



Methow Subbasin Larval Lamprey Monitoring Report, 2016



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

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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**

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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 Methow Subbasin. In an effort to monitor, manage and restore the species, the Yakama Nation Pacific Lamprey Program (YNPLP), in close coordination with Jon Crandall (Methow Salmon Recovery Foundation), has both aided and led electrofishing surveys for larval Pacific Lamprey throughout the Methow Subbasin since 2013. Jon Crandall has led ongoing electrofishing surveys in many of the index sites which have documented the decline of larval Pacific Lamprey in the Methow Subbasin since 2008. In the fall of 2015, adult Pacific Lamprey were released into the Methow River in an effort to rebuild the depressed population. This report highlights electrofishing efforts in the Methow Subbasin in 2016 by both the YNPLP and Jon Crandall (Methow Salmon Recovery).

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

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

A total of six sites were surveyed in the Chewuch River in 2016 by the YNPLP and Jon Crandall (river km 0.8 to river km 49.5). Pacific Lamprey was found at three out of the six sites (50%). The YNPLP surveyed one index site in the Chewuch River and a total of six larval lamprey were captured at this site (100%). In addition, Jon Crandall surveyed his established index sites in the Chewuch and Pacific Lamprey were present at three out of the five additional sites covered by Jon Crandall (60%). The furthest site upstream where Pacific Lamprey was found was at river km 26.1. The density of lamprey was highest at river km 16.1 (0.96 #/m²). On all sites surveyed, young of year larvae were found at river km 16.1 and 19.3, but not at river km 0.8, 28.6, or 26.1.

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

METHODS (YN Surveys)

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. In the Methow Subbasin, coordination with Jon Crandall (Methow Salmon Recovery Foundation) was vital to identify potential survey sites. Index sites were spatially distributed (in both the Methow River and Chewuch River) to supplement sites surveyed by Jon Crandall.

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 weight 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.

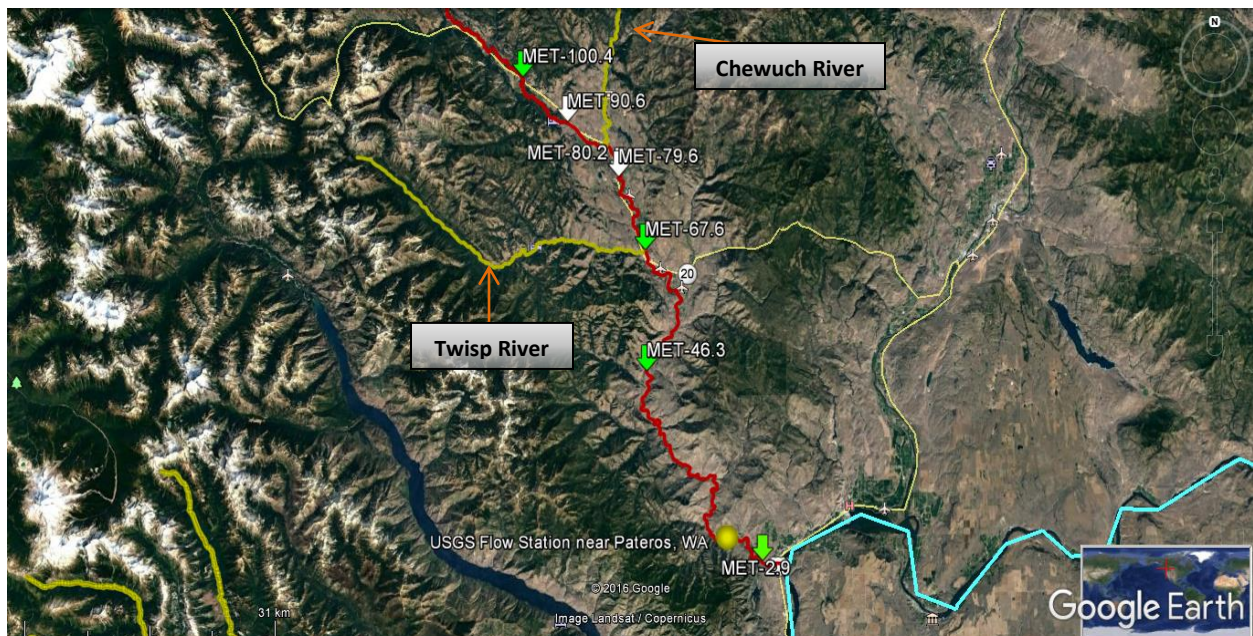
A condition factor for each site was calculated by averaging the condition factor for each of the fish measured by both length and weight. The average weight of the captured lamprey (total weight $g/\#$ weighed) was calculated for each site. In the event, that not all of the captured lampreys were weighed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

Methow River - Yakama Nation Surveys in 2016

- The Yakama Nation Pacific Lamprey Project began surveyed in the Methow Subbasin in 2013. Coordination with Jon Crandall (Methow Salmon Recovery) was necessary to choose the best survey sites. Yearly coordination between Jon Crandall and Yakama Nation has led comprehensive lamprey surveys throughout the Methow Subbasin. This section will present data collected by Yakama Nation in 2016 from index sites and exploratory sites in the Methow River and the Chewuch and Twisp rivers (two tributaries of the Methow River).



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

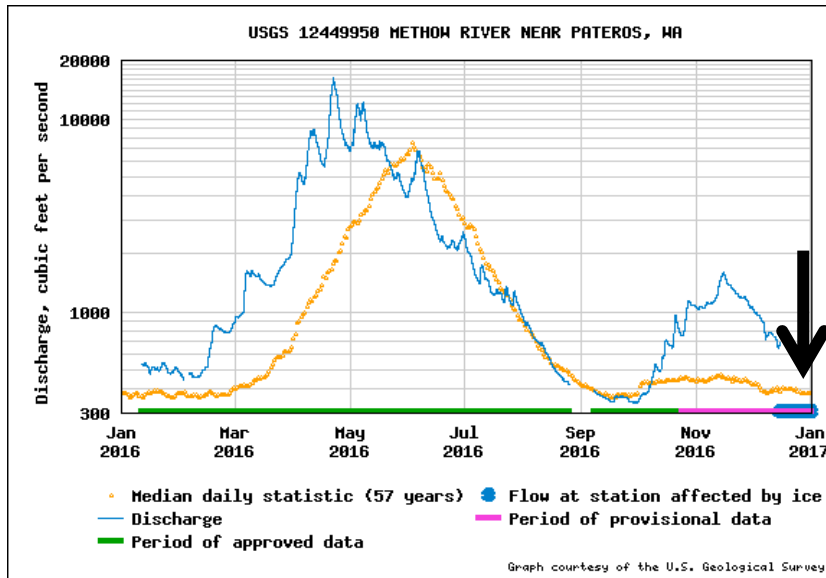


Figure 1. Discharge (cubic feet per second indicated by the narrow blue line) of the Methow River near Pateros, WA (river km 10.1) in 2016; black arrow indicates YN survey period (September, 2016). Surveys conducted near the flow station are also labeled.

YN Index Sites - Methow River Mainstem

- A total of four index sites were surveyed in the mainstem Methow River. Larval lamprey were present at one of the four sites (25%). Pacific Lamprey was only found at river km 46.3, despite efforts both upstream and downstream of this site.
- The density ($\#/m^2$) where lamprey were found was relatively low when compared to densities in other subbasins ($2.7 \#/m^2$). All observed lamprey at this site were small (32-48 mm). Within this 50 m reach, the estimated number of lamprey is 968, with an mass density (g/m^2) of 0.39, and a total estimated biomass within the reach of 138 grams.

Table 1. Larval lamprey habitat details from index sites surveyed in the Methow River. Under “Survey Type”, a “Full” indicates that both Type I and Type II habitat were electrofished (when available); “Short” indicates that either Type I habitat or Type II habitat was surveyed. 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; “Edge” indicates this took place 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	River Stream	River KM	Date	Survey Type	%	%	Type I Habitat Type	Primary Fine Sediment (Type I)	Primary Fine Sediment (Type II)	Plot Temp °C (Best)	Thalweg Temp °C
					Type I in 50 m	Type II in 50 m					
Index	Methow	2.9	9/16/16	Full	81%	19%	Side Chan.	Silt	Silt	15.2	15.1
Index	Methow	46.3	9/14/16	Full	88%	12%	Edge	Sand	-	13.6	13.4
Index	Methow	67.6	9/14/16	Short	25%	75%	Edge	Sand	Coarse	15.1	14.8
Index	Methow	100.4	9/15/16	Short	67%	33%	Side Chan.	Silt	Coarse	16.0	12.5

Table 4. Lamprey population and biomass estimates within a 50 m reach, separated by habitat type, for the Methow River index sites surveyed in September, 2016. “Estimated # of Pacific Lamprey” is assumed the same as “Estimated # of Lamprey” based on the fact that Pacific Lamprey is the only species confirmed to reside in the Methow Subbasin. 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	Methow	46.3	Type I	355	2.7	968	968	0.20	0.39	138
Index	Methow	46.3	Type II	50	-	-	-	-	-	-
Site Summary		46.3		405	2.7	968	-	0.20	0.39	138
Habitat Summary		-	Type I	355	2.7	968	-	0.20	0.39	138
			Type II	50	-	-	-	-	-	-

Additional Index Site Observations

- **River km 2.9** – This site was composed of a long, wide channel along the mainstem. The majority of the water was shallow; but along the bank, providing access to the island, there was a deep pool with aquatic grasses and schools of small fish. The pool was too deep to shock safely. After crossing to the island, silt and sand sediment was seen covering much of the channel. Moving from Type I to Type II habitat, cobble began to appear. Water turbidity was high and slow to settle, indicating a slow water flow; though a clear day, with less water glare, created very good visibility. Small worms, aquatic beetles, and small fish were seen; but no lamprey were observed while shocking.
- **River km 46.3** – Located at a public fishing access area so there was evidence of being a high traffic area, some garbage along the banks in between rocks, footprints, and while we were there conducting the survey, an elderly couple showed up with their two dogs. The best Type I habitat was located around three logs where a mixture of silt and sand collected with woody debris. All observed lamprey came from this spot. The middle of the river was a deep pool and there was some sediment located on the across bank but this side was the best.
- **River km 67.6** – This site was located just above the confluence of the Twisp River and there was only a very small section to sample. It was composed of course sand on top of cobble and no lamprey were observed. The sample area wasn't very deep and most likely washes out every season. There appeared to be some sediment across the river on the other side of a deep pool but we were unable to access it.
- **MET-100.4** – Located just upstream of the bridge in a small backwater area that was once the confluence of a side channel was composed of a large amount of silt compared to the RK90.3 just downstream. Area had no flow so got turbid fast, sculpin, worms, leeches, and beetles were seen while shocking but no lamprey were observed. The sediment appeared to be ideal but was not very deep and was layered on top of gravel and cobble

YN Exploratory Sites - Methow River Mainstem

- A total of three exploratory sites were surveyed in the Methow River. One larval lamprey was found at river km 79.6 (site occupancy 33.3%). This lamprey was 14 mm in total length (young of the year size class).

Table 5. Larval lamprey habitat details from exploratory sites surveyed in the Methow River. Under “Survey Type”, a “Full” indicates that both Type I and Type II habitat were electrofished (when available); “Short” indicates that either Type I habitat or Type II habitat was surveyed; “Visit” indicates that a sites was visited, but no electrofishing occurred. 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; “Edge” indicates this took place 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 Habitat Type	Primary Fine Sediment (Type I)	Primary Fine Sediment (Type II)	Plot Temp °C (Best)	Thalweg Temp °C
					in 50 m	in 50 m					
Expl.	Methow	79.6	9/14/16	Short	-	-	-	-	-	-	-
Expl.	Methow	80.2	9/14/16	Visit	-	-	-	-	-	-	-
Expl.	Methow	90.3	9/15/16	Short	59%	41%	Edge	coarse	Silt	11.2	10.8

Table 6. Survey details, separated by habitat type, for Methow River exploratory sites surveyed in September, 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.	Methow	79.6	Type I	60	1	1	1	5	1	1.0
Expl.	Methow	80.2	Type I	0	0	0	0	-	-	-
Expl.	Methow	90.3	Type I	451	8	0	0	5	-	-
Expl.	Methow	79.6	Type II	0	-	-	-	-	-	-
Expl.	Methow	80.2	Type II	0	-	-	-	-	-	-
Expl.	Methow	90.3	Type II	366	6	0	0	5	-	-
		79.6		60	1	1	1		1	1.0
Site Summary		80.2	-	0	0	0	0	-	0	0.0
		90.3		817	14	0	0		0	0.0
Habitat Summary		-	Type I	451	9	1	1	-	1	1.0
			Type II	366	6	0	0		-	-

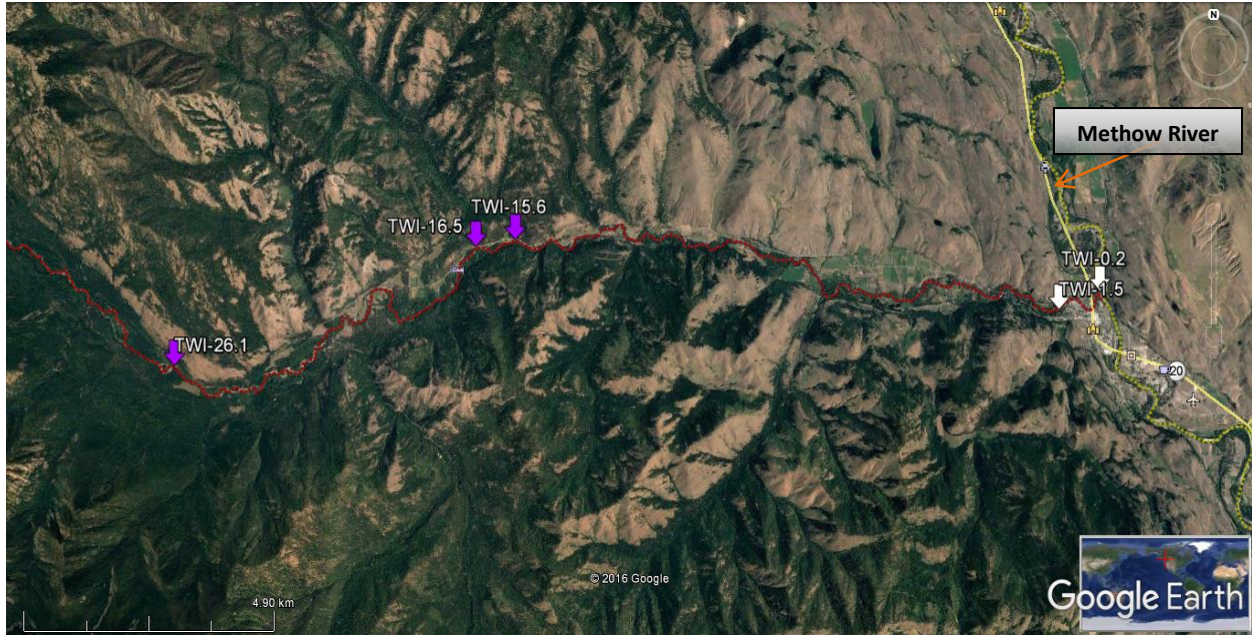
Table 8. Measurement details of captured lampreys, separated by habitat type, for the Methow River exploratory sites surveyed in September, 2016 (sites without lampreys are excluded). The summary rows are a sum of presented values, except for mean weight, mean length and mean condition factor, which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

Site Type	River 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.	Methow	79.6	Type I	0	-	-	14	14	14	-
Expl.	Methow	79.6	Type II	-	-	-	-	-	-	-
Site Summary		79.6	-	0	-	-	14	14	14	-
Habitat Summary		-	Type I	0	-	-	14	14	14	-
			Type II	-	-	-	-	-	-	-

Additional Exploratory Site Summaries

- **River km 79.6** – This site was briefly shocked in a small pool in a side channel. We walked in from the mostly dried up side channel and found a deep pool with a very steep bank that had some fine sediment there composed of mostly silt then sand, we found one larva here. Type I was about 4m² and Type II was about 7m² but was located in the deeper water we couldn't access. Water quality pH was 8.2, conductivity 128, Type I plot temp 14.58*, sediment temp 13.49*. We walked up along the river to RK80.2 and no other habitat was observed in between the two points.
- **River km 80.2** – Located at the beginning of the river bend and also the beginning of a dried up side channel. The habitat available was easily accessible but was only located in a thin section along the bank where the roots of the grasses met the water and had collected sediment. It was composed of compact fine sand mixed with coarse sand.
- **River km 90.3** – Traveled to the sites on this stretch of road and this site had the best habitat available. The sediment here collected behind a washed out tree at the confluence of a small side channel. The best habitat was collected immediately after the tree and was composed of a mix of fine and coarse sand and some woody debris spaced around. The area had other small amounts of Type I and Type II that was either surrounded by cobble or placed directly on top of. Small sculpin, worms, and aquatic grubs were seen during the survey but no lamprey were observed.

YN Exploratory Sites – Twisp River



Map 2. Overview of all sites in the Twisp River (red line) in September, 2016 displaying Yakama Nation surveyed exploratory sites (white arrows) and visited exploratory sites where electrofishing did not occur (purple arrows).

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

Table 14. Larval lamprey habitat details from exploratory sites surveyed in the Twisp River. Under “Survey Type”, a “Full” indicates that both Type I and Type II habitat were electrofished (when available); “Short” indicates that either Type I habitat or Type II habitat was surveyed; “Visit” indicates that a sites was visited, but no electrofishing occurred. 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”, “Alcove.” indicates that the primary survey location (for Type I habitat) was in an alcove; “Edge” indicates this took place on the edge of the main channel. 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.	Twisp	0.2	9/14/16	Short	31%	69%	Alcove	Silt	-	16.1	15.6
Expl.	Twisp	1.5	9/15/16	Short	67%	33%	Edge	Silt	-	13.2	16.0
Expl.	Twisp	15.6	9/15/16	Visit	-	-	-	-	-	-	-
Expl.	Twiso	16.5	9/15/16	Visit	0%	0%	-	-	-	-	-
Expl.	Twiso	26.1	9/15/16	Visit	0%	0%	-	-	-	-	-

Table 15. Survey details, separated by habitat type, for Twisp River exploratory sites surveyed in September, 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.	Twisp	0.2	Type I	286	4	0	0	5	-	-
Expl.	Twisp	1.5	Type I	516	7.5	0	0	3	-	-
Expl.	Twisp	0.2	Type II	0	-	-	-	-	-	-
Expl.	Twisp	1.5	Type II	0	-	-	-	-	-	-
Site Summary		0.2	-	286	4	0	0		-	
		1.5		516	8	0	0			
Habitat Summary			Type I	802	12	0	0		-	
			Type II	-	-	-	-			

Additional Exploratory Site Observations

- **River km 0.2** – This site was located just above the confluence, on the outside of a bend, in one of the braided channels. This area looks like it washes out every season. The whole area is composed of easily moved cobbles and gravel. The sediment here collected in a bend where the roots of the vegetation on the bank met the water and the compacted silt and fine sand wasn't very deep. It was only a thin strip along the bank and only worms observed, no lamprey. We walked the entire area checking both banks and this was the only habitat at the mouth of the Twisp River.
- **River km 1.5** – To access the area we parked up top by the houses and walked down a defined trail to the river. We walked the area till we found a small backwater area that was created from the lower water level. It was a small deep pool that collected sediment, due to the steep bank and deep water level we were not able to access the very bottom of the pool but instead shocked the sides as low as we could. The bank was hard and compact as the sediment was caught in the roots of the vegetation again. The sediment was mostly composed of silt and sand with some gravel mixed in. Sculpin, worms, and aquatic beetles were observed; but no lamprey were seen.
- **River km 15.6** – Only visited, did not shock. The only sediment found was a very thin section of sand collected behind a large boulder. This was located just above the confluence of a small stream that flows under the road through a large culvert.
- **River km 16.5** – This area was observed from the road due to lack of parking and no trespassing signs. There didn't appear to be any good habitat to sample so only 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. s were taken from the truck.

- **River km 26.1** – Again, lack of parking and no trespassing resulted in 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. s being taken from the road. There didn't appear to be any good habitat or any sediment collection of any kind and the small side channel was completely dried up. Just downstream of this there was some sort of construction along the river.

YN Index Sites - Chewuch River

- One index site was surveyed in the Chewuch River. Larval lamprey (a total of six) were captured at this site (site occupancy 100%).
- Captured lamprey lengths ranged from 21 to 50 mm.
- The density of captured lamprey was lower than river km 46.3 in the mainstem Methow River (1.9 #/m²). A small number of lamprey are estimated to reside in this 50 m reach (23).



Map 3. Overview of all surveyed sites in the Methow River (red line) in September, 2016 displaying Yakama Nation surveyed index sites (green arrows) and surveyed exploratory sites where electrofishing occurred (white arrows).

Table 9. Larval lamprey habitat details from index sites surveyed in the Chewuch River. Under “Survey Type”, a “Full” indicates that both Type I and Type II habitat were electrofished (when available); “Short” indicates that either Type I habitat or Type II habitat was surveyed. 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; “Edge” indicates this took place on the edge of the main channel. 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 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)		
Index	Chewuch	19.3	9/15/16	Short	48%	52%	Edge	coarse	-	9.8	9.7

Table 10. Survey details, separated by habitat type, for Chewuch River index sites surveyed in September, 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	Chewuch	19.3	Type I	469	7	6	12	4	13	1.9
Index	Chewuch	19.3	Type II	0	-	-	-	-	-	-
Site Summary		19.3	-	469	7	6	12	-	13	1.9
Habitat Summary		-	Type I	469	7	6	12	-	13	1.9
			Type II	0	-	-	-	-	-	-

Table 11. Measurement details of captured lampreys, separated by habitat type, for the Chewuch River index sites surveyed in September, 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	Mean	Min. Length (mm)	Max. Length (mm)	Mean Length (mm)	Mean Condition Factor
					Weight of Captured (g)	Weight of Captured (g)				
Index	Chewuch	19.3	Type I	0	-	-	21	50	35	-
Index	Chewuch	19.3	Type II	0	-	-	-	-	-	-
Site Summary		19.3	-	0	-	-	21	50	35	-
Habitat Summary		-	Type I	0	-	-	21	50	35	-
			Type II	0	-	-	-	-	-	-

Table 12. Lamprey population and biomass estimates within a 50 m reach, separated by habitat type, for the Chewuch River index sites surveyed in September, 2016. “Estimated # of Pacific Lamprey” is assumed the same as “Estimated # of Lamprey” based on the fact that Pacific Lamprey is the only species confirmed to reside in the Methow Subbasin. 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	Chewuch	19.3	Type I	12	1.9	23	23	-	-	-
Index	Chewuch	19.3	Type II	13	-	-	-	-	-	-
Site Summary		19.3	-	25	1.9	23	23	-	-	-
Habitat Summary		-	Type I	12	1.9	23	23			
			Type II	13	-	-	-			

Additional Index Site Observations

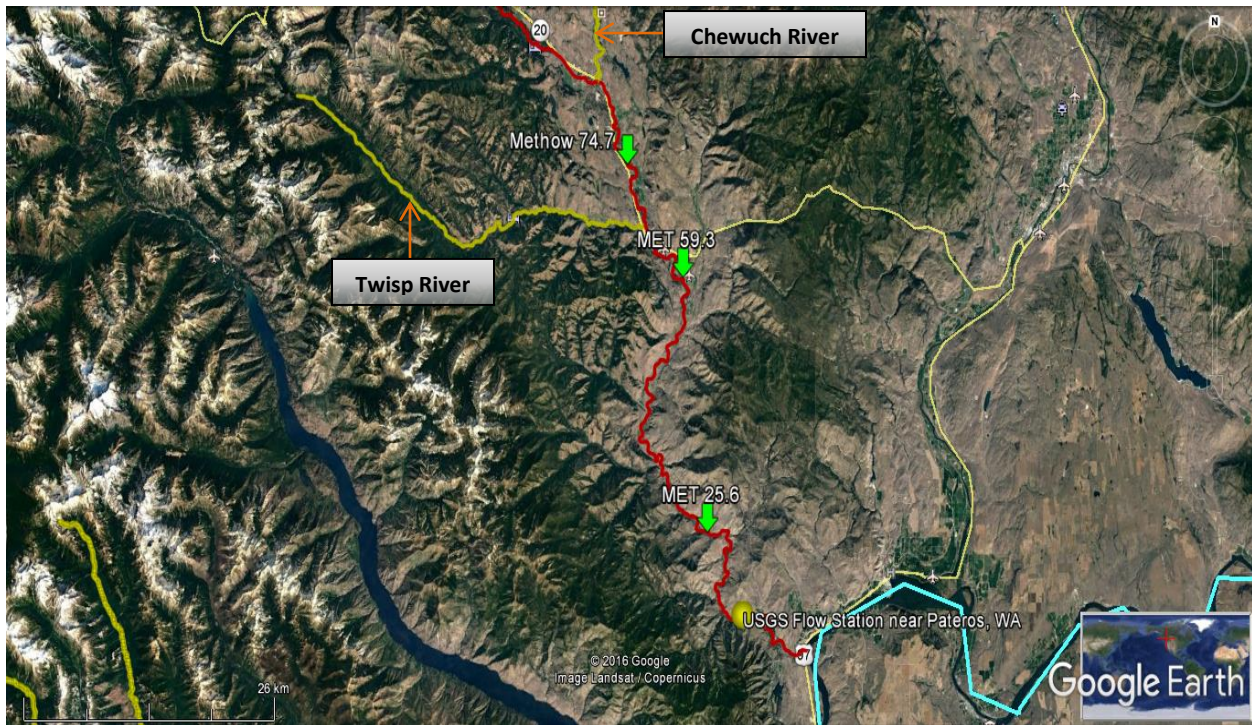
- River km 19.3 – This area was located just below a public camping/parking area. There was a small trail that led down to the site and was somewhat highly travel due to the amount of footprints observed. The sediment collected was along a pool on the outside of a river bend in a backwater area. The sediment was a mixture of mostly fine and coarse sand with small amounts of detritus and debris layered on top. Larval lamprey were observed in this area.

Index Sites Established by Jon Crandall (Methow Salmon Recovery)

- Jon Crandall (Methow Salmon Recovery) established long-term monitoring sites within the Methow and Chewuch rivers in 2008. Since then, Crandall has surveyed these sites each year. Since 2014, the Yakama Nation Pacific Lamprey Project has aided Jon Crandall with these surveys. The following is a summary of Jon Crandall’s information he collected in 2016. His survey methods differ from that of Yakama Nation, but the common information collected between Yakama Nation and Jon Crandall are presented.

Jon Crandall Index Sites - Methow River Mainstem

- The following section presents data collected by Jon Crandall. Pacific Lamprey was present at two of the three index sites (66.7%). Survey area data is missing from river km 25.6. At river km 25.6, a total of 121 lamprey were captured, with an average length of 46 mm. However, upstream at river km 59.3, a total of 59 lamprey were captured, with an average length of 100 mm. Young of the year larvae (< 36 mm) were captured at both of the sites when lamprey was present.



Map 4. Overview of index sites (green arrows) established by Jon Crandall in the Methow River (red line) that were surveyed in August, 2016, with the help of Yakama Nation. The location of a USGS Flow Station (near Peshastin, WA; river km 10.1) is also shown (yellow circle).

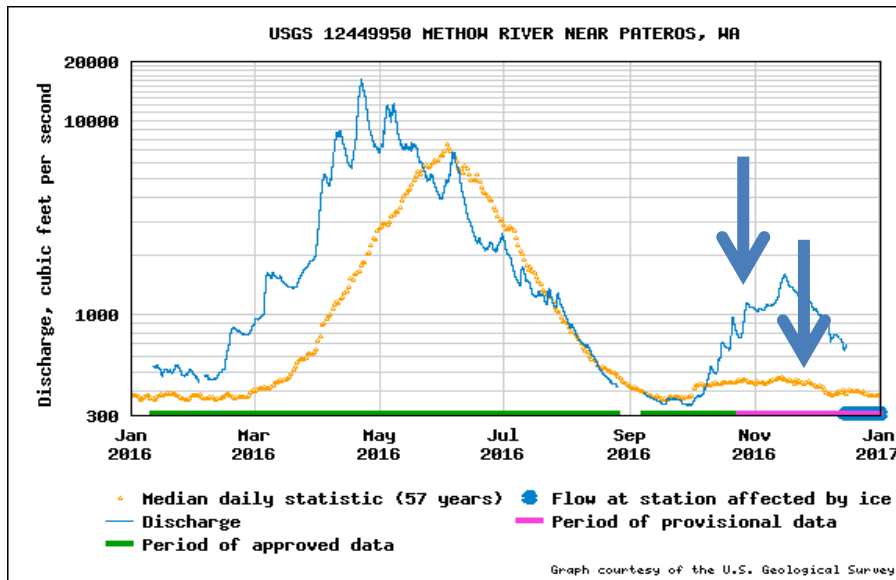


Figure 2. Discharge (cubic feet per second indicated by the narrow blue line) of the Methow River near Pateros, WA (river km 10.1) in 2016; blue arrow indicates JC survey period (August and September, 2016).

Table 13. Larval lamprey habitat details from Jon Crandall’s index sites surveyed in the Methow River. Under “Survey Type”, a “Full” indicates that both Type I and Type II habitat were electrofished (when available); “Short” indicates that either Type I habitat or Type II habitat was surveyed. 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; “Edge” indicates this took place 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	% of habitat		Type I Habitat Type	Primary Fine Sediment (Type I)	Primary Fine Sediment (Type II)	Plot Temp (Best) °C	Thalweg Temp °C
					in 50 m	in 50 m					
Index	Methow	25.6	8/29/16	-	-	-	-	-	-	15.0	-
Index	Methow	59.3	9/14/16	-	-	-	-	-	-	10.4	-
Index	Methow	74.7	8/29/16	-	-	-	-	-	-	16.5	-

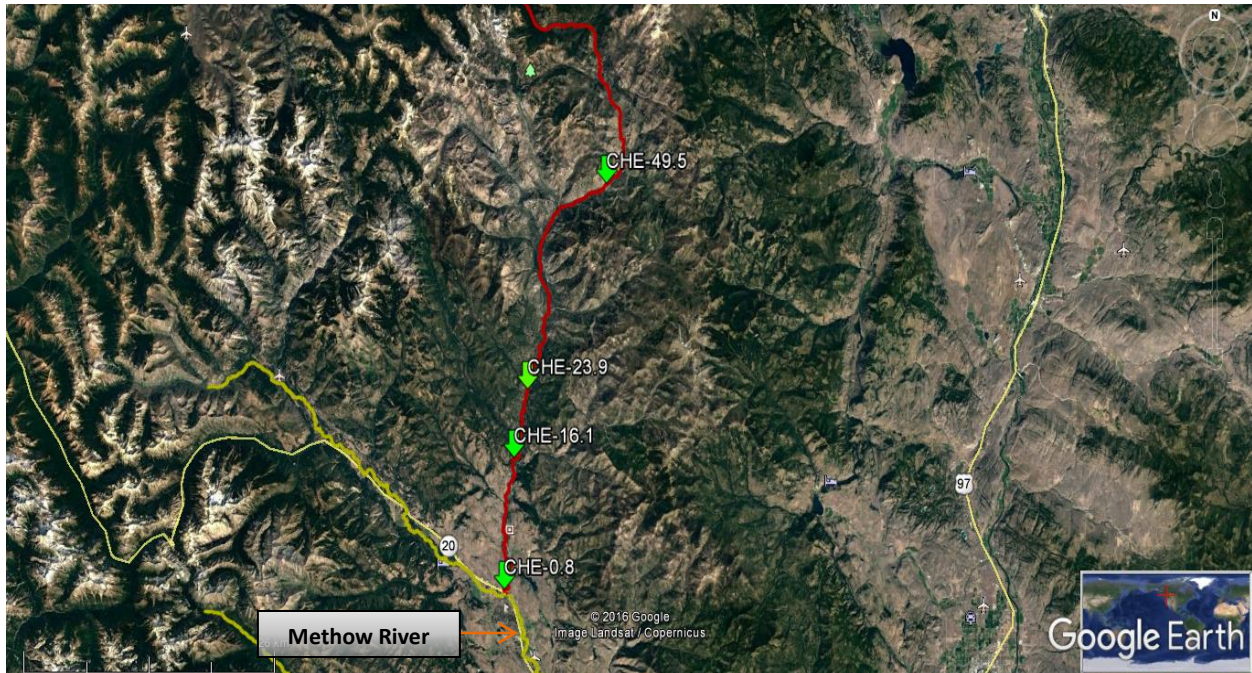
Table 14. Survey details, separated by habitat type, for Jon Crandall’s Methow River index sites surveyed in August and September, 2016. “Type I/II” indicates that both Type I and Type II habitat were surveyed together. The total number of lampreys observed was adjusted (increased) based on the following 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	Methow	59.3	Type I/II	888	41	59	61	-	-	1.5
Index	Methow	74.7	Type I/II	1160	114	0	0	-	-	0.0

Table 15. Measurement details of captured lampreys, separated by habitat type, for Jon Crandall's Methow River index sites surveyed in August and September, 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
Index	Methow	25.6	Type I/II	0	-	-	21	153	46	-
Index	Methow	59.3	Type I/II	0	-	-	22	140	100	-

Jon Crandall Index Sites – Chewuch River



Map5. Overview of index sites (green arrows) established by Jon Crandall in the Chewuch River (red line) that were surveyed in August, 2016, with the help of Yakama Nation.

Table 16. Larval lamprey habitat details from Jon Crandall’s index sites surveyed in the Chewuch River. Under “Survey Type”, a “Full” indicates that both Type I and Type II habitat were electrofished (when available); “Short” indicates that either Type I habitat or Type II habitat was surveyed. 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; “Edge” indicates this took place 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 Habitat Type	Primary	Primary	Plot	Thal-
					Type I in 50 m	Type II in 50 m		Fine Sediment (Type I)	Fine Sediment (Type II)	Temp °C (Best)	weg Temp °C
Index	Chewuch	0.8	7/21/16	-	-	-	-	-	-	-	-
Index	Chewuch	16.1	7/21/16	-	-	-	-	-	-	-	-
Index	Chewuch	23.9	7/21/16	-	-	-	-	-	-	-	-
Index	Chewuch	28.6	7/21/16	-	-	-	-	-	-	-	-
Index	Chewuch	49.5	7/21/16	-	-	-	-	-	-	-	-

Table 17. Survey details, separated by habitat type, for Jon Crandall’s Chewuch River index sites surveyed in September, 2016. “Type I/II” indicates that both Type I and Type II habitat were surveyed together. 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	Chewuch	0.8	Type I/II	894	129	1	1	-	-	0.01
Index	Chewuch	16.1	Type I/II	3388	219	198	211	-	-	0.96
Index	Chewuch	23.9	Type I/II	2255	210	2	3	-	-	0.01
Index	Chewuch	28.6	Type I/II	631	56	0	0	-	-	0.00
Index	Chewuch	49.5	Type I/II	1848	168	0	0	-	-	0.00

Table 18. Measurement details of captured lampreys, separated by habitat type, for Jon Crandall’s Chewuch River index sites surveyed in August and September, 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	Mean	Min. Length (mm)	Max. Length (mm)	Mean Length (mm)	Mean Condition Factor
					Weight of Captured (g)	Weight of Captured (g)				
Index	Chewuch	0.8	Type I/II	0	-	-	106	106	106	-
Index	Chewuch	16.1	Type I/II	0	-	-	20	190	62	-
Index	Chewuch	23.9	Type I/II	0	-	-	93	165	129	-

Collected Genetic Samples - Methow Subbasin

Table 19. Summary of larval lamprey genetic samples collected from the Methow River in August and September, 2016 through the efforts of Yakama Nation and Jon Crandall (Methow Salmon Recovery).

Stream Name	River KM	Collection Date	#				Primary Collection Purpose
			# of Pacific Samples (Larvae)	# of Pacific Samples (Macro.)	# of Western Brook Samples	Unknown Species Samples (< 50 mm)	
Methow	26.5	8/29/16	0	0	0	14	Translocaiton Success
Methow	46.3	9/14/16	0	0	0	10	Translocaiton Success
Methow	59.3	9/14/16	0	0	0	10	Translocaiton Success
Methow	67.6	9/14/16	0	0	0	0	Translocaiton Success
Methow	79.6	9/14/16	0	0	0	1	Translocaiton Success
Total			0	0	0	35	-

Table 20. Summary of larval lamprey genetic samples collected from the Chewuch River in August and September, 2016 through the efforts of Yakama Nation and Jon Crandall (Methow Salmon Recovery).

Stream Name	River KM	Collection Date	#				Primary Collection Purpose
			# of Pacific Samples (Larvae)	# of Pacific Samples (Macro.)	# of Western Brook Samples	Unknown Species Samples (< 50 mm)	
Chewuch	19.3	9/15/16	0	0	0	5	Translocaiton Success
Chewuch	16.1	8/31/16	2	0	0	20	Translocaiton Success
Total			2	0	0	25	

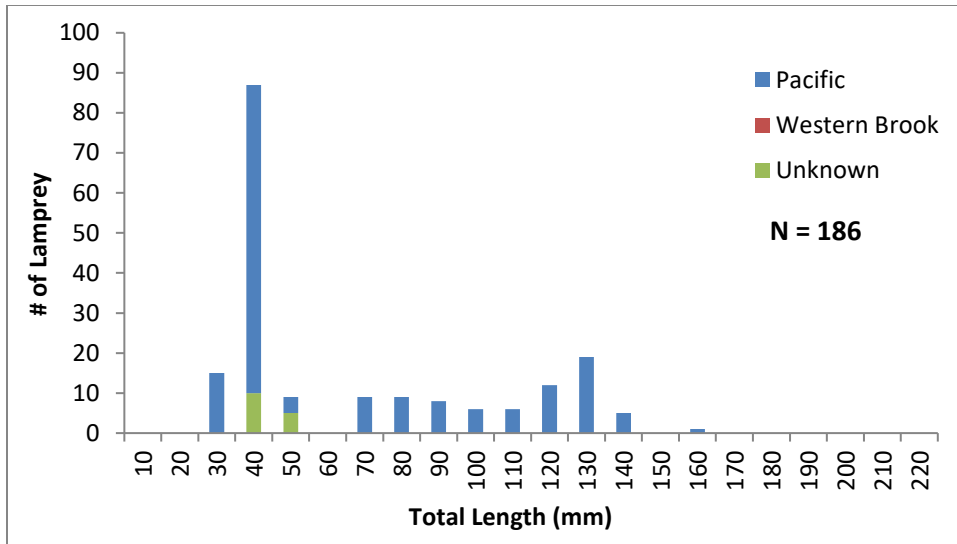


Figure 1. Histogram of all measured lampreys captured during electrofishing surveys (by both YN surveys and Jon Crandall surveys) separated by species (“PA”= Pacific Lamprey (blue), “UN”=Unknown Lamprey <50 mm (green)), in the Methow River in August and September, 2016.

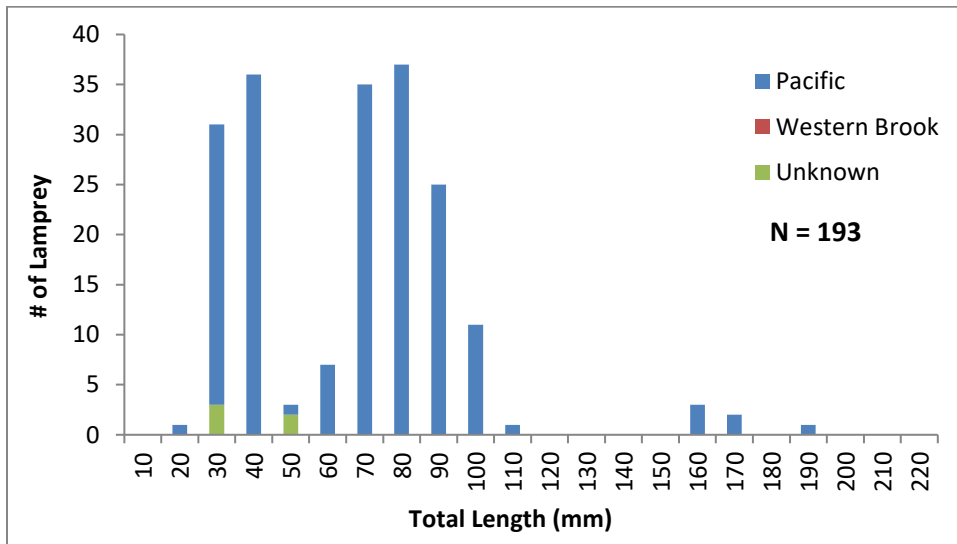
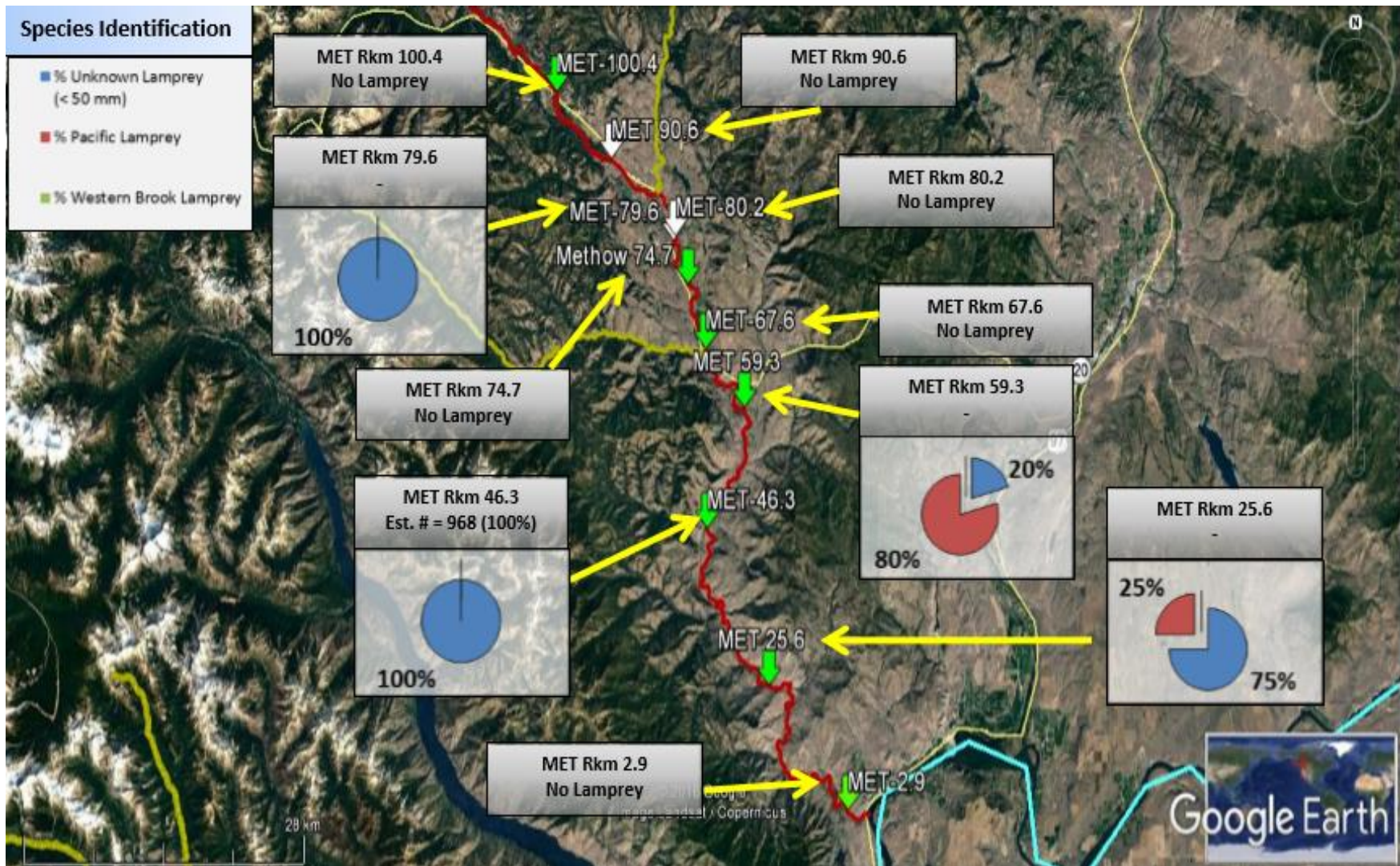
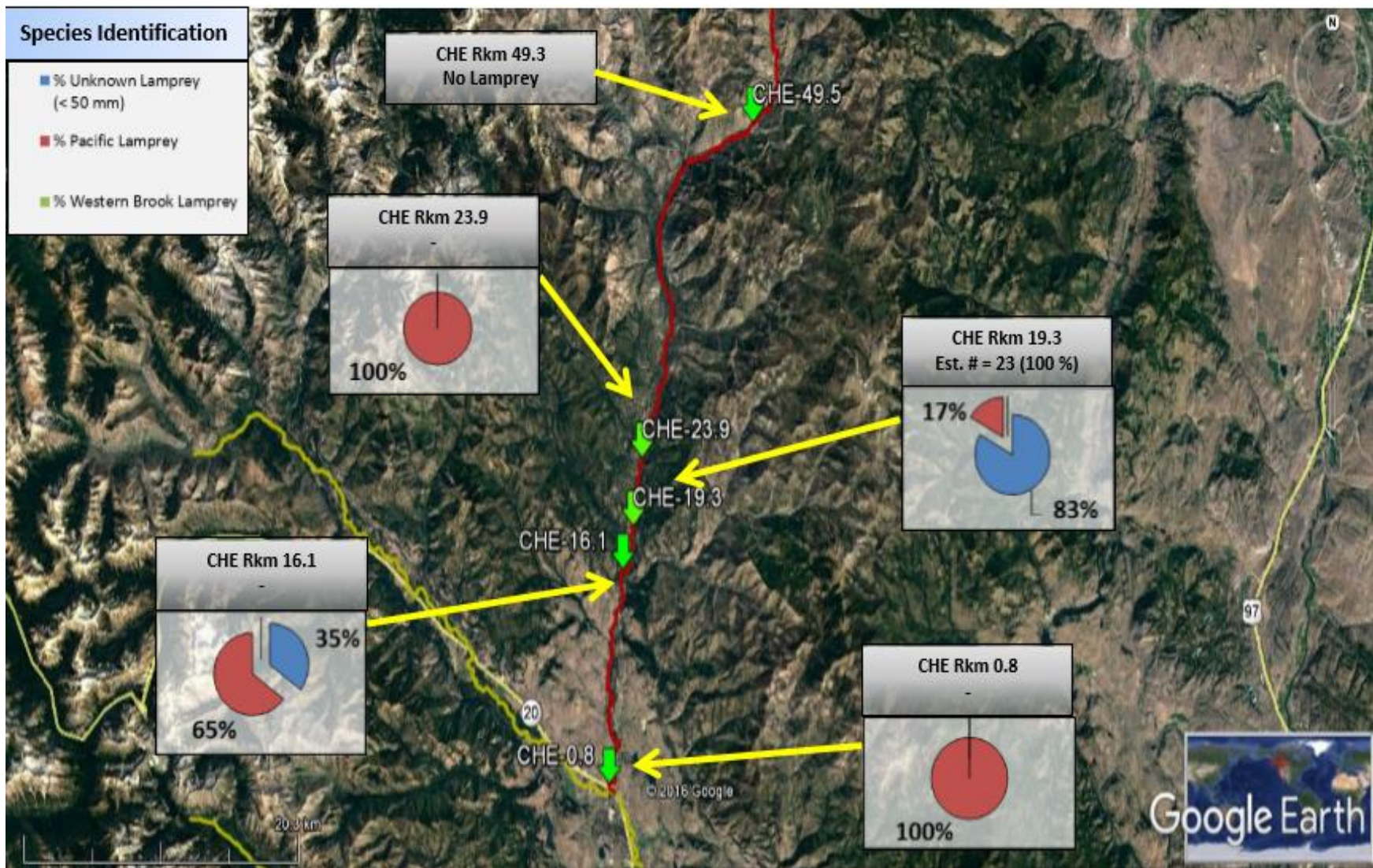


Figure 2. Histogram of all measured lampreys captured during electrofishing surveys, separated by species (“PA”= Pacific Lamprey (blue), “UN”=Unknown Lamprey <50 mm (green)), in the Chewuch River in August and September, 2016.



Map 6. Displayed is the distribution of Unknown Lamprey <50 mm (blue), Pacific Lamprey (red) and Western Brook Lamprey (green) in the Methow River from August and September, 2016 electrofishing surveys (performed by Yakama Nation and Jon Crandall). 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).



Map 7. Displayed is the distribution of Unknown Lamprey <50 mm (blue), Pacific Lamprey (red) and Western Brook Lamprey (green) in the Chewuch River from August and September, 2016 electrofishing surveys (performed by Yakama Nation and Jon Crandall). 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 (Yakama Nation Survey Sites)

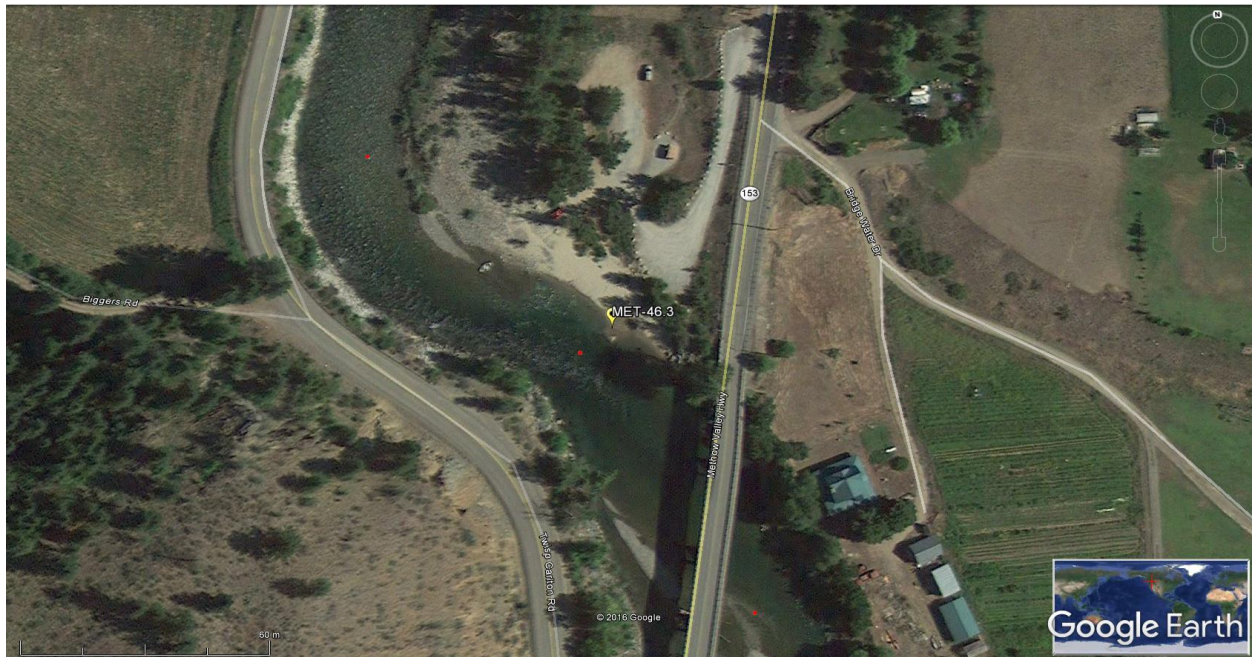
Methow River Mainstem



Map A1. Site map of Methow River index site at river km 2.9 (surveyed in September 2016); white balloon indicates that no lamprey were present at this site. The small red dots indicate stream distance of 100 m.



Photo A1. Methow River index site at river km 2.9; upstream view of site (left) and close-up of best Type I habitat sediment composed of silt/sand (right) from 2016 survey.



Map A2. Site map of Methow River index site at river km 46.3 (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. Methow River index site at river km 46.3; overview of Type I habitat (left) and close-up of best Type I habitat sediment composed of fine/course sand (right) from 2016 survey.



Map A3. Site map of Methow River site at river km 67.6 (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. Methow River index site at river km 67.6; overview of Type I habitat (left) and close-up of best Type I habitat sediment composed of fine/course sand (right) from 2016 survey.



Map A4. Site map of Methow River exploratory site at river km 79.6 (visited in September, 2016); purple balloon indicates that no electrofishing survey took place in 2016. The small red dots indicate stream distance of 100 m.



Map A5. Site map of Methow River exploratory site at river km 80.2 (visited in September, 2016); purple balloon indicates that no electrofishing survey took place in 2016. The small red dots indicate stream distance of 100 m.



Photo A4. Methow River exploratory site at river km 80.2; overview of Type I habitat (left) and close-up of best Type I habitat sediment composed of silt/sand (right) from 2016 survey.



Map A6. Site map of Methow River exploratory site at river km 90.3 (surveyed in September 2016); white balloon indicates that no lamprey were present at this site. The small red dots indicate stream distance of 100 m.



Photo A5. Methow River exploratory site at river km 90.3; overview of Type I habitat (left) and close-up of best Type I habitat sediment composed of fine/course sand (right) from 2016 survey.



Map A7. Site map of Methow River index site at river km 100.4 (surveyed in September 2016); white balloon indicates that no lamprey were present at this site. The small red dots indicate stream distance of 100 m.



Photo A6. Methow River index site at river km 100.4; overview of Type I habitat (left) and close-up of best Type I habitat sediment composed of silt/clay (right) from 2016 survey.

Methow River Tributaries

Twisp River



Map A8. Site map of Twisp River exploratory site at river km 0.2 (surveyed in September 2016); white balloon indicates that no lamprey were present at this site. The small red dots indicate stream distance of 100 m.



Photo A7. Twisp River exploratory site at river km 0.2; 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 Twisp River exploratory site at river km 1.5 (surveyed in September 2016); white balloon indicates that no lamprey were present at this site. The small red dots indicate stream distance of 100 m.



Photo A8. Twisp River exploratory site at river km 1.5; overview of best Type I habitat (left) and close-up of best Type I habitat sediment composed of silt/clay (right) from 2016 survey.



Map A10. Site map of Twisp River exploratory site at river km 15.6 (visited in September, 2016); purple balloon indicates that no electrofishing survey took place in 2016. The small red dots indicate stream distance of 100 m.



Photo A9. Twisp River exploratory site at river km 15.6; overview of site (left) and close-up of best habitat (right) from 2016 survey.



Map A11. Site map of Twisp River exploratory site at river km 16.5 (visited in September, 2016); purple balloon indicates that no electrofishing survey took place in 2016. The small red dots indicate stream distance of 100 m.



Photo A10. Twisp River exploratory site at river km 16.5; overview of site (left) and (right) from 2016 survey.



Map A12. Site map of Twisp River exploratory site at river km 26.1 (visited in September, 2016); purple balloon indicates that no electrofishing survey took place in 2016. The small red dots indicate stream distance of 100 m.



Photo A11. Twisp River exploratory site at river km 26.1; downstream (left) and upstream (right) view of site from 2016 survey.

Chewuch River



Map A13. Site map of Chewuch River index site at river km 19.3 (surveyed in September, 2016); red balloon indicates presence of Pacific Lamprey. The small red dots indicate stream distance of 100 m.



Photo A12. Chewuch River index site at river km 19.3; overview of Type I habitat (left) and close-up of best Type I habitat sediment composed of sand (right) from 2016 survey.