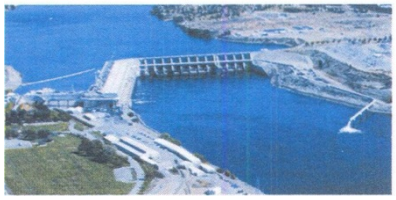
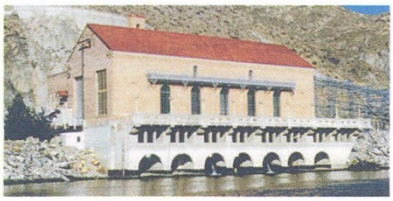


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MEMORANDUM

DATE: January 31, 2017

TO: Justin Fletcher, Chelan PUD

FROM: Steve Hemstrom, Chelan PUD

SUBJECT: Pacific Lamprey biological knowledge and assumptions supporting the TWD Lamprey Passage Feasibility Study

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This memo provides biological information that is known about adult Pacific Lamprey passage timing and behavior in the mid-Columbia River and biology-based assumptions of unknown information. It describes assumptions of adult lamprey behavior in the Wenatchee River and interactions with Tumwater Dam. This memo is intended to assist with development of alternatives for the lamprey passage feasibility study at Tumwater Dam on the Wenatchee River.

Knowledge is limited about adult Pacific Lampreys that move into the Wenatchee River each year. Researchers have conducted very few studies on adult lamprey in the Wenatchee River. Chelan PUD is in progress with a 2016 PIT Tag passage study designed to assess Rocky Reach Dam passage, migration timing, and tributary escapement rates for adult lamprey. Returning Adult lampreys are difficult to study because they are non-philopatric - that is, adults may or may not return, and are not obligated to return, to their natal stream of origin to spawn. Therefore Juvenile out-migrant numbers to adult return numbers cannot be assessed (equivalent to a SAR calculation in salmon). Adult lampreys are cryptic and strongly photonegative. They avoid lighted conditions when they can, but do migrate upstream in daylight conditions. During overwintering periods, adults are believed to avoid predation by hiding in dark boulder pockets or under large submerged wood or in plant debris mats. Adults move upstream mostly at night in smaller tributary stream environments. Lampreys in the mid-Columbia spend one full year, sometimes two years, in freshwater as adults prior to spawning in order to achieve gonad maturity and access tributary environments to spawn. As returning adults, individual fish size and stored energy reserves are the two co-variates that likely contribute to greater migration distance and necessity to overwinter prior to spawning.

Mainstem Adult Pacific Lamprey Passage

Timing of adult passage and counts of adult Pacific Lamprey at both Rock Island and Rocky Reach dams are tracked 24 hours per day, seven days per week, 14 April through 15 November. Adult passage typically peaks in August at both Projects; the July through September period encompasses greater than 90% of adult passage at both Projects. Table 1 contains total monthly passage counts of Pacific Lampreys at both Rock Island and Rocky Reach in 2016. Very few lampreys pass through mainstem fishways in April-June, or November, even though fishways are open and operating, and counts are in progress.

Table 1. Monthly fishway passage counts of adult Pacific Lamprey at Rock Island and Rocky Reach dams, April 14 – November 15, 2016.

	May	June	July	August	September	October	November
RIS Total Lamprey Count	0	36	278	1,912	1,162	547	4
RRH Total Lamprey Count	0	6	222	1,992	1,159	214	2

In the 17-year period 2000 to 2016, the earliest lamprey observed passing in the Rock Island fishway count-windows (three separate ladders each with a count station and window) is 26 May (Figure 1). The 17-year mean date of first lamprey passage at Rock Island is 18 June; the median first passage date for this 17-year period is 21 June. The duration of time for the middle 90% of the lamprey run to pass Rock Island Dam is 55 days on average, July through September (Figure 1). The 17-year cumulative April 15-June 30 count of adult lampreys passing Rock Island is only 140 lampreys total (Figure 1).

The earliest date of first lamprey passage observed in the fishway count window at Rocky Reach Dam is 8 June in the period 2000-2016. The mean date of first passage at Rocky Reach in this 17-year period is 5 July; the median date of first passage is 7 July. The total cumulative 17-year count of adult lampreys in the months of April through June at Rocky Reach is only 11 individuals (Figure 2).

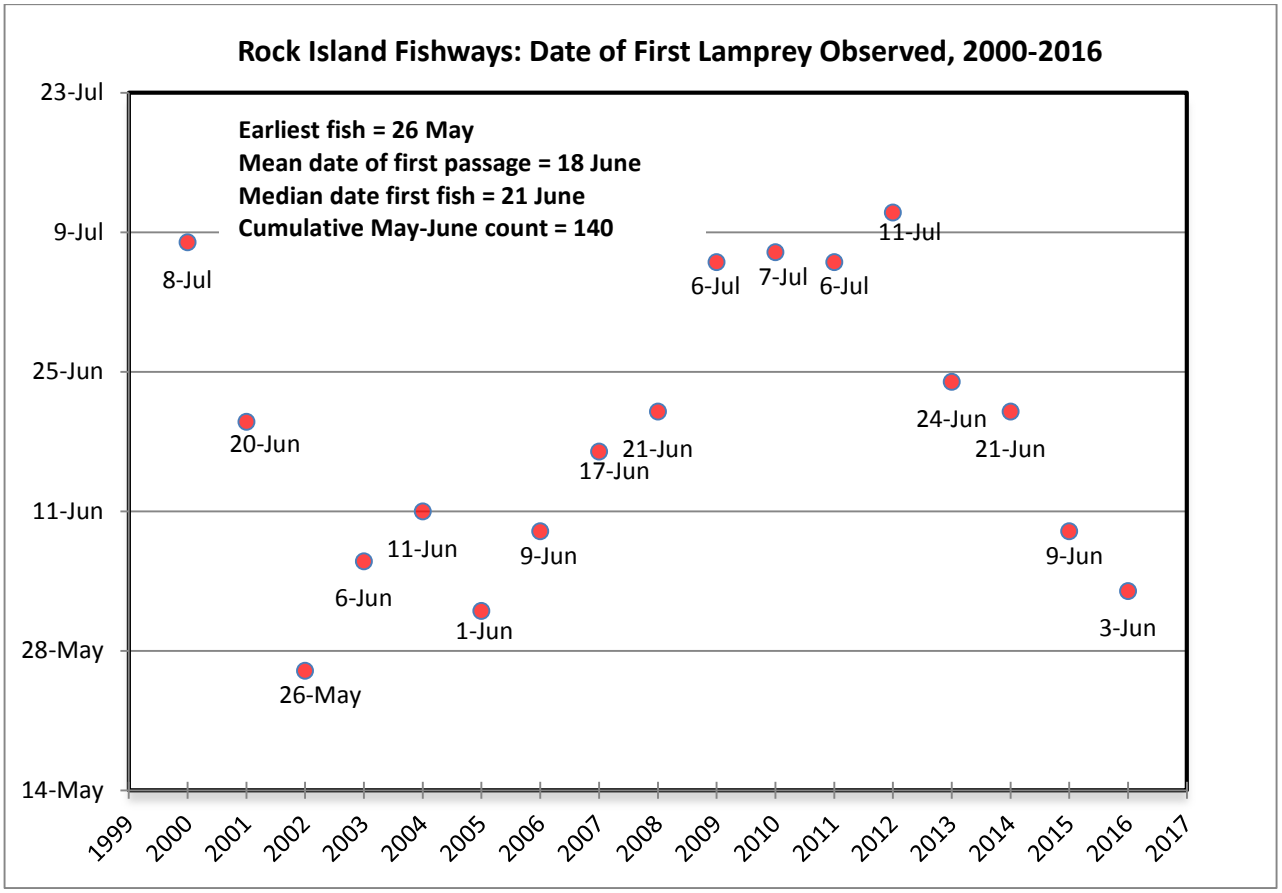

Figure 1. Dates of first adult Pacific Lamprey passage observed at Rock Island Dam, 2000-2016.

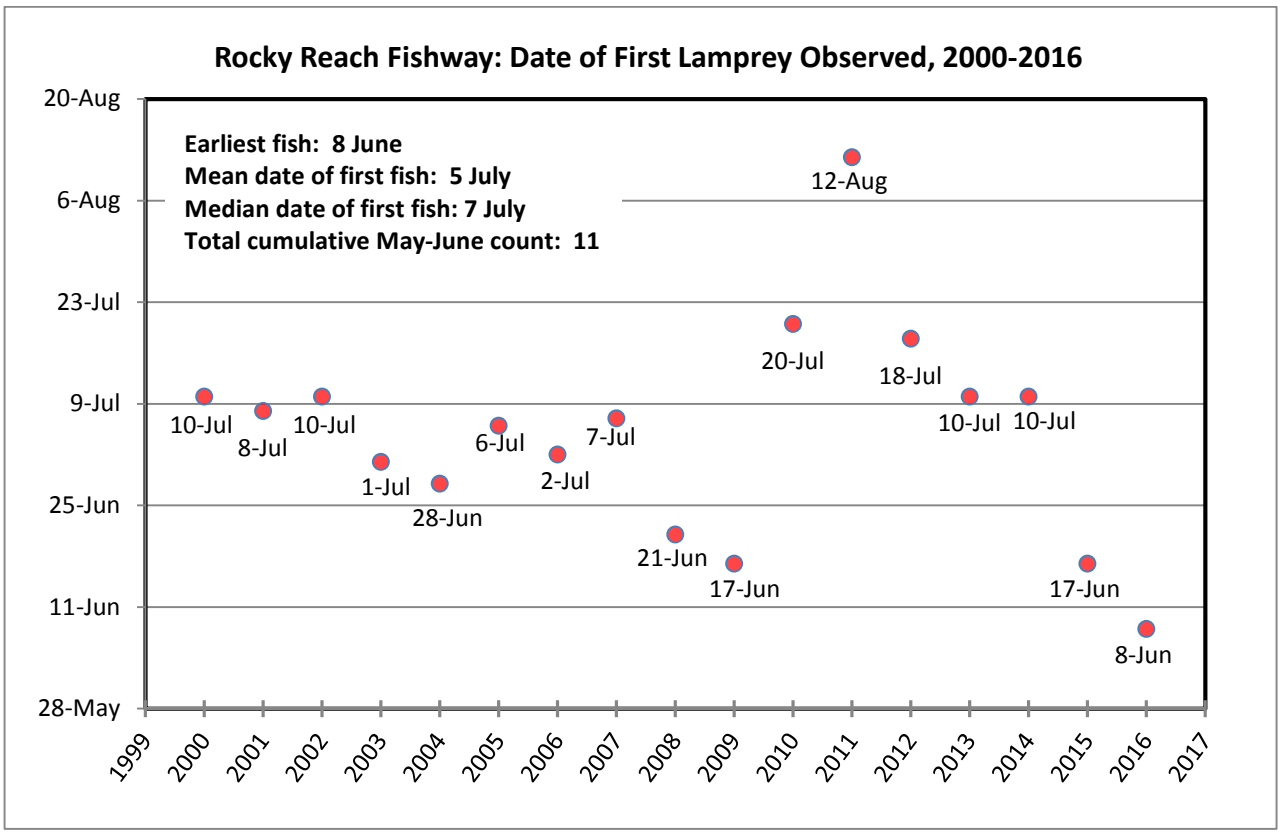

Figure 2. Dates of first adult Pacific Lamprey passage observed at Rocky Reach Dam, 2000-2016

Figure 3 shows the total annual season-wide counts of Pacific lamprey at Rock Island and Rocky Reach dams from 2000 through 2016. Total counts in this period vary widely, ranging from a low in 2010 (RIS-268; RRH-318) to a high in 2014 (RIS-4,600; RRH-3,799). The 17-year mean annual total lamprey count at Rock Island Dam is 2,108 lampreys; the mean count for this period at Rocky Reach is 1,185 lampreys.

Dam conversion rates for Pacific lamprey based same-year passage counts and count differences between Rock Island and Rocky Reach is demonstrated in Figures 4-6 and ranges from 6.4% 1996 to 98.6% in 2015. Significant improvements were completed in 2011 to the Rocky Reach fishway to aid adult Pacific Lamprey passage. Benefits of these modifications are recognizable in count conversions between Rock Island and Rocky Reach (Figures 4-6).

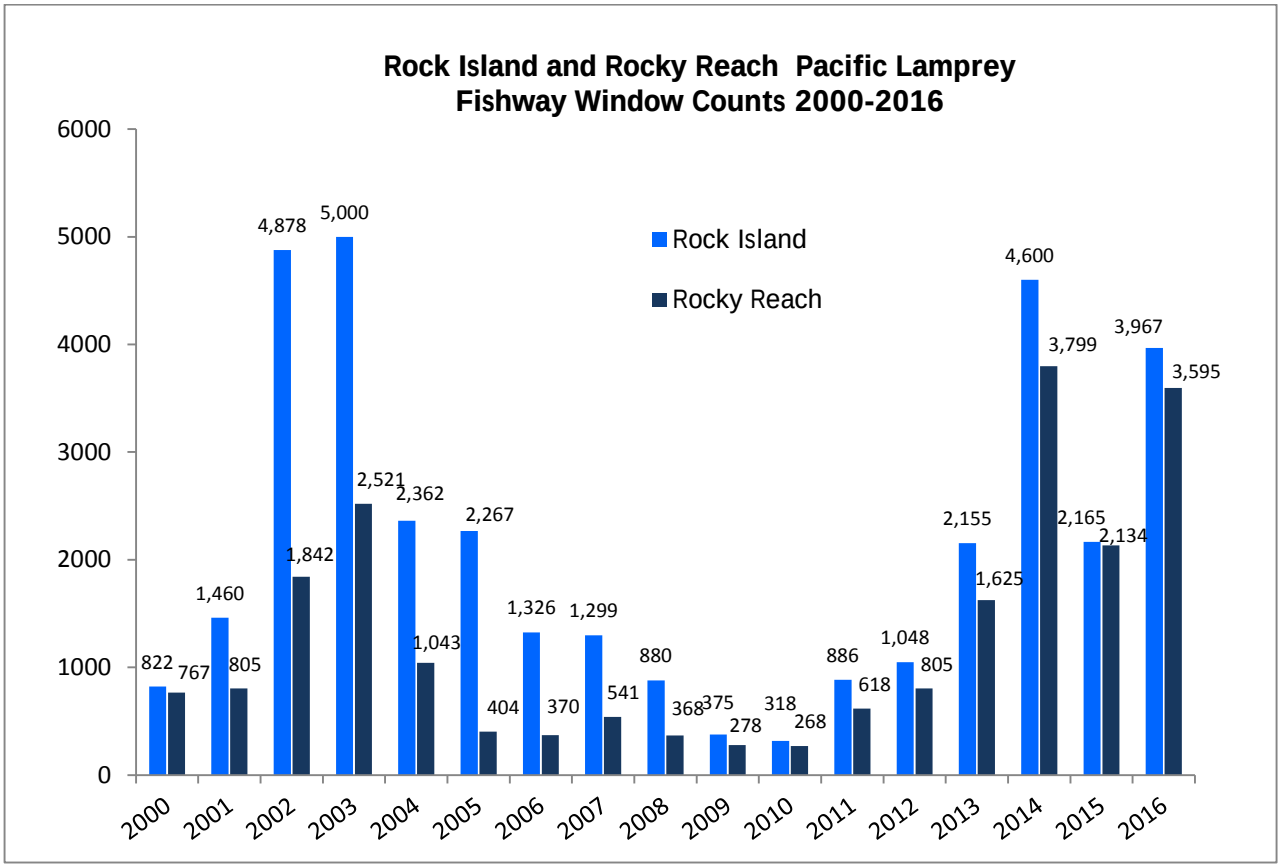

Figure 3. Total annual fishway counts of adult lampreys at Rock Island and Rocky Reach dams, 2000-2016.

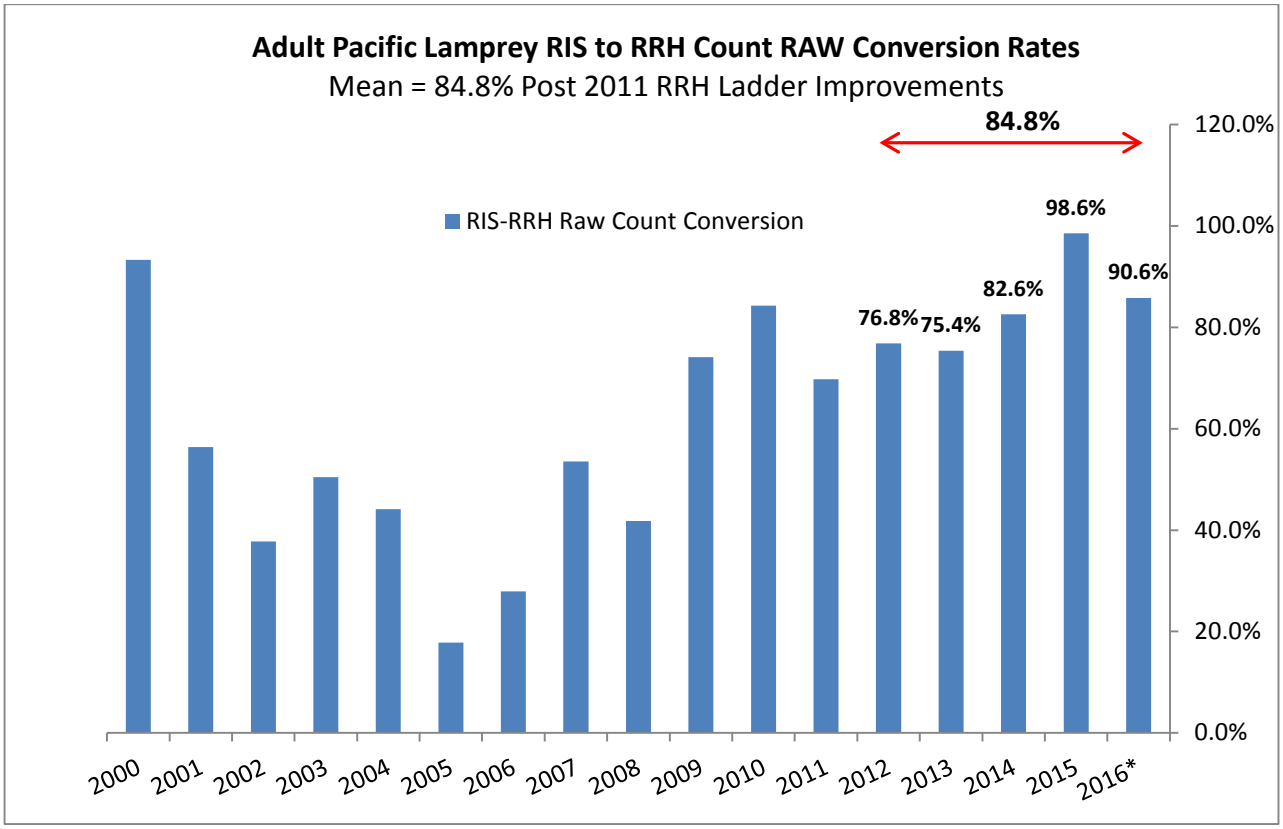

Figure 4. Adult lamprey fishway count conversion rates, Rock Island to Rocky Reach, 2000-2016

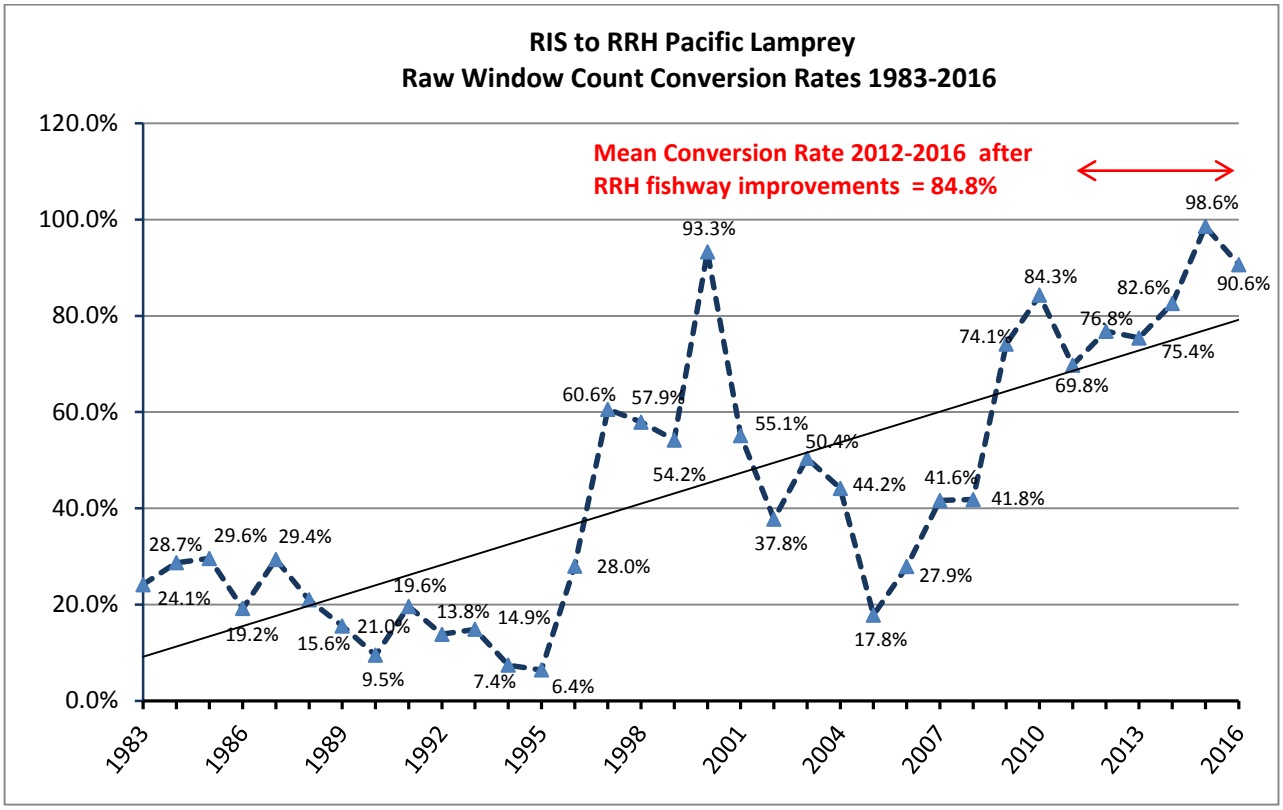

Figure 5. Rock Island to Rocky Reach unadjusted fishway window count conversion rates for adult Pacific Lamprey, 1983-2016.

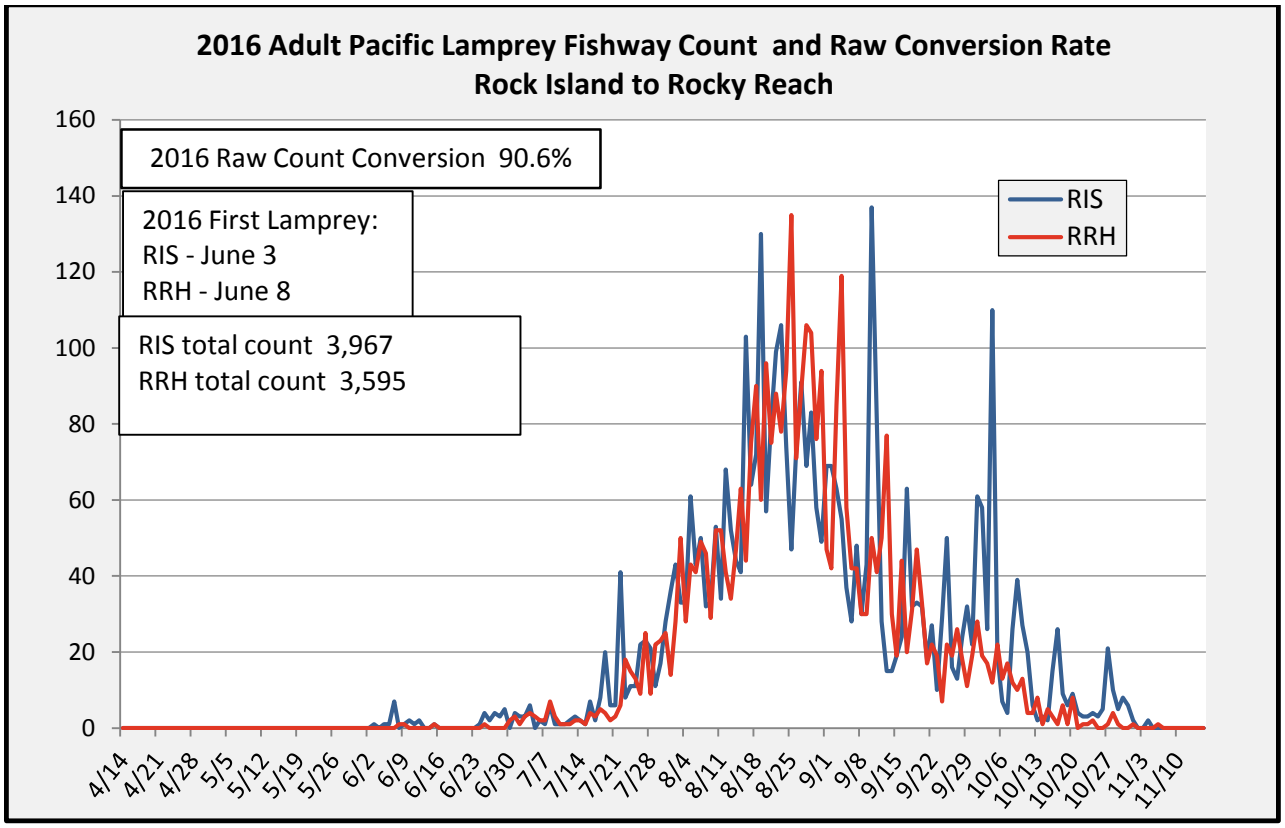

Figure 6. Adult Pacific Lamprey run-timing at Rock Island Dam and Rocky Reach dams and the unadjusted (unadjusted for escapement) lamprey window count conversion rate between the two projects in 2016.

2016 Rocky Reach Adult Lamprey PIT Tag Passage and Tributary Escapement Study

In 2016, Chelan PUD trapped, tagged, and transported 211 adult lampreys up from Priest Rapids Dam to conduct a dam passage and escapement rate study at Rocky Reach. Lampreys were single tagged with a full-duplex (FDX) PIT tag. All fish were re-released at Kirby Billingsley Hydro Park (KBH), approximately 7.5 river miles downstream of the Wenatchee River confluence. Lampreys were released from 3 August to 17 August, 2016.

As of 31 December, 2016, 169 of the 211 lampreys released in August 2016 at KBHP have been detected somewhere (80.1%). Only five of the total 211 lampreys released (though perhaps more undetected) have volitionally entered the Wenatchee River (initial escapement 2.4%) based on initial detections. The range of travel times for these five fish, from release to first PIT detection inside the Wenatchee River, was 0.5 to 13.6 days. This demonstrates the variable migration times exhibited by individual lampreys. None of the 211 tagged lampreys have been detected in the Entiat River or at Tumwater Dam. However, 164 of the 211 (77.7%) released lampreys were detected within the Rocky Reach fishway, with 162 verified to have exited the top of the Rocky Reach fishway (98.8% fishway passage rate). This passage rate nearly equals that of adult spring Chinook salmon and surpasses that of steelhead at Rocky Reach Dam.

Biological Assumptions: Wenatchee River Pacific Lamprey at Tumwater Dam

Wenatchee River Escapement Based on Mainstem Counts

Counts of adult lampreys passing through the fishways at both Rock Island Dam and at Rocky Reach Dam each year is known. These numbers are helpful to approximate the number of adults available to enter the Wenatchee River and available to pass Tumwater Dam (Table 2). The actual annual passage count differences between Rock Island Dam and Rocky Reach Dam are not known for certain because "fall back" of adult lamprey through dam routes other than the fishway, and possible subsequent re-count of twice passing lampreys ae unknown; however, re-count rates are believed to be very small based on radio-telemetry and PIT tag studies. Additionally, escapement rates are unknown because the numbers of adult lampreys that entered freshwater the previous year and may have overwintered somewhere between Rock Island and Rocky Reach dams or in the lower Wenatchee River, are now available to move upstream or enter the Wenatchee to spawn or approach Tumwater Dam.

The Wenatchee River mouth is approximately 24.9 km above Rock Island Dam and 7.2 km downstream of Rocky Reach Dam. We know that adult lamprey enter the Wenatchee River to spawn, how many enter and spawn is not known precisely. Comparison of full-season fishway window counts at Rock Island Dam and Rocky Reach Dam (Figure 3) suggests that escapement rates into the Wenatchee are variable, with perhaps 50 to 800 adults entering annually in recent years based on count conversions between the two Projects. Once in the Wenatchee, we know some adult lamprey spawn above the Dryden Irrigation Canal water in-take site. Chelan PUD observes and recovers lamprey ammocoetes that rear in the canal sediments every year; most years recovery number are in the thousands of larvae.

Table 2. Potential Wenatchee River lamprey escapement numbers based on full-season fishway lamprey count differences at Rock Island and Rocky Reach dams, 2010-2016.

Year	Rock Island Count	Rocky Reach Count	Count Difference Escapement Potential
2010	318	268	50
2011	886	618	268
2012	1,048	805	243
2013	2,155	1,625	530
2014	4,600	3,799	801
2015	2,165	2,134	31
2016	3,967	3,595	372

Migration Timing to Tumwater Dam

Tumwater Dam is located at approximately 52.6 km upstream (RM 32.7) on the Wenatchee River. The last adult lampreys observed passing Tumwater Dam occurred in 1995 when fish-counter video observed and counted eight adult lampreys passing on the same day on 15 July (Chelan PUD unpublished fish count data 1995). The time of day is noted in the fish-count sheets for these lamprey passage events in the July 15, 1995. Since that day, no lampreys have been observed passing Tumwater Dam that Chelan PUD is aware of. The USFWS conducted electrofishing surveys in 2012 in the upper Wenatchee above Tumwater Dam to document any presence of juvenile lamprey (Yonce and Nelle, 2012). They found no rearing juvenile lamprey in

multiple surveys. Juvenile lampreys may rear in sediments for four to seven years after eggs hatch, which based on electrofishing surveys, helps confirm that lamprey passage has likely not occurred recently at Tumwater Dam.

Given that no direct passage studies have occurred, migration timing is based on professional knowledge of agency and tribal lamprey biologists. In the Yakama River, the Yakama Nation noted that approximately 10% of the spring lamprey migration passes at flows above 4,400 cubic feet per second (cfs) (Lampman 2015). At Tumwater Dam, flows typically range from 800-1,400 cfs during the fall migration period August-October and 1,700-8,000 cfs in the spring. July flows average around 4,000 cfs.

Chelan PUD's best assumption of adult lamprey arrival timing at the Tumwater Dam site is first of July through late August. Because lamprey don't begin to move past Rock Island or Rocky Reach in the mainstem until July, it seems improbable first year fresh water fish or Mainstem overwintered fish would initiate migration up through the Tumwater Canyon to the Tumwater Dam site prior to July in most years. It also unlikely that overwintered lamprey already in the lower Wenatchee or Tumwater Canyon would begin to move upstream towards Tumwater Dam prior to late June or early July, depending on flow and temperature conditions. We therefore should assume that if Pacific lampreys intend to pass Tumwater Dam to spawn in the current year, they would be at Tumwater from late June through late July, and early to mid-August, depending Wenatchee temperatures and hydrograph conditions. Lampreys migrating in their first freshwater year, pre-overwintering could be present July-September at Tumwater Dam.

In 2015, one adult lamprey captured at Priest Rapids Dam by Grant PUD, FDX-PIT tagged (3D9.1C2DC96BFB) and released at Vantage in Wanapum Reservoir on 24 July 2015, was next detected at the Rock Island right bank fishway on 25 July 2016, one full year later. Six days later on 31 July 2016 after first detection at Rock Island, it was detected on the lower Wenatchee River PIT antenna. This lamprey's mainstem overwintering and migration timing would put it at Tumwater Dam (RM 32.7) if it chose to go there, no earlier than the first week of August or later, with spawning later yet in August or September.

<u>Spawn Timing in the Wenatchee</u>

The US Fish and Wildlife Service (USFWS) has indicated that Pacific lamprey likely spawn in the Wenatchee River on the backside of the hydrograph in the summer—likely in the period July through August, depending on the water year, and individual lamprey migration timing past Rock Rocky Reach and Rock Island Dam (Figures 7 and 8 photos) overwintering and entry time into the Wenatchee River. USFWS noted they have no direct observations of lamprey spawning in the Wenatchee, so spawn timing is based on supposition. USFWS did observe an adult lamprey carcass one year in the month of July in the lower Wenatchee, and YOY larvae sampled that were sampled in September (A. Grote, USFWS, personal communication January 26, 2017).

Spawn timing is therefore largely inferred from the Entiat River, where USFWS does have some recent spawning data. Active Pacific Lamprey redds have been observed in the Lower Entiat River as early as June 9 in 2016, and as late as the first week of August in 2014. The USFWS recovered a recently-spawned out carcass from the Entiat River in mid-September 2016 (A. Grote, USFWS, personal communication January 26, 2017).

Most of the information on lamprey spawning in the Entiat and Wenatchee rivers comes incidentally from spring steelhead surveys, and late summer/fall Chinook surveys. USFWS indicated that without salmonid surveys running in mid to late summer, when USFWS presumes much of the spawning occurs, they do not have directive confirmation of adult lamprey spawner abundance or spawn timing.

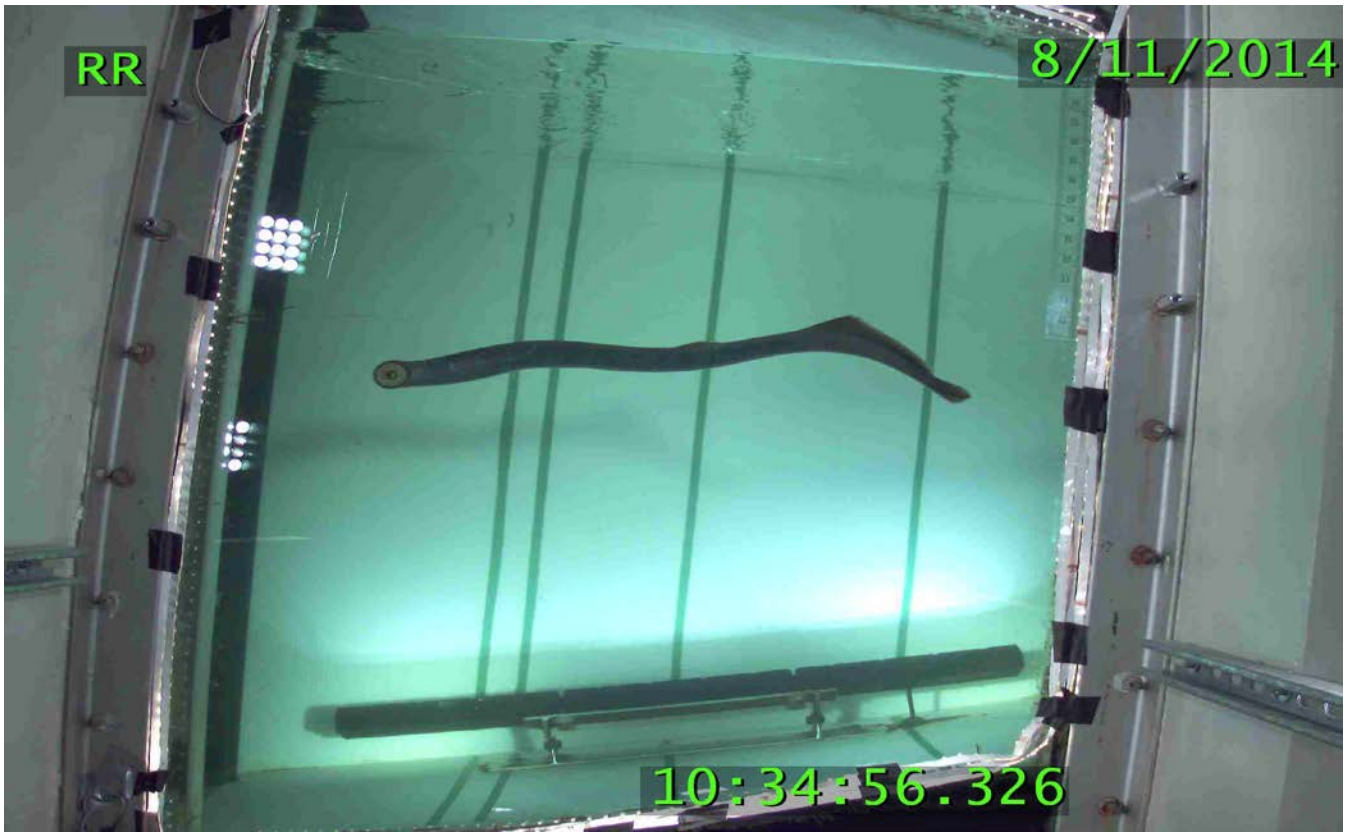

Figure 7. Adult lamprey passing through the Rocky Reach fishway count window, 11 August, 2014.

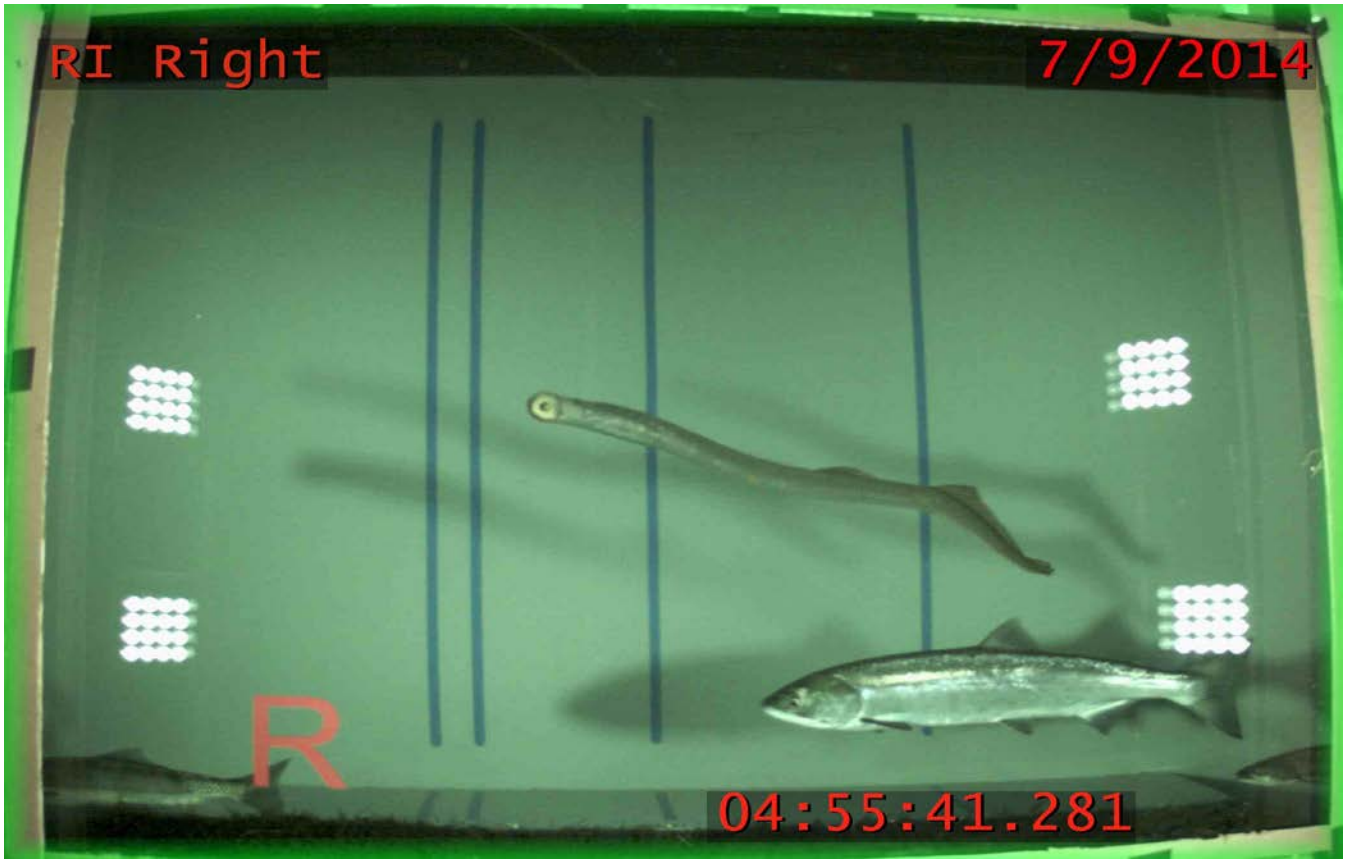

Figure 8. Adult lamprey passing through the Rock Island right bank fishway count window on 9 July, 2014.

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