



Translocation of Adult Pacific Lamprey within the Yakima Subbasin (2014-2015 Broodstock)



(Cover Photo: Patrick Luke showing an adult lamprey to Micah Lampman [3-yr-old] prior to its release in Satus Creek [river km 31.3] on April 28, 2015)

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Abstract

This report is composed of two parts: 1) summary of all 2014-2015 broodstock adult Pacific Lamprey releases within the Yakima Subbasin and 2) analysis of migration data from those adults that were PIT tagged. From the 2014-2015 broodstock (adults collected in summer 2014 that primarily matured in 2015), a total of 752 adult Pacific Lamprey were released in three lower Yakima River tributaries (Satus, Toppenish, and Ahtanum) and mainstem Yakima River between summer 2014 and spring 2015. Overall female ratio was 29.0%, PIT tag ratio was 72.6%, and genetic tag ratio was 97.7%. For comparison, up until 2014 the average female ratio has been 36.1%, PIT tag ratio has been 83.0%, and genetic tag ratio has been 94.6%. The accumulated total number of translocated adult Pacific Lamprey in the Yakima Subbasin from 2012-2015 is now 1159. Approximately 200 lamprey each were placed in Satus, Toppenish, and Ahtanum creeks, and 123 lamprey were placed in mainstem Yakima River (primarily in Upper Yakima above Roza Diversion Dam).

From the PITAGIS regional data base (<http://www.ptagis.org/>), we were able to find detection data from 259 individual lamprey (45.9% of the 564 total PIT tagged lamprey released). The vast majority of lamprey released in the lower reaches of Satus, Toppenish, and Ahtanum creeks were confirmed moving upstream after being released (96.3%, 91.4%, and 97.2%, respectfully). This rate (fidelity) has been increasing each year. We also confirmed some adults (5.2%, 6.8%, and 4.3% in Satus, Toppenish, and Ahtanum creeks, respectfully) moving downstream later in the season between April 20 and June 4, 2015, most of which were likely post-spawn downstream drifting while some of the early season downstream detections may be from lamprey exploring other spawning habitat. For example, two lamprey that were originally released in Lower Toppenish Creek migrated out to Yakima River and were detected in Yakima River further upstream; one moved upstream to river km 210.5 (Roza Diversion Dam) and one moved upstream to river km 171.2 (near Sunnyside Dam). The latter one was detected on March 6, 2016, indicating it overwintered twice (constitutes 0.4% of all tags detected). Approximately 64% of the lamprey released in Upper Toppenish (river km 54.3) were detected moving into Simcoe Creek (river km 8.9), while only about 22% of the lamprey that were confirmed moving upstream after being released in Lower Toppenish (river km 1.7) were detected moving into Simcoe Creek; based on this difference, we speculate that diversion dams, such as Unit 2 Diversion Dam (river km 44.6), may potentially be preventing about two-thirds of the lamprey from moving into Toppenish Creek spawning habitat. From lamprey (n=102) released in Upper Yakima (river km 271.2-286.6), the highest detection was observed at Teanaway River (average of 18.9%) followed by Swauk Creek (average of 5.7%); none were detected in Taneum Creek. One lamprey was also detected at the Upper Teanaway site (river km 19.8). Downstream movements were detected in 25.0% and 75.0% of fish detected moving upstream in Teanaway and Swauk streams, respectfully, between May 31 and June 13, 2015. The fastest upstream migration speed from this 2014-2015 broodstock analysis was 21.5 km/day (Lower Satus Creek) and the fastest downstream drifting speed was 43.3 km/day (from Prosser Dam to McNary Dam).

Part I: Release Summary

From the 2014-2015 broodstock (adults collected in summer 2014, most of which were released in 2015), a total of 752 adult Pacific Lamprey were released in three lower Yakima River tributaries (Satus, Toppenish, and Ahtanum) and mainstem Yakima River between summer 2014 and spring 2015 (Fig. 1 and Table 1). Overall female ratio was 29.0%, pit tag ratio was 73.2%, and genetic tag ratio was 97.8%. All lamprey were originally captured from Bonneville Dam, The Dalles Dam, or John Day Dam in the Lower Columbia River during the summer of 2014. Approximately one third of the PIT tagging was conducted in 2014 soon after collection and the rest were PIT tagged later in 2015. In the Yakima tributaries, water temperature ranged between 10.5 and 13.6°C during the early lower reach release events and ranged between 8.4 and 17.7°C for the late upper reach release (lamprey were released earlier than previous years due to the warm and dry season). Water temperature for mainstem Yakima ranged between 8.6 and 14.6°C during the release events.

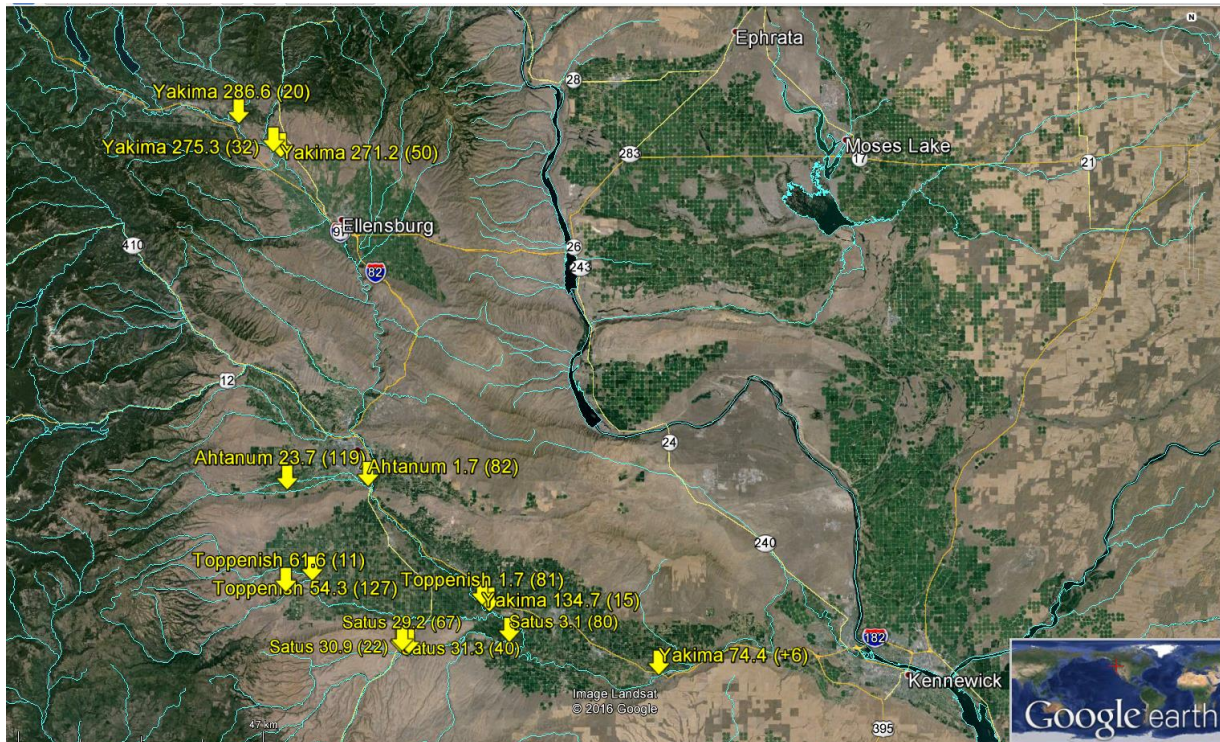


Figure 1. Overall aerial map of 2014-2015 broodstock adult Pacific Lamprey translocation release sites (the number next to the stream name is the stream km and the number in parenthesis is the total number of lamprey released).

Table 1. Summary of 2014-2015 broodstock adult Pacific Lamprey translocation release information.

Stream	# of Female	# of Male	# of Unknown	# with Pit Tags	# with		# Total	Female Ratio	Pit Tag Ratio	Genetic Tag Ratio
					Pit Tags	Genetic Tags				
Satus	70	129	10	168	209	209	35.2%	80.4%	100.0%	
Toppenish	55	145	19	194	207	219	27.5%	88.6%	94.5%	
Ahtanum	41	154	6	75	197	201	21.0%	37.3%	98.0%	
Lower Yakima	3	11	25	25	38	39	21.4%	64.1%	97.4%	
Upper Yakima	32	53	17	102	102	102	37.6%	100.0%	100.0%	
Overall	201	492	77	564	753	770	29.0%	73.2%	97.8%	

The number of translocated lamprey has steadily increased over the years since 2012, which started with only 15 lamprey (Table 2). The total accumulated number of translocated adult Pacific Lamprey in the Yakima Subbasin from 2012-2015 is 1,181. The female ratio has ranged between 20-44%, resulting in higher numbers of males than females over the years, except for the 2011-2012 broodstock with only 15 lamprey. Approximately three quarters of all lamprey have been PIT tagged over the four years to improve the assessment of distribution and final destination of the released lamprey. Genetic tagging ratios have stayed close to 100% for all release years to track the success of translocation (via larval/juvenile sampling using parentage genetics).

Table 2. Summary of all adult Yakama Nation Fisheries Pacific Lamprey translocation (Broodstock 2011-2012 through 2014-2015). *Number with genetic tags from 2012-2013 and 2013-2014 are estimates.

Broodstock Year	# of Female	# of Male	# of Unknown	# with Pit Tags	# with Genetic Tags	# Total	Female Ratio	Pit Tag Ratio	Genetic Tag Ratio
2012-2013	27	110	4	124	*130	141	19.7%	87.9%	94.9%
2013-2014	111	144	9	213	*240	264	43.5%	80.7%	94.1%
2014-2015	201	492	77	564	753	770	29.0%	73.2%	97.8%
Total	348	752	90	915	1120	1190	31.6%	76.9%	94.1%

Satus Creek

In Satus Creek, there were a total of five release events: 1) 80 lamprey were released at river km 3.1 on March 25, 2015, 2) 67 lamprey were released at river km 29.2 on May 22, 2015, 3) 4 lamprey were released at river km 30.9 on July 4, 2014, 4) 18 lamprey were released at river km 30.9 on March 20, 2015, and 5) 40 lamprey were released at river km 31.3 on April 28, 2015 (Fig. 2 and Table 3).

The release of four lamprey in 2014 was due to the capture of mature lamprey (likely overwintered adults) from Bonneville Dam in 2014. The first release in 2015 was on March 20, 2015, at river km 30.9 and mature lamprey (many lamprey matured early in 2015 likely due to the unusually warm and dry year) that could not be held any longer were released. The regular lower and upper reach release was conducted on March 25, 2015, and April 28, 2015. On May 22, 2015, an additional 67 lamprey were released – all these lamprey were double tagged (radio and PIT tags) as part of a University of Idaho research project (Matthew Dunkle’s thesis project) on the ecological roles of adult Pacific Lamprey post spawning.

The overall female ratio was 35.2%, PIT tag ratio was 80.4%, and genetic tag ratio was 100.0%. Water temperature was 11.8°C at the regular lower site (March 25, 2015, 3:20 PM) and 16.7°C at the regular upper site (April 28, 2015, 4:30 PM), which was already slightly higher than the optimal Pacific Lamprey spawning temperature range (11-15°C).

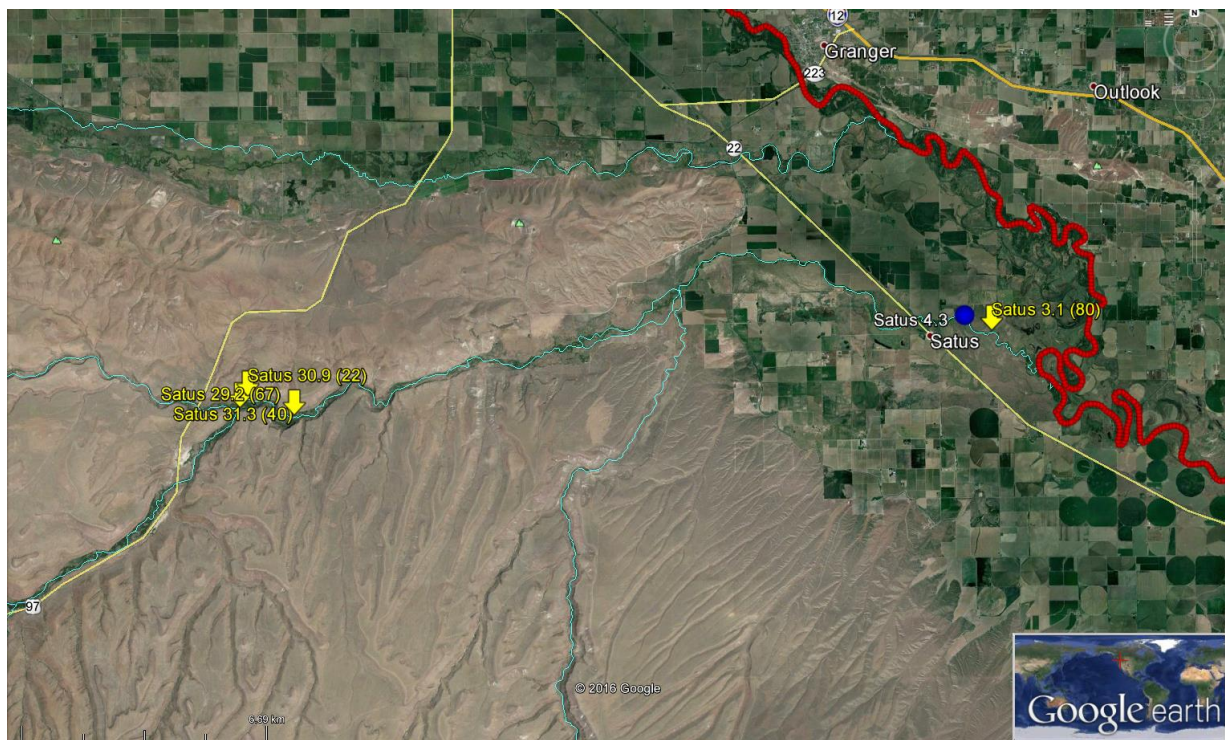


Figure 2. Aerial map of 2014-2015 broodstock adult Pacific Lamprey translocation release sites in Satus Creek. The number next to the stream name is the stream km and the number in parenthesis is the total number of lamprey released. Also shown with the blue circle is the PIT tag array location. Yakima River is the red line.

Table 3. Summary of 2014-2015 broodstock adult Pacific Lamprey translocation release information in Satus Creek.

Stream	River			Water	# of Female	# of Male	# of Unknown	# with Pit Tags	# with		Female Ratio	Pit Tag Ratio	Genetic Tag Ratio
	km	Date	Time	Temp (C)					Genetic	Total			
Satus	3.1	3/25/2015	3:20 PM	11.8	10	67	3	80	80	80	13.0%	100.0%	100.0%
Satus	29.2	5/22/2015	2:30 PM	17.7	35	32	0	67	67	67	52.2%	100.0%	100.0%
Satus	30.9	7/4/2014	5:00 PM	-	3	1	0	2	4	4	75.0%	50.0%	100.0%
Satus	30.9	3/20/2015	-	-	11	7	0	0	18	18	61.1%	0.0%	100.0%
Satus	31.3	4/28/2015	4:30 PM	16.7	11	22	7	19	40	40	33.3%	47.5%	100.0%
Total	-	-	-	-	70	129	10	168	209	209	35.2%	80.4%	100.0%

Toppenish Creek

In Toppenish Creek, there were a total of four release events: 1) 81 lamprey were released at river km 1.7 on March 25, 2015, 2) 25 lamprey were released at river km 54.3 on April 9, 2015, 3) 102 lamprey were released at river km 54.3 on April 30, 2015, and 4) 10 lamprey were released at river km 61.6 on May 13, 2015 (Fig. 3 and Table 4).

The release of 25 lamprey on April 9, 2015, at river km 54.3 were mostly mature lamprey (many lamprey matured early in 2015 likely due to the unusually warm and dry year) that could not be held any longer. The regular lower and upper reach release was conducted on March 25, 2015, and April 30, 2015. On May 13, 2015, an additional 10 lamprey were released further upstream at river km 61.6 during a Natural Resource Conservation Service tour on Toppenish Creek (with Ann Mills, USDA Deputy Under Secretary for Natural Resources and Environment).

The overall female ratio was 27.5%, PIT tag ratio was 88.6%, and genetic tag ratio was 94.5%. Water temperature was 13.6°C at the regular lower site (March 25, 2015, 2:00 PM) and 14.3°C at the regular upper site (April 30, 2015, 4:00 PM).

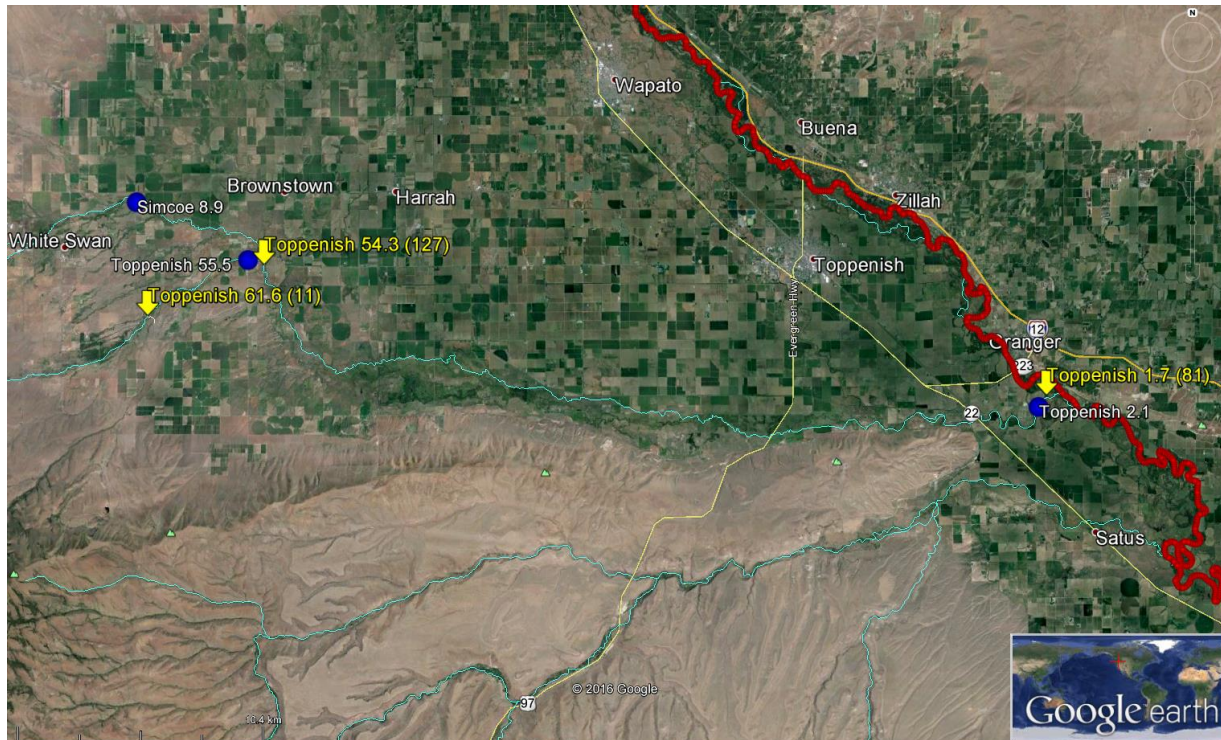


Figure 3. Aerial map of 2014-2015 broodstock adult Pacific Lamprey translocation release sites in Toppenish Creek. The number next to the stream name is the stream km and the number in parenthesis is the total number of lamprey released. Also shown with the blue circles are the PIT tag array locations. Yakima River is the red line.

Table 4. Summary of 2014-2015 broodstock adult Pacific Lamprey translocation release information in Toppenish Creek.

Stream	River km	Date	Time	Water Temp (C)	# of				# with Pit Tags	# with Genetic Tags	# Total	Female Ratio	Pit Tag Ratio	Genetic Tag Ratio
					Female	Male	Unknown	Unknown						
Toppenish	1.7	3/25/2015	2:00 PM	13.6	22	59	0	81	81	81	27.2%	100.0%	100.0%	
Toppenish	54.3	4/9/2015	5:00 PM	11.7	1	24	0	1	14	25	4.0%	4.0%	56.0%	
Toppenish	54.3	4/30/2015	4:00 PM	14.3	29	58	15	102	102	102	33.3%	100.0%	100.0%	
Toppenish	61.6	5/13/2015	11:00 AM	11.4	3	4	4	10	10	11	42.9%	90.9%	90.9%	
Total	-	-	-	-	55	145	19	194	207	219	27.5%	88.6%	94.5%	

Ahtanum Creek

In Ahtanum Creek, there were a total of two release events: 82 lamprey were released at river km 1.7 on March 30, 2015, and 117 lamprey were released at river km 23.7 on April 22, 2015 (Fig. 4 and Table 5).

The lower release site was moved downstream from river km 4.1 to 1.7 to allow PIT tag array detections of lamprey moving upstream at river km 4.0 (a new PIT array station was installed by the Yakama Nation Fisheries). The upper release site was moved downstream by 7.3 km to American Fruit Road (river km 23.7) from Ahtanum Mission Park / Saint Joseph Mission

Church (river km 31.0) as a result of being able to attain land owner access on the south bank side (provides access to more spawning habitat available between river km 23.7 and 31.0).

The overall female ratio was 21.0%, PIT tag ratio was 37.3% (low due to lack of PIT arrays in upper reaches), and genetic tag ratio was 98.0%. Water temperature was 10.5°C at the regular lower site (March 30, 2015, 3:05 PM) and 8.4°C at the regular upper site (April 22, 2015, 11:00 AM).

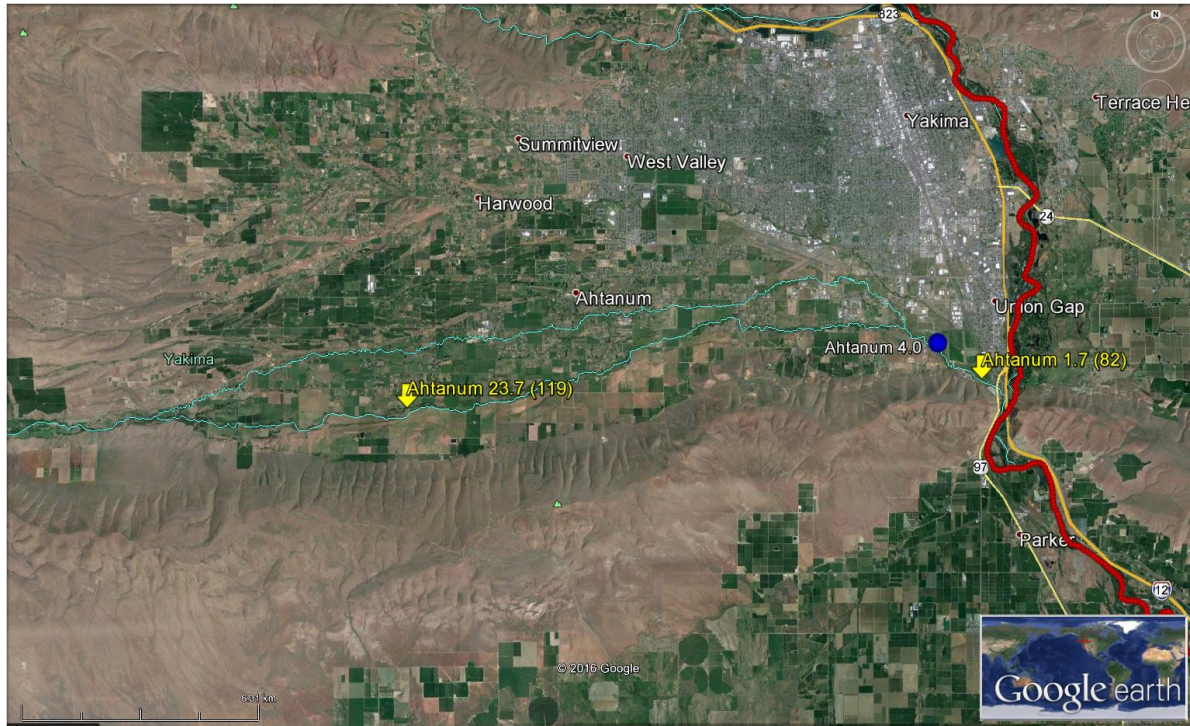


Figure 4. Aerial map of 2014-2015 broodstock adult Pacific Lamprey translocation release sites in Ahtanum Creek. The number next to the stream name is the stream km and the number in parenthesis is the total number of lamprey released. Also shown with the blue circles are the PIT tag array locations. Yakima River is the red line.

Table 5. Summary of 2014-2015 broodstock adult Pacific Lamprey translocation release information in Ahtanum Creek.

Stream	River km	Date	Time	Water Temp (C)	# of Female	# of Male	# of Unknown	# with Pit Tags	# with Genetic Tags	# Total	Female Ratio	Pit Tag Ratio	Genetic Tag Ratio
Ahtanum	1.7	3/30/2015	3:05 PM	10.5	30	51	1	71	80	82	37.0%	86.6%	97.6%
Ahtanum	23.7	4/22/2015	11:00 AM	8.4	11	103	5	4	117	119	9.6%	3.4%	98.3%
Total	-	-	-	-	41	154	6	75	197	201	21.0%	37.3%	98.0%

Yakima River

In Yakima River, there were a total of five release events: 1) 6+ lamprey were released at river km 74.4 (Prosser Hatchery) on March 22, 2015, 2) 15 lamprey were released at river km 134.7

on April 24, 2015, 3) 50 lamprey were released at river km 271.2 on March 30, 2015, 4) 32 lamprey were released at river km 275.3 on March 30, 2015, and 5) 20 lamprey were released at river km 286.6 on March 30, 2015 (Fig. 5, Fig. 6 and Table 6).

The release of lamprey at river km 74.4 occurred at Prosser Hatchery – adults escaped one of the adult holding tanks starting on March 22, 2015, and entered Yakima River just downstream of Prosser Dam (river km 75.7). At least six adults were detected at Prosser Dam fish ladders and potentially more may have escaped (some may have moved downstream or passed Prosser Dam undetected). We estimate that approximately 24 adults escaped into the Yakima River (based on 50% not passing the dam, and 50% passing the dam undetected). The release of 15 lamprey on April 24, 2015, at river km 134.7 (Grainger bridge) were mostly mature lamprey (many lamprey matured early in 2015 likely due to the unusually warm and dry year) that could not be held any longer. The main objective for the three releases in Upper Yakima was to examine which tributaries (primarily Taneum and Swauk creeks, and Teanaway River) lamprey would migrate to above Roza Dam (where upstream passage is blocked currently).

The overall female ratio was 35.4%, PIT tag ratio was 88.6%, and genetic tag ratio was 99.2%. Water temperature was 14.6°C at the lower site (April 24, 2015, 5:00 PM) and 8.6°C at the uppermost site (March 30, 2015, 5:50 PM).

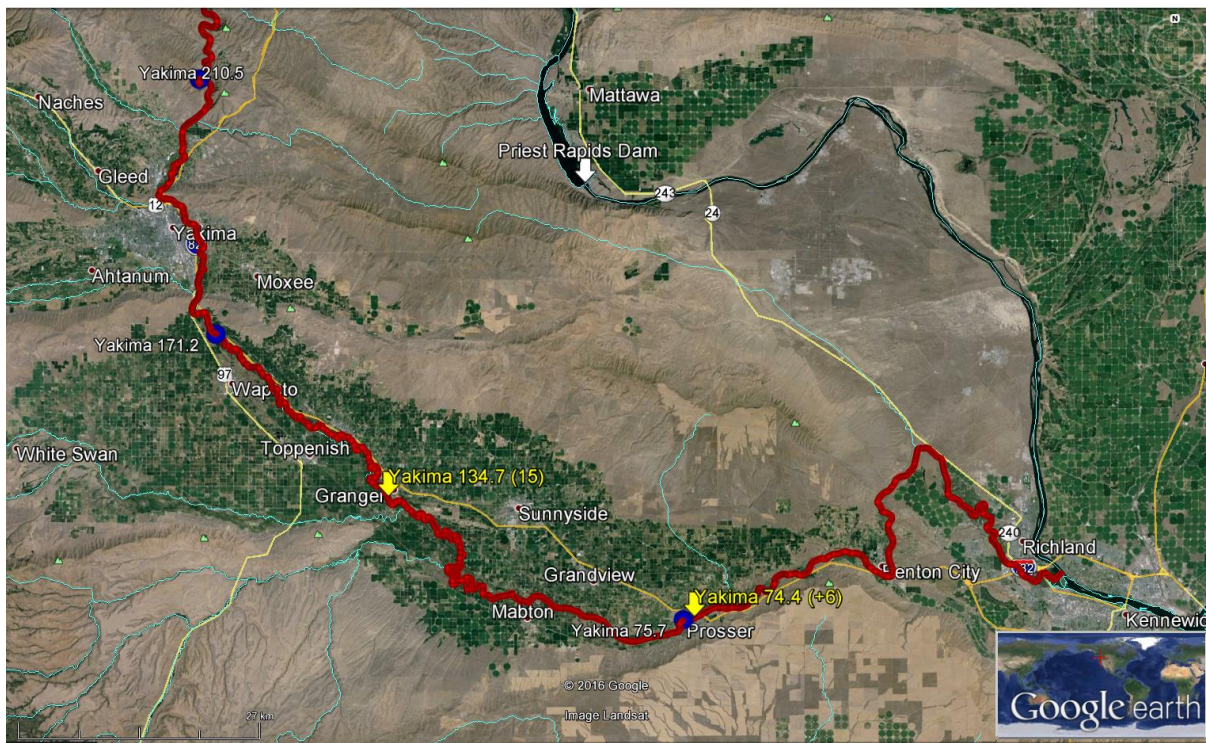


Figure 5. Aerial map of 2014-2015 broodstock adult Pacific Lamprey translocation release sites in Lower Yakima River. The number next to the stream name is the stream km and the number in parenthesis is the total number of lamprey released (yellow text). Also shown with the blue circles are the PIT tag array locations (white text). Yakima River is the red line.

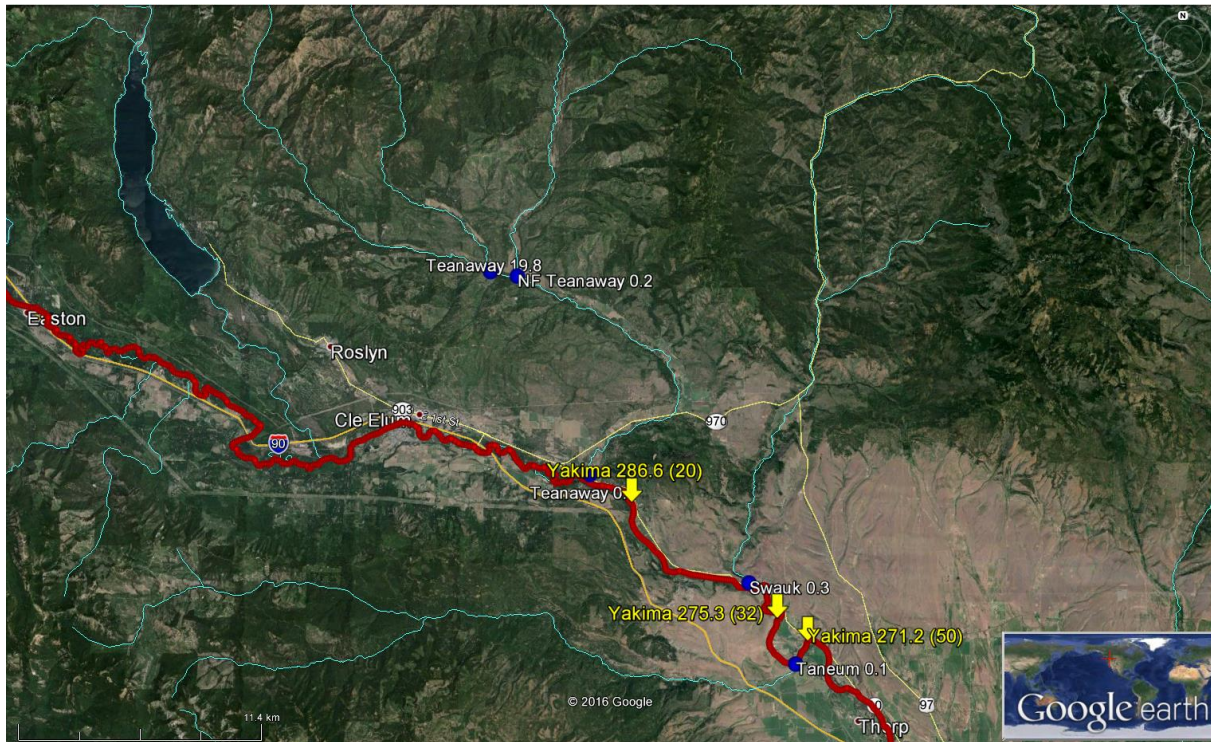


Figure 6. Aerial map of 2014-2015 broodstock adult Pacific Lamprey translocation release sites in Upper Yakima River. The number next to the stream name is the stream km and the number in parenthesis is the total number of lamprey released (yellow text label). Also shown with the blue circles are the PIT tag array locations (white text label). Yakima River is the red line.

Table 6. Summary of 2014-2015 broodstock adult Pacific Lamprey translocation release information in Yakima River.

Stream	River	km	Date	Time	Water Temp (C)	# of				# with			Genetic Tag Ratio	
						Female	Male	Unknown	Pit Tags	Genetic Tags	# Total	Female Ratio		Pit Tag Ratio
Yakima	74.4	3/22/2015	-	-	-	0	6	0	6	6	6	0.0%	100.0%	100.0%
Yakima	74.4	3/22/2015	-	-	-	0	0	18	18	18	18	-	100.0%	100.0%
Yakima	134.7	4/24/2015	5:00 PM	14.6	3	5	7	1	14	15	15	37.5%	6.7%	93.3%
Yakima	271.2	3/30/2015	7:00 PM	8.9	19	27	4	50	50	50	50	41.3%	100.0%	100.0%
Yakima	275.3	3/30/2015	4:50 PM	8.6	7	15	10	32	32	32	32	31.8%	100.0%	100.0%
Yakima	286.6	3/30/2015	5:50 PM	8.6	6	11	3	20	20	20	20	35.3%	100.0%	100.0%
Total	-	-	-	-	-	35	64	42	127	140	141	35.4%	90.1%	99.3%

Part II: Pit Tag Detection and Analysis

Lower Yakima Tributaries Stream Fidelity

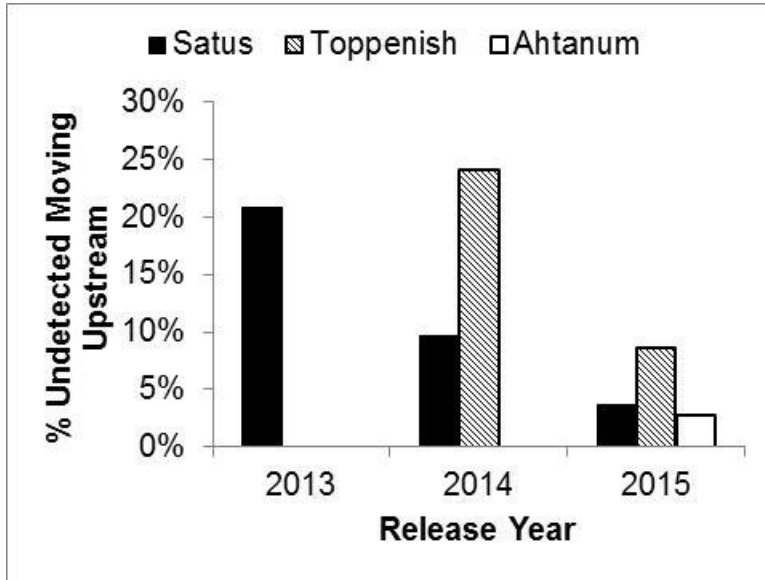


Figure 7. Percent of PIT tagged lamprey that were not detected moving upstream in Satus (n=3), Toppenish (n=2), and Ahtanum (n=1) creeks between 2013 and 2015 at the lowermost PIT array site in each respective streams. Toppenish Creek only had two years of data (2014 and 2015), and Ahtanum Creek only had one year of data (2015).

Upper Yakima Tributaries Stream Fidelity

Release	Taneum	Swauk	Teaway
Lower	0.0%	2.0%	28.0%
Middle	-	9.4%	18.8%
Upper	-	-	10.0%
Average	0.0%	5.7%	18.9%

Table 7. Percent of PIT tagged lamprey that were detected at Taneum, Swauk, and Teaway streams from the 2015 release (March 30, 2015). Assuming they all moved upstream, lamprey had the option to access all three streams from the lower release, only Swauk and Teaway streams from the middle release, and only Teaway stream for the upper release.

Satus Creek

Of the 80 PIT tagged lamprey released in lower Satus Creek at river km 3.1, all but three lamprey (96.3%) were detected upstream at the Lower Satus site at river km 4.3. All but one lamprey were detected on the very first night after the release. One lamprey was detected 15 days after release. While most lamprey arrived approximately 5 hours after release (around 8 PM;

median rate of 5.6 km/day), one lamprey was detected 1.3 hours after release (rate of 21.5 km/day). Detection at the site lasted from 1 second to 71 days (median of 22 seconds). Minimum number of detections at the site was 2 while the maximum number of detections was 178,767 (a lamprey that stayed by the array for a full day).

Four lamprey (5.2% of lamprey detected moving upstream) were detected moving downstream later in the spring (May 6, May 12, May 26, and June 4), potentially indicating post-spawn downstream drifting. Of the four lamprey detected moving downstream, two (50%) were again detected at Chandler Juvenile Fish Monitoring Facility (Prosser Dam) on Yakima River further downstream. Both of these fish moved the 40.8 river km distance in roughly 1 day (0.98 to 1.24 days), resulting in a downstream drift speed of 32.8-40.8 km/day. Furthermore, one of these two lamprey was detected 141.7 river km downstream at McNary Dam Juvenile Facility three days later on May 30, 2015 (downstream drift speed was 43.3 km/day).

The ratio of lamprey moving downstream has been steadily decreasing from 20.8% (2013) and 9.7% (2014) to 3.7% (2015) over the three year period, showcasing higher fidelity to remain within Satus creek. Those lamprey that were not detected at the Lower Satus site (3.7%) either used spawning habitat downstream of the release site, moved downstream into the Yakima River, or moved upstream but were not detected. Based on the presence of two antenna arrays (upstream and downstream) with high detection rates for lamprey moving upstream (92.2%), it is highly unlikely that they were undetected at both antenna arrays (<0.6% chance), so we assume that they moved downstream after release.

Of the 90 PIT tagged lamprey released in the upper reaches (river km 29.2-31.3), only two were detected downstream at the Lower Satus site at river km 3.1. One lamprey moved downstream 16 days after release on May 14, 2015 (indicating potential post-spawn downstream drift), while the other lamprey was detected at this site 313 days later on March 6, 2016 (this could be a lamprey that overwintered twice or could simply be just the tag drifting on its own later).

Toppenish Creek

Of the 81 PIT tagged lamprey released in lower Toppenish Creek at river km 1.7, seventy-four lamprey (91.4%) were detected upstream at the Lower Toppenish PIT array site at river km 2.1. All lamprey were detected on the very first night after the release, approximately 4 hours after release (around 8 PM; median rate of 1.6 km/day), one lamprey was detected 3 hours after release (rate of 3.0 km/day). Detection at the site lasted from 1 second to 38 days (median of 21 seconds). Minimum number of detections at the site was one while the maximum number of detections was three. Spawning habitat was not available near this pit tag array, which explains the limited duration of detection observed at this site.

Of the 74 lamprey detected moving upstream at Lower Toppenish site, five lamprey (6.8%) were detected moving downstream later in the season (April 20, April 23, April 25, May 2, and May 3). Because these dates are rather early in the spawning season, these may not be post-spawn downstream drifting; instead they may potentially be lamprey seeking a different spawning habitat. For instance, one lamprey detected moving downstream from the Lower Toppenish site on April 20, 2015, was 321 days later detected at a site immediately downstream of Sunnyside Dam on March 6, 2016, which is 39.7 river km upstream of Toppenish Creek confluence with Yakima River (this lamprey spent 11 days at this site). This also shows that this particular lamprey may have overwintered twice. Another lamprey was never detected at the Lower Toppenish site, but was detected 60 days later at Roza Diersion Dam fish ladder on May 25, 2016, which is 79 river km upstream of Toppenish Creek confluence with Yakima River (this lamprey spent 37 days at Roza Diversion Dam and was detected 3,811 times at the fish ladder, and was last detected at the upper weir site). The PIT array site just downstream of Sunnyside Dam was installed recently in the fall of 2015 and its first tag detection was on November 4, 2015 – additional tagged lamprey may have moved through this reach without being detected prior to this date.

Those lamprey that were never detected at the Lower Toppenish site (8.6%) either moved downstream into the Yakima River, or moved upstream but were not detected. Based on the presence of two antenna arrays (downstream and upstream) and high detection rates for lamprey moving upstream (95.9%), it is highly unlikely that they were undetected at both upstream and downstream antenna arrays (<0.2% chance). As a result, we assume these lamprey moved downstream after release. The ratio of lamprey moving downstream has decreased from 24.1% in 2014 to 8.6% in 2015, showcasing higher fidelity to remain within Toppenish creek. Of the seven lamprey that were never detected at the Lower Toppenish site, one lamprey was detected at Chandler Juvenile Fish Monitoring Facility (Prosser Dam) 18 days after its release on April 13, 2015.

Spawning habitat for Pacific Lamprey and Steelhead is limited (or non-existent) in Toppenish Creek between the mouth and river km ~60 and in Simcoe Creek between the mouth and river km ~9. The confluence of Simcoe Creek is at river km 54.5, so virtually no spawning habitat is available downstream of the Simcoe confluence with Toppenish Creek. In order for Pacific Lamprey to successfully spawn in Simcoe Creek, the vast majority of lamprey would have to pass the Simcoe PIT array site at river km 8.9. As a result, the detection at Simcoe site provides a coarse estimate for whether lamprey used Simcoe vs. Upper Toppenish creeks for spawning.

Of the 103 PIT tagged lamprey released at river km 54.3 (0.2 river km downstream of Simcoe confluence with Toppenish Creek), 66 lamprey (64.1%) were detected moving upstream to Simcoe PIT array site at river km 8.9. Twenty-five of the 66 lamprey (37.9%) were detected at Simcoe Site only one day after their release on May 1, 2015, whereas the median and maximum first detection dates at the site were May 6, 2015, and June 8, 2015, respectfully. We assume that

most of the remaining lamprey (35.9%) moved into Upper Toppenish Creek to complete spawning, minus some that moved out of Toppenish watershed.

Of the 74 lamprey detected moving past Lower Toppenish site, 15 lamprey (20.3%) were detected at the new Simcoe Creek PIT array at river km 8.9 (63.4 river km distance). If we exclude those lamprey that were later detected moving downstream at Lower Toppenish site (because some of these lamprey may not have spawned in Toppenish watershed), the total number of lamprey detected moving past Lower Toppenish site is 69, resulting in 21.7% entering Simcoe Creek. The earliest arrival date was on March 29, 2015, four days past the Lower Toppenish release date (migration speed of 18.6 km/day). The median arrival date was April 18, 2015, and the latest arrival date was June 11, 2015 (migration speed of 2.7 and 0.8 km/day).

If we assume that the same ratio of lamprey moving into Simcoe Creek vs. Upper Toppenish Creek stayed the same for the Lower and Upper Toppenish releases, the detection at Simcoe Site from the Lower Toppenish release was only about one-third (33.9%) of the detection from the Upper Toppenish release. This leads us to assume that there may be some hindrance for Pacific Lamprey to move between Lower and Upper Toppenish Creek; basically, 66.1% of the lamprey released in Lower Toppenish and confirmed moving upstream are not migrating to the spawning habitat in Simcoe and Upper Toppenish Creek. It is possible that irrigation diversion dam structures, such as Unit 2 Dam (river km 44.6), may be hindering approximately two-thirds of the adult lamprey from moving further upstream (Fig. 7 and Fig. 8). On April 7, 2015, Unit 2 Dam structure on the left channel was modified slightly with a heavy equipment by widening the thalweg flow (increased the gap in the ecology blocks) primarily for salmonids passage (Fig. 9). During this operation, we also inserted a plywood board on the right bank of the left channel to improve adult Pacific Lamprey passage (Fig. 10).



Figure 7. Unit 2 Diversion Dam in Toppenish Creek (river km 44.6), left channel looking downstream, a potential partial passage barrier for upstream migrating adult Pacific Lamprey.



Figure 8. Unit 2 Diversion Dam in Toppenish Creek (river km 44.6), right channel looking downstream, a potential partial passage barrier for upstream migrating adult Pacific Lamprey.



Figure 9. Toppenish Creek Unit 2 Diversion Dam (river km 44.6) left channel modification on April 7, 2015 (widening the thalweg width by increasing the gap between the ecology blocks in the center).



Figure 10. Plywood board inserted into the right bank of the left channel to improve adult Pacific Lamprey passage over Unit 2 Diversion Dam in Toppenish Creek (river km 44.6).

Of the 113 PIT tagged lamprey released in the upper reaches (river km 54.3-61.6), only one lamprey was detected at a PIT array site outside of the Toppenish watershed. This lamprey was detected in Yakima River at the Sunnyside Instream Array (river km 171.2) on January 11, 2016. Detections lasted for two days at this site. This means that this lamprey initially moved 54.3 river km downstream, then moved 39.7 river km upstream on Yakima River. This lamprey was not detected at Lower Toppenish site (river km 2.1), indicating that detection efficiency of adult lamprey moving downstream may be much lower than those moving upstream at this particular site.

Ahtanum Creek

Of the 71 PIT tagged lamprey released in lower Ahtanum Creek at river km 1.7, all but two lamprey (97.2%) were detected upstream at the Lower Ahtanum Site at river km 4.0. All but ten lamprey (85.5%) were detected on the very first night after the release. One lamprey was detected 43 days after release on May 12, 2015. Rate of upstream migration ranged approximately 0.1 and 11.2 km/day. Of those lamprey detected at the Lower Ahtanum site, three lamprey (4.3%) showed downstream movement (two on May 14 and one on May 24), potentially showcasing post-spawn downstream drifting.

The two lamprey that were not detected at the Lower Ahtanum site (2.8%) either used spawning habitat downstream of the release site, moved downstream into the Yakima River, or moved upstream but were not detected. This was the first year after a new PIT array was installed in Lower Ahtanum Creek. Based on the presence of two antenna arrays (upstream and downstream) with high detection rates for lamprey moving upstream, it is unlikely that they were undetected at

both antenna arrays, so we assume that they moved downstream after release. Of the 4 PIT tagged lamprey released in the upper reaches (river km 23.7), none were detected downstream at the Lower Ahtanum site at river km 1.7 or outside of Ahtanum Creek.

Yakima River

Of the 50 PIT tagged lamprey released in Yakima River at river km 271.2 (1.2 river km downstream of Tanuem Creek confluence) on March 30, 2015, 14 lamprey (28.0%) were detected at Lower Teanaway site in Teanaway River (river km 0.4), one lamprey (2.0%) was detected at Lower Swauk site in Swauk Creek (river km 0.3), and one lamprey (2.0%) was detected at Roza Diversion Dam in Yakima River (river km 210.5). The earliest lamprey first detection at Lower Teanaway site from this release group was on April 10, 2015, 10 days after release (migration speed of 1.7 km/day), and the median and latest lamprey first detection was on April 19, 2015, and May 1, 2015, respectively (20 and 32 days after release). Of the 14 lamprey detected at Lower Teanaway site, four lamprey (28.6%) were detected also moving downstream on May 31, June 2, June 6, and June 13, 2015, which were 29 to 56 days after its first detection. These dates correspond to typical spawning timing (May – June) and were likely post-spawn downstream drifting. Other lamprey that passed Lower Teanaway site were detected for only 0 – 6 minutes. The detection at Swauk Creek was on April 11, 2015, 11 days after the release (upstream migration rate of 0.7 km/day). The detection at Roza Diversion Dam was at the west spillway left flatplate on July 9, 2015, 100 days after the release and likely was post-spawn downstream drifting. No lamprey were detected in more than one PIT array site from this release group. Tanuem Creek also has a PIT array lower in the system but was not running throughout this study period (and may have missed lamprey passing through).

Of the 32 PIT tagged lamprey released in Yakima River at river km 275.3 (3.5 river km downstream of Swauk Creek confluence) on March 30, 2015, 6 lamprey (18.8%) were detected at Lower Teanaway site in Teanaway River (river km 0.4) and 3 lamprey (9.4%) were detected at Lower Swauk site in Swauk Creek (river km 0.3). The earliest lamprey first detection at Lower Teanaway site from this release group was on April 9, 2015, 10 days after release (migration speed of 1.4 km/day), and the median and latest lamprey first detection was on April 18, 2015, and April 20, 2015, respectively (19 and 20 days after release). No lamprey were detected moving downstream from the Lower Teanaway site. The earliest lamprey first detection at Lower Swauk site from this release group was on March 31, 2015, the same evening of the release (migration speed of 7.8 km/day), and the median and latest lamprey first detection was on April 3, 2015, and April 21, 2015, respectively (3 and 22 days after release). All three lamprey detected at Lower Swauk site were also detected moving downstream on May 3, May 18, and May 24, 2015, which were 27 to 55 days after its first detection. These events were likely post-spawn downstream drifting. No lamprey were detected in more than one PIT array site from this release group.

Of the 20 PIT tagged lamprey released in Yakima River at river km 286.6 (2.3 river km downstream of Teanaway River confluence) on March 30, 2015, 2 lamprey (10.0%) were detected at Lower Teanaway site (river km 0.4) in Teanaway River. The earliest lamprey first detection at Lower Teanaway site from this release group was on April 9, 2015, 10 days after release (migration speed of 0.3 km/day) and the latest lamprey first detection was on April 18, 2015 (19 days after release). The lamprey that was first detected on April 9, 2015, was detected also at the Upper Teanaway site (river km 19.8) on May 9, 2015, 30 days later (migration speed of 0.6 km/day). The lamprey that was first detected on April 18, 2015, was detected again on June 8, 2015, moving downstream, likely indicating post-spawn downstream drifting.

No detections were made from the one PIT tagged lamprey released at river km 134.7 on April 24, 2015.

In addition, there were six PIT tagged lamprey that escaped the Prosser Hatchery tank and accessed Yakima River downstream of Prosser Diversion Dam and were confirmed moving upstream of the dam through the middle and right ladders between March 22 and May 22, 2015. Small holes from wear and tear were found in some of the adult tank screens, which likely allowed some of the lamprey to escape into the river. Those that passed in March (n=4) passed through the right ladder, whereas those that passed in April and May (n=2) passed through the middle ladder. Migration time ranged between 9:34 PM and 7:11 AM and duration ranged from 1.5 minutes to 3 hours. Minimum number of detections at the site was 15 while the maximum number of detections was 24,620. Through radio telemetry, the detection efficiency of lamprey at the counting window was estimated to be approximately 50%. As a result, there may have been more lamprey (potentially twice as many) that migrated past Prosser Dam. There could also be more lamprey that were not able to pass Prosser Dam and as a result used habitat downstream of the dam (from radio telemetry, passage efficiency was approximately 50% at Prosser Dam).