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

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

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Abstract

This report is composed of two parts: 1) summary of all 2016-2017 broodstock adult Pacific Lamprey releases within the Wenatchee Subbasin and 2) analysis of migration data from PIT tagged adults. From the 2016-2017 broodstock (adults collected in summer 2016 that primarily mature in 2017), a total of 306 adult Pacific Lamprey were released in the Wenatchee Subbasin. Adults were released at nine locations between August 23, 2016, and April 19, 2017. This is the second year that adult Pacific Lamprey were translocated into the Wenatchee Subbasin. Until the recent adult translocation began in 2016 spring, no lamprey have been detected in the Wenatchee River upstream of Tumwater Dam for over two decades despite intensive monitoring efforts conducting larval lamprey electrofishing surveys by Yakama Nation Fisheries and USFWS. Translocation was implemented in 2016 out of concern for the species extinction observed upstream of Tumwater Dam and also to enhance the larval pheromone signal from Upper Wenatchee River to improve adult lamprey attraction.

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

- Within the Tumwater Dam PIT antenna arrays, overall pooled detection percentage from below dam to uppermost PIT antenna arrays within the fish ladder (entrance to weir #18) was estimated to be 6.0%. Due to a lack of upstream antennas, passage success beyond Weir 18 is not estimable from our data.
- Overall, 23.2% of PIT tagged lamprey released within the Wenatchee Subbasin were detected at least once.
- Sites that detected lamprey the most were TUF (Tumwater Dam Adult Fishway, Wenatchee river km 49.6; 26 lamprey), UWE (Upper Wenatchee River, river km 80.9; 21 lamprey), and LWE (Lower Wenatchee River, river km 2.7; 15 lamprey).
- Estimated detection efficiencies at some of the instream arrays were considerably low (especially UWE <11.1%, LWE = 45-50%, NAL <50.0), but likely higher compared to detection rates during spring high flow conditions.
- Among the lamprey detected, the percent of lamprey that were initially detected moving upstream was considerably lower for lamprey released within Tumwater Dam (42.5%) compared to the other releases (average of 84.6%).
- Only the uppermost release (at Wenatchee river km 74.6) resulted in some portion of lamprey being detected within Nason Creek.
- Although fall migration is the primary migration timing observed at major hydro dams, many lamprey migrate considerable distances (e.g. 30-50 km) during the spring final migration within this type of tributary environments.

Part I: Release Summary

From the 2016-2017 broodstock (adults collected in summer 2016, most of which mature in spring/summer 2017), a total of 306 adult Pacific Lamprey were released in the lower to upper reaches of the Wenatchee River between August 23, 2016, and April 19, 2017 (Fig. 1 and Table 1). Overall female ratio was estimated to be 28.8%, PIT tag ratio was 100.0% (only 9 mm tags for the fall release and 67:33 ratio for 9 and 12 mm tags for the spring release), and genetic tag ratio was 98.7% (Table 2). All lamprey were originally captured from John Day Dam (57.5%), The Dalles Dam (23.2%), or Bonneville Dam (17.0%) in the Lower Columbia River during the summer of 2016 [some lost the source information from shed tags (1.6%) or came from a mixed group of lamprey that were from The Dalles / John Day dams (0.7%)]. Total length averaged 647 mm (min. 540 mm and max. 754 mm), weight averaged 434.9 g (min. 225.2 g and max. 685.6 g), and interdorsal distance averaged 30.8 mm (min. 9.0 mm and max. 48 mm) during the PIT tagging operations in summer 2016 through spring 2017. In addition, one PIT tagged adult was released in mainstem Columbia River upstream of Rocky Reach Dam at river km 756.8 (this lamprey was displayed at the Wenatchee River Salmon Festival and then subsequently released in late September, 2017 – see appendix for more information).

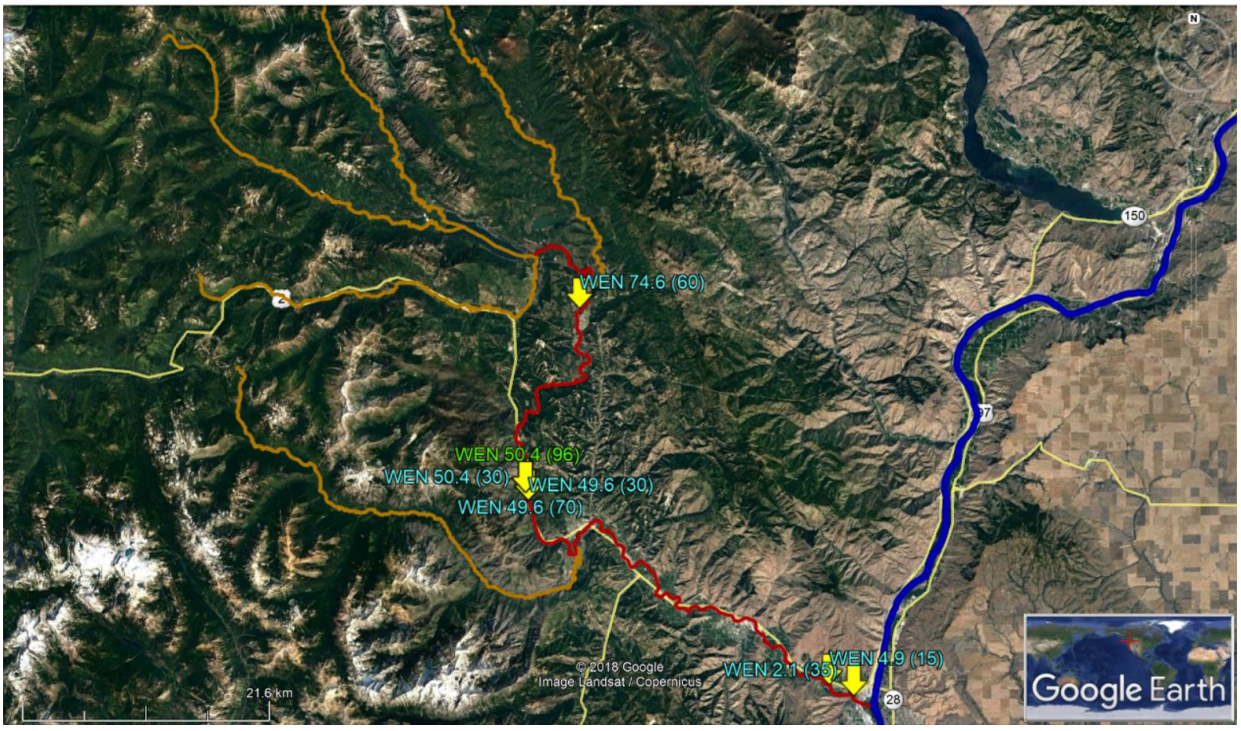

Figure 1. Overall aerial map of 2016-2017 broodstock Pacific Lamprey translocation release sites in the *Wenatchee* Subbasin. "*WEN*" stands for *Wenatchee*, the number next to the stream name is the river km, and the number in parenthesis is the total number of lamprey released (blue label indicates fall 2016 releases and green label indicates spring 2017 release). The red line represents mainstem *Wenatchee* River, the orange lines represent key tributaries, and the blue line represents the Columbia River.

Table 1. Summary of 2016-2017 broodstock Pacific Lamprey translocation release information in the Wenatchee Subbasin.

Subbasin	River	RKM	Date	Location	Season	Time	Water Temp (C°)	#
Wenatchee	Wenatchee	2.1	8/23/2016	Downstream of Lower PIT Array	Fall	18:50	20.5	35
Wenatchee	Wenatchee	4.9	8/23/2016	Upstream of Lower PIT Array	Fall	18:00	20.3	15
Wenatchee	Wenatchee	49.6	8/23/2016	Downstream Tumwater Dam	Fall	16:20	17.0	30
Wenatchee	Wenatchee	49.6	9/8/2016	within Tumwater Dam - Pool #2	Fall	21:15	15.0	10
Wenatchee	Wenatchee	49.6	9/8/2016	within Tumwater Dam - Pool #17	Fall	21:00	15.0	10
Wenatchee	Wenatchee	49.6	9/8/2016	within Tumwater Dam - below Counting Station	Fall	20:40	15.0	10
Wenatchee	Wenatchee	49.6	9/8/2016	within Tumwater Dam - Fish Hopper Pool	Fall	20:30	15.0	10
Wenatchee	Wenatchee	50.4	8/23/2016	Jolanda Lake	Fall	13:20	16.8	30
Wenatchee	Wenatchee	74.6	8/23/2016	Upper Release	Fall	14:45	18.5	60
Wenatchee	Wenatchee	50.4	4/19/2017	Jolanda Lake	Spring	12:40	5.6	96
Wenatchee	**Wenatchee**	**-**	**-**	**-**	**-**	**-**	**-**	**306**

Table 2. Summary of 2016-2017 broodstock Pacific Lamprey translocation release data in the Wenatchee Subbasin. "# F" is "# of female lamprey", and "# M" is "# of male lamprey." "(?)" denotes lower certainty with the sex ID. Female Ratio (Est. 1) is based solely on "# F" and "# M", whereas "Female Ratio (Est. 2)" includes "# F (?)" and "# M (?)" in the estimation.

River	RKM	Date	#	# F	# M	# F (?)	# M (?)	# UN	# with 9mm PIT	# with 12mm PIT	# with Genetic Tags	Female Ratio (Est. 1)	Female Ratio (Est. 2)	9mm PIT Tag Ratio	12mm PIT Tag Ratio	Genetic Tag Ratio
Wenatchee	2.1	8/23/2016	35	5	22	1	0	7	35	0	35	19%	21%	100%	0%	100%
Wenatchee	4.9	8/23/2016	15	2	10	0	0	3	15	0	15	17%	17%	100%	0%	100%
Wenatchee	49.6	8/23/2016	30	5	16	0	0	9	30	0	29	24%	24%	100%	0%	97%
Wenatchee	49.6	9/8/2016	10	1	7	0	0	2	10	0	10	13%	13%	100%	0%	100%
Wenatchee	49.6	9/8/2016	10	0	8	0	0	2	10	0	10	0%	0%	100%	0%	100%
Wenatchee	49.6	9/8/2016	10	1	7	0	0	2	10	0	10	13%	13%	100%	0%	100%
Wenatchee	49.6	9/8/2016	10	2	6	0	0	2	10	0	10	25%	25%	100%	0%	100%
Wenatchee	50.4	8/23/2016	30	4	21	0	0	5	30	0	30	16%	16%	100%	0%	100%
Wenatchee	74.6	8/23/2016	60	10	27	0	0	23	60	0	59	27%	27%	100%	0%	98%
Wenatchee	50.4	4/19/2017	96	34	48	5	1	8	64	32	94	41%	44%	67%	33%	98%
Wenatchee	**-**	**-**	**306**	**64**	**172**	**6**	**1**	**63**	**274**	**32**	**302**	**27%**	**29%**	**89.5%**	**10.5%**	**99%**

Lower Wenatchee Release (River KM 2.1 and 4.9)

A total of 35 lamprey were released at river km 2.1 in Lower Wenatchee River 0.7 km upstream of North Wenatchee Avenue (Highway 285) bridge on August 23, 2016 (Fig. 2). An additional 15 lamprey were released upstream of the PIT array on the same day. Water temperature was 20.3-20.5°C during the release. For summer/fall release, we target our releases to take place between 15-20°C.

The primary goal of the two lower releases was two-fold: 1) to release them in the lower reach of the mainstem to allow them to determine their preferred spawning reaches; and 2) to get a better understanding of the detection efficiency of the instream PIT array located at river km 2.7 (LWE arrays) and lamprey behavior above and below this array.

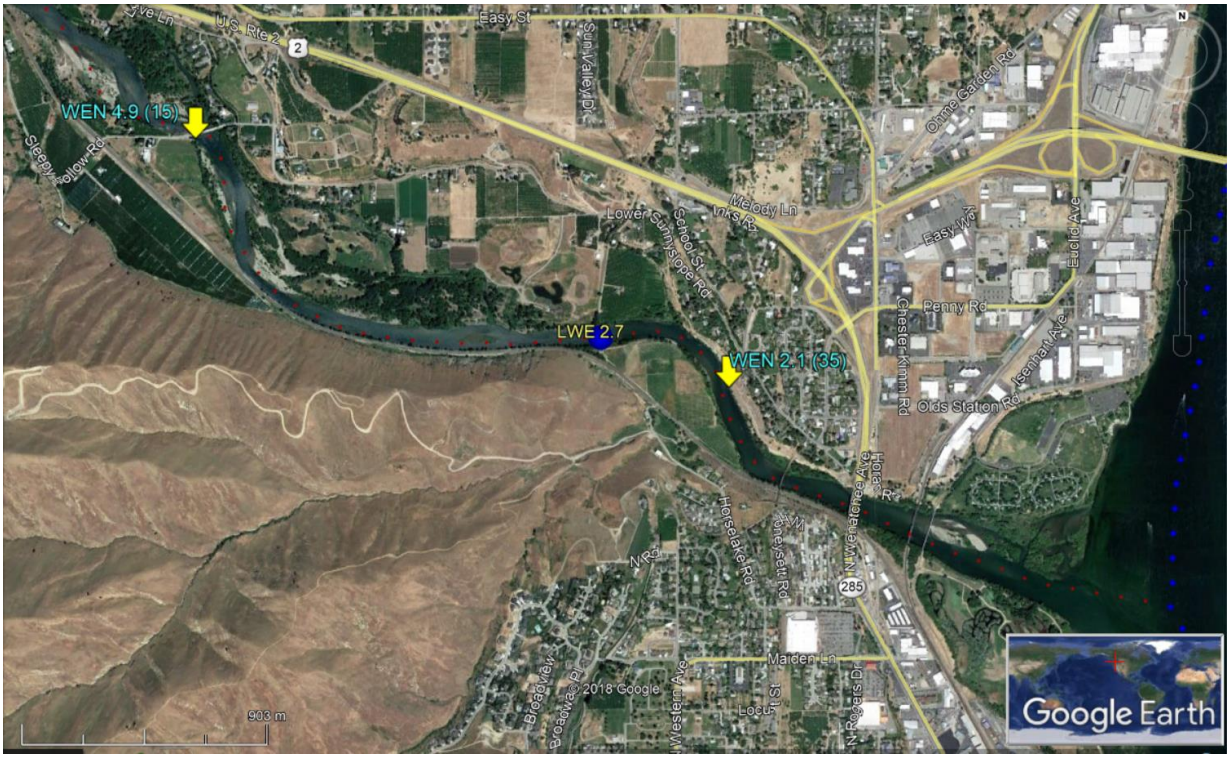

Figure 2. Aerial map of Pacific Lamprey translocation lower release site at Wenatchee river km 2.1 and 4.9 (yellow arrows). The number next to the stream abbreviation is the river km and the number in parenthesis is the total number of lamprey released. Shown with the blue circle is the PIT tag array location (LWE). Also, 0.1 km points along the Wenatchee River (red dots) and mainstem Columbia River (blue dots) are displayed.

Mid Wenatchee Release (River KM 49.6)

A total of 30 lamprey were released at river km 49.6, immediately downstream of Tumwater Dam in slow water habitat, on August 23, 2016 (Fig. 3). An additional 40 lamprey were released in four locations (10 lamprey each) within the Tumwater Dam on September 8, 2016, which were 1) Weir Pool #2, 2) Weir Pool #17, 3) immediately downstream of fish counting station, and 4) within the Fish Hopper pool. Adults with >19 mm interdorsal distance, indicating lack of sexual maturation, were purposefully selected to avoid the inclusion of energy deficient mature lamprey in this group (average was 32.2 mm and max. was 44 mm). Water temperature was 15.0-17.0°C for these two release groups. For summer/fall release, we target our releases to take place between 15-20°C.

The primary goal was to understand the ability of Pacific Lamprey to pass various parts of the Tumwater fish ladder. There are currently five arrays within the fish ladder (TUF arrays; Fig. 3, 4, and 5) but the first three arrays began operating after 3/14/2017 (towards the end of the study period): 1) high flow fish ladder entrance, 2) low flow fish ladder entrance, 3) between Weir Pool #2 and #3, 4) between Weir Pool #13 and #14 (in PTAGIS, it is labeled as “Weir 15”, however), 5) between Weir Pool #17 and #18.

The objective for the release at the Fish Hopper pool was to evaluate whether the pool could hold adult lamprey successfully overnight during the trapping season. The objective for the release just downstream of the fish counting station was to evaluate whether the fish counting station could detect and count all adults that pass the dam (assuming none can pass downstream through the closed upper gate). The objective for the release at Weir Pool #17 was to evaluate whether lamprey would be detected moving upstream to the upper array and potentially past the counting station or downstream to the lower array. The objective for the release at Weir Pool #2 was to evaluate passage from the lowermost section of the fish ladder. The objective for the release downstream of the fish ladder was to understand what portion of the adults would interact and pass the entrance to Tumwater Dam fish ladder and potentially pass through the PIT arrays within the ladder. By releasing them in these key strategic locations, the goal was to gain a better understanding of the passage efficiency and identify potential problematic areas for passage. Until the recent adult translocation began in 2016 spring, no lamprey have been detected in the Wenatchee River upstream of Tumwater Dam despite intensive monitoring efforts conducting larval lamprey electrofishing surveys by Yakama Nation Fisheries and USFWS.

Figure 3. Aerial map of Pacific Lamprey translocation middle release site at Wenatchee river km 49.6. The number next to the stream abbreviation is the river km and the number in parenthesis is the total number of lamprey released. Shown with the blue circles are the PIT tag array locations (TUF). Also, 0.1 km points along the Wenatchee River are displayed as red dots.

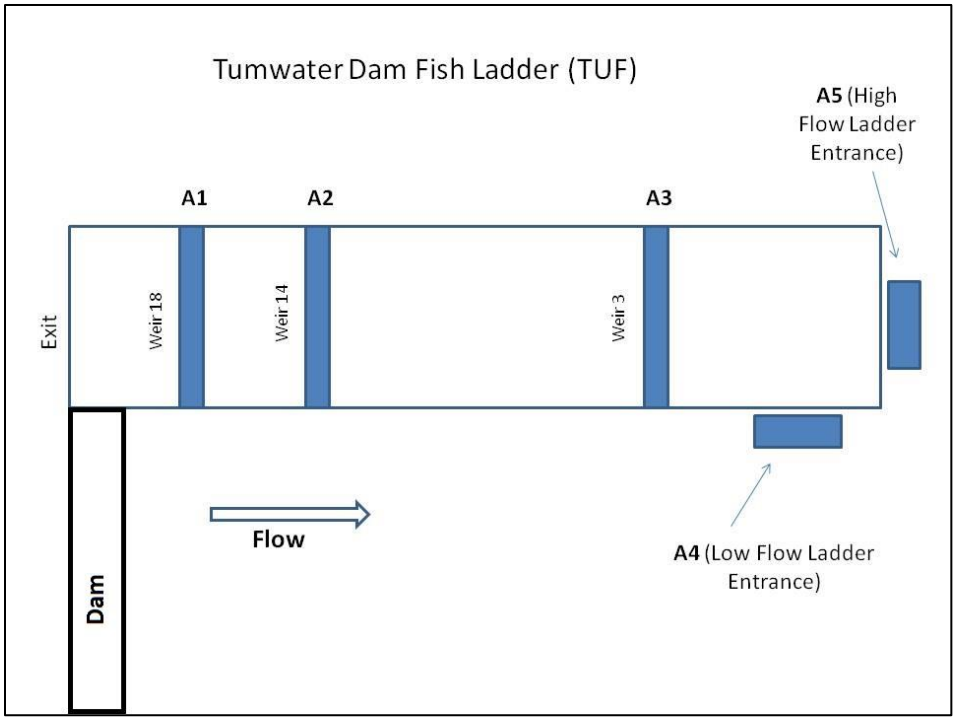

Figure 4. Array locations (5 total) within Tumwater Dam Fish Ladder (from PTAGIS website).

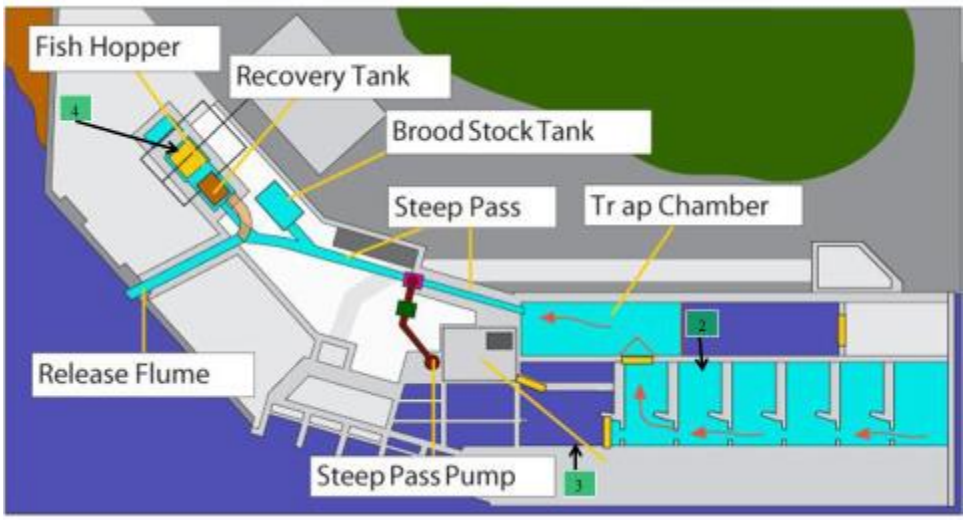

Figure 5. Diagram of the Upper portion of the Tumwater Dam Ladder showing the fish ladder as well as the trapping route. The three upper release locations are also shown (#s in green squares: 2, 3, and 4).

Upper Wenatchee Release #1 (River KM 50.4)

A total of 30 lamprey were released at river km 50.4 in the middle reach of the Wenatchee River just upstream of Tumwater Dam on August 23, 2016 (Fig. 6). An additional 96 overwintered lamprey were released at this same location on April 19, 2017. Water temperature was 16.8°C during the summer/fall release and 5.6°C during the spring release. For summer/fall release, we

target our releases to take place between 15-20°C, and for early spring release, we target our releases to take place when streams/rivers reach 7-12°C.

The primary goal was to understand where Pacific Lamprey will distribute themselves within the Upper Wenatchee River or any of the tributary streams, taking advantage of the existing instream PIT array sites in Upper Wenatchee as well as Chiwawa, Nason, White, and Little Wenatchee watersheds (UWE, CHL, CHU, NAL, NAU, WTL, LMN arrays).

Figure 6. Aerial map of Pacific Lamprey translocation upper release site #1 at Wenatchee river km 50.4. The number next to the stream abbreviation is the river km and the number in parenthesis is the total number of lamprey released. Shown with the blue circle are the PIT tag array locations (TUF and WEN). PIT array at WEN (river km 50.4), however, was not in operation during the release. Also, 0.1 km points along the Wenatchee River are displayed as red dots.

Upper Wenatchee Release #2 (River KM 74.6)

A total of 60 lamprey were released at river km 74.6 in the middle reach of the Wenatchee River at the Highway 209 (Chumstick Highway) bridge crossing in Plain, WA, on August 23, 2016 (Fig. 7). Water temperature was 18.5°C. For summer/fall release, we target our releases to take place between 15-20°C.

The primary goal was to understand where Pacific Lamprey would migrate to on their own within the Upper Wenatchee River or any of the tributary streams, taking advantage of the existing instream PIT array sites in Upper Wenatchee as well as Chiwawa, Nason, White, and Little Wenatchee watersheds (UWE, CHL, CHU, NAL, NAU, WTL, LMN arrays).

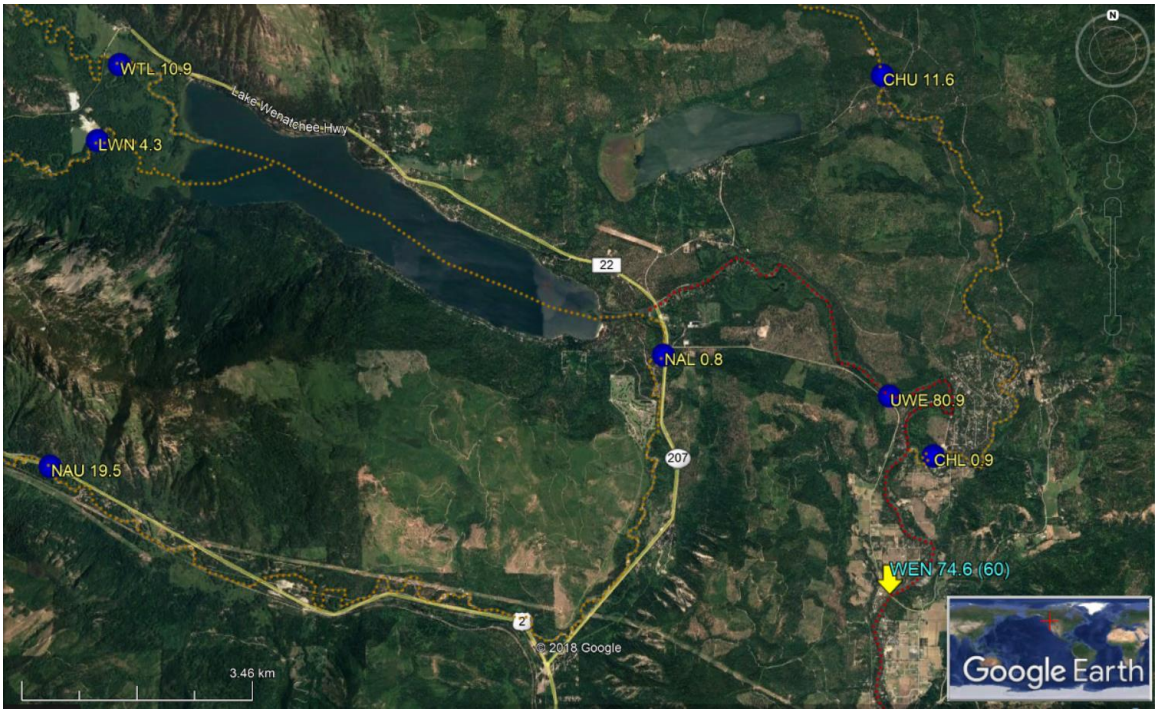

Figure 7. Aerial map of Pacific Lamprey translocation upper release site at Wenatchee river km 74.6. The number next to the stream abbreviation is the river km and the number in parenthesis is the total number of lamprey released. Shown with the blue circles are the PIT tag array locations (UWE, CHL, CHU, NAL, NAU, WTL, and LWN). Also, 0.1 km points along the Wenatchee River (red dots) and tributaries (orange dots; Chiwawa, Nason, White, and Little Wenatchee from downstream to upstream) are displayed.

Part II: Pit Tag Detection and Analysis

From the PITAGIS regional data base (http://www.ptagis.org/), using Query Builder2 Reports, the interrogation data of individual PIT tagged lamprey is summarized. A total of 71 lamprey out of 306 total PIT tagged lamprey released (23.2%) were detected in at least one PIT array site (none of the lamprey were detected in more than one site).

There are a total of four instream PIT array sites located on the mainstem Wenatchee River (river km 2.7, 49.6, 50.4, and 80.9), four sites on Icicle Creek (river km 0.4, 4.8, 6.8, and 9.7), three sites on Chiwawa Creek (river km 0.9, 11.6, 29.9), three sites on Nason Creek (river km 0.8, 19.5, and 25.9), and one site each on Mission, Preshastin, Chumstick, Chiwaukum, Little Wenatchee (river km 4.3), and White (river km 10.9) rivers/streams (Fig. 8). The PIT array site just above Tumwater Dam at river km 50.4 (MWE) was not in operation during the study period and three arrays at Tumwater Dam ("High Flow Ladder Entrance", "Low Flow Ladder Entrance", and "Weir 3" at TUF) began operating only after June 26, 2017. No lamprey were detected at the "Low Flow Ladder Entrance," however. Most sites have a pair of arrays, consisting of lower (downstream) and an upper (upstream) arrays.

At the flow monitoring station at Monitor, WA (river km 10.5), Wenatchee River water level was ~700 cfs during the first release event on August 23, 2016, and was 5,000 cfs during the second release event on April 19, 2017 (Fig. 9). The last detection was on September 24, 2017, corresponding to the lowest level of water flow period.

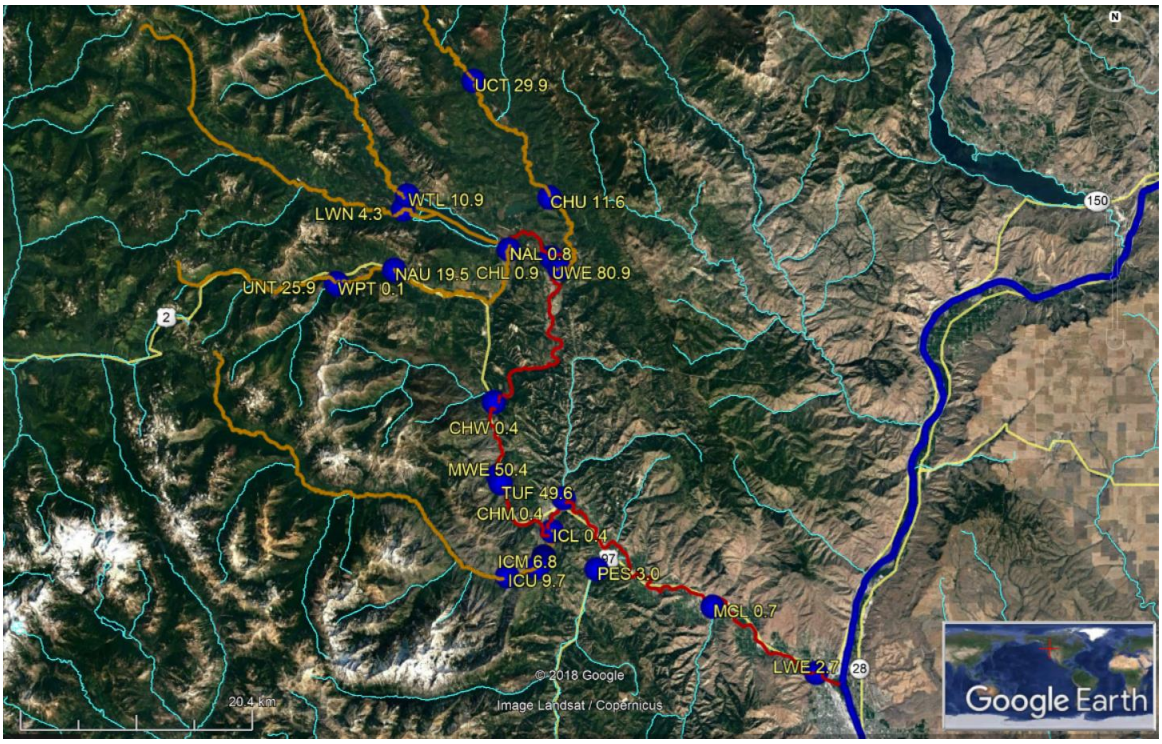

Figure 8. Overall aerial map of PIT tag arrays within the Wenatchee Subbasin (blue circles). The three letter abbreviation and its associated river km is labeled in yellow font. The red line represents mainstem Wenatchee River, the orange lines represent its tributaries, and the blue line represents the Columbia River.

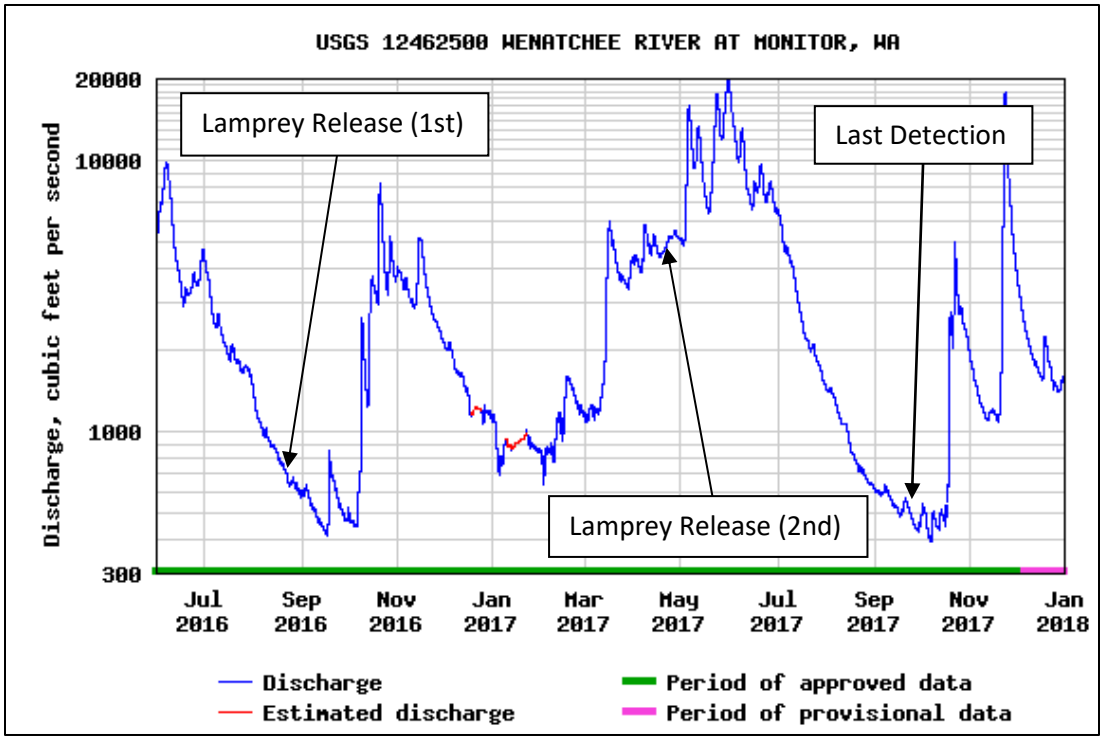

Figure 9. Discharge (cubic feet per second) data of the Wenatchee River at Monitor, WA (river km 10.5) between June 1, 2016, and December 31, 2017 (US Geological Survey National Water Information System: Web Interface).

Lower Wenatchee Release #1 (River KM 2.1; 8/23/2016; n=35)

- 16 of 35 detected (45.7%), and none were detected at more than 1 site.
- 15 of 16 (93.8%) were detected moving upstream whereas 1 of 16 (6.2%) was detected moving downstream to river mouth and upstream on Columbia River at RRF (Rocky Reach Fishway; river km 755.9).
- 14 of 16 (87.5%) were detected moving upstream to LWE (Lower Wenatchee River; river km 2.7) and 1 of 16 (6.2%) were detected moving upstream to TUF (Tumwater Dam Adult Fishway; river km 49.6).
- First detection at LWE occurred between 8/23/2016 and 8/25/2016 (0-1 day after release). 79% were detected the first evening (migration speed of 2.6-9.0 km/day). Two lamprey were detected moving downstream at this same site on 7/1/2017 and 7/31/2017 (311 and 342 days after release, respectively), potentially indicating post spawn drifting.
- Detection at TUF occurred on 10/9/2016 (47 days after release; migration speed of 1.0 km/day). All detections were from "Weir 15" with a duration of 1.1 days, indicating the fish likely did not pass the dam.

- Detection at RRF occurred on 8/28/2016 (4 days after release; migration speed of 4.2 km/day). First detection was from "A2 - Upper Weir," and last detection was from "A0 - Trap", which is the final array within the dam, and duration was 0.04 days (~1 hr).

Lower Wenatchee Release #2 (River KM 4.9; 8/23/2016; n=15)

- 2 of 15 detected (13.3%), and none were detected at more than 1 site.
- 1 of 2 (50%) was detected moving upstream to TUF (Tumwater Dam Adult Fishway; river km 49.6) whereas the other was detected moving downstream to LWE (Lower Wenatchee River; river km 2.7).
- Detection at TUF occurred on 7/11/2017 (321 days after release; migration speed of 0.1 km/day). All detections, spanning 1 min, were all from "High Flow Ladder Entrance" indicating that the fish approached the dam, but likely did not enter the dam.
- Detection at LWE occurred on 7/26/2017 (337 days after release).

Mid Wenatchee Release below Tumwater Dam (River KM 49.6; 8/23/2016; n=30)

- 3 of 30 detected (10%), and none were detected at more than 1 site.
- 3 of 3 (100%) were detected moving upstream to TUF (Tumwater Dam Adult Fishway; river km 49.6).
- First detections at TUF occurred on 8/26/2016, 8/29/2016, and 6/28/2017 (2, 5, and 309 days after release, respectively; migration speed of 0.04, 0.02, 0.00 km/day, respectively).
- The two lamprey that arrived in August were first detected at "Weir 15" and last detected at "Weir 18," indicating that it potentially passed the dam (however, through diffusion grating and auxillary water channel, lamprey can potentially pass downstream undetected as well).
- The lamprey that arrived the following year in June, 2017, was only detected at "High Flow Ladder Entrance," indicating the fish approached the dam but likely did not enter the fish ladder.
- Duration of detection at TUF were all less than 0.85 days.

Mid Wenatchee Release within Tumwater Dam (River KM 49.6; 9/8/2016; n=40)

Weir Pool #2 (n=10)

- 6 of 10 detected (60%), and none were detected at any site other than TUF (Tumwater Dam Adult Fishway; river km 49.6).
- 3 of 6 (50%) were first detected moving upstream to "Weir 15," and those detections occurred on 9/19/2016, 9/20/2016, and 9/26/2016 (10-17 days after release). Two were last

detected at "Weir 18" (0-3 days later) whereas one was last detected at "Weir 15" (1 day later), indicating two may potentially have passed the dam while the other may have moved downstream.

- 3 of 6 (50%) were first detected moving downstream to "High Flow Ladder Entrance," and those detections occurred on 6/30/2017, 7/3/2017, and 8/7/2017 (295-333 days after release). Of these, one was last detected at "Weir 18" (0 days later), indicating potential passage, whereas two were last detected at "Weir 3" (5 days later) or "High Flow Ladder Entrance" (0 days later), likely indicating downstream movement.
- The highest number of detections of an individual lamprey was 1,639 followed by 700 from this release group (the rest of the lamprey were detected fewer than 100 times).

Weir Pool #17 (n=10)

- 10 of 10 detected (100%), and none were detected at any site other than TUF (Tumwater Dam Adult Fishway; river km 49.6).
- 8 of 10 (80%) were first detected moving downstream to "Weir 15," and those detections all occurred within 2 hours of release, except for one lamprey that was detected 10.5 hours after release.
- Of those eight lamprey first detected at "Weir 15", five (62.5%) were last detected at "Weir 15" (within 3 days of first detection). Two were last detected at "High Flow Ladder Entrance" (both of these two lamprey initially left the ladder within 1 day after release but returned to the dam on June 30, 2017, and reentered the ladder and moved up to "Weir #3", but after 10-15 days of back and forth, they drifted downstream). One was last detected at "Weir 18" (3.6 hours after detection at "Weir 15"), indicating potential passage.
- 2 of 8 (25%) were first detected moving upstream to "Weir 18," and those detections occurred 2 and 3 hours after release. Of these two, one was last detected at "Weir 15" (2 days later), likely indicating downstream movement. The other one was last detected at "High Flow Ladder Entrance" (309 days later).
- The highest number of detections of an individual lamprey was 385,580 followed by 3,882 and 130 from this release group (the rest of the lamprey were detected fewer than 100 times).

Downstream of Fish Counting Station (n=10)

- 1 of 10 detected (10%), and none were detected at more than 1 site.
- The one and only detection was at UWE (Upper Wenatchee River; river km 80.9), which occurred on 7/26/2017 (320 days after release). Detection was between 12:25 AM and 12:26 AM, which is within the peak migration time period.

- It is difficult to assess whether the rest of the lamprey successfully passed the dam and moved upstream with only one PIT array detection (unless we review videos from fish counting station during this period).

Fish Hopper Pool (n=10)

- None of the 10 lamprey were detected by the WDFW monitoring crew the next morning at the Fish Hopper Pool, indicating they all escaped the trap.
- 3 of 10 detected (30%) by PIT arrays, and none were detected at any site other than TUF (Tumwater Dam Adult Fishway; river km 49.6).
- 1 of 3 (33%) was first detected downstream at "Weir 15" (33 days after release). This lamprey was last detected at "Weir 15" (less than 1 min of total detection).
- 2 of 3 (67%) were first detected downstream at "High Flow Ladder Entrance" on 6/26/2017 and 7/22/2017 (291 and 316 days after release, respectively), and both of them re-entered the ladder up to "Weir #3", but the last detections were also from the "High Flow Ladder Entrance" (11 and 21 days after their first detection, respectively), indicating they most likely drifted downstream.
- Those detected all appeared to have moved downstream one way or another (they potentially entered the auxillary water channel and were taken back to the bottom of the fish ladder). The fate of the rest are unknown.
- The highest number of detections of an individual lamprey was 331 from this release group, primarily from "High Flow Ladder Entrance" - (the rest of the lamprey were detected fewer than 100 times).

Upper Wenatchee Release #1 (River KM 50.4; 8/23/2016; n=30)

- 4 of 30 detected (13.3%), and none were detected at more than 1 site.
- 3 of 4 (75%) were detected moving upstream to UWE (Upper Wenatchee River; river km 80.9).
- 1 of 4 (25%) were detected moving downstream to TUF (Tumwater Dam Adult Fishway; river km 49.6).
- First detection at UWE occurred between 6/16/2017 and 7/15/2017 (296-326 days after release; migration speed of 0.1 km/day). This indicates that the final migration to spawning ground may not occur till the second summer; these lamprey may potentially spawn this year or the following year (2 year of overwintering).
- First detection at TUF occurred on 8/23/2016 (8 hours after release), and was from "Weir 18". The last detection was from "Weir 15" with detection duration less than 1 min, indicating lamprey was likely moving downstream immediately after release.

Upper Wenatchee Release #2 (River KM 50.4; 4/19/2017; n=96)

- 9 of 96 detected (9.4%), and none were detected at more than 1 site.
- 8 of 9 (88.9%) were detected moving upstream to UWE (Upper Wenatchee River; river km 80.9).
- 1 of 9 (11.1%) were detected moving downstream to TUF (Tumwater Dam Adult Fishway; river km 49.6).
- First detection at UWE occurred between 7/4/2017 and 9/24/2017 (76-158 days after release; migration speed of 0.2-0.4 km/day). This indicates that the final migration to spawning ground may not occur till the second summer; these lamprey may potentially spawn this year or the following year (2 year of overwintering), especially those that are moving in late September.
- First detection at TUF occurred on 8/4/2017 (107 days after release), and was from "High Flow Ladder Entrance". This lamprey entered the fish ladder on this day and was detected up to "Weir #3", but it likely drifted downstream in the end based on the last detection being from "High Flow Ladder Entrance" (all occurring within one hour) – this lamprey may be a 2-year overwintering lamprey based on the late summer movement and activity.

Upper Wenatchee Release #3 (River KM 74.6; 8/23/2016; n=60)

- 17 of 60 detected (28.3%), and none were detected at more than 1 site.
- 9 of 17 (52.9%) were detected moving upstream to UWE (Upper Wenatchee River; river km 80.9).
- 7 of 17 (41.2%) were detected moving upstream to NAL (Lower Nason Creek; river km 0.8).
- 1 of 17 (5.9%) was detected moving upstream to NAU (Upper Nason Creek; river km 19.5).
- Less than 1 of 9 (11.1%) detection efficiency at UWE (based on eight lamprey entering Nason Creek without being detected at UWE). Based on this estimate, more than 60 lamprey were estimated to have passed UWE (9 / 11.1% = 81), indicating potentially all have passed.
- Less than 1 of 2 (50%) detection efficiency at NAL (based on one lamprey passing NAU without being detected at NAL). Based on this estimate, more than 16 lamprey were estimated to have passed NAL (8 / 50% = 16).
- First detection at UWE occurred between 5/26/2017 and 7/26/2017 (276-337 days after release; migration speed of 0.02 km/day). This indicates that the final migration to spawning ground may not occur till the second summer; these lamprey may potentially spawn this year or the following year (2 year of overwintering).

- Most of the detection at UWE (7 of 9) lasted for less than 1 min, but one lamprey was also detected 4 days after its first detection, and one lamprey was also detected 49 days after its first detection, potentially indicating post spawn drifting.
- First detection at TUF occurred on 8/4/2017 (107 days after release).

Summary of Tumwater Dam Detections

(Red, underline font indicates that the lamprey was last detected at "Weir 18.")

- 2 lamprey from the Lower Wenatchee release (river km 2.1 and 4.9) approached Tumwater Dam.
    - 1 detected at "Weir 15" (no detection after 2 days)
    - 1 detected at "High Flow Ladder Entrance" only (no detection after 1 day)
- 3 lamprey from downstream of Tumwater Dam release (river km 49.6) approached Tumwater Dam.
    - 1 detected at "Weir 18" (last detection here on 8/29/2016, detection lasted <1 day)
    - 1 detected at "Weir 18" (last detection here on 8/27/2016, detection lasted <2 days)
    - 1 detected at "High Flow Ladder Entrance" only (no detection after 1 day)
- 6 lamprey from fish ladder release (Weir Pool #2) detected within Tumwater Dam
    - 1 detected at "Weir 18" (last detection here on 9/26/2016, detection lasted <1 day)
    - 1 detected at "Weir 18" (last detection here on 9/22/2016, detection lasted <4 days)
    - 1 detected at "High Flow Ladder Entrance" and then at "Weir 18" (last detection here on 8/8/2017, detection lasted <2 days)
    - 1 detected at "Weir 15" (no detection after 1 day)
    - 1 detected at "High Flow Ladder Entrance" and then at "Weir 3" (no passage after 6 days)
    - 1 detected at "High Flow Ladder Entrance" only (no detection after 1 day)
- 10 lamprey from fish ladder release (Weir Pool #17) detected within Tumwater Dam
    - 1 detected at "Weir 18" (last detection here on 9/11/2016, detection lasted <3 days)
    - 1 detected at "Weir 18" (no detection after 1 day) – then approached the ladder entrance ~10 months later
    - 1 detected at "Weir 18" (no detection after 4 days)
    - 2 detected at "Weir 15" (no detection for 2-3 days)
    - 3 detected at "Weir 15" (drifting downstream)
    - 1 detected at "Weir 15" (no detection after 2 days) – then approached the ladder entrance ~10 months later, detected at "Weir 3" (no detection after 15 days)
    - 1 detected at "Weir 15" (no detection after 1 day) – then approached the ladder entrance ~10 months later, detected at "Weir 3" (at least 2 separate ascending and descending of the ladder entrance) (no detection after 10 days)

- 0 lamprey from fish ladder release (Below Fish Counting Station) detected within Tumwater Dam (video camera analysis still needed to assess count detection rates)
- 3 lamprey from fish ladder release (Fish Hopper Pool) detected within Tumwater Dam
    - 1 detected at "Weir 15" (drifting downstream)
    - 1 detected at "High Flow Ladder Entrance" and then at "Weir 3" (at least 3 separate ascending and descending of the ladder entrance) (no detection after 12 days)
    - 1 detected at "High Flow Ladder Entrance" and then at "Weir 3" (no detection after 2 days) – then at "High Flow Ladder Entrance" 19 days later (no detection afterwards).
- 2 lamprey from the Jolanda Lake release (river km 50.4) detected within Tumwater Dam
    - 1 detected at "Weir 18" (drifting downstream)
    - 1 detected at "High Flow Ladder Entrance" and then at "Weir 3" (no detection after 1 day)

Based on all the detections at Tumwater Dam (TUF), the percent of lamprey detected in specific areas within the fishway with PIT array antennae were used to estimate the percent of upstream movement between 1) fish ladder entrance to Weir 3, 2) Weir 3 to 15, and 3) Weir 15 to 18 (Table 3). The term "detection percentage" is used herein to indicate the percent of lamprey that were detected moving from one array to another based on this calculation (while these arrays were operating). Lamprey released in the fish ladder that were either never detected or only detected moving downstream were excluded from this analysis. The purpose of this analysis is to share very coarse detection data from PIT tagged lamprey released at various locations within or near Tumwater Dam to gain a better understanding of lamprey movement behavior within the fishway. However, the detection percentages reported here are based on a small sample sizes and do not include estimate of error or detection probability (which likely varies between stations and over time). In addition, it assumes that there is nearly 100% detection rates at each array, which have not been specifically confirmed or tested for lamprey. It is also worth noting that these lamprey were collected from the Lower Columbia Hydroelectric Projects (Bonneville, The Dalles, and John Day dams) and held at Prosser Hatchery using a combination of Yakima river and well water; their behavior may not represent the run of the river fish.

Detection at fish ladder entrance ("High Flow Ladder Entrance") and Weir 3 only started after June 26, 2017, even though those PIT arrays were installed on March 14, 2017; it is uncertain if lamprey only moved through these arrays after June 26, 2017, or if the two arrays had unusually lower detection rates prior to June 26, 2017. One estimate for ladder to Weir 3 detection percentage was calculated based on those detections that took place after June 26, 2017 (63.6%; Table 3). However, this assumes that all the lamprey approaching the dam were also detected by the lowermost array, when in fact a group of lamprey may have approached the dam without ever being detected by the lowermost array (only those either passing or reaching very close to the array at the entrance may be getting detected at this site). Hence, this estimate does not account for all those that have approached the dam. The detection percentage from below ladder to Weir 3 can be

calculated alternatively by using the overall pooled detection percentage of 6.0%. Because the detection percentage from Weir 3 to Weir 18 (with last detection occurring there) was estimated to be 31.3% (58.3% x 71.4% x 75.0%), by dividing the cumulative detection percentages of 6.0% by 31.3%, we can back calculate and estimate the detection percentage from below ladder to Weir 3 (19.2%; Fig. 10). However, caution is needed in interpreting these results because these estimates are based on a small sample size with the assumption that there is nearly 100% detection rates at each array, which have not been confirmed or tested for lamprey.

The overall pooled detection percentage from these releases to Weir 18 (last detection being there) was 6.0% (Table 3). A similar detection percentage was observed from the 30 lamprey released immediately downstream of Tumwater Dam (6.7%; Table 3). Lamprey that were last detected at Weir 18 (N=6) may potentially have had the opportunity to pass the fishway if 1) there were any major gap in the upper closed gate, 2) lamprey passed the upper gate during a time frame when the gate stayed open at least part of the time [outside of September 1 – mid-November season (when the gate is closed all the time)], or 3) lamprey found an alternate passage route somewhere along the trapping route [a potential route through floor grating is mentioned in the "Rapid Assessment of Adult Pacific Lamprey Passage at Tumwater Dam" (2015)]. Four of the lamprey were last detected at "Weir 18" in August, 2016, and August, 2017, when the ladder trap was only operated during the day time for 8 hrs during the week days and upper gate was otherwise open at night time and all weekends. The other two lamprey were last detected at "Weir 18" in September, 2016, when the ladder trap was in operation 24 hrs of the day. There is a large degree of uncertainty as to whether these lamprey being detected last at Weir 18 successfully reached the forebay. Further analysis of the fish count video files could potentially provide more insights on this specific question. In summary, although the PIT tag data provided herein showcases very interesting movement behavior and patterns, they cannot be used solely to estimate Tumwater Dam "fishway passage rates" (unless an additional array is installed at the upper end of the fish ladder to detect the completion of "dam passage").

Table 3. Summary of Tumwater Dam (TUF) detections and percent detected. Lamprey released in the fish ladder that were never detected or only detected moving downstream were excluded from this analysis. Detection percentages are calculated based on the number of lamprey that were detected at a certain array divided by all the lamprey that approached the next downstream array (moving upstream). Because the operation of the new entrance and Weir 3 arrays only began after June 26, 2017, only those detected after that date were included in the detection percentage between entrance and Weir 3 (red font).

Release River	Release River KM	Release Location	Release Date	Sample Size	# at Entrance (After*)	# at Weir 3 (After*)	# at Weir 3 (Start)	# at Weir 15	# at Weir 18 (End)	# at Weir 18 (Start)	# at Weir 18 (Last Detection)	% Lasted Detected at Weir 18
Wenatchee	2.1/4.9	Lower Wenatchee	8/23/2016	50	1	0	1	1	0	0	0	0.0%
Wenatchee	49.6	Below Dam	8/23/2016	30	1	0	2	2	2	2	2	6.7%
Wenatchee	49.6	Weir Pool #2 (stayed in ladder)	9/8/2016	7	-	-	3	3	2	2	2	28.6%
Wenatchee	49.6	Weir Pool #2 (reascending)	9/8/2016	3	3	2	2	1	1	1	1	33.3%
Wenatchee	49.6	Weir Pool #17 (stayed in ladder)	9/8/2016	4	-	-	-	-	-	3	1	25.0%
Wenatchee	49.6	Weir Pool #17 (reascending)	9/8/2016	3	3	2	2	0	0	0	0	0.0%
Wenatchee	49.6	Fish Hopper Pool	9/8/2016	2	2	2	1	0	0	0	0	0.0%
Wenatchee	50.4	Jolanda Lake	8/23/2016	1	1	1	1	0	0	0	0	0.0%
-	-	**Total**	-	**100**	**11**	**7**	**12**	**7**	**5**	**8**	**6**	-
		Detection %	-	-	-	**63.6%**	-	**58.3%**	**71.4%**	-	**75.0%**	**6.0%**

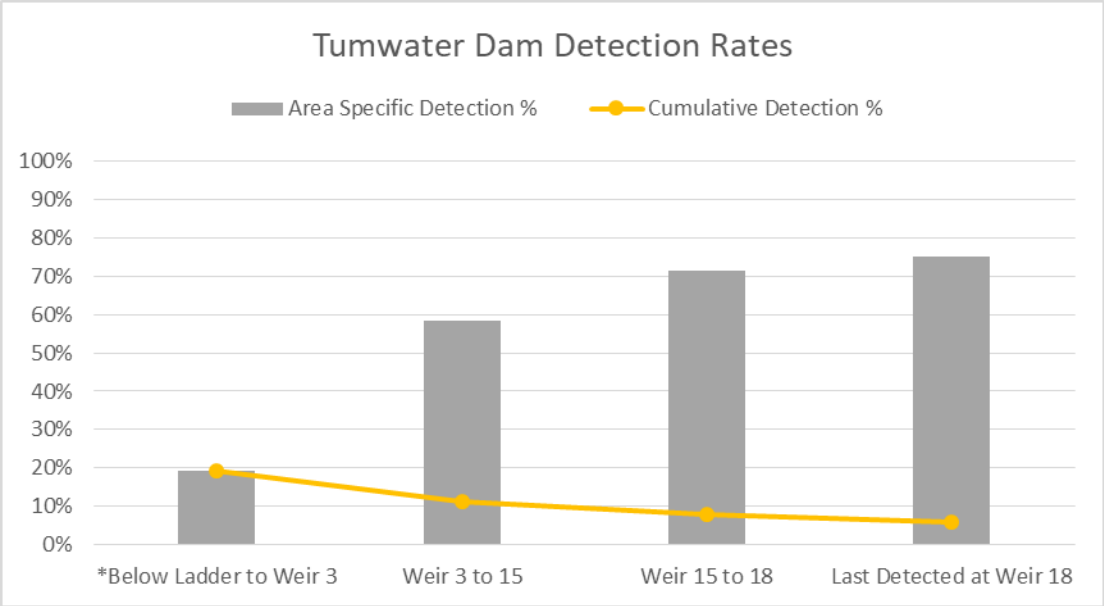

Figure 10. Estimated area specific and cumulative detection percentages based on PIT tag detection within Tumwater Dam arrays (TUF). "Entrance to Weir 3" detection percentage was calculated based on the overall pooled detection percentage from overall sample. It is uncertain if those lamprey "Last Detected at Weir 18" successfully passed the dam.

Summary

The highlights from the 2016-2017 broodstock Pacific Lamprey translocation monitoring are the following (Table 4 and 5 and Figure 11, 12, and 13):

- Within the Tumwater Dam PIT antenna arrays, overall pooled detection percentage from below dam to uppermost PIT antenna arrays within the fish ladder (entrance to weir #18) was estimated to be 6.0%. Between the individual arrays, detection percentages ranged from 19.2 – 75.0% (lower portion of the ladder had lower percentages). Due to a lack of upstream antennas, passage success beyond Weir 18 is not estimable from our data.
- Overall, 23.2% of PIT tagged lamprey released within the Wenatchee Subbasin were detected at least once.
- Sites that detected lamprey the most were TUF (Tumwater Dam Adult Fishway, Wenatchee river km 49.6; 26 lamprey), UWE (Upper Wenatchee River, river km 80.9; 21 lamprey), and LWE (Lower Wenatchee River, river km 2.7; 15 lamprey).
- Estimated detection efficiencies at some of the instream arrays were considerably low (especially UWE <11.1%, LWE = 45-50%, NAL <50.0), but likely higher compared to detection rates during spring high flow conditions.
- Among the lamprey detected, the percent of lamprey that were initially detected moving upstream was considerably lower for lamprey released within Tumwater Dam (42.5%) compared to the other releases (average of 84.6%).
- Only the uppermost release (at Wenatchee river km 74.6) resulted in some portion of lamprey being detected within Nason Creek.
- Within the spring release group, the same percentage of 9 and 12 mm tags were detected (9.4%) for the 2017 spring release group (this was the only release group using both tag types) (Table 5).
- The most movements were detected between late August and mid October ("initial migration") and between early June and end of July ("spawning"), followed by limited detections in August and September (potential "twice overwintering lamprey") (Fig. 12).
- When these movements are compared and contrasted with the associated discharge data, it becomes apparent that lamprey either avoid movement during the winter high flow period (mid October to April) or their detection efficiency are extremely low (Fig. 13).
- Although fall migration is the primary migration timing observed at major hydro dams, many lamprey migrate considerable distances (e.g. 30-50 km) and at high levels of frequency during the spring final migration within this type of tributary environments.
- The fastest upstream traveling lamprey (n=3) detected were 4.1-5.5 km/day (three lamprey that moved up to the lowermost array from the Lower Wenatchee release).

Table 4. Summary of 2016-2017 broodstock Pacific Lamprey translocation detection sites from the Wenatchee Subbasin releases.

River	River KM	Site ID	# of Lamprey Detected	% of Detection	Estimated Detection Efficiency
Wenatchee	2.7	LWE	15	4.9%	45-50%
Wenatchee	49.6	TUF	26	8.5%	N/A
Wenatchee	80.9	UWE	21	6.9%	<11.1%
Nason	0.8	NAL	7	2.3%	<50.0%
Nason	19.5	NAU	1	0.3%	N/A
Columbia	755.9	RRF	1	0.3%	N/A

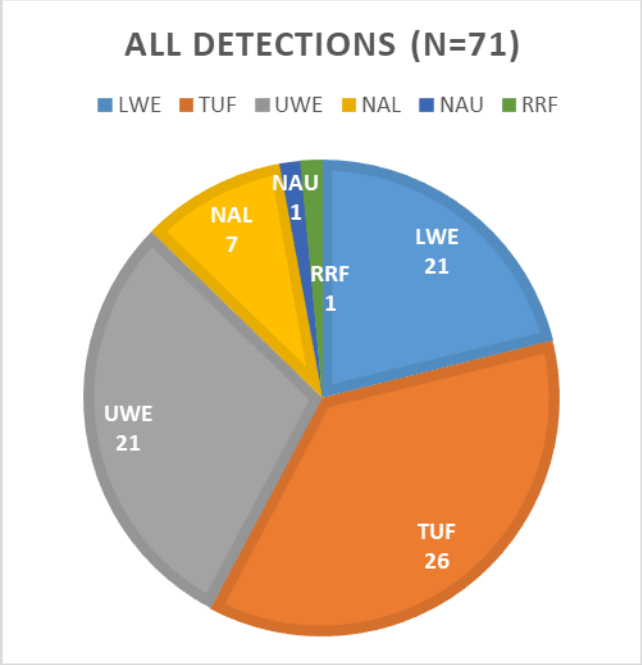

Figure 10. A pie chart summarizing all the site detections (N=71) from the 71 lamprey that were detected at least once from the 2016 summer/fall and 2017 spring translocation release in the Wenatchee Subbasin.

Table 5. Percent of lamprey that initially migrated upstream, moved to Nason Creek, and percent detection of two sizes of PIT tag by release location.

Release River	Release River KM	Release Location	Release Date	% Moving Upstream	% Moving to Nason Cr.	9 mm % Detection	12 mm % Detection
Wenatchee	2.1	-	8/23/2016	93.8%	0%	45.7%	N/A
Wenatchee	4.9	-	8/23/2016	50.0%	0%	13.3%	N/A
Wenatchee	49.6	Below Dam	8/23/2016	100.0%	0%	10.0%	N/A
Wenatchee	49.6	Weir Pool #2	9/8/2016	50.0%	0%	60.0%	N/A
Wenatchee	49.6	Weir Pool #17	9/8/2016	20.0%	0%	100.0%	N/A
Wenatchee	49.6	Below Counting Station	9/8/2016	100.0%	0%	10.0%	N/A
Wenatchee	49.6	Fish Hopper Pool	9/8/2016	0.0%	0%	30.0%	N/A
Wenatchee	50.4	-	8/23/2016	75.0%	0%	13.3%	N/A
Wenatchee	50.4	-	4/19/2017	88.9%	0%	9.4%	9.4%
Wenatchee	74.6	-	8/23/2016	100.0%	47.1%	28.3%	N/A
Mean	-	-	-	**67.8%**	**4.7%**	**32.0%**	**9.4%**

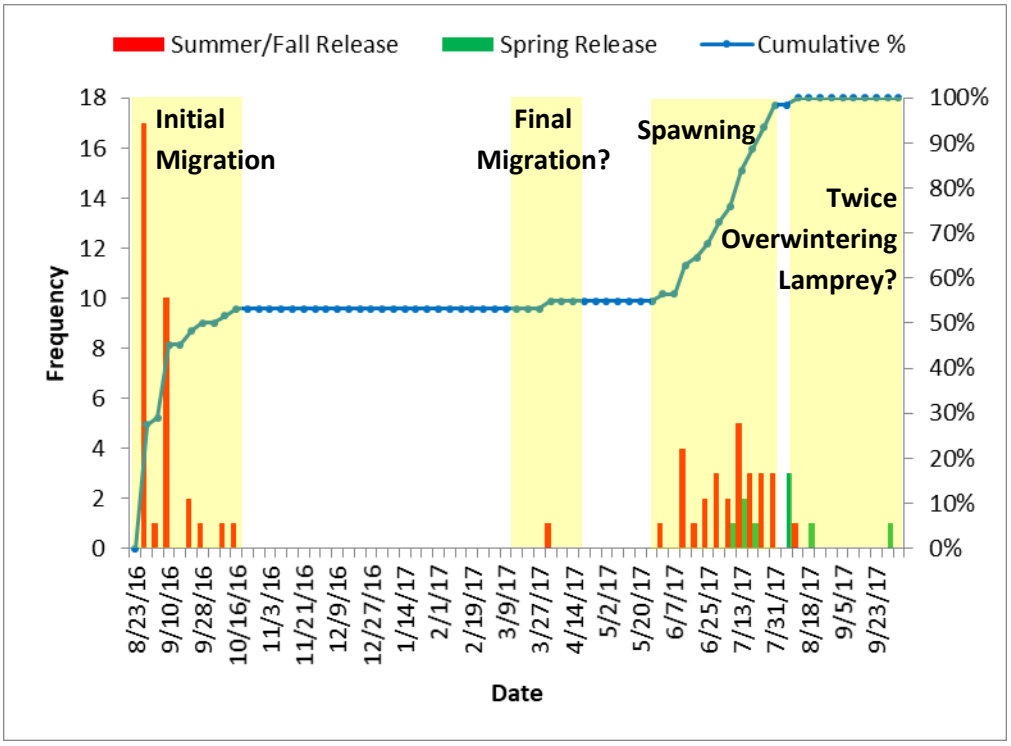

Figure 11. Frequency of movement displayed by adult Pacific Lamprey from the 2016 summer/fall (red bars) and 2017 spring (green bars) translocation release in the Wenatchee Subbasin based on PIT tag data. The three phases of migration are highlighted in cream color with a label.

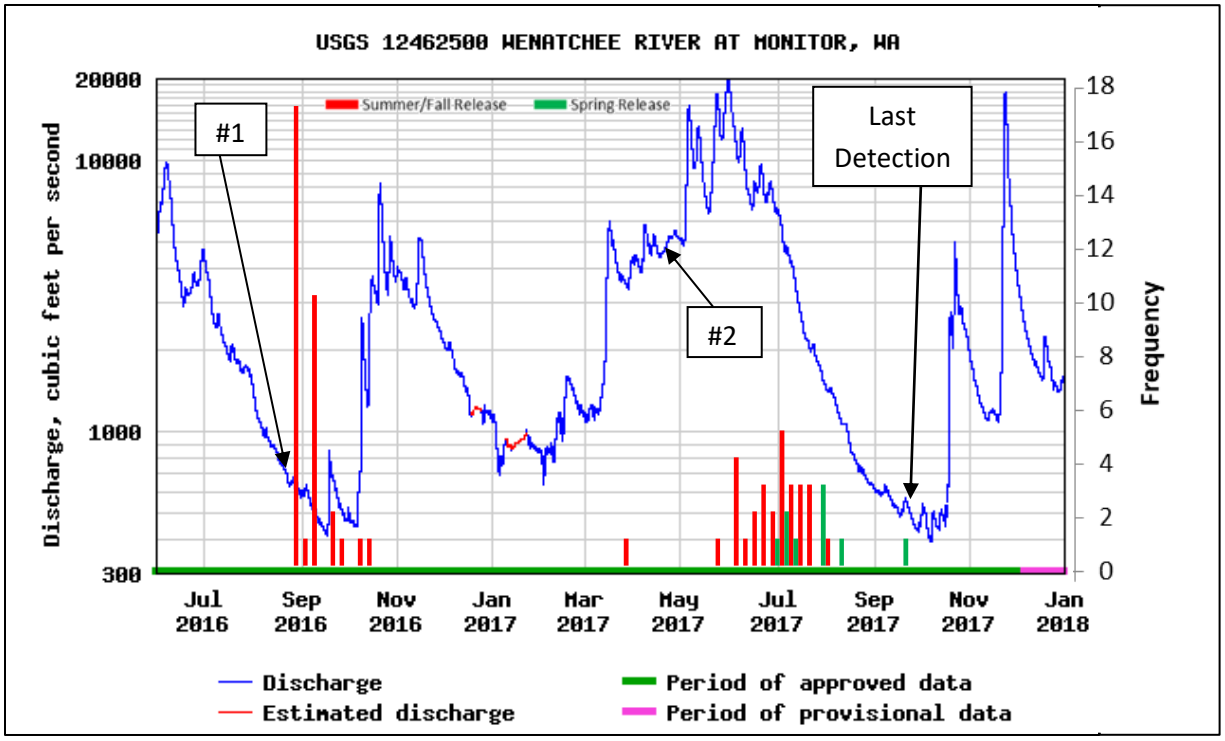

Figure 12. Frequency of movement displayed by adult Pacific Lamprey from 2016 summer/fall (#1 release; red bars) and 2017 spring (#2 release; green bars) translocation release in the Wenatchee Subbasin based on PIT data, displayed along with the discharge data from Figure 9.

Appendix: PIT Tag Information

#	PIT Tag ID	Release Date	Release River	Release River KM	Release Latitude	Release Longitude
1	3DA.1A19B3364F	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
2	3DA.1A19B30BA5	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
3	3DA.1A19B31BED	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
4	3DA.1A19B33D3F	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
5	3DA.1A19B31C4A	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
6	3DA.1A19B31AC4	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
7	3DA.1A19B30B99	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
8	3DA.1A19B31BC7	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
9	3DA.1A19B3312F	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
10	3DA.1A19B301C7	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
11	3DA.1A19B336BE	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
12	3DA.1A19B31A51	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
13	3DA.1A19B2F79D	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
14	3DA.1A19B2FD0C	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
15	3DA.1A19B2F7D3	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
16	3DA.1A19B318CC	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
17	3DA.1A19B318B4	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
18	3DA.1A19B2F876	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
19	3DA.1A19B32BE8	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
20	3DA.1A19B33BBA	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
21	3DA.1A19B33B14	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
22	3DA.1A19B32876	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
23	3DA.1A19B31A52	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
24	3DA.1A19B31A64	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
25	3DA.1A19B33B61	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
26	3DA.1A19B33B69	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
27	3DA.1A19B33C93	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
28	3DA.1A19B33C59	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
29	3DA.1A19B33B5F	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
30	3DA.1A19B31DA3	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
31	3DA.1A19B2FABD	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
32	3DA.1A19B33AE5	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
33	3DA.1A19B2FA74	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
34	3DA.1A19B323A7	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
35	3DA.1A19B3226A	8/23/2016	Wenatchee	2.1	47.46316	-120.34336
36	3DA.1A19B324C5	8/23/2016	Wenatchee	4.9	47.47228	-120.37222
37	3DA.1A19B2FB7B	8/23/2016	Wenatchee	4.9	47.47228	-120.37222
38	3DA.1A19B339CE	8/23/2016	Wenatchee	4.9	47.47228	-120.37222
39	3DA.1A19B30B50	8/23/2016	Wenatchee	4.9	47.47228	-120.37222
40	3DA.1A19B329DB	8/23/2016	Wenatchee	4.9	47.47228	-120.37222
41	3DA.1A19B31E02	8/23/2016	Wenatchee	4.9	47.47228	-120.37222
42	3DA.1A19B31CF6	8/23/2016	Wenatchee	4.9	47.47228	-120.37222
43	3DA.1A19B32252	8/23/2016	Wenatchee	4.9	47.47228	-120.37222
44	3DA.1A19B32C90	8/23/2016	Wenatchee	4.9	47.47228	-120.37222
45	3DA.1A19B33B8A	8/23/2016	Wenatchee	4.9	47.47228	-120.37222
46	3DA.1A19B2FA16	8/23/2016	Wenatchee	4.9	47.47228	-120.37222
47	3DA.1A19B33B20	8/23/2016	Wenatchee	4.9	47.47228	-120.37222
48	3DA.1A19B2F7B1	8/23/2016	Wenatchee	4.9	47.47228	-120.37222
49	3DA.1A19B30202	8/23/2016	Wenatchee	4.9	47.47228	-120.37222
50	3DA.1A19B32378	8/23/2016	Wenatchee	4.9	47.47228	-120.37222
51	3DA.1A19B33C3F	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
52	3DA.1A19B31B32	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
53	3DA.1A19B31BAE	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
54	3DA.1A19B31ABC	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
55	384.3515DC43D2	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
56	3DA.1A19B325E6	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
57	3DA.1A19B32587	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
58	3DA.1A19B31BBD	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
59	3DA.1A19B3280F	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
60	3DA.1A19B32534	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
61	3DA.1A19B2FD6C	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
62	3DA.1A19B31CCA	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
63	3DA.1A19B325EF	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
64	3DA.1A19B31CA5	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
65	3DA.1A19B2FA44	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
66	3DA.1A19B32285	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
67	3DA.1A19B30348	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
68	3DA.1A19B3399C	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
69	3DA.1A19B2F8C5	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
70	3DA.1A19B2F734	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
71	3DA.1A19B31CE1	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
72	3DA.1A19B31BD2	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
73	3DA.1A19B31A5F	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
74	384.1B79769C18	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
75	3DA.1A19B2FB74	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
76	3DA.1A19B328BB	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
77	3DA.1A19B2FAB9	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
78	3DA.1A19B33CA5	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
79	3DA.1A19B32C9A	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
80	3DA.1A19B32651	8/23/2016	Wenatchee	49.6	47.61672	-120.72254
81	3DA.1A19B32B9C	9/8/2016	Wenatchee	49.6	47.61710	-120.72320
82	3DA.1A19B2F996	9/8/2016	Wenatchee	49.6	47.61710	-120.72320
83	384.1B79764AF1	9/8/2016	Wenatchee	49.6	47.61710	-120.72320
84	3DA.1A19B33AED	9/8/2016	Wenatchee	49.6	47.61710	-120.72320
85	3DA.1A19B31D71	9/8/2016	Wenatchee	49.6	47.61710	-120.72320
86	3DA.1A19B33B56	9/8/2016	Wenatchee	49.6	47.61710	-120.72320
87	3DA.1A19B31E03	9/8/2016	Wenatchee	49.6	47.61710	-120.72320
88	3DA.1A19B2F7AE	9/8/2016	Wenatchee	49.6	47.61710	-120.72320
89	3DA.1A19B33ADD	9/8/2016	Wenatchee	49.6	47.61710	-120.72320
90	3DA.1A19B322F0	9/8/2016	Wenatchee	49.6	47.61710	-120.72320
91	3DA.1A19B2FAF9	9/8/2016	Wenatchee	49.6	47.61729	-120.72329
92	3DA.1A19B324A1	9/8/2016	Wenatchee	49.6	47.61729	-120.72329
93	3DA.1A19B3245B	9/8/2016	Wenatchee	49.6	47.61729	-120.72329
94	3DA.1A19B31D87	9/8/2016	Wenatchee	49.6	47.61729	-120.72329
95	3DA.1A19B31DF9	9/8/2016	Wenatchee	49.6	47.61729	-120.72329
96	3DA.1A19B323FD	9/8/2016	Wenatchee	49.6	47.61729	-120.72329
97	3DA.1A19B2F72A	9/8/2016	Wenatchee	49.6	47.61729	-120.72329
98	3DA.1A19B33B00	9/8/2016	Wenatchee	49.6	47.61729	-120.72329
99	3DA.1A19B339B7	9/8/2016	Wenatchee	49.6	47.61729	-120.72329
100	3DA.1A19B33C2E	9/8/2016	Wenatchee	49.6	47.61729	-120.72329
101	3DA.1A19B31A8D	9/8/2016	Wenatchee	49.6	47.61708	-120.72309
102	3DA.1A19B323CA	9/8/2016	Wenatchee	49.6	47.61708	-120.72309
103	3DA.1A19B326DA	9/8/2016	Wenatchee	49.6	47.61708	-120.72309
104	3DA.1A19B31D94	9/8/2016	Wenatchee	49.6	47.61708	-120.72309
105	3DA.1A19B2FA42	9/8/2016	Wenatchee	49.6	47.61708	-120.72309
106	3DA.1A19B2FA5C	9/8/2016	Wenatchee	49.6	47.61708	-120.72309
107	3DA.1A19B31BE6	9/8/2016	Wenatchee	49.6	47.61708	-120.72309
108	3DA.1A19B322B1	9/8/2016	Wenatchee	49.6	47.61708	-120.72309
109	3DA.1A19B31DF5	9/8/2016	Wenatchee	49.6	47.61708	-120.72309
110	3DA.1A19B33BDE	9/8/2016	Wenatchee	49.6	47.61708	-120.72309
111	3DA.1A19B32D2C	9/8/2016	Wenatchee	49.6	47.61686	-120.72276
112	3DA.1A19B31C05	9/8/2016	Wenatchee	49.6	47.61686	-120.72276
113	3DA.1A19B3225E	9/8/2016	Wenatchee	49.6	47.61686	-120.72276
114	3DA.1A19B31D65	9/8/2016	Wenatchee	49.6	47.61686	-120.72276
115	3DA.1A19B31B22	9/8/2016	Wenatchee	49.6	47.61686	-120.72276
116	3DA.1A19B2FB19	9/8/2016	Wenatchee	49.6	47.61686	-120.72276
117	3DA.1A19B32260	9/8/2016	Wenatchee	49.6	47.61686	-120.72276
118	3DA.1A19B31673	9/8/2016	Wenatchee	49.6	47.61686	-120.72276
119	3DA.1A19B32656	9/8/2016	Wenatchee	49.6	47.61686	-120.72276
120	3DA.1A19B307F2	9/8/2016	Wenatchee	49.6	47.61686	-120.72276
121	3DA.1A19B32596	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
122	3DA.1A19B31AE7	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
123	3DA.1A19B32463	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
124	3DA.1A19B32BFE	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
125	3DA.1A19B32C50	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
126	3DA.1A19B317AA	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
127	3DA.1A19B32D19	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
128	3DA.1A19B31CF4	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
129	3DA.1A19B33A73	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
130	3DA.1A19B33C1C	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
131	3DA.1A19B3239F	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
132	3DA.1A19B3186F	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
133	3DA.1A19B2FB77	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
134	3DA.1A19B2F9E6	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
135	3DA.1A19B33AA1	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
136	3DA.1A19B31A65	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
137	3DA.1A19B31A74	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
138	3DA.1A19B33D28	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
139	3DA.1A19B318C1	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
140	3DA.1A19B2FAFD	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
141	3DA.1A19B31C28	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
142	3DA.1A19B31D5F	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
143	3DA.1A19B3255A	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
144	3DA.1A19B33CA8	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
145	3DA.1A19B2F84E	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
146	3DA.1A19B32C9C	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
147	3DA.1A19B31B59	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
148	3DA.1A19B33B90	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
149	3DA.1A19B31DB7	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
150	3DA.1A19B31C8D	8/23/2016	Wenatchee	50.4	47.62293	-120.72577
151	3DD.0077974A9B	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
152	3DD.007796439A	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
153	3DD.007796F480	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
154	3DD.00779534BD	4/19/2017	Wenatchee	50.4	47.62287	-120.72577

#	PIT Tag ID	Release Date	Release River	Release River KM	Release Latitude	Release Longitude
155	3DD.00779707C5	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
156	3DD.0077966E2F	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
157	3DD.007796797D	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
158	3DD.00779661A0	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
159	3DD.007796F123	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
160	3DD.0077961BAB	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
161	3DD.0077961E50	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
162	3DD.0077970BAA	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
163	3DD.0077962CDC	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
164	3DD.00779655D1	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
165	3DA.1A19B31C49	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
166	3DD.007796476E	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
167	3DD.007796A9D3	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
168	3DD.007796C3B2	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
169	3DD.007796DFDD	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
170	3DD.0077960FDC	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
171	3DD.0077961B16	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
172	3DD.0077966D5A	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
173	3DD.007796F1F4	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
174	3DD.0077967AB6	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
175	3DD.0077964688	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
176	3DD.007795FA79	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
177	3DD.0077967878	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
178	3DD.0077968FA2	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
179	3DD.007796FA0D	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
180	3DD.007797030B	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
181	3DD.007796ED70	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
182	3DD.007797126D	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
183	3DA.1A19B33BCB	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
184	3DD.007796F0F0	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
185	3DA.1A19B2F9D8	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
186	3DA.1A19B2FA45	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
187	3DA.1A19B2F863	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
188	3DA.1A19B2F744	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
189	3DA.1A19B2FF98	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
190	3DA.1A19B33ABE	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
191	3DA.1A19B31D74	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
192	3DA.1A19B33B97	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
193	3DA.1A19B323D4	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
194	3DA.1A19B31CC6	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
195	3DA.1A19B31AA4	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
196	3DA.1A19B33417	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
197	3DA.1A19B2FA8A	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
198	3DA.1A19B33990	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
199	3DA.1A19B3258C	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
200	3DA.1A19B324C8	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
201	3DA.1A19B31D1D	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
202	3DA.1A19B3248E	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
203	3DA.1A19B2FD68	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
204	3DA.1A19B2F7A4	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
205	3DA.1A19B322C5	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
206	3DA.1A19B2F737	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
207	3DA.1A19B3A4B7	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
208	3DA.1A19B31CEC	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
209	3DA.1A19B32D2D	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
210	3DA.1A19B33C38	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
211	3DA.1A19B392BF	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
212	3DA.1A19B322AA	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
213	3DA.1A19B3122E	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
214	3DA.1A19B3243D	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
215	3DA.1A19B3341F	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
216	3DA.1A19B3234F	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
217	3DA.1A19B32245	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
218	3DA.1A19B31AE6	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
219	3DA.1A19B39016	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
220	3DA.1A19B31B74	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
221	3DA.1A19B31C8C	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
222	3DA.1A19B3385B	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
223	3DA.1A19B38F94	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
224	3DA.1A19B33BFF	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
225	3DA.1A19B3A542	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
226	3DA.1A19B3A6DE	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
227	3DA.1A19B31C61	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
228	3DA.1A19B33A54	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
229	3DA.1A19B3923A	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
230	3DA.1A19B32235	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
231	3DA.1A19B3019D	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
232	3DA.1A19B2F8B1	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
233	3DA.1A19B3A34E	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
234	3DA.1A19B3249C	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
235	3DA.1A19B329D4	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
236	3DA.1A19B33BCD	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
237	3DA.1A19B390B2	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
238	3DA.1A19B329F9	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
239	3DA.1A19B31DF0	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
240	3DA.1A19B33CBC	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
241	3DA.1A19B31A6D	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
242	3DA.1A19B314C0	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
243	3DA.1A19B2F789	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
244	3DA.1A19B39336	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
245	3DA.1A19B38FD5	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
246	3DA.1A19B339F4	4/19/2017	Wenatchee	50.4	47.62287	-120.72577
247	3DA.1A19B3221D	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
248	3DA.1A19B31B9B	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
249	3DA.1A19B32411	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
250	3DA.1A19B32C21	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
251	3DA.1A19B31A87	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
252	3DA.1A19B31B2F	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
253	3DA.1A19B31C19	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
254	3DA.1A19B32671	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
255	3DA.1A19B31A9F	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
256	3DA.1A19B31E06	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
257	3DA.1A19B2F937	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
258	3DA.1A19B31C9B	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
259	3DA.1A19B2FEBE	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
260	3DA.1A19B303F6	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
261	3DA.1A19B31B27	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
262	3DA.1A19B31A71	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
263	3DA.1A19B31CB5	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
264	3DA.1A19B3242A	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
265	3DA.1A19B2F7D2	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
266	3DA.1A19B31BC4	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
267	3DA.1A19B3281F	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
268	3DA.1A19B2FEB6	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
269	3DA.1A19B32216	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
270	3DA.1A19B31D2E	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
271	3DA.1A19B30CF7	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
272	3DA.1A19B3239C	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
273	3DA.1A19B2F992	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
274	3DA.1A19B33A30	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
275	3DA.1A19B31AE3	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
276	3DA.1A19B30478	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
277	3DA.1A19B31742	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
278	3DA.1A19B32370	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
279	3DA.1A19B2F804	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
280	3DA.1A19B323A2	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
281	3DA.1A19B33C7B	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
282	3DA.1A19B338EB	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
283	3DA.1A19B30482	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
284	3DA.1A19B3266E	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
285	3DA.1A19B31C8B	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
286	3DA.1A19B32D0F	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
287	3DA.1A19B33B94	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
288	3DA.1A19B2F72F	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
289	3DA.1A19B331FA	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
290	3DA.1A19B329A3	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
291	3DA.1A19B31D24	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
292	3DA.1A19B30FFA	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
293	3DA.1A19B31D4E	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
294	3DA.1A19B2FD06	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
295	3DA.1A19B33BD5	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
296	3DA.1A19B33A42	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
297	3DA.1A19B325A1	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
298	3DA.1A19B31C2C	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
299	3DA.1A19B33BF6	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
300	3DA.1A19B30656	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
301	3DA.1A19B3257D	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
302	3DA.1A19B327BC	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
303	3DA.1A19B3350E	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
304	3DA.1A19B32706	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
305	3DA.1A19B32333	8/23/2016	Wenatchee	74.6	47.76686	-120.66344
306	3DA.1A19B31B79	8/23/2016	Wenatchee	74.6	47.76686	-120.66344

*Columbia river km 756.8 release in late Septemper, 2016 - 3DA.1A19B31D1F / 3DA.1A19B2FAEB (no detection as of 3/18/2018)