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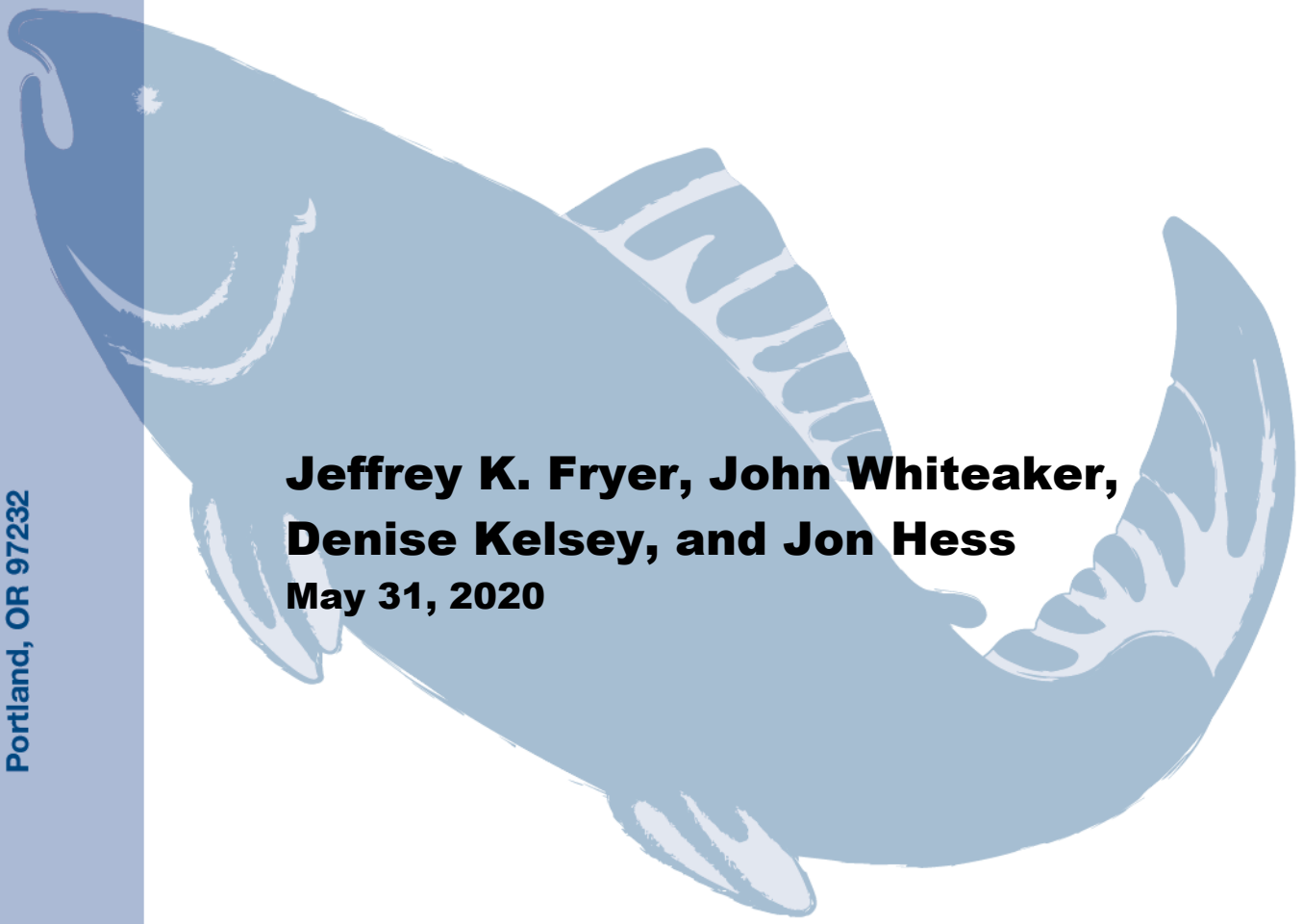
TECHNICAL REPORT 20-02

Upstream Migration Timing of Columbia Basin Chinook and Sockeye Salmon and Steelhead in 2018



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May 31, 2020

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Columbia River Inter-Tribal Fish Commission Technical Report for BPA Project 2008-518-00, Contract 73354

Report date range: 1/18–12/18

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ABSTRACT

Between April 25 and October 12, 2018, we sampled Chinook *(Oncorhynchus tshawytscha) and* Sockeye *(Oncorhynchus nerka)* salmon as well as steelhead (*Oncorhynchus mykiss)* at the Bonneville Dam Adult Fish Facility (AFF). Fish were measured for fork length, scales were collected for analysis of age, tissue samples collected for genetic analysis, and the fish were tagged with Passive Integrated Transponder (PIT) tags. These fish were tracked upstream as they passed through sites with PIT tag antennas, including fish ladders at dams, juvenile bypasses, hatcheries, and weirs, as well as in-stream antennas. Total numbers of fish tracked upstream were 1,269 spring Chinook, 643 summer Chinook, 1,266 fall Chinook, 893 steelhead, and 1,848 Sockeye Salmon.

Chinook Salmon median migration rates between mainstem dams ranged between 11.1 km/day for fall Chinook migrating between Priest Rapids and Wells dams and 56.5 km/day for fall Chinook migrating between John Day and McNary dams. An estimated 39.2% of spring Chinook passed into the Snake Basin upstream of Ice Harbor Dam, while an estimated 62.1% of summer Chinook passed upstream of Priest Rapids dam into the Upper Columbia Basin. Among fall Chinook, the primary terminal area was between McNary Dam (passed by 55.3% of fall Chinook) and Ice Harbor Dam (passed by 13.0% of fall Chinook) and Priest Rapids Dam (passed by 10.7% of all fall Chinook). Escapement estimates for the entire Chinook run derived from PIT tag detections differ from those estimated by visual counts by 16.2% to -4.6% at mainstem dams.

Steelhead median migration rates reported between mainstem dams ranged from 12.6 km to 37.6 km/day. Among Steelhead classified as B-run (greater or equal to 78 cm fork length) that were last detected in terminal areas (tributaries between Bonneville and McNary Dam and above McNary Dam), 98.1% were detected in the Snake Basin. Based on the data reported, the percentage of steelhead classified as B-run at Bonneville Dam reached its highest level at 78.3% of the run in Statistical Week 40. The number of B-run steelhead peaked in Week 37 at 5,123 steelhead while the number of A-run (<78 cm) peaked in Week 30 at 8,660 fish. A total of 80 steelhead PIT tagged and tracked in 2018 were detected moving downstream (mostly in juvenile bypasses) after spawning, recovered or detected in kelt programs, or detected moving upstream in summer/fall 2018 or in 2019 and were designated as kelt.

The principle age components of the run were Age 1.2 (94.2%), Age 2.1 (2.0%), Age 1.3 (1.4%), and Age 2.2 (1.3%). Sockeye median migration rates between mainstem dams ranged between 33.0 and 59.8 km/day. Escapement estimates for the entire Sockeye run derived from PIT tag detections at mainstem Columbia River dams differ from those estimated by visual counts by -12.9% to 18.8% at Columbia River dams.

ACKNOWLEDGMENTS

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INTRODUCTION

Since 1985, the Columbia River Inter-Tribal Fish Commission (CRITFC) has been funded by the Pacific Salmon Commission (PSC) to sample Chinook *(Oncorhynchus tshawytscha)* and Sockeye *(Oncorhynchus nerka)* salmon at Bonneville Dam to determine age, length-at-age, and, in the case of Sockeye Salmon, stock composition (Fryer 2009). In 2004, CRITFC took over a similar long-running steelhead (*Oncorhynchus mykiss)* sampling program at Bonneville Dam from Oregon Department of Fish and Wildlife (Whiteaker and Fryer 2008). The development and maturation of two new technologies, Passive Integrated Transponder (PIT) tags and genetic stock identification (GSI), have provided an opportunity to greatly expand the information obtained from our stock monitoring program at Bonneville Dam. PIT tag antennas are now installed in fish ladders at most mainstem Columbia and Snake River dams, as well as at dams and weirs on many of the Columbia Basin tributaries. By PIT tagging fish sampled at Bonneville Dam, we can track tagged fish upstream providing valuable information on migration timing and survival rates. Data on the movement of PIT tagged fish through Columbia Basin receivers is readily available to all managers and researchers on a near real-time basis through the PIT Tag Information System (PTAGIS) at www.ptagis.org. The information obtained by PIT tags can be further expanded by identifying the origin of the fish using GSI. Using these two technologies it becomes possible to determine migration timing, stray rates, and upstream survival on a stock-specific basis for Chinook and Sockeye salmon and steelhead.

The vast majority of PIT tagging in the Columbia Basin is conducted on juvenile salmonids captured at hatcheries, tributary smolt traps, or at dam juvenile bypasses. These tagging programs predominantly study downstream juvenile migration and survival through the hydrosystem, but rarely tag enough fish to assess survival of returning adults as they pass Bonneville Dam and migrate to the spawning grounds. There are also many salmon stocks in the Columbia Basin which are not PIT tagged, thus it is difficult to answer questions on upstream migration timing, straying, and survival for those stocks. Because our project randomly samples adult salmon and steelhead passing through the Bonneville Dam Adult Fish Trap, this study tags salmonid stocks that have not previously been tagged and monitored.

METHODS

Sampling

Chinook and Sockeye salmon and steelhead were collected from April 25 through October 12, 2018, at the Bonneville Dam Adult Fish Facility (AFF), located adjacent to the Second Powerhouse at river km 234. This facility uses a weir with four pickets to divert fish ascending the Washington shore fish ladder into the AFF collection pool. An attraction flow is used to draw fish that enter the collection pool through a false weir where they then can be selected for sampling. Fish not selected, and fish that have recovered from sampling, migrate back to the Washington shore fish ladder above the pickets. An attempt was made to exclude minijacks (defined as Chinook spending no winters in saltwater) from the sample by not diverting Chinook Salmon into the sampling tank that were estimated to be less than 36 cm in length, and immediately releasing without sampling any fish diverted that turned out to be less than this threshold. These small Chinook Salmon are excluded because sampling these fish would reduce our collection of larger Chinook, and other species, which are more important to managers. Also excluded from further analysis, other than reporting the site of final PIT tag detection, were any Chinook, Steelhead, and Sockeye salmon that, based on scale analysis, did not spend a winter in saltwater.

Use of the Bonneville Dam Adult Fish Facility is restricted by protocols established by the Fish Passage Operation and Maintenance Team (http://pweb.crohms.org/tmt/documents/fpp/2017/final/FPP17_AppG.pdf). These protocols have restrictions on the number of salmonids that can simultaneously be in the anesthetic and recovery tanks and restrict picket lead operations at higher fish abundances. At temperatures above 21.1°C (70.0°F), sampling is restricted to four days per week from 0600-1030 hours, the number of salmonids allowed in the anesthetic tank is reduced, and picket lead operations are changed to divert fewer fish into the AFF. Above 22.2°C (72.0°F) sampling is halted until the daily average water temperature drops to 21.16°C (71.9°F). Picket lead deployment is also restricted when abundance of salmonids or shad is high with further restrictions when abundance occurs at high temperatures (Appendix A).

Salmon and steelhead selected for sampling were diverted into a tank where they were anesthetized, examined for tags, fin clips, wounds, and condition. They were measured for fork length, and tissue and six scales (four scales for Sockeye) were collected for age analysis (Whiteaker and Fryer 2008, Kelsey et. al 2011). A small caudal clip for later genetic analysis was also collected

(https://www.monitoringresources.org/Document/Method/Details/4087). Fish were scanned for PIT tags. If no tags were detected, standard techniques were used to inject PIT tags using a needle that penetrates the fish between the posterior tip of the pectoral fin and the anterior point of the pelvic girdle (CBFWA 1999). Tagged fish were then scanned for the PIT tag code, which was recorded if detected. If no tag was detected, no effort was made to re-tag the fish. Data on each PIT tagged fish was uploaded to www.ptagis.org.

Columbia Basin Chinook salmon are classified by Bonneville Dam passage date as being spring, summer, or fall run. Spring Chinook are most commonly considered as those Chinook passing Bonneville Dam between March 15 and May 31 annually (FPC 2018), although for management purposes June 15 is used as the end date of the spring Chinook migration (https://wdfw.wa.gov/sites/default/files/about/commission/meetings/2018/06/jun_1318_16_summary.pdf). This report will use the May 31 date, although some comparisons using the June 15 date will be provided. Chinook passing Bonneville Dam on or after June 1 will be classified as summer Chinook, while those passing on or after August 1 will be classified as fall Chinook Salmon.

Upstream Detection

As tagged salmon and steelhead continued their migration they were detected by PIT tag receivers located in the adult fish ladders at major Columbia Basin mainstem dams (Bonneville, The Dalles, John Day, McNary, Priest Rapids, Rock Island, Rocky Reach, and Wells dams on the Columbia River; Ice Harbor, Lower Monumental, Little Goose, and Lower Granite dams on the Snake River) as well as in numerous tributaries and hatcheries in the Columbia Basin (Appendix B – Table B1 and Figure B1). PIT tag detection data from these sites is uploaded to www.ptagis.org, which is then accessible to users of the site.

Almost all detection sites have multiple antennas, often laid out in parallel so that the antennas span a river or fishway in more than one location. We refer to each parallel antenna array as a "weir." Salmon can be detected more than once as they pass over or through each weir. Each detection will subsequently be referred to as a "weir detection." The combination of all detections at the multiple weirs at a given site, regardless of the time between those detections, will subsequently be referred to as a "site detection." For example, the configuration of PIT tag antennas at Rock Island Dam is shown in Figure 1. Salmon or steelhead can pass this dam using any of three fish ladders. Each ladder has two weirs

(referred to as baffles 2 and 4 at each ladder) with PIT tag detection and two antennas in each weir (numbered as 01 to 0C in hexadecimal format). If a fish ascended the left ladder and generated two detections at Baffle 2 and three at Baffle 4 (the words “baffle” and “weir” are interchangeable), this is five weir detections, but only one site detection (Rock Island Dam).

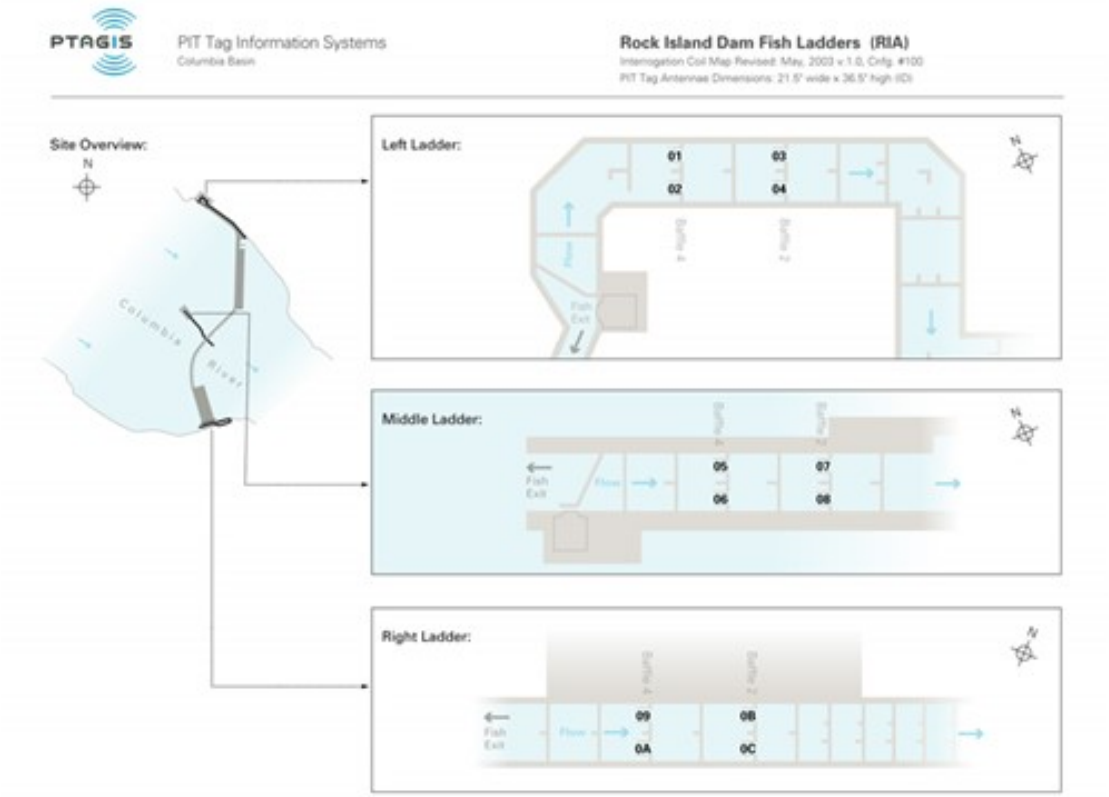

Figure 1. Example PIT tag detection configuration at Rock Island Dam showing two adjoining antennas at two weirs in each fish ladder. (Figure from www.ptagis.org.)

Site Detection Efficiencies

Any fish detected at an upstream dam should have been detected at lower dams (with the exception of Bonneville, The Dalles, John Day, McNary, Ice Harbor, Little Goose, Lower Monumental, and Lower Granite dams, where it is possible that a fish could use the navigation locks to pass the dam). The percentage of PIT tagged fish missed at each dam with PIT tag detection arrays was calculated by looking at the fish detected upstream of the site in question and estimating the percentage not detected at that site. For example, the percentage missed at Rocky Reach Dam was calculated as:

$$P = \frac{R_m}{R_d}$$

where R_m was the number of fishes missed at Rocky Reach Dam but detected upstream of Rocky Reach Dam and R_d was the number of fish detected upstream of Rocky Reach Dam.

PIT tag detection antennas in fish ladders are always placed in at least two locations in relatively close proximity. PIT tag interrogation maps (available at www.ptagis.org) indicate that these antennas are placed at vertical slots, weirs, or pools. To simplify the nomenclature, these locations will all subsequently be referred to as weirs.

Age Analysis

Visual assessment of scale patterns was used to determine age composition through techniques developed for the Bonneville Stock Sampling project *(*Whiteaker and Fryer 2008, Kelsey et al. 2011*).* The European method for fish age description (Koo 1962) was used where the number of winters a fish spent in freshwater (not including the winter of egg incubation) is described by an Arabic numeral followed by a period. The number following the period indicates the number of winters a fish spent in saltwater. Total age, therefore, is equal to one plus the sum of both numerals. If poor scale quality, particularly in the freshwater, prevents age determination in all scales collected from a particular fish, no age is assigned. The exception is steelhead, where if saltwater age can be reliably determined, the age is designated as r.y where “y” is the saltwater age and “r” stands for regenerated. Any salmonid (Chinook, steelhead, or Sockeye) judged by scale analysis to have spent no winters in saltwater were excluded from further analysis.

Other sources of age information are available in the form of age since release, from PIT tags from salmonids tagged as juveniles, as well as the total age of salmonids that could be identified using Parental Based Tagging (PBT). In 2018, the PBT age was available when Chinook and steelhead were being aged and that information was considered in estimating a scale age.

Escapement

Chinook and Sockeye salmon escapements at upstream detection sites were estimated as:

$$N = \sum_i \frac{B_i R_i}{T_i}$$

where N was the estimated escapement at a particular upstream site, *i* was the week at Bonneville Dam, B_i was the weekly count of fish passing Bonneville Dam in week *i*, T_i was the number of fish PIT tagged at Bonneville Dam in week *i,* and R_i was the number of PIT tag detections at the dam where escapement was being estimated of those fish tagged in week *i.* Estimated dam counts using PIT tag data were compared with dam counts made at fish ladder viewing windows or weir counts. No estimates were made for steelhead because many overwinter between dams on their upstream migration making it difficult to compare PIT tag estimates with dam counts.

Migration Rates and Passage Times

Run timing was estimated using the date and time of detection between sites. Migration rates were calculated between sites as the time between the last detection at the first site and the first detection at the upper site. The amount of time required to pass each dam was estimated as the difference between the first detection time at a dam and the last detection time at the same dam.

Upstream Age and Length-at-Age Composition Estimates

The age composition at upstream locations was calculated as:

$$T_j = \sum_k A_{j,k} * W_k$$

where T_j was the estimate for age group *j* at a particular location, $A_{j,k}$ was the percentage of fish for age group *j* in week *k* at Bonneville Dam (such that $\sum_j A_{j,k} = 1$) and W_k was the percentage of the run that passed Bonneville Dam in week *k.*

Fallback

Three methods were used to determine fallback, which is defined as a fish that ascends a fish ladder into the reservoir above the dam, then “falls back” to the downstream side of the dam either over the spillway, or through the navigation locks, juvenile bypass systems, or turbines. The first method was if an adult salmon or steelhead was detected in the juvenile bypass system. However, on the Columbia River, only Bonneville, John Day, McNary, and Rocky Reach dams have juvenile bypass system PIT detection capability while all four dams in the Snake River have juvenile detection. Furthermore, there is no detection at any dam for

fish falling back over the spillway or through the navigation locks or turbines. Therefore, a second method of estimating fallback was to look at each dam for fish detected at an “upper” weir followed by detection at a “lower” weir separated by more than two hours. At McNary and Bonneville dams, the upper detection weir is at the fish counting windows (which are believed to detect all passing PIT tagged fish), while the PIT tag detectors near the entrance to the fish ladder are the lower weirs. At Priest Rapids, Rock Island, Rocky Reach, and Wells dams, there are only two weirs with PIT tag detection in each fish ladder, so these were designated as the upper and lower detection weirs, even if they are not at the top or bottom of the ladders. At McNary and Bonneville dams, detection histories of fish detected at multiple ladders were also reviewed (MC1 and MC2 for McNary and BO1 and BO4 for Bonneville) (see http://www.ptagis.org for maps of sites). Finally, a third method of estimating fallback was ascertained by fish that passed an upstream PIT tag detector at a given dam but then were next observed at a site downstream of the dam in question. These methodologies will underestimate fallback as they do not include fish that fall back over a dam and are not subsequently detected.

Adult steelhead downstream movements on or after March 31, 2018, were not considered fallbacks; rather, they were considered kelts on their way downstream. Some steelhead move out of the system before April 1st, and with more detection sites added at dams and in-stream arrays placed in tributaries in the last few years, it has been easier to determine more kelts between March 1st and April 1st. Consideration of these fish as kelts versus assigning them as fallbacks is now part of the analysis process.

Night Passage

Fish counting at Columbia Basin dams is not consistent between dams. Salmonids passing Corps of Engineers-operated dams (Bonneville, The Dalles, John Day, McNary, Ice Harbor, Lower Monumental, Little Goose and Lower Granite) are counted live by observers stationed at fish ladder viewing windows from 0400 to 2000 PST with most supplemented with video counts of passage between 2000 and 0400 from June through September (http://www.nwd-wc.usace.army.mil/tmt/documents/fpp/2016/index.html), which is the span of months that salmonids are tagged by this study. Salmonids passing Priest Rapids, Rock Island, Rocky Reach, and Wells dams are all counted 24 hours per day from recorded video. Tributary dam passage is estimated using 24-hour recorded video and/or counts at adult fish traps.

Night passage rates (where night is defined as 2000 to 0400 PST) were calculated based on the last time fish were detected in a fish ladder for all dams passed. This last time detected at a ladder was used as an approximation for passage time at the counting window, as the uppermost weir is closest to the fish counting window at nearly all ladders. (For maps of site configuration for mainstem dams see http://www.ptagis.org.)

Steelhead B-Run Analyses

For management purposes, Columbia Basin steelhead are commonly referred to as being either A- or B-run. B-run steelhead are defined as greater than or equal to 78 cm in length, while A-run steelhead are under 78 cm (Busby et al. 1996). B-run steelhead are generally older, spending three winters in saltwater compared to one or two winters for A-run steelhead, and generally pass Bonneville Dam after August 25, while A-run steelhead generally pass earlier (Busby et al. 1996). Upstream, run timing separation is not observed and the groups are separated based on size and age (Busby et al. 1996). B-run steelhead are thought to only be produced in the Clearwater, Middle Fork and South Fork Salmon rivers (Busby et al. 1996).

Analyses of B-run steelhead consisted of comparing the timing of the A- and B-runs at Bonneville Dam with the established August 25 criteria, comparing the length group of sampled steelhead with where they were last detected, and looking at the destination of B-run-sized steelhead by statistical week sampled at Bonneville Dam.

Steelhead Kelt Analyses

Steelhead differ from other salmonids studied in this project as they are capable of spawning multiple times. After spawning in late winter or early spring, some steelhead will migrate downstream to the ocean to feed; these fish are known as kelt. The fish that survive return in a subsequent spawning season. We considered all steelhead detected moving downstream (mostly in juvenile bypasses) on or after March 31, the year after tagging, to be kelt and tabulated where they were last detected. We also carefully considered fish moving between March 1st and April 1st through juvenile bypasses and the Bonneville Corner Collector as kelts, especially when tag detections indicate they have visited upper reaches of tributaries in late winter early spring.

Straying

For the first time in 2017, and continuing in 2018, stray rates were estimated by comparing PIT tag movements of steelhead and Chinook with GSI/PBT results. A matrix of final-PIT-fate categories (neutral, on-target, putative stray, and putative overshoot) was created where “neutral” fates indicate movements through the mainstem river corridor on route to their expected destination (basin-of-origin, population-of-origin, or hatchery-of-origin). “On-target” fates indicate fish that were last detected at their expected destination. “Putative stray” indicates fish that were last detected in tributaries or the mainstem that were outside of a normal route to their expected destination. “Putative overshoot” indicates when a fish may have gone into an area adjacent to its expected destination. Common examples of “putative overshoot” are Umatilla River Chinook last detected at McNary Dam and Priest Rapids Hatchery Chinook last detected at Priest Rapids Dam. The stray rate for a given stock was estimated as the number of “putative stray” fish divided by the sum of the “on-target” and “putative stray” fish for that stock. This is the template that we will build upon in future years.

RESULTS-CHINOOK

Sample Size

A total of 1,280 spring Chinook, 648 summer Chinook, and 1,272[1] fall Chinook Salmon were sampled in 2018 (Tables 1-3) between April 25 and October 12. Sampling restrictions due to water temperatures exceeding 21.1°C reduced sampling days and hours during Statistical Week[2] 30 of the summer Chinook run and Week 34 of the fall Chinook run and shut down sampling entirely during weeks 31 to 33 as the water temperature exceeded 22.2°C. Restrictions on the number of pickets which could be lowered to divert fish into the AFF due to fish abundance affected sampling in weeks 23-28, and 35-37. A total of 1,250 spring Chinook, 635 summer Chinook, and 1,270 fall Chinook Salmon were PIT tagged (Tables 1-3). After adding previously tagged fish (which were sampled and therefore identified for the tracking study and included in our sample), subtracting fish that were not detected after release (due to shed tags, mortalities, malfunctioning tags, or PIT tagged Chinook missing PIT tag antennas), and excluding six summer Chinook and two fall Chinook classified as minijacks, the numbers of Chinook tracked upstream and used in analysis consisted of 1,269 spring Chinook, 643 summer Chinook, and 1,266 fall Chinook Salmon (Table 1-3). We had one additional summer Chinook (3DD.0077BA6576) that we trapped and tagged at the AFF on June 4. After tagging, this fish then moved downstream in the fish ladder only to be recaptured by this project on June 6, 2018. This second capture event was excluded from further analysis as it seems likely that this downstream movement after tagging was a result of the tagging process.

[1] After 12 Chinook were excluded as minijacks

[2] Statistical weeks are sequentially numbered calendar-year weeks. Excepting the first and last weeks of most years, statistical weeks are seven days long beginning on Sunday and ending on Saturday. In 2017, for instance, Statistical Week 24 began on June 11 and ended on June 17.

Table 1. Number of PIT tagged spring Chinook Salmon at Bonneville Dam and then tracked, by date and statistical week, in 2018.

Sample Dates	Week	Sample Size	Number Tagged	Previously Tagged		Mortalities	Not Detected After Release	Total Tracked	Days Sampling Restrictions in Effect		
				By this study at AFF	By other Studies				Reduced Sampling-Temperature	Reduced Sampling-Shad or Salmonid Abundance	No Sampling-Temperature
4/25-27	17	62	60	0	2	0	0	62	0	0	0
4/30, 5/1-4	18	204	203	0	1	0	0	204	0	0	0
5/7-11	19	283	278	0	5	1	1	281	0	0	0
5/14-5/18	20	274	262	0	5	0	0	267	0	0	0
5/21-5/25	21	349	341	0	8	1	0	348	0	0	0
5/29-31	22	108	106	0	2	0	1	107	0	0	0
Total		**1280**	**1250**	**0**	**23**	**2**	4	**1269**	**0**	**0**	**0**

Table 2. Number of PIT tagged summer Chinook Salmon tracked at Bonneville Dam by date and statistical week in 2018.

Sampling Dates	Week	Sample Size	Number Tagged	Previously Tagged		Mortalities	Not Detected After Release	Excluded as Minijacks	Total Tracked	Days Sampling Restrictions in Effect		
				By this study at AFF	By other Studies					Reduced Sampling-Temperature	Reduced Sampling-Shad or Salmonid Abundance	No Sampling-Temperature
6/1	22	30	28	0	2	0	2	0	30	0	0	0
6/4-6/8	23	158	155	1	2	0	2	1	157	0	1	0
6/11-6/15	24	98	94	0	3	0	4	0	96	0	5	0
6/18-6/22	25	75	72	0	2	0	2	0	74	0	5	0
6/25-6/29	26	71	71	0	0	0	0	0	71	0	5	0
7/2-4,7/6	27	28	27	0	0	0	1	0	26	0	3	0
7/10-7/14	28	66	66	0	0	0	0	1	65	0	1	0
716-7/20	29	73	73	0	0	0	0	3	70	0	0	0
7/23-7/27	30	49	48	0	1	0	1	1	48	1	0	1
No sampling	31	0	0	0	0	0	0	0	0	0	0	2
Total		**648**	**635**	**1**	**10**	**0**	**12**	**6**	**643**	**0**	**20**	**3**

Table 3. Number of PIT tagged fall Chinook Salmon tracked at Bonneville Dam by date and statistical week in 2018.

Sampling Dates	Week	Sampled	Number Tagged	Previously Tagged		Mortalities	Not Detected After Release	Excluded as Minijacks	Total Tracked	Days Sampling Restrictions in Effect		
				By this study at AFF	By other Studies					Reduced Sampling-Temperature	Reduced Sampling-Shad or Salmonid Abundance	No Sampling-Temperature
No Sampling	31									0	0	3
No Sampling	32									0	0	5
No Sampling	33									0	0	5
8/20-8/22	34	93	93	0	1	0	2	0	92	3	0	2
8/27-8/31	35	231	229	0	0	0	1	0	228	0	1	0
9/4-9/7	36	141	141	0	0	0	0	0	141	0	4	0
9/10-9/14	37	255	255	0	0	0	0	0	255	0	1	0
9/17-9/21	38	206	206	0	1	0	1	2	204	0	0	0
9/24-9/28	39	161	161	0	0	0	0	0	161	0	0	0
10/1-10/5	40	127	127	0	0	0	0	0	127	0	0	0
10/8-10/12	41	58	58	0	0	0	0	0	58	0	0	0
Total		**1272**	**1270**	**0**	**2**	**0**	**4**	**2**	**1266**	**3**	**6**	**15**

Distribution of Sample

The weekly distribution of Chinook sampled at Bonneville Dam differed from the actual run distribution, but less so than in many previous years because in 2018 high temperatures curtailed sampling primarily during weeks when few Chinook were passing (Figures 2-4). The largest deviations where the weekly sample proportion and run proportion was less than the run proportion were in weeks 25 and 27 of the summer Chinook sample and in week 36 of the fall Chinook sample. These were all periods when sampling restrictions due to limitations on the deployment of picket leads were in effect due to high summer shad abundance in weeks 25-27 and high Chinook/steelhead abundance in the Week 36.

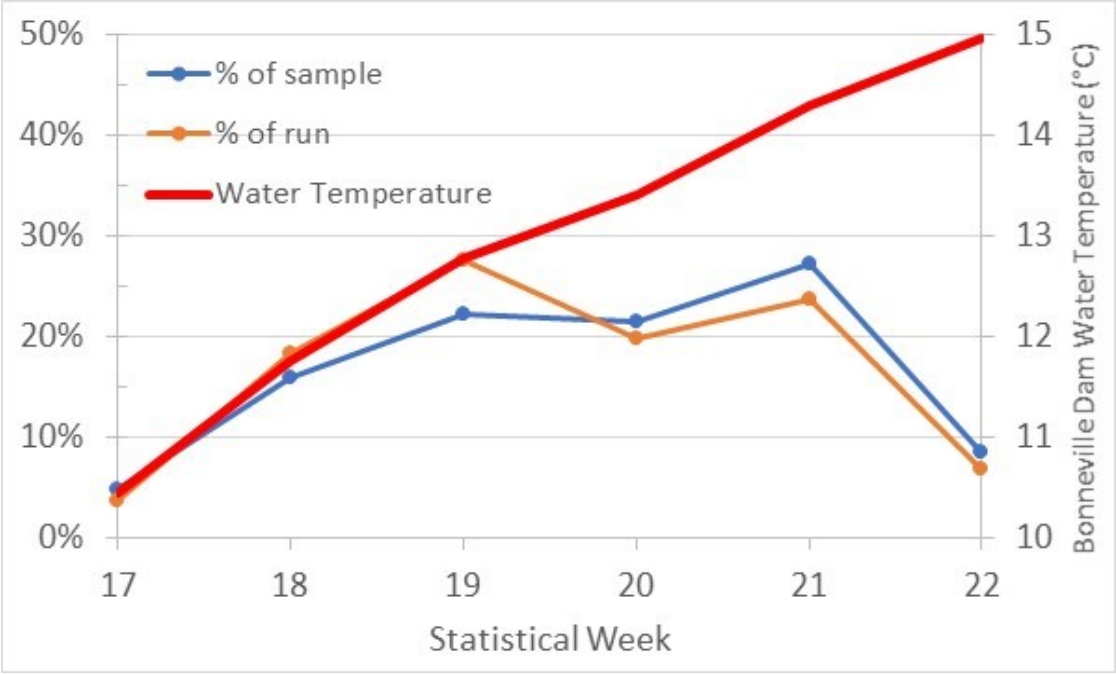

Figure 2. The weekly spring Chinook sample and run as a percentage of the total sample and run size at Bonneville Dam in 2018.

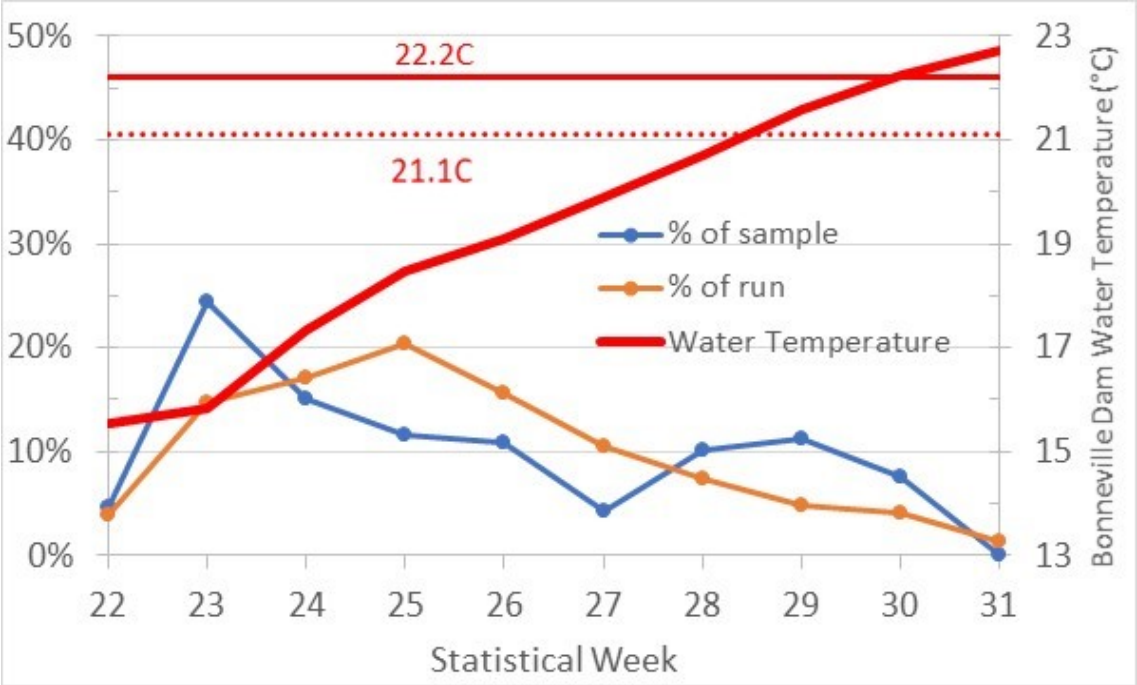

Figure 3. The weekly summer Chinook sample and run as a percentage of the total sample and run size at Bonneville Dam in 2018. Bonneville trap regulations require reduced sampling at 21.1°C with sampling halted at 22.2°C.

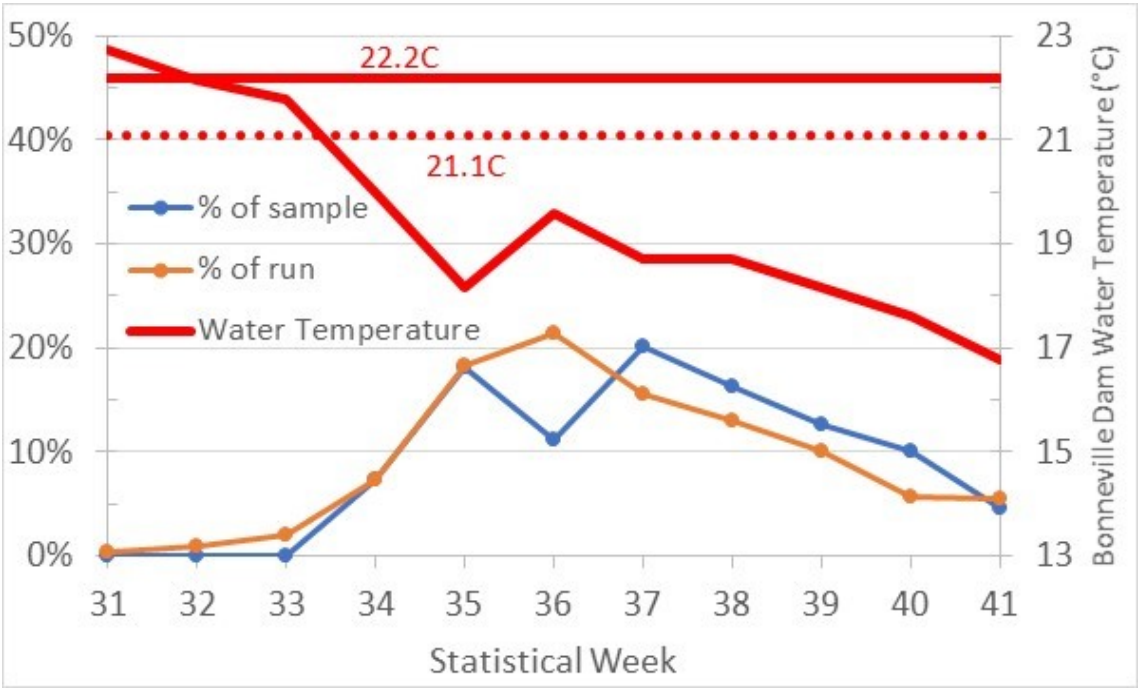

Figure 4. The weekly fall Chinook sample and run as a percentage of the total sample and run size at Bonneville Dam in 2018. Bonneville trap regulations require reduced sampling at 21.1°C with sampling halted at 22.2°C.

Detection Numbers

The tracking of 1,269 spring Chinook generated 86,829 weir detections, which were grouped into 8,105 site detections at 129 sites. The 643 summer Chinook generated 38,924 weir detections, grouped into 4,683 site detections at 89 sites, and the 1,266 fall Chinook generated 43,935 weir detections grouped into 5,963 site detections at 50 sites. Maps and table of sites found in the Appendix B (Table B1 and Figures B1, B2-B14) show the sites and the categorical ranges of detection numbers at the sites throughout the Columbia Basin. Note that the number of Chinook tracked in each run is determined by the migration timing at Bonneville, with the spring Chinook run ending May 31st, the summer Chinook running from June 1 through July 31st, and the fall Chinook run starting August 1st (FPC 2018) with minijacks excluded.

Mainstem Dam Recoveries, Mortality, and Escapement Estimates

Spring Chinook were predominantly last detected upstream of Ice Harbor Dam, Summer Chinook upstream of Priest Rapids Dam, and fall Chinook upstream of McNary Dam (Table 4). Spring Chinook sampled in weeks 17-19 were primarily last detected downstream of McNary Dam (Figures 5 and 6). Chinook sampled in weeks 20-22 were predominantly last detected in the Snake River above Ice

Harbor Dam. From weeks 23-30 the majority of Chinook sampled by this project were last detected upstream of Priest Rapids Dam (Figures 5 and 7). High water temperatures at Bonneville Dam resulted in no sampling in weeks 31-33. Upon the resumption of sampling in Week 34, the run had transitioned to consisting of Chinook destined for below McNary Dam until Week 39, after which Chinook last detected at areas between McNary and Ice Harbor/Priest Rapids dams (the location of Ringold and Priest Rapids hatcheries, which rear fall Chinook Salmon as well as the spawning grounds of Hanford Reach fall Chinook) predominated (Table 4, Figures 5 and 8).

Table 4. Percentage of spring, summer, and fall Chinook Salmon tracked from Bonneville Dam detected at upstream dams in 2018.

Dam	Spring Chinook	Summer Chinook	Fall Chinook
The Dalles	67.7%	85.0%	73.2%
John Day	60.6%	78.1%	61.2%
McNary	56.3%	75.6%	55.3%
Priest Rapids	10.0%	62.1%	10.7%
Rock Island	9.7%	60.0%	4.0%
Rocky Reach	7.3%	53.9%	3.0%
Wells	6.9%	38.4%	1.7%
Ice Harbor	39.2%	11.3%	13.0%
Lower Monumental	38.2%	11.1%	12.9%
Little Goose	36.8%	10.9%	12.8%
Lower Granite	35.8%	10.8%	12.4%

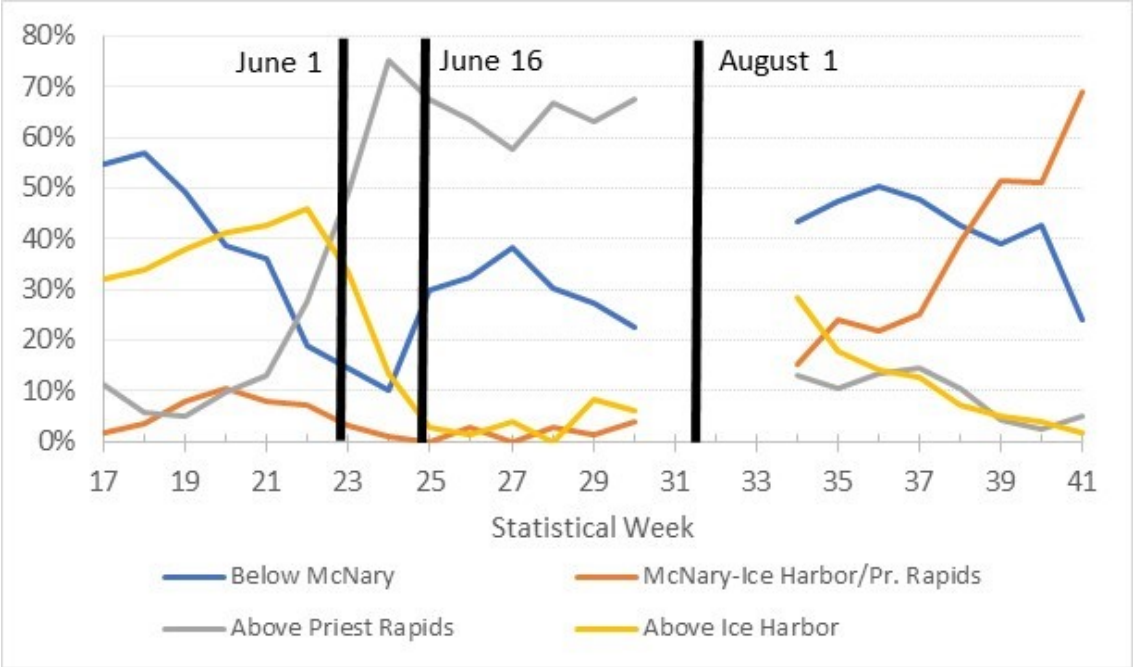

Figure 5. Distribution of final detection areas of the Columbia Basin by statistical week for Chinook Salmon PIT tagged at Bonneville Dam in 2018. Dates used to differentiate spring, summer, and fall Chinook are shown, with both June 1 and June 16 used to differentiate spring and summer Chinook.

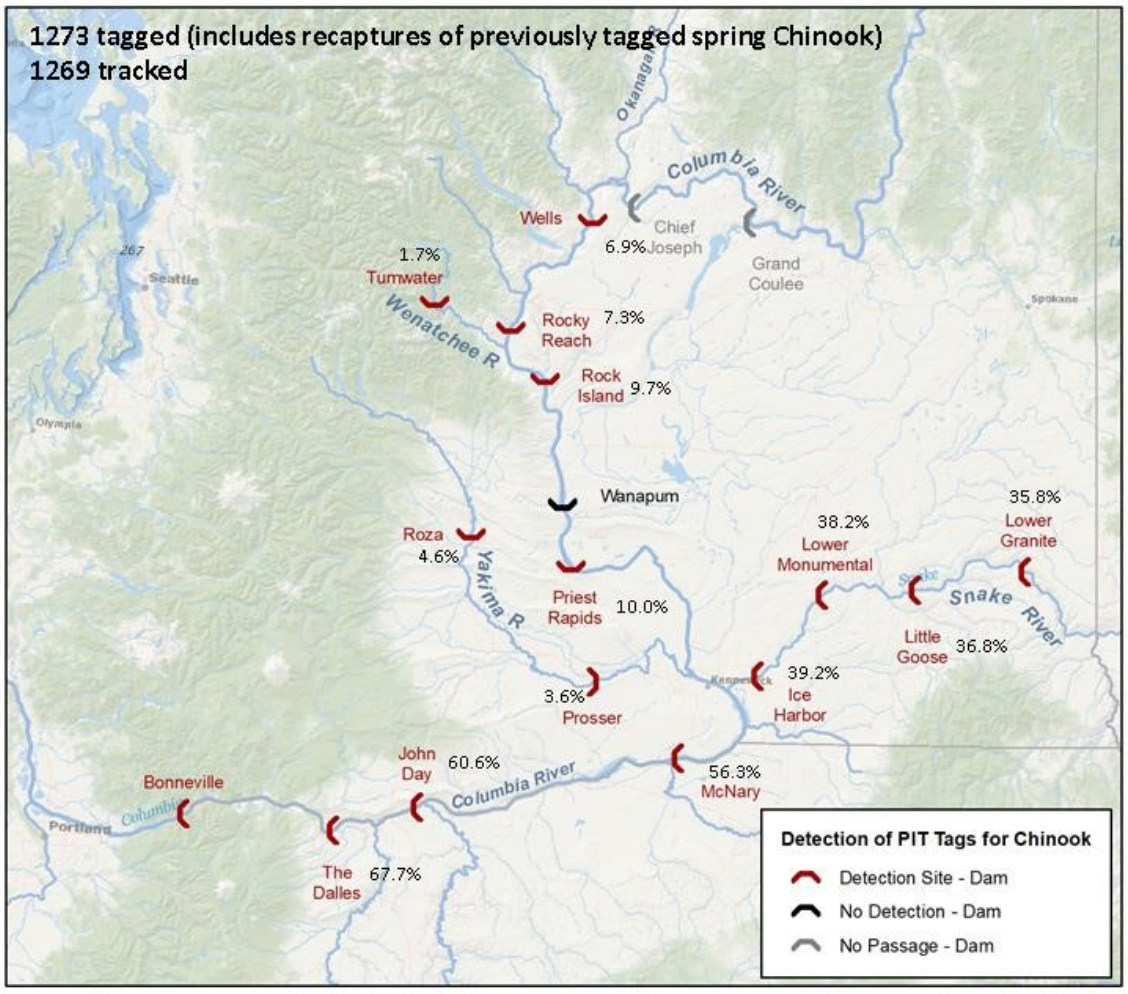

Figure 6. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of spring Chinook Salmon PIT tagged at Bonneville Dam, and the percentage of the run estimated to pass upstream dams in 2018.

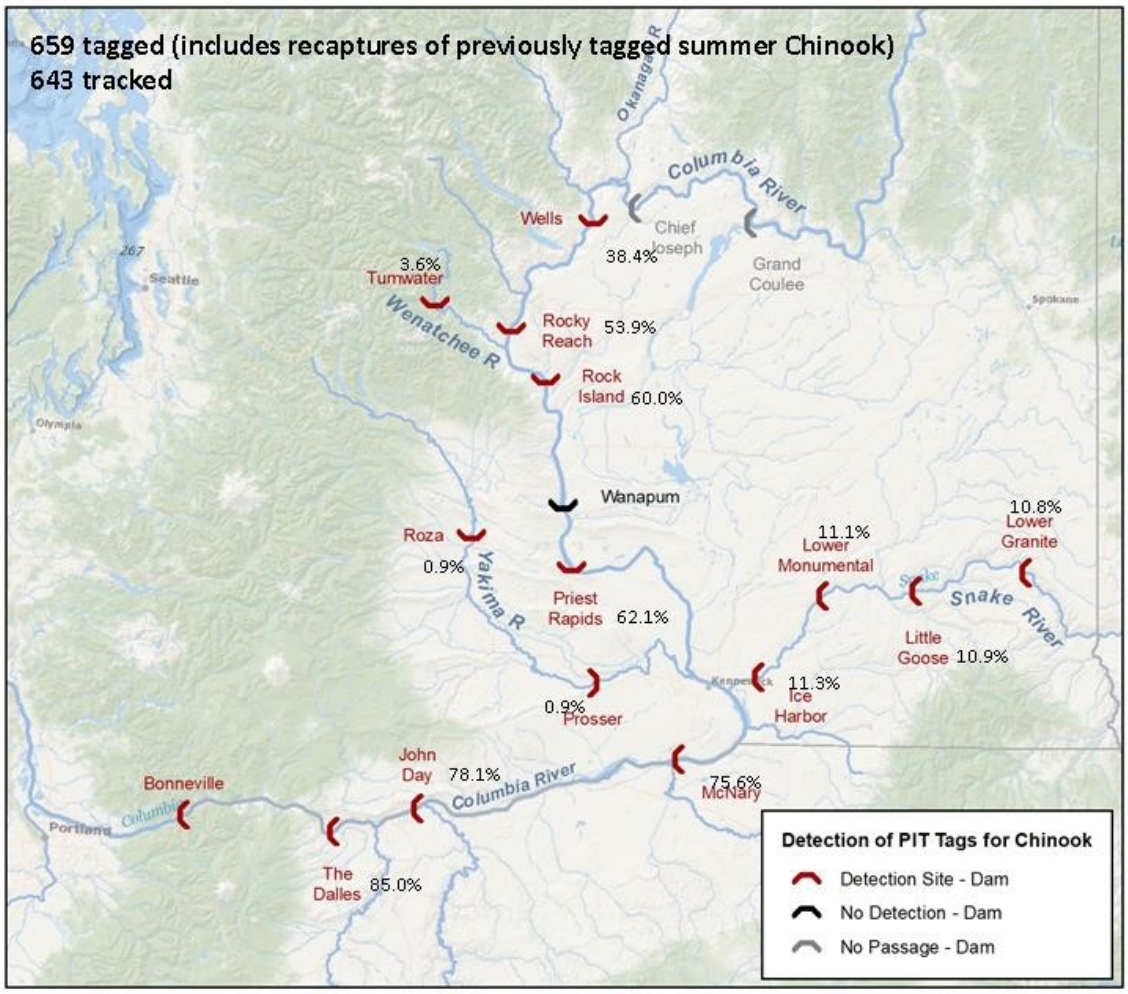

Figure 7. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of summer Chinook Salmon PIT tagged at Bonneville Dam, and the percentage of the run estimated to pass upstream dams in 2018.

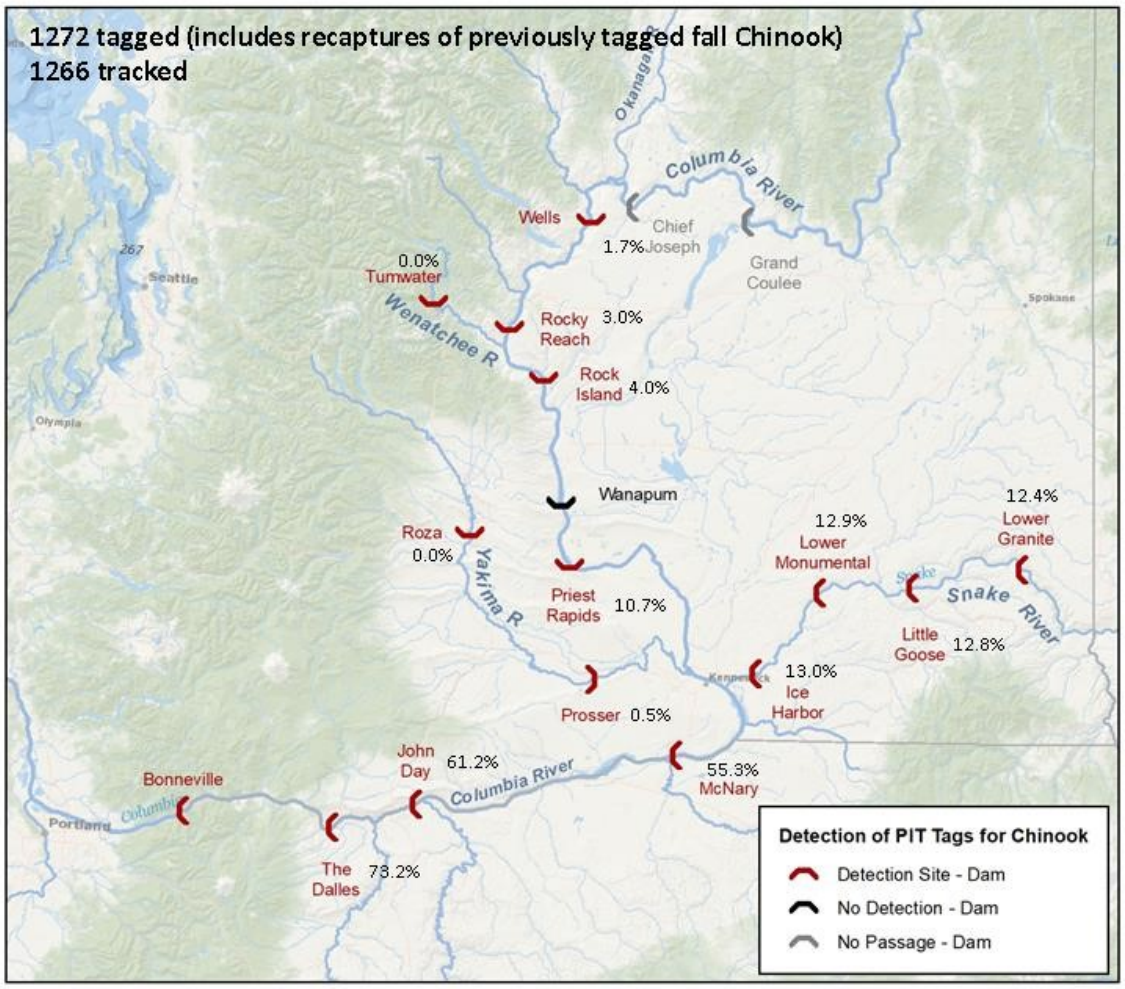

Figure 8. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of fall Chinook Salmon PIT tagged at Bonneville Dam, and the percentage of the run estimated to pass upstream dams in 2018. Twelve minijacks sampled and tagged are excluded.

The mean percentage of PIT tagged Chinook Salmon passing a dam without detection, excluding Rock Island Dam, was 0.8% for spring and summer Chinook and 0.5% for fall Chinook (Table 5). At Rock Island Dam, the rate for missed tags was 33.8% for spring Chinook, 36.7% for summer Chinook, and 47.7% for fall Chinook. High rates of missed PIT tagged fish at Rock Island Dam have also been observed in other years and are likely attributable to antenna size and electrical noise (Fryer et al. 2011). The percentage of spring Chinook missing Rocky Reach Dam was also higher than normal due to a power outage that lasted for 53 hours from May 23 through May 25, 2018. Six of the eight missed PIT tagged Chinook likely passed during this period with the two other missed tags likely being attributable to elevated noise levels that plagued this site in the days following this

event[3]. Bonneville, The Dalles, John Day, McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite dams all have navigation locks where it is possible that PIT tagged fish could pass upstream undetected.

Table 5. Percentage of Chinook Salmon detected upstream that missed detection at mainstem dams in 2018.

Dam	Spring	Summer	Fall
Bonneville	0.0%	0.0%	0.1%
The Dalles	0.6%	0.6%	0.4%
John Day	0.8%	3.0%	0.3%
McNary	0.3%	0.6%	0.6%
Priest Rapids	2.2%	0.3%	0.0%
Rock Island	33.8%	36.7%	47.7%
Rocky Reach	8.3%	0.0%	0.0%
Wells	0.0%	0.0%	0.0%
Ice Harbor	1.0%	1.1%	2.1%
Lower Monumental	0.8%	0.0%	1.4%
Little Goose	0.0%	0.0%	0.7%
Lower Granite	0.0%	0.0%	0.0%
Weighted Mean (by sample size) excluding Rock Island Dam	**0.8%**	**0.8%**	**0.5%**

Total Chinook escapement estimates based on PIT tags varied from visual counts 8.1% or less at all mainstem dams except for Ice Harbor (+16.2%) and Little Goose (+9.6%) dams (Table 6). PIT tag estimates were generally greater than those of visual counts, with the mean difference of 1.6% for spring Chinook, 2.2% for summer Chinook, 10.8% for fall Chinook, and 4.9% for all Chinook.

Major deviations between race classifications based on passage date were for Chinook passing Bonneville Dam as spring Chinook (on or before May 31) but passing upstream of Rock Island, Rocky Reach, and Priest Rapids dams, as summer Chinook, as well as Bonneville summer Chinook passing upstream of Lower Monumental, Ice Harbor, Lower Granite, Little Goose, and Wells dams as spring Chinook (Table 7).

[3] E-mail from Brett Turley, Biomark, February 4, 2020.

Table 6. Spring, summer, fall, and total Chinook Salmon escapement at Columbia Basin mainstem dams upstream of Bonneville Dam in 2018. Estimates are from both PIT tag recoveries and dam counts (FPC 2018).

Site	Spring Chinook Salmon			Summer Chinook Salmon		
	Viewing Window Count	PIT Tag Estimate	Percent Difference	Viewing Window Count	PIT Tag Estimate	Percent Difference
The Dalles	62,728	63,892	1.9%	53,083	55,607	4.8%
John Day	55,625	57,196	2.8%	47,128	51,114	8.5%
McNary	47,899	53,154	11.0%	45,162	49,449	9.5%
Priest Rapids	8,016	9,465	18.1%	42,345	40,588	-4.2%
Rock Island	8,891	9,173	3.2%	40,462	39,227	-3.1%
Rocky Reach	6,726	6,905	2.7%	34,216	35,242	3.0%
Wells	8,476	6,541	-22.8%	23,242	25,097	8.0%
Ice Harbor	34,797	36,940	6.2%	6,368	7,378	15.9%
L. Monumental	38,418	36,062	-6.1%	6,860	7,273	6.0%
Little Goose	34,320	34,745	1.2%	8,047	7,125	-11.5%
Lower Granite	34,109	33,811	-0.9%	8,123	7,064	-13.0%
Mean			**1.6%**			**2.2%**
	Fall Chinook Salmon			**All Chinook Salmon**		
The Dalles	148,933	160,993	8.1%	264,744	280,491	5.9%
John Day	127,107	134,689	6.0%	229,860	243,000	5.7%
McNary	114,446	121,753	6.4%	207,507	224,356	8.1%
Priest Rapids	20,453	23,539	15.1%	70,814	73,591	3.9%
Rock Island	10,588	8,793	-17.0%	59,941	57,194	-4.6%
Rocky Reach	8,231	6,692	-18.7%	49,173	48,839	-0.7%
Wells	3,123	3,694	18.3%	34,841	35,332	1.4%
Ice Harbor	21,679	28,695	32.4%	62,844	73,013	16.2%
L. Monumental	25,184	28,426	12.9%	70,462	71,760	1.8%
Little Goose	21,536	28,149	30.7%	63,903	70,019	9.6%
Lower Granite	21,897	27,235	24.4%	64,129	68,110	6.2%
Mean			**10.8%**			**4.9%**

Table 7. Percentage of Chinook sampled at Bonneville Dam as one race (as determined by run timing) that passed upstream dams as another race (as determined by run timing) in 2018.

Last Date Spring Run	First Date Fall Run	Race at Bonneville / Race at Dam Listed Below	Spring / Summer	Summer / Spring	Summer / Fall
June 3	August 4	The Dalles	1.5%	4.1%	0.2%
June 5	August 6	John Day	3.0%	3.4%	0.8%
June 8	August 9	McNary	2.7%	4.9%	1.0%
June 13	August 14	Priest Rapids	17.0%	0.5%	1.0%
June 17	August 18	Rock Island	24.7%	1.3%	0.8%
June 19	August 20	Rocky Reach	21.5%	0.6%	0.9%
June 28	August 29	Wells	4.2%	13.3%	2.5%
June 11	August 12	Ice Harbor	0.6%	25.5%	2.1%
June 13	August 14	L. Monumental	0.4%	33.3%	2.2%
June 15	August 16	Little Goose	3.8%	19.8%	2.2%
June 17	August 18	Lower Granite	4.1%	20.0%	2.2%

Dam escapement estimates for three tributary dams (Tumwater Dam on the Wenatchee River and Prosser and Roza dams on the Yakima River), each with more than 40 detections, are found in Table 8 alongside estimates using visual counts. Much lower sample sizes than at mainstem dams likely contributed to the larger deviations from visual counts than at those same mainstem dams. Chinook that ultimately passed these three dams primarily passed Bonneville Dam in the spring with a smaller migration in the fall (Figure 9).

Table 8. Estimated Chinook Salmon escapement, as estimated using PIT tag detections, to Tumwater, Prosser, and Roza dams in 2018.

Location and River	Number of Tag Detections	Escapement Estimate from Visual Counts	Estimated Escapement Using PIT Tags	Percent Difference
Tumwater Dam, Wenatchee River	45	3583	3946	10.1%
Prosser Dam, Yakima River	72	3690	6143	66.5%
Roza Dam, Yakima River	52	2020	3981	97.1%

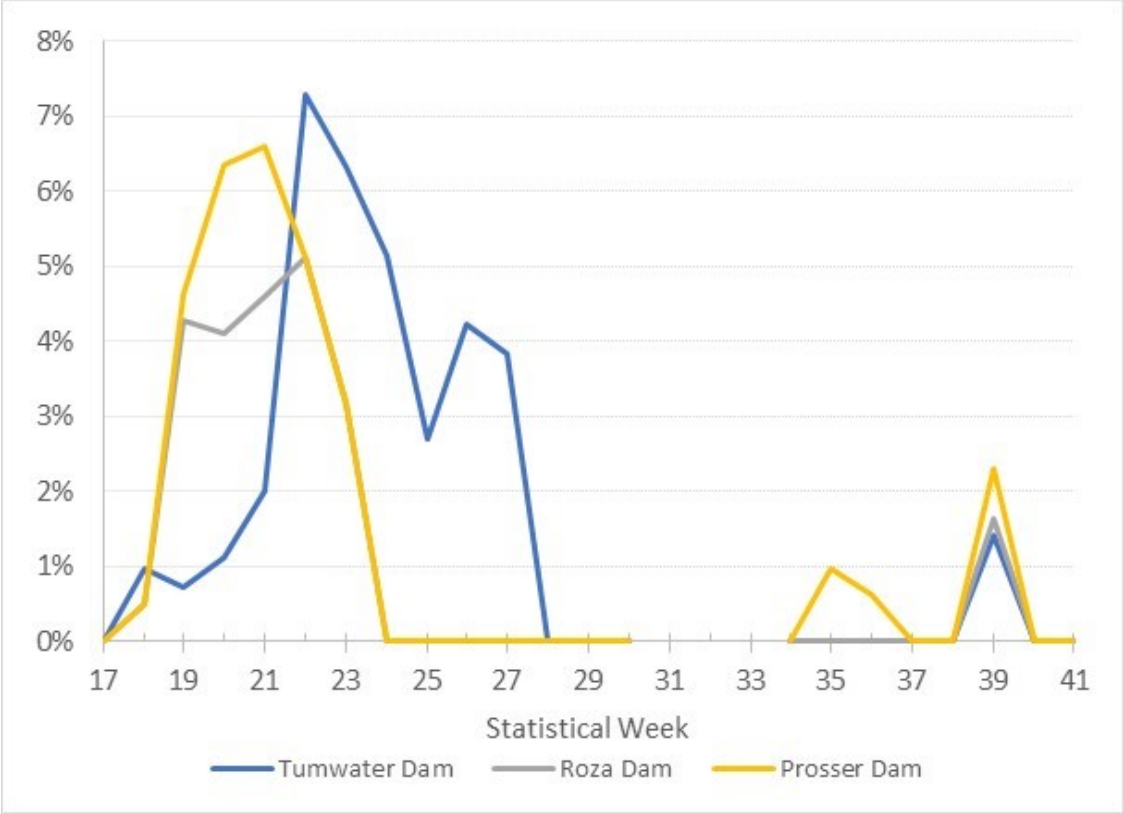

Figure 9. Percentage of Chinook Salmon by statistical week tagged at Bonneville Dam in 2018 destined for the Tumwater Dam (Wenatchee River), Prosser Dam (Yakima River) and Roza Dam (Yakima River) based on upstream PIT tag detections.

Migration Rates and Passage Time

Chinook migration rates between mainstem dams in 2018 ranged between 11.1 km/day for fall Chinook between Priest Rapids and Wells dams (n=21) and 56.5 km/day for fall Chinook between John Day and McNary dams (Table 9).

Among the mainstem Columbia and Snake River dams, Chinook Salmon had the greatest median dam passage time (as determined by minutes between first detection time and last detection time at a dam) at Lower Granite, Wells, and McNary dams (Table 10). At Bonneville, Lower Granite, McNary, Rocky Reach and Wells dams, there is a greater distance between the furthest downstream and furthest upstream PIT tag detection antennas than at other dams; conversely, the distance between the PIT tag detection antennas at most other dams are placed at adjacent or nearby weirs. Passage times at Lower Granite, Bonneville, Priest Rapids, Tumwater, and Wells dams may also be inflated by trapping operations that take place at fish ladders at those dams.

Table 9. Chinook Salmon migration rates between Columbia Basin dams estimated using PIT tag data in 2018.

		Median Migration Rate (km/day)		
Between Mainstem Dams	Distance (km)	Spring Chinook	Summer Chinook	Fall Chinook
Bonneville-The Dalles	74	34.0	36.1	38.1
The Dalles-John Day	39	39.6	35.2	43.1
John Day-McNary	63	49.7	53.3	56.5
McNary-Priest Rapids	167	34.3	37.5	28.0
Priest Rapids-Rock Island	89	29.8	30.5	22.5
Rock Island-Rocky Reach	33	28.2	28.4	25.7
Rocky Reach-Wells	65	36.7	24.5	19.6
Bonneville-McNary	156	38.1	38.9	45.7
Bonneville-Priest Rapids	231	32.9	36.2	34.0
Bonneville-Wells	596	29.8	30.9	21.1
Bonneville-Ice Harbor	304	34.2	41.2	38.5
Bonneville-Lower Granite	472	32.4	29.8	35.4
Priest Rapids-Wells	191	34.0	26.6	11.1
McNary-Ice Harbor	585	39.6	36.9	37.0
Ice Harbor-Lower Granite	67	49.7	22.2	36.1
To and Between Tributary Sites				
Rock Island - Tumwater	73	3.8	3.7	--
McNary - Prosser	141	28.4	26.4	5.7
Prosser - Roza	133	18.5	22.0	--
Lower Granite - South Fork Salmon (SFG)	375	24.6	35.5	--

Table 10. Median passage time in minutes by run, from the time of first detection to time of last detection at a dam and the percentage of Chinook taking more than 12 hours between first and last detection in 2018.

	Median Passage Time (minutes)			Percentage of run with more than 12 hours between first and last detection at a dam		
Dam	Spring Chinook	Summer Chinook	Fall Chinook	Spring Chinook	Summer Chinook	Fall Chinook
Bonneville	6.0	6.5	9.5	0.8%	0.3%	0.2%
The Dalles	0.2	0.1	0.1	5.2%	2.9%	1.6%
John Day	1.2	0.1	0.1	4.0%	4.6%	1.9%
McNary	104.4	84.7	82.8	7.8%	2.8%	4.7%
Priest Rapids	4.4	4.1	2.5	2.2%	1.8%	5.5%
Rock Island	1.5	2.1	0.1	1.1%	0.8%	0.0%
Rocky Reach	14.1	12.1	29.5	4.3%	3.3%	0.0%
Wells	152.4	112.0	85.8	32.6%	10.0%	4.8%
Ice Harbor	2.2	1.8	1.6	4.8%	5.3%	1.4%
Lower Monumental	3.2	1.4	0.2	6.4%	3.2%	1.4%
Little Goose	0.1	0.0	0.0	8.9%	5.5%	4.9%
Lower Granite	205.6	178.8	163.8	27.7%	24.4%	28.1%
Prosser	0.2	0.1	0.1	1.8%	0.0%	0.0%
Roza	2.0	4.2	–	9.1%	37.5%	--
Tumwater	44.4	27.4	67.3	43.5%	4.5%	--

Bonneville Dam Chinook Salmon Age Composition

The predominant age class for spring and summer Chinook was 1.2, comprising an estimated 89.5% of the spring Chinook and 60.1% of the summer Chinook population (Tables 11 and 12, Figure 10). Two age classes predominated among fall Chinook, Age 0.3 at 36.3% and Age 0.2 at 32.2% (Table 13). The percentage of yearling freshwater (Age 1.x) Chinook was at or near 100% through May, then began to decline through the rest of the year, with the percentage of subyearling freshwater Chinook (0.2) showing the opposite trend. The transition from being primarily a yearling run to a subyearling run took place during the three weeks sampling was prohibited due to temperature restrictions as the run was 89.7% yearling in Week 30 and 75.0% subyearling in Week 34 (Figure 11).

Table 11. Weekly and total age composition of Chinook Salmon at Bonneville Dam as estimated from scale patterns in 2018. (Composite age composition estimates are weighted by the percentage of the run passing Bonneville Dam in each week.)

Week	Percent of Run	Number Ageable	Brood Year and Age Class				
			2015	2014		2013	2012
			1.1	1.2	0.3	1.3	0.5
17	3.7%	49	0.0%	98.0%	0.0%	2.0%	0.0%
18	18.4%	158	0.6%	99.4%	0.0%	0.0%	0.0%
19	27.7%	241	5.4%	93.8%	0.0%	0.8%	0.0%
20	19.7%	233	17.2%	82.0%	0.0%	0.9%	0.0%
21	23.7%	294	10.2%	85.4%	0.0%	4.1%	0.3%
22	6.8%	93	8.6%	77.4%	1.1%	12.9%	0.0%
Composite		**1068**	**8.0%**	**89.5%**	**0.1%**	**2.3%**	**0.1%**

Table 12. Weekly and total age composition of summer Chinook Salmon at Bonneville Dam as estimated from scale patterns in 2018. (Composite age composition estimates are weighted by the percentage of the run passing Bonneville Dam in each week, with weeks 30-31 pooled as no sampling occurred in Week 31.)

Week	Percent of Run	Number Ageable	Brood Year and Age Class								
			2016	2015		2014		2013		2012	
			0.1	0.2	1.1	0.3	1.2	0.4	1.3	1.4	2.3
22	4.0%	25	0.0%	0.0%	4.0%	0.0%	84.0%	0.0%	12.0%	0.0%	0.0%
23	14.7%	135	0.0%	0.7%	4.4%	3.0%	63.7%	1.5%	25.9%	0.7%	0.0%
24	17.1%	79	0.0%	1.3%	3.8%	8.9%	45.6%	1.3%	36.7%	1.3%	1.3%
25	20.4%	52	0.0%	0.0%	3.8%	7.7%	61.5%	3.8%	23.1%	0.0%	0.0%
26	15.6%	54	0.0%	3.7%	7.4%	5.6%	55.6%	0.0%	27.8%	0.0%	0.0%
27	10.6%	19	0.0%	0.0%	5.3%	5.3%	78.9%	0.0%	10.5%	0.0%	0.0%
28	7.4%	43	0.0%	7.0%	11.6%	0.0%	62.8%	0.0%	18.6%	0.0%	0.0%
29	4.8%	57	1.8%	0.0%	7.0%	14.0%	54.4%	0.0%	22.8%	0.0%	0.0%
30	4.1%	39	2.6%	0.0%	12.8%	7.7%	51.3%	0.0%	25.6%	0.0%	0.0%
31	1.3%	Bonneville Trap closed due to high temperatures-no sampling									
Composite		**503**	**25**	**1.4%**	**5.9%**	**6.0%**	**60.1%**	**1.2%**	**24.6%**	**0.3%**	**0.2%**

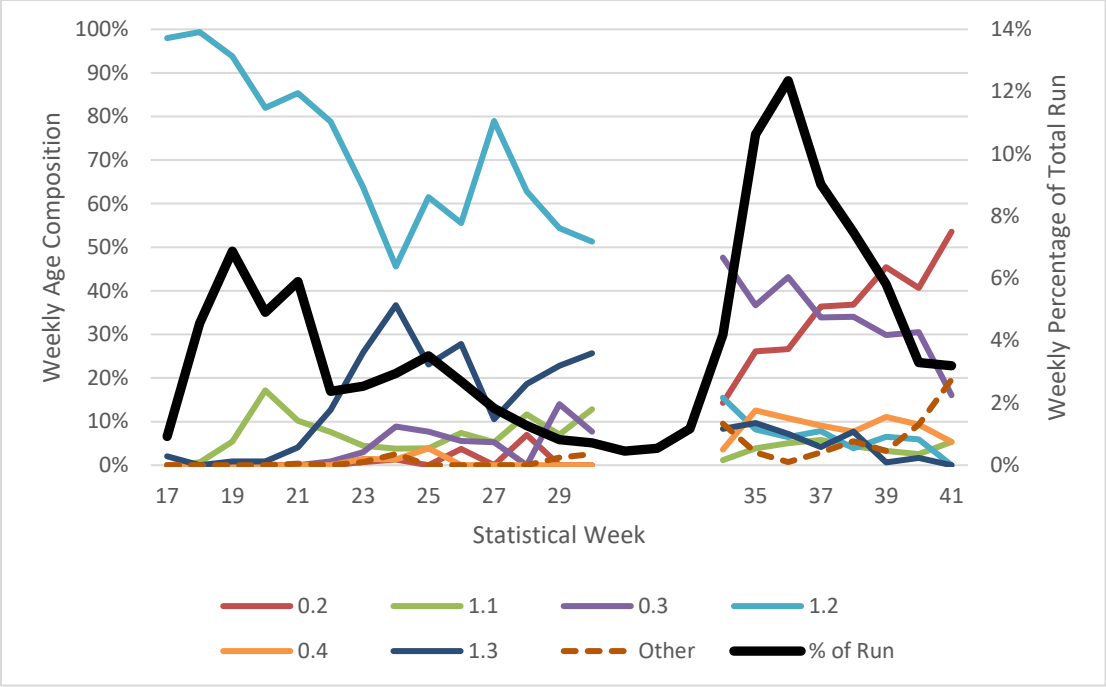

Figure 10. Weekly age composition of Chinook Salmon at Bonneville Dam as estimated from scale patterns in 2018 with weekly percentage of run.

Table 13. Weekly and total age composition of fall Chinook Salmon at Bonneville Dam as estimated from scale patterns in 2018. (Composite age composition estimates are weighted by the percentage of the run passing Bonneville Dam in each week, with weeks 31-34 pooled as no sampling occurred in weeks 31-33.)

			Brood Year and Age Class								
			2016	2015		2014			2013		2012
Week	Percent of Run	Number Ageable	0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	0.5
31	0.4%	Bonneville Trap closed due to high temperatures-no sampling									
32	0.9%										
33	2.0%										
34	7.2%	84	9.5%	14.3%	1.2%	47.6%	15.5%	0.0%	3.6%	8.3%	0.0%
35	18.4%	207	2.9%	26.1%	3.9%	36.7%	8.2%	0.0%	12.6%	9.7%	0.0%
36	21.3%	139	0.7%	26.6%	5.0%	43.2%	6.5%	0.0%	10.8%	7.2%	0.0%
37	15.6%	242	1.7%	36.4%	5.8%	33.9%	7.9%	0.4%	9.1%	4.1%	0.4%
38	12.9%	182	5.5%	36.8%	4.4%	34.1%	3.8%	0.0%	7.7%	7.7%	0.0%
39	10.0%	154	3.2%	45.5%	3.2%	29.9%	6.5%	0.0%	11.0%	0.6%	0.0%
40	5.7%	118	9.3%	40.7%	2.5%	30.5%	5.9%	0.0%	9.3%	1.7%	0.0%
41	5.5%	56	17.9%	53.6%	5.4%	16.1%	0.0%	0.0%	5.4%	0.0%	1.8%
Composite		**1182**	**4.5%**	**32.2%**	**4.1%**	**36.3%**	**7.2%**	**0.1%**	**9.3%**	**6.0%**	**0.2%**

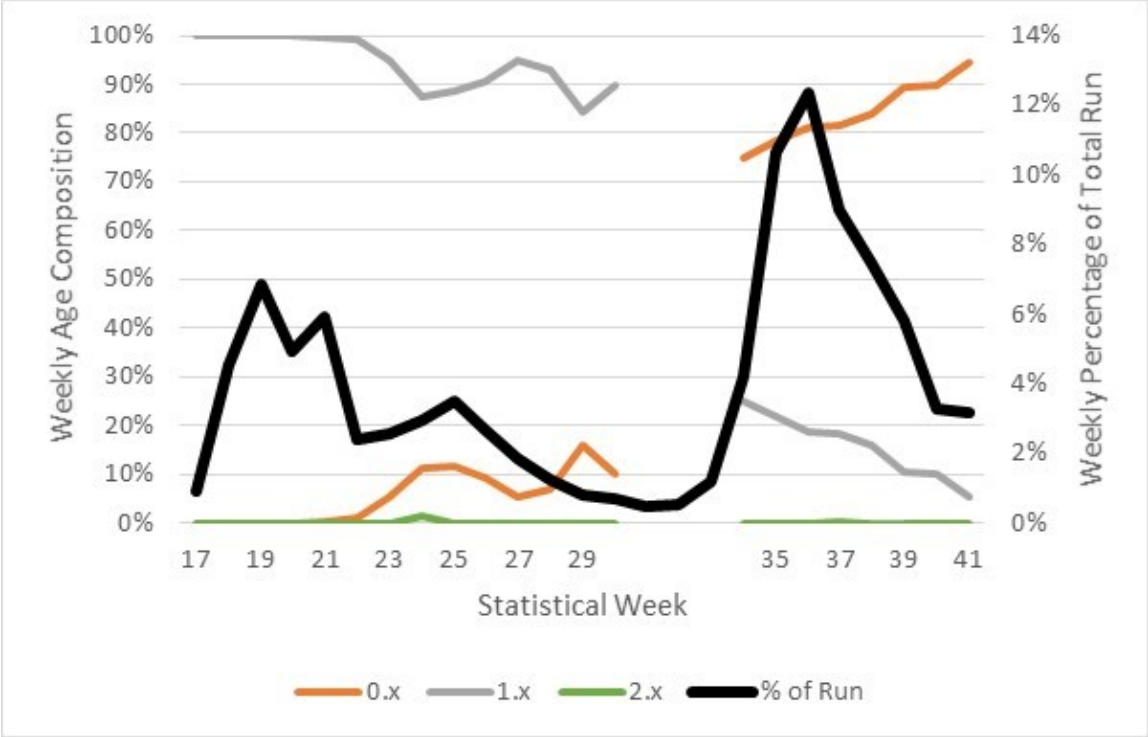

Figure 11. Weekly age composition of Chinook Salmon at Bonneville Dam as estimated from scale patterns in 2018 with weekly percentage of run.

Upstream Age and Length-at-Age Composition

Age 1.2 was the majority age class for spring and summer Chinook passing each mainstem dam in this study (Table 14, Figures 12 and 13) with Age 1.1 being second most abundant for spring Chinook, and 1.3 for summer Chinook at all dams. Among fall Chinook, Age 0.2 was the predominant age class at all mainstem dams except Bonneville Dam, where it was narrowly exceeded by the Age 0.3 age class (34.7% versus 34.4%, Table 14, Figure 14). Age 0.2 was the second largest age class at all other mainstem dams. Mean length-at-age composition estimates at mainstem dam sites are shown in Tables 16-18.

Table 14. Age composition estimates of spring, summer, and fall Chinook salmon at mainstem Columbia Basin dams as estimated using upstream PIT tag detections for Chinook sampled at Bonneville Dam and aged using scale pattern analysis in 2018[4].

		Brood Year and Age Class										
Run and Site	Ageable	2015	2014		2013			2012		2011		
Spring	**N**	**0.1**	**0.2**	**1.1**	**0.3**	**1.2**	**2.1**	**0.4**	**1.3**	**0.5**	**1.4**	**2.3**
Bonneville	1059	0.0%	0.0%	8.3%	0.1%	88.8%	0.0%	0.0%	2.7%	0.1%	0.0%	0.0%
The Dalles	763	0.0%	0.0%	10.1%	0.1%	86.6%	0.0%	0.0%	3.0%	0.1%	0.0%	0.0%
McNary	689	0.0%	0.0%	10.6%	0.1%	86.2%	0.0%	0.0%	2.9%	0.1%	0.0%	0.0%
Priest Rapids	641	0.0%	0.0%	10.9%	0.2%	85.6%	0.0%	0.0%	3.1%	0.2%	0.0%	0.0%
Rock Island	121	0.0%	0.0%	20.7%	0.8%	65.3%	0.0%	0.0%	12.4%	0.8%	0.0%	0.0%
Rocky Reach	117	0.0%	0.0%	20.5%	0.9%	65.0%	0.0%	0.0%	12.8%	0.9%	0.0%	0.0%
Wells	89	0.0%	0.0%	25.8%	1.1%	59.6%	0.0%	0.0%	12.4%	1.1%	0.0%	0.0%
Ice Harbor	84	0.0%	0.0%	27.4%	1.2%	60.7%	0.0%	0.0%	9.5%	1.2%	0.0%	0.0%
Low. Mon.	442	0.0%	0.0%	8.8%	0.0%	90.7%	0.0%	0.0%	0.5%	0.0%	0.0%	0.0%
Little Goose	433	0.0%	0.0%	8.5%	0.0%	91.0%	0.0%	0.0%	0.5%	0.0%	0.0%	0.0%
Lower Granite	417	0.0%	0.0%	8.2%	0.0%	91.4%	0.0%	0.0%	0.5%	0.0%	0.0%	0.0%
Summer	**N**	**0.1**	**0.2**	**1.1**	**0.3**	**1.2**	**2.1**	**0.4**	**1.3**	**0.5**	**1.4**	**2.3**
Bonneville	499	0.4%	1.4%	6.2%	6.0%	59.1%	0.0%	1.0%	25.3%	0.0%	0.4%	0.2%
The Dalles	446	0.4%	1.6%	6.7%	6.3%	59.2%	0.0%	0.9%	24.2%	0.0%	0.4%	0.2%
McNary	410	0.2%	1.5%	7.1%	5.4%	59.3%	0.0%	1.0%	24.9%	0.0%	0.5%	0.2%
Priest Rapids	396	0.3%	1.3%	7.1%	5.6%	60.1%	0.0%	1.0%	24.0%	0.0%	0.5%	0.3%
Rock Island	298	0.3%	1.3%	7.7%	6.4%	52.7%	0.0%	1.3%	29.2%	0.0%	0.7%	0.3%
Rocky Reach	286	0.3%	1.4%	8.0%	5.9%	53.1%	0.0%	1.4%	28.7%	0.0%	0.7%	0.3%
Wells	251	0.4%	1.2%	7.6%	5.2%	57.0%	0.0%	0.8%	27.1%	0.0%	0.8%	0.0%
Ice Harbor	185	0.5%	1.6%	9.2%	5.9%	55.7%	0.0%	0.5%	25.4%	0.0%	1.1%	0.0%
Low. Mon.	82	0.0%	1.2%	4.9%	2.4%	84.1%	0.0%	0.0%	7.3%	0.0%	0.0%	0.0%
Little Goose	80	0.0%	1.3%	5.0%	2.5%	83.8%	0.0%	0.0%	7.5%	0.0%	0.0%	0.0%
Lower Granite	78	0.0%	1.3%	5.1%	2.6%	83.3%	0.0%	0.0%	7.7%	0.0%	0.0%	0.0%
Fall	**N**	**0.1**	**0.2**	**1.1**	**0.3**	**1.2**	**2.1**	**0.4**	**1.3**	**0.5**	**1.4**	**2.3**
Bonneville	1179	4.7%	34.4%	4.2%	34.7%	6.9%	0.1%	9.4%	5.4%	0.2%	0.1%	0.0%
The Dalles	863	5.0%	36.7%	5.0%	33.7%	6.8%	0.1%	7.8%	4.6%	0.2%	0.0%	0.0%
McNary	725	4.6%	36.3%	5.4%	33.7%	7.9%	0.1%	7.3%	4.6%	0.3%	0.0%	0.0%
Priest Rapids	659	5.0%	37.8%	5.8%	33.2%	7.3%	0.2%	6.2%	4.4%	0.2%	0.0%	0.0%
Rock Island	118	1.7%	44.9%	6.8%	33.9%	1.7%	0.0%	4.2%	6.8%	0.0%	0.0%	0.0%
Rocky Reach	45	2.2%	40.0%	8.9%	31.1%	0.0%	0.0%	6.7%	11.1%	0.0%	0.0%	0.0%
Wells	34	2.9%	50.0%	8.8%	23.5%	0.0%	0.0%	8.8%	5.9%	0.0%	0.0%	0.0%
Ice Harbor	18	5.6%	38.9%	11.1%	22.2%	0.0%	0.0%	11.1%	11.1%	0.0%	0.0%	0.0%
Low. Mon.	134	7.5%	34.3%	8.2%	29.9%	17.9%	0.0%	1.5%	0.7%	0.0%	0.0%	0.0%
Little Goose	132	7.6%	34.1%	8.3%	30.3%	17.4%	0.0%	1.5%	0.8%	0.0%	0.0%	0.0%
Lower Granite	131	7.6%	34.4%	8.4%	30.5%	16.8%	0.0%	1.5%	0.8%	0.0%	0.0%	0.0%

[4] The Bonneville estimates in this table differ up to 2.2 percentage points from those presented in Tables 12-14 for two reasons. First is that Table 15 does not include fish not detected at Bonneville Dam and second, estimates in this table are unweighted by run size while tables 12-14 are weighted.

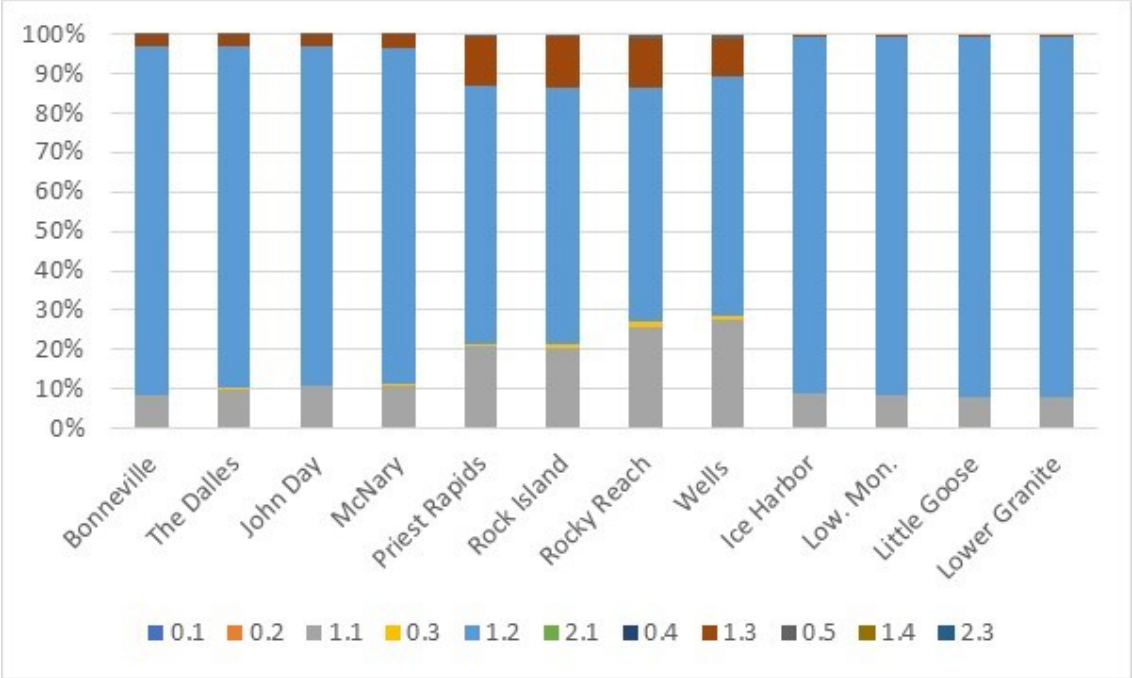

Figure 12. Spring Chinook age composition at Columbia and Snake River dams estimated using PIT tagged Chinook tracked by this project. Spring Chinook are defined as passing Bonneville Dam between April 1 and May 31, 2018.

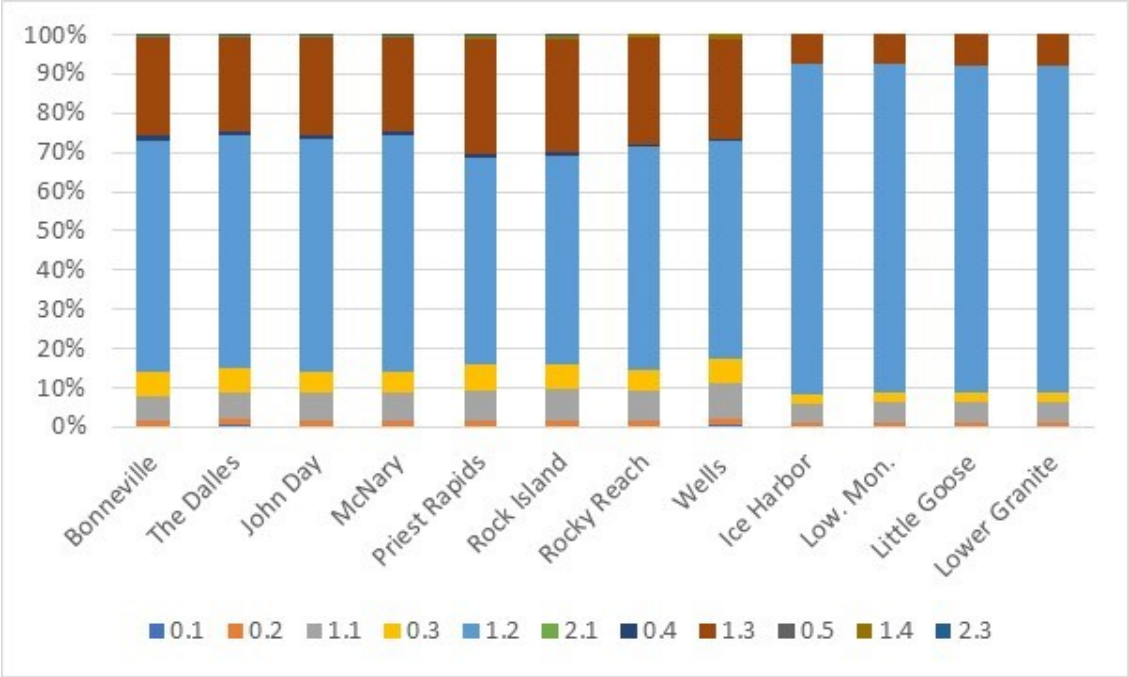

Figure 13. Summer Chinook age composition at Columbia and Snake River dams estimated using PIT tagged Chinook tracked by this project. Summer Chinook are defined as passing Bonneville Dam between June 1 and July 31, 2018.

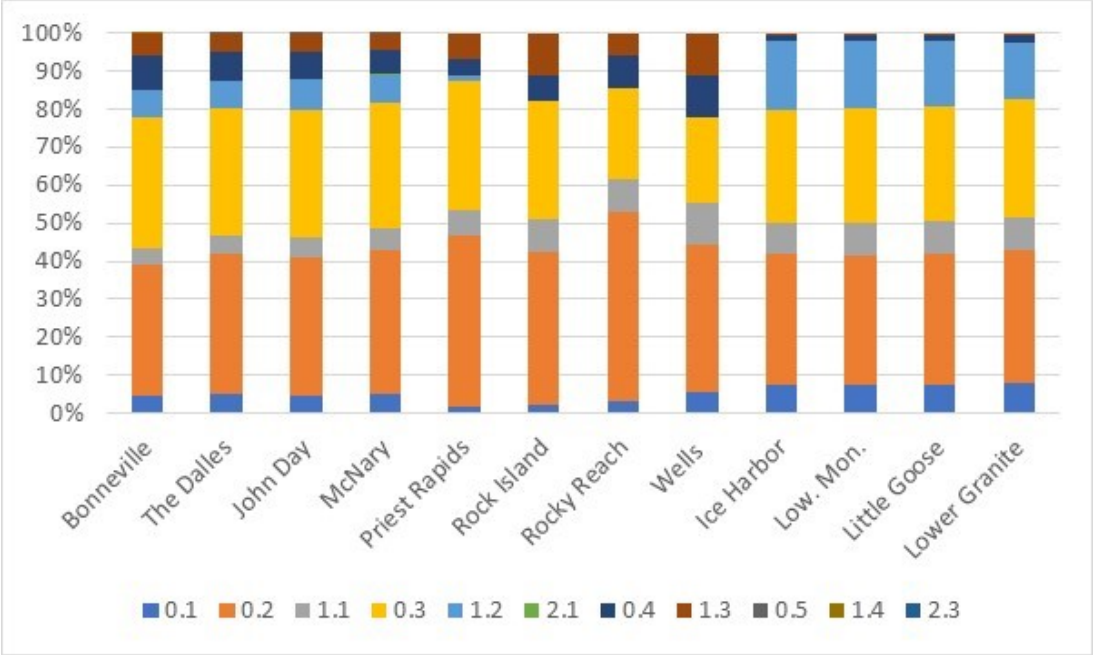

Figure 14. Fall Chinook age composition at Columbia and Snake river dams estimated using PIT tagged Chinook tracked by this project. Fall Chinook are defined as passing Bonneville Dam on or after August 1, 2018.

Table 15. Spring Chinook Salmon length-at-age composition, as estimated by PIT tag detections at upstream dams of fish aged using scale pattern analysis that passed Bonneville Dam on or before May 31 at Columbia and Snake River dams in 2018.

Dam	Statistic	Brood Year and Age Class									
		2016	2015		2014			2013		2012	
		0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	0.5	1.4
Bonneville	μ			48.5	80.0	71.4			83.6	90.5	
	s			5.2	--	4.8			6.6	--	
	n			88	1	940			29	1	
The Dalles	μ			48.5	80.0	71.0			84.7	90.5	
	s			4.5	--	4.9			5.8	--	
	n			76	1	658			23	1	
John Day	μ			47.9	80.0	70.9			85.2	90.5	
	s			4.7	--	4.9			5.3	--	
	n			72	1	591			19	1	
McNary	μ			47.8	80.0	71.0			84.8	90.5	
	s			4.6	--	4.8			5.2	--	
	n			7	1	547			2	1	
Priest Rapids	μ			46.4	80.0	71.0			84.3	90.5	
	s			5.2	--	4.7			5.7	--	
	n			25	1	397			15	1	
Rock Island	μ			46.0	80.0	71.0			84.4		
	s			5.2	--	4.7			5.9		
	n			16	1	390			11		
Rocky Reach	μ			46.4	80.0	71.1			84.5	90.5	
	s			5.6	--	4.7			5.8	--	
	n			21	1	381			11	1	
Wells	μ			46.4	80.0	71.1			84.8	90.5	
	s			5.4	--	4.7			6.3	--	
	n			23	1	375			8	1	
Ice Harbor	μ			49.9		72.0			85.8		
	s			4.2		5.7			1.8		
	n			38		76			2		
Lower Monumental	μ			49.5		71.0			85.8		
	s			4.3		6.2			1.8		
	n			37		50			2		
Little Goose	μ			49.4		72.0			85.8		
	s			4.4		5.4			1.8		
	n			34		47			2		
Lower Granite	μ			49.3		72.2			85.8		
	s			4.4		5.5			1.8		
	n			32		51			2		

Table 16. Summer Chinook Salmon length-at-age composition, as estimated by PIT tag detections at upstream dams of fish aged using scale pattern analysis that passed Bonneville Dam between June 1-July 31 at Columbia and Snake River dams in 2018.

Dam	Statistic	Brood Year and Age Class										
		2016	2015		2014			2013		2012		
		0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	0.5	1.4	2.3
Bonneville	μ	43.5	65.4	54.3	79.7	71.8		86.3	82.3		86.5	93.5
	s	6.4	3.8	6.5	4.7	6.4		1.6	9.4		7.8	--
	n	2	7	31	3	295		5	126		2	1
The Dalles	μ	43.5	65.4	54.0	79.4	71.6		86.4	82.0		86.5	93.5
	s	6.4	3.8	6.6	4.5	6.3		1.9	9.9		7.8	--
	n	2	7	3	28	263		4	18		2	1
John Day	μ	48.0	65.2	53.5	78.5	71.4		86.4	81.8		86.5	93.5
	s	--	4.1	6.5	4.6	6.4		1.9	1.2		7.8	--
	n	1	6	28	21	237		4	98		2	1
McNary	μ	48.0	65.6	54.0	78.5	71.3		86.4	82.0		86.5	93.5
	s	--	4.5	6.9	4.5	6.5		1.9	1.4		7.8	--
	n	1	5	27	22	238		4	94		2	1
Priest Rapids	μ	48.0	64.5	53.8	78.5	70.2		86.4	81.8		86.5	93.5
	s	--	4.3	7.7	4.2	6.6		1.9	1.8		7.8	--
	N	1	4	23	19	156		4	87		2	1
Rock Island	μ		64.5	53.0	78.7	69.9		87.5	81.2		86.5	93.5
	S		4.3	6.5	4.8	6.5		2.1	12.2		7.8	--
	N		4	17	11	88		2	58		2	1
Rocky Reach	μ	48.0	64.2	53.8	79.0	69.9		87.5	81.4		86.5	
	s	--	5.2	7.7	4.4	6.5		2.1	11.6		7.8	
	n	1	3	19	13	143		2	68		2	
Wells	μ	48.0	64.2	52.9	78.9	69.7		86.0	80.9		86.5	
	s	--	5.2	7.1	3.2	6.3		--	13.5		7.8	
	n	1	3	17	11	13		1	47		2	
Ice Harbor	μ		70.0	55.4	74.5	74.2			82.9			
	s		--	5.0	0.0	5.2			4.2			
	n		1	4	2	69			5			
Lower Monumental	μ		70.0	55.4	74.5	74.1			83.0			
	s		--	5.0	0.0	5.2			3.7			
	n		1	4	2	67			6			
Little Goose	μ		70.0	55.4	74.5	74.3			83.0			
	s		--	5	0.0	5			4			
	n		1.0	4.0	2.0	65.0			6.0			
Lower Granite	μ		70.0	55.4	74.5	74.3			83.0			
	s		--	5	0.0	5			4			
	n		1.0	4.0	2.0	65.0			6.0			

Table 17. Fall Chinook Salmon length-at-age composition, as estimated by PIT tag detections at upstream dams of fish aged using scale pattern analysis that passed Bonneville after July 31 for fall Chinook Salmon at Columbia and Snake River dams in 2018.

Dam	Statistic	Brood Year and Age Class									
		2016	2015		2014			2013		2012	
		0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	0.5	1.4
Bonneville	μ	44.8	65.2	59.7	77.6	72.7	66.0	84.0	81.1	90.5	83.0
	s	3.6	4.8	4.9	5.4	5.9	--	5.1	4.8	2.8	--
	n	55	406	49	409	80	1	111	64	2	1
The Dalles	μ	45.0	64.7	59.8	77.4	72.3	66.0	84.1	81.3	90.5	
	s	2.9	4.6	5.9	5.5	7.0	--	5.5	4.5	2.8	
	n	43	316	43	290	58	1	67	4	2	
John Day	μ	45.8	64.8	59.5	77.6	72.3	66.0	84.6	80.8	90.5	
	s	2.8	4.4	4.8	5.6	6.5	--	5.9	4.6	2.8	
	n	33	262	39	243	57	1	53	33	2	
McNary	μ	45.8	64.7	59.4	76.7	72.5	66.0	84.6	80.3	88.5	
	s	2.8	4.4	4.8	5.5	6.2	--	5.7	4.4	--	
	n	33	248	38	219	48	1	4	29	1	
Priest Rapids	μ	45.3	65.9	62.6	77.7	77.5		81.7	80.4		
	s	0.4	4.3	2.6	4.9	3.5		3.3	4.7		
	n	2	53	8	4	2		5	8		
Rock Island	μ		65.7	62.5	81.5			84.0	83.7		
	s		4.9	0.8	3.8			--	4.3		
	n		15	2	7			1	3		
Rocky Reach	μ	45.0	65.4	62.2	78.6			81.0	76.0		
	s	--	4.6	2.8	5.2			4.4	5.7		
	n	1	17	3	8			3	2		
Wells	μ	45.0	66.3	61.8	82.3			79.5	76.0		
	s	--	3.0	3.9	4.6			4.9	5.7		
	n	1	7	2	4			2	2		
Ice Harbor	μ	45.7	65.2	57.5	76.4	73.9		80.0	82.5		
	s	3.1	3.8	5.5	4.7	5.7		5.7	--		
	n	10	45	11	4	23		2	1		
Lower Monumental	μ	45.7	65.2	57.5	76.4	73.0		80.0	82.5		
	s	3.1	3.8	5.5	4.8	5.8		5.7	--		
	n	10	45	11	39	22		2	1		
Little Goose	μ	45.7	65.2	56.7	76.4	72.6		80.0	82.5		
	s	3.1	3.8	5.6	4.7	6.1		5.7	--		
	n	10	45	11	4	22		2	1		
Lower Granite	μ	45.7	65.1	57.5	76.3	73.4		80.0	82.5		
	s	3.1	3.9	5.5	4.7	6.6		5.7	--		
	n	10	44	11	39	19		2	1		

Fallback

Estimated fallback rates, based on Chinook Salmon reascending fish ladders or being detected downstream after ascending a fish ladder, ranged from a low of 0.2% for fall Chinook at Bonneville Dam to 15.4% for summer Chinook at

Wells Dam (Table 18). These rates likely underestimate the true fallback rates as they do not include any fish that ascended a dam, fell back, and then were not subsequently detected.

Table 18. Estimated minimum Chinook Salmon fallback rates by race at Columbia Basin dams with PIT tag detection in 2018 as estimated by PIT tags[5].

Dam	Spring Chinook (%)	Summer Chinook (%)	Fall Chinook (%)
Bonneville	1.3%	1.1%	0.2%
The Dalles	6.0%	3.8%	2.3%
John Day	5.0%	3.8%	1.2%
McNary	4.7%	0.6%	3.1%
Priest Rapids	2.2%	1.8%	14.2%
Rock Island	1.1%	0.0%	3.4%
Rocky Reach	7.5%	6.0%	7.7%
Wells	12.6%	15.4%	4.8%
Ice Harbor	8.7%	8.5%	1.4%
L. Monumental	9.9%	4.3%	0.7%
Little Goose	15.1%	6.6%	7.7%
Lower Granite	13.8%	12.2%	8.6%
Tumwater	4.3%	4.5%	NA
Weighted Mean	**6.5%**	**3.8%**	**2.3%**

A total of 409 Chinook generated 654 fallback events at mainstem dams with adult PIT tag detection (Table 19). A total of 129 Chinook had more than one fallback event at a single dam or several dams. One Chinook fell back over mainstem dams 11 times, while two fell back 8 times. Figures showing the movement of some of these Chinook are in the Appendix B (Table B1 and Figures B24 – B26).

[5] Fallback rates do not include Chinook Salmon which fell back over a dam and were not subsequently detected.

Table 19. Frequency of fallback events for Chinook Salmon tagged by this project in 2018.

Number of Dams Fallen Back Over	Total Number of Chinook
1	283
2	78
3	26
4	11
5	9
6	2
7	0
8	2
11	1
Number of Chinook falling back at least once	**409**
% of Chinook with at least one fallback event	**12.9%**
Total fallback events	**654**
Number of Chinook in study	**3178**
Fallback events per Chinook	**0.21**

Night Passage

Night passage (2000-0400 Pacific Standard Time) of tagged Chinook Salmon was under 10% at all mainstem dams except for fall Chinook at Rock Island Dam (Table 20). Higher percentages of night passage were observed at Prosser and Roza dams, but sample sizes are relatively small (for example, only seven fall Chinook passed Prosser Dam, four at night) (Table 20).

Table 20. Estimated Chinook Salmon night passage (2000-0400) in 2018 at Columbia Basin dams as estimated by PIT tag detections.

Site	Spring Chinook	Summer Chinook	Fall Chinook
Bonneville	0.0%	0.3%	0.2%
The Dalles	2.8%	2.3%	1.1%
John Day	0.8%	0.8%	0.1%
McNary	2.5%	2.2%	0.6%
Priest Rapids	0.7%	2.1%	1.6%
Rock Island	7.9%	3.4%	17.2%
Rocky Reach	3.2%	1.5%	7.7%
Wells	9.5%	4.6%	4.8%
Ice Harbor	2.2%	5.3%	3.4%
Lower Monumental	3.3%	2.2%	3.5%
Little Goose	3.0%	2.2%	4.9%
Lower Granite	2.4%	2.2%	2.2%
Prosser	7.0%	12.5%	57.1%
Roza	29.5%	12.5%	NA
Tumwater	8.7%	4.5%	NA

Straying

Estimated Chinook stray rates by stock for those with more than 10 fish that were designated as either putative strays or on-target, ranged from 45.8% at Carson hatcheries to 0% for numerous stocks (Table 21). Hatcheries with >10% stray rates (and 10 or more Chinook in terminal areas) were Carson fish (45.8% with strays in the Deschutes, Umatilla and above McNary), Priest Rapids (21.4% with strays in Bonneville Pool tributaries, the Deschutes, and above Rocky Reach Dam), and Parkdale (16.7% with strays in the Deschutes). The combined stray rate for all stocks was 14.1% with 2.5% categorized as putative overshoots.

Table 21. Table showing final-PIT-fate categories by hatchery. Fate categories are categorized by color. Grey is neutral (meaning last detected on route to expected destinations), green is on target (meaning last detected at their expected destination), yellow is putative overshoot meaning a fish last detected in an area adjacent to its expected destination, and red is putative stray meaning a fish was last detected in tributaries or the mainstem outside their normal route to their expected destination. Stray rates are also tabulated.

Stock Classification using Parental Based Tagging	BCC	BO1	BO3	BO4	CAL	WRU	LWL	SCL	HRM	MVF	LFF	TD1	TD2	DRM	DSF	WSR	WSH	JO1	JO2	JDM	MJ1	TMF	UMF	MC1	MC2	MCJ	WW1	ICH	LMA
Columbia River River Kilometer	234	234	234	234	251	251	261	269	273	273	290	308	308	328	328	328	328	347	347	351	351	465	465	470	470	470	509	522	522
Basin	Bonneville Dam				Bonneville Pool Sites				Hood Basin			The Dalles		Deschutes Basin				John Day Dam		John Day R.		Umatilla R.		McNary Dam					
Site	BON PH2 Corner Collector	Bonneville-Bradford Ladder	Bonneville-WA Shore Ladder	Bonneille WA Ladder Slots	Carson Fish Hatchery	Upper Wind River	Little White Salmon Hatchery	Spring Creek Hachery	Hood River Mouth	Moving Falls Ladder	Lyle Falls Fishway, Klickitat R	The Dalles-East Fish Ladder	The Dalles-North Fish Ladder	Deschutes River Mouth	Deschutes-Sherars Falls	Warm Springs River PIT array	Warm Springs Hatchery	John Day Dam-Oregon Shore	John Day Dam-WA Shore	John Day River Mouth	Middle Fork, John Day	Three Mile Dam	Umatilla-Feed Dam	McNary-Oregon Shore	McNary-WA Shore	McNary Juvenile Bypass	Walla Walla River	Ice Harbor Dam	Lower Monumental Ladders
Carson National Fish Hatchery				25	6	6	1					3															3		
Chief Joseph Hatchery (Summer/Fall)				15								4	2					4	2					2	1				
Clearwater Fish Hatchery		1		27								6						1		1				1					
Clearwater-Powell Creek Facility	1	1		11								2												1				1	
Dworshak National Fish Hatchery				8								2																	
Eastbank Fish Hatchery (Summer)				10								3	2					1						2					
Entiat National Fish Hatchery (Summer)				7								3																	
Klickitat State Fish Hatchery				5							1	1	2																1
Leavenworth Hatchery				4								1																	
Little White Salmon National Fish Hatchery (Fall)		2		140			32		4		3	11	1	2	1		1	2				11		4	4			1	
Lookingglass Fish Hatchery - Imnaha River				2								1																	
Lookingglass Fish Hatchery - Lostine River				2								1		1															1
Lyons Ferry Hatchery				12								3	1					1	3		0			1					2
McCall Hatchery				3								2																	1
Methow																													
Nez Perce Hatchery				3																				1		1			
Pahsimmeroi hatchery				2									1																
Parkdate Fish Facility				14					3	7		1			2														
Rapid River Hatchery	1	1		31								9						1						2					2
Round Butte			1	7								4	1	1	2	1													
Sawtooth Hatchery				13								3												1				1	
Tucannon Hatchery				2																									
Umatilla				30								2						6				36	3	2				2	1
Warm Springs Hatchery				1																									
Wells Hatchery				1								2	1					2	1					1					
Winthrop Hatchery				10								3																	
Yakima				3														1							1				
Grand Ronde				2								1									1								
McCall-Johnson Creek																													
Priest Rapids Hatchery				22			1		1			2	1	1				3	4					12	8				
Spring Creek Tule				5				8																					
Total	**2**	**5**	**1**	**417**	**6**	**6**	**34**	**8**	**8**	**7**	**4**	**70**	**12**	**5**	**5**	**1**	**1**	**22**	**10**	**1**	**1**	**47**	**3**	**30**	**14**	**1**	**3**	**5**	**8**

Stock Classification using Parental Based Tagging	UTR	TFH	GOA	GOJ	GRA	GRJ	DWL	SC1	SC2	CLC	LRL	LRU	SW1	SW2	WEN	WR1	CCW	UGS	SFG	KRS	ESS	STR	USE	USI	YFK	STL	IR2	IML	IR4	PRO	SUN	ROZ	RSH	PRH	PRA
Columbia River River Kilometer	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	539	539	539	567	635	639
Basin	Tucannon R.		L. Goose Dam		L. Granite		Clearwater Basin								Grand Ronde Basin				S. Fork Salmon Basin				Upper Salmon Basin				Imnaha Basin			Yakima Basin					
Site	Upper Tucannon River	Tucannon Fish Hatchery	Little Goose Dam	Little Goose Juvenile Bypass	Lower Granite	Lower Granite Juvenile Bypass	Dworshak Hatcheyr	SF Clearwater rkm 1	SF Clearwater rkm 2	Clear Creek	Lower Lochsa River	Upper Lochsa River	Lower Selway River	Upper Selway River	Wenaha River Mouth	Wallow River rkm 14	Catherine Creek	Upper Grand Ronde	SF Salmon-Guard Bridge	SF Salmon-Krassel Cr	EFSF Salmon River	SF Salmon Satellite	Upper Salmon rkm 437	Upper Salmon rkm 460	Yankee Fork	Sawtooth Hatchery	Lower Imnaha	Imnaha Weir Adult Ladder	Imnaha Weir Downstream	Prosser Dam	Sunnyside Instream Array	Roza Dam	Ringold Hatchery	Priest Rapids Hatchery	Priest Rapids Dam
Carson National Fish Hatchery																																			
Chief Joseph Hatchery (Summer/Fall)																																			1
Clearwater Fish Hatchery					21		2	6	23	1	2	11				1	1																		
Clearwater-Powell Creek Facility					14		2	2		5		3	4	3																					
Dworshak National Fish Hatchery					17		2	1	1	1																									
Eastbank Fish Hatchery (Summer)																																			1
Entiat National Fish Hatchery (Summer)																																			1
Klickitat State Fish Hatchery																																			
Leavenworth Hatchery																																			1
Little White Salmon National Fish Hatchery (Fall)																														1	1			1	2
Lookingglass Fish Hatchery - Imnaha River																												3	2						
Lookingglass Fish Hatchery - Lostine River					3											1																			
Lyons Ferry Hatchery			3	1	45	1			1						1												2				1			2	
McCall Hatchery					5														1	19		9													
Methow																																			
Nez Perce Hatchery					16			1	2					1																				1	
Pahsimmeroi hatchery			1		11																		9	1											
Parkdate Fish Facility																																			
Rapid River Hatchery			1		62																							1							
Round Butte																																			
Sawtooth Hatchery					15																		10	8	1	18									
Tucannon Hatchery		6																																	
Umatilla	1	2			2																											1		1	
Warm Springs Hatchery																																			
Wells Hatchery																																			1
Winthrop Hatchery																																			
Yakima																														3		27			
Grand Ronde					2													4																	
McCall-Johnson Creek																					3														
Priest Rapids Hatchery																																	3	33	7
Spring Creek Tule																																			
Total	**1**	**8**	**5**	**1**	**213**	**1**	**6**	**10**	**27**	**7**	**2**	**14**	**4**	**4**	**1**	**2**	**1**	**4**	**1**	**19**	**3**	**9**	**19**	**9**	**1**	**18**	**2**	**4**	**2**	**4**	**2**	**28**	**3**	**38**	**14**

Stock Classification using Parental Based Tagging	LWE	TUF	LNF	CHL	UWE	CHU	RRF	RRJ	EBO	ENL	EHL	WEA	WEH	LMR	MRC	SCP	MSH	OKL	SAO	Total	Neutral	On-Target	Putative Stray	Putative Overshoot	% Putative Strays/On-Target
Columbia River River Kilometer	754	754	754	754	754	754	763	763	764	778	778	830	830	843	843	843	843	858	858	Total					
Basin	Wenatchee Basin						R. Reach Dam			Entiat Basin		Wells		Methow Basin				Okanagan							
Site	Lower Wenatchee River	Tumwater Dam	Leavenworth Hatchery	Lower Chiwawa River	Upper Wenatchee	Upper Chiwawa Weir	Rocky Reach Dam	Rocky Reach Juv. Bypass	Eastbank Hatchery	Lower Entiat	Entiat Ladder	Wells Dam	Wells Hatchery	Lower Methow River	Methow River (Carlton)	Spring Cr. Acclimation Pond	Methow Hatchery	Lower Okanogan	Salmon River						
Carson National Fish Hatchery												5								46	22	13	8	3	38.1%
Chief Joseph Hatchery (Summer/Fall)	1						6	1		1		46	7	1				26		120	45	72	3	0	4.0%
Clearwater Fish Hatchery												1								106	57	45	4	0	8.2%
Clearwater-Powell Creek Facility																				50	31	19	0	0	0.0%
Dworshak National Fish Hatchery																				32	27	5	0	0	0.0%
Eastbank Fish Hatchery (Summer)	5	4		1	1	2	12	1	2		1	27	3	4	4			1		87	19	68	0	0	0.0%
Entiat National Fish Hatchery (Summer)							1			5	16	4	3							40	12	21	0	7	0.0%
Klickitat State Fish Hatchery																				10	5	1	1	3	50.0%
Leavenworth Hatchery			8									1								15	6	8	1	0	11.1%
Little White Salmon National Fish Hatchery (Fall)																				224	142	39	31	12	44.3%
Lookingglass Fish Hatchery - Imnaha River																				8	3	5	0	0	0.0%
Lookingglass Fish Hatchery - Lostine River																				9	7	0	2	0	100.0%
Lyons Ferry Hatchery																				80	73	0	7	0	100.0%
McCall Hatchery																				40	11	29	0	0	0.0%
Methow												1					2		1	4	1	2	1	0	33.3%
Nez Perce Hatchery													1							23	21	0	2	0	100.0%
Pahsimmeroi hatchery																				25	15	10	0	0	0.0%
Parkdate Fish Facility																				27	14	10	2	1	16.7%
Rapid River Hatchery																				111	110	0	1	0	100.0%
Round Butte																				17	13	4	0	0	0.0%
Sawtooth Hatchery																				70	33	37	0	0	0.0%
Tucannon Hatchery																				8	2	6	0	0	0.0%
Umatilla																				89	38	39	10	2	20.4%
Warm Springs Hatchery																				1	1	0	0	0	NA
Wells Hatchery								3	2	1		24	29	1				1		70	33	29	3	5	9.4%
Winthrop Hatchery												2			1	12		1		29	15	13	1	0	7.1%
Yakima							1													36	5	30	1	0	3.2%
Grand Ronde																				10	5	4	1	0	20.0%
McCall-Johnson Creek																				3	0	3	0	0	0.0%
Priest Rapids Hatchery							2		2			1	1							101	52	33	9	7	21.4%
Spring Creek Tule																				13	5	8	0	0	0.0%
Total	**6**	**4**	**8**	**1**	**1**	**2**	**22**	**5**	**6**	**7**	**17**	**112**	**44**	**6**	**5**	**12**	**2**	**29**	**1**	**1504**	**823**	**553**	**88**	**40**	**13.7%**

RESULTS-STEELHEAD

Sample Size

A total of 896 steelhead were sampled at Bonneville Dam in 2018, of which 870 were PIT tagged (Table 22). After adding previously tagged fish (which were sampled and therefore identified for the tracking study and included in our sample) and subtracting fish that were not detected after release (possibly a result of tag shed, tag malfunction, mortality, or the fish moving downstream after tagging) or which spent no winters in the ocean, the number of steelhead tracked upstream totaled 893 (Table 22). There were no mortalities of steelhead sampled in 2018.

Table 22. Number of steelhead PIT tagged at Bonneville Dam and tracked past Bonneville by date and statistical week in 2018.

Dates	Week	Sampled	PIT Tagged	Previously Tagged	Not Detected After Release	Total Tracked	Days Sampling Restrictions in Effect		
							Reduced Sampling-Temp	Reduced Sampling-Shad or Salmon Abundance	No Sampling Due to Temp
4/25-27	17	13	12	1	1	12	0	0	0
4/30, 5/1-4	18	5	3	2	0	5	0	0	0
5/7-11	19	10	8	2	0	10	0	0	0
5/14-5/18	20	9	9	0	0	9	0	0	0
5/21-5/25	21	6	5	1	0	6	0	1	0
5/29-6/1	22	7	6	1	0	7	0	0	0
6/4-6/8	23	12	12	0	0	12	0	1	0
6/11-6/15	24	9	7	2	0	9	0	5	0
6/18-6/22	25	7	7	0	0	7	0	5	0
6/25-6/29	26	9	8	1	0	9	0	5	0
7/2-4,7/6	27	13	12	1	1	12	0	3	0
7/10-7/14	28	43	42	1	0	43	0	1	0
716-7/20	29	75	75	0	0	75	0	*0*	0
7/23-7/27	30	99	95	4	0	99	1	*0*	1
No Sampling	31						0	0	5
No Sampling	32						0	0	5
No Sampling	33						0	0	5
8/20-8/22	34	45	42	3	0	45	3	0	2
8/27-8/31	35	69	67	2	0	69	0	1	0
9/4-9/7	36	60	59	1	0	60	0	4	0
9/10-9/14	37	69	68	1	0	69	0	1	0
9/17-9/21	38	64	63	1	0	64	0	0	0
9/24-9/28	39	78	77	1	0	78	0	0	0
10/1-10/5	40	83	83	0	0	83	0	0	0
10/8-10/12	41	111	110	0	0	110	0	0	0
Total		**896**	**870**	**25**	**2**	**893**	**4**	**27**	**18**

Distribution of Sample

The distribution of our sample over the run was relatively similar to the run distribution with three exceptions (Figure 15). The first was in Statistical Weeks 30 to 32 when the AFF was shut down due to the water temperature exceeding 22.2°C. A second was during Week 36 when Labor Day eliminated one day of sampling and sample sizes during the remaining four days were reduced due to the picket leads being raised more frequently because of high Chinook abundance. Raising and lowering the leads likely reduced the number of fish in the trap. And a third exception was at the end of the run after all sampling restrictions had ended; the Chinook run had decreased and we were sampling mostly steelhead.

The AFF was shut down from July 27 through August 19, 2018, which comprised three entire statistical weeks (31-33) and parts of two others (30 and 34). During the period when the trap was shut down, 25.0% of the run passed. Over weeks 30-34, 35.3% of the steelhead passed while we sampled 143 steelhead, which comprised 16.0% of our sample.

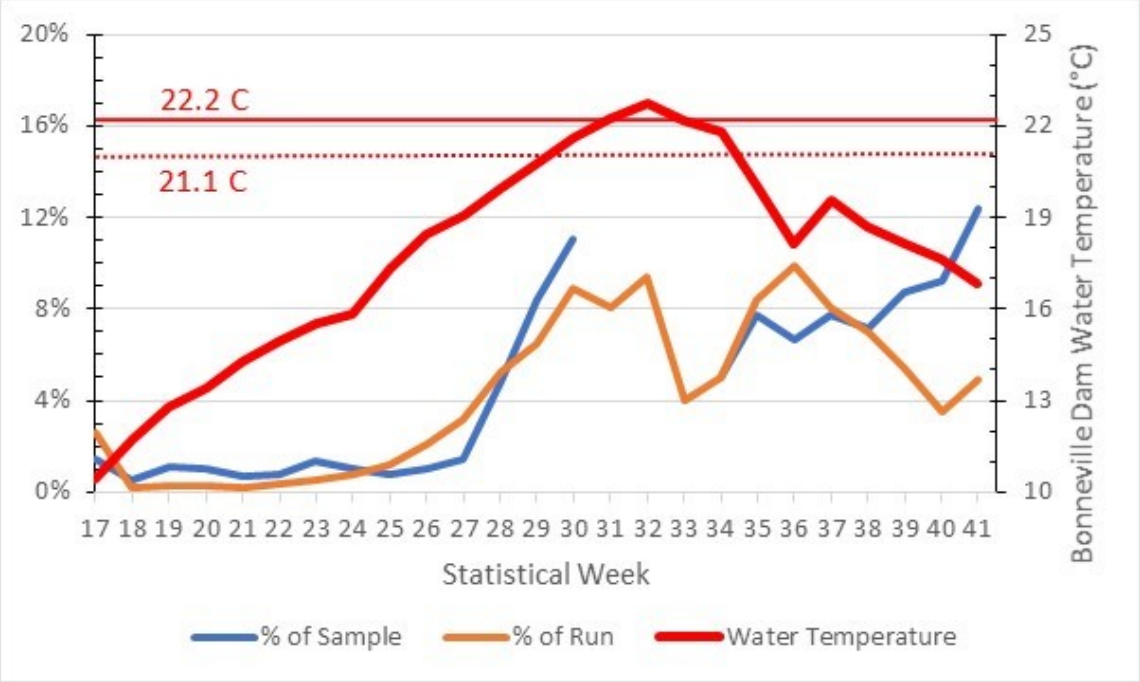

Figure 15. The weekly steelhead sample and run as a percentage of the total sample and run size at Bonneville Dam in 2018. Sampling was reduced at 21.1°C and halted at 22.2°C.

Detection Numbers

The 893 steelhead tracked in 2018 generated 54,357 weir detections and 6,277 site detections at 123 sites. Maps and table of sites (Table B1 and Figures

B1, B15-B19) found in Appendix B show the categorical ranges of detection numbers at the sites throughout the Columbia Basin.

Bonneville Dam Steelhead Age Composition

For the 32.2% of the steelhead migration passing during or prior to Statistical Week 30, the predominant age was Age 1.2, comprising an estimated 23.0% of the run (Figure 16, Table 23). There were five additional age groups (1.1, 1.2, 2.1, 2.2 and r.2) individually comprising between 14.9% and 19.9% of the run with a sixth age group, r.1, comprising 9.5% of the run. During weeks 31 and 33, when we were shut down due to high temperatures, 21.4% of the run passed. After sampling restarted in Week 34, the age composition had changed considerably. Among steelhead passing during or after Week 34, 57.3% of the run was Age 1.2, 14.2% was Age 1.1, 12.4% was Age r.2, with all other components at 5.1% or less.

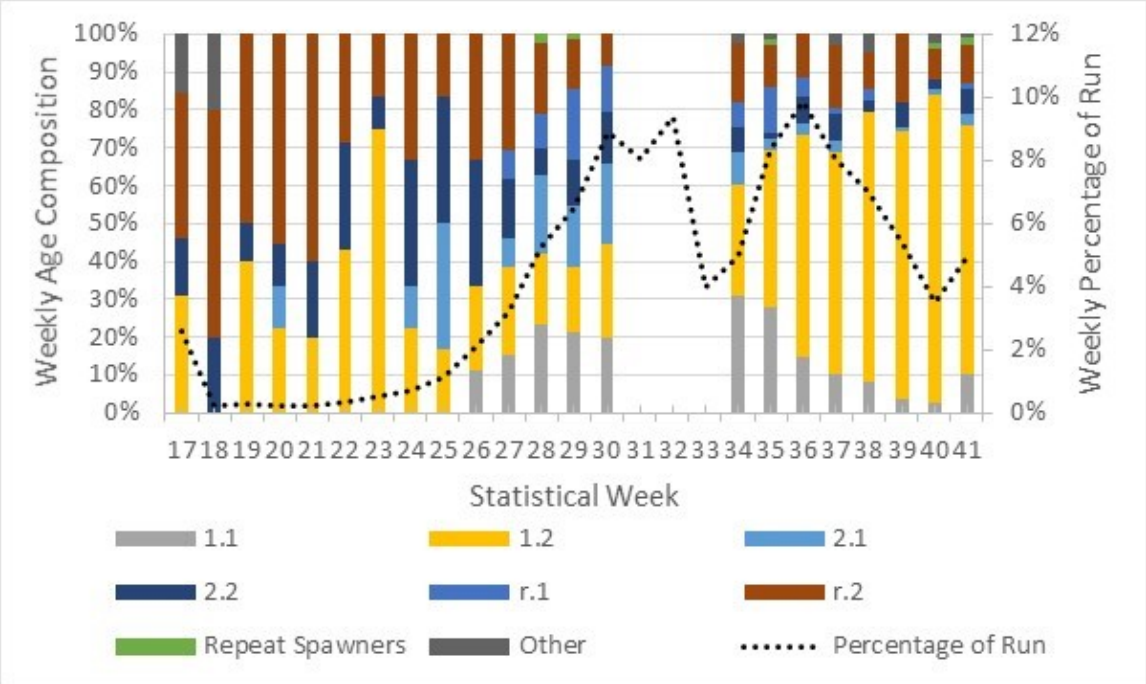

Figure 16. Weekly age composition of steelhead at Bonneville Dam as estimated from scale patterns for the five most abundant age classes in 2018 with weekly abundance.

Table 23. Weekly and total age composition of steelhead at Bonneville Dam as estimated from scale patterns in 2018. (Composite age composition estimates are weighted by the percentage of the run passing Bonneville Dam in each.)

		Brood Year and Age Class											
		2015	2014		2013		2012		Freshwater Zone Unageable				Repeat
Week	Weight	1.1	1.2	2.1	1.3	2.2	2.3	3.2	r	r.1	r.2	r.3	Spawners
17	2.5%	0.0%	30.8%	0.0%	0.0%	15.4%	0.0%	0.0%	0.0%	0.0%	38.5%	15.4%	0.0%
18	0.2%	0.0%	0.0%	0.0%	0.0%	20.0%	0.0%	0.0%	0.0%	0.0%	60.0%	20.0%	0.0%
19	0.3%	0.0%	40.0%	0.0%	0.0%	10.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%
20	0.2%	0.0%	22.2%	11.1%	0.0%	11.1%	0.0%	0.0%	0.0%	0.0%	55.6%	0.0%	0.0%
21	0.2%	0.0%	20.0%	0.0%	0.0%	20.0%	0.0%	0.0%	0.0%	0.0%	60.0%	0.0%	0.0%
22	0.3%	0.0%	42.9%	0.0%	0.0%	28.6%	0.0%	0.0%	0.0%	0.0%	28.6%	0.0%	0.0%
23	0.5%	0.0%	75.0%	0.0%	0.0%	8.3%	0.0%	0.0%	0.0%	0.0%	16.7%	0.0%	0.0%
24	0.7%	0.0%	22.2%	11.1%	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	33.3%	0.0%	0.0%
25	1.1%	0.0%	16.7%	33.3%	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	16.7%	0.0%	0.0%
26	2.0%	11.1%	22.2%	0.0%	0.0%	33.3%	0.0%	0.0%	0.0%	0.0%	33.3%	0.0%	0.0%
27	3.0%	15.4%	23.1%	7.7%	0.0%	15.4%	0.0%	0.0%	0.0%	7.7%	30.8%	0.0%	0.0%
28	4.9%	23.3%	18.6%	20.9%	0.0%	7.0%	0.0%	0.0%	0.0%	9.3%	18.6%	0.0%	2.3%
29	6.1%	21.3%	17.3%	16.0%	0.0%	12.0%	0.0%	0.0%	0.0%	18.7%	13.3%	0.0%	1.3%
30	8.4%	19.6%	24.7%	21.6%	0.0%	13.4%	0.0%	0.0%	0.0%	12.4%	8.2%	0.0%	0.0%
31	7.6%	**No Sampling Due to Trap Closure at Temperatures at or above 22.2°C**											
32	8.9%												
33	3.8%												
34	4.7%	31.1%	28.9%	8.9%	0.0%	6.7%	0.0%	2.2%	0.0%	6.7%	15.6%	0.0%	0.0%
35	7.9%	26.5%	39.7%	2.9%	0.0%	1.5%	0.0%	1.5%	4.4%	11.8%	10.3%	0.0%	1.5%
36	9.4%	15.0%	58.3%	3.3%	0.0%	6.7%	0.0%	0.0%	0.0%	5.0%	11.7%	0.0%	0.0%
37	7.6%	10.1%	56.5%	2.9%	0.0%	7.2%	2.9%	0.0%	2.9%	1.4%	15.9%	0.0%	0.0%
38	6.6%	7.8%	70.3%	0.0%	3.1%	3.1%	0.0%	0.0%	1.6%	3.1%	9.4%	1.6%	0.0%
39	5.1%	3.8%	70.5%	1.3%	0.0%	6.4%	0.0%	0.0%	0.0%	0.0%	17.9%	0.0%	0.0%
40	3.3%	2.4%	80.7%	1.2%	1.2%	2.4%	1.2%	0.0%	1.2%	0.0%	8.4%	0.0%	1.2%
41	4.7%	10.0%	65.5%	2.7%	0.9%	6.4%	0.0%	0.0%	0.9%	1.8%	10.0%	0.0%	1.8%
Weeks <=30	32.2%	15.7%	23.0%	14.9%	0.0%	15.0%	0.0%	0.0%	0.0%	9.5%	19.9%	1.4%	0.6%
Weeks 31-33	21.4%	**Unknown**											
Weeks >=34	52.1%	14.2%	57.3%	2.9%	0.6%	5.1%	0.5%	0.4%	1.5%	4.3%	12.4%	0.2%	0.5%

A higher percentage of Age 2.1 fish migrated upstream of Priest Rapids, while Age 1.2 steelhead migrated into the Snake River (Table 24, Figure 17). No returning repeat spawners were last detected upstream of Priest Rapids Dam. Upstream length-at-age estimates are in Table 25.

Table 24. Unweighted age composition of steelhead at mainstem dams in 2018.

Dam	1.1	1.2	2.1	2.2	Other Ages (1.3,2.3,3.2)	Repeat Spawners	Unageable
Bonneville	13.1%	48.0%	7.1%	8.2%	1.0%	0.7%	21.9%
The Dalles	18.1%	62.0%	9.1%	8.8%	1.5%	0.5%	23.4%
John Day	17.1%	62.9%	9.6%	8.2%	1.6%	0.6%	23.3%
McNary	17.1%	63.6%	8.9%	8.1%	1.6%	0.6%	21.7%
Priest Rapids	13.3%	33.3%	36.7%	16.7%	0.0%	0.0%	26.7%
Rock Island	10.7%	35.7%	39.3%	14.3%	0.0%	0.0%	25.0%
Rocky Reach	9.1%	45.5%	36.4%	9.1%	0.0%	0.0%	27.3%
Wells	9.5%	42.9%	38.1%	9.5%	0.0%	0.0%	23.8%
Ice Harbor	17.9%	68.3%	4.4%	7.0%	1.9%	0.5%	21.4%
Lower Monumental	17.8%	67.4%	4.8%	7.5%	2.0%	0.5%	21.8%
Little Goose	16.6%	68.3%	4.9%	7.7%	2.0%	0.5%	21.2%
Lower Granite	16.4%	68.8%	4.9%	7.3%	2.1%	0.5%	21.0%

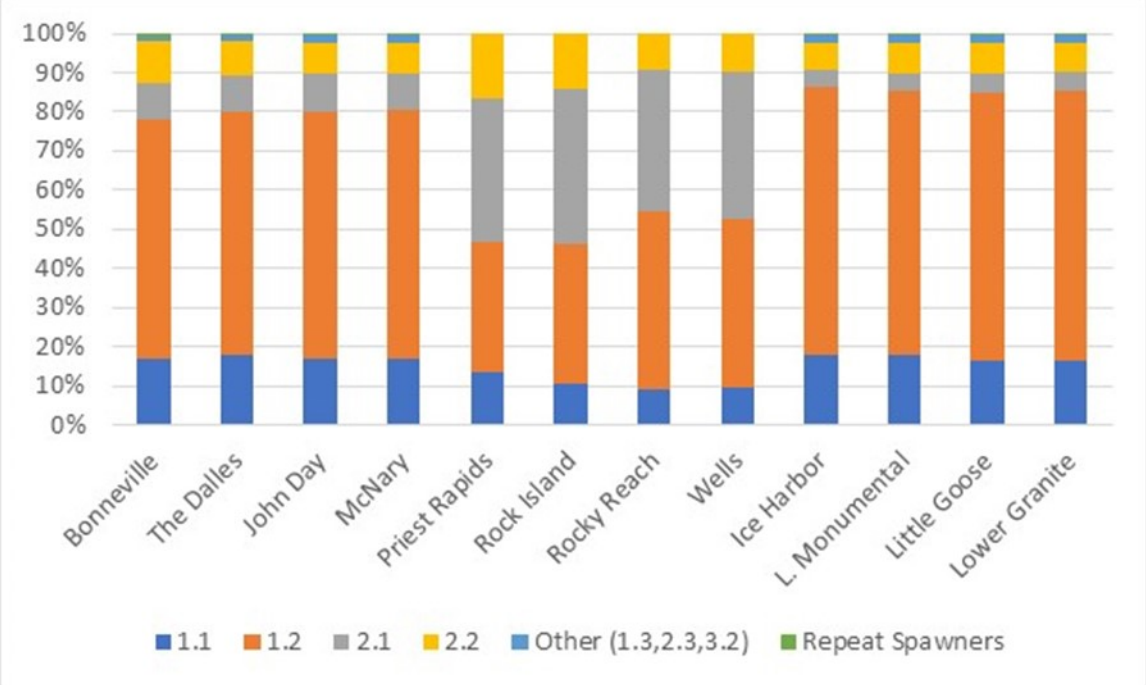

Table 25. Steelhead length-at-age composition at mainstem Columbia Basin dams, as estimated by upstream PIT tag detections of steelhead sampled at Bonneville Dam in 2018.

		Brood Year and Age										
		2015	2014		2013			2012	2011	Unknown		
Dam	Sta-tistic	1.1	1.2	2.1	1.3	2.2	3.1	2.3	3.2	r.1	r.2	r.3
Bonneville	μ	57.9	78.4	57.8	90.5	73.2		85.8	79.8	66.8	56.0	75.0
	s	3.4	7.1	3.8	2.8	6.4		7.5	6.7	11.4	8.7	7.8
	n	117	427	63	4	73		3	2	8	51	132
The Dalles	μ	57.9	79.1	58.3	89.2	73.4		85.8	79.8	64.9	55.3	76.3
	s	3.0	6.7	3.8	1.0	6.5		7.5	6.7	10.9	9.8	8.6
	n	99	339	50	3	48		3	2	7	38	82
John Day		58.0	79.6	58.4	89.2	73.6		85.8	79.8	63.2	55.1	76.9
		3.0	6.5	3.9	1.0	6.5		7.5	6.7	10.8	10.2	8.7
		86	316	48	3	41		3	2	6	35	75
McNary	μ	58.1	79.6	58.4	89.2	73.7		85.8	79.8	63.2	54.7	76.6
	s	2.9	6.5	3.9	1.0	6.6		7.5	6.7	10.8	10.8	8.5
	n	84	313	44	3	40		3	2	6	30	70
Priest Rapids	μ	57.9	70.8	58.6		71.6					53.5	67.8
	s	5.7	4.5	4.2		6.5					3.1	1.5
	n	4	10	11		5					4	4
Rock Island	μ	55.5	70.8	58.6		70.5					52.3	67.8
	s	3.9	4.5	4.2		6.9					2.6	1.5
	n	3	10	11		4					3	4
Rocky Reach	μ	54.3	70.8	58.9		67.3					52.0	67.8
	s	4.6	4.5	4.1		3.2					3.5	1.5
	n	2	10	8		2					2	4
Wells	μ	54.3	71.7	58.9		67.3					52.0	68.3
	s	4.6	3.6	4.1		3.2					3.5	1.2
	n	2	9	8		2					2	3
Ice Harbor	μ	58.2	80.0	58.1	89.2	74.7		85.8	79.8	63.2	54.5	77.9
	s	2.9	6.2	4.4	1.0	6.9		7.5	6.7	10.8	12.3	8.1
	n	77	293	19	3	30		3	2	6	23	62
Lower Monumental	μ	58.0	80.1	58.1	89.2	74.7		85.8	79.8	63.2	54.4	78.2
	s	2.9	6.3	4.4	1.0	6.9		7.5	6.7	10.8	12.9	7.7
	n	71	269	19	3	30		3	2	6	21	59
Little Goose	μ	57.9	80.1	58.1	89.2	74.7		85.8	79.8	63.2	54.4	77.9
	s	2.9	6.3	4.4	1.0	6.9		7.5	6.7	10.8	12.9	7.8
	n	65	267	19	3	30		3	2	6	21	55
Lower Granite	μ	57.9	80.2	58.1	89.2	74.7		85.8	79.8	63.2	54.4	78.0
	s	2.9	6.2	4.4	1.0	6.9		7.5	6.7	10.8	13.2	7.8
	n	63	265	19	3	28		3	2	6	20	54

Figure 17. Unweighted age composition of steelhead at mainstem dams in 2018.

Dam	Stat	Brood Year and Age									
		2016	2015		2014		2013		Unknown		
		1.1	1.2	2.1	1.3	2.2	2.3	3.2	r.1	r.2	r.3
Bonneville	μ	57.9	70.4	59.2	81.8	68.7	81.0	69.3	58.0	69.3	77.7
	s	3.4	10.3	5.7	19.2	5.3	--	4.7	6.2	10.8	2.5
	n	117	87	150	20	51	1	7	130	67	3
The Dalles	μ	57.9	79.1	58.3	89.2	73.4	85.8	79.8	64.9	55.3	76.3
	s	3.0	6.7	3.8	1.0	6.5	7.5	6.7	10.9	9.8	8.6
	n	99	339	50	3	48	3	2	7	38	82
John Day	μ	58.0	79.6	58.4	89.2	73.6		85.8	79.8	63.2	55.1
	s	3.0	6.5	3.9	1.0	6.5		7.5	6.7	10.8	10.2
	n	86	316	48	3	41		3	2	6	35
McNary	μ	58.1	79.6	58.4	89.2	73.7		85.8	79.8	63.2	54.7
	s	2.9	6.5	3.9	1.0	6.6		7.5	6.7	10.8	10.8
	n	84	313	44	3	40		3	2	6	30
Priest Rapids	μ	57.9	70.8	58.6		71.6					53.5
	s	5.7	4.5	4.2		6.5					3.1
	n	4	10	11		5					4
Rock Island	μ	55.5	70.8	58.6		70.5					52.3
	s	3.9	4.5	4.2		6.9					2.6
	n	3	10	11		4					3
Rocky Reach	μ	54.3	70.8	58.9		67.3					52.0
	s	4.6	4.5	4.1		3.2					3.5
	n	2	10	8		2					2
Wells	μ	54.3	71.7	58.9		67.3					52.0
	s	4.6	3.6	4.1		3.2					3.5
	n	2	9	8		2					2
Ice Harbor	μ	58.2	80.0	58.1	89.2	74.7		85.8	79.8	63.2	54.5
	s	2.9	6.2	4.4	1.0	6.9		7.5	6.7	10.8	12.3
	n	77	293	19	3	30		3	2	6	23
Lower Monumental	μ	58.0	80.1	58.1	89.2	74.7		85.8	79.8	63.2	54.4
	s	2.9	6.3	4.4	1.0	6.9		7.5	6.7	10.8	12.9
	n	71	269	19	3	30		3	2	6	21
Little Goose	μ	57.9	80.1	58.1	89.2	74.7		85.8	79.8	63.2	54.4
	s	2.9	6.3	4.4	1.0	6.9		7.5	6.7	10.8	12.9
	n	65	267	19	3	30		3	2	6	21
Lower Granite	μ	57.9	80.2	58.1	89.2	74.7		85.8	79.8	63.2	54.4
	s	2.9	6.2	4.4	1.0	6.9		7.5	6.7	10.8	13.2
	n	63	265	19	3	28		3	2	6	20

Mainstem Dam Recoveries, Mortality, and Escapement Estimates

Data on tag detections was last downloaded from www.ptagis.org on February 12, 2020. Since no sampling was allowed in weeks 31-33, the run was divided into an early run in weeks 17-30 and a late run in weeks 34-41. An estimated 29.8% of the early run was last detected above Ice Harbor Dam,

compared to 72.8% of the late run. Above Priest Rapids Dam the percentages were 7.3% and 3.9% respectively (Figure 18).

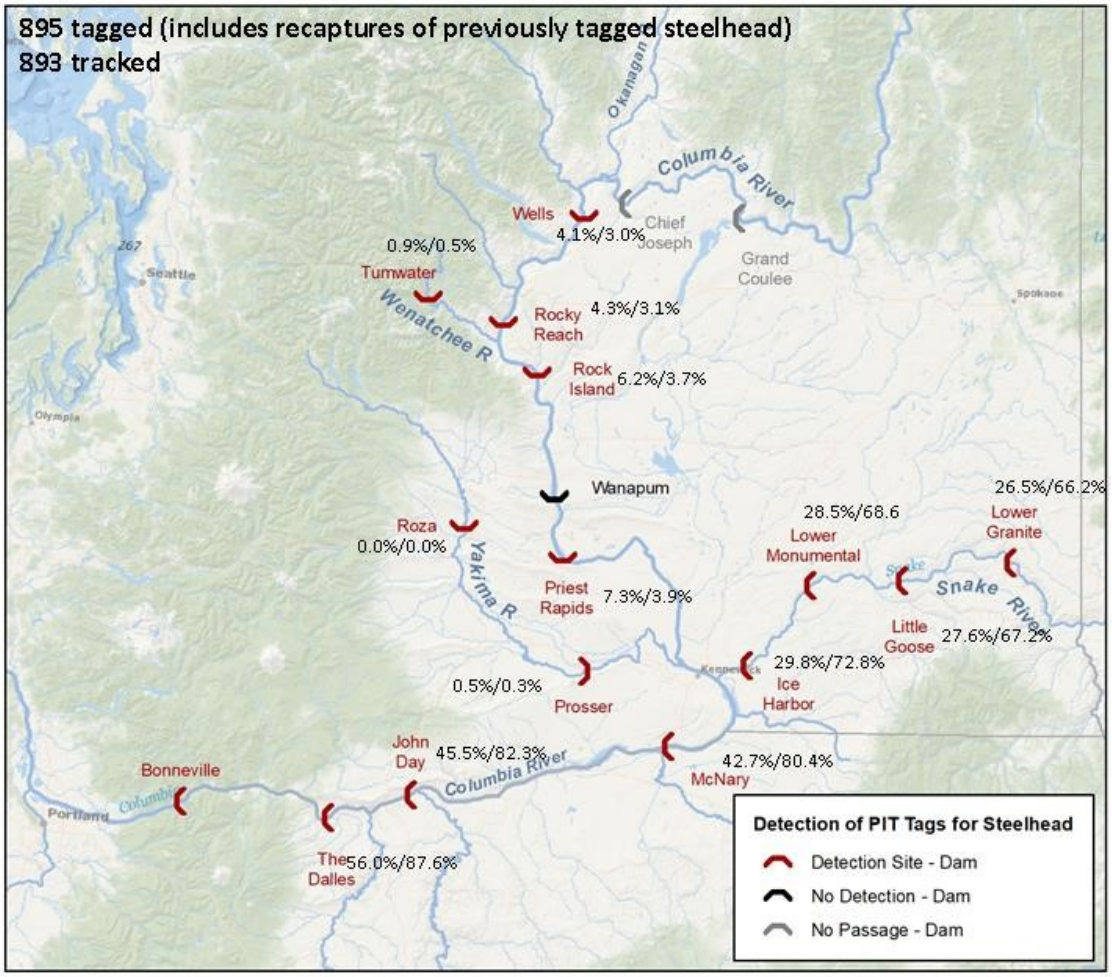

Figure 18. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of steelhead PIT tagged at Bonneville Dam, and the percentage of the early and late run estimated to pass upstream dams in 2018. The early run was in weeks 17-30 comprising 30.4% of the run; the late run was weeks 34-41 comprising 49.3% of the run. The 20.3% of the run passing in weeks 31-33 could not be sampled due to temperature restrictions.

The early portion of the run comprising those steelhead initially tracked through Statistical Week 26 was dominated by steelhead last detected at or downstream of McNary Dam (Table 26, Figure 19). Only one steelhead tracked at Bonneville Dam between weeks 17 and 22 was detected at McNary Dam; all others were last detected below McNary Dam. Among steelhead tracked by this project that passed Bonneville Dam prior to the closure of the trap in Week 31, 43.8% of these fish were last detected at mainstem dams between Bonneville and McNary dams (Table 26, Figures 19 and 20). Between weeks 26 and 30, the proportion of the run detected in the Snake River generally increased, with a total

estimate of 28.7% of those steelhead tracked in this study prior to Week 31 being ultimately detected in the Snake River. This jumped to 72.6% in weeks 34-41 after the AFF was reopened. We had one steelhead (3DD.0077BAB8B5), which was tagged in Week 19 on May 11, that passed upstream of Bonneville Dam, then was next detected passing Willamette Falls fishway on May 19, followed by the Lebanon Dam North Ladder on the Santiam River on May 29, and Foster Dam Ladder on the South Santiam River between June 4 and June 25, 2018.

Table 26. Most upstream detection by Statistical Week and region for steelhead tracked by this study in 2018.

Statistical Week	% of Run	Below Bonneville dam in Willamette Basin	At main-stem dams between Bonneville- and McNary	Tributaries between Bonneville and McNary dams	Between McNary and Priest Rapids dams	Above Priest Rapids Dam	Above Ice Harbor (Snake River)
17	2.5%	0.0%	61.5%	38.5%	0.0%	0.0%	0.0%
18	0.2%	0.0%	20.0%	80.0%	0.0%	0.0%	0.0%
19	0.3%	10.0%	50.0%	40.0%	0.0%	0.0%	0.0%
20	0.2%	0.0%	55.6%	44.4%	0.0%	0.0%	0.0%
21	0.2%	0.0%	66.7%	16.7%	0.0%	0.0%	16.7%
22	0.3%	0.0%	57.1%	42.9%	0.0%	0.0%	0.0%
23	0.5%	0.0%	50.0%	41.7%	0.0%	0.0%	8.3%
24	0.7%	0.0%	55.6%	11.1%	0.0%	11.1%	22.2%
25	1.1%	0.0%	42.9%	28.6%	14.3%	0.0%	14.3%
26	2.0%	0.0%	44.4%	33.3%	0.0%	11.1%	11.1%
27	3.0%	0.0%	30.8%	23.1%	0.0%	7.7%	38.5%
28	4.9%	0.0%	39.5%	14.0%	2.3%	4.7%	39.5%
29	6.1%	0.0%	45.3%	10.7%	2.7%	5.3%	36.0%
30	8.4%	0.0%	42.4%	7.1%	4.0%	13.1%	33.3%
31	7.6%	**No Sampling Due to Trap Closure at Temperatures at or above 22.2°C**					
32	8.9%						
33	3.8%						
34	4.7%	0.0%	31.1%	0.0%	4.4%	13.3%	51.1%
35	7.9%	0.0%	20.3%	7.2%	2.9%	5.8%	63.8%
36	9.4%	0.0%	18.3%	5.0%	1.7%	6.7%	68.3%
37	7.6%	0.0%	17.4%	0.0%	1.4%	1.4%	79.7%
38	6.6%	0.0%	17.2%	0.0%	0.0%	0.0%	82.8%
39	5.1%	0.0%	19.2%	0.0%	0.0%	1.3%	79.5%
40	3.3%	0.0%	14.5%	0.0%	0.0%	0.0%	85.5%
41	4.7%	0.0%	22.7%	0.0%	1.8%	0.9%	74.5%
Weeks 17-30	30.4%	0.1%	43.8%	17.6%	2.5%	7.2%	28.7%
Weeks 31-33	20.3%	**Unknown**					
Weeks 34-41	49.3%	0.0%	19.8%	2.1%	1.6%	3.9%	72.6%

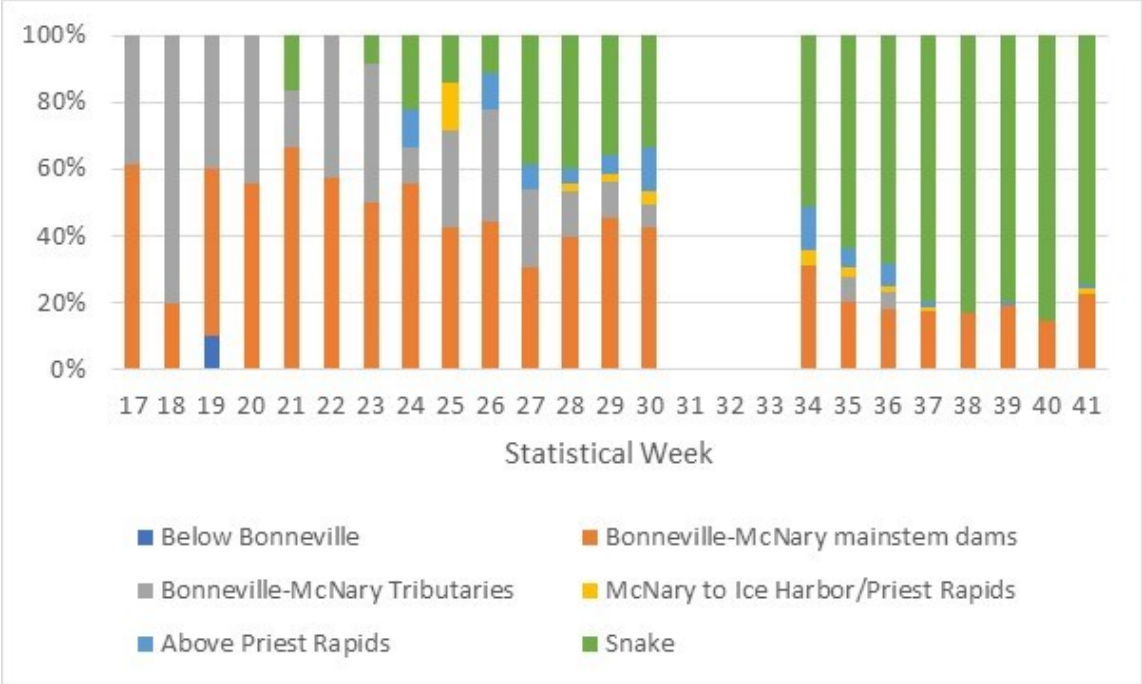

Figure 19. Most upstream detection by Statistical Week and region for steelhead tracked by this study in 2018 as a percentage of the weekly run.

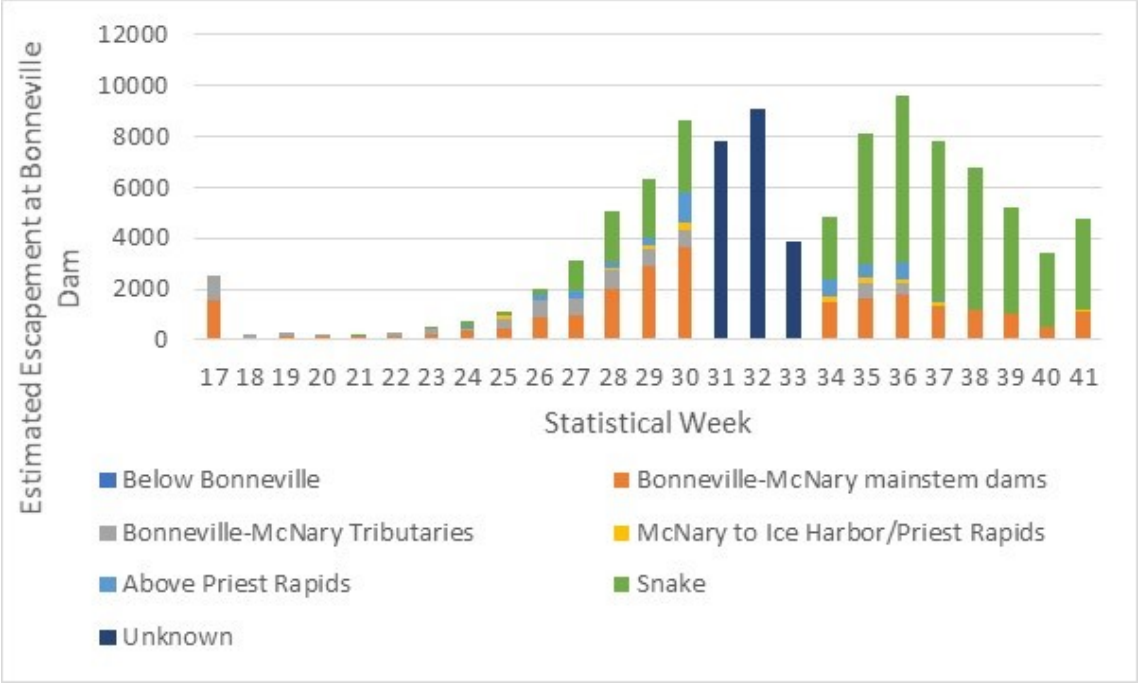

Figure 20. Most upstream detection by Statistical Week and region for steelhead tracked by this study in 2018 as estimated by numbers of fish passing Bonneville Dam by week. No sampling was conducted during weeks 31-33.

In 2013, a PIT tag array (DRM) was installed across the width of the Deschutes River one kilometer upstream of the river's mouth. A total of 69 of the 677 steelhead in this study that were detected at and/or upstream of The Dalles Dam by this study were detected at this site (Figure 21). Of these 69 steelhead, 36 were subsequently detected in the Snake River. Among the other 33 steelhead, for three steelhead their most upstream detection was above Priest Rapids Dam, four were between McNary and Priest Rapids dams, 13 in the Deschutes Basin (with eight not being detected past DRM), and 13 went elsewhere between Bonneville and McNary dams (Figure 21). Sixteen steelhead tagged by this project were detected upstream of DRM at Sherar's Falls PIT tag array (DSF); of these, six were detected at DRM. Of the 16 DSF detections, two were last detected in the Snake Basin, one (3DD.0077C0CBB5) at the Lower Granite fish ladder exit and the second (3DD.0077BA4C1F) at an antenna low in the Ice Harbor fish ladder. Two more were last detected in the McNary Dam fish ladders, one at Shitike Creek (SHK) in the Deschutes Basin and the remaining 10 were not detected after DSF.

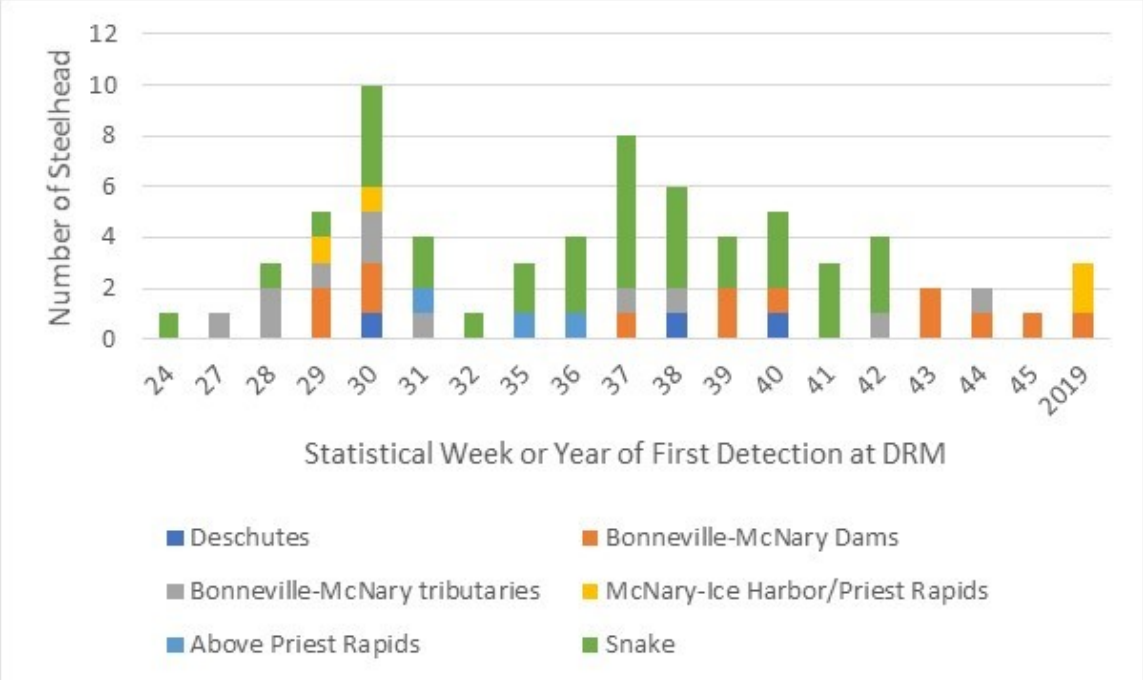

Figure 21. Distribution of final detection site by 2018 statistical week for steelhead PIT tagged at Bonneville Dam in 2018 that were detected at the Deschutes River Mouth antenna (DRM). Three steelhead had their first detection at DRM in early 2019.

The percentage of PIT tagged steelhead passing a dam without detection was under 1% (Table 27) at all dams except for Rock Island, which has known detection issues due to antenna size and electrical noise (Fryer et al. 2014).

Table 27. Percentages of steelhead passing a dam undetected that were subsequently detected upstream in 2018.

Dam	Percent not Detected
Bonneville	0.8%
The Dalles	0.5%
John Day	1.5%
McNary	1.2%
Priest Rapids	2.7%
Rock Island	48.7%
Rocky Reach	3.7%
Wells	7.1%
Ice Harbor	1.2%
Lower Monumental	1.3%
Little Goose	1.1%
Lower Granite	0.7%
Mean (weighted by number passing each dam)	**0.9%**

Migration Rates and Passage Time

The fastest median migration rate between mainstem dams, as measured in kilometers per day, was between John Day and McNary dams (37.6 km/day), while the slowest was 12.6 km/day between Bonneville and Wells dams (Table 28).

Table 28. Steelhead migration rate between Columbia Basin dams as estimated by PIT tag detections in 2018.

Dam Pair	Distance (km)	Median Migration Rate (km/day)
Bonneville-The Dalles	74	23.9
The Dalles-John Day	39	27.4
John Day-McNary	123	37.6
Bonneville-John Day	113	21.3
Bonneville - McNary	231	23.3
McNary - Priest Rapids	167	29.7
Priest Rapids - Rock Island	89	22.9
Rock Island - Rocky Reach	33	29.7
Rocky Reach - Wells	65	33.0
Rock Island - Tumwater	73	4.4
Bonneville – Rock Island	487	23.7
Bonneville - Wells	585	12.6
McNary - Ice Harbor	67	24.4
Ice Harbor - Lower Granite	156	21.3
Bonneville-Lower Granite	461	19.0

Weekly data for steelhead tracked by this project provides finer granularity on steelhead migration from Bonneville to McNary Dam (Table 29, Figure 22). No steelhead tracked from Bonneville Dam in weeks 17-20 and 22 were detected at McNary Dam but those in weeks 21 and 23-26 generally moved quickly to McNary

with mean weekly travel times of 6.5 to 11.7 days as the mean river temperature at Bonneville Dam increased to 18.5°C. In Week 27, when the river temperature at Bonneville reached 19.1°C, this increased to 45.7 days with increasing numbers of detections in the Deschutes River, suggesting that these fish may have been taking advantage of the cooler river temperatures in the Deschutes to hold until the mainstem Columbia River cooled.

Table 29. Summary of travel time and conversion between Bonneville and McNary with mean temperature and the number detected at the DRM site in the Deschutes River for steelhead included in this study in 2018.

Week	Number Tracked from Bonneville Dam	Number Detected at McNary Dam	Bonneville-McNary Conversion Rate	Mean Travel Days Bonneville to McNary	Mean Temperature at Bonneville Dam	Number Detected at PIT Tag Site DRM in Deschutes River
17	12	0	0.0%	NA	10.4	0
18	5	0	0.0%	NA	11.8	0
19	10	0	0.0%	NA	12.8	0
20	9	0	0.0%	NA	13.4	0
21	6	1	16.7%	11.7	14.3	0
22	7	0	0.0%	NA	15.0	0
23	12	1	8.3%	10.7	15.5	0
24	9	3	33.3%	7.9	15.8	1
25	7	2	28.6%	6.5	17.3	1
26	9	2	22.2%	10.9	18.5	1
27	12	6	50.0%	45.7	19.1	1
28	43	23	53.5%	39.2	19.9	5
29	75	36	48.0%	50.7	20.7	15
30	99	53	53.5%	51.8	21.6	11
31	0	0	NA	NA	22.3	0
32	0	0	NA	NA	22.7	0
33	0	0	NA	NA	22.2	0
34	45	32	71.1%	29.9	21.8	3
35	69	53	76.8%	27.0	20.8	7
36	60	47	78.3%	23.7	20.0	7
37	69	59	85.5%	21.6	19.6	5
38	64	52	81.3%	11.6	18.7	1
39	78	64	82.1%	19.2	18.2	5
40	83	72	86.7%	16.5	17.6	1
41	110	88	80.0%	13.5	16.8	5

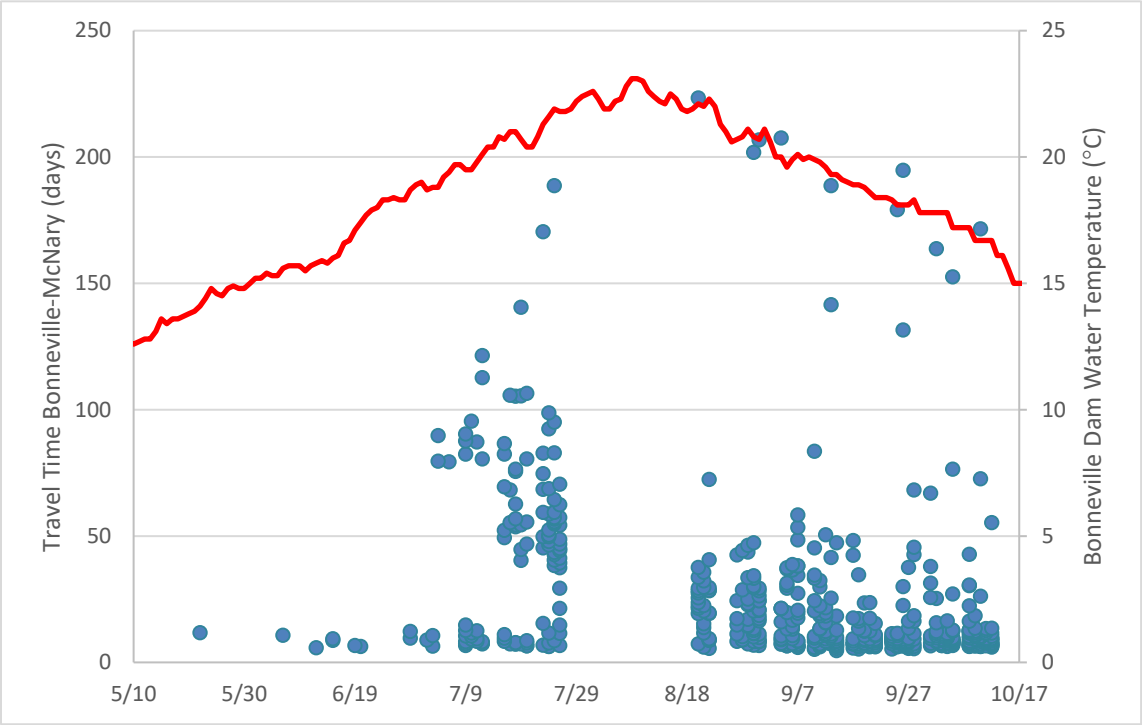

Figure 22. Steelhead travel time from Bonneville to McNary Dam by date passing Bonneville Dam in 2018.

Lower Granite, Wells, and McNary dams had the greatest median passage time from first to last PIT tag detection among mainstem Columbia Basin dams (Table 30). Passage times at Wells, Lower Granite, Priest Rapids, and Bonneville dams may be inflated because of fish trapping programs delaying fish passage. At many of the dam sites, passage times are very short, which reflects the very short distance between lower-most and upper-most PIT tag antennas.

Table 30. Steelhead median passage times from time of first detection at a dam to time of last detection and the percentage of steelhead taking more than 12 hours between first detection and last detection in 2018.

Dam	Median Passage Time (minutes)	Percentage with more than 12 hours between first detection and last detection at a dam
Bonneville	8.0	2.5%
The Dalles	0.0	2.8%
John Day	1.0	2.8%
McNary	84.0	7.0%
Priest Rapids	4.0	2.6%
Rock Island	0.0	0.0%
Rocky Reach	9.0	3.6%
Wells	123.0	15.4%
Ice Harbor	3.0	4.2%
Lower Monumental	1.0	5.0%
Little Goose	0.0	3.6%
Lower Granite	232.0	27.2%

Fallback

Estimated minimum fallback rates based on steelhead either reascending fish ladders or steelhead subsequently detected downstream ranged from 1.0% at Bonneville and Lower Granite dams to 57.7% at Wells Dam in 2018 (Table 31). These rates likely underestimate the true fallback rates as they do not include any fish that ascended a dam, fell back, and then were not subsequently detected. Steelhead migrating downstream through a fish ladder were not considered fallbacks. Steelhead were detected falling back up to nine times over dams (Table 32). Figures showing the movement of the two steelhead with five and nine fallbacks are in Appendix B (Figures B27 – B28).

Table 31. Estimated minimum steelhead fallback at Columbia Basin dams in 2018 as estimated by PIT tag[6] detections.

Dam	Percent Fallback
Bonneville	1.0%
The Dalles	4.1%
John Day	3.4%
McNary	3.0%
Priest Rapids	7.7%
Rock Island	2.8%
Rocky Reach	7.1%
Wells	57.7%
Ice Harbor	4.2%
Lower Monumental	4.5%
Little Goose	5.3%
Lower Granite	2.1%

Table 32. Frequency of fallback events for steelhead tagged by this project in 2018.

Number of Dams Fallen Back Over	Total Number of Steelhead
1	88
2	20
3	8
4	3
5	1
9	1
Number of steelhead falling back at least once	**121**
% of steelhead with at least one fallback event	**13.6%**
Total fallback events	**178**
Number of steelhead in study	**893**
Fallback events per steelhead	**0.20**

[6] Fallback rates do not include steelhead that fell back over a dam and were not subsequently detected.

Night Passage

Night passage (2000-0400 Pacific Standard Time) by tagged steelhead ranged from 2.6% at Bonneville Dam to 21.1% at Rock Island Dam (Table 33). The Bonneville Dam estimate is likely biased low as sampling generally took place between 0600 and 1400. Given the median Bonneville Dam passage time of 8.0 minutes (Table 30) steelhead we sampled and tagged would be expected to pass during daytime hours.

Table 33. Estimated steelhead night passage (2000-0400 PST) at Columbia Basin dams in 2018.

Site	Percentage Night Passage
Bonneville	2.6%
The Dalles	5.2%
John Day	4.9%
McNary	5.4%
Priest Rapids	5.1%
Rock Island	21.1%
Rocky Reach	7.1%
Wells	15.4%
Ice Harbor	7.9%
Lower Monumental	8.9%
Little Goose	9.1%
Lower Granite	6.2%

B-Run Analyses

A total of 336 B-run steelhead were sampled in 2018 (where B-run is defined as steelhead greater than or equal to 78.0 cm fork length). Among the weeks sampled, the percentage of steelhead sampled and tagged that were classified as B-run peaked in Statistical Week 40 at 78.3% (Figure 23, Table 34). The estimated B-Run escapement at Bonneville Dam (estimated by multiplying the weekly run size, using counting window data, by the percentage B-run in that week estimated by this project) peaked in Week 37 at 5,123 fish while the A-run steelhead peaked in Week 30 at 8,660 fish (Table 34). The percentage of B-run steelhead comprised an estimated 4.1% of the run through Week 30 but 51.3% on or after Week 34. Among steelhead sampled and detected above McNary Dam and in tributaries between Bonneville and McNary dams (thereby eliminating most of the steelhead that may have been captured in the Zone 6 fishery in the mainstem Columbia between those dams), 98.1% of steelhead with fork lengths 78.0 cm and greater were destined for the Snake Basin (Figure 24). Among the 880 steelhead sampled at Bonneville Dam where ocean age could be estimated, B-run steelhead were comprised entirely of two- and three-ocean steelhead, while A-run steelhead

were comprised almost entirely of one- and two-ocean steelhead (Table 35). The mean length of sampled A-run steelhead was 61.8 cm compared to 82.4 cm for B-run steelhead.

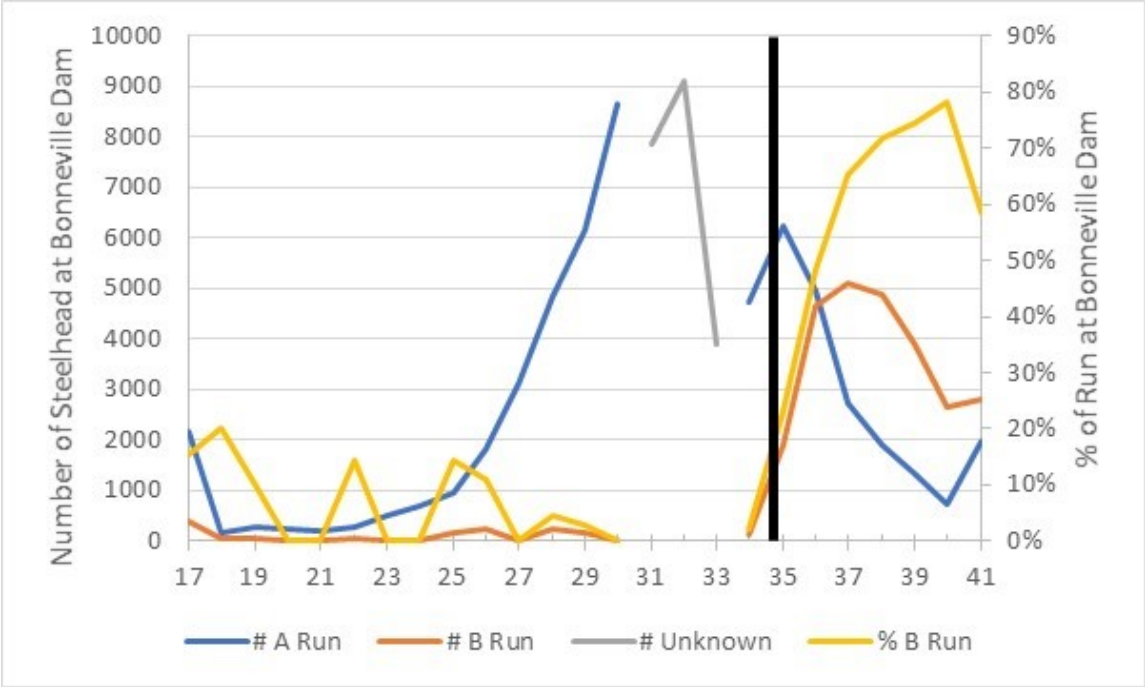

Figure 23. Percentage of B-run steelhead and estimated A- and B-run escapement at Bonneville Dam by statistical week in 2018. The vertical line shows the approximate location of August 25, which is considered the date that separates A- and B-run steelhead.

Table 34. Percentage and number of A- and B-run steelhead estimated at Bonneville Dam by Statistical Week in 2018.

Week	Percent of Run	Sample Size	% A Run	% B Run	# A Run	# B Run	Unknown
17	2.5%	13	84.6%	15.4%	2149	391	
18	0.2%	5	80.0%	20.0%	162	41	
19	0.3%	10	90.0%	10.0%	274	30	
20	0.2%	9	100.0%	0.0%	228	0	
21	0.2%	6	100.0%	0.0%	215	0	
22	0.3%	7	85.7%	14.3%	273	45	
23	0.5%	12	100.0%	0.0%	492	0	
24	0.7%	9	100.0%	0.0%	709	0	
25	1.1%	7	85.7%	14.3%	956	159	
26	2.0%	9	88.9%	11.1%	1810	226	
27	3.0%	13	100.0%	0.0%	3099	0	
28	4.9%	43	95.3%	4.7%	4855	237	
29	6.1%	75	97.3%	2.7%	6154	169	
30	8.4%	99	100.0%	0.0%	8660	0	
31	7.6%	**No Sampling**					7847
32	8.9%						9125
33	3.8%						3889
34	4.7%	45	97.8%	2.2%	4741	108	
35	7.9%	69	76.8%	23.2%	6259	1889	
36	9.4%	60	51.7%	48.3%	4972	4652	
37	7.6%	69	34.8%	65.2%	2732	5123	
38	6.6%	64	28.1%	71.9%	1914	4891	
39	5.1%	78	25.6%	74.4%	1346	3904	
40	3.3%	83	21.7%	78.3%	738	2663	
41	4.7%	111	41.4%	58.6%	1986	2807	
Weeks 17-30	30.4%	317	95.9%	4.1%	30,036	1298	
Weeks 31-33	20.3%	**Unknown**					20,861
Weeks 34-41	49.3%	579	48.7%	51.3%	24,668	26,037	

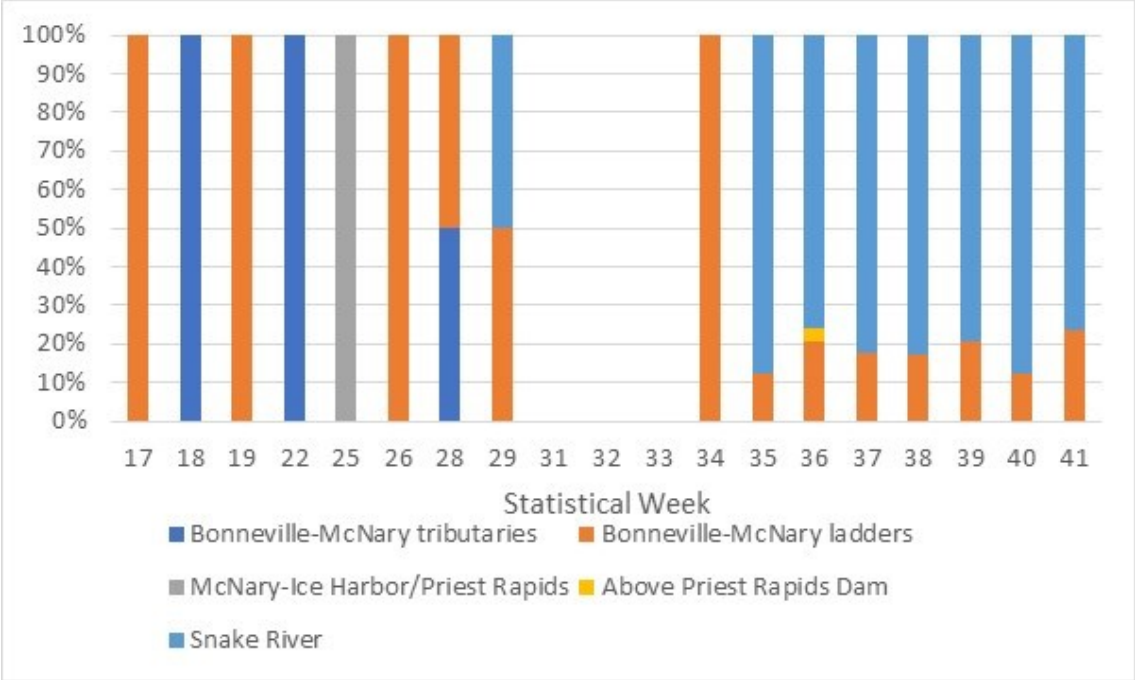

Figure 24. Most upstream detection site for B-run steelhead (≥78 cm fork length) by Statistical Week they were sampled at Bonneville Dam in 2018. There was no sampling the weeks of 31 to 33.

Table 35. Ocean age composition of A- (<78 cm fork length) and B-Run (≥78 cm fork length) steelhead sampled at Bonneville Dam in 2018 (weighted by run size).

Run	N	One-Ocean (x.1)	Two-Ocean (x.2)	Three Ocean (x.3)
A-Run	549	41.9%	58.1%	0.0%
B-Run	331	0.3%	96.4%	3.3%
All Steelhead	**880**	**26.3%**	**72.5%**	**1.3%**

Kelt Analyses

A total of 80 steelhead PIT tagged in 2018 were detected going downstream in the Columbia Basin in late winter, spring, and summer of 2019, presumably in an attempt to return to the ocean after spawning (kelts), or detected moving back upstream later in 2019, or as part of the Kelt Reconditioning Project (Hatch et. al. multiple years) as spawned-out and moving back downriver or moving back into reaches as reconditioned fish ready to spawn (Table 36 and B2). At the start of this study in 2009, we assigned a cutoff date of March 31st to define kelts so that any steelhead moving downstream before April 1st were assumed to still be wandering the basin and would eventually spawn. However, in the last few years, as more and more PIT detector systems have been placed in the Columbia Basin, we can now track and observe that several steelhead move out of the system before April 1st after visiting the upper reaches of tributaries (assumed to spawn);

usually this fish spawns in the tributaries between Bonneville and McNary dams. Therefore, each year we assess and add several more steelhead that have left the system before the cutoff date to the list of kelts, based on the detailed movements of these fish. In 2018, five steelhead were added (Tables 36 and B3) for a total of 85 kelts. The highest percentage of kelt passing Bonneville was in Week 28 while the greatest number of kelt was estimated to be in Week 33 (Figures 25 and 26).

Table 36. Some biological and detection information on the steelhead moving in the Columbia Basin system in 2018 that were determined to be kelts (CRITFC Kelt Project) or repeat spawners and potential kelts (because of their behavior). Please see Tables A2 and A3 for more details on the detected behavior of the steelhead.

					Most Upstream Site		Last Site Detected				
PIT Tag	Date Tagged	Fin Clip	Age	Fork Length	Basin and Site	Date	Basin and Site	Date	Moving downstream at last detection	Upstream in Summer/Fall 2019	In Kelt Program
3DD.0077BA371F	4/25/2018	AD	r.3	78	Columbia (BCC)	5/11/2018	Columbia (BCC)	5/11/2018	X		
3DD.0077BA54A9	5/2/2018		2.2	68	Klickitat (LKR)	3/2/2019	Columbia (B2J)	3/2/2019	X		
3DD.0077BA76F1	5/2/2018	AD	r.2	73.5	Klickitat (KLR)	2/26/2019	Columbia (BCC)	2/26/2019	X		
3DD.0077BA495F	5/29/2018		2.2	71	Wind (WRU)	5/12/2019	Columbia (BCC)	5/12/2019	X		
3DD.0077BAC143	6/29/2018		2.2	71	Snake (GRA)	4/4/2019	Tucannon (MTR)	4/26/2019	X		
3DD.0077BA7072	7/3/2018		r.2	65	Klickitat (SWC)	4/10/2019	Klickitat (SWC)	4/14/2019	X		
3DD.0077BA76FE	7/6/2018	AD	1.2	74	Lemhi (KEN)	5/12/2019	Lemhi (S2I)	5/15/2019	X		
3DD.0077BA5950	7/9/2018		2.1	56.5	Snake (GRA)	5/31/2019	Columbia (BCC)	5/31/2019	X		
3DD.0077BA7289	7/16/2018		1.1	57.5	Yakima (LNR)	3/25/2019	Yakima (LNR)	3/25/2019			X
3DD.0077BA98F6	7/16/2018		2.1	55	Touchet (COP)	5/7/2019	Columbia (MCJ)	5/7/2019	X		
3DD.0077BA700C	7/17/2018		2.1	58.5	Grande Ronde (JOC)	4/18/2019	Grande Ronde (JOC)	5/18/2019	X		
3DD.0077BACB71	7/17/2018		2.1	59.5	Columbia (MC1)	3/25/2019	Columbia (MC2)	3/25/2019	X		
3DD.0077BA66FF	7/18/2018		r.1	56	Grande Ronde (WR1)	5/17/2019	Snake (GOJ)	5/17/2019	X		
3DD.0077BA3B0D	7/19/2018	AD	1.2	71	Snake (GRA)	4/25/2019	Snake (GRJ)	4/25/2019	X		X
3DD.0077BA64C8	7/19/2018		2.2	69.5	Snake (GRA)	4/24/2019	Walla Walla (NBA)	5/24/2019	X		
3DD.0077BAA648	7/19/2018		2.2	69	Umatilla (UMF)	5/17/2019	Columbia (JDJ)	5/17/2019	X		
3DD.0077BAA70C	7/19/2018		2.1	53.5	Columbia (WEA)	4/20/2019	Columbia (RRJ)	4/20/2019	X		
3DD.0077BAB613	7/19/2018		r.1	57	Umatilla (UMF)	4/3/2019	Umatilla (UMF)	5/9/2019	X		
3DD.0077BA4CCF	7/20/2018	AD	r.1	0	Snake (GRA)	5/15/2019	Snake (GRJ)	5/15/2019	X		X
3DD.0077BA5782	7/20/2018		2.2	69	Tucannon (UTR)	4/18/2019	Snake (LMJ)	4/18/2019	X		
3DD.0077BA58D1	7/20/2018		r.1	59.5	Imnaha (COC)	4/5/2019	Imnaha (COC)	5/4/2019	X		
3DD.0077BA8377	7/20/2018		2.1	61.5	Grande Ronde (JOC)	5/10/2019	Snake (GRJ)	5/10/2019	X		X

					Most Upstream Site		Last Site Detected				
PIT Tag	Date Tagged	Fin Clip	Age	Fork Length	Basin and Site	Date	Basin and Site	Date	Moving downstream at last detection	Upstream in Summer/Fall 2019	In Kelt Program
3DD.0077BA9BEE	7/20/2018	AD	1.2	62.5	Columbia (WEH)	4/26/2019	Columbia (RRJ)	4/26/2019	X		
3DD.0077BAA999	7/20/2018		2.1	51.5	Methow (CHU)	6/7/2019	Columbia (BCC)	6/7/2019	X		
3DD.0077BA6FEA	7/23/2018		2.1	57	Methow (TWR)	4/2/2019	Methow (TWR)	4/20/2019	X		
3DD.0077BA757A	7/23/2018		2.2	69	Walla Walla (NBA)	5/10/2019	Walla Walla (BGM)	5/10/2019	X		
3DD.0077BACBAF	7/23/2018		r.1	55.5	John Day (BR1)	5/28/2019	Columbia (TWX)	5/28/2019	X		
3DD.0077BA4F0D	7/24/2018	AD	r.1	57.5	Snake (GRA)	5/15/2019	Snake (GRJ)	5/15/2019	X		X
3DD.0077BA62C6	7/24/2018		2.1	59.5	Methow (CRW)	6/12/2019	Columbia (RRJ)	6/12/2019	X		
3DD.0077BA651F	7/24/2018		2.2	65	Okanagan (OKC)	5/18/2019	Columbia (RRJ)	5/18/2019	X		
3DD.0077BA6602	7/24/2018		2.1	60	Columbia (MC1)	5/5/2019	Umatilla (TMF)	5/5/2019	X		
3DD.0077BA8FD4	7/24/2018		2.2	73	Snake (GRA)	5/10/2019	Snake (GRJ)	5/10/2019	X		X
3DD.0077BAA8B9	7/24/2018		2.1	65	Methow (MRW)	5/15/2019	Columbia (RRJ)	5/15/2019	X		
3DD.0077BAAD58	7/24/2018		2.2	64	Snake (GRA)	5/3/2019	Columbia (BCC)	5/3/2019	X		
3DD.007738205F	7/25/2018		2.1	56	Grande Ronde (UGS)	6/16/2019	Columbia (BCC)	6/16/2019	X		
3DD.0077BA3F98	7/25/2018		2.2	69	Grande Ronde (JOC)	5/7/2019	Columbia (BCC)	5/7/2019	X		
3DD.0077BA590B	7/25/2018		2.1	56.5	Columbia (MC1)	4/8/2019	Columbia (JDJ)	4/8/2019	X		
3DD.0077BA72A7	7/25/2018	AD	r.2	70.5	Grande Ronde (WR1)	4/14/2019	Grande Ronde (WR1)	4/14/2019	X		
3DD.0077BA72C6	7/25/2018		r.2	64.5	Touchet (BBT)	5/14/2019	Columbia (MCJ)	5/14/2019	X		
3DD.0077BAA621	7/25/2018	AD	1.2	67	Snake (GRA)	4/23/2019	Snake (GOJ)	4/23/2019	X		
3DD.0077BA37E3	7/26/2018		r.1	60	Columbia (JO1)	5/20/2019	Columbia (BCC)	5/20/2019	X		
3DD.0077BA9FC2	7/26/2018		2.1	63.5	Columbia (MC1)	4/15/2019	Columbia (JDJ)	4/15/2019	X		
3DD.0077BAB605	7/26/2018		r.1	58	Yakima (TOP)	3/17/2019	Yakima (TP2)	4/29/2019		X	X
3DD.003BFAC872	8/20/2018	AD	1.1	51	Columbia (WEA)	9/20/2018	Columbia (RRJ)	5/13/2019	X		
3DD.0077BA91CD	8/20/2018	AD	1.2	67.5	Snake (GRA)	4/21/2019	Tucannon (LTR)	4/21/2019	X		
3DD.0077C0C965	8/20/2018		r.2	64.5	Yakima (TOP)	3/18/2019	Yakima (SM1)	4/6/2019		X	X

					Most Upstream Site		Last Site Detected		Moving downstream at last detection	Upstream in Summer/Fall 2019	In Kelt Program
PIT Tag	Date Tagged	Fin Clip	Age	Fork Length	Basin and Site	Date	Basin and Site	Date			
3DD.0077C15B20	8/20/2018		2.1	58.5	Columbia (MC1)	10/1/2018	Columbia (MC2)	3/25/2019	X		
3DD.0077C04DFE	8/21/2018	AD	r.2	69	Methow (MRC)	4/22/2019	Columbia (RRJ)	4/22/2019	X		
3DD.0077C09370	8/21/2018		2.2	70	Snake (GRA)	5/10/2019	Snake (LMJ)	5/11/2019	X		
3DD.0077C0F2A9	8/21/2018		2.1	52.5	Grande Ronde (JOC)	5/23/2019	Columbia (BCC)	5/23/2019	X		
3DD.0077C040B9	8/22/2018		r.2	72	Snake (GOA)	4/1/2019	Snake (LMJ)	4/1/2019	X		
3DD.0077C128FF	8/22/2018	AD	r.1	54.5	Methow (TWR)	5/11/2019	Columbia (RRJ)	5/11/2019	X		
3DD.0077C15B9B	8/22/2018		r.2	70	Imnaha (IR3)	5/21/2019	Columbia (BCC)	5/21/2019	X		
3DD.0077C1275D	8/27/2018	AD	1.1	56.5	Snake (GRA)	4/29/2019	Snake (GOJ)	4/29/2019	X		
3DD.0077C15BDB	8/27/2018		r.1	63.5	Umatilla (UMF)	3/20/2019	Umatilla (UMF)	5/6/2019	X		
3DD.0077C0F3B8	8/30/2018	AD	r	65	Snake (GRA)	4/29/2019	Snake (GOJ)	4/29/2019	X		
3DD.0077C141D8	8/30/2018	AD	1.1	55	Snake (GRA)	5/31/2019	Columbia (TWX)	5/31/2019	X		
3DD.0077C09F68	8/31/2018		2.1	63	Walla Walla (BGM)	3/31/2019	Walla Walla (BGM)	4/26/2019	X		
3DD.0077C0AE64	8/31/2018		3.2	84.5	Lochsa (LRU)	3/23/2019	Lochsa (LRU)	5/12/2019	X		
3DD.0077C19420	8/31/2018		2.1S	63	Umatilla (UMF)	5/30/2019	Columbia (BCC)	5/30/2019	X		
3DD.0077C06C75	9/4/2018		2.2	82	Salmon (SFG)	6/14/2019	Columbia (BCC)	6/14/2019	X		
3DD.0077C0AE96	9/4/2018	AD	1.1	55.5	Walla Walla (BGM)	4/5/2019	Walla Walla (BGM)	5/7/2019	X		
3DD.0077C0F462	9/4/2018		2.1	47.5	Snake (GRA)	4/30/2019	Snake (GOJ)	4/30/2019	X		
3DD.0077C0ADF1	9/5/2018		2.2	80.5	Wenatchee (UWE)	2/8/2019	Wenatchee (UWE)	5/19/2019	X		
3DD.0077C0E6FA	9/5/2018	AD	1.1	57	Snake (GRA)	4/27/2019	Snake (GRJ)	4/27/2019	X		X
3DD.0077C0FFA9	9/5/2018	AD	r.2	77.5	Snake (GRA)	4/24/2019	Snake (GOJ)	4/24/2019	X		
3DD.0077C08738	9/10/2018	AD	1.2	77	Clearwater (DWL)	2/14/2019	Clearwater (DWL)	4/16/2019	X		
3DD.0077BFEF43	9/14/2018		2.2	84	Lochsa (LRU)	5/25/2019	Columbia (BCC)	5/25/2019	X		
3DD.0077C02E02	9/14/2018	AD	r.2	68	Snake (GRA)	5/12/2019	Snake (GRJ)	5/12/2019	X		

					Most Upstream Site		Last Site Detected				
PIT Tag	Date Tagged	Fin Clip	Age	Fork Length	Basin and Site	Date	Basin and Site	Date	Moving downstream at last detection	Upstream in Summer/Fall 2019	In Kelt Program
3DD.0077C0CBD6	9/14/2018	AD	1.1	58	Snake (GRA)	4/13/2019	Snake (GOJ)	4/14/2019	X		
3DD.0077C11851	9/14/2018		1.2	73	Columbia (WEA)	5/2/2019	Columbia (RRJ)	5/2/2019	X		
3DD.0077C08815	9/21/2018	AD	1.2	72.5	Snake (GRA)	4/24/2019	Columbia (BCC)	4/24/2019	X		
3DD.0077C134A4	9/21/2018	AD	1.2	82	Snake (GRA)	4/27/2019	Snake (LMJ)	4/27/2019	X		
3DD.0077C15C5A	9/21/2018	AD	1.2	63.5	Snake (GOA)	5/7/2019	Touchet (HST)	5/7/2019	X		
3DD.003BDE4C87	9/27/2018	AD	1.2	77.5	Clearwater (SC2)	3/31/2019	Snake (SC1)	3/31/2019	X		
3DD.0077BFE1B2	9/27/2018	AD	r.2	83	Snake (GRA)	4/27/2019	Columbia (BCC)	4/27/2019	X		
3DD.0077C0C9E6	10/2/2018		1.2	75.5	Salmon (USE)	4/30/2019	Snake (GRJ)	4/30/2019	X		X
3DD.0077C177D0	10/2/2018		2.1	57.5	Columbia (JDJ)	5/23/2019	Columbia (BCC)	5/23/2019	X		
3DD.0077C09550	10/8/2018	AD	1.1	56.5	Snake (GRA)	10/29/2018	Columbia (MC2)	6/2/2019	X		
3DD.0077BFEC1D	10/9/2018	AD RP	1.2	75	Columbia (MC1)	4/22/2019	Columbia (B2J)	4/22/2019	X		
3DD.0077C049E9	10/9/2018		2.2	68	Snake (GRA)	5/12/2019	Snake (GRJ)	5/12/2019	X		X
3DD.0077C0ADD8	10/9/2018	AD	1.1	57.5	Snake (GRA)	5/30/2019	Snake (LMJ)	5/30/2019	X		X
3DD.0077BFE41A	10/10/2018	AD	1.1	64	Snake (GRA)	4/24/2019	Snake (GRJ)	4/24/2019	X		X
3DD.0077C16A76	10/11/2018		2.1	60	Snake (GRA)	5/25/2019	Snake (GRJ)	5/25/2019	X		
3DD.0077C0DA20	10/12/2018		2.1	57.5	Yakima (SUN)	11/8/2019	Yakima (BO2)	3/19/2019	X	X	X

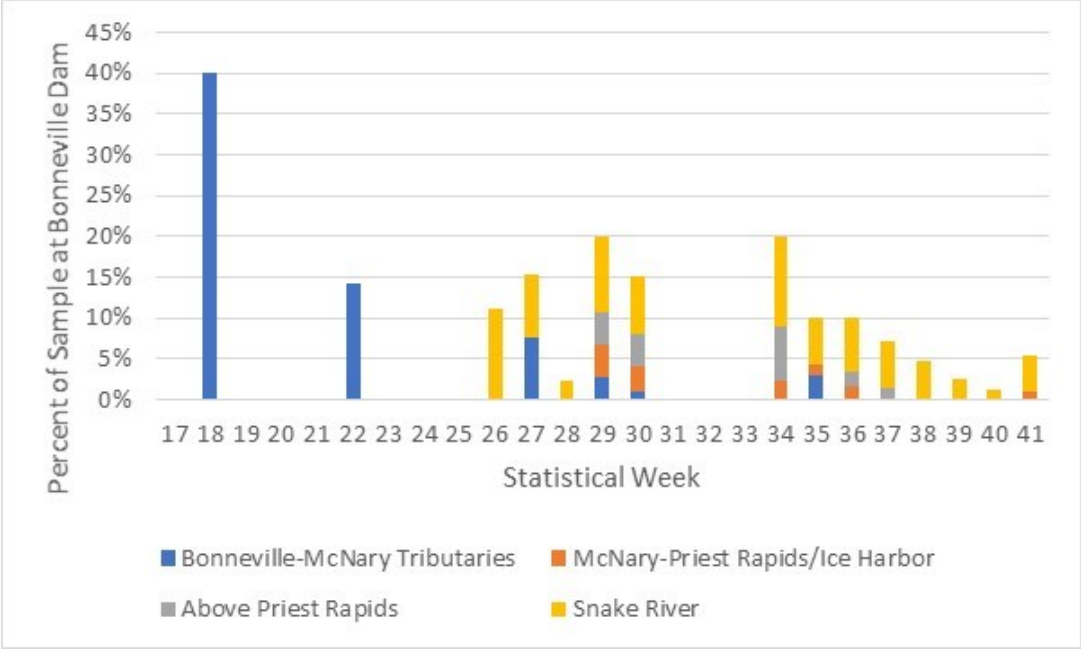

Figure 25. Percentage of run designated as kelt by week sampled in 2018 at Bonneville Dam and the most upstream detection area for those kelt. No sampling occurred in weeks 31 to 33.

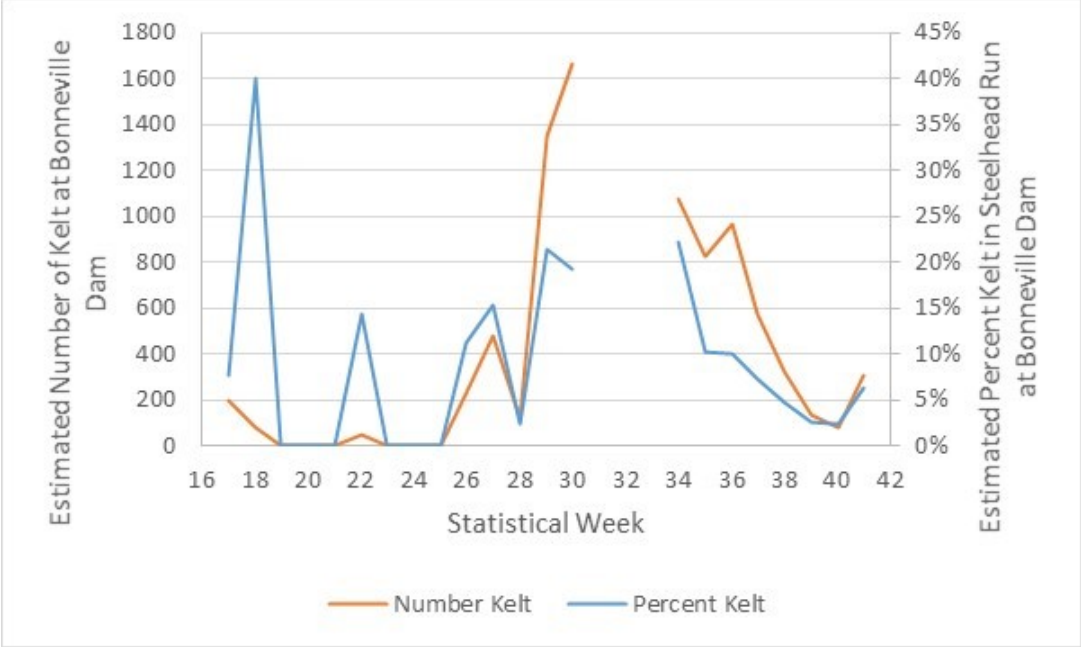

Figure 26. Percentage and number of kelt estimated to be passing Bonneville Dam by Statistical Week as estimated by this project in 2018. No sampling occurred in weeks 31 to 33.

Many kelts that are detected moving out of the system are last detected in the juvenile bypasses of the major Columbia and Snake dams. For 2018 tagged fish, the juvenile bypass at these dams detected kelts: Bonneville (2), John Day (3), McNary (2), Lower Monumental (5), Little Goose (7), Lower Granite (11), and Rocky Reach (9) (Table 37 and B2). Another major exit location for kelts is the Bonneville Dam Corner Collector, where 17 steelhead tagged by this study were last detected migrating downstream in spring and summer 2019. Of the 85 identified kelts, 22 of them were tracked into the Columbia River tributaries; many had multiple detections in the tributaries as they made their way to the spawning grounds and back out after spawning (Tables B1, B2, and Figure B1 – map of all detection locations). This year, 14 steelhead collected by the Kelt Project were collected at Lower Granite Dam Juvenile Bypass (10 fish) or at Prosser Dam (Yakima River – 4 fish) as they were moving downstream after spawning. Except for three steelhead captured by the Kelt Reconditioning Project (that were conditioned and then released to spawn again) it appeared that no other steelhead tagged and/or sampled by this project behaved like repeat spawners, which would normally be seen in the spring or early summer of 2019 heading downstream, and then again in either the late summer, fall, or early winter 2019, detected moving upstream through the Bonneville Dam fish ladders or into tributaries.

We have also updated information on kelts/repeat spawners from past annual reports with data from 2018/2019/2020 movements. Some steelhead already identified as kelts or repeat spawners in the past reports have new information added; others are newly added because they were detected a year or two later moving upriver again to spawn. Up to three past years of tagged steelhead have appeared in the detection system; see Table B4 in Appendix B for new information on steelhead tagged in 2015 (no records), 2016 (four records), and 2017 (five records).

Table 37. PIT tagged steelhead sampled at Bonneville Dam subsequently designated as kelt by being last detected moving downstream the year after sampling or being last detected moving upstream the year after sampling for sampling years 2009-2018. Data is categorized by last detection site.

	Tag Year									
Last site	**2018**	**2017**	**2016**	**2015**	**2014**	**2013**	**2012**	**2011**	**2010**	**2009**
Bonneville Corner Collector	17	14	32	25	38	30	25	10	23	61
Bonneville Juvenile Bypass	2	6	1	5	3	6	5	1	4	7
Bonneville Dam Bradford Island Ladders heading downstream	0	0	0	2	1	3	2	0	0	0
Bonneville Dam ladders heading downstream	1	1	0	0	0	0	0	0	0	0
Estuary Trawl or Pile Dikes (TWX or PD7)	2	1	1	0	0	2	2	0	0	1
Ice Harbor Juvenile Bypass	0	0	2	1	0	0	0	1	6	0
Ice Harbor Ladders heading downstream	0	0	0	0	0	1	0	NA	NA	NA
John Day Juvenile Bypass	3	3	20	6	2	8	6	3	11	3
Little Goose Juvenile Bypass	7	5	11	5	2	9	5	11	13	6
Lower Granite Juvenile Bypass	11	7	5	0	3	4	3	4	10	3
Lower Monumental Juvenile Bypass	5	5	4	0	2	7	1	12	9	4
Lower Granite Dam adult ladders moving downstream	1	0	0	0	0	0	0	0	0	0
Washington Shore McNary Dam ladder downstream.	3	1	3	0	1	0	0	0	2	1
McNary Dam Juvenile Bypass	2	3	4	1	1	4	4	3	2	4
Rocky Reach Juvenile Bypass	9	5	1	2	10	1	0	4	6	7
Migrating downstream in tributaries	22	9	2	6	NA	4	3	0	0	0
Repeat spawners, at Bonneville Dam or above migrating upstream	0	4	4	4	5	12	1	NA	NA	NA
Trapped by CRITFC Kelt Program										
Snake Basin	10	6	7	5	4	11	NA	NA	NA	NA
Yakima Basin	4	0	1	1	6	6	1	NA	NA	NA
Total[7]	**85**	**64**	**98**	**63**	**77**	**108**	**58**	**49**	**86**	**97**
Percent of steelhead tracked designated as kelt	**9.5%**	**7.6%**	**6.1%**	**5.3%**	**4.5%**	**7.2%**	**4.0%**	**3.1%**	**5.2%**	**4.8%**
Additional steelhead detected migrating upstream in subsequent migration year	**9**	**7**	**0**	**0**	**2**	**5**	**13**	**3**	**9**	**5**
Minimum number of kelts	**94**	**71**	**98**	**63**	**79**	**113**	**71**	**52**	**95**	**102**

[7] Since some kelt were both detected downstream and trapped by the CRITFC kelt program, the total may exceed the sum of the detections by site plus the number trapped by the kelt program.

Among the 812 steelhead sampled at Bonneville Dam where ocean age could be estimated, when kelt were compared to non-kelt, kelt had a higher percentage of one-ocean fish (49.4% vs. 23.8%) and lower percentage of two ocean fish (49.4% vs. 74.9%) (Table 38). The mean length of non-kelt was 72.1 cm compared to 64.9 cm for kelt.

Table 38. Ocean age composition of steelhead designated as kelt or non-kelt sampled at Bonneville Dam in 2018.

Run	Number Ageable	One-Ocean (x.1)	Two-Ocean (x.2)	Three Ocean (x.3)
Kelt	85	49.4%	49.4%	1.2%
Non-Kelt	797	23.8%	74.9%	1.3%

Straying

Steelhead stray rates by stock were estimated with stock classification by two different criteria. The first was for stock that could be designated by Parental Based Tagging (PBT), presumably the most accurate genetic stock classification (Table 39). For those fish for which PBT was not available, stock classifications were made using Genetic Stock Identification (GSI) (Table 40). The overall stray rate for both the PBT-classified and GSI was 4.9%.

Table 39. Showing final-PIT-fate categories by stock as determined using PBT for fish tagged in 2018. Fate categories are categorized by color. Grey is neutral (meaning last detected on route to expected destinations), green is on target (meaning last detected at their expected destination), yellow is putative overshoot meaning a fish last detected in an area adjacent to its expected destination, and red is putative stray meaning a fish was last detected in tributaries or the mainstem outside their normal route to their expected destination. Stray rates are also tabulated.

Final Site, PTAGIS Site Name, RKm, and PTAGIS Site Code

Stock Classification using Parental Based Tagging (PBT)	Bonneville						Hood	Lyle Falls	The Dalles		Deshutes			Three Mile Falls	McNary		Burlingame	Ice Harbor	Lower Monumental	Tucannon	Little Goose	Lower Granite	Clearwater					Grande Ronde		Salmon River				Imnaha	Prosser	Rock Island	Tumwater	Wells	Methow River					Okanogan			Total					Percentages
	Bonneville PH2 Juvenile	BON PH2 Corner Collector	Bonneville Bradford Is. Ladder	Bonneville Cascades Is. Ladder	Bonneville WA Shore Ladder/AFF	Bonneville WA Ladder Slots	Hood River Mouth	Lyle Falls Fishway	The Dalles East Fish Ladder	The Dalles North Fish Ladder	Deschutes River mouth	Deschutes Sherars Falls	Warm Springs River PIT Array	Three Mile Falls Dam Combined	McNary Oregon Shore Ladder	McNary Washington Shore Ladder	Burlingame Dam and Canal	Ice Harbor Dam (Combined)	Lower Monumental Adult Ladders	Middle Tucannon River	Little Goose Fish Ladder	Lower Granite Dam Adult	Clear Creek near Kooskia NFH	Dworshak NFH adult trap	Upper Lolo Creek at rkm 25	Lower SF Clearwater R at rkm 1	Lower SF Clearwater R at rkm 2	Joseph Creek ISA @ km 3	Wallowa River at river km 14	Sawtooth Hatchery Adult Trap	Upper Salmon River at rkm 437	Upper Salmon River at rkm 460	Wimpey Creek, Lemhi R. Basin	Lower Imnaha River ISA @ km 10	Prosser Diversion Dam Combined	Rock Island Adult	Tumwater Dam Adult Fishway	Wells Dam, DCPUD Adult Ladders	Chewuch River above Winthrop	Lower Methow River at Pateros	Methow River at Carlton	Methow River at Winthrop	Lwr Twisp Rvr near MSRF Ponds	Bonaparte Creek Instream Array	Loup Loup Creek Instream Array	Omak Creek below Mission Falls	Total	Neutral	On Target	Putative Stray	Putative overshoot	Stray Rate
	234	234	234	234	234	234	273	290	308	308	328	328	328	465	470	470	509	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	539	730	754	830	843	843	843	843	843	858	858	858						
	B2J	**BCC**	**BO1**	**BO2**	**BO3**	**BO4**	**HRM**	**LFF**	**TD1**	**TD2**	**DRM**	**DSF**	**WSR**	**TMF**	**MC1**	**MC2**	**BGM**	**ICH**	**LMA**	**MTR**	**GOA**	**GRA**	**CLC**	**DWL**	**LC2**	**SC1**	**SC2**	**JOC**	**WR1**	**STL**	**USE**	**USI**	**WPC**	**IR2**	**PRO**	**RIA**	**TUF**	**WEA**	**CRW**	**LMR**	**MRC**	**MRW**	**TWR**	**BPC**	**LLC**	**OBF**						
Lower Columbia					2	1	3																																								6	3	3	0	0	0.0%
Skamania		2	1		8	17	1	9																																							38	28	10	0	0	0.0%
Mid-Col. To Low. Snake	1			1	14	3			7	1	1	13	1	3	1		2	1	5	3	3	55						1	6					3	1	1								1	1		129	30	88	11	0	11.1%
Upper Columbia					3				1							1																					1	5	2	2	1	1	2			1	20	5	88	0	0	0.0%
SF Clearwater		1			7				3						1	1			2		1	45	1	15	3	17	13																				110	61	49	0	0	0.0%
Upper Salmon					12			1	2									1				33								5	5	1	1							1							62	48	12	2	0	14.3%
Total	**1**	**3**	**1**	**1**	**46**	**21**	**4**	**10**	**13**	**1**	**1**	**13**	**1**	**3**	**2**	**2**	**2**	**2**	**7**	**3**	**4**	**133**	**1**	**15**	**3**	**17**	**13**	**1**	**6**	**5**	**5**	**1**	**1**	**3**	**1**	**1**	**1**	**5**	**2**	**3**	**1**	**1**	**2**	**1**	**1**	**1**	**365**	**175**	**250**	**13**	**0**	**4.9%**

Table 40. Showing final-PIT-fate categories by stock as determined using Genetics Stock Identification for fish tagged in 2018. Fate categories are categorized by color. Grey is neutral (meaning last detected on route to expected destinations), green is on target (meaning last detected at their expected destination), yellow is putative overshoot meaning a fish last detected in an area adjacent to its expected destination, and red is putative stray meaning a fish was last detected in tributaries or the mainstem outside their normal route to their expected destination. Stray rates are also tabulated.

Final Site, PTAGIS Site Name, RKm, and PTAGIS Site Code

Stock Classification using Genetic Stock Identification (p>=0.8)	Bonneville: BON PH2 Corner Collector (234, BCC)	Bonneville: Bonneville Bradford Is. Ladder (234, BO1)	Bonneville: Bonneville Cascades Is. Ladder (234, BO2)	Bonneville: Bonneville WA Shore Ladder/AFF (234, BO3)	Bonneville: Bonneville WA Ladder Slots (234, BO4)	White: Ltl. White Salmon NFH returns (261, LWL)	Hood: Hood River Mouth (273, HRM)	Hood: Moving Falls Fish Ladder (273, MVF)	Klickitat: Lyle Falls Fishway (290, LFF)	Klickitat: Little Klickitat River Array (290, LKR)	Klickitat: Swale Creek Array (290, SWC)	Klickitat: Lwr White Creek, Klickitat Bsn (290, WHC)	The Dalles: The Dalles East Fish Ladder (308, TD1)	The Dalles: The Dalles North Fish Ladder (308, TD2)	Fifteenmile: Fifteenmile Ck at Dry Ck (309, 15D)	Deschutes: Deschutes River mouth (328, DRM)	Deschutes: Deschutes Sherars Falls (328, DSF)	Deschutes: Lower Trout Cr - Deschutes (328, TR1)	Deschutes: Warm Springs Hatchery (328, WSH)	Deschutes: Warm Springs River PIT Array (328, WSR)
Lower Columbia		1			2		2		1						1					
Skamania	1			4	3	1	3	1		1							1			
Willamette				1																
Klickitat		1		1	1				1		1	1								
Yakima				4									2							
Upper Columbia				4																
Clearwater				4									1							
Salmon				4	1								1							
Total	**1**	**2**	**0**	**22**	**7**	**1**	**5**	**1**	**2**	**1**	**1**	**1**	**4**	**0**	**1**	**0**	**1**	**0**	**0**	**0**

Stock Classification using Genetic Stock Identification (p>=0.8)	John Day: Thirtymile Crk John Day Basin (351, 30M)	John Day: Bridge Creek Gauge (351, BR0)	John Day: Bridge Creek Kiosk (351, BR1)	John Day: John Day River, McDonald Ferry (351, JD1)	John Day: Upper John Day River Array (351, JDM)	John Day: Middle Fork John Day Array (351, MJ1)	John Day: SF John Day (Mid) (351, SJ1)	Umatilla: Maxwell Canal (465, MWC)	Umatilla: Three Mile Falls Dam Combined (465, TMF)	Umatilla: Umatilla R below Feed Dam (465, UMF)	Umatilla: Umatilla R Recycled Water Fac (465, UMW)	McNary: McNary Oregon Shore Ladder (470, MC1)	McNary: McNary Washington Shore Ladder (470, MC2)	Walla Walla: Lower Coppei Instream Array (509, COP)	Walla Walla: Nursery Bridge Adult (509, NBA)	Walla Walla: Pattit Creek Instream Site (509, PAT)	Walla Walla: Harris Bridge S F Walla Walla (509, WW1)
Lower Columbia																	
Skamania																	
Willamette																	
Klickitat																	
Yakima																	
Upper Columbia												3					
Clearwater												1					
Salmon									1								
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**4**	**0**	**0**	**0**	**0**	**0**

Stock Classification using Genetic Stock Identification (p>=0.8)	Ice Harbor: Ice Harbor Dam (Combined) (522, ICH)	Lower Monumental: Lower Monumental Adult Ladders (522, LMA)	Tucannon: Middle Tucannon River (522, MTR)	Little Goose: Little Goose Fish Ladder (522, GOA)	Lower Granite: Lower Granite Dam Adult (522, GRA)	Clearwater: Dworshak NFH adult trap (522, DWL)	Clearwater: Lapwai Creek, near its mouth (522, LAP)	Clearwater: Upper Lolo Creek at rkm 25 (522, LC2)	Clearwater: Lochsa River Upper Site (522, LRU)	Clearwater: Lower SF Clearwater R at rkm 1 (522, SC1)	Clearwater: Lower SF Clearwater R at rkm 2 (522, SC2)	Clearwater: Upper Selway River Array (522, SW2)	Grande Ronde: Joseph Creek ISA @ km 3 (522, JOC)	Grande Ronde: Upper Grande Ronde at rkm 155 (522, UGR)	Grande Ronde: Upper Grande Ronde Starkey (522, UGS)	Grande Ronde: Wallowa River at river km 14 (522, WR1)
Lower Columbia																
Skamania																
Willamette																
Klickitat					1											
Yakima																
Upper Columbia		1			1											
Clearwater	3				7	1		1	1		1	1				
Salmon					27								1			
Total	**3**	**1**	**0**	**0**	**36**	**1**	**0**	**1**	**1**	**0**	**1**	**1**	**1**	**0**	**0**	**0**

Stock Classification using Genetic Stock Identification (p>=0.8)	Salmon: Cearley Creek Side Channel (522, CEY)	Salmon: Sawtooth Hatchery Adult Trap (522, STL)	Salmon: Upper Salmon River at rkm 437 (522, USE)	Salmon: Upper Salmon River at rkm 460 (522, USI)	Salmon: Valley Creek, Downstream Site (522, VC2)	Salmon: Secesh River at Zena Cr. Ranch (522, ZEN)	Imanah: Big Sheep Creek ISA at km 6 (522, BSC)	Imanah: Lower Imnaha River ISA @ km 10 (522, IR2)	Imanah: Upper Imnaha River ISA @ km 41 (522, IR3)	Yakima: Lower Satus Creek (539, SAT)	Yakima: Lower Naches River (539, LNR)	Yakima: Prosser Diversion Dam Combined (539, PRO)	Yakima: Lower Toppenish Creek (539, TOP)
Lower Columbia													
Skamania													
Willamette													
Klickitat													
Yakima										3	1	1	4
Upper Columbia													
Clearwater	1												
Salmon		2	7	4	1	1						1	
Total	**1**	**2**	**7**	**4**	**1**	**1**	**0**	**0**	**0**	**3**	**1**	**2**	**4**

Stock Classification using Genetic Stock Identification (p>=0.8)	Priest Rapids: Priest Rapids Adult (639, PRA)	Rock Island: Rock Island Adult (730, RIA)	Wenatchee: Upper Peshastin Creek (754, PEU)	Wenatchee: Tumwater Dam Adult Fishway (754, TUF)	Wenatchee: Upper Wenatchee River (754, UWE)	Rocky Reach: Rocky Reach Fishway (763, RRF)	Wells: Wells Dam, DCPUD Adult Ladders (830, WEA)	Methow: Chewuch River above Winthrop (843, CRW)	Methow: Methow River at Carlton (843, MRC)	Methow: Lwr Twisp Rvr near MSRF Ponds (843, TWR)	Total: Total	Total: Neutral	Total: On Target	Total: Putative Stray	Total: Putative overshoot	Percentages: Stray Rate
Lower Columbia											7	3	2	2	0	50.0%
Skamania											15	8	7	0	0	0.0%
Willamette											1	0	0	1	0	100.0%
Klickitat											7	6	0	1	0	100.0%
Yakima						1					15	6	9	0	0	0.0%
Upper Columbia				1			2		1		11	7	4	0	0	0.0%
Clearwater											21	9	12	0	0	0.0%
Salmon											49	6	43	0	0	0.0%
Total	**0**	**0**	**0**	**1**	**0**	**1**	**2**	**0**	**1**	**0**	**126**	**45**	**77**	**4**	**0**	**4.9%**

RESULTS-SOCKEYE[8]

Sample Size

In 2018 a total of 1,871 Sockeye Salmon were sampled for this project at the Bonneville Dam Adult Fish Facility between May 31 and July 26 (Table 41). Of these, 1,859 were tagged while there were two recaptures of Sockeye previously PIT tagged by this project. Both of the recaptures dropped downstream after the first tagging event and were recaptured two days later. These recapture events were removed from subsequent analysis. Eleven Sockeye were not detected after release, resulting in a total of 1,848 Sockeye tracked upstream. In 2018, sampling restrictions resulting in raised picket leads affected this project on 22 sampling days through July 26, 2018, 19 days due to high shad abundance and three days due to high water temperatures (21.1-22.2°C, Table 41). Temperatures reached or exceeded 22.2°C from July 27 through August 19, 2018, resulting in no sampling during a period when 0.3% of the Sockeye run passed Bonneville Dam (as estimated using visual fish counts).

The Sockeye not detected after tagging may have shed their tags, had defective tags or died. It is also possible that these Sockeye Salmon passed downstream without being detected as Sockeye often pass over the top of weirs in the fish ladder rather than through the underwater slots where PIT tag antennas are located in the lower portions of Bonneville Dam fish ladders. It is unlikely that Sockeye Salmon pass upstream through Bonneville Dam fish ladders undetected since they pass through a series of antennas at the upper end of both the Oregon and Washington shore fish ladders that detect virtually all passing PIT tagged fish. However, at Bonneville Dam (as well as The Dalles, John Day, McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite dams) fish can pass upstream (or downstream) through the navigation locks without being detected at PIT tag antennas. All other dams with PIT tag detection have antennas in fish ladders that Sockeye Salmon must pass, though data from 2006-2018 indicate that, even at those dams without navigation locks, PIT tagged Sockeye occasionally escape detection as they migrate upstream (Table 42).

[8] The information presented in this section of the report is a summary of Fryer et al. 2020.

Table 41. Number of Sockeye Salmon sampled and PIT tagged at Bonneville Dam and tracked upstream by date and statistical week in 2018.

									Days Sampling Restrictions in Effect		
Sampling Dates	Statistical Week[9]	% of Run	Sampled (N)	Tagged	Previously Tagged At AFF[10]	Mortalities	Not Detected after Tagging	Detected After Tagging and Tracked	Reduced Sampling Temperature	Reduced Sampling Shad or Salmon Abundance	No Sampling Temperature
5/31,6/4-6/8	22-23	1.7	86	86	0	0	1	85	0	1	0
6/11-6/15	24	9.2	233	232	0	0	2	230	0	5	0
6/18-6/22	25	30.6	353	352	1	0	2	350	0	5	0
6/25-6/29	26	32.5	463	456	1	0	1	455	0	5	0
7/2-7/4,7/6	27	17.6	310	307	0	0	0	307	0	3	0
7/9-7/13	28	5.6	222	222	0	0	0	222	0	1	0
7/16-7/20	29	1.7	114	114	0	0	4	110	0	0	0
7/23-7/26	30	1.2	90	90	0	0	1	89	3	0	1
Total			**1871**	**1859**	**2**	**0**	**11**	**1848**	**3**	**20**	**1**

Table 42. Number and percentage of Bonneville Dam PIT tagged fish not detected at detection sites as estimated from upstream detections for 2006-2018. Okanagan and Wenatchee in-stream antenna sites (LWE, UWE, OKL, and OKC) are also included in recent years[11].

	Percentage by Year and Mean of All Years													
Dam/Array	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	Mean
Bonneville	1.1	0.2	2.8	1.6	0.7	0.4	1.8	0.5	0.7	0.6	0.4	2.1	0.2	1.0
The Dalles	0.9	2.1	0.4	0.6	0.3	1.6	--	--	--	--	--	--	--	1.0
John Day	2.8	--	--	--	--	--	--	--	--	--	--	--	--	2.8
McNary	2.9	5.2	2.4	1.1	3.8	2.1	12.1	1.6	3.8	5.0	10.1	6.5	3.1	4.6
Priest Rapids	0.1	0.0	0.3	0.4	0.2	0.0	0.4	0.2	0.6	0.3	0.3	0.8	0.0	0.3
Rock Island	28.3	5.9	2.9	10.2	41.5	4.4	5.4	4.4	6.2	2.6	6.9	6.8	1.3	9.7
Rocky Reach	0.2	0.7	0.0	0.0	0.3	0.0	1.4	0.7	0.5	0.0	0.2	0.7	12.3	1.3
Wells	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	--	--	0.0
Ice Harbor	0.0	0.0	0.0	0.0	12.5	--	0.0	--	0.0	20.0	0.0	--	--	3.6
Lower Monumental	0.0	0.0	0.0	0.0	--	--	--	--	--	--	--	--	--	0.0
Little Goose	0.0	0.0	0.0	0.0	--	--	--	--	--	--	--	--	--	0.0
Lower Granite	0.0	0.0	0.0	--	0.0	--	--	--	--	--	--	--	--	0.0
Tumwater	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	--	0.0
Zosel	57.5	74.5	1.6	0.0	0.9	87.3	83.0	98.6	--	--	--	--	--	50.4
LWE	68.4	49.6	54.7	17.9	48.0	--	--	--	--	--	--	--	--	47.7
UWE	9.9	9.3	9.7	24.6	52.7	--	--	--	--	--	--	--	--	21.2
OKL	50.1	47.4	59.4	13.8	68.9	--	--	--	--	--	--	--		47.9
OKC	7.7	NA	16.9	--	--	--	--	--	--	--	--	--	--	16.9

[9] Statistical weeks are sequentially numbered calendar-year weeks. Excepting the first and last weeks of most years, statistical weeks are seven days long beginning on Sunday and ending on Saturday. In 2018, for instance, Statistical Week 24 began on June 10 and ended on June 16.
[10] These were fish that were tagged by CRITFC and, after tagging, moved downstream in the fish ladder only to be recaptured by CRITFC later. These second capture events were excluded from further analyses of upstream migrating Sockeye.
[11] No data indicates there were either no antennas installed at the site, or there were no detections upstream of the site.

Based on Sockeye PIT tagged at Bonneville Dam by this study, the dam with the highest percentage passing upstream undetected in 2018 was Zosel Dam (57.5%) due to high flows resulting in Sockeye Salmon going through the Zosel Dam spillways rather than using the fish ladder. Rock Island Dam has had the highest percentage of Sockeye passing upstream undetected among mainstem Columbia River dams every year since 2013, likely due to electrical noise adversely affecting the ability of PIT tag antennas to detect PIT tags (Fryer et al. 2017). See also Appendix B (Table B1 and Figures B1, B20-B26) for detection site information and maps showing sites where Sockeye were detected.

Distribution of Sample

The percentage of the Sockeye sample was less than the percentage of the run during peak weeks and greater during weeks of lower abundance (Figure 27). This is typical during years with high abundance as available sampling hours and trapping constraints put an upper limit on how many fish we can sample in a week.

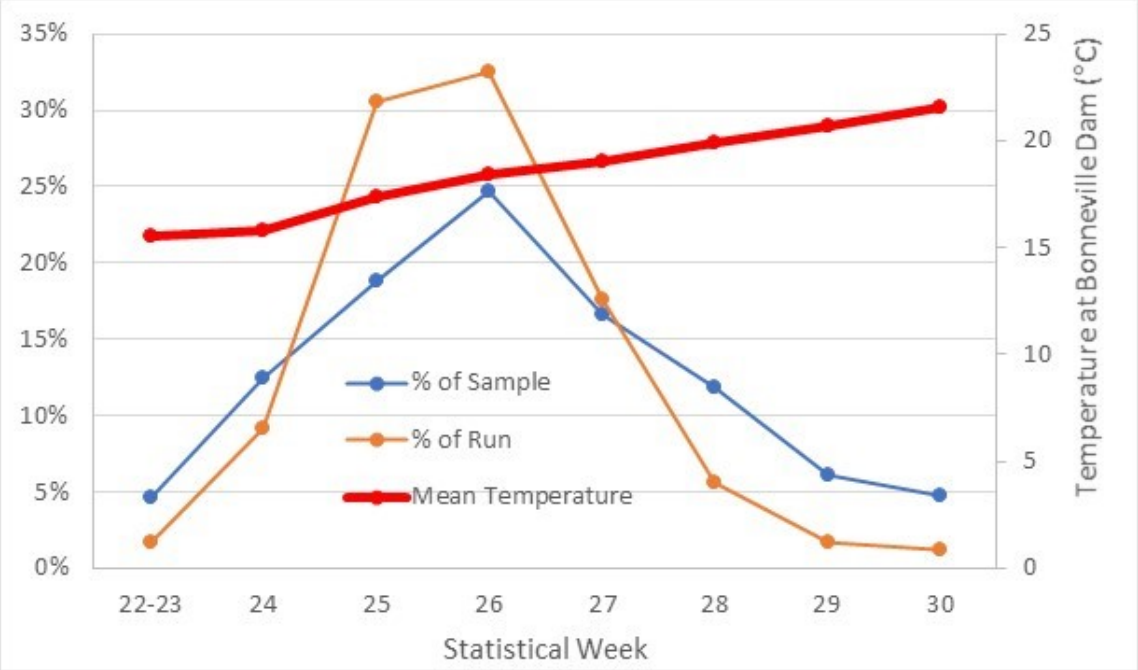

Figure 27. Weekly Sockeye Salmon and run as a percentage of total sample and run size at Bonneville Dam in 2018.

Detection Numbers

The tracking of 1,848 Sockeye Salmon generated 62,656 weir detections, which were grouped into 15,074 site detections at 44 sites. The 643 summer Chinook generated 38,924 weir detections, grouped into 4,683 site detections at 89 sites, and the 1,266 fall Chinook generated 43,935 weir detections grouped into 5,963 site detections at 50 sites. Maps and table of sites found in Appendix B (Table B1 and Figures B1, B20-B26) show the sites and the categorical ranges of detection numbers at the sites throughout the Columbia Basin.

Bonneville Dam Sockeye Salmon Age Composition

The predominant age group in 2018, at 94.2% of the run, was estimated to be Age 1.2 (Table 43). All the other age groups observed individually comprised 2% or less of the run.

Table 43. Weekly and total age composition of Sockeye Salmon at Bonneville Dam as estimated from scale patterns in 2018. (Composite estimates are weighted by the percentage of the run passing Bonneville Dam in each week.)

Statistical Week	% of Run	N Ageable	Age Class					
			1.1	2.1	1.2	1.3	2.2	3.1
22-23	1.7	83	0.0%	6.0%	89.3%	2.4%	2.4%	0.0%
24	9.2	232	0.0%	3.0%	91.3%	3.0%	0.9%	1.7%
25	30.6	345	0.3%	2.0%	94.0%	2.0%	1.1%	0.6%
26	32.5	453	0.7%	1.5%	96.0%	0.9%	0.4%	0.4%
27	17.6	308	0.3%	1.6%	93.9%	1.0%	2.3%	1.0%
28	5.6	214	0.9%	3.2%	93.5%	0.0%	1.9%	0.5%
29	1.7	110	0.9%	1.8%	92.8%	0.9%	3.6%	0.0%
30	1.2	90	0.0%	0.0%	89.9%	2.2%	7.9%	0.0%
Composite	**100.0**	**1835**	**0.4%**	**2.0%**	**94.2%**	**1.4%**	**1.3%**	**0.7%**

Mainstem Dam Recoveries, Mortality, and Escapement Estimates

Survival rates to upstream dams, as estimated from detections of Sockeye PIT tagged by this study at Bonneville Dam in 2018 can be found in Figure 28 with annual data since 2006 in Table 44. Survival to upstream dams in 2018 was higher than the mean rate reported by this study for all dams except The Dalles and Tumwater dams.

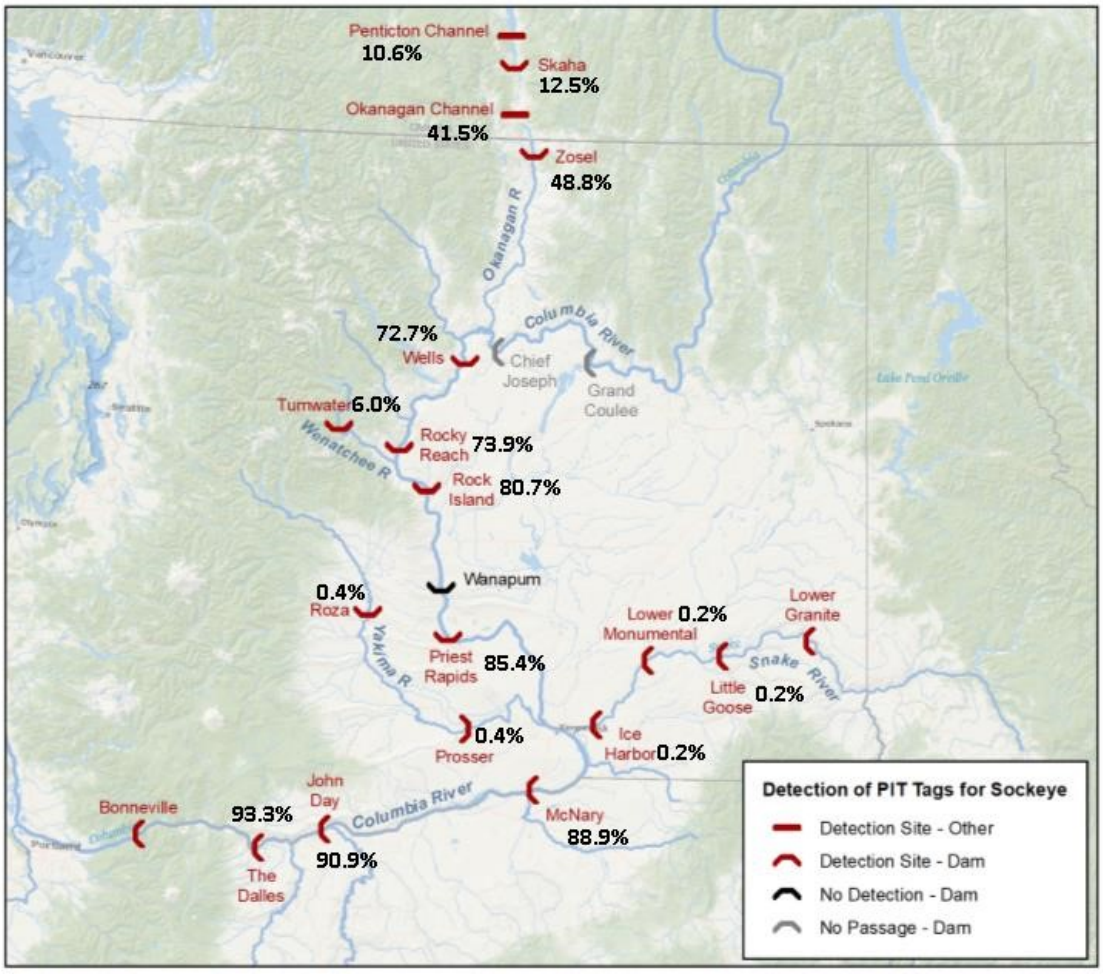

Figure 28. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of fish PIT tagged at Bonneville Dam, and the percentage of the run estimated to pass upstream dams and upstream detection sites in 2018.

Table 44. Survival of Sockeye PIT tagged at Bonneville Dam to upstream dams 2006-2018 with the mean June 15-July 14 water temperature at Bonneville Dam.

	Percentage by Year and Mean of All Years													
Dam	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	Mean
The Dalles	93.3	89.3	94.0	82.8	93.1	89.5	--	--	--	--	--	--	--	90.3
John Day	90.9	--	--	--	--	--	--	--	--	--	--	--	--	90.9
McNary	88.9	81.7	89.2	54.0	88.3	83.6	82.4	76.1	81.5	85.7	89.4	84.0	88.4	82.6
Priest Rapids	85.4	74.6	85.3	44.9	84.5	78.6	77.3	71.9	78.4	82.1	86.3	77.4	84.8	77.8
Rock Island	80.7	70.8	81.6	40.6	79.5	74.2	75.0	68.9	76.3	80.2	85.8	73.4	81.1	74.5
Rocky Reach	73.9	43.7	60.5	31.6	65.3	52.4	62.1	55.3	63.7	67.1	73.7	62.2	58.8	59.3
Wells	72.7	42.5	59.3	29.4	64.2	50.5	60.8	53.9	62.6	65.2	71.1	60.9	53.8	57.5
Tumwater	6.0	25.8	20.8	8.3	13.6	20.9	12.9	14.2	13.3	12.2	9.4	NA	NA	14.3
Bonneville Dam mean water temp 6/15-7/14	18.5	18.1	18.8	21.3	17.9	18.2	16.4	15.8	16.6	17.9	17.0	18.2	18.3	17.8

Survival rates were also calculated since the 2008 return year for a group of approximately 3,000 juvenile Sockeye captured and PIT tagged annually at the Rock Island Dam juvenile bypass (Table 45). Both Wenatchee and Okanagan juvenile Sockeye Salmon pass this site, making the mixed stock composition relatively similar to that of Sockeye tagged as adults at Bonneville Dam. However, sample sizes of returning adults from the Rock Island tagging program tend to be small, with only 32 returns to Bonneville Dam in 2018. These Sockeye survived at high rates in 2018; 100% to Rock Island Dam and a combined 87.5% to Wells and Tumwater dams. Annual survival rates for these fish from Bonneville Dam to Priest Rapids Dam are compared with adults tagged by this study at Bonneville Dam in Figure 29.

Table 45. Survival of Sockeye PIT tagged as smolts at Rock Island Dam, on their adult upstream migration from Bonneville Dam to upstream dams 2008-2018[12].

	Percentage by Year and Mean of All Years											
Dam	2018	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	Mean
# at Bonneville	32	16	35	128	155	66	121	125	130	33	38	80
The Dalles	100.0	87.5	82.9	85.9	92.9	87.9	--	--	--	--	--	89.5
John Day	100.0	--	--	--	--	--	--	--	--	--	--	100.0
McNary	100.0	81.3	74.3	60.2	87.1	80.3	74.4	74.4	82.3	100.0	89.5	82.2
Priest Rapids	100.0	68.8	74.3	54.7	83.9	74.2	71.9	73.6	81.5	93.9	89.5	78.8
Rock Island	93.9	68.8	68.6	46.9	77.4	68.2	69.4	68.8	79.2	90.9	81.6	74.0
Rocky Reach	65.6	68.8	45.7	36.7	60.0	56.1	48.8	55.2	70.0	87.9	55.3	59.1
Wells	62.5	62.5	42.9	32.8	58.7	56.1	43.8	52.8	68.5	87.9	55.3	56.7
Zosel	46.9	18.8	37.1	7.0	39.4	3.0	0.8	1.6	--	--	--	19.3
Tumwater	25.0	6.3	22.9	13.3	16.1	10.6	23.1	14.4	10.0	3.0	26.3	15.5

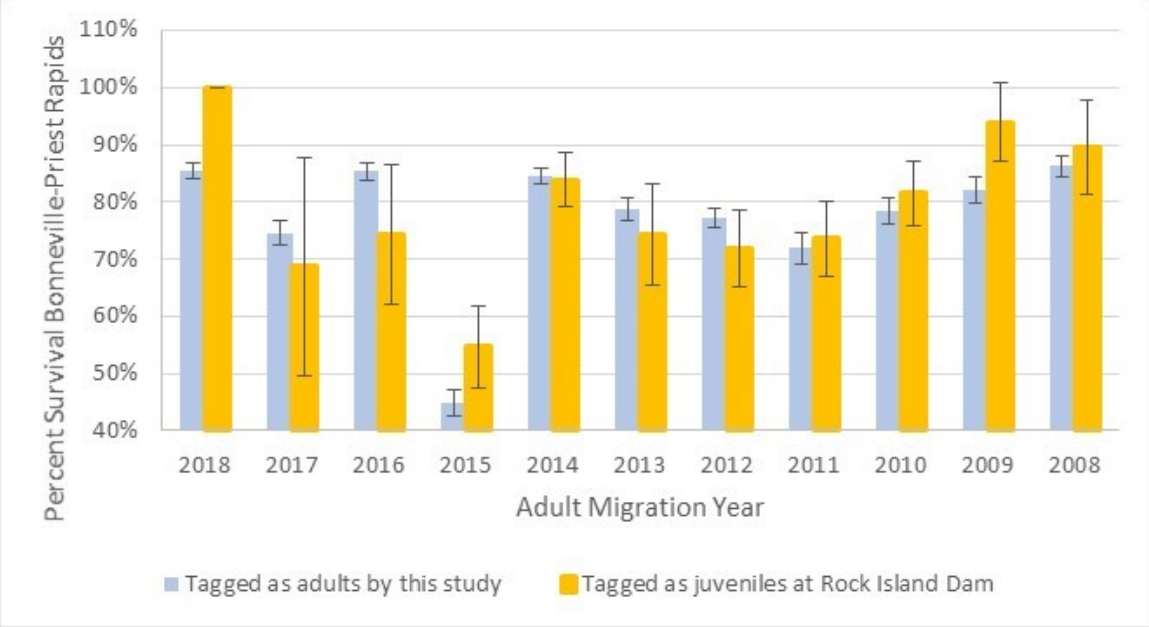

Figure 29. Annual percentage survival with 90% CI from Bonneville Dam to Priest Rapids Dam for adult Sockeye Salmon tagged by this study at Bonneville Dam and for returning Sockeye Salmon tagged as juveniles at Rock Island Dam 2008-2018.

[12] Years prior to 2008 were not included due to low sample sizes. From 2002-2007, the number of Sockeye PIT tagged as juveniles detected at Bonneville ranged between one and eight fish annually. Year 2011 was the first with PIT tag detection at Zosel Dam, 2013 the first year for detection at The Dalles Dam.

The estimated escapement based on upstream PIT tag detections was greater than the number of Sockeye counted at The Dalles, John Day, and McNary dams, but less than at Priest Rapids, Rock Island, Rocky Reach, Wells, and Tumwater dams (Table 46, Figure 30). The PIT tag estimates show a consistent decrease in Sockeye counts as the run progresses upstream, which is to be expected as Sockeye die on the upstream migration due to fisheries and natural mortality. However, the visual dam counts show an irregular pattern of increases and decreases with Priest Rapids counting, where almost as many Sockeye (189,884) were counted as at Bonneville Dam (193,816), while the number of Sockeye counted at The Dalles Dam (152,101) was less than at any other dam on the Columbia River.

Table 46. Percentage of PIT tagged Sockeye Salmon detected at upstream dams sub-sequent to tagging at Bonneville Dam, estimated escapement from both PIT tags and visual means, and the difference between the PIT tag and visual escapement estimate in 2018.

Dam	Estimated Percentage Reaching Dam	Escapement Estimate Using Bonneville PIT Tagged Sockeye	Visual Dam Count	Difference Between Bonneville PIT Tag and Visual Estimate
Bonneville	--	--	193,816	--
The Dalles	93.3%	180,667	152,101	18.8%
John Day	90.9%	175,979	168,469	4.5%
McNary	88.9%	172,219	155,480	10.8%
Priest Rapids	85.4%	165,434	189,884	-12.9%
Rock Island	80.7%	156,180	172,009	-9.2%
Rocky Reach	73.9%	143,036	162,684	-12.1%
Wells	72.7%	140,760	153,637	-8.4%
Ice Harbor	0.2%	278	392	-63.8%
Tumwater	6.0%	11,591	13,973	-17.0%
Prosser	0.4%	870	456	90.8%
Roza	0.4%	701	201	248.7%

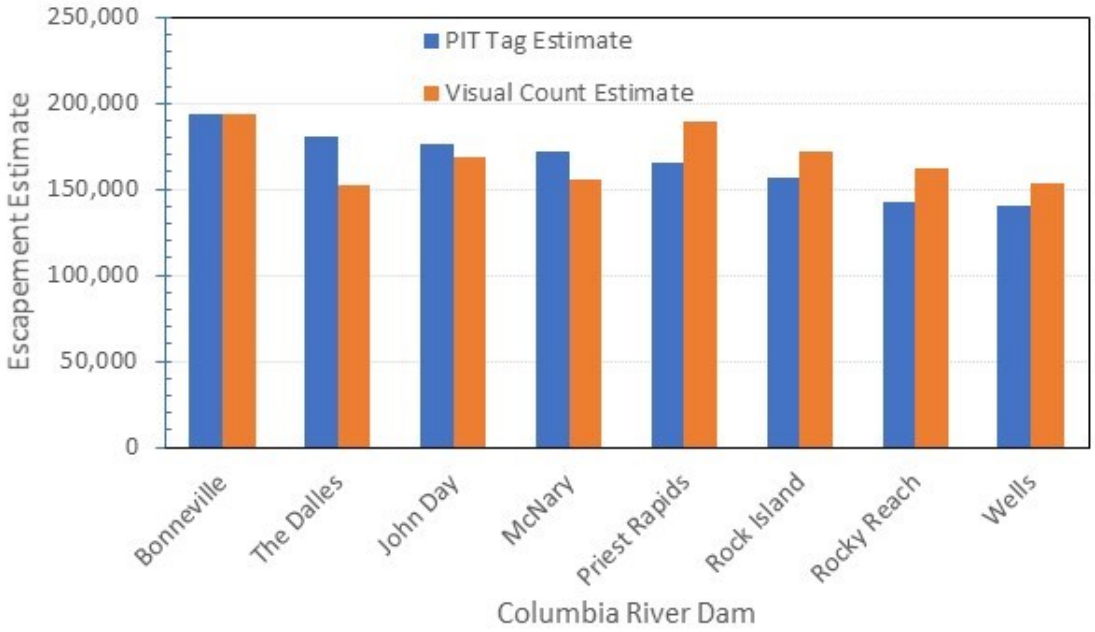

Figure 30. PIT tag and visual count estimates of escapement at Columbia River dams in 2018.

Sockeye Salmon tagged at Bonneville Dam show a significant linear decrease in survival over the period of the run to upstream dams in 2018 (Table 47, Figure 31). Sample sizes were low among Sockeye groups tagged as juveniles returning in 2018. Survival of the Rock Island-tagged group to Rock Island Dam (93.9%, n=33) was greater than that for the Bonneville-tagged group (80.7%) while that of the Okanagan-tagged group (69.5%, n=59) and the Wenatchee-tagged group (80.0%, n=5) was less (Table 47).

Table 47. Sockeye Salmon survival through selected reaches by statistical week as estimated by PIT tag detections in 2018 and the p-value for a linear regression between weekly reach survival and statistical week. No linear regressions were conducted for returning Sockeye tagged as juveniles due to the low number of returning adults.

Statistical Week at Bonneville Dam	Adults Tagged at Bonneville Dam				Sockeye Tagged as Juveniles Bonneville-Rock Island Dam Survival by Tag Group		
	BON-TDA	BON-MCN	BON-PRD	BON-RIS	Wenatchee (n=5)	Okanagan (n=59)	Rock Island (n=33)
22-23	97.6%	97.6%	96.4%	95.2%	--	50.0%	100.0%
24	94.8%	92.1%	90.8%	89.5%	100.0%	42.9%	80.0%
25	94.3%	89.7%	86.9%	80.3%	66.7%	87.5%	100.0%
26	94.1%	91.6%	87.9%	82.0%	100.0%	82.4%	87.5%
27	91.2%	87.6%	84.0%	81.7%	--	--	100.0%
28	91.4%	79.2%	73.3%	71.0%	--	63.6%	100.0%
29	83.6%	67.3%	57.3%	51.8%	--	0.0%	--
30	83.1%	53.9%	41.6%	34.8%	--	0.0%	100.0%
Not Detected at Bonneville					--	66.7%	100.0%
Composite[13]	**93.3%**	**88.9%**	**85.4%**	**80.7%**	**80.0%**	**69.5%**	**93.9%**
p-value	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**--**	**--**	**--**

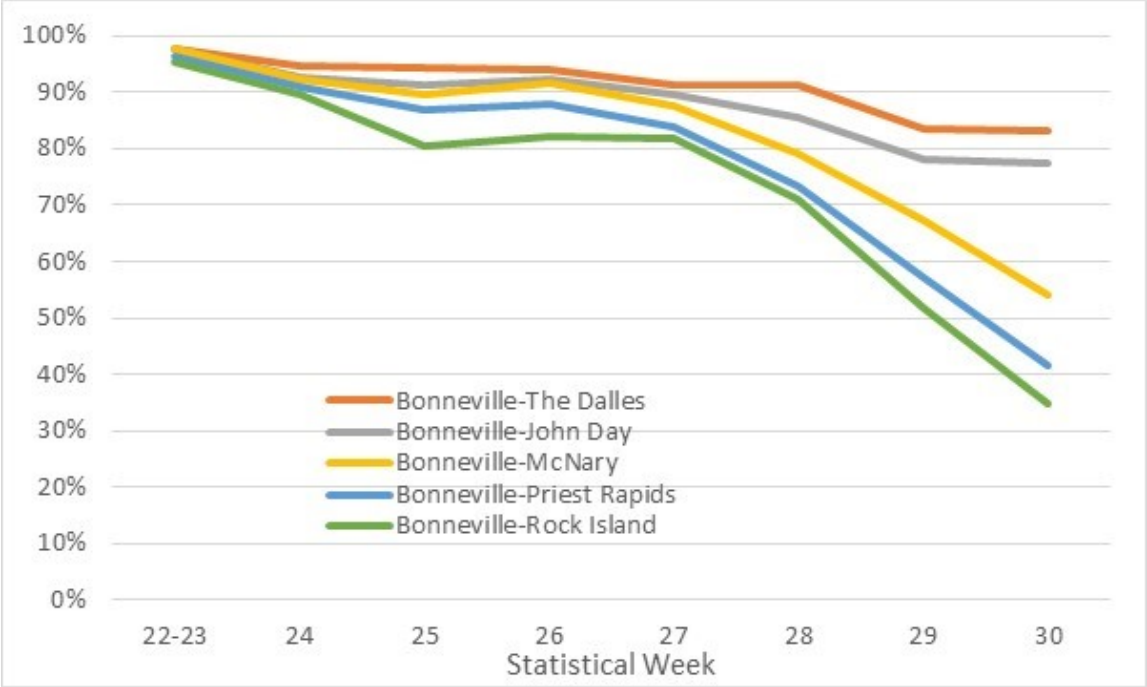

Figure 31. Survival of Sockeye Salmon PIT tagged at Bonneville Dam to The Dalles, McNary, Priest Rapids, and Rock Island dams by statistical week in 2018.

[13] Composite estimates for Bonneville Dam-tagged Sockeye Salmon are weighted by Statistical Week, juvenile estimates are unweighted.

Table 48. Survival of Sockeye groups PIT tagged as juveniles from Bonneville Dam to upstream dams with adults tagged by this study at Bonneville Dam included for comparison in 2018.

			Percent Survival to Upstream Dam									
Tagging Location	Life Stage at Tagging	# at BON	The Dalles	John Day	McNary	Priest Rapids	Rock Island	Rocky Reach	Wells	Tumwater	Ice Harbor	Spawning Ground Conversion Rate (%)
Okanagan	Juvenile	56	87.5	83.9	83.9	75.0	69.6	69.6	69.6	0.0	0.0	41.1
Wenatchee	Juvenile	6	100.0	100.0	100.0	100.0	80.0	0.0	0.0	80.0	0.0	83.3
Rock Island	Juvenile	32	100.0	100.0	100.0	100.0	93.8	65.6	62.5	25.0	0.0	52.5
Snake	Juvenile	8	87.5	75.0	75.0	12.5	12.5	12.5	12.5	0.0	62.5	12.5
Bonneville	Adult	1848	93.3	90.9	88.9	80.7	85.4	73.9	72.7	6.0	0.1	46.5

Among Sockeye tagged as juveniles, there were a total of eight returning Snake Basin juvenile-tagged Sockeye, five of which were detected at Ice Harbor and one (3D9.1C2E07D72C) strayed to Wells Dam. Among the five returning Wenatchee juvenile-tagged Sockeye, one was last detected at Priest Rapids Dam with the remaining four being detected at or above Tumwater Dam. Four were detected at Rock Island Dam and five were detected at Tumwater Dam. The returning Rock Island juvenile-tagged Sockeye had high upstream survival, with all 32 fish being detected at Priest Rapids Dam. Returning Okanagan juvenile-tagged Sockeye had a lower survival to all upstream dams than did Bonneville-tagged Sockeye from this study. Spawning ground conversion rates were highest for the six Wenatchee juvenile-tagged Sockeye (83.3%) and lowest for the Snake River Basin Sockeye (12.5%, Table 52).

Migration Rates and Passage Time

Adult Sockeye Salmon travel quickly upstream with a median migration rate between mainstem dams ranging between 33.0 and 59.8 km/day in 2018 for adults tagged at Bonneville; among juvenile-tagged Sockeye returning as adults, this ranged from 31.5 to 61.0 km/d (Table 49).

Table 49. Median Sockeye Salmon migration rates and travel time between dams as estimated by PIT tag detections in 2018.

		Tagged at Bonneville Dam		Adults Tagged as Juveniles	
Dam Pair	Distance (km)	Median Travel Time (days)	Median Migration Rate (km/day)	Median Travel Time (days)	Median Migration Rate (km/day)
Bonneville-The Dalles	74	1.7	41.4	1.5	47.4
The Dalles-John Day	39	0.9	49.4	0.8	52.5
John Day-McNary	63	2.0	59.8	1.9	61.0
McNary-Priest Rapids	167	3.9	42.8	4.1	41.5
Priest Rapids-Rock Island	89	2.7	33.5	2.8	32.4
Rock Island-Rocky Reach	33	1.0	33.0	1.0	31.5
Rocky Reach-Wells	65	1.8	38.5	1.7	40.1
Rock Island-Tumwater	73	9.8	7.1	8.1	8.5
Bonneville-John Day	113	2.7	42.6	2.3	49.4
Bonneville-McNary	231	4.7	49.6	4.4	52.6
Bonneville-Priest Rapids	329	8.7	46.1	8.6	46.6
Bonneville-Rock Island	487	11.4	43.0	11.9	41.1
Bonneville-Tumwater	560	21.8	25.6	21.5	26.0
Bonneville-Wells	585	14.4	41.0	14.1	41.9

Sockeye Salmon tagged at Bonneville Dam later in the migration travel upstream faster than those tagged earlier in the migration (Table 50). This relationship was significant (α=0.05) for all dam pairings listed in Table 50 except for Bonneville-The Dalles, Bonneville-John Day, and Bonneville-Tumwater dams in 2018.

Table 50. Adult Sockeye Salmon median travel time in days between dam pairs by statistical week tagged at Bonneville Dam, the p-value for a linear regression between travel time and statistical week, and mean travel time by stock as estimated using PIT tags in 2018.

Statistical Week at Bonneville Dam	BON to TDA	BON to JDA	BON to MCN	BON to PRA	BON to RIA	BON to TUM	BON to RRH	BON to WEL	BON to ZSL	WEL to ZSL	RIA to TUM
22-23	1.8	2.8	5.2	10.9	14.7	29.4	15.9	18.2	NA	NA	21.5
24	1.9	2.8	5.0	9.1	12.1	23.7	13.0	15.2	NA	NA	17.6
25	1.9	2.8	4.8	9.0	12.0	21.7	13.1	15.0	64.3	44.9	11.0
26	1.7	2.7	4.6	8.2	11.2	19.1	12.1	13.9	56.5	41.5	9.2
27	1.7	2.6	4.5	8.1	10.9	18.0	11.8	13.4	48.5	34.6	7.5
28	1.4	2.3	4.5	8.0	10.7	20.2	11.7	13.4	40.5	27.1	6.8
29	1.3	2.1	4.1	8.0	10.2	18.1	11.7	13.8	32.5	18.2	10.8
30	1.8	2.7	4.8	8.7	11.4	32.0	12.5	14.4	26.5	11.1	7.3
p-value	**0.84**	**0.08**	**0.05**	**0.04**	**0.03**	**0.09**	**0.04**	**0.04**	**<0.01**	**<0.01**	**0.02**
Stock											
Okanagan	1.7	2.7	4.7	8.7	11.3	-	12.7	14.4	45.5	32.3	NA
Wenatchee	1.7	2.6	4.6	8.7	11.9	21.8	13.2	15.4	NA	NA	9.8
Age											
1.1	1.8	2.7	4.6	8.7	11.6	-	12.2	13.7	47.5	33.9	NA
1.2	1.9	2.9	4.9	9.0	11.9	21.8	13.1	15.0	45.1	30.7	9.8
1.3	2.1	3.1	5.0	9.3	12.3	27.1	12.7	15.4	28.5	8.3	14.8

The median passage time at a dam (defined as the difference between the first and last detection at a dam and weighted by the number of detections at each dam) for Sockeye tagged at Bonneville Dam in 2018 was 3.8 minutes compared to 6.7 minutes for Sockeye tagged as juveniles (Table 51). The weighted mean percentage of Sockeye taking more than 12 hours to pass a dam was also greater for Sockeye tagged as juveniles compared to those tagged as adults at the AFF (Table 51).

Table 51. Sockeye Salmon median passage time (from time of first detection at a dam to last detection at a dam) and the percentage of Sockeye Salmon taking greater than 12 hours between first detection and last detection in 2018.

	Adults Tagged at Bonneville Dam			Previously Tagged as Juveniles		
Dam	N	Median Passage (Minutes)	%>12 Hours	N	Median Passage (Minutes)	%>12 Hours
Bonneville	1772	9.2	0.1	75	7.6	0.0
The Dalles	1689	0.1	1.9	98	0.1	3.1
John Day	1607	0.1	3.4	91	0.1	4.4
McNary	1544	0.2	1.9	91	0.4	12.1
Priest Rapids	1512	5.0	1.6	85	6.4	2.4
Rock Island	1030	2.0	0.6	58	1.5	1.7
Rocky Reach	1316	6.0	1.7	65	6.5	1.5
Wells	1296	5.7	5.6	64	5.4	6.2
Zosel	370	37.2	10.2	11	0.2	0.0
Tumwater	98	7.4	0.0	13	27.7	0.0
Ice Harbor	4	0.2	0.0	5	2.0	0.0
Lower Monumental	1	0.1	0.0	5	3.9	20.0
Little Goose	1	224.6	0.0	5	0.1	0.0
Lower Granite	1	5.7	5.6	5	419.2	0.0
Weighted Mean (by detection number)	**12,241**	**3.8**	**2.1**	**671**	**6.7**	**4.0**

Night Passage

Okanagan Sockeye Salmon stock tagged at Bonneville Dam passed PIT tag antennas at night (2000-0400 hours) at a higher rate than Wenatchee Sockeye Salmon stock at seven out of eight dams where Sockeye from both stocks were detected (Table 52).

Table 52. Estimated Sockeye Salmon night passage (2000-0400) by stock at mainstem Columbia River dams in 2018.

Dam	Adults Tagged at Bonneville Dam			Sockeye Tagged as Juveniles
	All Adults	Okanagan	Wenatchee	
Bonneville	0.6%	0.7%	0.0%	2.7%
The Dalles	9.9%	9.8%	12.9%	7.1%
John Day	5.0%	5.1%	4.0%	2.2%
McNary	10.7%	10.8%	8.3%	13.2%
Priest Rapids	4.2%	4.4%	1.8%	5.9%
Rock Island	6.7%	7.2%	1.3%	3.4%
Rocky Reach	8.5%	8.6%	0.0%	7.7%
Wells	13.0%	13.0%	0.0%	10.9%
Tumwater	3.1%	NA	3.1%	7.7%
Zosel	51.1%	51.2%	NA	63.6%

Fallback

Estimated minimum fallback rates for adults tagged at Bonneville Dam in 2018 ranged from 0.1% at Bonneville Dam to 4.5% at John Day Dam for Columbia River dams (Table 53). Sockeye at Snake River dams had no fallback; however, sample sizes were very small with only four Sockeye detected at Ice Harbor and one at the other three Snake River dams with fish passage. Fallback rates of Sockeye tagged as juveniles were higher than those tagged as adults at five out of eight Columbia River dams, reaching a high of 4.9% at Priest Rapids Dam. Of the 201 Sockeye tagged as adults by this project in 2018 that were estimated to fall back over at least one dam, 20 fell back over two dams while one fell back over three dams (Table 54). Among Sockeye tagged as juveniles, the mean number of fallback events per Sockeye Salmon ranged from 0.00 for Sockeye tagged in the Wenatchee Basin (n=6) to 0.25 for the Snake Basin (n=12) compared to 0.16 for adult-tagged Sockeye in our Bonneville study (Table 54).

Table 53. Estimated minimum fallback rates for Sockeye Salmon at mainstem dams in 2018[14]. (NA indicates Sockeye were not detected at a dam outside the range of the particular stock.)

		Sockeye Tagged as Juveniles by Tagging Location				
Dam	Adults Tagged at Bonneville	Okanagan Basin (n=56)	Rock Island Dam (n=32)	Snake Basin (n=8)	Wenatchee Basin (n=6)	Total (n=102)
Bonneville	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
The Dalles	0.7%	0.0%	0.0%	0.0%	0.0%	4.3%
John Day	4.5%	2.1%	6.3%	16.7%	0.0%	4.7%
McNary	0.4%	4.3%	0.0%	0.0%	0.0%	2.2%
Priest Rapids	1.8%	9.5%	0.0%	NA	0.0%	4.9%
Rock Island	0.6%	0.0%	4.2%	NA	0.0%	1.3%
Rocky Reach	1.7%	2.6%	0.0%	NA	NA	1.6%
Wells	3.7%	0.0%	0.0%	NA	NA	0.0%
Tumwater	4.1%	NA	0.0%	NA	0.0%	0.0%
Ice Harbor	0.0%	NA	NA	20.0%	NA	16.8%
Lower Monumental	0.0%	NA	NA	20.0%	NA	12.4%
Little Goose	0.0%	NA	NA	0.0%	NA	7.9%
Lower Granite	0.0%	NA	NA	0.0%	NA	7.3%

Table 54. Number of fallback events by tag group for returning Sockeye tagged as juveniles and Sockeye included in our Bonneville adult tagging study in 2018.

	Sockeye Tagged as Juveniles by Tagging Location				Adults Tagged at Bonneville
Fallback Events	Okanagan Basin	Rock Island Dam	Snake Basin	Wenatchee Basin	
1	7	5	0	0	180
2	2	0	0	0	20
3	0	0	1	0	1
4	0	0	0	0	0
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	0	0	0	0	0
Number of Sockeye falling back at least once	**9**	**5**	**1**	**0**	**201**
% of Sockeye with at least one fallback event	**16.1%**	**15.6%**	**12.5%**	**0.0%**	**10.9%**
Total fallback events	**11**	**5**	**3**	**0**	**223**
Number of Sockeye in study	**56**	**32**	**12**	**6**	**1848**
Fallbacks events per Sockeye	**0.20**	**0.16**	**0.25**	**0.00**	**0.12**

[14] Does not include Sockeye Salmon that fell back over a dam and were not subsequently detected.

Straying

The Sockeye stray rate estimated by this project is 1.4%; however, among the 10 Okanagan stock Sockeye strays in Table 55, only one strayed to sites that was over 3 km from its migration route. The sole exception was a Sockeye detected at rkm 45 in the Methow Basin, a river where a relative handful of Sockeye are commonly observed spawning, but for which there is not a baseline genetics stock.

A reintroduction program at Cle Elum Lake in the Yakima Basin complicates stray analysis. Some Yakima stock Sockeye can be identified using PBT, but those are rare. Sockeye not identified by PBT are classified using GSI, which cannot differentiate between a Wenatchee or Okanagan stock Sockeye and the offspring of Wenatchee or Okanagan stock Sockeye Salmon whose parents spawned in the Yakima Basin. Also, adult Sockeye Salmon are trapped at Priest Rapids Dam and transported to Cle Elum Lake and released. It is not uncommon for some of these fish to exit the lake and be detected at Roza Dam. Thus, all Sockeye last detected in the Yakima River were excluded from this analysis unless they could be identified using PBT.

There were two Sockeye Salmon that were not classified as Snake River stock that were last detected above Ice Harbor Dam. Both of these were identified using GSI as being of Wenatchee stock; however, one of them was identified by PBT as being of Yakima origin. It is possible, if not likely, that the second “Wenatchee” stock Sockeye was of Yakima origin, but genetics samples were not taken of its parents.

There were two Wenatchee stock Sockeye Salmon classified as overshoots that were last detected at Rocky Reach and Wells dam fish ladders respectively. One additional Wenatchee stock Sockeye Salmon was detected at Wells Dam before being last detected at the UWE array in the Wenatchee River, while two additional Wenatchee stock Sockeye Salmon were last detected at Tumwater Dam and White River arrays.

Table 55. Showing final-PIT-fate categories by stock as determined using Genetics Stock Identification for fish tagged in 2018. Fate categories are categorized by color. Grey is neutral (meaning last detected on route to expected destinations), green is on target (meaning last detected at their expected destination), yellow is putative overshoot meaning a fish last detected in an area adjacent to its expected destination, and red is putative stray meaning a fish was last detected in tributaries or the mainstem outside their normal route to their expected destination. Stray rates are also tabulated.

Genetic Stock Identification Classification	Bonneville Dam				The Dalles Dam			John Day Dam			McNary Dam			Snake River		Yakima River					Wenatchee River					Rocky Reach				Wells Dam			Okanagan Basin						Total						
	Bonneville-Bradford Ladder	Bonneville-WA Shore Ladder	Bonneville WA Ladder Slots	Hood River Mouth	The Dalles-East Fish Ladder	The Dalles-North Fish Ladder	Deschutes River Mouth	John Day Juvenile Bypass	John Day Dam-Oregon Shore	John Day Dam-WA Shore	McNary-Oregon Shore	McNary-WA Shore	McNary Juvenile Bypass	Ice Harbor Dam	Lower Granite	Prosser Dam	Roza Dam	Ringold Hatchery	Priest Rapids Dam	Rock Island Dam	Lower Wenatchee River	Tumwater Dam	Upper Wenatchee	Little Wenatchee River	White River	Rocky Reach Dam	Rocky Reach Juv. Bypass	Eastbank Hatchery	Lower Entiat	Wells Dam	Wells Juvenile Bypass	Methow River (Carlton)	Lower Okanogan	Johnson Creek, Okanagon	Zosel Dam	Okanagan River-Oliver	Skaha Dam	Okanagn River-Penticton	Total	Neutral	On-Target	Putative Stray	Putative Overshoot	Likely Cle Elum Program	% Putative Strays/On-Target
Columbia RKM	234	234	234	273	308	308	328	347	347	347	470	470	470	522	522	539	539	567	639	730	754	754	754	754	754	763	763	764	778	830	830	843	858	858	858	858	858	858							
Site	**BO1**	**BO3**	**BO4**	**HRM**	**TD1**	**TD2**	**DRM**	**JDJ**	**JO1**	**JO2**	**MC1**	**MC2**	**MCJ**	**ICH**	**GRA**	**PRO**	**ROZ**	**RSH**	**PRA**	**RIA**	**LWE**	**TUF**	**UWE**	**LWN**	**WTL**	**RRF**	**RRJ**	**EBO**	**ENL**	**WEA**	**WEJ**	**MRC**	**OKL**	**JOH**	**ZSL**	**OKC**	**SKA**	**OKP**	**Total**						
LBC			2			1																																3	3	0	0	0		NA
Osoyoos	3	2	107	1	31	12	3	1	40	15	29	25				3		2	68	14						19	3	1	1	407	1	1	73	1	61	509	43	188	1664	850	801	10	0	3	1.2%
Redfish			2											1	1																								4	4	0	0	0		NA
Wenatchee			23		4	2	1		3	1	4	4	1	1		1	5		6	2	5	11	6	5	76	1				1									163	50	103	2	2	6	1.9%
Yakima			1								1	1		1		1																							5	3	1	1	0		50.0%
Grand Total	3	2	135	1	35	15	4	1	43	16	34	30	1	3	1	1	9	2	74	16	5	11	6	5	76	20	3	1	1	408	1	1	73	1	61	509	43	188		910	905	13	2	9	1.4%

DISCUSSION

This project tracked a total of 3,178 Chinook, 893 steelhead, and 1,848 Sockeye (Table 56) upstream to estimate parameters such as upstream escapement, age composition, length composition, and migration rates at and between mainstem dams and other tributary interrogation sites. The year 2018 marked the 13th year we have been PIT tagging Sockeye Salmon, the 12th year we have tagged Chinook Salmon and the 10th year we have tagged steelhead at Bonneville Dam. Over this time, the number of PIT tag detection sites has continually increased, allowing us to learn more about the movement of tagged salmonids throughout the Columbia Basin. The number of Sockeye Salmon tracked in 2018 was the highest in the past 10 years in both absolute numbers and as a proportion of the entire run. The number of steelhead tracked was the second lowest since 2018, only exceeding that of 2017. This was partly a function of a low run, but the sample size was also hampered by temperature restrictions halting sampling from July 27 through August 19, a period in which 23.7% of the steelhead run passed and included the peak week of the run (Week 30). Between weeks 30 and 34, 33.4% of the steelhead run passed during which we were only able to track 143 steelhead (15.9% of the run) due to temperature restrictions. The number of Chinook Salmon tracked exceeded only the number tracked in 2017 for the years since 2011. However, this was primarily due to low abundance as the percentage of the run tracked, 0.95%, was the highest since this project began in 2009. The shutdown for weeks 31-33 due to temperature was not a significant impact as only 1.3% of the summer Chinook run and 3.3% of the fall Chinook run passed during these weeks.

Table 56. Total number of Chinook and Sockeye salmon and steelhead PIT tags tracked by year (includes recaptures of previously PIT tagged fish) 2009-2018.

	Total Tracked				Percent of Run Tracked			
Year	Chinook	Steelhead	Sockeye	Total	Chinook	Steelhead	Sockeye	Total
2009	2,968	2,485	838	6,291	0.42%	0.41%	0.47%	0.42%
2010	2,579	1,741	913	5,233	0.29%	0.42%	0.24%	0.31%
2011	3,253	1,377	763	5,393	0.38%	0.37%	0.41%	0.38%
2012	3,438	1,451	1,601	6,496	0.50%	0.62%	0.31%	0.45%
2013	3,406	1,276	772	5,454	0.26%	0.55%	0.42%	0.32%
2014	3,869	1,717	1,400	6,986	0.27%	0.63%	0.27%	0.33%
2015	3,563	898	901	5,362	0.25%	0.33%	0.18%	0.24%
2016	3,396	1,610	1,653	6,659	0.44%	0.86%	0.48%	0.51%
2017	2,805	836	1,079	4,720	0.69%	0.71%	1.23%	0.87%
2018	3,178	893	1,848	5,919	0.95%	0.87%	0.95%	0.94%
Total	**32,455**	**14,284**	**11,768**	**58,513**				
Mean	**3,246**	**1,428**	**1,177**	**5,851**	**0.44%**	**0.58%**	**0.50%**	**0.48%**

For both Chinook Salmon and steelhead, there are management concerns regarding the timing of run components. One question of interest to fish managers is the definition of a summer Chinook Salmon. Traditionally, spring Chinook Salmon were defined as those migrating past Bonneville Dam through May 31, with summer Chinook Salmon passing from June 1 through July 31, and fall Chinook Salmon defined as passing on or after August 1. Dates of defining a Chinook run at upstream dams were lagged to take into account migration times from Bonneville Dam to the dam in question. However, in 2005, for management purposes the spring-summer differentiation at Bonneville Dam was moved from June 1 to June 16 (though visual counts are typically reported using the old cutoff). Managers moved this date because radio tagging studies suggested that many of the Chinook Salmon migrating in early June are from the Snake River (many spring/summer Chinook in the Snake River Basin are listed as endangered under ESA), while Chinook migrating in late June are mid-Columbia summers. The PIT tag detection data from this project showed that in 2018 the percentage of Chinook Salmon at Bonneville Dam, which ultimately passed Ice Harbor Dam, peaked at 46.0% of the run for Statistical Week 22, which started May 27 (Figure 5). By Week 23 (which started June 3), the percentage of Chinook tagged at Bonneville that were detected at Priest Rapids Dam exceeded that at Ice Harbor, and by Week 25 (June 17), the percentage that ultimately passed Ice Harbor Dam had declined to 2.7% of the run. The percentage detected above Priest Rapids Dam reached 75.3% for those Chinook tagged in Week 24 and remained above 57% through

Week 30 when sampling ceased until Week 34, when the percentage of tagged Chinook above Priest Rapids Dam was only 13.0% (Figure 5). The run at Bonneville Dam transitioned over the month of June from being primarily Snake River spring/summer to being primarily mid-Columbia summer Chinook. In 2018, as in 2014-2017, this transition started earlier in May than in those prior years.

As at Bonneville Dam, Chinook runs (spring, summer, and fall) passing dams upstream of Bonneville Dam are differentiated based on the date they pass, and these dates per dam are based on fixed migration rates assumed by managers. For instance, spring Chinook transition to summer Chinook on June 1 at Bonneville Dam, June 11 at Ice Harbor Dam and June 13 at Priest Rapids Dam. This means that the same Chinook traveling slower than expected could be classified differently at different dams. For example, a “spring” Chinook passing Bonneville Dam on May 31 would be a “summer” Chinook passing Priest Rapids Dam on June 13. Using PIT tag data, this study found that an estimated 17.0% of spring and 0.5% of summer Chinook at Bonneville Dam were classified differently at Priest Rapids Dam (Table 7). This study also found that 0.6% of spring and 25.5% of summer Chinook at Bonneville Dam were classified differently at Ice Harbor Dam. Given that temperature restrictions resulted in no sampling at Bonneville Dam from July 27 through August 20, the only way it would have been possible for a fall Chinook to be misclassified as a summer was for a fall Chinook tagged at Bonneville Dam on or after August 20 to pass Wells Dam prior to August 29 (Table 7) as by August 20 the summer/fall transition date had passed at all other dams.

REFERENCES

Busby, P.J. T. C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, R. W. Waknitz, and I.V. Lagomarsino. 1996. Status review of West Coast steelhead from Washington, Idaho, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-27. http://www.nwfsc.noaa.gov/publications/techmemos/tm27.

CBFWA (Columbia Basin Fish and Wildlife Authority PIT Tag Steering Committee). 1999. PIT tag marking procedures manual. CBFWA. Portland. 26p.

FPC (Fish Passage Center). 2018. Adult fish counts online at www.fpc.org.

Fryer, J.K. 2008. Use of PIT tags to determine upstream migratory timing and survival of Columbia Basin Sockeye Salmon in 2007. Columbia River Inter-Tribal Fish Commission Technical Report 08-02. 41p.

Fryer, J.K. 2009. Use of PIT tags to determine upstream migratory timing and survival of Columbia Basin Sockeye Salmon in 2008. Columbia River Inter-Tribal Fish Commission Technical Report 09-03. 43p.

Fryer, J.K., H. Wright, S. Folks, R. Bussanich, K.D. Hyatt, and M.M. Stockwell. 2014. Limiting Factors of the Abundance of Okanogan and Wenatchee Sockeye Salmon in 2012. Columbia River Inter-Tribal Fish Commission Technical Report 14-01 for U.S. Dept. of Energy Bonneville Power Administration Report Project 2008-503-00. 155p.

Fryer, J.K., D. Kelsey, H. Wright, S. Folks, R. Bussanich, K.D. Hyatt, and M.M. Stockwell. 2017. Studies into Factors Limiting the Abundance of Okanogan and Wenatchee Sockeye Salmon in 2015. Columbia River Inter-Tribal Fish Commission Technical Report 17-06 for U.S. Dept. of Energy Bonneville Power Administration Report Project 2008-503-00. 217p.

Fryer, J.K., D. Kelsey, H. Wright, S. Folks, R. Bussanich, K.D. Hyatt, and D. Selbie, and M.M. Stockwell. 2018. Studies into Factors Limiting the Abundance of Okanogan and Wenatchee Sockeye Salmon in 2016 and 2017. Columbia River Inter-Tribal Fish Commission Technical Report 18-02 for U.S. Dept. of Energy Bonneville Power Administration Report Project 2008-503-00. 224p.

Fryer, J.K., D. Kelsey, H. Wright, S. Folks, R. Bussanich, K.D. Hyatt, D. Selbie, and M.M. Stockwell. 2020. Studies into Factors Limiting the Abundance of Okanogan and Wenatchee Sockeye Salmon in 2018. Columbia River Inter-

Tribal Fish Commission Technical Report 20-01 for U.S. Dept. of Energy Bonneville Power Administration Project 2008-503-00. 239p.

Hatch, D. et al. *Multiple Years. Annual Reports on the Kelt Reconditioning and Reproductive Success*. Columbia River Inter-Tribal Fish Commission Technical Report. http://www.critfc.org/fish-and-watersheds/fishery-science/scientific-reports/

Kelsey D., J. Mainord, J. Whiteaker, and J.K. Fryer. 2011. Age and length composition of Columbia Basin Chinook and Sockeye salmon and steelhead at Bonneville Dam in 2009. Columbia River Inter-Tribal Fish Commission Technical Report 11-08 for U.S. Dept. of Energy Bonneville Power Administration Project 2008-518-00. 41p.

Koo, T.S.Y. 1962. Age designation in salmon. Pages 37-48 *in* T.S.Y. Koo (editor). Studies of Alaska Red Salmon. University of Washington Press, Seattle, Washington.

Whiteaker J., and J.K. Fryer. 2008. Age and length composition of Columbia Basin Chinook and Sockeye salmon and steelhead at Bonneville Dam in 2007. Columbia River Inter-Tribal Fish Commission Technical Report 08-04. 45p.

APPENDIX A

Section on Adult Trap Protocols out of the 2017 Fish Passage Plan for Bonneville Adult Fish Facility. Full document FFP17_AppG.pdf can be found at **http://pweb.crohms.org/tmt/documents/fpp/2017/final/FPP17_AppG.pdf**.

1. BONNEVILLE DAM ADULT FISH FACILITY

The following protocols will be implemented by agencies conducting research in the Bonneville Dam second powerhouse Adult Fish Facility (AFF). These protocols were coordinated with fish agencies and tribes through the Fish Passage Operation and Maintenance Coordination Team (FPOM). The purpose of these protocols is to provide measures to limit mortality resulting from stress when handling fish.

1.1. General Facility Protocols.

1.1.1. Users must have appropriate documentation for conducting research at the dam (see *Guide for Researchers at Bonneville Dam*). This includes valid state and federal permits that cover all listed species passing the project during the trapping period. Users shall comply with all fish handling conditions in the permits. *If permit conditions are more restrictive than the following protocols, users must follow permit conditions*.

1.1.2. The Corps reserves the right to terminate trapping operations at any time.

1.1.3. Users will be trained in the proper operation of the AFF to insure fish and personnel safety. Users may request training through the Project Biologists.

1.1.4. Bridge crane certification is required prior to operating the overhead crane. Training will not be provided by the Corps of Engineers.

1.1.5. Hard hats, long pants or raingear, steel-toed shoes or rubber boots are to be worn at all times. Shorts, tennis shoes, or sandals will not be permitted in the lab.

1.1.6. Water temperatures should be observed upon arrival and periodically during the day.

1.1.7. Personnel conducting research are required to be present in the AFF to divert desired fish into the anesthetic tank using the flume swing gates. While the AFF is in operation, flumes shall be open and a researcher must be on-site.

1.1.8. Undesired fish will be bypassed to the return pool.

1.1.9. Researchers shall perform no maintenance on Corps owned/installed equipment. Nets may be mended as necessary.

1.1.10. Qualified users may lower the main ladder picket leads and downstream exit bulkhead when they arrive, and must raise the picket leads when they are completed for the day. The downstream exit bulkhead may be left down when shad and lamprey are attempting to pass.

1.1.11. Users will be permitted to operate valves 9 and 10 to control flow down the flumes at their discretion and to operate the raw water booster pump. Users may operate valve 12 to provide flow in the holding pool and valve 15 to drain water at the return pool.

1.1.12. Users must use a sanctuary net large enough to safely handle the largest fish passing the project during the trapping period.

1.1.13. Fish greater than 100 cm forklength may be diverted into the main anesthetic tank or returned to the ladder untouched. These fish will not be diverted into any auxiliary anesthetic tanks.

1.2. Notification & Documentation.

1.2.1. Users will notify the control room when they set up and close down the lab.

1.2.2. Users will record the times picket leads are lowered and raised and which agency they are representing on the sheet provided by the project biologists.

1.2.3. Lamprey may be held up to 48 hours in the AFF. Researchers will notify Project Fisheries and the Control Room whenever lamprey are held.

1.2.4. Any and all mortalities must be immediately reported to a Project Biologist. The Project Biologist will examine the mortality and take any photos. The researcher shall give a detailed report including:

- **(a)** Species;
- **(b)** Origin;
- **(c)** Length;
- **(d)** Weight;
- **(e)** Marks and injuries;
- **(f)** Cause and time of death;
- **(g)** Future preventative measures.

1.2.5. All mortalities are included in Project Fisheries weekly reports submitted to FPOM.

1.3. Trapping Protocols – Ladder Water Temperatures <70°F.

1.3.1. There will be no start time restriction for trapping operations.

1.3.2. There will be no more than 4 Chinook, or 4 steelhead, or 6 sockeye, or any combination of 4 adult salmonids allowed in the anesthetic tank at any one time. This assumes that users can effectively track the length of time fish stay in the anesthetic tank.

1.3.3. There will be no more than two adult fish in any one observation tank at any one time. The brail pool is the primary and preferred recovery area.

1.3.3.1. Observation tanks will primarily be used for fish in "*distress*", defined as fish that have sustained injury during the trapping and sampling process; fish that have a previous injury (e.g., fish in "*fair*" or "*poor*" condition upon trapping due to marine mammal injuries or similar) fish that are showing symptoms of heavy sedation (e.g., diminishing gill movement, reduced gasp response when out of water).

1.3.3.2. Fish will be released from the observation tanks when they are in the state of "*Partial Equilibrium,*" defined as: gilling normally, making weak tailing movements, cannot swim upright and swims off course without avoiding obstacles; fish will not strongly try to break free of handlers.

1.3.3.3. All fish in an observation tank must be continuously observed by a dedicated observer to ensure adult fish do not recover beyond partial equilibrium prior to return to the brail pool. No lid or restraining device shall be installed on top of the observation tanks.

1.3.3.4. Observation tanks may be used for study objectives such as monitoring recovery time from anesthetic, if approved by FPOM and USACE.

1.3.4. Anesthetic tank water will be replaced at least two times per day. Water temperatures in the anesthetic tank will be maintained within 2°F of the fish ladder water temperature. *If anesthetic tank water temperature exceeds 70°F, criteria in* ***section 4*** *will go into effect.*

1.3.5. Water in the observation tanks will be running continuously to allow a constant exchange of water through the tank.

1.3.6. Personnel shall ensure fish are sampled as quickly as possible. It is recommended that it take no longer than 25 minutes to transition the fish from entry into the anesthetic tank to release back into the return ladder or transportation tank.

1.3.7. Personnel shall ensure that fish are fully recovered from anesthetization prior to release into the return ladder. Fish may volitionally leave the brail pool when they are ready.

1.3.8. When trapping is completed for the day, users will properly shut down the lab.

1.3.9. Four picket leads will be allowed during trap operations for up to four hours. After all picketed leads are raised, fish already in the AFF can be sampled for an additional one hour. The picketed lead operations are as follows[1]:

(a) 0–6,000: All 4 picket leads can be lowered for 4 continuous hours.

(b) 6,000–12,000: All 4 picket leads down for 3 hours. At the 3rd hour, raise at least 1 picket lead for ½ hour, and then continue sampling for additional 1 hour.

(c) 12,000–25,000: All 4 picket leads down for 2 hours. At the 2nd hour, raise at least 2 picket leads for ½ hour, and then continue sampling for an additional 2 hours.

(d) 25,000–35,000: Two picket leads down for four hours.

(e) > 35,000: No picket leads down.

1.3.10. Researchers will also be required to monitor the ladder every hour to ensure there is no crowding. If evidence of crowding is occurring at least two picket leads will be raised.

[1] All counts are of adult salmonids (including jacks) as enumerated the previous day at the Washington Shore count station. Assumes 4 shad = 1 salmonid (e.g., 6,000 salmonids + 4,000 shad = 7,000 total).

1.3.11. Project Fisheries will notify FPOM as soon as Weir 37 violates FPP criteria.

1.3.12. Project biologists retain the authority to raise additional picket leads depending on fish densities and ladder conditions.

1.4. Trapping Protocols – Ladder Water Temperatures >=70°F.

1.4.1. Trapping will not occur when fish ladder water temperatures meet or exceed 70°F as measured in the brail pool. The only exception is for *US v Oregon* requirements and for nighttime lamprey trapping. Nighttime is defined as official sunset to sunrise.

1.4.1.1. Project Biologists will use the Corps temperature probe reading as the official temperature.

1.4.1.2. Temperatures are both instantaneous readings and 0000–2400 daily averages. Researchers can review daily average, minimum and maximum temperatures from www.nwd-wc.usace.army.mil/tmt/documents/ops/temp/daily_by_basin.html to determine if the trap is within temperature criteria prior to traveling to BON. Instantaneous temperatures will be used to determine if trapping operations will continue for the day.

1.4.1.3. Project biologists will collect temperature data weekly from the data logger in the exit ladder. Daily checks may be requested when temperatures approach 70°F.

1.4.2. At water temperatures of 70–72°F, sampling will be permitted as defined below for up to four days per week from 0600-1030 hours to allow for *U.S. v Oregon* requirements. This operation will remain in effect until daily average water temperature drops to ≤ 69.9°F. All sampling will cease when temperature reaches 72°F. No sampling may resume until daily average water temperature drops to ≤ 71.9°F. An exception is that nighttime lamprey trapping will be permitted up to 73.9°F for tagging and transport purposes. All nighttime trapping for lamprey will cease when temperatures reach 74°F.

1.4.3. Researchers may continue to work through fish in the holding pool for one hour after picket leads have been raised.

1.4.4. Project Fisheries will notify FPOM as soon as Weir 37 consistently violates FPP criteria.

1.4.5. The density criteria for picket lead operations will be altered and the operations will be as follows (density criteria and adult ladder monitoring outlined above in **1.3.9** also apply[1]):

(a) 0–3,000: All 4 picket leads can be lowered for 4 continuous hours.

(b) 3,000–6,000: All 4 picket leads down for 3 hours. At the 3rd hour, raise at least 1 picket lead for ½ hour and then continue sampling for an additional 1 hour.

(c) 6,000–9,000: All 4 picket leads down for 2 hours. At the 2nd hour, raise at least 1 picket lead for ½ hour and then continue sampling for an additional 2 hours.

(d) 9,000–18,000: 2 leads down for 4 hours. All picket leads raised by 10:30 am.

(e) > 18,000: No picket leads down.

1.4.6. There will be no more than 3 adult Chinook or steelhead or 4 sockeye in the anesthetic tank at a time. A combination of salmonids is allowed, with the maximum of either 2 Chinook or steelhead and 1 sockeye, or 1 Chinook or steelhead and 2 sockeye. This assumes users can effectively track the length of time fish stay in the anesthetic tank.

1.4.7. The brail pool is the primary and preferred recovery pool.

1.4.8. The observation tanks will be used for fish in distress under guidelines established in 3.3.1 through 3.3.4.

1.4.9. If used, water in the observation tanks will be running continuously allowing a constant exchange of water through the tank.

1.4.10. Assure oxygen levels are maintained at saturation in the anesthetic and recovery tanks. There will be no depression in oxygen levels in the anesthetic or recovery tanks. To assure this, water in the anesthetic tank will be replaced at least every three hours.

1.4.11. Maintain the anesthetic and recovery tank water temperatures 1-2°F lower than the ladder water temperature. If ice is used to cool the anesthetic or recovery tank water, the ice should be from river water or from an un-chlorinated water source and should be added in individual sealed containers. Do not exceed a 2°F difference between the anesthetic or recovery tank water and fish ladder water.

1.4.12. Personnel shall ensure fish are sampled as quickly as possible. It is recommended that it take no longer than 25 minutes to transition the fish from entry into the anesthetic tank to release back into the return ladder or transportation tank.

1.4.13. Personnel shall ensure fish are fully recovered from anesthetization prior to release. Fish may volitionally leave the brail pool when they are ready.

1.4.14. Project biologists retain the authority to raise additional picket leads depending on fish densities and ladder conditions.

1.5. Winter Trapping Protocols (December 1 – March 14).

The purpose of these protocols is to provide measures to limit passage delay and stress from overcrowding in the brail pool. Personnel conducting research during this time are not required to be present in the AFF. Users are allowed to activate the flume swing gates to divert all fish into the brail pool.

1.5.1. Fish will not be permitted to remain in the brail pool longer than 24 hours. It is recommended that handling of fish occurs daily by 1800 hours. This assures that if fish are sampled at the end of the day, most of the fish captured are only held from the morning until afternoon since passage at night is minimal, thus reducing delay.

1.5.2. During sampling, the brail pool should be raised and one adult salmonid netted, via a sanctuary net, and placed into the anesthetic tank at a time. After removing fish from the brail pool into the anesthetic tank, the brail pool will be lowered back to its full depth.

1.5.3. There will be no more than three adult salmonids in the anesthetic tank at a time. This assumes users can effectively track the length of time fish are in the anesthetic tank.

1.5.4. There will be no more than two adult salmonids in the recovery tank at a time.

1.5.5. Water in the recovery tank will be running continuously, allowing a constant exchange of water through the tank.

1.5.6. Personnel shall ensure fish are sampled as quickly as possible. It is recommended that it take no longer than 25 minutes to transition the fish from entry into the anesthetic tank to release back into the return ladder or transportation tank.

1.5.7. Personnel shall ensure fish are fully recovered from anesthesia prior to release.

1.5.8. If daily sampling is not to occur within 24 hours, the main ladder picket leads and downstream exit gate will be raised. The lab will be properly returned to bypass mode.

APPENDIX B

Table B1. List of PTAGIS interrogation sites (three letter code, name, and description) to use with maps that follow. Out of 336 active sites, 181 sites detected the fish tagged in 2018.

Site Code	Site Name	Site Description
18M	Eighteenmile Creek	In-stream detection system on Eighteenmile Creek located approximately 300 meters upstream from the confluence with Texas Creek to form the Lemhi River.
ACM	Asotin Creek near mouth	Near the mouth of Asotin Creek 50 m upstream of the Highway 129 bridge spanning the mainstem of Asotin Creek in two serial sets of two antennas.
AH1	Ahtanum at LaSalle HS	Ahtanum Creek site is located 3 KM from the mouth of Ahtanum Creek at the lower end of the Lasalle High School property.
B2J	Bonneville PH2 Juvenile	Bonneville Dam PH2 Juvenile Bypass and Sampling Facility.
BBT	Touchet River at Bolles Bridge	The Bolles Bridge site is located about 200 feet above the State HWY 124 bridge on the Touchet River, near Bolles Road, at River Kilometer 65.2.
BCC	BON PH2 Corner Collector	Bonneville Dam 2nd Powerhouse Corner Collector Outfall Channel.
BGM	Burlingame Dam and Canal	Burlingame Diversion Dam is located on the lower Walla Walla River.
BO1	Bonneville Bradford Is Ladder	Bradford Island Adult Fishway at Bonneville Dam.
BO2	Bonneville Cascades Is Ladder	Cascades Island Adult Fishway at Bonneville Dam.
BO3	Bonneville WA Shore Ladder/AFF	Washington Shore Adult Fishway and AFF at Bonneville Dam; replaces B2A and BWL.
BO4	Bonneville WA Ladder Slots	Washington Shore Fishway Vertical Slots at Bonneville Dam.
BPC	Bonaparte Creek Instream Array	A permanent in-stream PIT Tag Interrogation System on Bonaparte Creek. Bonaparte Creek enters the Okanogan River at RKM 91.2, within the city of Tonasket, WA.
BR0	Bridge Creek Gauge	This is an in-stream interrogation system located near the USGS flow gauge site on Bridge Creek.
BR1	Bridge Creek Kiosk	This is an in-stream interrogation system located at the John Day Fossil Beds National Monument on Bridge Creek.
BRC	Bear Valley Adult Video Weir	Interrogation system on the existing Bear Valley Creek Chinook adult monitoring weir.
BVC	Beaver Creek, Methow River	The site was located at river kilometer 3 on Beaver Creek in the Methow River Basin. In July 2014, the site was burned over by a wildfire and removed. In March 2015, the site was reinstalled 2 kilometers downstream from the original location.
CAC	Canyon Creek ISA @km1	In-stream detection system is located in Canyon Creek 100-meters upstream of the confluence with the Lemhi River.
CAL	Carson NFH Adult Return Ladder	Hatchery adult spring Chinook return ladder from the Wind River to Carson NFH.
CCW	Catherine Creek Ladder/Weir	Instream detection array located in the adult return fish ladder at the Catherine Creek weir.
CHL	Lower Chiwawa River	Chiwawa River rkm 1, located between the Chiwawa smolt trap and the Chiwawa Acclimation Ponds.
CHM	Chumstick Creek	This site is located at rkm 0.4 on Chumstick Creek (Wenatchee River Basin), located just above the North Road Bridge, near Leavenworth, WA.
CHU	Upper Chiwawa River	Chiwawa River rkm 12, located above the Forest Road 62 bridge and below Alder Creek.
CHW	Chiwaukum Creek	This site is a permanent instream PIT tag detection system located at rkm 0.4 on Chiwaukum Creek (Wenatchee River Basin), located near Tumwater Campground (access through site 51).
CJP	CJH Juvenile Release Pond	This site consists of two juvenile ponds at the Chief Joseph Hatchery at 38 Half Sun Way in Bridgeport, WA. The antennas are installed at the outpipe for both ponds.
CLC	Clear Creek near Kooskia NFH	Instream detection array located in lower Clear Creek, a tributary to the Clearwater River, just downstream of Kooskia National Fish Hatchery.
COC	Cow Creek ISA @ Stream Mouth	The array is located in Cow Creek at 0.5 km upstream of the confluence with the Imnaha River.
COP	Lower Coppei Instream Array	A permanent instream PIT tag interrogation site at RKM 0.8 on Coppei Creek.
CRU	Upper Chewuch instream Array	Instream PIT tag interrogation site at RKM 28.35 on the Chewuch River.
CRW	Chewuch River above Winthrop	Chewuch River at river km 1, above Winthrop, WA.
DRM	Deschutes River mouth	Mouth of the Deschutes River in the west channel at Moody Island (rkm 0.46).
DSF	Deschutes Sherars Falls	Site consists of two monitored weirs in the main fishway and two monitored weirs in the high flow fishway; one antenna per weir.
DWL	Dworshak NFH adult trap	Located at the terminus of the Dworshak National Hatchery adult fish ladder in the North Fork Clearwater River.
DXP	Dexter Ponds Fish Ladder	Detection array located inside the fish ladder leading to Dexter Ponds Fish Hatchery on the north bank of the
EBO	East Bank Hatchery Outfall	Located in the East Bank Hatchery outfall channel.
EFD	East Fork Diversion Fishway	Located in a fish ladder at a irrigation diversion site for the East Fork Irrigation District on the East Fork of the Hood River.
EHL	Entiat NFH Adult Ladder	This adult interrogation site is located in the Entiat National Fish Hatchery adult ladder.
ENA	Upper Entiat River at rkm 17.1	The site is located approximately 400 meters above the mouth of the Mad River near the township of Ardenvoir at river kilometer 17.1.
ENF	Upper Entiat River at rkm 40.6	The site is located approximately 600 meters below the beginning of Forest Service Property within the upper portion of the Entiat River at rkm 40.6.
ENL	Lower Entiat River	Entiat River rkm 2, located immediately upstream of Entiat, WA.
ENS	Upper Entiat River at rkm 35.7	The site is located approximately 4.3 km above Stormy Creek at river kilometer 35.7 and near the entrance of the Riverwood subdivision.
ESJ	Easton Acc. Pond	Easton Acclimation Pond Outfall
ESS	EFSF Salmon River at Parks Cr	East Fk South Fk Salmon River (rkm 21) near Parks Creek.
FOL	Foster Dam Ladder S Santiam R	Fish Ladder detection array at the Foster Dam Fish Collection Facility on the South Santiam River, a tributary to the Willamette River near Sweet Home, Oregon.

Table B1. Continued.

Site Code	Site Name	Site Description
GOA	Little Goose Fish Ladder	Adult Fishway at Little Goose Dam.
GOJ	Little Goose Dam Juvenile	Little Goose Dam Juvenile Fish Bypass/Transportation Facility.
GRA	Lower Granite Dam Adult	Lower Granite Dam Adult Fishway and Fish Trap.
GRJ	Lower Granite Dam Juvenile	Lower Granite Dam Juvenile Fish Bypass/Transportation Facility.
HRM	Hood River Mouth	Located at the mouth of the Hood River against the west side jetty just inside the bar where the Hood River
HST	Touchet River at Harvey Shaw	Site at RKM 50 on the Touchet river.
HYC	Hayden Creek Instream Array	Lower section of Hayden Creek, in the Lemhi River Basin.
ICH	Ice Harbor Dam (Combined)	Ice Harbor Dam Adult Fishways (both) and Full Flow Bypass.
ICL	Lower Icicle Instream Array	Located at rkm 0.4 on Icicle Creek (Wenatchee River Basin), near Leavenworth, WA.
ICM	Middle Icicle Instream Array	A permanent in-stream PIT tag interrogation site at RKM 7 on Icicle Creek.
IML	Imnaha River Weir Adult Ladder	Located in the adult return fish ladder at the Imnaha River weir. Site is on public land.
IR1	Lower Imnaha River ISA at km 7	Lower Imnaha River at river km 7 (N 45.761162, W -116.750658).
IR2	Lower Imnaha River ISA at km 10	Lower Imnaha River at river km 10 (N 45.742839 W -116.764563).
IR3	Upper Imnaha River ISA at km 41	Upper Imnaha River at river km 41 (N 45.49004 W 116.80393).
IR4	Imnaha Weir Downstream Array	Located downstream of the Oregon Dept. of Fish and Wildlife (ODFW) fish weir on the Imnaha River.
IR5	Imnaha Weir Upstream Array	Located upstream of the Oregon Dept. of Fish and Wildlife (ODFW) fish weir on the Imnaha River.
JD1	John Day River, McDonald Ferry	John Day River in-stream detection, near McDonald Ferry at RM 20.
JDJ	John Day Dam Juvenile	John Day Dam Juvenile Fish Bypass and Sampling Facility.
JDM	Upper John Day Array	Located on the Upper Mainstem John Day River approximately 7 miles upstream of Dayville, Oregon.
JO1	John Day Dam South Fish Ladder	The interrogation site at the John Day Dam south fish ladder.
JO2	John Day Dam North Fish Ladder	The interrogation site at the John Day Dam north fish ladder.
JOC	Joseph Creek ISA at km 3	Joseph Creek, Grande Ronde basin at river km 3 (N 46.030016, W -117.016042).
JOH	Johnson Creek	A permanent PIT tag interrogation site on Johnson Creek, which enters the Okanogan River at RKM 65.3, in the town of Riverside, WA. The site is approximately 0.2 km upstream from the confluence.
KEN	Kenney Creek In-stream Arrays	The site is located on Kenney Creek approximately 400-meters upstream of the confluence with the Lemhi River.
KLR	Klickitat River Floating Array	The array is located in the lower Klickitat River, Klickitat County, Washington.
KRS	SF Salmon River at Krassel Creek	This in-stream interrogation system is located near Krassel Creek at rkm 65 on the South Fork Salmon River.
LBC	Libby Creek, Methow River	The site at RKM 1 on Libby Creek.
LC1	Lower Lolo Creek at rkm 21	Lolo Creek, a tributary to the Clearwater River located at river km 522.224.087.021 (N 46.294434 W -115.976119).
LC2	Upper Lolo Creek at rkm 25	Lolo Creek, a tributary to the Clearwater River located at river km 522.224.087.025 (N 46.290562 W -115.934153.
LD2	Lebanon Dam North Ladder	In-stream detection array in the North Fish Ladder at Lebanon Dam on the South Santiam River, a tributary to the Willamette River.
LFF	Lyle Falls Fishway	The Lyle Falls Fishway in Klickitat River.
LKR	Little Klickitat River Array	The array is located in the Little Klickitat River, a tributary to the Klickitat River, Klickitat County, Washington, approximately 0.4 kilometers upstream from the confluence.
LLR	Lower Lemhi River	Lower Lemhi River in Salmon, ID.
LMA	Lower Monumental Adult Ladders	This interrogation site is in both ladders at Lower Monumental Dam.
LMJ	Lower Monumental Dam Juvenile	Lower Monumental Dam Juvenile Fish Bypass/Transportation Facility.
LMR	Lower Methow River at Pateros	Lower Methow River near the WDFW 'Miller Hole' access site on the lower Methow River immediately upstream of Pateros, WA.
LNF	Leavenworth NFH Adult Ladder	Located in the Leavenworth National Fish Hatcheries adult ladder and holding pond.
LNR	Lower Naches River	This site is a permanent in-stream system located at rkm 5.3 on the lower Naches river, 700 meters below Nelson dam.
LRL	Lower Lochsa River Array Site	Site is located in lower 1km of the mainstem Lochsa River.
LRU	Lochsa River Upper Site	Site is located in lower 3km of the mainstem Lochsa River.
LRW	Lemhi River Weir	Lemhi River above the mouth of Hayden Creek and below the IDFG weir.
LTR	Lower Tucannon River	Near the mouth of the Tucannon River. The upstream array group was located at an abandoned railroad bridge abutment upstream of Hwy 261 on the Tucannon River downstream from Starbuck. The CO in-stream array was relocated below the Hwy 261 bridge on Sept. 29, 2010.
LWE	Lower Wenatchee River	Wenatchee River rkm 2.
LWL	Ltl. White Salmon NFH returns	Adult fish ladder allowing passage from the Little White Salmon River into the adult holding ponds at Little White Salmon NFH.
LWN	Little Wenatchee River	Instream PIT tag interrogation site at rkm 4 located at the old fish weir.
MC1	McNary Oregon Shore Ladder	Oregon Shore Adult Fishway at McNary Dam.
MC2	McNary Washington Shore Ladder	Washington Shore Adult Fishway at McNary Dam.
MCJ	McNary Dam Juvenile	McNary Dam Juvenile Fish Bypass/Transportation Facility.
MCL	Lower Mission Creek Instream	Instream PIT tag detection system located at rkm 0.7 on Mission Creek (Wenatchee River Basin), near Cashmere, WA.
MJ1	Middle Fork John Day Array	The Middle Fork John Day Array is near the current confluence with Mosquito Creek on Malheur National Forest Service Land.
MRC	Methow River at Carlton	Located in the mainstem Methow River near the town of Carlton at rkm 45.
MRW	Methow River at Winthrop	Methow River. During 2009 and early 2010, the array was located at river km 81, above Winthrop, WA near Winthrop National Fish Hatchery. In Sept. 2010 it was moved upstream to its new location below Wolf Creek on the mainstem Methow River, at river km 85.
MSH	Methow Fish Hatchery Outfall	On the outlet of the Washington Department of Fish and Wildlife (WDFW) Methow Hatchery located on the Methow River at Rk 82.3 from the confluence with the Columbia River.

Table B1. Continued.

Site Code	Site Name	Site Description
MTD	Mill Creek at The Dalles	Array is approximately 2.5 km upstream of the mouth of Mill Creek and the confluence with the Columbia River, below The Dalles Dam.
MTR	Middle Tucannon River	The Middle Tucannon River site is located about 250 feet above the River Ranch Ln bridge on the Tucannon River, at River Kilometer 19.5.
MVF	Moving Falls Fish Ladder	Located in the fish ladder at a site known as Moving Falls on the West Fork of the Hood River.
MWF	Whitefish SC in Methow River	PIT tag interrogators at the entrance and exit of Whitefish Island side channel (rkm 76).
NAL	Lower Nason Creek	Nason Creek rkm 1, located within Lake Wenatchee State Park.
NAU	Upper Nason Creek	Nason Creek rkm 19 (Wenatchee River Basin).
NBA	Nursery Bridge Adult	Nursery Bridge Dam Fishways (both), Walla Walla River at Milton-Freewater, OR.
NFS	North Fork Salmon River	Located on the North Fork Salmon River approximately 0.5 km above the confluence with the Salmon River.
OBF	Omak Creek below Mission Falls	Omak Creek enters the Okanogan River at RKM 51.5, approximately 1 KM upriver from the town of Omak, WA. The site is approximately 9.90 KM upstream from the confluence.
OKC	Okanagan Channel at VDS-3	The OKC site is located in the Okanagan (Canadian spelling) Channel at 310th Avenue/Road 18 upstream from Osoyoos Lake.
OKL	Lower Okanogan Instream Array	Site at RKM 24.9 on the mainstem Okanogan River, upstream of Chiliwist area in Okanogan County.
OKP	Penticton Channel PIT Array	Penticton Channel, is the channelized portion of the Okanagan River connecting Okanagan Lake with Skaha Lake, within the city of Penticton BC.
OMF	Omak Creek above Mission Falls	A permanent system located above Mission Falls in Omak Creek. Omak Creek enters the Okanogan River at RKM 51.5, approximately 1 KM upriver from the town of Omak, WA. The site is approximately 10.5 RKM upstream from the confluence.
OMK	Omak Creek Instream Array	Omak Creek enters the Okanogan River at RKM 51.5, approximately 1 km upstream from the city of Omak, WA. The site is located on Omak Creek, 0.24 km from the confluence with the Okanogan River.
OMP	Omak Acclimation Pond	Located at 23 Brooks Tracts Rd. in Omak, WA.
PAT	Pattit Creek Instream Site	Instream PIT tag interrogation site at RKM 1.3 on Pattit Creek a tributary to the Touchet River.
PCA	Panther Creek Array	The array is on Panther Creek approximately 5 rkm from the confluence with Salmon River.
PD7	Columbia River Estuary rkm 70	The array (PD7) is located at river km 70 (46.14661N, -123.379867W).
PEL	Pelton Dam Ladder - Deschutes	The ladder is located at PGE's Pelton Dam on the Deschutes River (rkm 328.161).
PRA	Priest Rapids Adult	Priest Rapids Dam Adult Fishways (both).
PRH	Priest Rapids Hatchery Outfall	Priest Rapids Hatchery outfall channel. The site is located just upstream of the typical point of inundation in the channel.
PRO	Prosser Diversion Dam Combined	Adult Fishways (all three) and Juvenile Bypass/Sampling Facility at Prosser Dam.
PRV	Walla Walla R at Pierce RV Prk	Lower Walla Walla River at Pierce Green Valley RV Park.
RCL	Rock Creek (WA) at rkm 5	Rock Creek (WA) at rkm 5 near the Yakama Nation Longhouse.
RCS	Rock Creek (WA) at Rkm 14	Located on Rock Creek (WA) at rkm 14 at the confluence of Rock and Squaw Creeks.
RCT	Roaring Creek Temporary Array	This is generally a seasonal PIT tag detection system, based on flows, that is located at rkm 0.3 on Roaring Creek (Entiat River basin).
RIA	Rock Island Adult	Rock Island Dam Adult Fishways (all three).
ROZ	Roza Diversion Dam (Combined)	Roza Dam Smolt Bypass.
RPJ	Rapid River Hatchery Pond	Rapid River Hatchery (IDFG) outfall.
RRF	Rocky Reach Fishway	Rocky Reach Dam Adult Fishway.
RRJ	Rocky Reach Dam Juvenile	Juvenile Fish Bypass Surface Collector.
RSH	Ringold Springs Hatch. Outfall	PIT tag detection system located in the Ringold Springs Hatchery outfall channel.
S2I	Lemhi Sub-reach 2 SC Inlet	This interrogation site is located on the inlet of a constructed side channel in sub-reach 2 of the the Eagle Valley Ranch restoration project in the lower Lemhi River.
SA0	Salmon Creek below OID DIV	Salmon Creek enters the Okanogan River at RKM 41.3, in the town of Okanogan, WA. The site is approximately 6.35 KM upstream from the confluence.
SA1	Salmon Creek Instream Array	Salmon Creek enters the Okanogan River at RKM 41.3, in the town of Okanogan, WA. The site is approximately 2.9
SC1	Lower SF Clearwater R at rkm 1	Lower South Fork Clearwater River at river km 0.9 (N 46.13685 W -115.98091).
SC2	Lower SF Clearwater R at rkm 2	Lower South Fork Clearwater River at river km 2 (N 46.12749 W -115.97730).
SCL	Spring Creek NFH Adult Ladder	Fish ladder allowing passage from the Columbia River into the adult holding ponds at Spring Creek NFH.
SCP	Spring Creek Acclimation Pond	Juvenile releases from and adults returning to Winthrop National Fish Hatchery.
SFG	SF Salmon at Guard Station Br.	Located at rkm 30 near the lower South Fork Salmon River Guard Station on the South Fork Salmon River.
SHK	Shitike Creek PIT Array	he array is located across the tailout of a pool created by a bridge (known as the Scale Bridge) that is used by logging truck to deliver lumber to the Warm Springs Mill.
SKA	Skaha Dam Fish Ladder	Skaha Dam is located within the community of Okanagan Falls at the south end of Skaha Lake, BC along the Okanagan River. The fishway is at the western edge of the dam.
SM1	Simcoe Creek at Stephensen Rd	Simcoe Creek at Stephensen road is located about 100 meters downstream from the Stephensen Rd bridge about 12 KM upstream from the mouth. This tributary converges with Toppenish Creek at about River km 50.
STL	Sawtooth Hatchery Adult Trap	Ladder of the Sawtooth Hatchery adult fish trap.
STR	SF Salmon Satellite Facility	Ladder of the South Fork Salmon River adult fish trap.
SUN	Sunnyside Instream Array	Located 600 M below Sunnyside Dam on the Yakima River.
SW1	Lower Selway River Array	PIT tag array is located 5 rkm upstream of the mouth of the Selway River in the upper Clearwater Basin Idaho.
SW2	Upper Selway River Array	PIT tag array is located 13 rkm upstream of the mouth of the Selway River in the upper Clearwater Basin Idaho.
SWC	Swale Creek Array	Array is located in Swale Creek, a tributary to the Klickitat River, Klickitat County, Washington and is approximately 100 m upstream from the confluence.

Table B1. Continued.

Site Code	Site Name	Site Description
TAY	Big Creek at Taylor Ranch	Centered around the bridge at Taylor Ranch, Big Creek, ID.
TD1	The Dalles East Fish Ladder	East Fish Ladder at The Dalles Dam.
TD2	The Dalles North Fish Ladder	North Fish Ladder at The Dalles Dam.
TFH	Tucannon Fish Hatchery	The Tucannon Fish Hatchery site is located about 200 feet above the Tucannon Fish Hatchery Adult Trap and Water Intake System on the Tucannon River, at River Kilometer 59.4.
TMF	Three Mile Falls Dam Combined	Adult Fishway and Juvenile Bypass/subsampling facility at Three Mile Falls Dam.
TOP	Lower Toppenish Creek	The site is located approximately 1700 meters upstream from the confluence of Toppenish Creek with the Yakima River at rkm 130.
TP2	Toppenish Creek at Simcoe Ck	The array is located about 0.75 km upstream from the confluence of Toppenish Creek and Simcoe Creek.
TUF	Tumwater Dam Adult Fishway	Adult Fishway at Tumwater Dam.
TWR	Lwr Twisp Rvr near MSRF Ponds	Lower Twisp River adjacent to the Methow Salmon Recovery Foundation Ponds.
TWX	Estuary Towed Array (Exp.)	The TWX experimental trawl detector is typically deployed in the Columbia River estuary, at and above Jones Beach (rkm 75).
UGR	Upper Grande Ronde at rkm 155	Grand Ronde River located at river km 522.271.155 (45. 593338, -117.903124).
UGS	Upper Grande Ronde Starkey	In-stream detection array near the upper Grande Ronde weir at Starkey.
UMF	Umatilla River below Feed Dam	In-stream array in the Umatilla River about 150 feet downstream of Feed Diversion Dam.
USE	Upper Salmon River at rkm 437	Located in the Salmon River at river km 522.303.437 (N45.028939 W-113.915892).
USI	Upper Salmon River at rkm 460	Located in the mainstem Salmon River at river km 522.303.460 (N44.890380 W-113.962575).
UTR	Upper Tucannon River	The Upper Tucannon River site is located about 200 yards above Don Howards House on the Tucannon River, at River Kilometer 53.2.
UWE	Upper Wenatchee River	Located at rkm 81.2 on the Wenatchee River, near Plain, WA.
VC1	Valley Creek, Upstream Site	Located on Valley Creek at Stanley, ID., in the Upper Salmon River.
VC2	Valley Creek, Downstream Site	Located on Valley Creek below Stanley, ID., in the Upper Salmon River.
WEA	Wells Dam, DCPUD Adult Ladders	Wells Dam Adult Fishways (both).
WEH	Wells Dam Hatchery	Points of detection include the adult fish handling facility, juvenile pond outflows and adult volunteer channel.
WEJ	Wells Dam Bypass Bay Sample	Site is located in Bypass Bay 2 on the right (west) side of Wells dam on the Columbia River, Washington.
WEN	Wenaha River Mouth	Array on the Wenaha River near Troy, Oregon.
WFC	Wolf Creek, Methow River	Instream detector on Wolf Creek, Methow River Basin
WFF	Willamette Falls Fishway	Site located in the Willamette Falls Adult Fishway.
WR1	Wallowa River at river km 14	Instream array located in the Wallowa River, Oregon rkm 522.271.131.014 (N 45.633769 ° W -117.73369°).
WR2	Wallowa River at Rkm 32	The array is located in the Wallowa River at approximately river km 32 just upstream of Lower Diamond Road bridge near the town of Wallowa, OR.
WRU	Upper Wind River (WA) rkm 30	At rkm 30 of the Wind River, WA. The site is at the FR3065 bridge over the Wind River.
WSH	Warm Springs Hatchery	Adult Fishway at Warm Springs NFH.
WSR	Warm Springs River PIT Array	The Warm Springs River PIT tag array is installed end-to-end across the entire river channel.
WTL	White River, Wenatchee Basin	A permanent instream PIT tag interrogation site at RKM 2.88 on the White River.
WW1	Harris Bridge S F Walla Walla	Site is located on the South Fork Walla Walla River approximately 13 kilometers upstream from the confluence with the North Fork Walla Walla River.
YFK	Yankee Fork Salmon River	The site is located 3.14 river kilometers upstream from the confluence with the Salmon River at an elevation of 1855m.
ZEN	Secesh River at Zena Cr Ranch	Near the Zena Creek Ranch.
ZSL	Zosel Dam Adult Fishways	Zosel Dam is located at Okanogan River km 132, approximately 3 km downstream from the outlet of Lake Osoyoos in the town of Oroville, Washington.

Table B2.Season by season activities of steelhead tagged in 2018 and later labeled as kelts or repeat spawners when they began migrating downstream (after March 31st) and upstream in spring, summer, winter or fall of 2018/19/20, presumably to and from the ocean.

Tag Year	Tag Number	First Detection After Tagging 2018 in All Seasons	Fall 2018	Winter 2018/19	Spring 2019	Summer 2019	Fall 2019	Comments
2018	3DD.0077BACBAF	The Dalles East Ladder - September 11th	Lower John Day - November 30th		Bridge Creek (John Day) - April 14th to May 13th Estuary Trawl - May 28th			Unclear where steelhead was for several months between The Dalles and John Day detections.
2018	3DD.0077C141D8	The Dalles East Ladder - September 5th	Lower Granite - September 18th		Ice Harbor - May 25th Bonneville Dam Corner Collector - May 30th Estuary Trawl - May 31st			Unclear where steelhead was for several months between The Dalles and John Day detections.
2018	3DD.0077C19420	The Dalles East Ladder - September 2nd	McNary - September 10th		Threemile Dam (Umatilla) - March 23rd Feed Dam (Umatilla) - April 1st Bonneville Dam Corner Collector - May 30th			
2018	3DD.0077BA495F	Upper Wind - October 28th	Upper Wind - October 30th to November 29th	Upper Wind - December 1st to February 27th	Upper Wind - March 1st to May 5th Bonneville Dam Corner Collector - May 12th			Steelhead captured at Bonneville on May 29th, 2018, where it was between May and October is unknown.
2018	3DD.0077BA5950	The Dalles East Ladder - July 11th	Lower Granite - November 4th		Lower Granite - March 26th Little Goose Juvenile - May 24th Bonneville Dam Corner Collector - May 31st			
2018	3DD.0077BFEC1D	The Dalles East Ladder - October 13th	McNary - October 21st McNary - November 12th		Deschutes Mouth - March 25th Lyle Falls (Klickitat) - April 5th Bonneville Dam Corner Collector - April 22nd			
2018	3DD.0077BA371F				Bonneville Dam Corner Collector - May 11th			Steelhead was tagged at Bonneville AFF on April 25th 2018.
2018	3DD.0077BAAD58	The Dalles East Ladder - July 26th	Lower Granite - September 29th		Bonneville Dam Corner Collector - May 3rd			
2018	3DD.0077BFE1B2	The Dalles North Ladder - September 30th	Lower Granite - October 29th		Bonneville Dam Corner Collector - April 27th			
2018	3DD.0077C08815	The Dalles East Ladder - September 24th	Lower Granite - October 19th		Bonneville Dam Corner Collector - April 24th			Steelhead was captured at Lower Granite on October 19th, 2018.
2018	3DD.0077BA37E3	The Dalles East Ladder - July 28th	John Day - October 23rd		Bonneville Dam Corner Collector - May 20th			Unclear where steelhead was for several months between The Dalles and John Day detections.
2018	3DD.0077C06C75	The Dalles East Ladder - September 20th	Little Goose - October 3rd		SF Salmon - April 19th	Bonneville Dam Corner Collector - June 14th		
2018	3DD.0077BA3F98	The Dalles East Ladder - October 24th	Lower Granite - November 5th		Joseph Creek (Grande Ronde) - March 15th Lower Monumental Juvenile Bypass - April 23rd John Day Juvenile Bypass - May 2nd Bonneville Dam Corner Collector - May 7th			Steelhead captured at Bonneville on July 25th, 2018, where it was between July and October of 2018 is unknown.
2018	3DD.0077BAA999	The Dalles East Ladder - July 22nd Tumwater Dam (Wenatchee) - August 21st			Lower Chiwawa (Wenatchee) - March 26th Upper Chiwawa (Wenatchee) - April 13th	Bonneville Dam Corner Collector - June 6th		
2018	3DD.0077C0F2A9	The Dalles North Ladder - August 23rd	Lower Granite - September 2nd		Joseph Creek (Grande Ronde) - March 20th Bonneville Dam Corner Collector - May 23rd			
2018	3DD.0077C177D0	The Dalles East Ladder - October 5th	Joseph Creek (Grande Ronde) - October 7th		John Day Juvenile Bypass - May 20th Bonneville Dam Corner Collector - May 23rd			
2018	3DD.0077BFEF43	The Dalles East Ladder - September 22nd	Lower Granite - November 19th		Lochsa (Clearwater) - March 29th Bonneville Dam Corner Collector - May 25th			
2018	3DD.007738205F	The Dalles East Ladder - September 3rd	Lower Granite - September 24th		Upper Grande Ronde - May 13th - 30th	Middle Grande Ronde - June 1st Bonneville Dam Corner Collector - June 16th		Steelhead captured at Bonneville on April 18th, 2018. Unclear where steelhead was for several months between Bonneville and The Dalles detections.
2018	3DD.0077C15B9B	The Dalles East Ladder - August 24th	Lower Granite - September 6th		Lower Imnaha - March 24th Upper Imnaha - April 16th Upper Imnaha - May 1st Bonneville Dam Corner Collector - May 21st			
2018	3DD.0077BA590B	The Dalles East Ladder - September 14th	McNary - September 17th McNary Juvenile Bypass - September 24th		John Day Juvenile Bypass - April 8th			
2018	3DD.0077BAA648	The Dalles East Ladder - July 25th		John Day - December 12th	Lower Umatilla - April 1st John Day Juvenile Bypass - May 17th			Unclear where steelhead was for several months between The Dalles and John Day detections.
2018	3DD.0077BA9FC2	The Dalles North Ladder - August 21st			John Day Juvenile Bypass - April 15th			
2018	3DD.0077BA98F6	The Dalles East Ladder - July 21st	McNary - October 10th	Walla Walla - December 20th	Touchet (Walla Walla) - March 19th Lower Coppei Creek (Touchet) - March 21st Lower Coppei Creek (Touchet) - May 2nd McNary Juvenile Bypass - May 7th			Steelhead was captured at Juvenile Monitoring on Upper Coppei Creek May 2nd, 2019.
2018	3DD.0077BA72C6	The Dalles North Ladder - October 9th	McNary - October 16th	Walla Walla - December 30th	Lower Touchet (Walla Walla) - April 1st Middle Touchet (Walla Walla) - April 4th to May 9th McNary Juvenile Bypass - May 14th			Steelhead captured at Bonneville on July 25th, 2018. Unclear where steelhead was for several months between Bonneville and The Dalles detections.
2018	3DD.0077C09550	The Dalles East Ladder - October 10th	Lower Granite - October 29th			McNary - June 2nd		
2018	3DD.0077BA5782	The Dalles East Ladder - July 22nd	Little Goose - October 4th		Middle Tucannon - March 25th Upper Tucannon - March 30th to April 7th Lower Monumental Juvenile Bypass - April 18th			
2018	3DD.0077C040B9	The Dalles East Ladder - September 26th	Little Goose - October 4th Little Goose Juvenile Bypass - November 8th		Lower Monumental Juvenile Bypass - April 1st			
2018	3DD.0077C09370	The Dalles East Ladder - September 15th	Lower Granite - September 29th		Lower Monumental Juvenile Bypass - May 11th			
2018	3DD.0077C134A4	The Dalles East Ladder - September 23rd	Lower Granite - October 5th		Lower Monumental Juvenile Bypass - April 27th			
2018	3DD.0077C0F462	The Dalles East Ladder - September 7th	Lower Granite - September 21st		Little Goose Juvenile Bypass - April 30th			
2018	3DD.0077C1275D	The Dalles East Ladder - September 16th	Lower Granite - September 29th		Little Goose Juvenile Bypass - April 29th			
2018	3DD.0077BAA621	The Dalles East Ladder - September 15th	Lower Granite - September 30th		Little Goose Juvenile Bypass - April 23rd			Steelhead was captured at Lower Granite on September 29th, 2018.
2018	3DD.0077BA66FF	The Dalles East Ladder - July 20th	Lower Granite - September 20th		Wallowa (Grande Ronde) - March 26th to April 3rd Little Goose Juvenile Bypass - May 17th			
2018	3DD.0077C0CBD6	The Dalles East Ladder - September 15th	Lower Granite - September 24th		Little Goose Juvenile Bypass - April 14th			
2018	3DD.0077C0F3B8	The Dalles East Ladder - September 8th	Lower Granite - September 22nd		Little Goose Juvenile Bypass - April 29th			
2018	3DD.0077C0FFA9	The Dalles East Ladder - September 19th	Lower Granite - October 21st		Little Goose Juvenile Bypass - April 24th			
2018	3DD.0077C08738	The Dalles North Ladder - September 29th	Lower Granite - October 16th	Dworshak NFH (Clearwater) - February 14th	Dworshak NFH (Clearwater) - March 28th Lower Granite - April 16th			
2018	3DD.0077BA4CCF	The Dalles North Ladder - July 24th	Lower Granite - September 20th		Lower Granite - May 15th			
2018	3DD.0077C16A76	The Dalles East Ladder - October 13th	Lower Granite - November 5th		Middle Wallowa (Grande Ronde) - May 1st Lower Granite Juvenile Bypass - May 25th			
2018	3DD.0077C02E02	The Dalles East Ladder - September 17th	Lower Granite - October 6th		Lower Granite - May 12th			
2018	3DD.0077C128FF	The Dalles East Ladder - August 25th	Methow - September 21st		Twisp (Methow) - April 5th Rocky Reach Juvenile Bypass - May 11th			Steelhead was captured at Priest Rapids on September 7th, 2018.
2018	3DD.0077BA9BEE	The Dalles East Ladder - July 22nd			Wells Hatchery Return Channel - April 14th to 17th East Bank Hatchery Outfall - April 18th to 22nd Rocky Reach Juvenile Bypass - April 26th			
2018	3DD.0077C11851	The Dalles East Ladder - September 16th	Wells Juvenile Bypass - November 28th		Wells Juvenile Bypass - March 27th Wells Hatchery Return Channel - April 16th to 24th Rocky Reach Juvenile Bypass - May 2nd			
2018	3DD.0077BAA70C	The Dalles East Ladder - July 23rd	Wells - September 27th		Rocky Reach Juvenile Bypass - April 20th			Steelhead was captured at Wells on September 27th, 2018.
2018	3DD.0077C04DFE	The Dalles East Ladder - August 26th	Wells - September 16th		Methow - March 1st to 24th Rocky Reach Juvenile Bypass - April 22nd			

Table B2. Continued.

Tag Year	Tag Number	First Detection After Tagging 2018 in All Seasons	Fall 2018	Winter 2018/19	Spring 2019	Summer 2019	Fall 2019	Comments
2018	3DD.003BFAC872	The Dalles East Ladder - September 2nd	Wells - September 20th		Rocky Reach - April 15th Rocky Reach Juvenile Bypass - May 13th			
2018	3DD.0077BA651F	The Dalles North Ladder - July 28th	Zosel Dam (Okanagan) - October 2nd		Okanagan - May 5th Rocky Reach Juvenile Bypass - May 18th			
2018	3DD.0077BA62C6	The Dalles North Ladder - September 10th	Lower Methow - November 2nd		Methow - April 12th Chewuch (Methow) - April 17th Rocky Reach Juvenile Bypass - June 12th			Steelhead recaptured on June 17th, 2018 at Priest Rapids Dam.
2018	3DD.0077BAA8B9	The Dalles North Ladder - July 27th	Lower Okanagan - September 10th		Lower Methow - March 26th Upper Methow - April 5th to 11th Rocky Reach Juvenile Bypass - May 15th			
2018	3DD.0077BA7072				Swale Creek (Klickitat) - April 10th Swale Creek (Klickitat) - April 14th			Steelhead was tagged at Bonnevile AFF on July 3rd 2018.
2018	3DD.0077C0ADF1	The Dalles East Ladder - October 8th	Tumwater Dam (Wenatchee) - November 26th	Upper Wenatchee - February 8th	Upper Wenatchee - May 19th			
2018	3DD.0077BA6FEA	The Dalles East Ladder - July 24th			Methow - March 19th Lower Twisp (Methow) - April 2nd Methow - April 20th			
2018	3DD.0077BA64C8	The Dalles North Ladder - December 16th		Mouth Deschutes - January 16th	John Day - March 24th Lower Granite - April 4th Upper Walla Walla - April 24th Middle Walla Walla - May 24th			Steelhead captured at Bonneville on July 19th, 2018. Unclear where steelhead was for several months between Bonneville and The Dalles detections.
2018	3DD.0077BA757A	The Dalles East Ladder - October 7th	McNary - November 18th		Lower Walla Walla - March 23rd Upper Walla Walla - April 23rd Middle Walla Walla - May 10th			Steelhead captured at Bonneville on July 23rd, 2018. Unclear where steelhead was for several months between Bonneville and The Dalles detections.
2018	3DD.0077C0AE96	The Dalles North Ladder - October 28th			McNary - March 30th Middle Walla Walla - April 5th Middle Walla Walla - May 7th			
2018	3DD.0077C15C5A	The Dalles North Ladder - September 23rd	Little Goose - October 13th		Little Goose - March 30th Lower Walla Walla - April 3rd Upper Touchet (Walla Walla) - May 5th Middle Touchet (Walla Walla) - May 7th			
2018	3DD.0077C09F68	The Dalles East Ladder - September 5th		Mouth Deschutes - January 28th to February 3rd	McNary - March 25th Middle Walla Walla - March 31st Middle Walla Walla - April 26th			
2018	3DD.0077BA72A7	The Dalles East Ladder - September 22nd	Lower Granite - October 3rd		Middle Wallowa (Grande Ronde) - March 24th Lower Wallowa (Grande Ronde) - April 14th			Steelhead captured at Bonneville on July 25th, 2018, where it was between July and September is unknown. Steelhead was recaptured at Lower Granite on October 3rd, 2019.
2018	3DD.0077BA700C	The Dalles North Ladder -July 19th	Lower Granite - September 25th		Joseph Creek (Grande Ronde) - April 18th Joseph Creek (Grande Ronde) - May 18th			Steelhead was recaptured at Lower Granite on August 20th and 30th, 2018. Detected in the Juvenile Bypass on September 6th, 2018.
2018	3DD.0077BA91CD	The Dalles North Ladder - September 10th	Lower Granite - October 26th		Middle Tucannon - April 7th Lower Tucannon - April 21st			Steelhead was recaptured at Lower Granite on October 26th, 2018.
2018	3DD.0077BAC143	The Dalles East Ladder - July 5th	Lower Granite - October 1st		Lower Tucannon - April 3rd Upper Tucannon - April 4th to 25th Lower Tucannon - April 26th			
2018	3DD.0077C0C965	The Dalles East Ladder - August 23rd	Lower Toppenish Creek (Yakima) - October 28th	Lower Toppenish Creek (Yakima) - February 10th	Simcoe Creek (Yakima) - March 18th Simcoe Creek (Yakima) - April 6th		Prosser Dam (Yakima) - November 19th	Steelhead was recaptured at Processor Dam on April 22nd, 2019.
2018	3DD.0077BAB613	The Dalles East Ladder - October 7th	John Day - October 10th		Threemile Dam (Umatilla) - March 30th Umatilla - April 3rd Threemile Dam Juvenile Bypass (Umatilla) - May 9th			
2018	3DD.0077BA6602	The Dalles North Ladder - August 29th	McNary - October 24th		Threemile Dam Juvenile Bypass (Umatilla) - May 5th			
2018	3DD.0077C15BDB	The Dalles East Ladder - September 8th	John Day - October 14th		Threemile Dam (Umatilla) - March 16th Feed Dam (Umatilla) - March 20th Threemile Dam Juvenile Bypass (Umatilla) - May 6th			
2018	3DD.0077C0AE64	The Dalles East Ladder - September 3rd	Lower Granite - October 4th		Lochsa (Clearwater) - March 23rd Lochsa (Clearwater) - May 12th			Steelhead was recaptured at Lower Granite on October 4th, 2018.
2018	3DD.0077BA58D1	The Dalles East Ladder - July 26th	Lower Granite - October 19th		Cow Creek (Imnaha) - April 5th Cow Creek (Imnaha) - May 4th			
2018	3DD.0077BAB605	The Dalles East Ladder - September 2nd	Prosser Dam (Yakima) - November 9th		Lower Toppenish Creek (Yakima) - March 8th Upper Toppenish Creek (Yakima) - March 17th to April 27th Lower Toppenish Creek (Yakima) - April 29th		Prosser Dam (Yakima) - November 13th	Steelhead tagged at Bonneville AFF on October 12th, 2018. Steelhead was recaptured/retained on May 13th, 2019 at Prosser Dam by CRITFC Kelt Project. Released on October 31st, 2019 below Bonneville Dam. Considered a kelt, by Kelt Project.
2018	3DD.0077BA76FE	The Dalles East Ladder - September 20th	Lower Granite - September 28th		Upper Salmon - March 19th Kenney Creek (Lemhi) - May 4th to 10th Lower Lemhi (Salmon) - May 15th			Steelhead captured at Bonneville on July 6th, 2018. Unclear where steelhead was for several months between Bonneville and The Dalles detections.
2018	3DD.0077C0C9E6	The Dalles East Ladder - October 5th	Lower Granite - October 24th		Upper Salmon - April 6th Lower Granite Juvenile Bypass - April 30th			Steelhead tagged at Bonneville AFF on October 2nd, 2018. Steelhead was recaptured/retained on May 1st, 2019 by CRITFC Kelt Project. Considered a kelt, by Kelt Project.
2018	3DD.0077BA3B0D	The Dalles North Ladder - August 25th	Lower Granite - September 3rd		Lower Granite Juvenile Bypass - April 25th			Steelhead tagged at Bonneville AFF on July 19th, 2018. Steelhead was recaptured/released April 27th, 2019 by CRITFC Kelt Project. Considered a kelt, by Kelt Project.
2018	3DD.0077C0DA20	The Dalles East Ladder - October 14th	McNary - October 19th	Prosser Dam (Yakima) - January 5th	Sunnyside Dam (Yakima) - March 16th Ahtanum Creek (Yakima) - March 19th		Bonneville WA Ladder - November 8th	Steelhead tagged at Bonneville AFF on October 12th, 2018. Steelhead was recaptured/retained on May 13th, 2019 at Prosser Dam by CRITFC Kelt Project. Released on October 31st, 2019 below Bonneville Dam. Considered a kelt, by Kelt Project.
2018	3DD.0077BA4F0D	The Dalles North Ladder - September 6th	Lower Granite - September 22nd		Lower Granite Juvenile Bypass - May 15th			Steelhead tagged at Bonneville AFF on July 28th, 2018. Steelhead was recaptured/released on May 16th, 2019 by CRITFC Kelt Project. Considered a kelt, by Kelt Project.
2018	3DD.0077C0ADD8	The Dalles East Ladder - October 1st	Lower Granite - November 12th		Lower Granite Juvenile Bypass - May 27th Lower Monumental Juvenile Bypass - May 30th			Steelhead tagged at Bonneville AFF on October 9th, 2018. Steelhead was recaptured/released on May 27th, 2019 by CRITFC Kelt Project. Considered a kelt, by Kelt Project.
2018	3DD.0077C0E6FA	The Dalles East Ladder - September 8th	Lower Granite - October 17th		Lower Granite Juvenile Bypass - April 27th			Steelhead tagged at Bonneville AFF on September 5th, 2018. Steelhead was recaptured/released on April 28th, 2019 by CRITFC Kelt Project. Considered a kelt, by Kelt Project.
2018	3DD.0077BA8377	The Dalles East Ladder -July 22nd	Lower Granite - October 19th		Joseph Creek (Grande Ronde) - March 16th Lower Granite Juvenile Bypass - May 10th			Steelhead tagged at Bonneville AFF on July 20th, 2018. Steelhead was recaptured/retained on May 11th, 2019 by CRITFC Kelt Project. Considered a kelt, by Kelt Project.
2018	3DD.0077BA7289	The Dalles East Ladder -July 18th	Prosser Dam (Yakima) - October 5th		Lower Naches (Yakima) - March 25th	Prosser Dam (Yakima) - June 3rd		Steelhead tagged at Bonneville AFF on July 16th, 2018. Steelhead was recaptured/retrained at Prosser Dam on June 6th, 2019 by CRITFC Kelt Project. Released on October 31st, 2019 below Bonneville Dam. Considered a kelt, by Kelt Project.
2018	3DD.0077C049E9	The Dalles North Ladder - October 13th	Lower Granite - November 12th		Lower Granite Juvenile Bypass - May 12th			Steelhead tagged at Bonneville AFF on October 9th, 2018. Steelhead was recaptured/retrained at Lower Granite on May 13th, 2019 by CRITFC Kelt Project. Considered a kelt, by Kelt Project.
2018	3DD.0077BA8FD4	The Dalles East Ladder - July 25th	Ice Harbor - November 9th	Little Goose - December 14th	Little Goose - March 31st Lower Granite - April 1st Lower Granite Juvenile Bypass - May 10th			Steelhead tagged at Bonneville AFF on July 24th, 2018. Steelhead was recaptured/released at Lower Granite on May 10th, 2019 by CRITFC Kelt Project. Considered a kelt, by Kelt Project.
2018	3DD.0077BFE41A	The Dalles East Ladder - November 7th		Ice Harbor - December 26th	Lower Granite - March 30th Lower Granite Juvenile Bypass - April 24th			Steelhead tagged at Bonneville AFF on October 10th, 2018. Steelhead was recaptured/released at Lower Granite on April 24th, 2019 by CRITFC Kelt Project. Considered a kelt, by Kelt Project.

Key - - - Upstream | Downstream | Spawning

Table B3. Season by season activities of steelhead tagged in 2018 and later labeled as kelts or repeat spawners when they began migrating downstream (before April 1st) and upstream in spring, summer, or fall of 2018, and winter, spring 2019, presumably to and from the ocean.

Tag Year	Tag Number	First Detection After Tagging 2018 in Spring/Summer/Fall	Fall 2018	Winter 2018/19	Spring 2019	Comments
2018	3DD.0077BA54A9	Lyle Falls (Klickitat) - May 11th		Little Klickitat - January 23rd Little Klickitat - February 26th	Bonneville Juvenile Bypass - March 2nd	
2018	3DD.003BDE4C87	Bonneville AFF - September 27th	Lower Granite - October 12th		Lower SF Clearwater - March 19th Lower SF Clearwater - March 31st	This fish was tagged as a juvenile in 2016, recaptured at Bonneville as a returning adult.
2018	3DD.0077BA76F1	Lyle Falls (Klickitat) - May 9th	Lyle Falls (Klickitat) - November 4th	Bonneville Dam Corner Collector - February 26th		
2018	3DD.0077C15B20	The Dalles East Ladder - September 14th	McNary - October 2nd		McNary - March 25th	
2018	3DD.0077BACB71	The Dalles East Ladder - July 21st	McNary - October 30th		McNary - March 25th	

Key - - - Upstream | Downstream | Spawning

Table B4. Season by season activities of steelhead tagged in 2016 and 2017 (fish from 2015, no new) and later labeled as kelts or repeat spawners when they began migrating downstream and upstream presumably to and from the ocean. Any new steelhead or steelhead with additional information from previous annual reports is included here as behavioral detections became available in 2018/19/20.

Tag Year	Tag Number	First Detection After Tagging in Spring/Summer/Fall	Fall	Winter	Spring	Comments
2016	3DD.00779937A4	The Dalles East Ladder - July 3rd, 2016			Lower Imnaha - March 17th, 2017	Steelhead tagged at Bonneville AFF on June 30th, 2016 and was also recaptured on May 26th, 2017 by CRITFC Kelt Project. Entered reconditioning program at Nez Perce Tribal Hatchery. Information added.
					Big Sheep Creek (Imnaha) - March 28th, 2017	
			Lower Granite - November 12th, 2018		Lower Imnaha - March 25th, 2019	
					Big Sheep Creek (Imnaha) - April 5th, 2019	
2016	3DD.00778BB5AB	The Dalles North Ladder - August 3rd, 2016	Prosser Dam (Yakima) - October 10th, 2016			Tagged August 1st, 2016. Fish likely spent months in the ocean between Summer 2016 and Summer 2018. Information added.
		Bonneville WA Ladder - July 12th, 2018	Prosser Dam (Yakima) - November 28th, 2018		Lower Naches (Yakima) - April 1st, 2019	
2016	3DD.00778B34BD		Bonneville WA Shore Ladder - October 2nd, 2017		Bonneville Dam Corner Collector - April 28th, 2018	Repeat Spawner - this fish was tagged by this project August 11th of 2016 over a year before it was seen again migrating upriver passed Bonneville Dam again. We assume this fish spent time in the ocean between detections. Information added.
2016	3DD.00778A6FCA	The Dalles East Ladder - August 22nd, 2016	McNary - September 25th, 2016	Lower Walla Walla - February 5th, 2017		Tagged August 18th, 2016. Fish likely spent months in the ocean between Summer 2016 and Summer 2018. Information added.
				Lower John Day - February 22nd, 2017		
		Bonneville WA Ladder - July 4th, 2018	John Day - October 3rd, 2018	Lower John Day - January 24th, 2019	Cottonwood Creek (NF John Day - March 18th, 2019	
2017	3DD.00778A10CD	Bonneville Bradford Ladder - May 4th, 2017	Upper Wind - October 23rd, 2017	Upper Wind - February 20th, 2018	Upper Wind - March 10th, 2018	Tagged May 19th, 2017. Fish likely spent months in the ocean between Spring 2018 and Spring 2019. New steelhead.
					Bonneville WA Ladder - May 2nd, 2019	
2017	3DD.0077BA55A2	The Dalles East Ladder - October 18th, 2017	McNary - October 21st, 2017	Lower Walla Walla - December 21st, 2017	Lower Coppei Creek (Touchet) - April 27th, 2018	Tagged October 16th, 2017. Fish likely spent months in the ocean between Spring 2018 and Fall 2018. Information added.
				Lower Coppei Creek (Touchet) - January 29th, 2018		
		Bonneville Cascade Ladder - September 8th, 2018	Lower Walla Walla - November 26th, 2018	Touchet (Walla Walla) - January 25th, 2019	Touchet (Walla Walla) - May 11th, 2019	
				Lower Coppei Creek (Touchet) - March 15th		
2017	3DD.007797C0B8	The Dalles East Ladder - July 15th, 2017	Middle Deschutes - September 18th, 2017		John Day - March 13th, 2018	Tagged July 10th, 2017. Fish likely spent months in the ocean between Spring 2018 and Summer 2019. New steelhead.
		Bonneville Bradford Ladder - July 18th, 2019				
2017	3DD.007797BB36	Bonneville WA Ladder - July 10th, 2017				Tagged July 10th, 2017. Fish likely spent months in the ocean between Summer 2017 and Summer 2018. New steelhead.
		Bonneville WA Ladder - July 21st, 2019				
2017	3DD.0077BAC383	The Dalles East Ladder - October 21st, 2017	Lower Walla Walla - November 26th, 2017		Pattit Creek (Walla Walla) - April 11th to 13th, 2018	Tagged July 19th, 2017. Fish likely spent months in the ocean between Spring 2018 and Summer 2019. Information added.
					Bonneville Juvenile Bypass - May 5th, 2018	
		Bonneville Bradford Ladder - July 16th, 2019	McNary - September 30th, 2019			

Key - - - Upstream | Downstream | Spawning

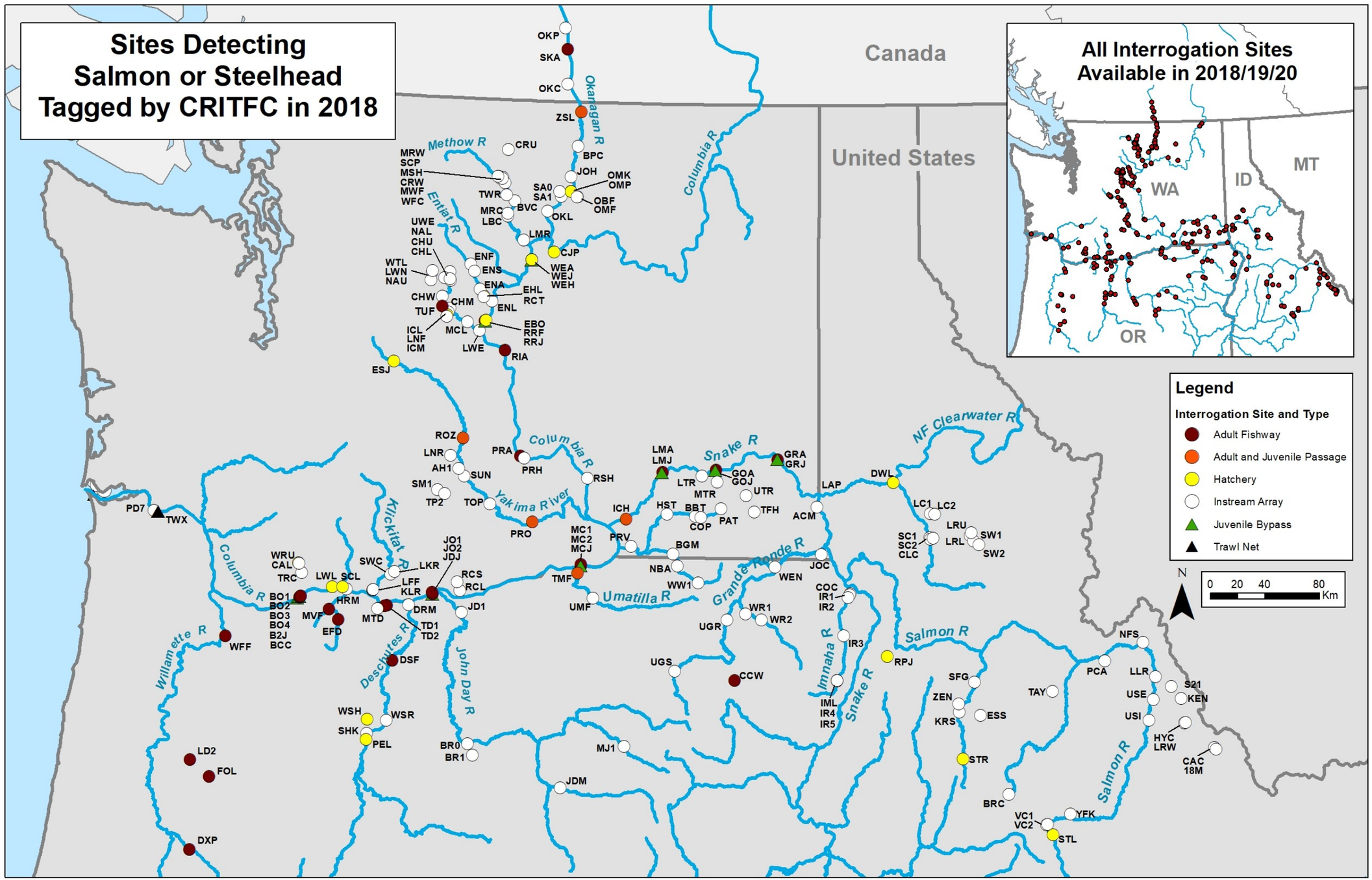

Figure B1. Map of Columbia River interrogation sites that detected Chinook and Sockeye salmon, and steelhead in 2018. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

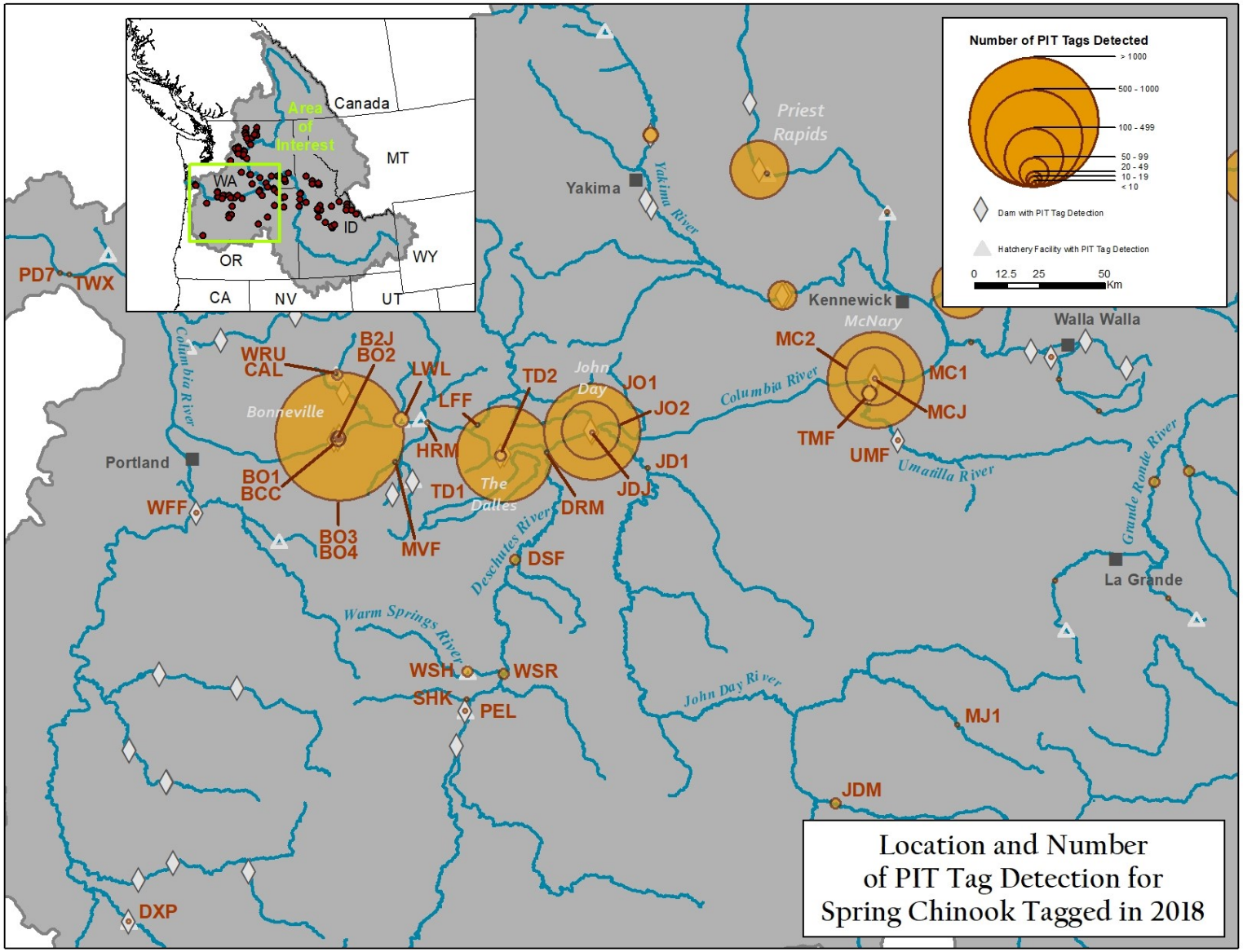

Figure B2. Map of Lower Columbia River detection sites (below Snake River) and number of spring Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January 1 to June 1.

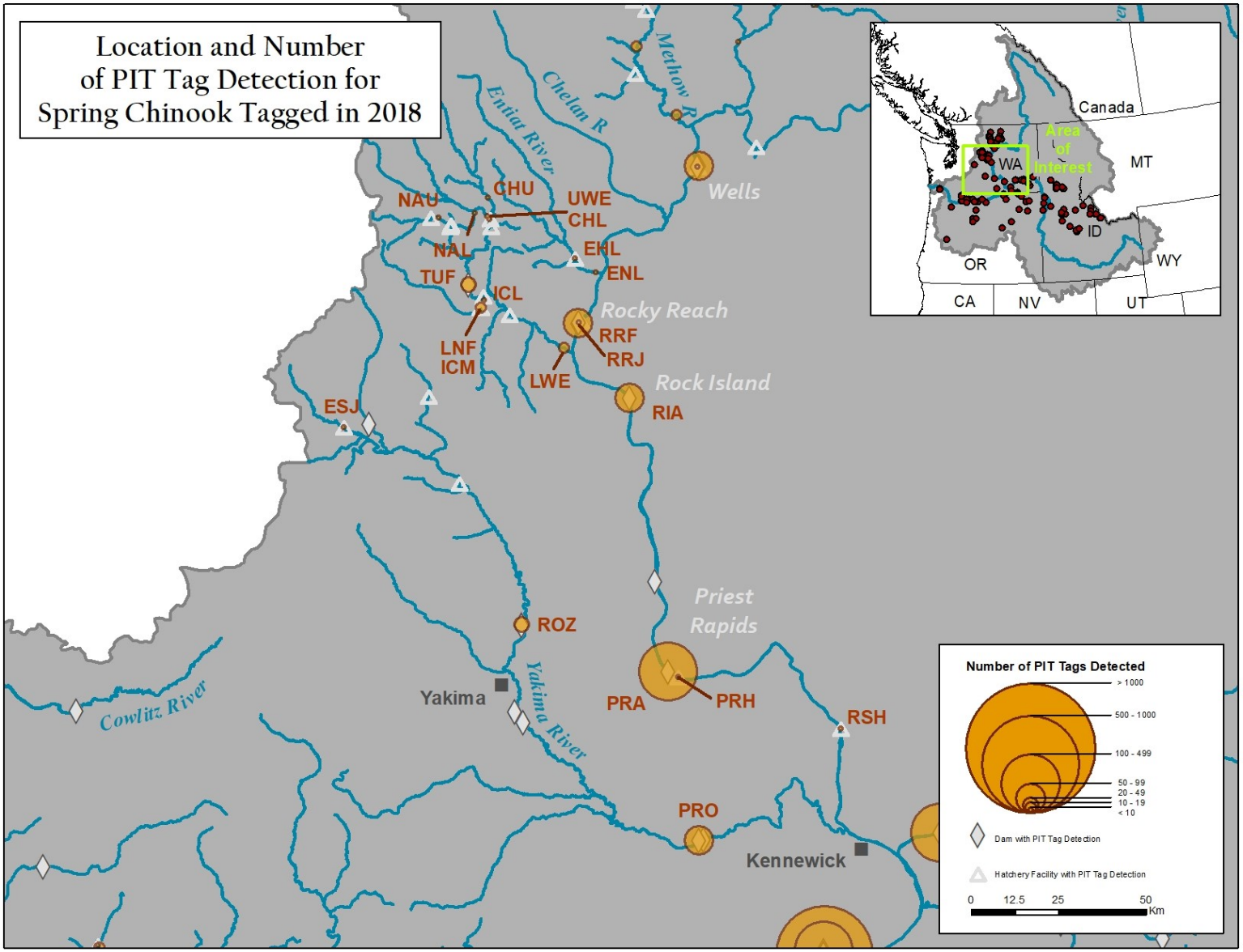

Figure B3. Map of Upper Columbia River (between the Snake River and Wells Dam) detection sites and number of spring Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January 1 to June 1.

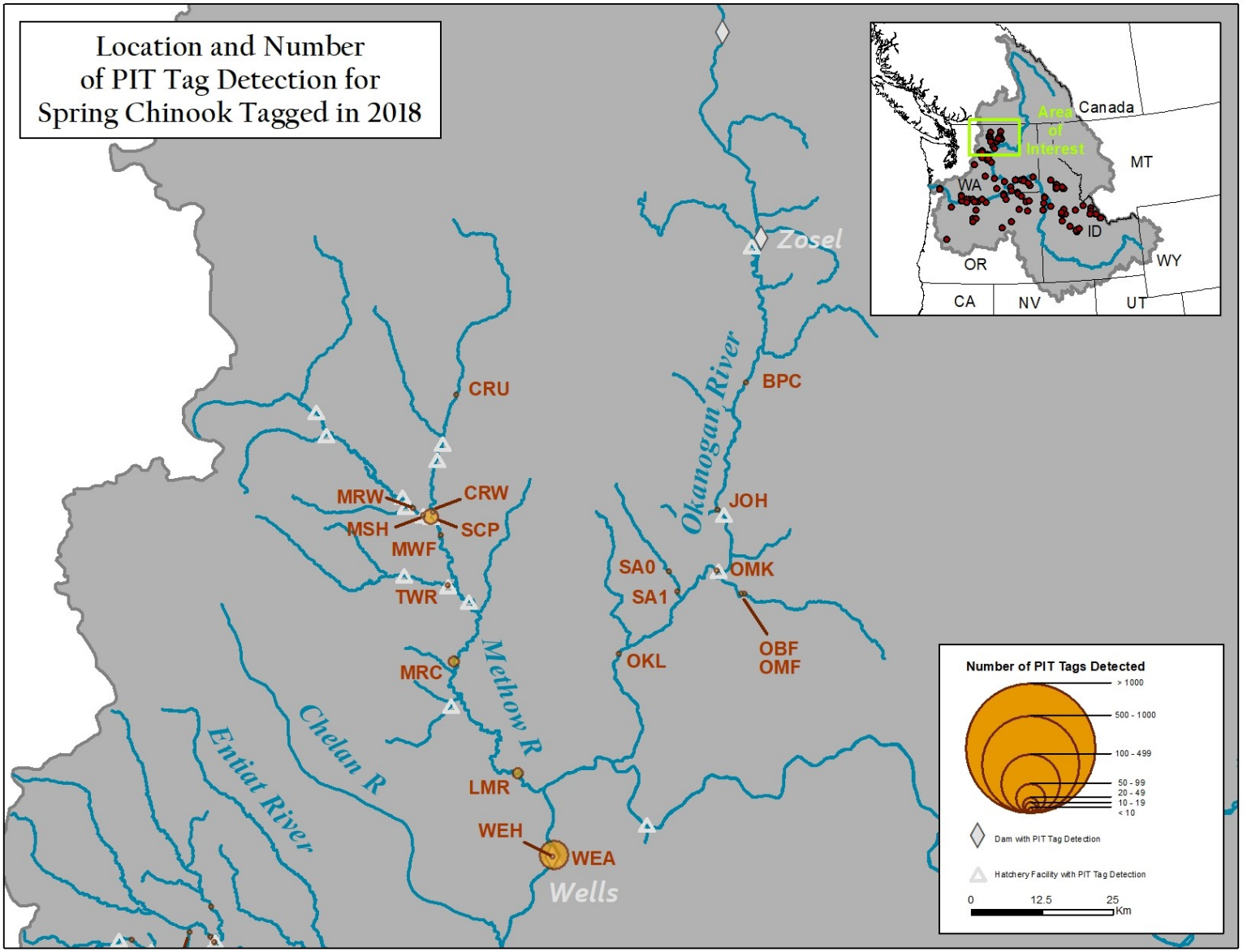

Figure B4. Map of Upper Columbia River (Wells Dam and above) detection sites and number of spring Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January 1 to June 1.

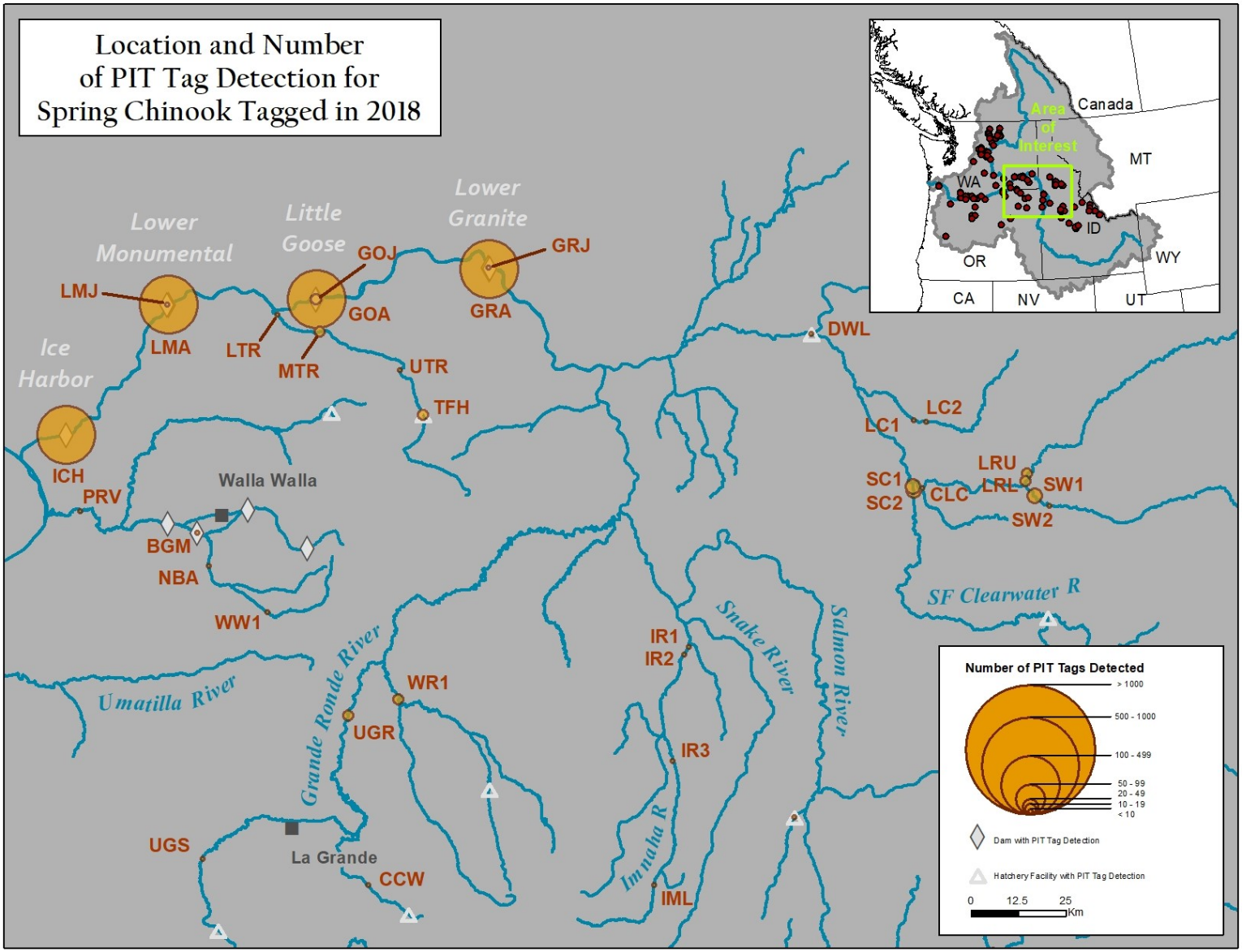

Figure B5. Map of Lower Snake River detection sites (Salmon River not included) and number of spring Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January 1 to June 1.

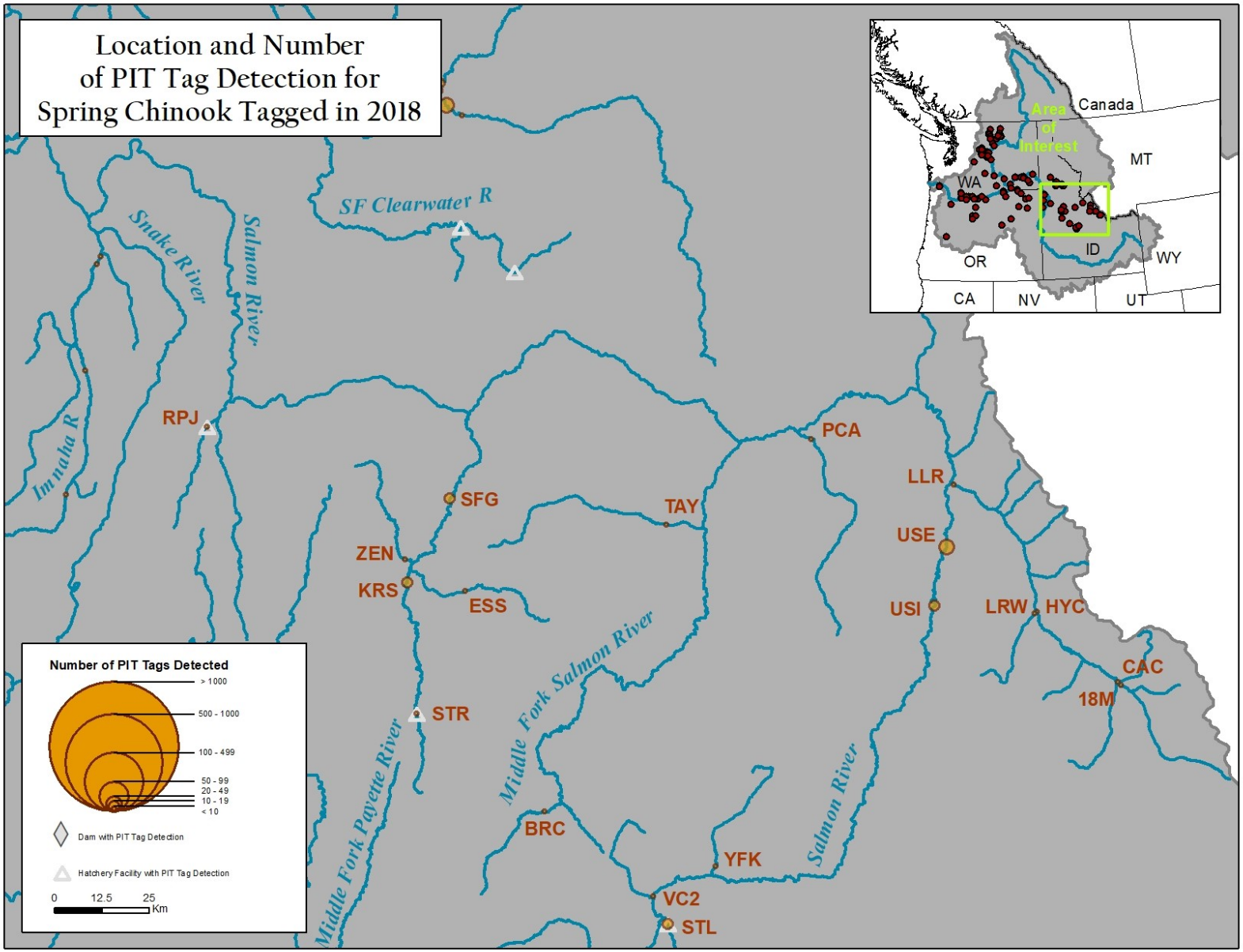

Figure B6. Map of Salmon River detection sites and number of spring Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January 1 to June 1.

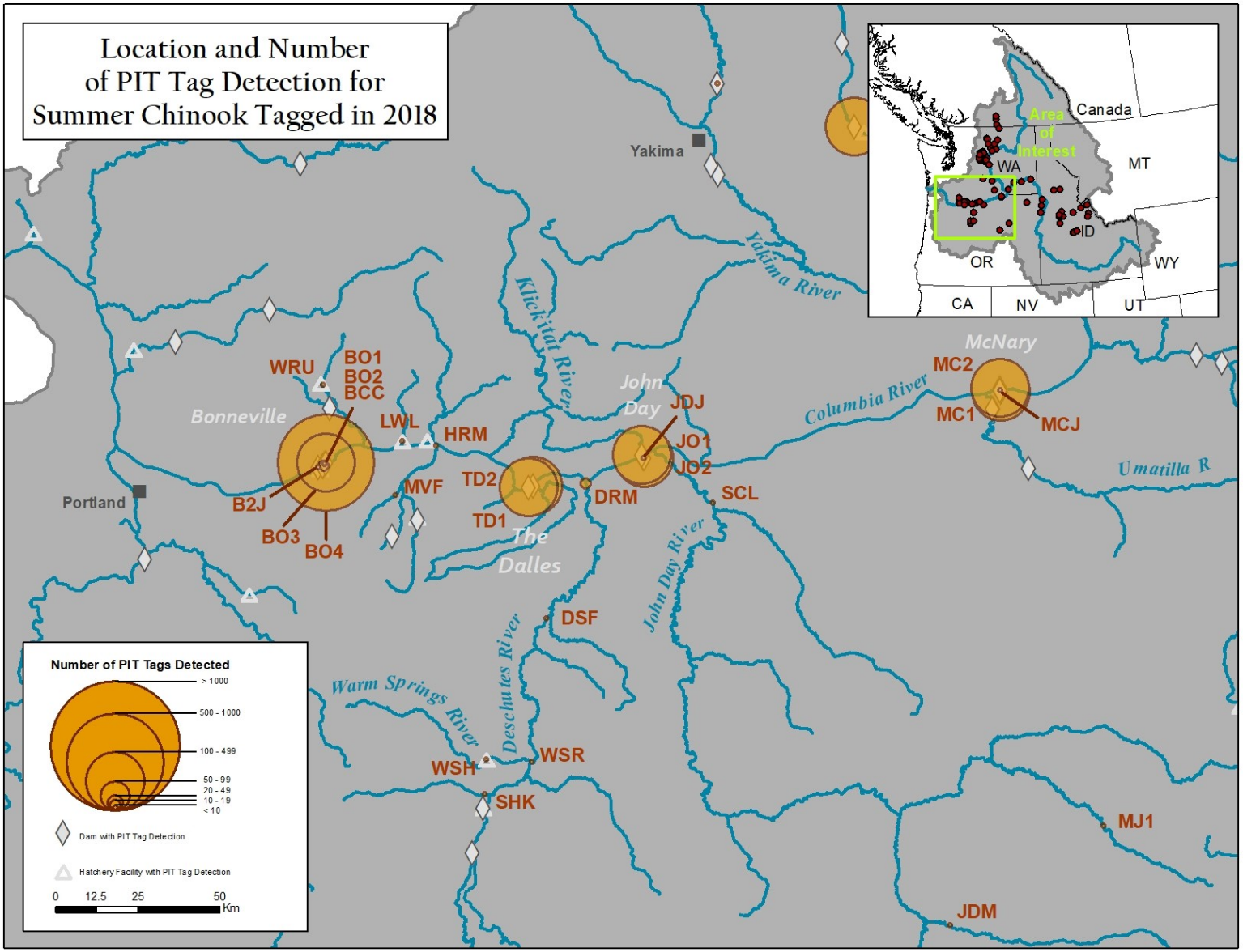

Figure B7. Map of Lower Columbia River detection sites (below Snake River) and number of summer Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June 1 to August 1.

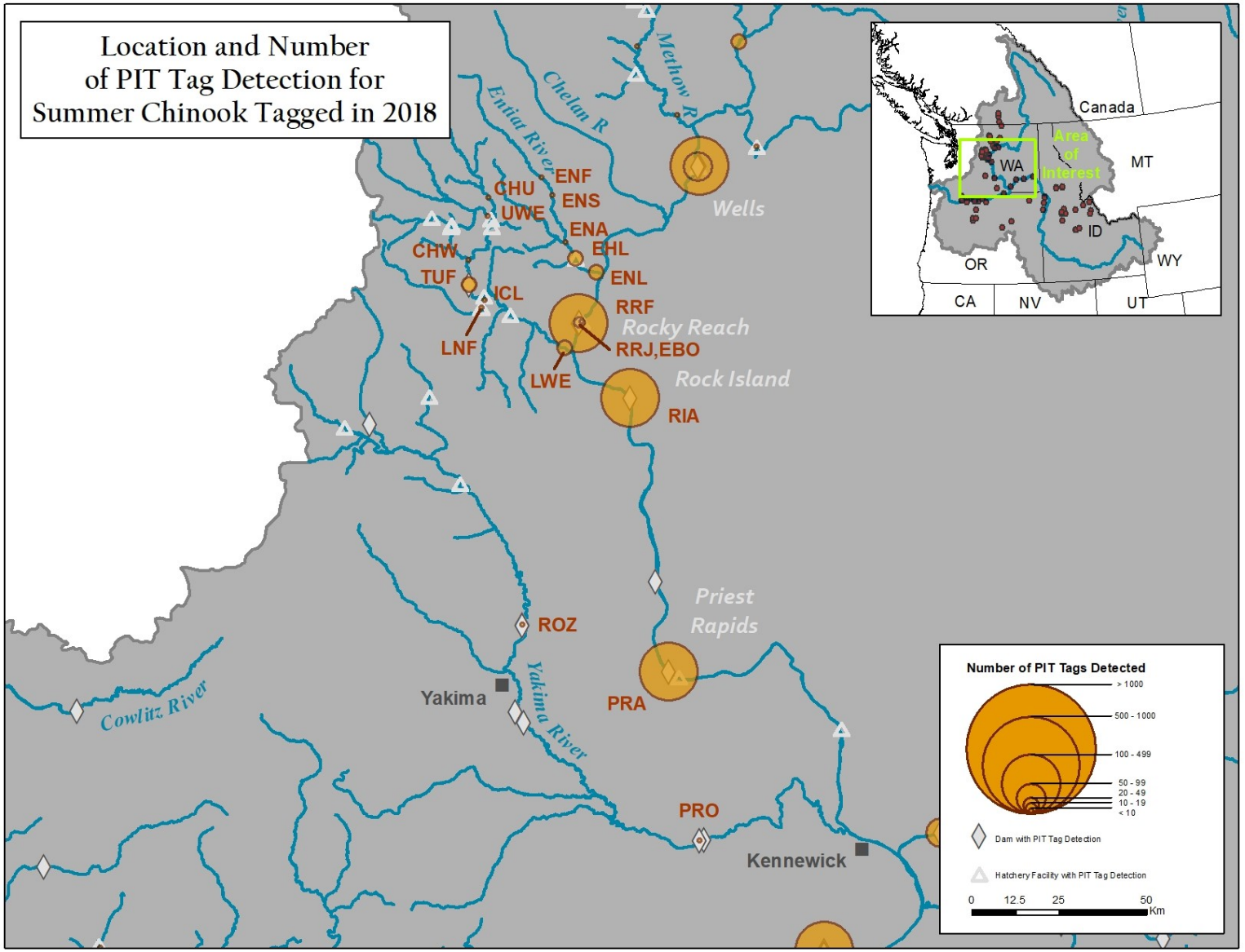

Figure B8. Map of Upper Columbia River (between the Snake River and Wells Dam) detection sites and number of summer Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June 1 to August 1.

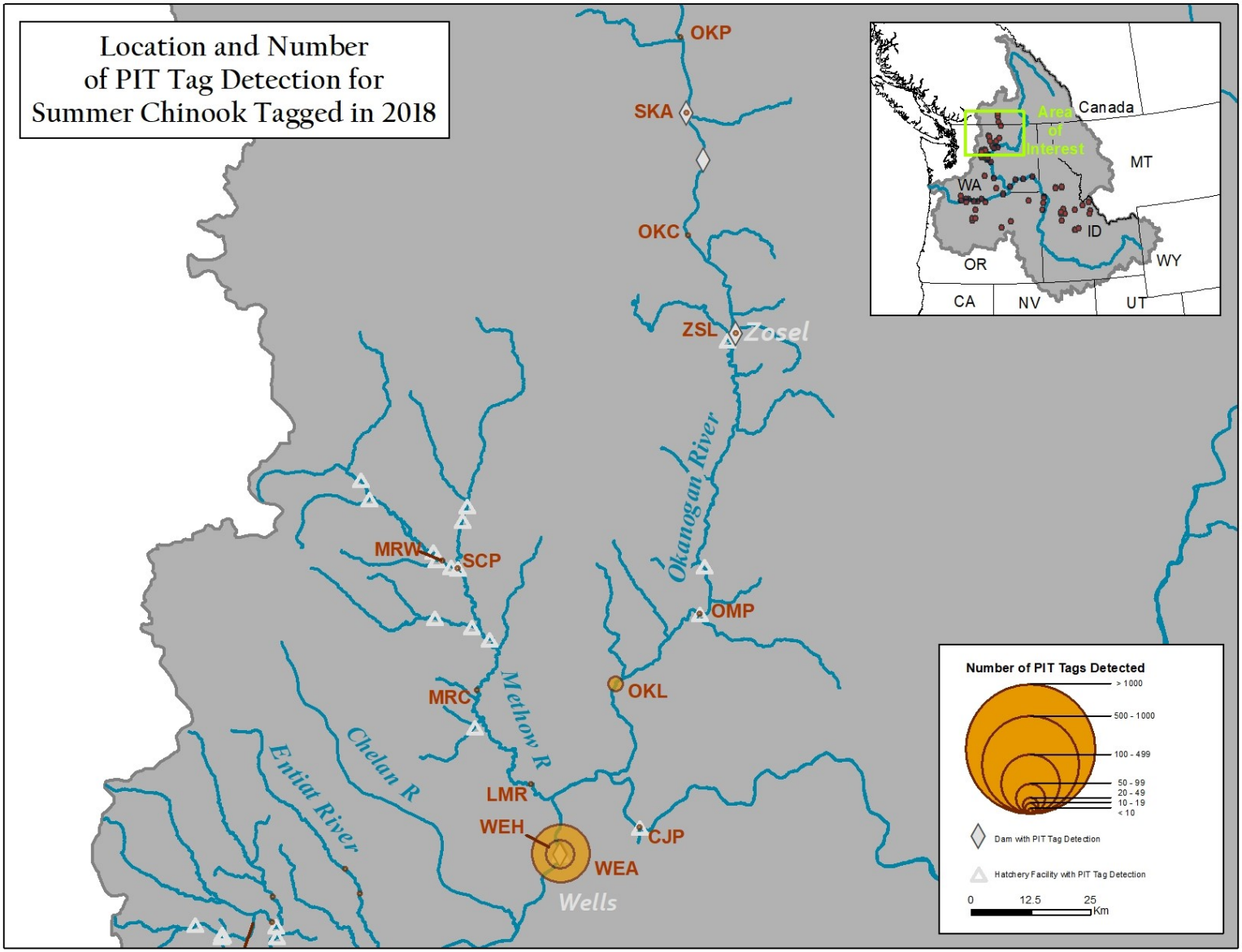

Figure B9. Map of Upper Columbia River (Wells Dam and above) detection sites and number of summer Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June 1 to August 1.

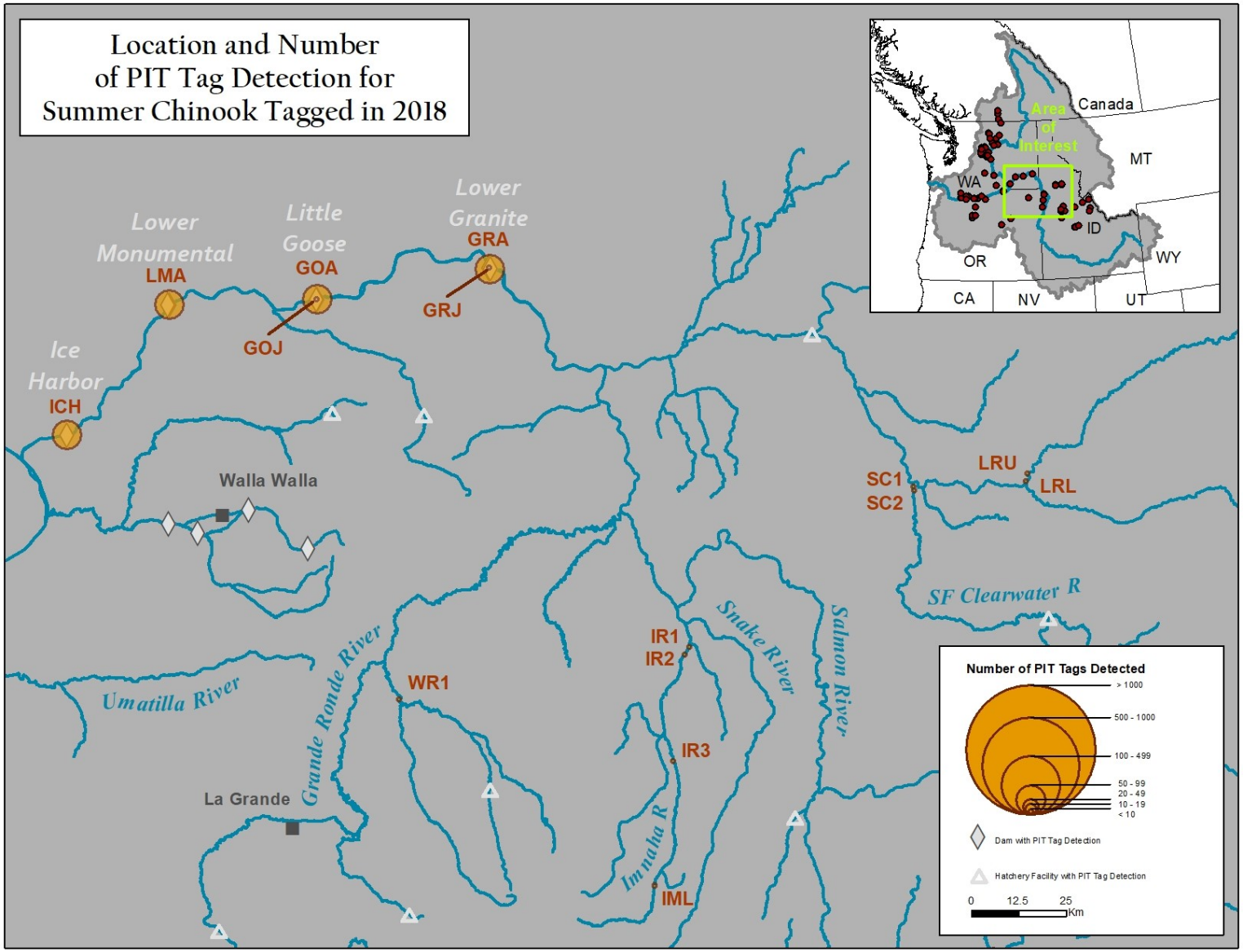

Figure B10. Map of Lower Snake River detection sites (Salmon River not included) and number of summer Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June 1 to August 1.

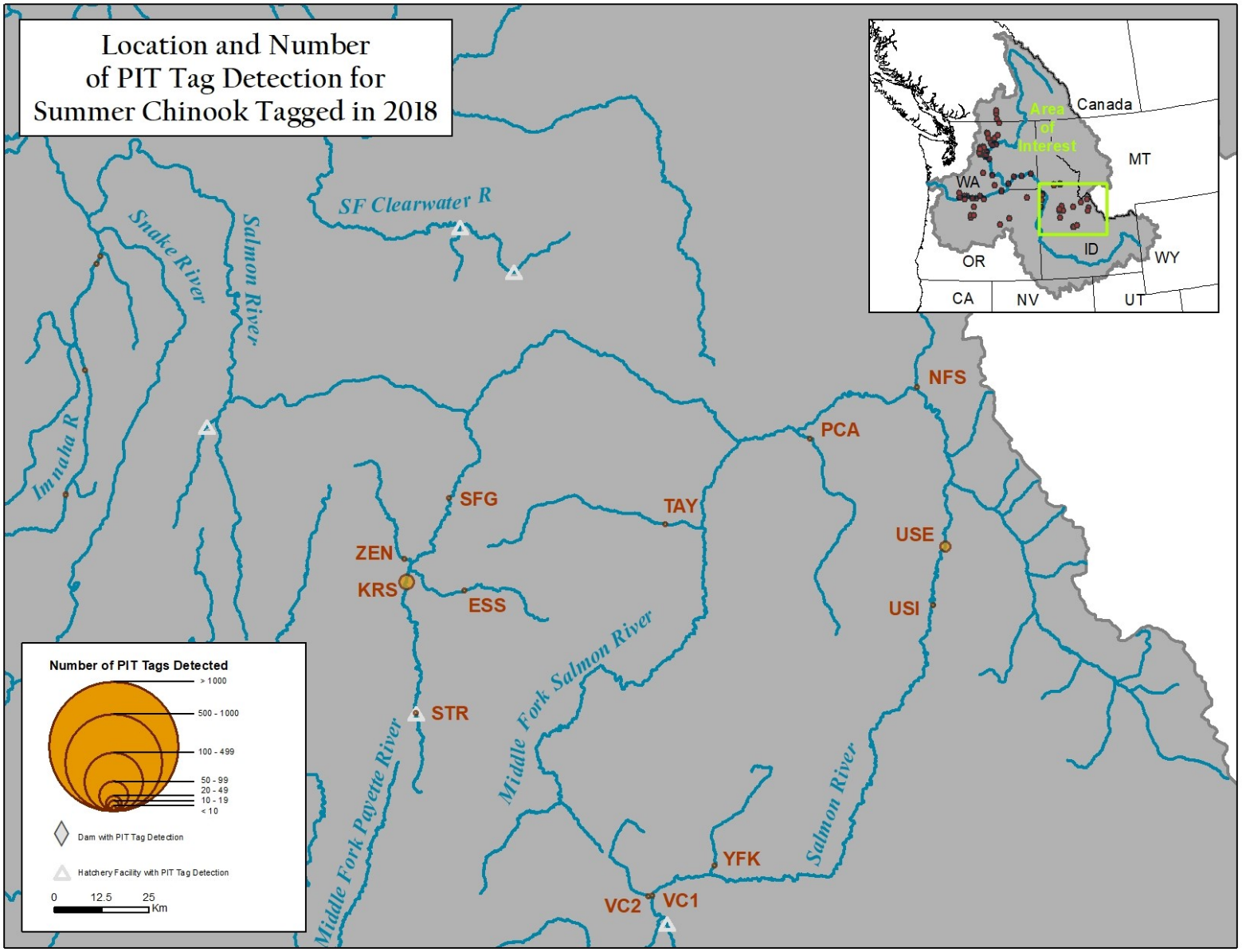

Figure B11. Map of Salmon River detection sites and number of summer Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June 1 to August 1.

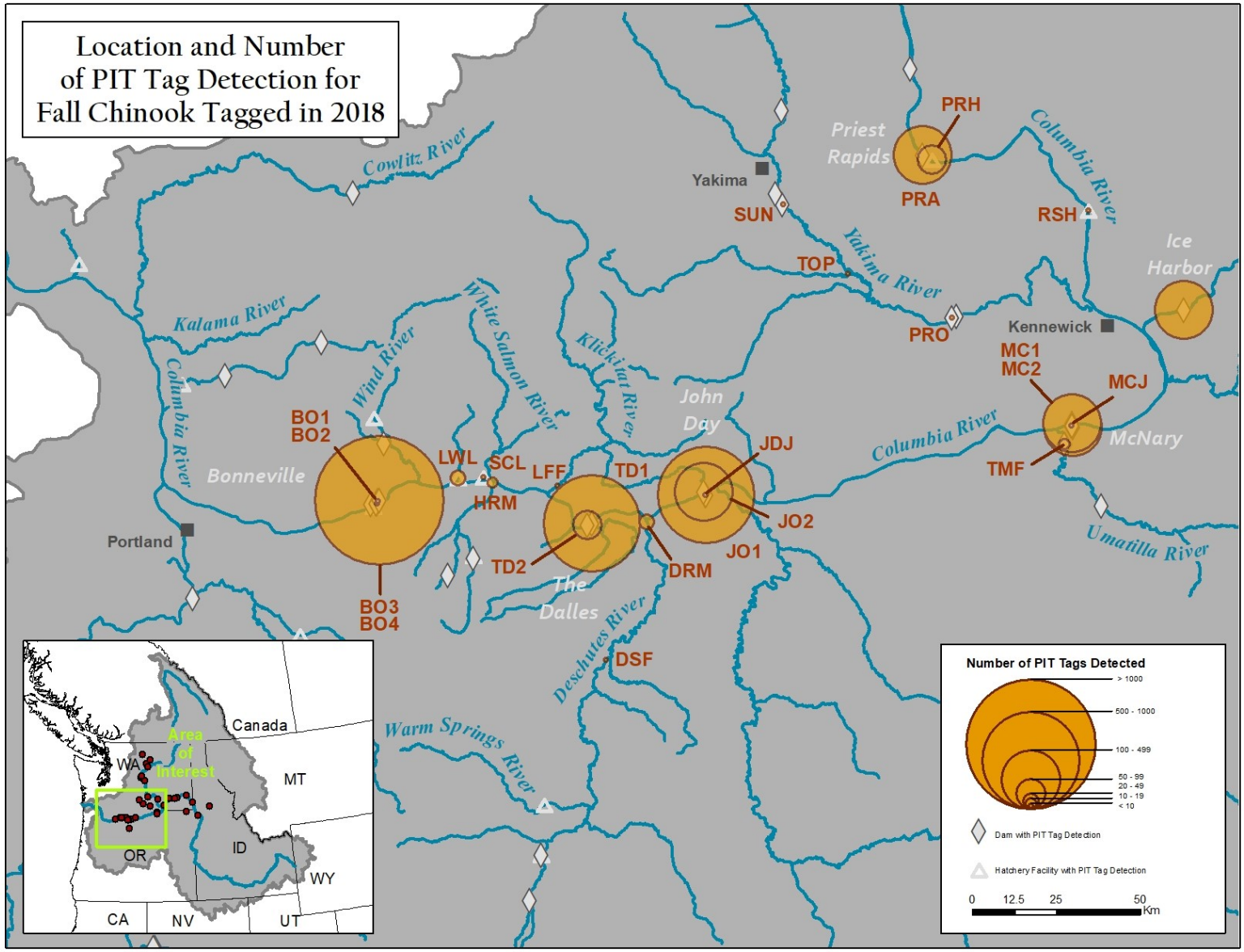

Figure B12. Map of Lower and Middle Columbia River detection sites (below Rock Island Dam) and number of fall Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Fall Chinook is defined as fish passing Bonneville Dam from August 1 to end of year.

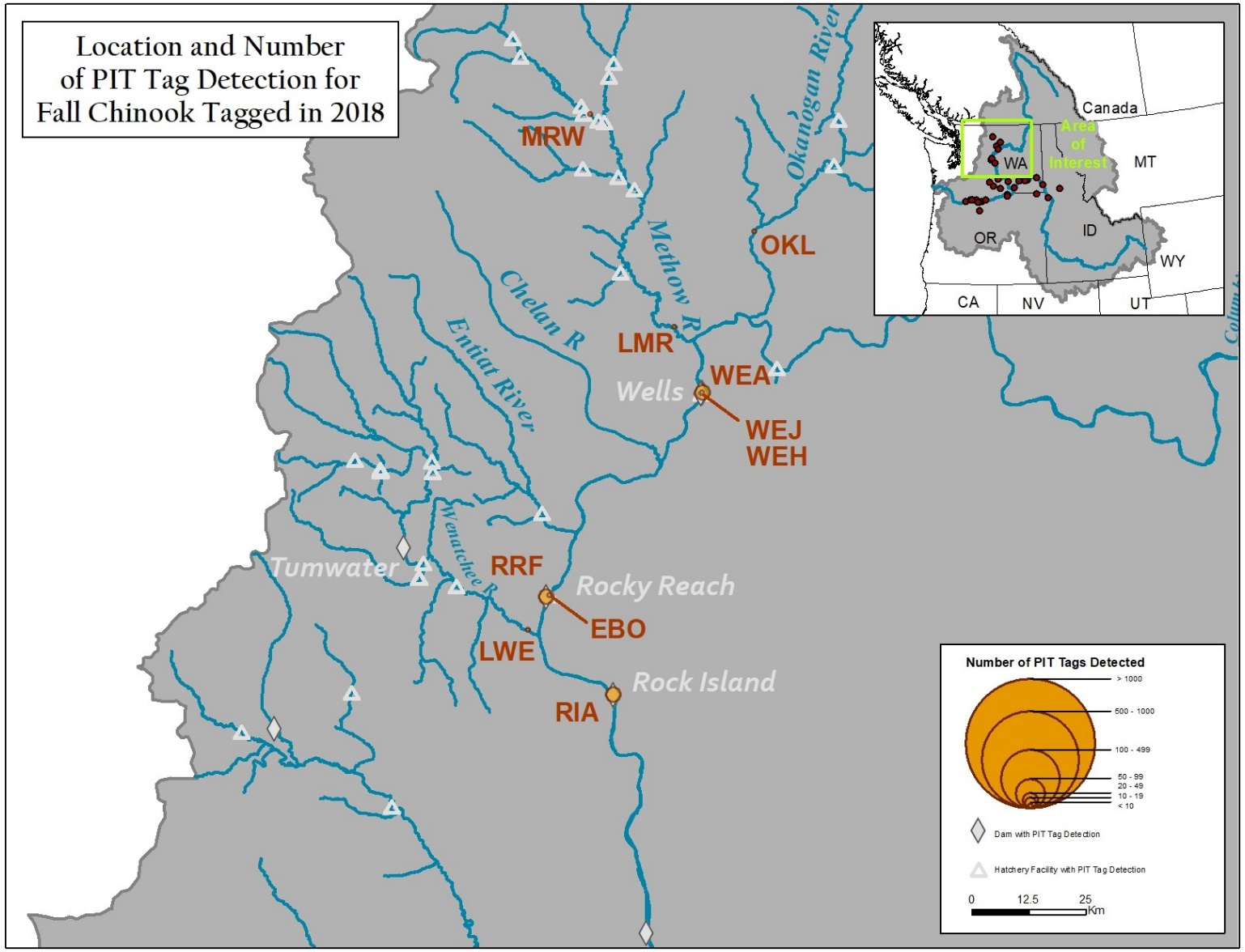

Figure B13. Map of Upper Columbia River detection sites (Rock Island Dam and above) and number of fall Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Fall Chinook is defined as fish passing Bonneville Dam from August 1 to end of year.

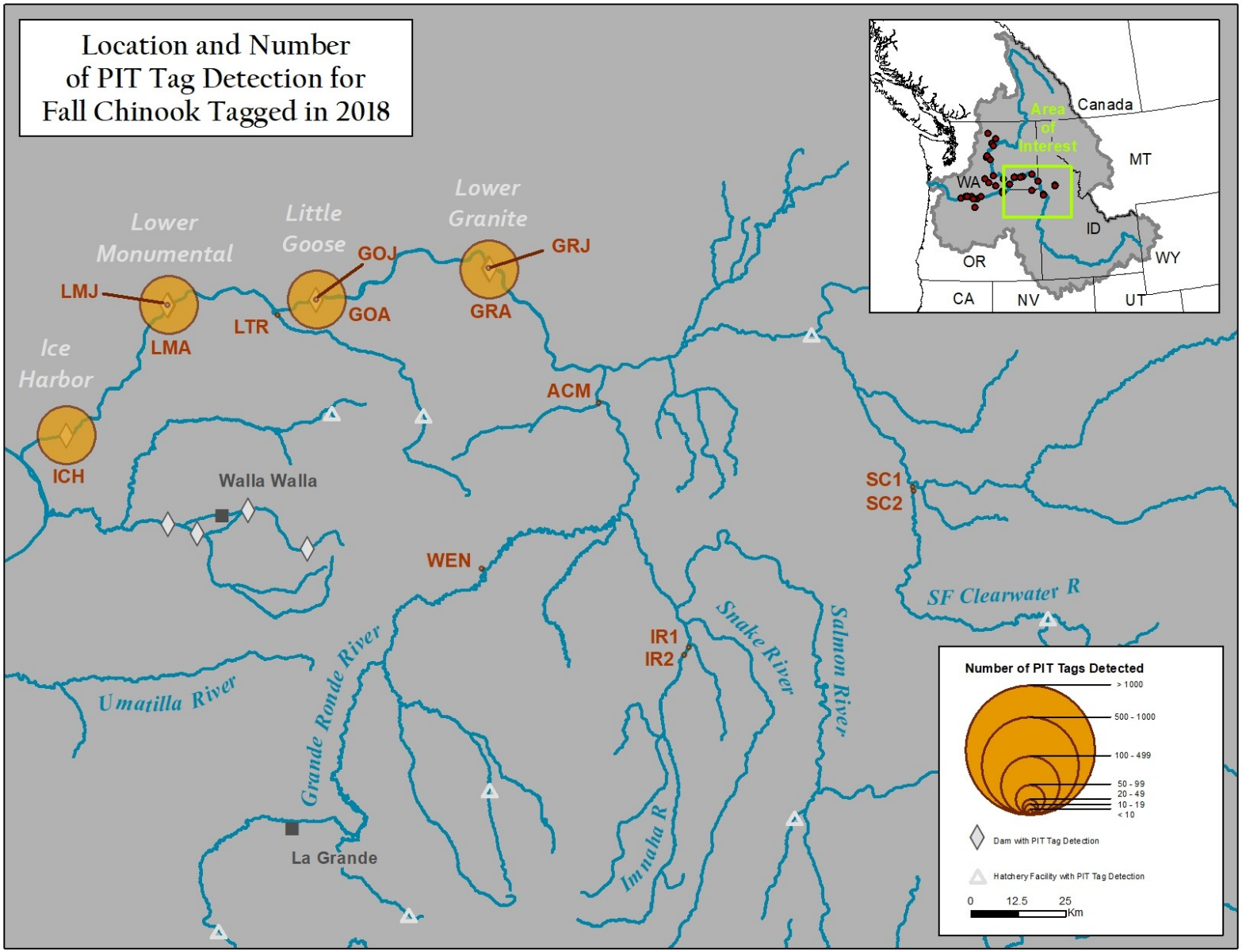

Figure B14. Map of Lower Snake River detection sites and number of fall Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Fall Chinook is defined as fish passing Bonneville Dam from August 1 to end of year.

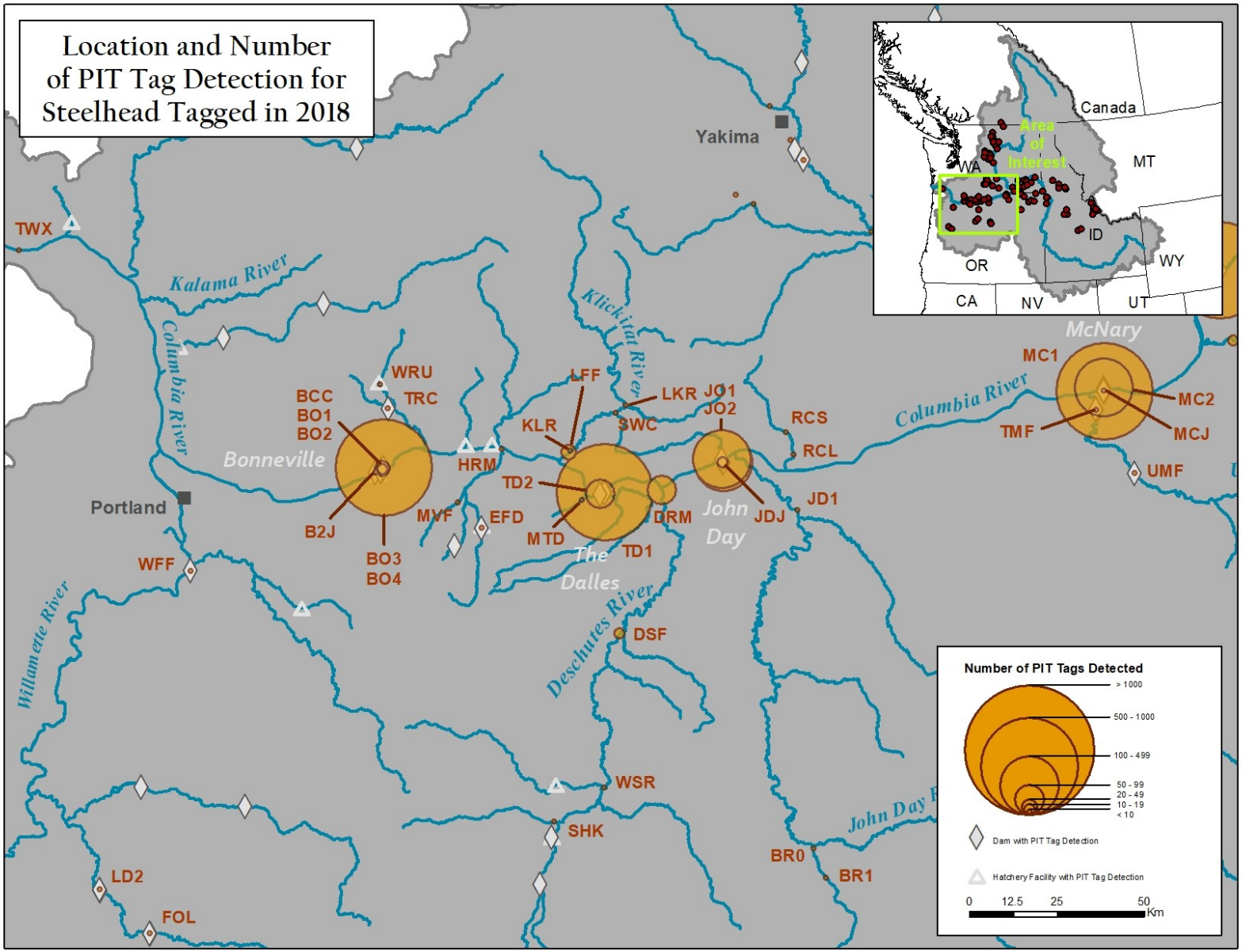

Figure B15. Map of Lower Columbia River detection sites (below Snake River) and number of steelhead detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

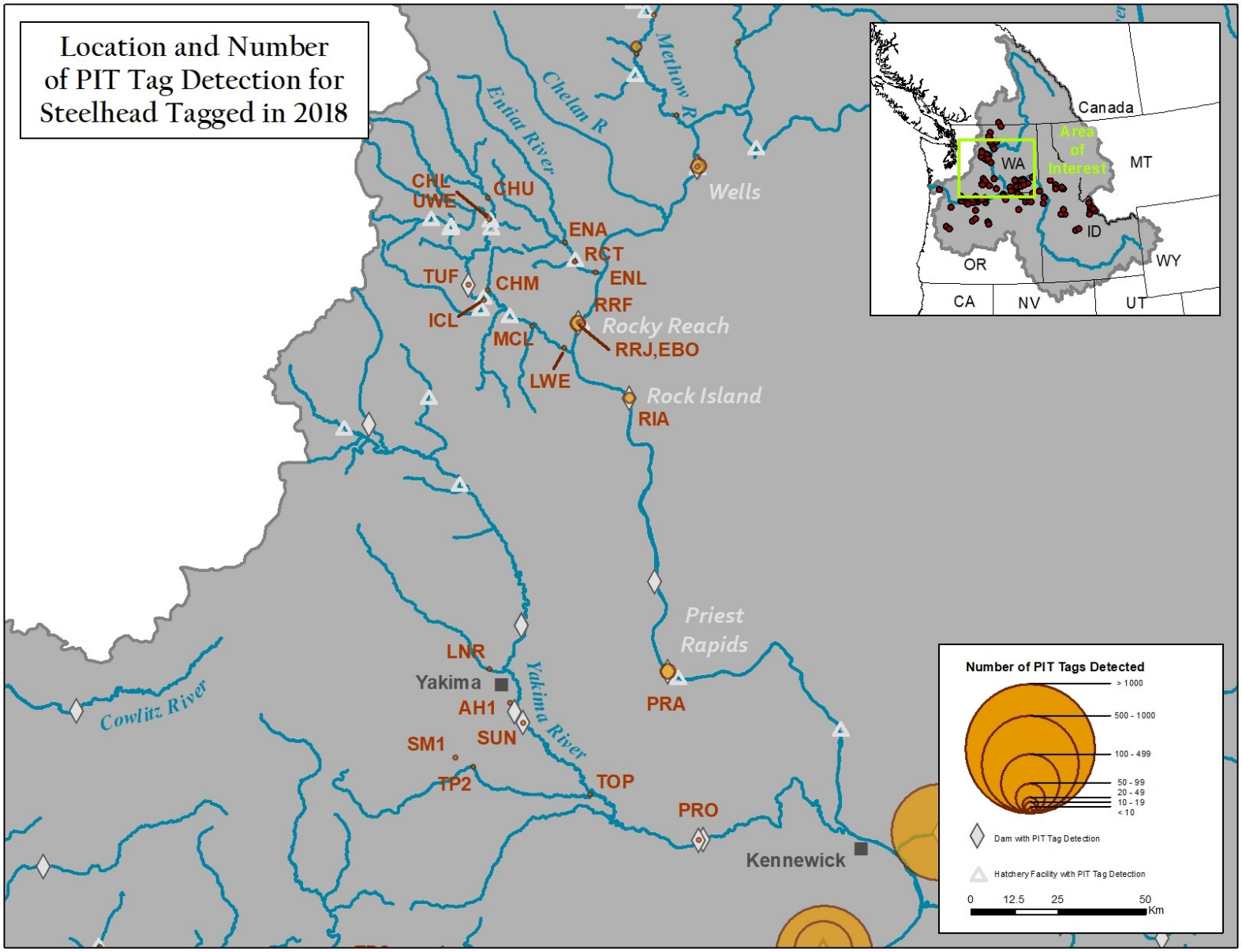

Figure B16. Map of Upper Columbia River (between the Snake River and Wells Dam) detection sites and number of steelhead detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

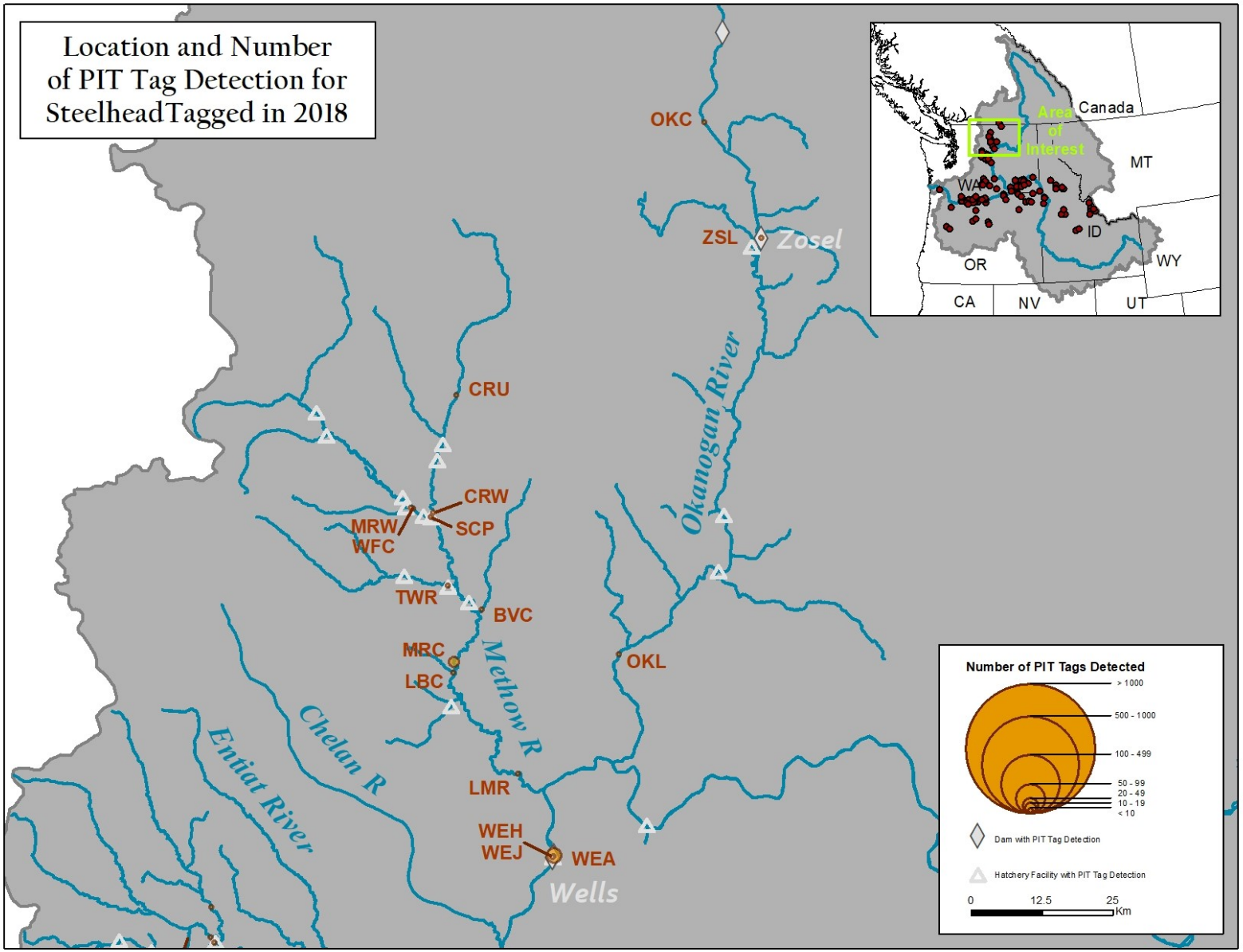

Figure B17. Map of Upper Columbia River (Wells Dam and above) detection sites and number of steelhead detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

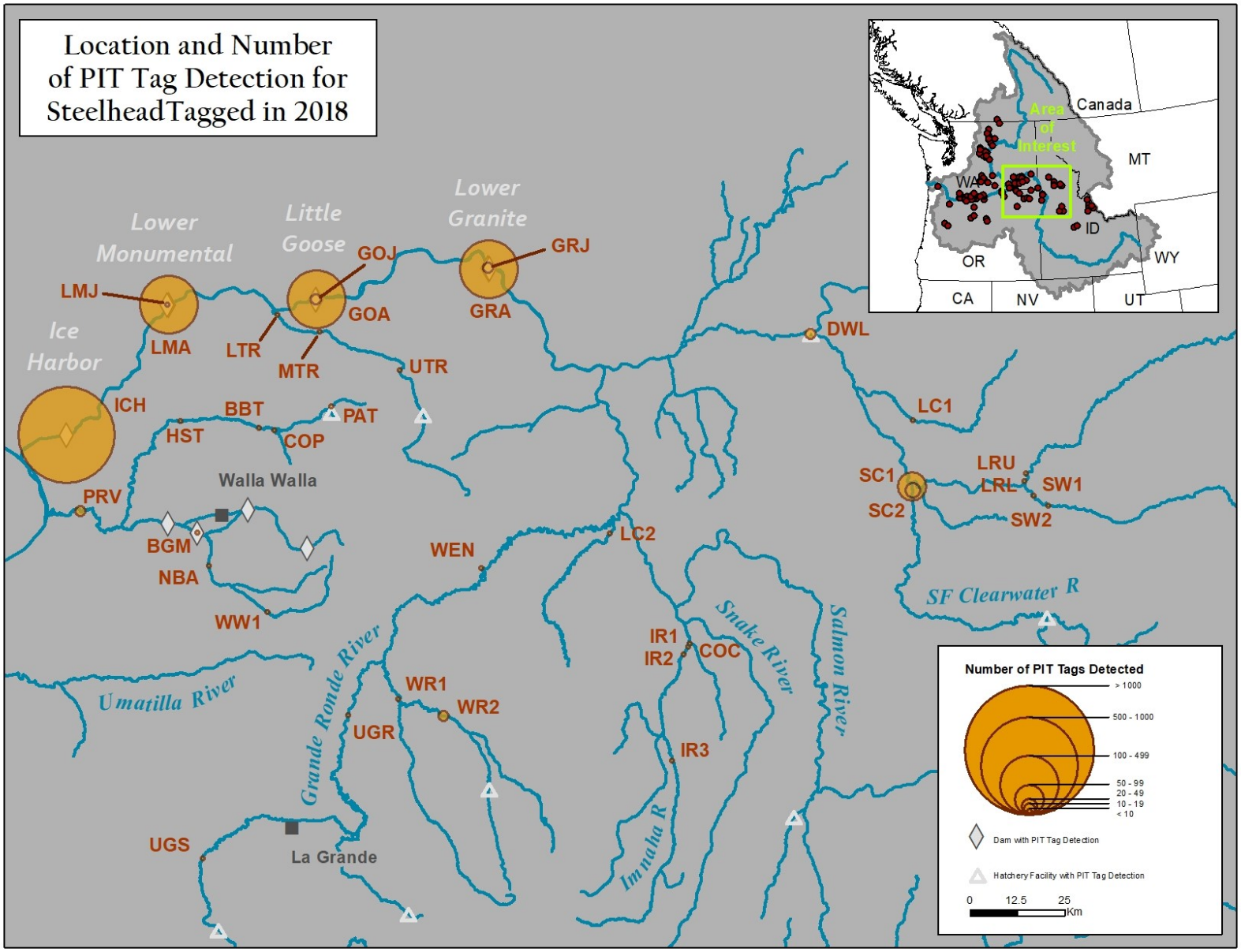

Figure B18. Map of Lower Snake River detection sites (Salmon River not included) and number of steelhead detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

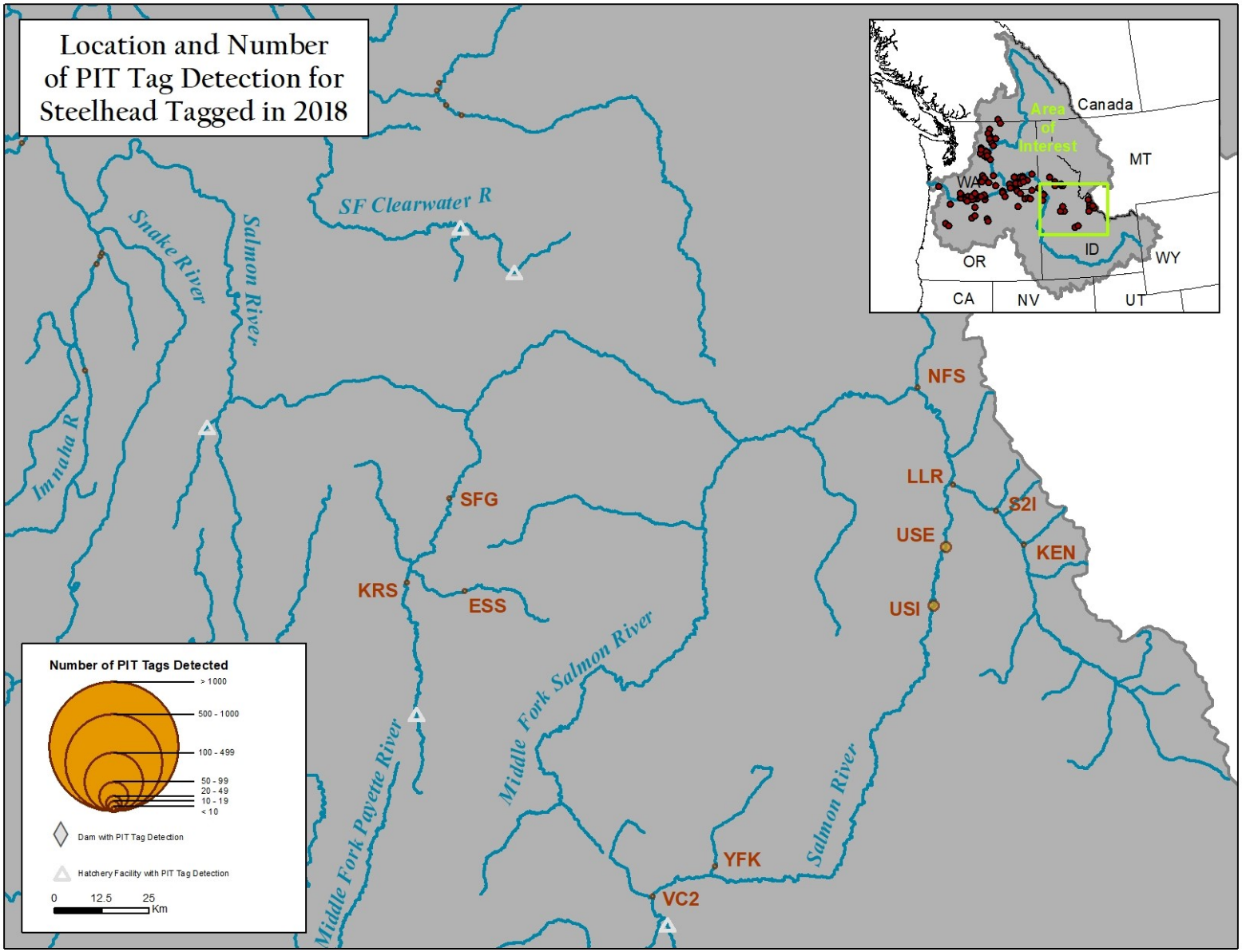

Figure B19. Map of Salmon River detection sites and number of steelhead detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

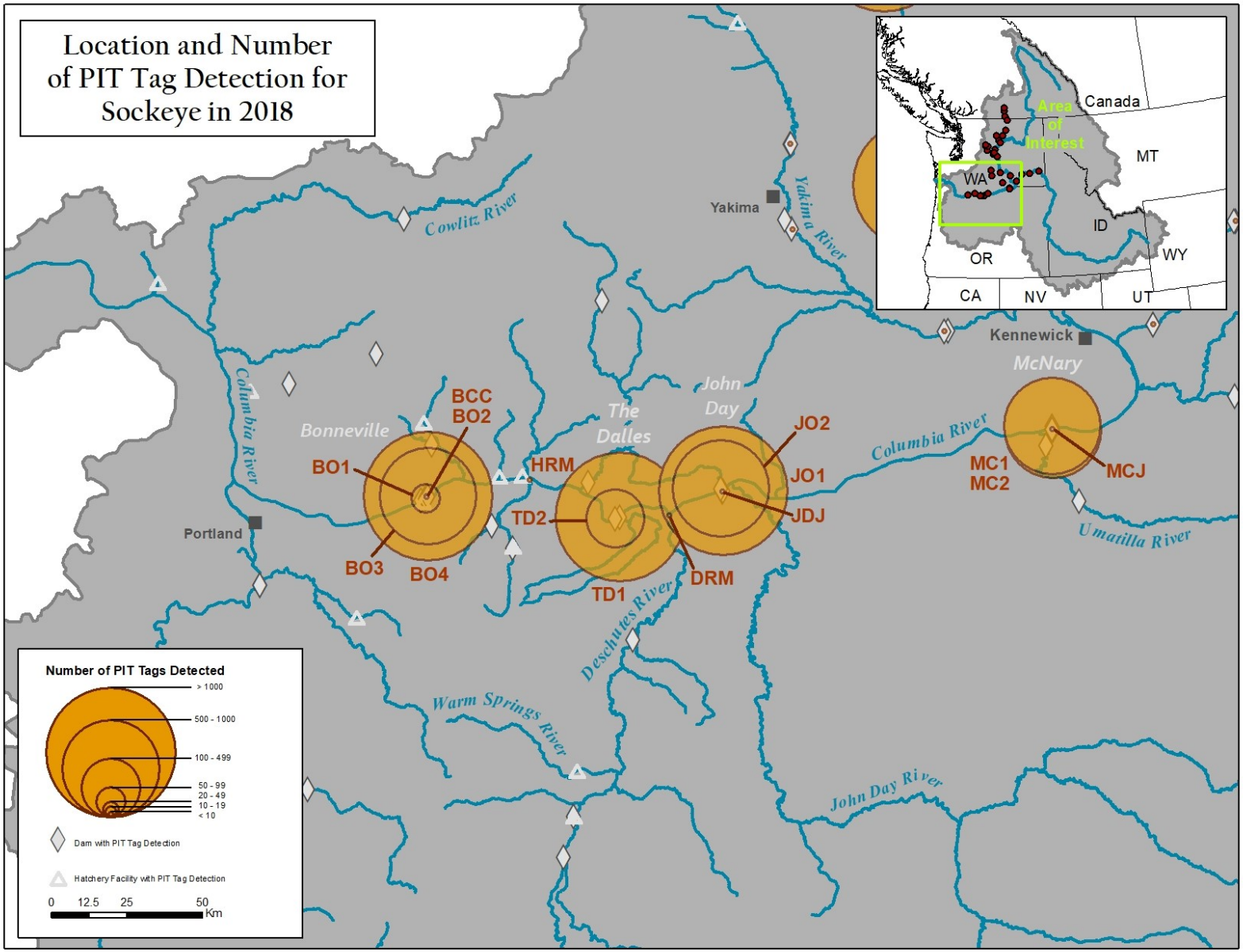

Figure B20. Map of Lower Columbia River detection sites (below Snake River) and number of Sockeye Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

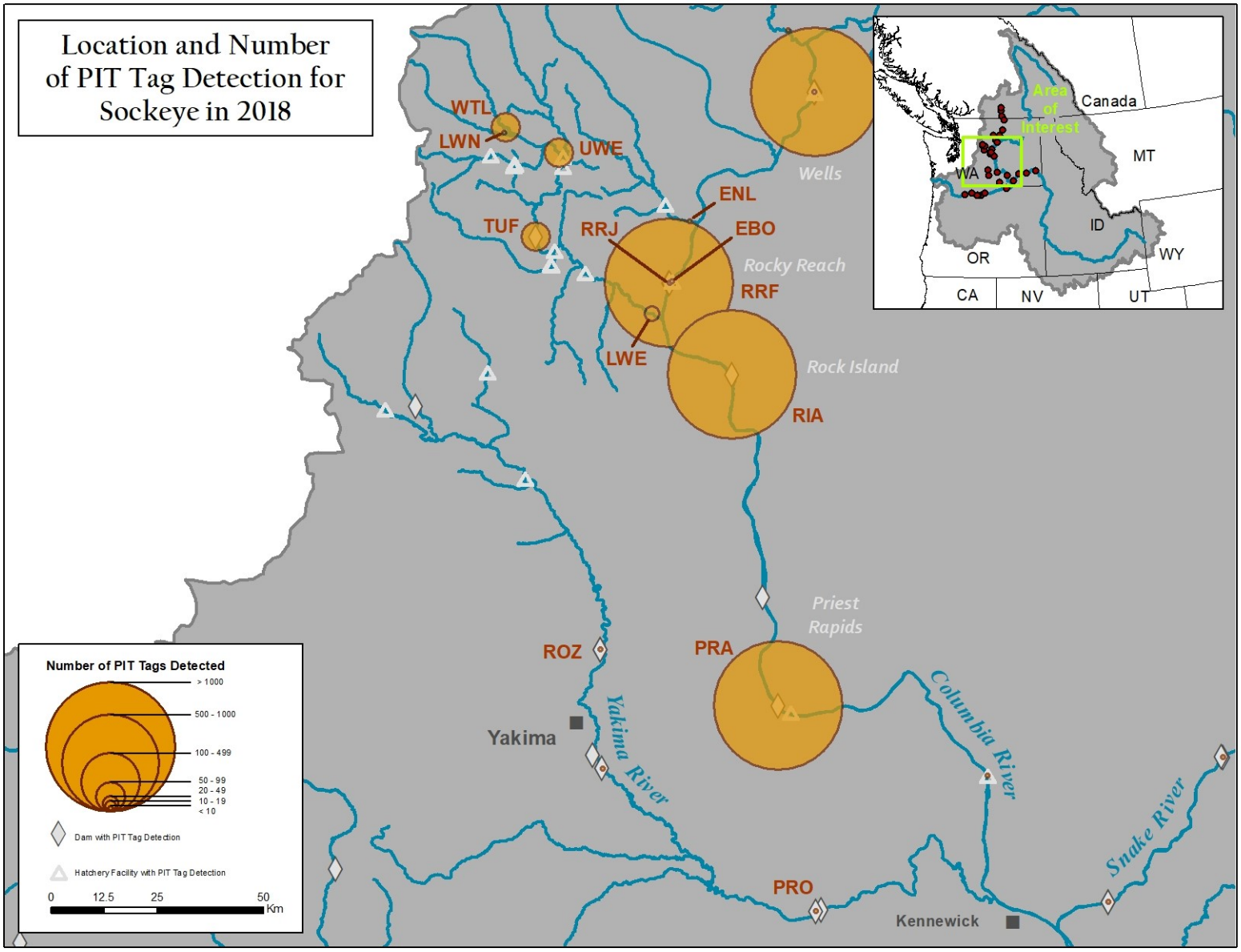

Figure B21. Map of Upper Columbia River (between the Snake River and Wells Dam) detection sites and number of Sockeye Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

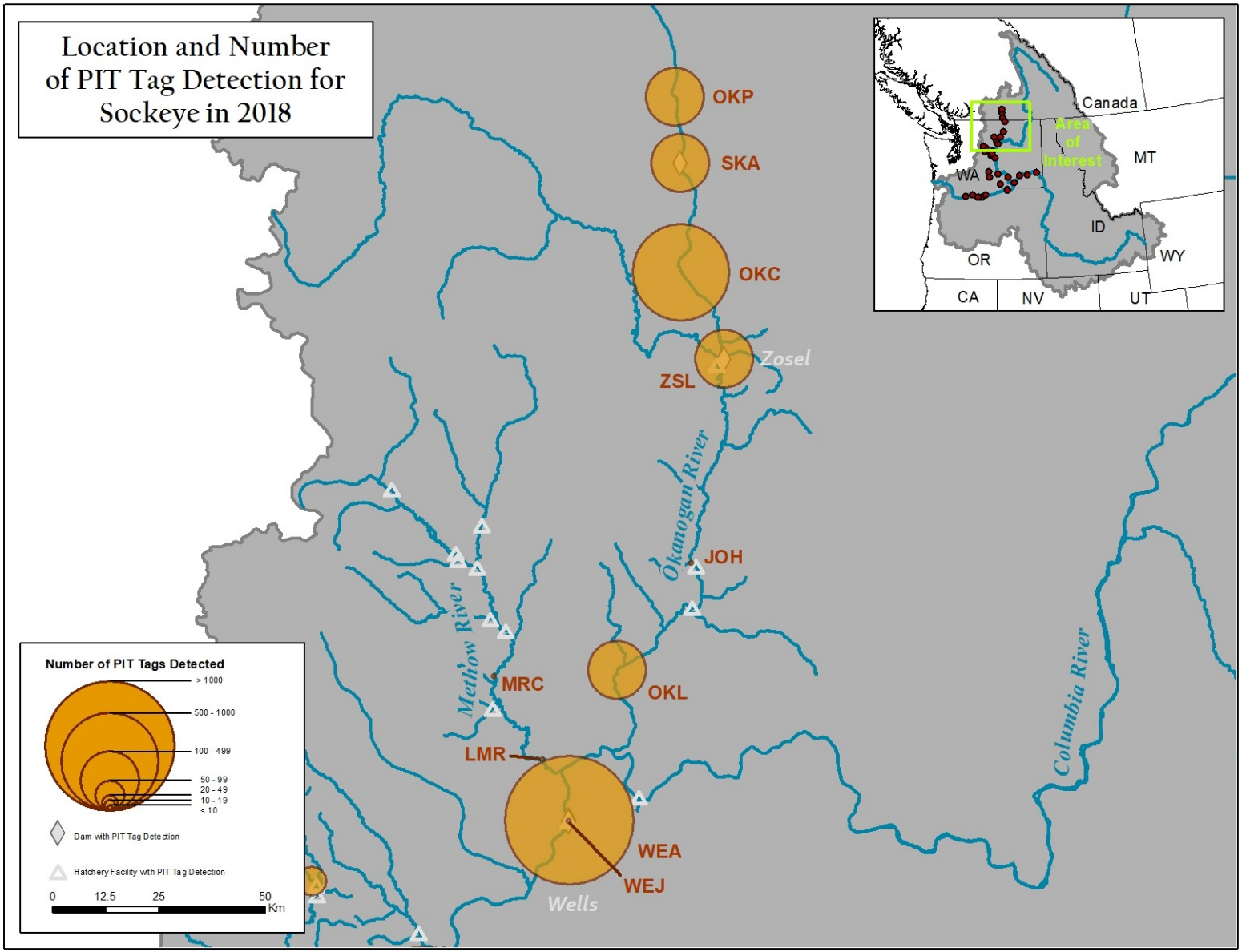

Figure B22. Map of Upper Columbia River (Wells Dam and above) detection sites and number of Sockeye Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

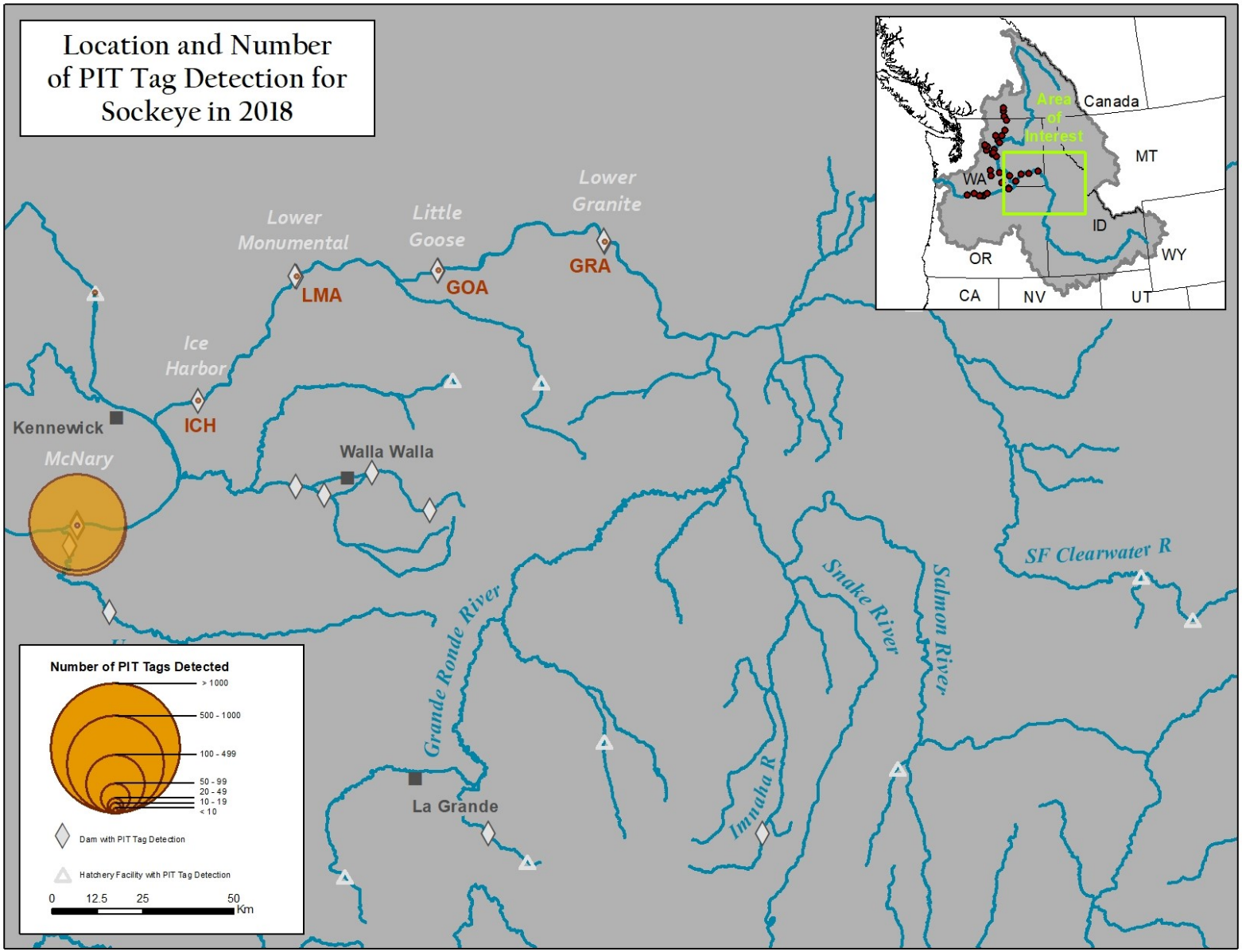

Figure B23. Map of Lower Snake River detection sites (Salmon River not included) and number of Sockeye Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

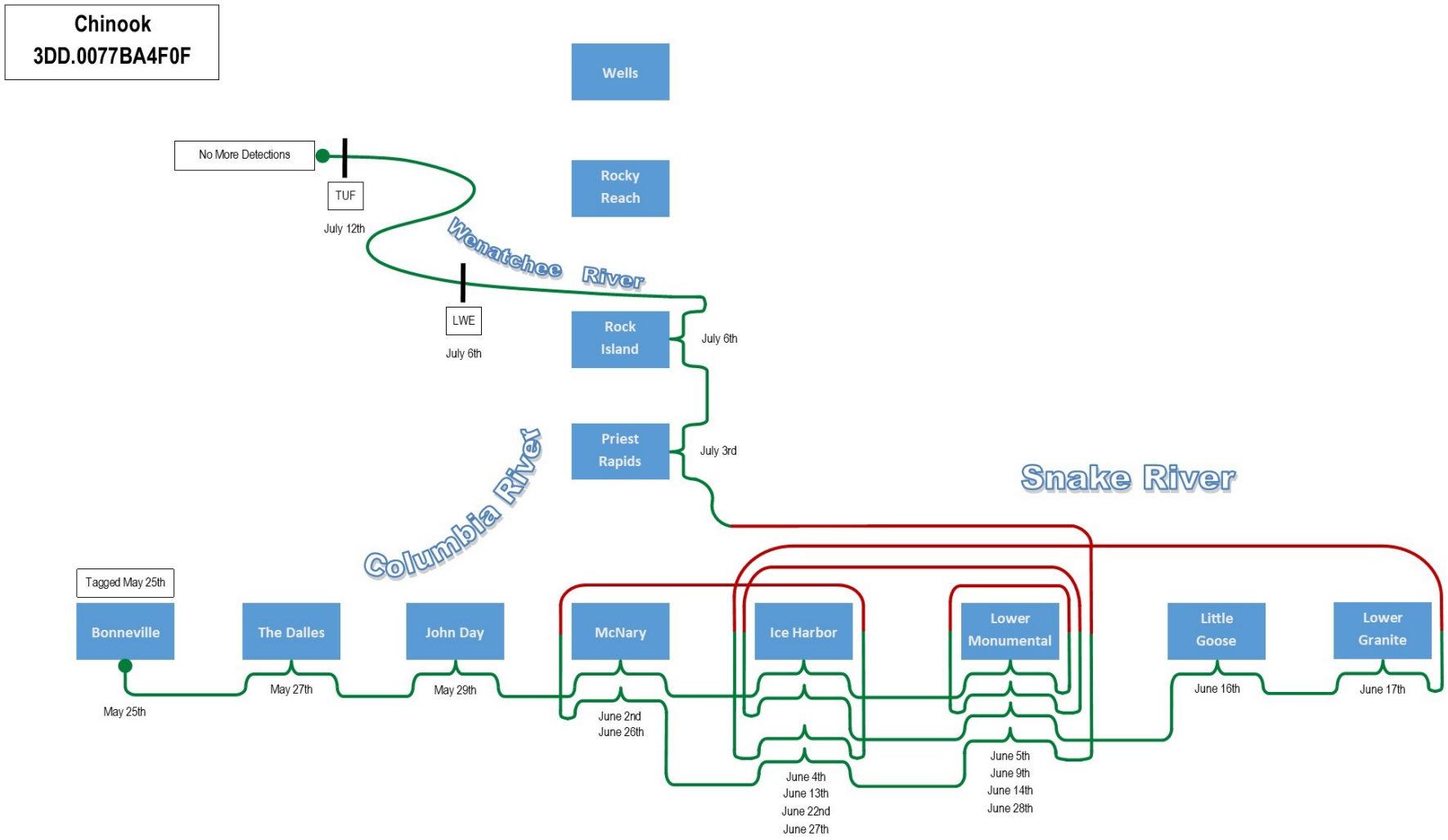

Figure B24. Chart showing the pattern and location of fall back events at mainstem dams on the Columbia and Snake rivers for Chinook Salmon with PIT tag 3DD.0077BA4F0F, tagged and tracked in 2018.

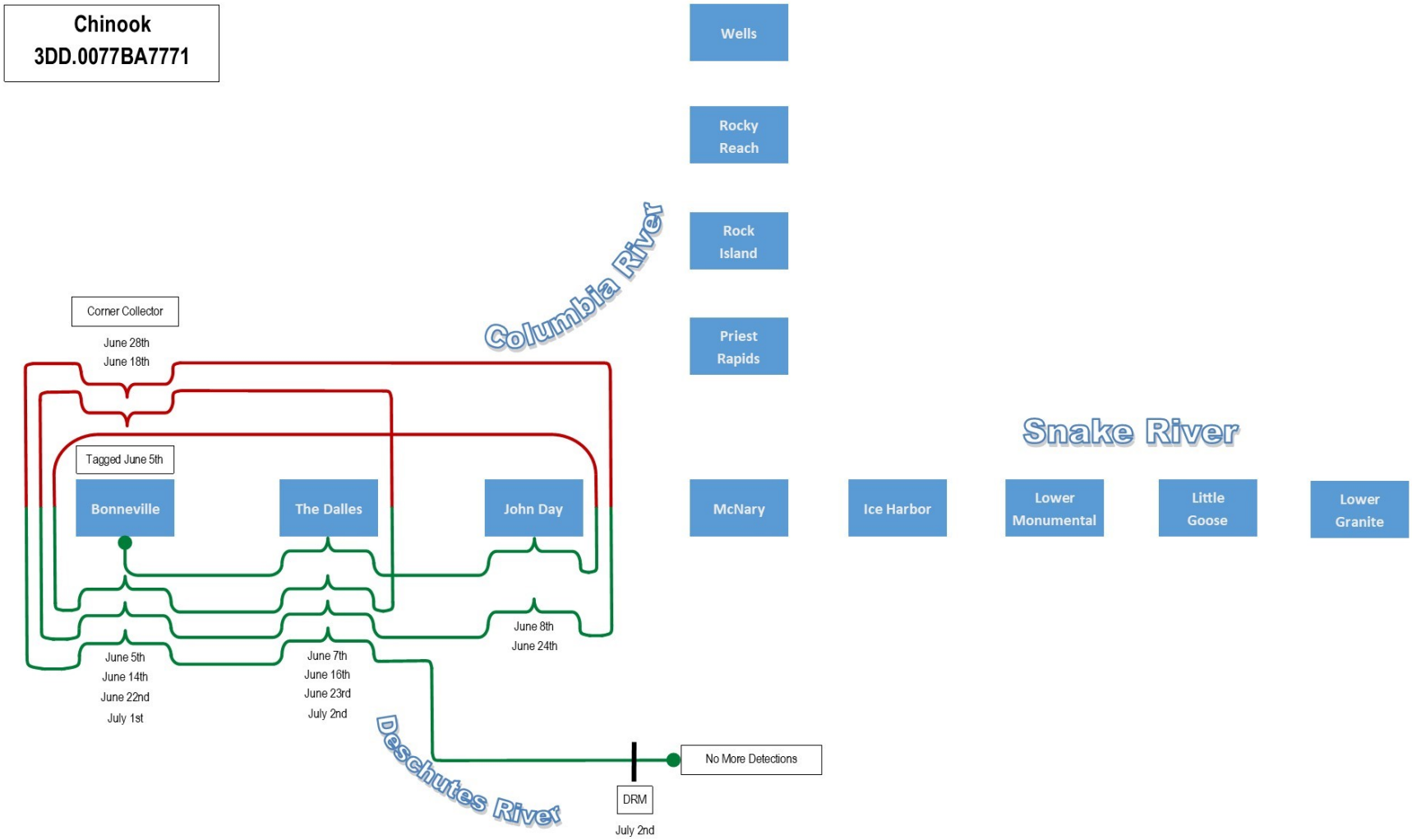

Figure B25. Chart showing the pattern and location of fall back events at mainstem dams on the Columbia and Snake rivers for Chinook Salmon with PIT tag 3DD.0077BA7771, tagged and tracked in 2018.

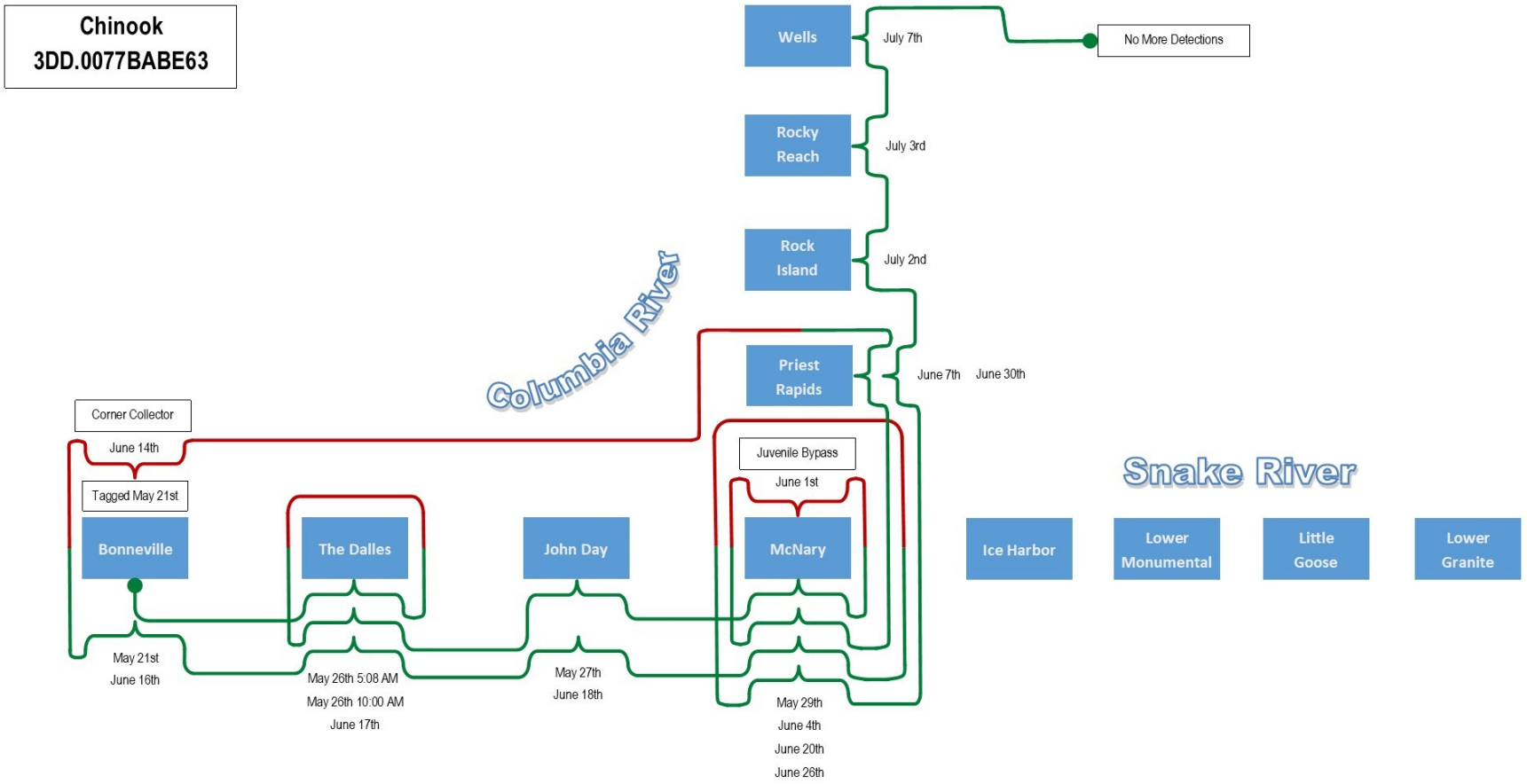

Figure B26. Chart showing the pattern and location of fall back events at mainstem dams on the Columbia and Snake rivers for Chinook Salmon with PIT tag 3DD.0077BABE63, tagged and tracked in 2018.

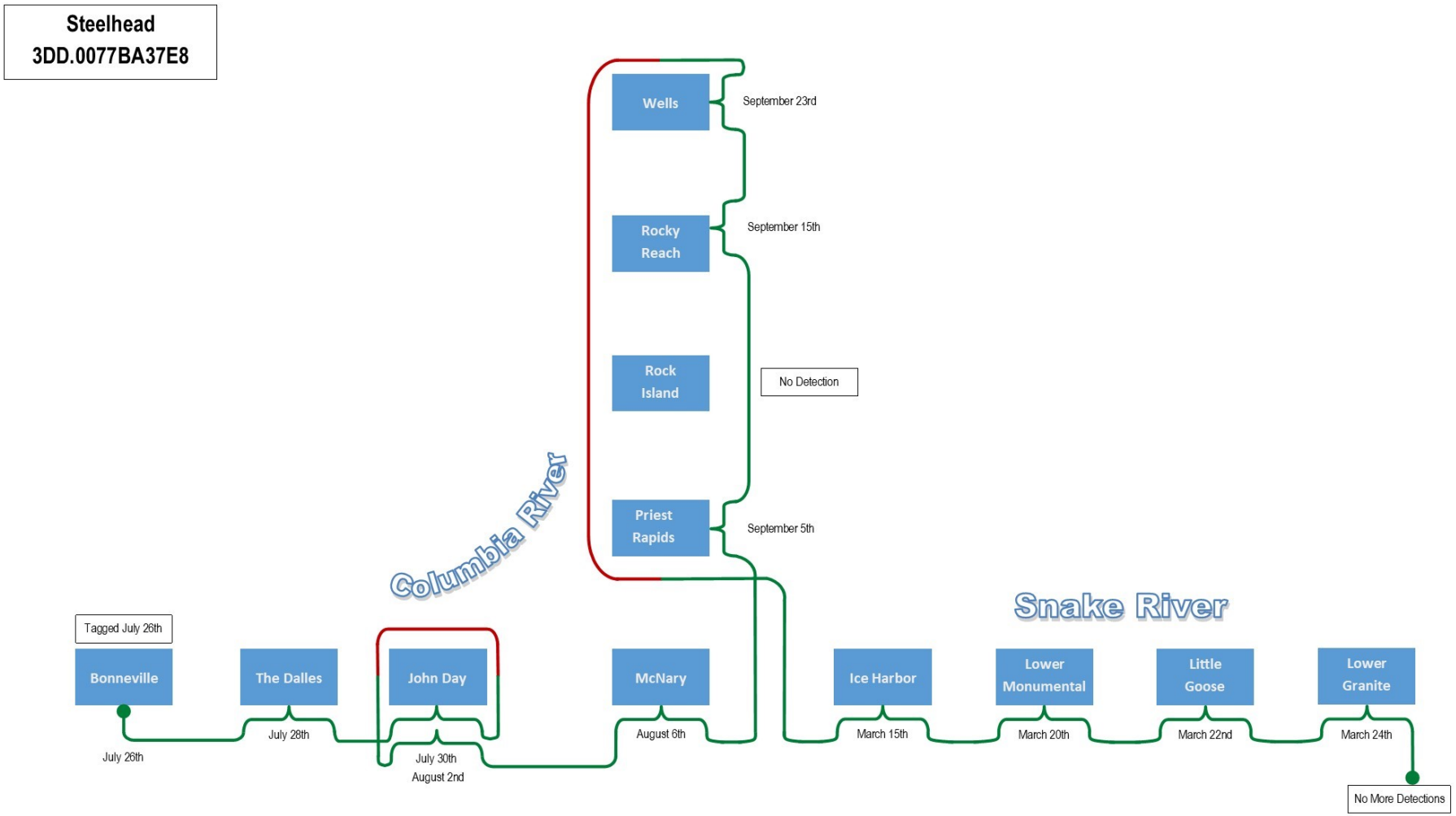

Figure B27. Chart showing the pattern and location of fall back events at mainstem dams on the Columbia and Snake rivers for steelhead with PIT tag 3DD.0077BA37E8, tagged and tracked in 2018.

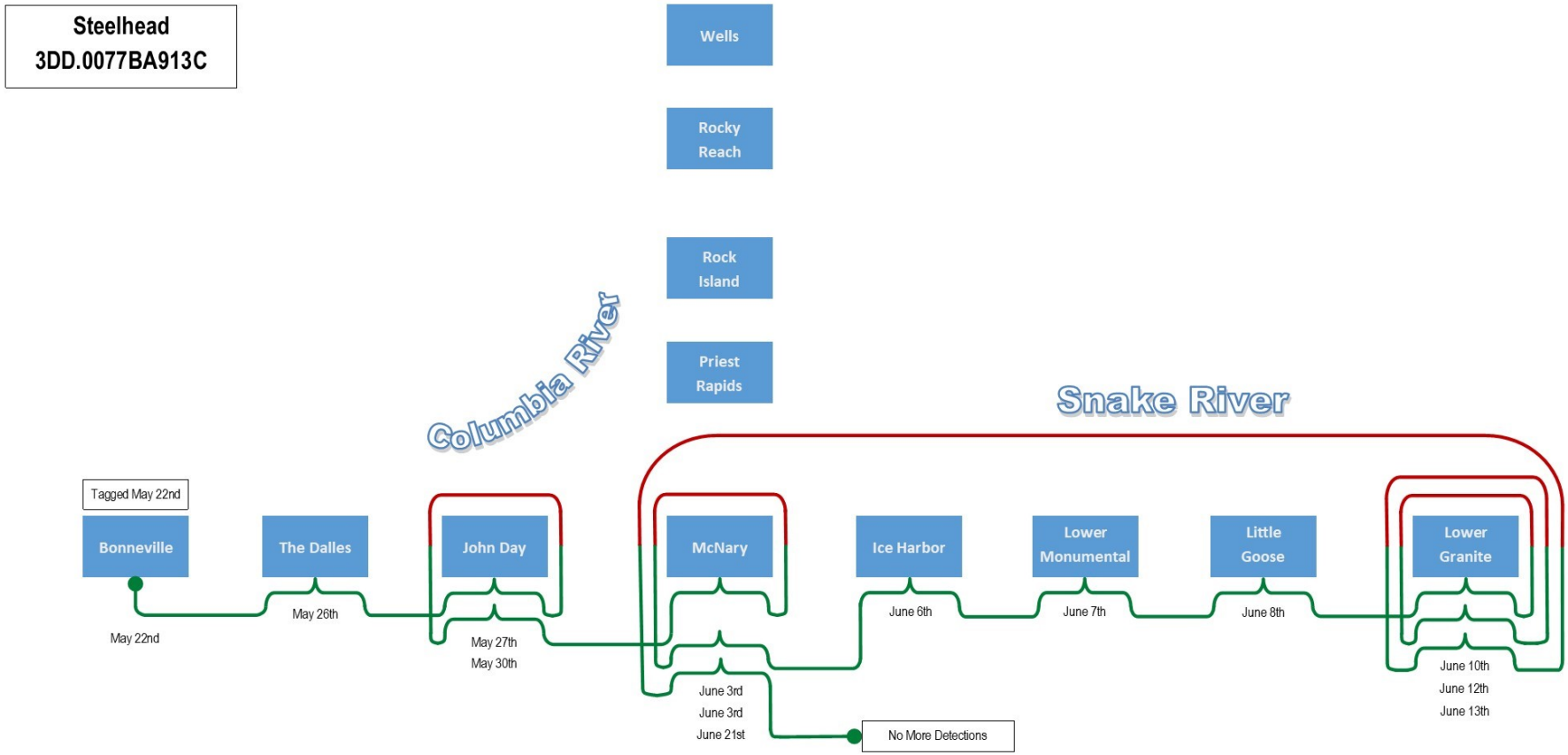

Figure B28. Chart showing the pattern and location of fall back events at mainstem dams on the Columbia and Snake rivers for steelhead with PIT tag 3DD.0077BA913C, tagged and tracked in 2018.