Yakima	221.7	9/15/16	Short	33%	67%	Edge	Sand	-	15.4	-
Expl.	Yakima	235.7	9/15/16	Short	75%	25%	Edge	Silt	-	18.6	-
Expl.	Yakima	244.0	9/15/16	Short	60%	40%	Side Chan.	Sand	-	20.0	20.0
Expl.	Yakima	288.5	9/14/16	Short	40%	60%	Side Chan.	Sand	-	15.7	15.3

Table 7. Survey details, separated by habitat type, for the Yakima River exploratory sites surveyed in in September and October, 2016. The total number of lampreys observed was adjusted (increased) based on the following 1-5 visibility scale (with estimated % visibility in parenthesis): (1) poor (60%), (2) fair (70%), (3) good (80%), (4) very good (90%) and (5) excellent (90%). Survey densities (#/m²) were calculated using the adjusted observed number of lampreys. The summary rows are a sum of presented values, except for e-fish density which is a mean of presented values.

Site Type	Stream	River KM	Habitat Type Surveyed	Shock Time (sec)	Shock Area (m2)	# Captured	# Observed	Survey Visibility (1-5)	Total # Observed (Adjusted)	E-Fish Density (#/m2)
Expl.	Yakima	192.2	Type I	426	10	3	18	3	23	2.3
Expl.	Yakima	193.2	Type I	358	8	9	19	1	32	4.0
Expl.	Yakima	221.7	Type I	130	2	6	12	5	12	6.0
Expl.	Yakima	235.7	Type I	303	6	27	54	3	68	11.3
Expl.	Yakima	244.0	Type I	390	7	104	208	3	260	37.1
Expl.	Yakima	288.5	Type I	190	4.5	45	217	5	217	48.2
Expl.	Yakima	192.2	Type II	0	-	-	-	-	-	-
Expl.	Yakima	193.2	Type II	0	-	-	-	-	-	-
Expl.	Yakima	221.7	Type II	0	-	-	-	-	-	-
Expl.	Yakima	235.7	Type II	0	-	-	-	-	-	-
Expl.	Yakima	244.0	Type II	0	-	-	-	-	-	-
Expl.	Yakima	288.5	Type II	0	-	-	-	-	-	-
Site Summary		192.2		426	10	3	18		23	2.3
		193.2		358	8	9	19		32	4.0
		221.7	-	130	2	6	12	-	12	6.0
		235.7		303	6	27	54		68	11.3
		244.0		390	7	104	208		260	37.1
		288.5		190	5	45	217		217	48.2
Habitat Summary		-	Type I	1797	38	194	528	-	611	18.1
			Type II	-	-	-	-	-	-	-

Table 8. Measurement details of captured lampreys, separated by habitat type, for the Yakima River exploratory site surveyed in September and October, 2016 (sites without lamprey are excluded). The summary rows are a sum of presented values, except for mean weight, mean length and mean condition factor, which are a mean of presented values, and min and max length, which are the lowest and highest value, respectively.

Site Type	Stream	River KM	Habitat Type Surveyed	# Weighed	Total Weight of Captured (g)	Mean Weight of Captured (g)	Min. Length (mm)	Max. Length (mm)	Mean Length (mm)	Mean Condition Factor
Expl.	Yakima	192.2	Type I	0	-	-	-	-	-	-
Expl.	Yakima	193.2	Type I	0	-	-	-	-	-	-
Expl.	Yakima	221.7	Type I	0	-	-	28	76	46	-
Expl.	Yakima	235.7	Type I	0	-	-	26	76	38	-
Expl.	Yakima	244	Type I	0	-	-	21	34	27	-
Expl.	Yakima	288.5	Type I	0	-	-	-	-	-	-
Expl.	Yakima	192.2	Type II	-	-	-	-	-	-	-
Expl.	Yakima	193.2	Type II	-	-	-	-	-	-	-
Expl.	Yakima	221.7	Type II	-	-	-	-	-	-	-
Expl.	Yakima	235.7	Type II	-	-	-	-	-	-	-
Expl.	Yakima	244	Type II	-	-	-	-	-	-	-
Expl.	Yakima	288.5	Type II	-	-	-	-	-	-	-
Site Summary		192.2					-	-	-	
		193.2					-	-	-	
		221.7			-		28	76	46	
		235.7					26	76	38	
		244					21	34	27	
Habitat Summary		288.5					-	-	-	
		192.2	Type I				21	76	37	
	193.2	Type II					-	-	-	

Table 10. Lamprey population and biomass estimates within a 50 m reach, separated by habitat type, for the Yakima River exploratory site surveyed in September and October, 2016. “Estimated # of Pacific Lamprey” is calculated based on the identified ratio of Pacific Lamprey (to Western Brook Lamprey) generally > 50 mm in length. Summary rows are a sum of presented values, except for e-fish density and mean weight of captured, which are a mean of presented values.

Site Type	Stream	River KM	Habitat Type	50 m		Estimated # in 50 m	Estimated # of Pacific Lamprey in 50 m	Mean Weight of Cap. (g)	Estimated Mass Density (g/m ²)	Estimated Mass (g) in 50 m
				Habitat Area (m ²)	E-Fish Density (#/m ²)					
Expl.	Yakima	192.2	Type I	160	2.3	360	0	-	-	-
Expl.	Yakima	193.2	Type I	30	4.0	119	0	-	-	-
Expl.	Yakima	221.7	Type I	4	6.0	24	0	-	-	-
Expl.	Yakima	235.7	Type I	300	11.3	3375	0	-	-	-
Expl.	Yakima	244	Type I	180	37.1	6686	0	-	-	-
Expl.	Yakima	288.5	Type I	10	48.2	482	76	-	-	-
Expl.	Yakima	192.2	Type II	300	-	-	-	-	-	-
Expl.	Yakima	193.2	Type II	240	-	-	-	-	-	-
Expl.	Yakima	221.7	Type II	8	-	-	-	-	-	-
Expl.	Yakima	235.7	Type II	100	-	-	-	-	-	-
Expl.	Yakima	244	Type II	120	-	-	-	-	-	-
Expl.	Yakima	288.5	Type II	15	-	-	-	-	-	-
Site Summary		192.2		460	2.3	360.0	0			
		193.2		270	4.0	118.8	0			
		221.7	-	12	6.0	24.0	0			
		235.7	-	400	11.3	3375.0	0			
		244	-	300	37.1	6685.7	0			
		288.5		25	48.2	482	76			
Habitat Summary		-	Type I	684	109	11046	76			
		-	Type II	783	-	-	-			

Additional Exploratory Site Observations:

- **River km 192.2** – This site is located under the Northbound I-82 Bridge in Yakima, WA. This is heavily impacted by people (popular river access point). Type I habitat is focused on the left bank, though might be more prevalent in the deeper water (hard to see). The goal of this site was to explore the distribution of Pacific Lamprey upstream of the Naches River confluence (in the reach downstream of Roza Dam).
- **River km 193.2** – This site is located downstream of the Highway 97 Bridge in Selah, WA. Type I habitat is limited to a small back water area. The majority of this reach is Type II/Type III habitat. There are several dried side channels also near this site. The goal of this site was to explore the distribution of Pacific Lamprey upstream of Roza Dam (in the reach downstream of Roza Dam).
- **River km 201.7** – This site is located at a private residence north of Selah, WA (just upstream of the confluence of Wenas Creek). The channel is split by an island at this site. Our survey focused on the left bank channel. In this channel, Type I habitat is patchy and limited to the channel margins. The deep water made survey difficult. The data for this site is missing

- **River km 221.7** – This site is located at the Lmuma Creek public access site in the Yakima River Canyon. Type I habitat is limited only to a small public access spot on the left bank of the river. This site is heavily impacted by people. The mainstem at this location is mostly Type III habitat.
- **River km 235.7** – This site is located in the Yakima River Canyon (easily accessed from Canyon Road). Type I habitat collects downstream of a large rock outcrop (similar to the site at river k 235.5). This site was visited during low flows after the “Flip-Flop”. Approximately 50% of the available Type I habitat was dewatered (~300 m² dewatered).
- **River km 244.0** – This site is located near Ellensburg, WA off of Ringer Loop Road. The site is within a side channel, where restoration work took place in 1996. This visit was shortly after the “Flip-Flop” and several isolated pools (packed with young of the year larvae) were present at this site (isolated pool densities and salvage are not included in the presented tables).
- **River km 288.5** – This site is located downstream of the confluence of the Teanaway River in a small side channel (~10 m wide and ~150 m long). The Type I habitat (and survey area) was near the mouth of the side channel where it connects back to the main channel.

Genetic Samples – Upper Yakima River Mainstem.

Table 11. Lamprey genetic samples collected from the Upper Yakima River in September and October, 2016.

Stream Name	River KM	Collection Date	# of Pacific Samples (Larvae)	# of Pacific Samples (Macro.)	# of Western Brook Samples	# Unknown Species Samples (< 50 mm)	Primary Collection Purpose
Yakima	201.7	10/14/16	0	0	0	3	Species ID
Yakima	235.5	9/15/16	0	0	0	9	Translocaiton Success
Yakima	235.7	9/15/16	0	0	0	6	Translocaiton Success
Yakima	244.0	9/15/16	0	0	0	10	Translocaiton Success
Yakima	264.8	9/14/16	13	0	0	2	Translocaiton Success
Yakima	288.5	9/14/16	3	0	0	10	Translocaiton Success
Total			16	0	0	37	

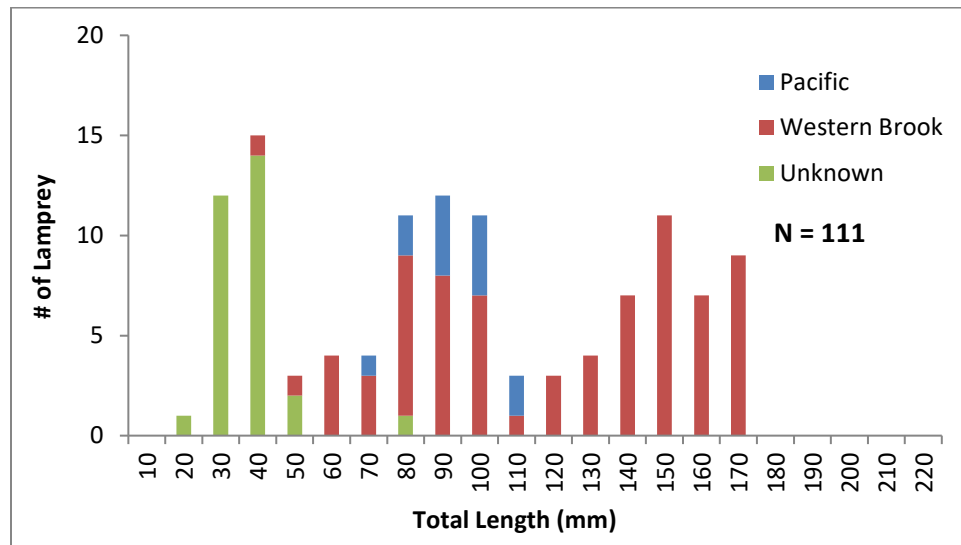
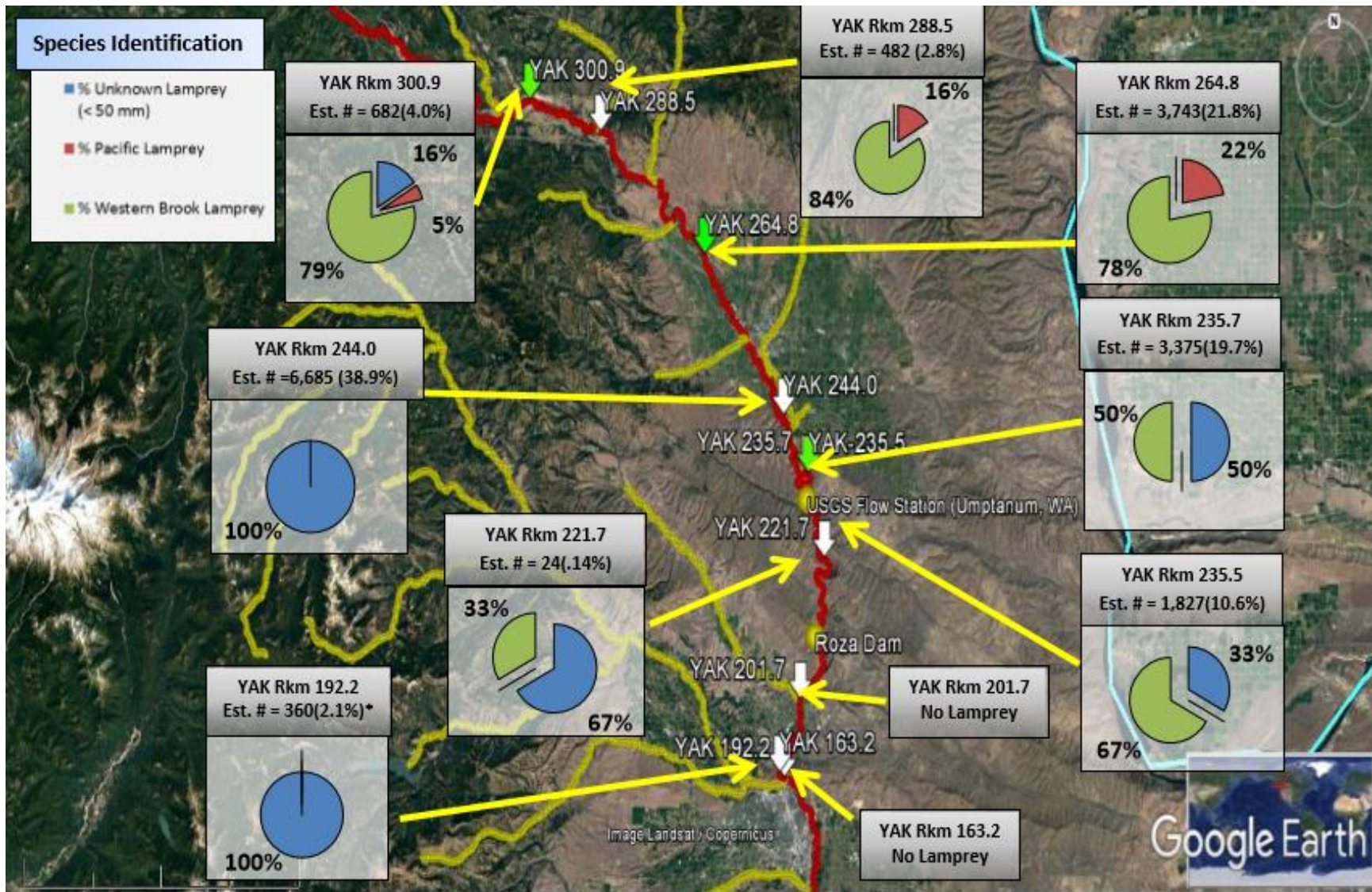


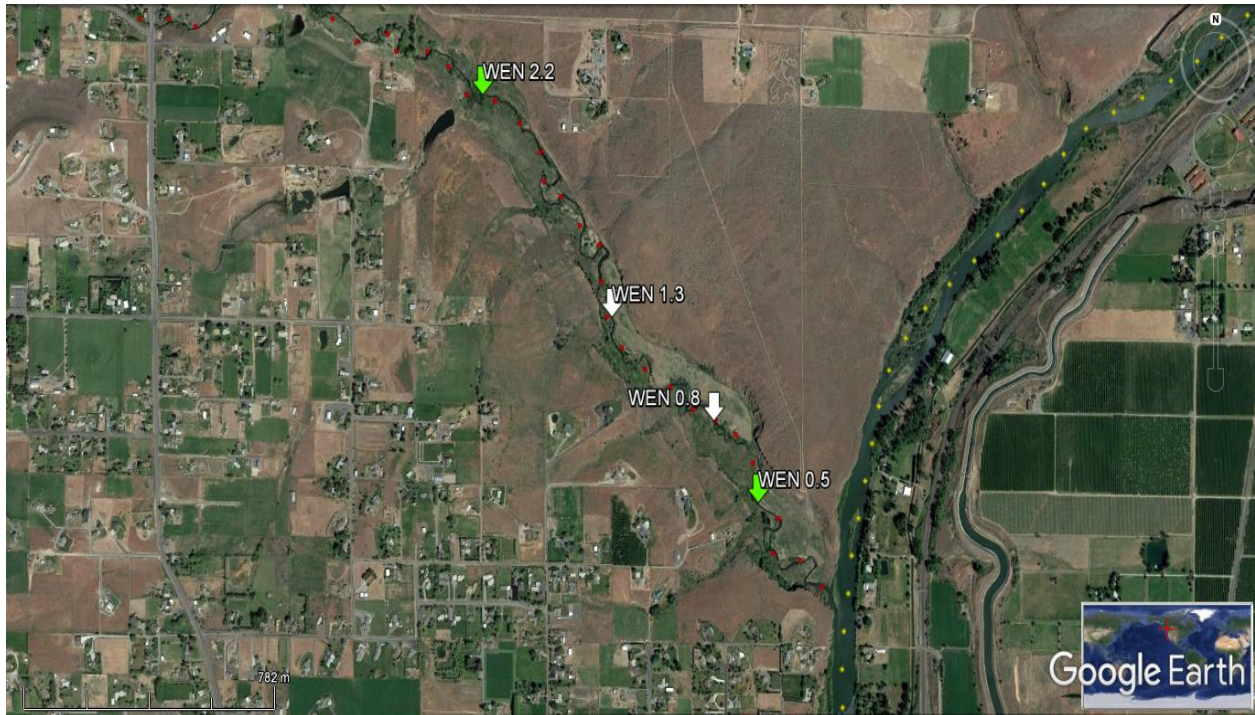
Figure 2. Histogram of all measured lampreys captured during electrofishing surveys, separated by species (“PA”= Pacific Lamprey (blue), “UN”=Unknown Lamprey <50 mm (green), “WB” Western Brook Lamprey (Red), in the Upper Yakima River in August, 2016.



Map 3. Displayed is the distribution of Unknown Lamprey <50 mm (blue), Pacific Lamprey (red) and Western Brook Lamprey (green) in Upper Yakima River from September and October, 2016 electrofishing surveys. Species ratio of lampreys is based on captured and measured data only. Also shown is the estimated number of lampreys at each surveyed site (within a 50 m reach). Index sites are labeled by green arrows, exploratory sites labeled by white arrows, and sites where no electrofishing surveys labeled by purple arrows. * Species ratio calculated from counted and identified fish (no lengths taken).

Upper Yakima River Tributaries

Wenas Creek Watershed



Map 4. Overview of all surveyed sites in Wenas Creek (red dotted line) in September-October, 2016 displaying index sites (green arrows) and surveyed exploratory sites where electrofishing occurred (white arrows).

Index Sites – Wenas Creek

- No Pacific Lamprey were present at index sites in Wenas Creek.
- River km 2.2 is upstream of a beaver dam, and has a large area of Type I habitat (400 m²), but relatively low density (0.3 #/m²).

Table 12. Larval lamprey habitat details from index sites surveyed in Wenas Creek. Under “Survey Type”, a “Short” survey indicates that either Type I or Type II habitat was electrofished. The percent of larval habitat shown is the ratio between available Type I and Type II habitat, and excludes Type III (unusable) habitat within the 25 m survey reach. Under “Type I Habitat Type”, “Edge” indicates that the primary survey location (for Type I habitat) was on the edge of the main channel. Plot temp was taken where the most lampreys were found, and thalweg temp was taken in the main channel flow.

Site Type	Stream	River KM	Date	Survey Type	% Type I in 50 m	% Type II in 50 m	Type I Habitat Type	Primary Fine Sediment (Type I)	Primary Fine Sediment (Type II)	Plot Temp °C (Best)	Thalweg Temp °C
Index	Wenas	0.5	8/17/16	Short	30%	70%	Edge	Sand	-	21.0	21.0
Index	Wenas	2.2	8/17/16	Short	80%	20%	Edge	Silt	-	24.2	-

Table 15. Lamprey identification details, separated by habitat type, for Wenas Creek index sites surveyed in August, 2016. The summary rows are a sum of presented values except for % values, which are a weighted average.

Site Type	Stream	River KM	Habitat Type	# Identified	# of Pacific	# of Western Brook	% Pacific	% Western Brook	% of Cap. Identified
Index	Wenas	0.5	Type I	14	0	14	0%	100%	100%
Index	Wenas	2.2	Type I	1	0	1	0%	100%	100%
Index	Wenas	0.5	Type II	-	-	-	-	-	-
Index	Wenas	2.2	Type II	-	-	-	-	-	-
Site Summary		0.5	-	14	0	14	0%	100%	100%
		2.2	-	1	0	1	0%	100%	100%
Habitat Summary			Type I	15	0	15	0%	100%	100%
			Type II	-	-	-	-	-	-

Table 16. Lamprey population and biomass estimates within a 25 m reach, separated by habitat type, for Satus Creek index sites surveyed in July and September, 2016. “Estimated # of Pacific Lamprey” is calculated based on the identified ratio of Pacific Lamprey (to Western Brook Lamprey) generally > 50 mm in length. Summary rows are a sum of presented values, except for e-fish density and mean weight of captured, which are a mean of presented values.

Site Type	Stream	River KM	Habitat Type	50 m Habitat Area (m2)	E-Fish Density (#/m2)	Estimated # in 25 m	Estimated # of Pacific Lamprey in 50 m	Mean Weight of Cap. (g)	Estimated Mass Density (g/m2)	Estimated Mass (g) in 50 m
Index	Wenas	0.5	Type I	60	8.5	509	0	-	-	-
Index	Wenas	2.2	Type I	400	0.3	100	0	-	-	-
Index	Wenas	0.5	Type II	140	-	-	-	-	-	-
Index	Wenas	2.2	Type II	100	-	-	-	-	-	-
Site Summary		0.5	-	200	8.5	509	0			
		2.2	-	500	0.3	100	0			
Habitat Summary			Type I	460	4.4	609	0			
			Type II	240	-	-	-			

Additional Index Site Observations:

- **River km 0.5** – At this site, (~3-4 m stream width), there is abundant aquatic vegetation (potentially limiting visibility of smaller larvae). Type I habitat was present along the channel margins. It looked like a beaver is starting to build a dam in this site.
- **River km 2.2** – This site is immediately upstream of a large beaver dam. The dam collects a large area of Type I habitat. The sediment is very black with sand and silt (rich with organic debris? Anoxic?). The site is has deep water, but the survey was conducted along the upstream side of the beaver dam.

Exploratory Sites – Wenas Creek

- No Pacific Lamprey were present at exploratory sites) in Weans Creek.
- 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 #/m² at river km 193.2.
- River km 0.8 is upstream of a beaver dam, and has a large area of Type I habitat (400 m²), but relatively low density (0.3 #/m²).
- River km 1.3 had the highest density (14.2 #/m²), however, there was also a relatively small area of Type I habitat (5 m²).

Table 17. Larval lamprey habitat details from exploratory sites surveyed in Wenas Creek. Under “Survey Type”, a “Full” survey indicates that both Type I and Type II habitat were electrofished (when available); “Short” survey indicates that only Type I or Type II habitat was electrofished. The percent of larval habitat shown is the ratio between available Type I and Type II habitat, and excludes Type III (unusable) habitat within the 50 m survey reach. Under “Type I Habitat Type”, “Edge” indicates that the primary survey location (for Type I habitat) was on the edge of the main channel; “Main” indicates that this occurred in the main channel. Plot temp was taken where the most lampreys were found, and thalweg temp was taken in the main channel flow.

Site Type	River Stream	River KM	Date	Survey Type	%	%	Type I Habitat Type	Primary	Primary	Plot Temp °C	Thal- weg Temp °C
					Type I	Type II		Fine	Fine		
					in 25	in 25	Sediment				
					m	m	(Type I)	(Type II)	(Best)		
Expl.	Wenas	0.1	8/17/16	Short	7%	93%	Edge	Sand	-	22.5	22.5
Expl.	Wenas	0.8	8/17/16	Short	93%	7%	Edge	Sand	-	22.0	22.0
Expl.	Wenas	1.3	8/17/16	Full	10%	90%	Main	Silt	Sand	24.2	24.2

Table 20. Lamprey identification details, separated by habitat type, for Wenas Creek exploratory sites where lampreys were present surveyed in August, 2016. The summary rows are a sum of presented values.

Site Type	Stream	River KM	Habitat Type	# Identified	# of Pacific	# of Western Brook	% Pacific	% Western Brook	% of Cap. Identified
Expl.	Wenas	0.1	Type I	0	-	-	-	-	-
Expl.	Wenas	0.8	Type I	2	0	2	0%	100%	100%
Expl.	Wenas	1.3	Type I	0	-	-	-	-	-
Expl.	Wenas	0.1	Type II	-	-	-	-	-	-
Expl.	Wenas	0.8	Type II	-	-	-	-	-	-
Expl.	Wenas	1.3	Type II	-	-	-	-	-	-
Site Summary		0.1		0	-	-	-	-	-
		0.8	-	2	0	2	0%	100%	100%
		1.3		0	-	-	-	-	-
Habitat Summary			Type I	2	0	2	0%	100%	15%
			Type II	-	-	-	-	-	-

Table 21. Lamprey population and biomass estimates within a 50 m reach, separated by habitat type, for Wenas Creek exploratory sites (where lampreys were present) surveyed in August, 2016. “Estimated # of Pacific Lamprey” is calculated based on the identified ratio of Pacific Lamprey (to Western Brook Lamprey) generally > 50 mm in length. Summary rows are a sum of presented values, except for e-fish density and mean weight of captured, which are a mean of presented values.

Site Type	Stream	River KM	Habitat Type	25 m Habitat Area (m ²)	E-Fish Density (#/m ²)	Estimated # in 25 m	Estimated # of Pacific Lamprey in 50 m	Mean Weight of Cap. (g)	Estimated Mass Density (g/m ²)	Estimated Mass (g) in 50 m
Expl.	Wenas	0.1	Type I	4	-	-	-	-	-	-
Expl.	Wenas	0.8	Type I	135	0.3	45	0	-	-	-
Expl.	Wenas	1.3	Type I	5	14.7	73	0	-	-	-
Expl.	Wenas	0.1	Type II	56	-	-	-	-	-	-
Expl.	Wenas	0.8	Type II	10	-	-	-	-	-	-
Expl.	Wenas	1.3	Type II	45	6.7	300	0	-	-	-
Site Summary		0.1		60	-	-	0			
		0.8	-	145	0.3	45	0			
		1.3		50	10.7	373	0			
Habitat Summary			Type I	144	7.5	118	0			
			Type II	111	6.7	300	0			

Additional Exploratory Site Observations:

- **River km 0.1** –This site is the mouth of Wenas Creek (confluence with the Yakima River) – near Selah, WA. Type I habitat appears to be abundant, but the water is was too turbid for a survey.
- **River km 0.8** – This site has abundant aquatic vegetation and some Type I habitat in a small backwater area where a riffle joins with a pool. Wenas Creek is only ~ 2-4 m wide at this site. Type II dominates this reach

- **River km 1.3** – The stream at this site is a mix of runs and riffles, and only ~ 2 m wide. The narrow stream reach collects fine sediments along the left bank, and under patchy aquatic vegetation sporadically distributed throughout the reach. This was the only site where young of the year larvae (<36 mm) were found.

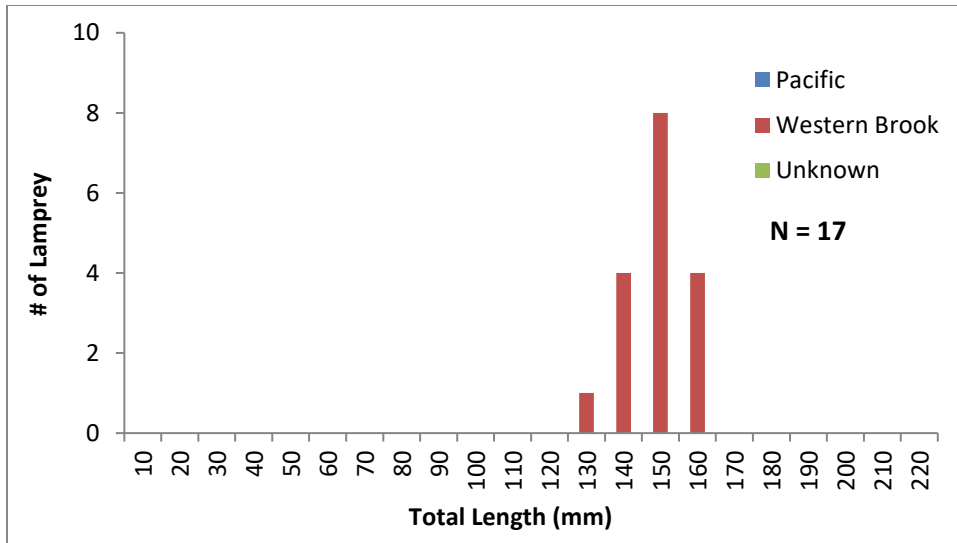
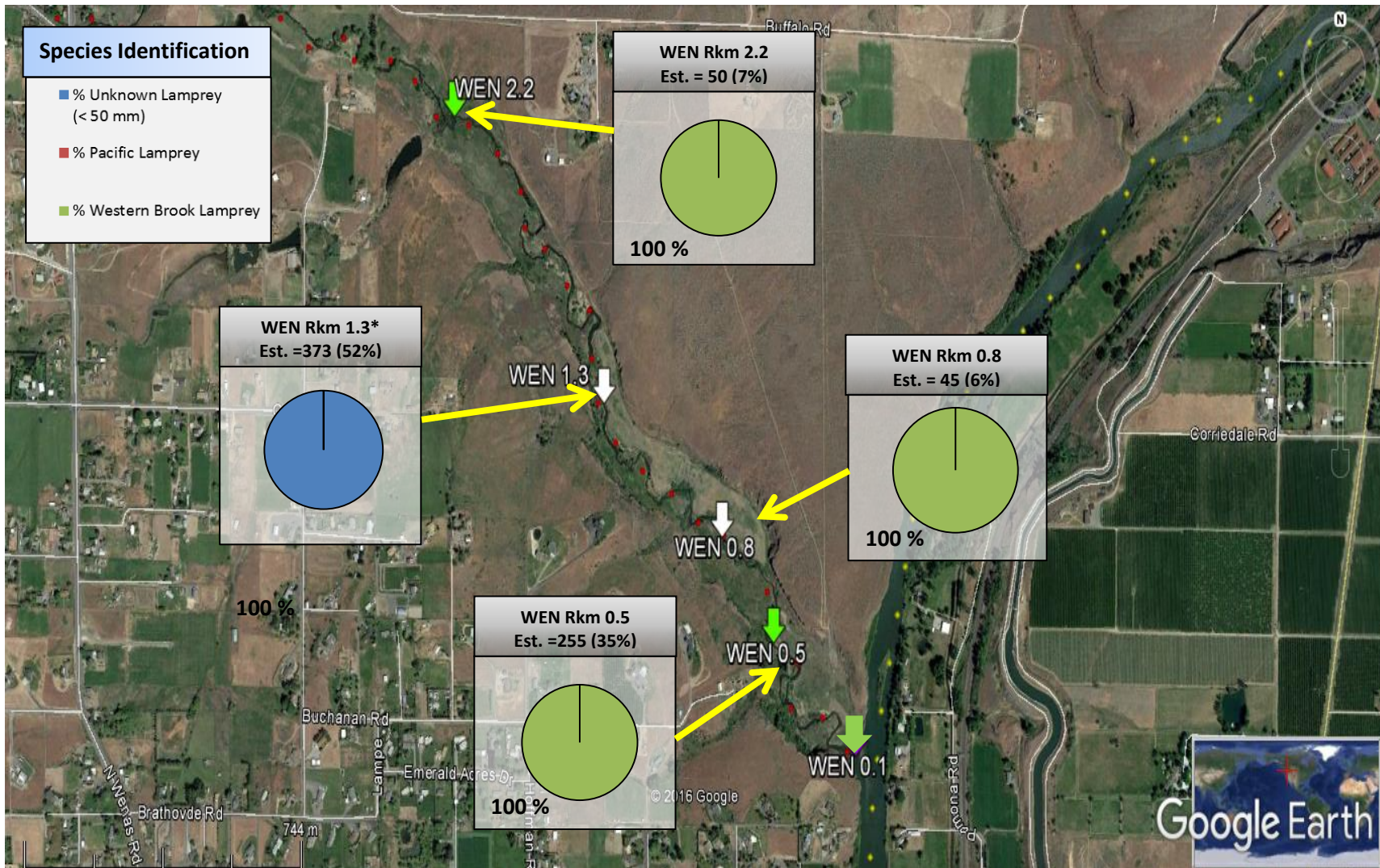
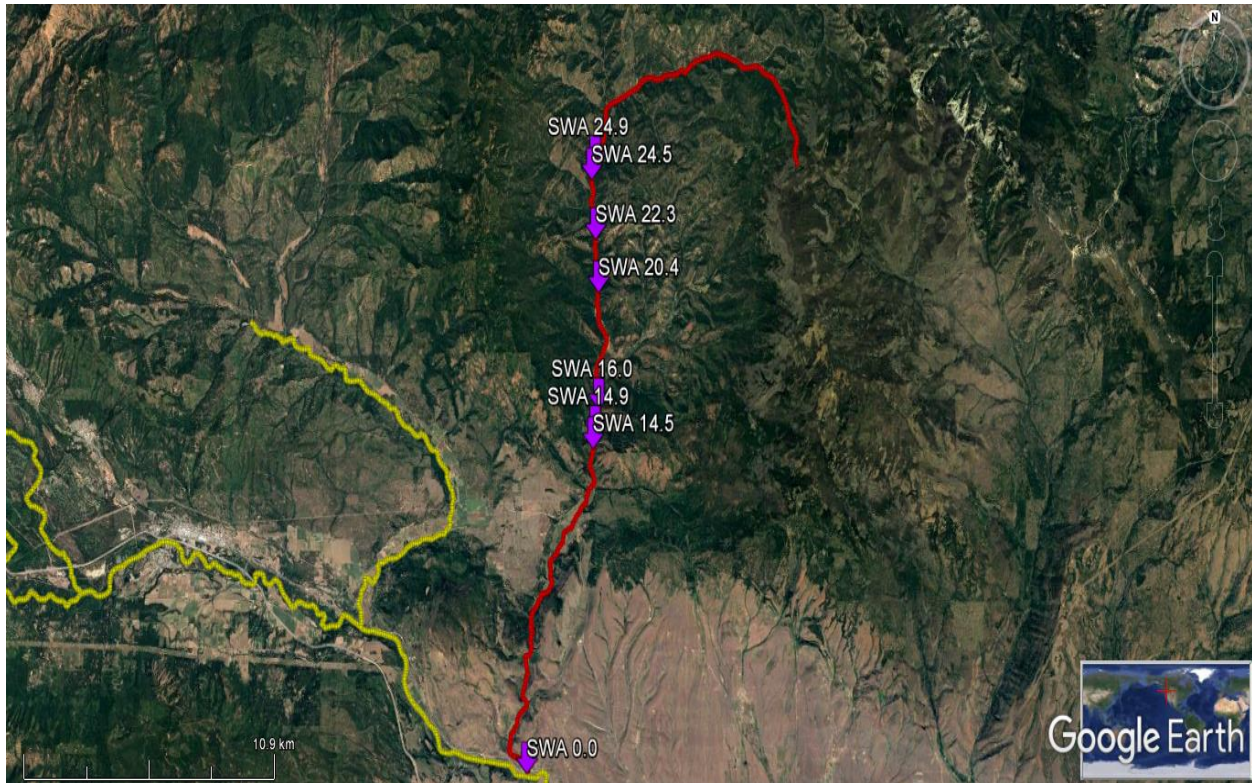


Figure 3. Histogram of all measured lampreys captured during electrofishing surveys, separated by species (“PA”= Pacific Lamprey (blue), “UN”=Unknown Lamprey <50 mm (green), “WB” Western Brook Lamprey (Red), in Wenas Creek in August, 2016.



Map 5. Displayed is the distribution of Unknown Lamprey <50 mm (blue), Pacific Lamprey (red) and Western Brook Lamprey (green) in Wenas Creek from August, 2016 electrofishing surveys. Species ratio of lampreys is based on captured and measured data only. Also shown is the estimated number of lampreys at each surveyed site (within a 50 m reach). Index sites are labeled by green arrows, exploratory sites labeled by white arrows, and sites where no electrofishing surveys labeled by purple arrows. * Species ratio calculated from counted and identified fish (no lengths taken).

Swauk Creek Watershed



Map 6. Overview of all surveyed sites in Swauk Creek (red dotted line) in August, 2016 displaying sites where electrofishing did not occur (purple arrows).

Exploratory Sites – Swauk Creek

- Eight exploratory sites were visited in Swauk Creek (a tributary upstream of Roza Dam), but not surveyed (electrofished), in order to get a broad understand of the distribution of larval habitat within the watershed.

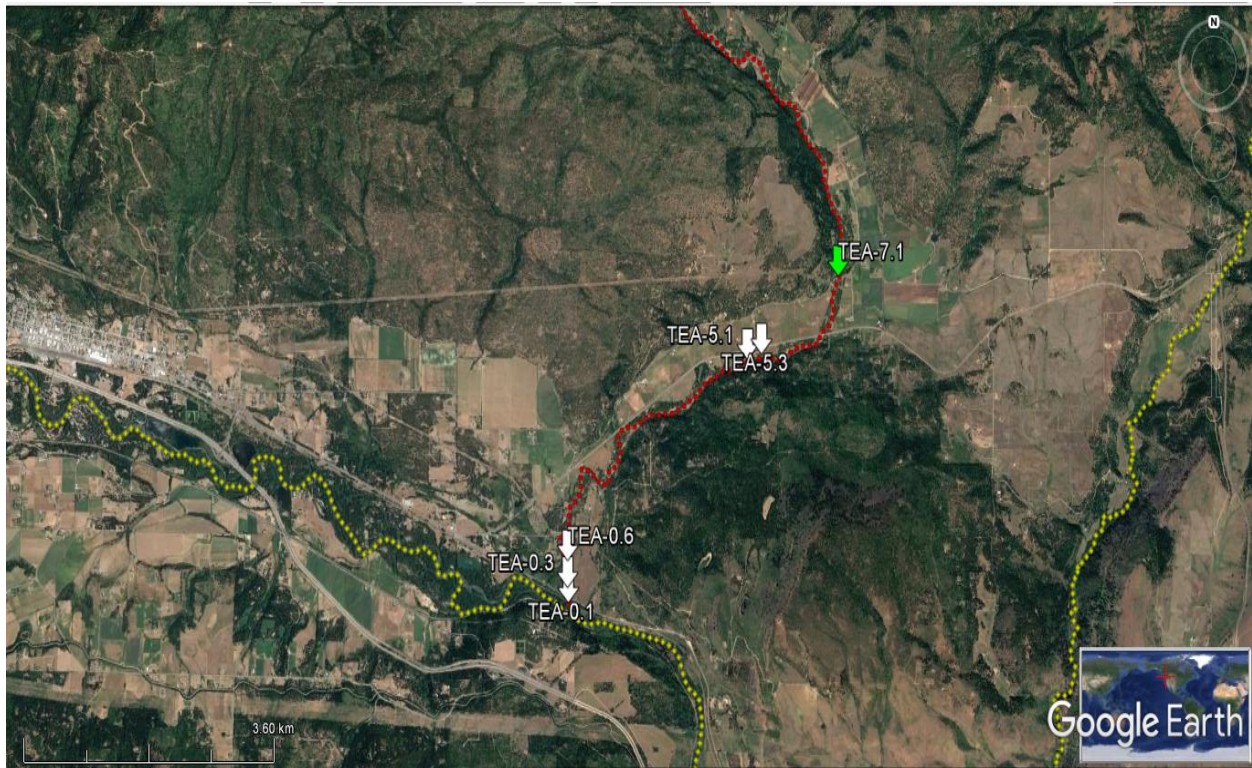
Table 22. Larval lamprey habitat details from index sites surveyed in Swauk Creek. Under “Survey Type”, a “Visit” survey indicates that electrofishing took place. Plot temp was taken where the most lampreys were found, and thalwag temp was taken in the main channel flow.

Site Type	Stream	River KM	Date	Survey Type	% Type I in 50 m	% Type II in 50 m	Type I Habitat Type	Primary Fine Sediment (Type I)	Primary Fine Sediment (Type II)	Plot Temp °C (Best)	Thalwag Temp °C
Expl.	Swauk	0.0	7/18/16	Visit	-	-	-	-	-	-	-
Expl.	Swauk	14.5	7/18/16	Visit	-	-	-	-	-	-	-
Expl.	Swauk	14.9	7/18/16	Visit	-	-	-	-	-	-	-
Expl.	Swauk	16.0	7/18/16	Visit	-	-	-	-	-	-	-
Expl.	Swauk	20.4	7/18/16	Visit	-	-	-	-	-	-	-
Expl.	Swauk	22.3	7/18/16	Visit	-	-	-	-	-	-	-
Expl.	Swauk	24.5	7/18/16	Visit	-	-	-	-	-	-	-
Expl.	Swauk	24.9	7/18/16	Visit	-	-	-	-	-	-	-

Additional Exploratory Site Observations:

- **River km 0.0** – This site is located at the mouth of Swauk Creek (accessed from the Highway 10 Bridge that crosses Swauk Creek near the Swauk Creek Ranch). No Type I habitat was observed at this site (all cobble topped with fine silt or sand).
- **River km 14.5** – This site is located north of Ellensburg on Bitter Sweet Driver near its intersection with Highway 97. There was minimal Type I habitat along the edges of a deep pool. The majority of the available larval habitat at this site is Type II habitat, though the majority of the 50 m reach is Type III habitat.
- **River km 14.9** – This site is behind the Liberty Café, in Liberty, WA. At this site, there is a large cut bank on the opposite side of the café, and there is limited habitat for lamprey. The majority of the area is Type III habitat.
- **River km 16.0** – This site is located where the creek meets Highway 97 across from a road maintenance area (large barn of salt for roadways). The site has some Type I habitat (is the best site for larval lamprey of the visited sites at Swauk Creek). Type I habitat is along the inside edge of a corner pool.
- **River km 20.4** – This site is located further north off Highway 97. One patch of Type I habitat (<5 m²) was found at this site. The majority of this reach, however, is Type III habitat.
- **River km 22.3** – This site is located further north off Highway 97. The majority of this reach is Type III habitat, with patchy areas of Type II habitat scattered throughout the reach.
- **River km 24.5** – This site is located further north off Highway 97. The majority of this reach is Type III habitat.
- **River km 24.9** – This site is located further north off Highway 97. The majority of this reach is Type III habitat (with scattered/patchy of Type II habitat).

Teanaway River Watershed



Map 7. Overview of all surveyed sites in the Teanaway River (red dotted line) in August, 2016 displaying index sites (green arrows) and surveyed exploratory sites where electrofishing occurred (white arrows).

Index Sites – Teanaway River

- In the Teanaway River, no Pacific Lamprey were found at the one index site (0%).

Table 23. Larval lamprey habitat details from index sites surveyed in the Teanaway River. Under “Survey Type”, a “Short” survey indicates that either Type I or Type II habitat was electrofished. The percent of larval habitat shown is the ratio between available Type I and Type II habitat, and excludes Type III (unusable) habitat within the 50 m survey reach. Under “Type I Habitat Type”, “Side Chan.” indicates that the primary survey location (for Type I habitat) was in a side channel. Plot temp was taken where the most lampreys were found, and thalweg temp was taken in the main channel flow.

Site Type	Stream	River KM	Date	Survey Type	% Type I in 50 m	% Type II in 50 m	Type I Habitat Type	Primary Fine Sediment (Type I)	Primary Fine Sediment (Type II)	Plot Temp (Best) °C	Thalweg Temp °C
Index	Teanaway	7.1	8/17/16	Short	53%	47%	Side Chan.	Silt	-	25.9	-

Table 14. Survey details, separated by habitat type, for the Teanaway River index sites surveyed in August, 2016. 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%). Survey densities (#/m²) were calculated using the adjusted observed number of lampreys. The summary rows are a sum of presented values, except for e-fish density which is a mean of presented values.

Site Type	Stream	River KM	Habitat Type Surveyed	Shock Time (sec)	Shock Area (m ²)	# Captured	# Observed	Survey Visibility (1-5)	Total # Observed (Adjusted)	E-Fish Density (#/m ²)
Index	Teanaway	7.1	Type I	200	4	19	38	5	38	9.5
Index	Teanaway	7.1	Type II	0	-	-	-	-	-	-
Site Summary		7.1	-	200	4	19	38	-	38	9.5
Habitat Summary		-	Type I	200	4	19	38		38	9.5
			Type II	0	-	-	-	-	-	-

Table 15. Lamprey identification details, separated by habitat type, for Teanaway River index sites surveyed in July, 2016. The summary rows are a sum of presented values except for % values, which are a weighted average.

Site Type	Stream	River KM	Habitat Type	# Identified	# of Pacific	# of Western Brook	% Pacific	% Western Brook	% of Cap. Identified
Index	Teanaway	7.1	Type I	13	0	13	0%	100%	68%
Index	Teanaway	7.1	Type II	0	-	-	-	-	-
Site Summary		7.1	-	13	0	13	0%	100%	68%
Habitat Summary		-	Type I	13	0	13	0%	100%	68%
			Type II	-	-	-	-	-	-

Table 16. Lamprey population and biomass estimates within a 50 m reach, separated by habitat type, for Teanaway River index sites surveyed in August, 2016. “Estimated # of Pacific Lamprey” is calculated based on the identified ratio of Pacific Lamprey (to Western Brook Lamprey) generally > 50 mm in length. Summary rows are a sum of presented values, except for e-fish density and mean weight of captured, which are a mean of presented values.

Site Type	Stream	River KM	Habitat Type	50 m Habitat Area (m ²)	E-Fish Density (#/m ²)	Estimated # in 50 m	Estimated # of Pacific Lamprey in 50 m	Mean Weight of Cap. (g)	Estimated Mass Density (g/m ²)	Estimated Mass (g) in 50 m
Index	Teanaway	7.1	Type I	14	9.5	133	0	-	-	-
Index	Teanaway	7.1	Type II	12.5	-	-	-	-	-	-
Site Summary		7.1	-	27	9.5	133	0	-	-	-
Habitat Summary		-	Type I	14	9.5	133	0		-	
			Type II	13	-	-	-			

Additional Index Site Observations:

- **River km7.1** – This site was located approximately at the bridge crossing on Red Bridge Rd., and was explored above, underneath, and below the bridge. Both sides and the center of the river were spot checked and the sediment types ranged from fine and coarse sand to sediment composed of silt and high organic matter with very little aquatic vegetation. Larvae and transformers were observed along with aquatic insects. A diversion was located directly below the bridge and the beaten path indicated that this was a high traffic area for private and public access.

Exploratory Sites – Teanaway River

- Pacific Lamprey were found at two of the five exploratory sites (40.0%).
- In the Teanaway River, lamprey densities were highest at river km 5.3 (33.1 #/m²). The largest area of Type I habitat, and additionally the highest number of lampreys within a 50 m reach was at river km 5.3 (26.5 m², 877). Most of the lampreys observed at this site were young of the year larvae (generally < 36 mm), suggesting lamprey spawning occurs in this reach.

Table 17. Larval lamprey habitat details from exploratory sites surveyed in the Teanaway River. Under “Survey Type”, a “Short” survey indicates that both Type I and Type II habitat were electrofished. The percent of larval habitat shown is the ratio between available Type I and Type II habitat, and excludes Type III (unusable) habitat within the 50 m survey reach. Under “Type I Habitat Type”, “Main” indicates that the primary survey location (for Type I habitat) was in the main channel; “Side Chan.” indicates this occurred in a side channel. Plot temp was taken where the most lampreys were found, and thalweg temp was taken in the main channel flow.

Site Type	Stream	River KM	Date	Survey Type	%	%	Type I Habitat Type	Primary	Primary	Plot Temp °C (Best)	Thalweg Temp °C
					in 50 m	in 50 m		Fine Sediment (Type I)	Fine Sediment (Type II)		
Expl.	Teanaway	0.1	8/17/16	Short	59%	41%	Main	Sand	-	20.4	-
Expl.	Teanaway	0.3	8/17/16	Short	8%	92%	Main	-	Coarse	20.8	-
Expl.	Teanaway	0.6	8/17/16	Short	0%	100%	Main	-	Sand	19.7	-
Expl.	Teanaway	5.1	8/17/16	Short	33%	67%	Main	Sand	-	22.7	-
Expl.	Teanaway	5.3	8/17/16	Short	66%	34%	Side Chan.	Sand	-	21.6	-

Table 18. Survey details, separated by habitat type, for the Teanaway River exploratory sites surveyed in in August, 2016. 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%). Survey densities (#/m²) were calculated using the adjusted observed number of lampreys. The summary rows are a sum of presented values, except for e-fish density which is a mean of presented values.

Site Type	Stream	River KM	Habitat Type Surveyed	Shock Time (sec)	Shock Area (m2)	# Captured	# Observed	Survey Visibility (1-5)	Total # Observed (Adjusted)	E-Fish Density (#/m2)
Expl.	Teanaway	0.1	Type I	71	1.5	5	10	5	10	6.7
Expl.	Teanaway	0.3	Type I	0	-	-	-	-	-	-
Expl.	Teanaway	0.6	Type I	0	-	-	-	-	-	-
Expl.	Teanaway	5.1	Type I	55	1.5	0	0	-	-	-
Expl.	Teanaway	5.3	Type I	264	4.5	16	149	5	149	33.1
Expl.	Teanaway	0.1	Type II	0	-	-	-	-	-	-
Expl.	Teanaway	0.3	Type II	146	2	4	8	3	10	5.0
Expl.	Teanaway	0.6	Type II	175	3	2	4	3	5	1.7
Expl.	Teanaway	5.1	Type II	0	-	-	-	-	-	-
Expl.	Teanaway	5.3	Type II	0	-	-	-	-	-	-
Site Summary		0.1		71	2	5	10		10	6.7
		0.3		146	2	4	8		10	5.0
		0.6	-	175	3	2	4	-	5	1.7
		5.1		55	2	0	-		-	-
		5.3		264	5	16	149		149	33.1
Habitat Summary		-	Type I	390	8	21	159	-	159	19.9
			Type II	321	5	6	12		15	3.3

Table 19. Measurement details of captured lampreys, separated by habitat type, for Teanaway River exploratory sites surveyed in August, 2016 (sites without lampreys are excluded). The summary rows are a sum of presented values, except for mean weight, mean length and mean condition factor, which are a mean of presented values, and min and max length, which are the lowest and highest value, respectively.

Site Type	Stream	River KM	Habitat Type Surveyed	# Weighed	Total Weight of Captured (g)	Mean Weight of Captured (g)	Min. Length (mm)	Max. Length (mm)	Mean Length (mm)	Mean Condition Factor
Expl.	Teanaway	0.1	Type I	0	-	-	30	150	88	-
Expl.	Teanaway	0.3	Type I	-	-	-	-	-	-	-
Expl.	Teanaway	0.6	Type I	-	-	-	-	-	-	-
Expl.	Teanaway	5.3	Type I	0	-	-	-	-	-	-
Expl.	Teanaway	0.1	Type II	-	-	-	-	-	-	-
Expl.	Teanaway	0.3	Type II	0	-	-	50	140	80	-
Expl.	Teanaway	0.6	Type II	0	-	-	60	75	68	-
Expl.	Teanaway	5.3	Type II	-	-	-	-	-	-	-
Site Summary		0.1					30	150	88	
		0.3	-		-		50	140	80	-
		0.6					60	75	68	
		5.3					-	-	-	
Habitat Summary		0.1	Type I		-		30	150	88	-
		0.3	Type II				50	140	74	-

Table 20. Lamprey identification details, separated by habitat type, for Teanaway River exploratory sites surveyed in July, 2016. The summary rows are a sum of presented values except for % values, which are a weighted average.

Site Type	Stream	River KM	Habitat Type	# Identified	# of Pacific	# of Western Brook	% Pacific	% Western Brook	% of Cap. Identified
Expl.	Teanaway	0.1	Type I	4	0	4	0%	100%	80%
Expl.	Teanaway	0.3	Type I	0	0	0	-	-	-
Expl.	Teanaway	0.6	Type I	0	0	0	-	-	-
Expl.	Teanaway	5.3	Type I	5	0	5	0%	100%	31%
Expl.	Teanaway	0.1	Type II	0	0	0	-	-	-
Expl.	Teanaway	0.3	Type II	4	1	3	25%	75%	100%
Expl.	Teanaway	0.6	Type II	2	1	1	50%	50%	100%
Expl.	Teanaway	5.3	Type II	0	0	0	-	-	-
Site Summary		0.1		4	0	4	0%	100%	80%
		0.3	-	4	1	3	25%	75%	100%
		0.6		2	1	1	50%	50%	100%
		5.3		5	0	5	0%	100%	31%
Habitat Summary		-	Type I	9	0	9	0%	100%	43%
			Type II	6	2	4	33%	67%	100%

Table 21. Lamprey population and biomass estimates within a 50 m reach, separated by habitat type, for Teanaway River index sites surveyed in August, 2016. “Estimated # of Pacific Lamprey” is calculated based on the identified ratio of Pacific Lamprey (to Western Brook Lamprey) generally > 50 mm in length. Summary rows are a sum of presented values, except for e-fish density and mean weight of captured, which are a mean of presented values.

Site Type	Stream	River KM	Habitat Type	50 m		Estimated # in 50 m	Estimated # of Pacific Lamprey in 50 m	Mean Weight of Cap. (g)	Estimated Mass Density (g/m ²)	Estimated Mass (g) in 50 m
				Habitat Area (m ²)	E-Fish Density (#/m ²)					
Expl.	Teanaway	0.1	Type I	5.0	6.7	33	0	-	-	-
Expl.	Teanaway	0.3	Type I	0.5	-	-	-	-	-	-
Expl.	Teanaway	0.6	Type I	0.0	-	-	-	-	-	-
Expl.	Teanaway	5.3	Type I	26.5	33.1	877	0	-	-	-
Expl.	Teanaway	0.1	Type II	3.5	-	-	-	-	-	-
Expl.	Teanaway	0.3	Type II	6.0	5.0	30	8	-	-	-
Expl.	Teanaway	0.6	Type II	6.0	1.7	10	5	-	-	-
Expl.	Teanaway	5.3	Type II	13.5	-	-	-	-	-	-
Site Summary		0.1		8.5	6.7	33	0			
		0.3	-	6.5	5.0	30	8			
		0.6		6.0	1.7	10	5			
		5.3		40.0	33.1	877	0			
Habitat Summary		-	Type I	32.0	19.9	911	0			
		-	Type II	29.0	3.3	40	13			

Additional Exploratory Site Observations:

- **River km 0.1** – Located outside of Cle Elum off of Hwy 10 just past the intersection with Hwy970, downstream from the bridge. The site was composed of a small amount of habitat that was available on only one side of the river. Woody debris was abundant along the bank and caused sediment to build up around the woody mass. The sediment was composed of mostly sand with no vegetation growing in the water, and no other organisms were observed. The access to this site was below the bridge at a public access site with heavy human traffic.
- **Rkm0.3** – This site was located off of Hwy10 upstream of the bridge and the surveyed habitat was located on one side of the river in a small pool. The pool was located along a cutoff bank in a small bend of the low river and the collected sediment was composed of sand, small organic matter and small woody debris layered on top of cobble. Few lamprey were found along with other small aquatic insects.
- **Rkm0.6** – This site was located upstream of 0.3 approximately in the bend of the river that created a backwater eddy on the inside corner of the bend where the water slowed to deposit sediment which formed a mound along the bank. The sediment was a mixture was composed of coarse sand and small bits of organic matter. Visibility was decreased due to the fast water movement and no lamprey or any other organisms were observed.
- **Rkm5.1** – This site was located off of Hwy970 and the very small amount of habitat that was present was located on one side of the river at what appeared to be the outlet for a

small side channel that was dried up due to the low water. There was very little sediment available in this area and it was composed of coarse sand and no lamprey or any other organisms were overserved.

- **Rkm5.3:** The River at this site was split into two large channels due to a large established island in the center of the river. Two surveys were conducted, one in each channel approximately across from each other. Sediment collected behind large boulders located along the bank of the main channel along Hwy970 and small lamprey along with small aquatic insects were collected. The opposite side of the river was composed of silt, sand and small amounts woody debris, and no lamprey were observed.

Genetic Samples – Teanaway River

A total of 11 genetic samples were collected from the Teanaway River. Nine were from young of the year larvae were collected to identify them to species, and Pacific Lamprey will be used to further assess the spawning success of adult Pacific Lamprey from a release upstream of Roza Dam in Spring, 2014. Two Pacific Lamprey larvae were collected, and genetic samples will be used to further assess spawning success.

Table 22. Genetic samples collected from the Teanaway River in August, 2016.

Stream Name	River KM	Collection Date	# of Pacific Samples (Larvae)	# of Pacific Samples (Macro.)	# of Western Brook Samples	# Unknown Species Samples (< 50 mm)	Primary Collection Purpose
Teanaway	0.1	8/17/16	0	0	0	1	Translocaiton Success
Teanaway	0.6	8/17/16	0	0	0	1	Translocaiton Success
Teanaway	5.3	8/17/16	2	0	0	6	Translocaiton Success
Teanaway	7.1	8/17/16	0	0	0	1	Translocaiton Success
Total			0	0	0	9	

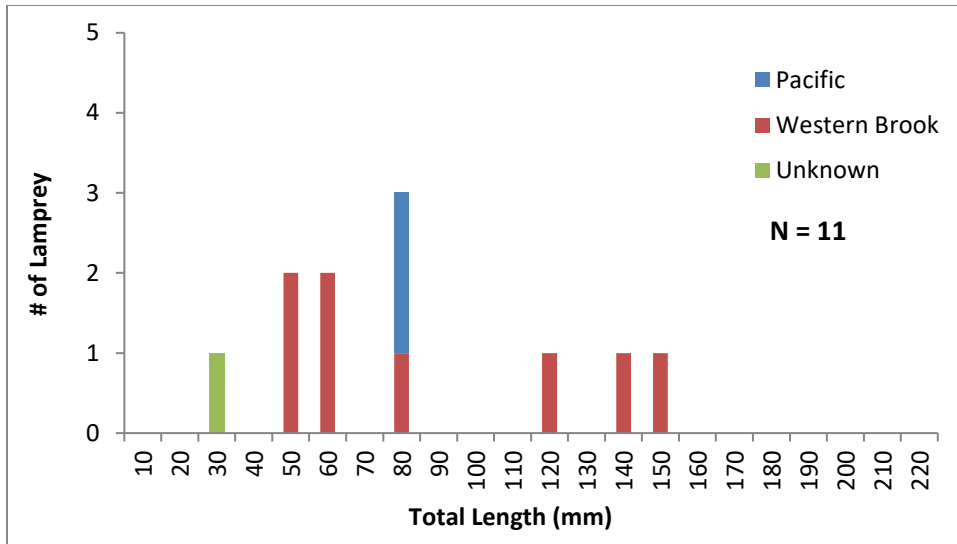
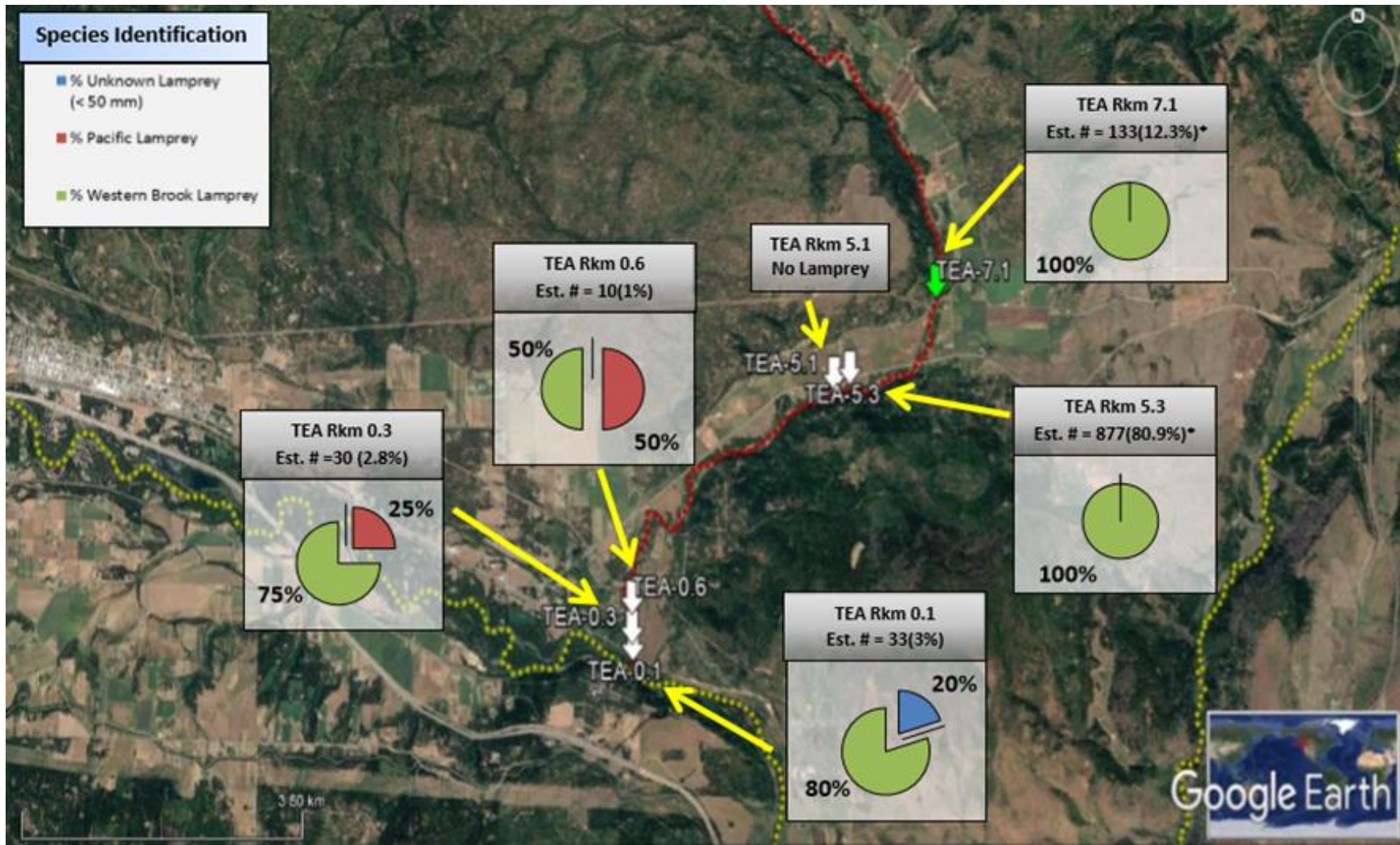


Figure 4. Histogram of all measured lampreys captured during electrofishing surveys, separated by species (“PA”= Pacific Lamprey (blue), “UN”=Unknown Lamprey <50 mm (green), “WB” Western Brook Lamprey (Red), in the Teanaway River in August, 2016.



Map 8. Displayed is the distribution of Unknown Lamprey <50 mm (blue), Pacific Lamprey (red) and Western Brook Lamprey (green) in the Teaway River from August, 2016 electrofishing surveys. Species ratio of lampreys is based on captured and measured data only. Also shown is the estimated number of lampreys at each surveyed site (within a 50 m reach). Index sites are labeled by green arrows, exploratory sites labeled by white arrows, and sites where no electrofishing surveys labeled by purple arrows. * Species ratio calculated from counted and identified fish (no lengths taken).

Appendix: Additional Site Maps and Photos

Upper Yakima River Mainstem



Map A1. Site map of Yakima River site at river km 192.2 (surveyed in September, 2016); yellow balloon indicates that lamprey of unknown species (<50 mm) were present at this site. The small red dots indicate stream distance of 100 m.

****No Photos Available**



Map A2. Site map of Yakima River site at river km 193.2 (surveyed in September, 2016); yellow balloon indicates that lamprey of unknown species (<50 mm) were present at this site. The small red dots indicate stream distance of 100 m.



Photo A1. Yakima River site at river km 193.2; overview of habitat (left) and overview of best Type I habitat sediment from 2016 survey(right).



Map A3. Site map of Yakima River site at river km221.7 (surveyed in September, 2016); yellow balloon indicates that lamprey of unknown species (<50 mm) were present at this site. The small red dots indicate stream distance of 100 m.



Photo A2. Yakima River index site at river km 221.7; looking downstream (left) and overview of best Type I habitat (right) from 2016 survey.



Map A4. Site map of Yakima River index site at river km 235.5 (surveyed in September, 2016); yellow balloon indicates that lamprey of unknown species (<50 mm) were present at this site. The small red dots indicate stream distance of 100 m.

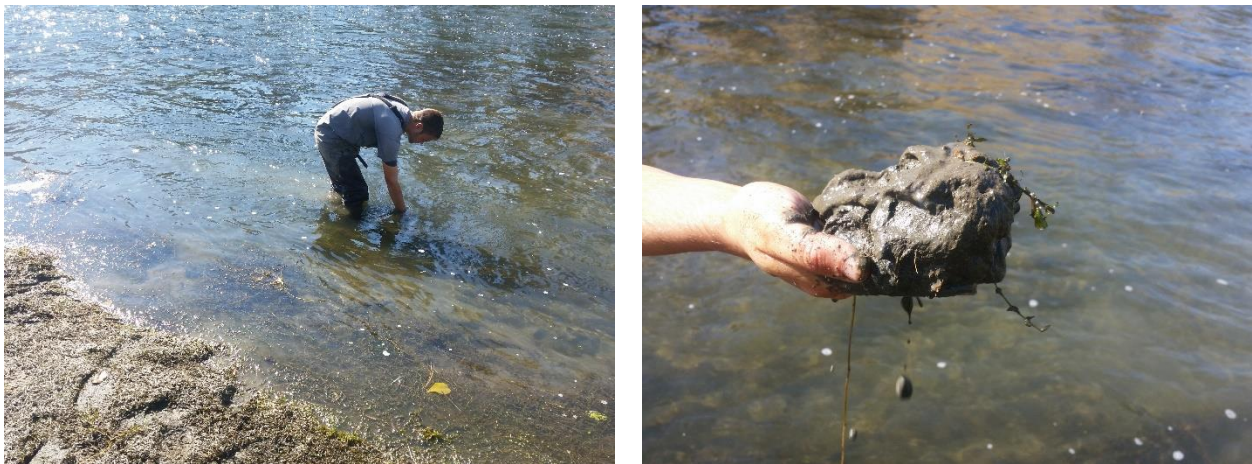


Photo A3. Yakima River index site at river km 235.5; overview of Type I habitat (left) and close-up of best Type I habitat sediment composed of silt/sand (right) from 2016 survey.



Map A5. Site map of Yakima River site at river km 235.7 (surveyed in September, 2016); yellow balloon indicates that lamprey of unknown species (<50 mm) were present at this site. The small red dots indicate stream distance of 100 m.



Photo A4. Yakima River index site at river km 235.7; overview of Type I habitat (left) and downstream view (right) from 2016 survey.



Map A6. Site map of Yakima River site at river km 244.0 (surveyed in September, 2016); yellow balloon indicates that lamprey of unknown species (<50 mm) were present at this site. The small red dots indicate stream distance of 100 m.

****No Photos Available**



Map A7. Site map of Yakima River index site at river km 264.8 (surveyed in September, 2016); red balloon indicates presence of Pacific Lamprey. The small red dots indicate stream distance of 100 m.



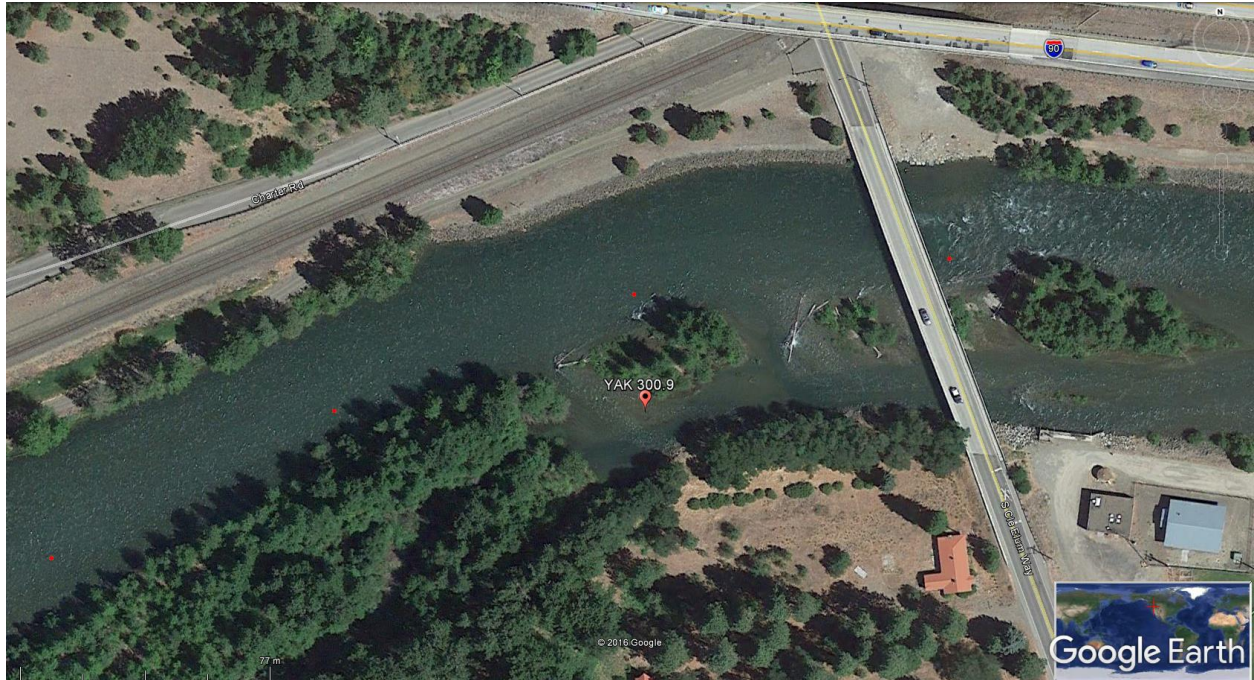
Photo A5. Yakima River index site at river km 264.8; overview of Type I habitat (left) and close-up of best Type I habitat (right) from 2016 survey.



Map A8. Site map of Yakima River site at river km 288.5 (surveyed in September, 2016); red balloon indicates presence of Pacific Lamprey. The small red dots indicate stream distance of 100 m.



Photo A6. Yakima River site at river km 288.5; overview of Type I habitat (left) and close-up of best Type I habitat sediment composed of silt/sand (right) from 2016 survey.



Map A9. Site map of Yakima River index site at river km 300.9 (surveyed in September, 2016); red balloon indicates presence of Pacific Lamprey. The small red dots indicate stream distance of 100 m.



Photo A7. Yakima River index site at river km 300.9; downstream view of habitat (left) and close-up of best Type I habitat composed of sand/clay/silt (right) from 2016 survey.

**Upper Yakima River Tributaries
Wenas Creek**



Map A10. Site map of Wenas Creek index site at river km 0.5 (surveyed in August, 2016); green balloon indicates all captured lamprey were > 50 mm and identified as Western Brook Lamprey. The small red dots indicate stream distance of 100 m.



Photo A8. Wenas Creek index site at river km 0.5; overview of Type I habitat (left) and close-up of best Type I habitat sediment composed of silt/sand (right) from 2016 survey.



Map A11. Site map of Wenas Creek site at river km 0.8 (surveyed in August, 2016); green balloon indicates all captured lamprey were > 50 mm and identified as Western Brook Lamprey. The small red dots indicate stream distance of 100 m.



Photo A9. Wenas Creek site at river km 0.8; overview of Type I habitat (left) and close-up of best Type I habitat sediment composed of silt/sand (right) from 2016 survey.



Map A12. Site map of Wenas Creek site at river km 1.3 (surveyed in August, 2016); yellow balloon indicates that lamprey of unknown species (<50 mm) were present at this site. The small red dots indicate stream distance of 100 m.



Photo A10. Wenas Creek site at river km 1.3; overview of Type I habitat (left) and close-up of best Type I habitat (right) from 2016 survey.



Map A13. Site map of Wenas Creek index site at river km 2.2 (surveyed in August 2016); white balloon indicates that no lamprey were present at this site. The small red dots indicate stream distance of 100 m.



Photo A11. Wenas Creek index site at river km 2.2; overview of Type I habitat (left) and close-up of best Type I habitat sediment composed of silt/clay (right) from 2016 survey.

Swauk Creek



Map A14. Site map of Swauk Creek site at river km 0.0 (visited in July, 2016); purple balloon indicates that no electrofishing survey took place in 2016. The small red dots indicate stream distance of 100 m.



Photo A12. Swauk Creek site at river km 0.0; downstream view of site (left) and close-up of best habitat (right) from 2016 survey.



Map A15. Site map of Swauk Creek site at river km 14.5 (visited in July, 2016); purple balloon indicates that no electrofishing survey took place in 2016. The small red dots indicate stream distance of 100 m.



Photo A13. Swauk Creek site at river km 14.5; overview of best Type I habitat (left) and overview of site (right) from 2016 survey.



Map A16. Site map of Swauk Creek site at river km 14.9 (visited in July, 2016); purple balloon indicates that no electrofishing survey took place in 2016. The small red dots indicate stream distance of 100 m.



Photo A14. Swauk Creek site at river km 14.9; overview of Type I habitat (left) and overview of site (right) from 2016 survey.



Map A17. Site map of Swauk Creek site at river km 16.0 (visited in July, 2016); purple balloon indicates that no electrofishing survey took place in 2016. The small red dots indicate stream distance of 100 m.



Photo A15. Swauk Creek site at river km 16.0; overview of Type I habitat (left) and close-up of best Type I habitat sediment composed of silt/sand/clay (right) from 2016 survey.



Map A18. Site map of Swauk Creek site at river km 20.4 (visited in July, 2016); purple balloon indicates that no electrofishing survey took place in 2016. The small red dots indicate stream distance of 100 m.



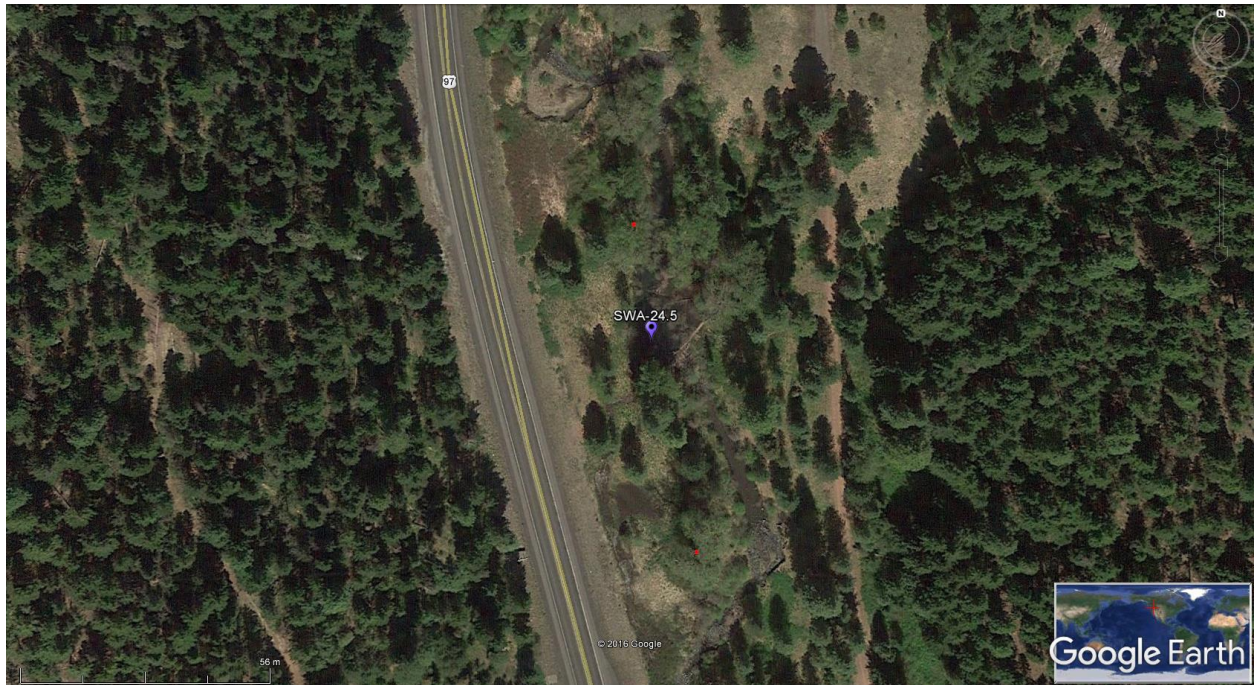
Photo A16. Swauk Creek site at river km 20.4; overview of Type I habitat (left) and close-up of best Type I habitat (right) from 2016 survey.



Map A19. Site map of Swauk Creek site at river km 22.3 (visited in July, 2016); purple balloon indicates that no electrofishing survey took place in 2016. The small red dots indicate stream distance of 100 m.



Photo A17. Swauk Creek site at river km 22.3; overview of site (left) and close-up of best habitat sediment (right) from 2016 survey.



Map A20. Site map of Swauk Creek site at river km 24.5 (visited in July, 2016); purple balloon indicates that no electrofishing survey took place in 2016. The small red dots indicate stream distance of 100 m.



Photo A18. Swauk Creek site at river km 24.5; overview of habitat (left) and upstream view of site (right) from 2016 survey.

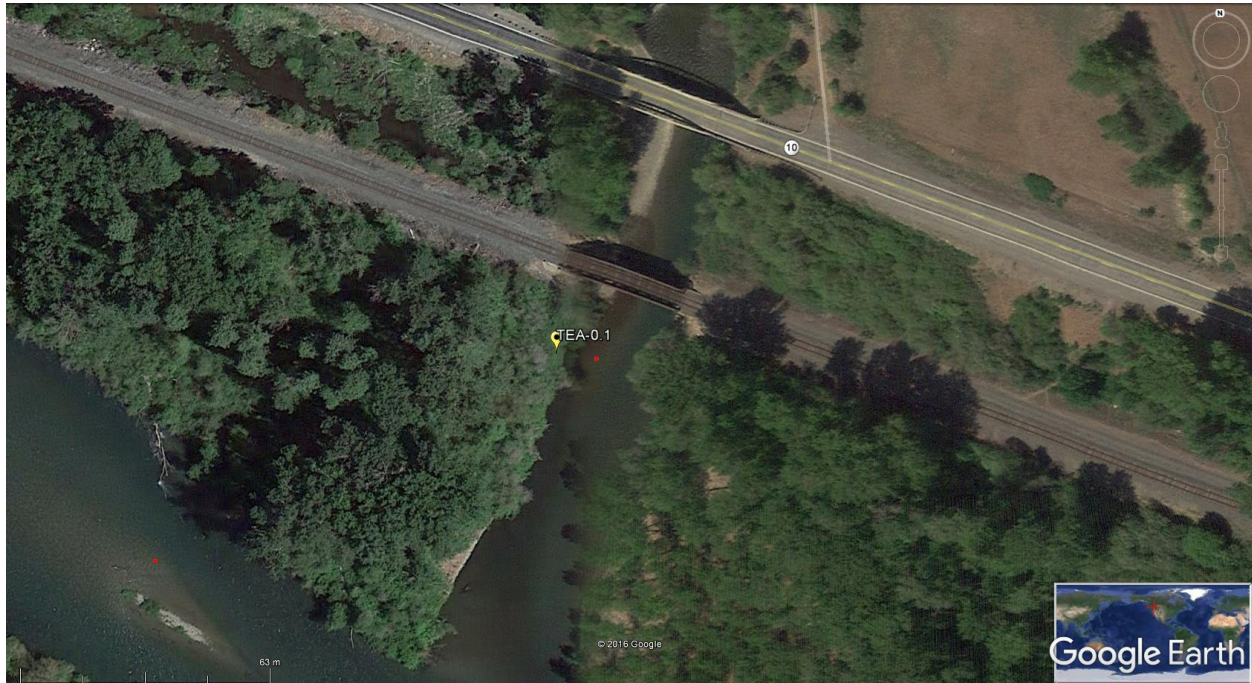


Map A21. Site map of Swauk Creek site at river km 24.9 (visited in July, 2016); purple balloon indicates that no electrofishing survey took place in 2016. The small red dots indicate stream distance of 100 m.



Photo A19. Swauk Creek site at river km 24.9; overview of site (left) and close-up of best habitat (right) from 2016 survey.

Teanaway River



Map 22. Site map of Teanaway River site at river km 0.1 (surveyed in August, 2016); yellow balloon indicates that lamprey of unknown species (<50 mm) were present at this site. The small red dots indicate stream distance of 100 m.



Photo A20. Teanaway River site at river km 0.1; overview of Type I habitat (left) and close-up of best Type I habitat sediment composed of sand/silt (right) from 2016 survey.



Map A23. Site map of Teanaway River site at river km 0.3 (surveyed in August, 2016); red balloon indicates presence of Pacific Lamprey. The small red dots indicate stream distance of 100 m.



Photo A21. Teanaway River site at river km 0.3; overview of Type I habitat (left) and close-up of best Type I habitat sediment composed of sand/silt and organic debris (right) from 2016 survey.



Map A24. Site map of Teanaway River site at river km 0.6 (surveyed in August, 2016); red balloon indicates presence of Pacific Lamprey. The small red dots indicate stream distance of 100 m.



Photo A22. Teanaway River site at river km 0.6; overview of Type I habitat (left) and close-up of best habitat sediment composed of coarse sand (right) from 2016 survey.



Map A25. Site map of Teanaway River site at river km 5.1 (surveyed in August, 2016); white balloon indicates that no lamprey were present at this site. The small red dots indicate stream distance of 100 m.



Photo A23. Teanaway River site at river km 5.1; overview of best habitat (left) and close-up of best habitat (right) from 2016 survey.



Map A26. Site map of Teanaway River site at river km 5.3 (surveyed in August, 2016); yellow balloons indicates that lamprey of unknown species (<50 mm) were present at this site. The small red dots indicate stream distance of 100 m.



Photo A24. Teanaway River site at river km 5.3; close-up of best habitat sediment composed of sand/silt and organic debris (left) and overview of best habitat (right) from 2016 survey.



Map A21. Site map of Teanaway River index site at river km 7.1 (surveyed in August, 2016); yellow balloon indicates that lamprey of unknown species (<50 mm) were present at this site. The small red dots indicate stream distance of 100 m.



Photo A19. Teanaway River index site at river km 7.1; close-up of best Type I habitat sediment composed of silt/sand (left) and overview of Type I habitat (right) from 2016 survey.

