CRITFC

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Upstream Migration Timing of Columbia Basin Chinook and Sockeye Salmon and Steelhead in 2019

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May 12, 2020

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

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ABSTRACT

Between April 25 and October 18, 2019, Chinook *(Oncorhynchus tshawytscha) and* Sockeye *(Oncorhynchus nerka)* salmon as well as steelhead (*Oncorhynchus mykiss)* were sampled at the Bonneville Dam Adult Fish Facility. 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 1,190 spring Chinook, 878 summer Chinook, 1,415 fall Chinook, 820 steelhead, and 972 Sockeye Salmon.

Chinook Salmon median migration rates between mainstem dams ranged between 21.4 km/day for fall Chinook migrating between Rock Island and Rocky Reach dams and 54.6 km/day for fall Chinook migrating between John Day and McNary dams. An estimated 37.6% of spring Chinook passed into the Snake Basin upstream of Ice Harbor Dam, while an estimated 71.8% of summer Chinook passed into the portion of the Columbia Basin upstream of Priest Rapids Dam. Among fall Chinook, the primary terminal area was between McNary Dam (passed by 49.8% of fall Chinook) and Ice Harbor Dam (passed by 10.7% of fall Chinook) and Priest Rapids Dam (passed by 7.2% of all fall Chinook). Escapement estimates for the entire Chinook run derived from PIT tag detections differ from those estimated by visual counts by 14.2% to -33.8% at mainstem dams.

Steelhead median migration rates reported between mainstem dams ranged from 12.6 km to 39.9 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), 98.9% 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 51.4% of the run in Statistical Week 40. The number of B-run steelhead peaked in Week 38 at 1,526 steelhead while the number of A-run (<78 cm) peaked in Week 33 at 8,367 fish. A total of 119 steelhead PIT tagged and tracked in 2019 were detected moving downstream (mostly in juvenile bypasses) after spawning, recovered or detected in kelt programs, or detected moving upstream in summer/fall 2019 or in 2020 and were designated as kelt.

The principal age components for spring Chinook were Age 1.2 (82.9%), 1.3 (8.6%) and Age 1.1 (8.4%); for summer Chinook Age 1.2 (39.3%), 1.3 (32.3%), and Age 1.1 (20.5%) and for fall Chinook Age 0.3 (54.5%), and 0.2 (24.7%).

The principal age components of the Sockeye run were Age 1.1 (47.4%), Age 1.3 (27.9%), and Age 1.2 (18.6%.). Median migration rates between mainstem dams ranged between 31.8 and 58.7 km/day for adults tagged at Bonneville 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 -12.2% to 17.6%.

Stray rates were estimated using both Genetic Stock Identification (GSI]) and Parental Based Tagging (PBT) and site of last PIT tag detection. The stray rate was 7.6% for PBT-classified steelhead and 40.2% for GSI-classified steelhead. For Chinook, the stray rate was 6.6% for PBT-classified Chinook and 26.5% for GSI-classified Chinook. For Sockeye, the stray rate estimated by this project using GSI was 1.4%. Insufficient numbers of Sockeye could not be classified by PBT, so a stray rate was not estimated.

In 2019, the Whooshh FishL Recognition System (WFRS) was installed in the AFF, allowing comparisons of fish sampled in the AFF with those bypassing the AFF that passed through the WFRS where images were taken and could be analyzed for length, species, and fin clips. There was a significant difference in the mean fork length of the WFRS and AFF samples for Sockeye salmon, but not for Chinook or steelhead. Significant differences were found between the mean percentage adipose clipped detected in the AFF and WFRS samples for both Chinook and steelhead, although the actual mean rates differed by less than 2.3 percentage points for Chinook and 3.1 percentage points for steelhead.

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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 Facility (AFF) 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 18, 2019, at the Bonneville Dam 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 length. These small Chinook Salmon are excluded because sampling these fish would reduce our sample of larger Chinook as well as other species which are of more importance 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 AFF is restricted by protocols established by the Fish Passage Operation and Maintenance Coordination Team[1]. These protocols include 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

[1] The protocols can be found at http://pweb.crohms.org/tmt/documents/fpp/2019/final/FPP19_AppG.pdf.

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 2020), although for management purposes June 15 is used as the end date of the spring Chinook migration (https://www.fws.gov/lsnakecomplan/Reports/USvOregon/FINAL.2018-%202027%20USvOR%20Management%20Agreement%20with%20Signature%20Feb%202018%20.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 between August 1 and November 15 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).

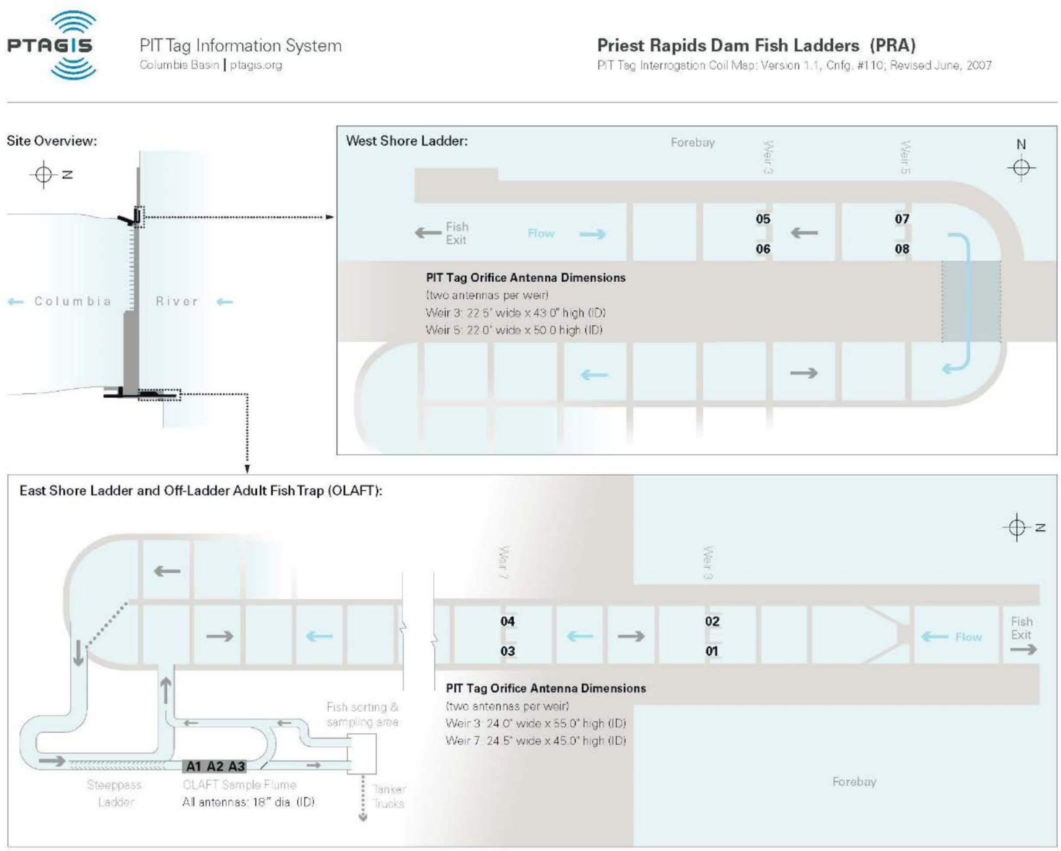

Figure 1. PIT tag detection configuration at Priest Rapids Dam showing two adjoining antennas at two weirs in each fish ladder (Figure from www.ptagis.org.)

Site Detection Percentage

All fish PIT tagged and released at the Bonneville Dam AFF exit into a fish ladder with PIT tag antennas in both the upstream and downstream directions at site BO3. However, these antennas are at the underwater orifices with no monitoring of overflow weirs (Figure 2) which many salmonids, especially Sockeye Salmon use. Furthermore, it is possible for any salmon that moves downstream following tagging could pass upstream through the navigation locks at Bonneville

Dam (Figure 3). There are other dams with navigation locks (The Dalles, John Day, McNary, Ice Harbor, Little Goose, Lower Monumental, and Lower Granite dams) where PIT tagged salmon can pass undetected. 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.

Bonneville Dam Vertical Slot Antenna

Bonneville Dam underwater antenna with unmonitored overflow weir

Figure 2. Pictures of the two types of PIT tag antennas at Bonneville Dam. The vertical slot antennas are at the upper end of both ladders, while the underwater antennas are in the lower parts of the ladders. Photos courtesy of Alan Brower of PTAGIS.

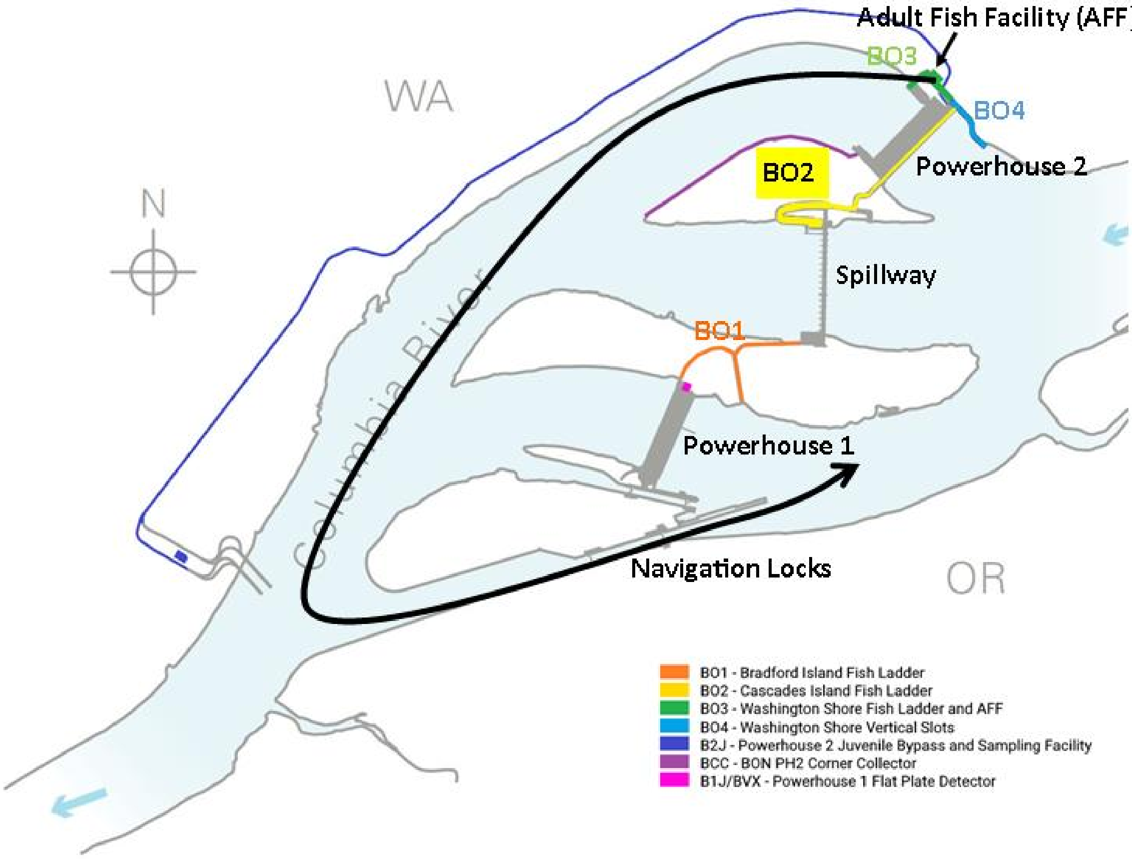

Figure 3. Site of Bonneville Dam PIT tag antennas and the most likely route for fish tagged at the Adult Fish Facility to pass upstream undetected (Figure from www.ptagis.org).

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 2019, 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. Migrating downstream through the fish ladders is not considered a fallback. 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, 2020, were not considered fallbacks; rather, they were considered kelts on their way downstream. Some steelhead move out of the system before April 1^{st}, 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 1^{st} and April 1^{st}. 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 50 minutes per hour (with the counts then expanded by 20% to account for the missing 10 minutes) from 0400 to 2000 PST with most supplemented with video counts of passage between 2000 and 0400 from June through September (https://www.fpc.org/111_sharedfiles/adult_metadatav3.php), 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

Since 2017, stray rates have been 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.

Whooshh FishL™ Recognition System (WFRS) Testing

In 2019, Whooshh Innovations (WI) installed the WFRS at one exit flume at the AFF (Figure 4). This system was designed by WI to capture images of passing fish to select fish for transport via the Whooshh passage system (www.whooshh.com). The WFRS was installed on the right (south) flume at the AFF downstream of the location where fish were diverted for sampling. Thus, the WFRS only collected images from those fish not selected for sampling for our studythat passed through that flume.

The WFRS uses multiple images from three different camera angles, together with a proprietary algorithm, to calculate the fork length of an individual fish to the 1/10 mm (provided there were no overlapping fish). Other data collected were adipose presence or absence, and species. These data from steelhead, Chinook, and Sockeye that were not sampled by our study were used to compare with data from study sampled fish as well as to assess the potential for improving precision of estimates provided by our study.

The following statistical tests were conducted to assess how similar the Whooshh data were to AFF study data and whether the addition of Whooshh data would improve estimates.

1.) Comparison of the lengths of Whooshh and AFF-sampled fish for Sockeye, Chinook, and steelhead. A Kolmogorov-Smirnov test between two distributions was used as was a Student T-test.
2.) A two-proportion z-test was used for comparison of the percentage of adipose clipped for steelhead and Chinook. (There were too few adipose-clipped Sockeye to make a comparison for this species.) The same test was used to compare the percentage of stubby dorsal steelhead; a characteristic common in hatchery-raised steelhead but not seen in Chinook and Sockeye and thus not recorded.

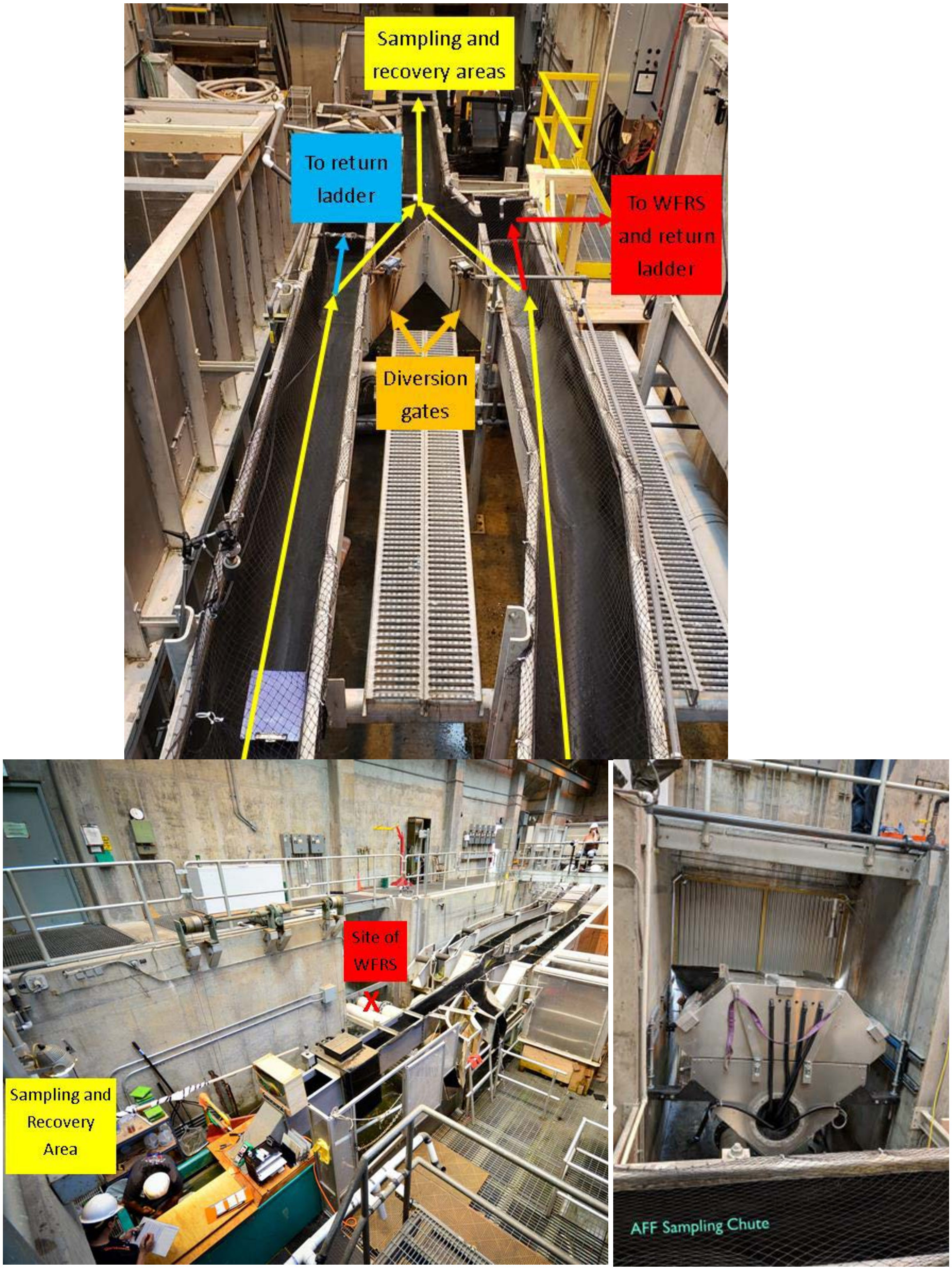

Figure 4. Bonneville Adult Fish Facility. The top picture shows the routes fish can take as they go down the sampling flumes; to either the tagging area, directly to the return ladder (left flume, or to the return ladder after passing through the WFRS. Lower left shows the site of the WFRS, lower right shows the WFRS unit being installed. (Photos from Whooshh Innovations.)

RESULTS-CHINOOK

Sample Size

A total of 1,196 spring Chinook, 881 summer Chinook, and 1,431 fall Chinook Salmon were sampled in 2019 (Tables 1-3) between April 25 and October 18[2]. Sampling restrictions due to water temperatures exceeding 21.1°C reduced sampling days and hours during Statistical weeks[3] 30 and 31 of the summer Chinook run and Week 31 to 37 of the fall Chinook run and shut down sampling entirely during Week 32 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 17, 22 to 27, and 38. A total of 1,173 spring Chinook, 873 summer Chinook, and 1,423 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 3 summer Chinook and 9 fall Chinook classified as minijacks, the numbers of Chinook tracked upstream and used in analysis consisted of 1,190 spring Chinook, 878 summer Chinook, and 1,415 fall Chinook Salmon (Table 1-3). Two spring Chinook were sampled twice, the first (3DD.0077C0AD1C) tagged on May 21 and recaptured on May 22, with the second (3DD.0077BFEB76) tagged May 29 and recaptured on May 30. After tagging, both fish moved downstream in the fish ladder only to be recaptured the subsequent day. The second capture events for both fish were excluded from further analysis as it seems likely that this downstream movement after tagging was a result of the tagging process.

[2] An addition 150 Tule Chinook (identified by their dark coloration) were sampled between August 20 and October 24 for a genetics study and are not included in the results but will be briefly summarized in the discussion.

[3] 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 2019, for instance, Statistical Week 23 began on June 2 and ended on June 8.

Table 1. Number of sampled and PIT tagged spring Chinook Salmon at Bonneville Dam that were then tracked, by date and statistical week, in 2019.

Sample Dates	Week	Number Sampled	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
4/25-26	17	16	15	0	1	0	0	16	0	1	0
4/29, 5/1-3	18	319	313	0	6	0	0	319	0	0	0
5/6-10	19	307	303	0	4	0	1	306	0	0	0
5/13-5/16	20	210	208	0	2	0	2	208	0	0	0
5/20-5/24	21	216	209	1	6	0	1	215	0	0	0
5/28-31	22	128	124	0	3	0	0	127	0	2	0
Total		**1196**	**1172**	**1**	**22**	**0**	**4**	**1190**	**0**	**3**	**0**

Table 2. Number of sampled and PIT tagged summer Chinook Salmon at Bonneville Dam that were then tracked, by date and statistical week in 2019.

Sampling Dates	Week	Number 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
6/3-6/7	23	139	137	0	2	0	0	0	139	0	4	0
610-6/14	24	165	165	0	0	0	0	0	165	0	5	0
6/17-6/21	25	109	108	0	1	0	0	0	109	0	5	0
6/24-6/28	26	110	109	0	1	0	0	0	110	0	5	0
7/1-7/4	27	73	72	0	1	0	0	1	72	0	4	0
7/8-7/12	28	119	117	0	2	0	0	0	119	0	0	0
7/15-7/19	29	76	75	0	1	0	0	1	75	0	0	0
7/22-7/25	30	50	50	0	0	0	0	0	50	0	0	1
7/29-7/31	31	40	40	0	0	0	0	1	39	3	0	0
Total		**881**	**873**	**0**	**8**	**0**	**0**	**3**	**878**	**3**	**23**	**1**

Table 3. Number of sampled and PIT tagged fall Chinook Salmon at Bonneville Dam that were then tracked, by date and statistical week in 2019.

Sampling Dates	Week	Number Sampled	Number Tagged	Previously Tagged: By this study at AFF	Previously Tagged: By other Studies	Mortalities	Not Detected After Release	Excluded as Minijacks	Total Tracked	Days Sampling Restrictions in Effect: Reduced Sampling-Temperature	Days Sampling Restrictions in Effect: Reduced Sampling-Shad or Salmonid Abundance	Days Sampling Restrictions in Effect: No Sampling-Temperature
8/1	31	18	18	0	0	0	0	1	17	1	0	1
No Sampling	32	AFF Closed due to temperatures at or above 22.2C, no sampling								0	0	5
8/12-8/13	33	24	24	0	0	0	0	0	24	2	0	3
8/19-8/21, 8/23	34	98	98	0	0	0	2	3	95	4	0	1
8/26-8/29	35	93	93	0	0	0	1	0	93	4	0	1
9/4-9/6	36	107	106	0	1	0	0	1	106	3	0	2
9/9-9/12	37	228	225	0	2	1	0	1	224	4	0	1
9/16-9/20	38	290	287	0	3	0	1	0	289	0	4	0
9/23-9/27	39	286	286	0	0	0	0	1	285	0	0	0
10/1-10/4	40	53	53	0	0	0	0	1	52	0	0	0
10/7,10/9-11	41	148	147	0	0	0	0	1	146	0	0	0
10/14,15,17,18	42	86	86	0	0	0	0	0	86	0	0	0
Total		**1431**	**1423**	**0**	**6**	**1**	**4**	**9**	**1415**	**18**	**4**	**14**

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 2019 high temperatures curtailed sampling primarily during weeks when few Chinook were passing (Figures 5-7). The largest deviations where the weekly sample proportion and run proportion was less than the run proportion were in weeks 25 through 27 of the summer Chinook sample when we were also sampling Sockeye Salmon and shad abundance trap restrictions reduced the deployment of picket leads. Abundance-based trap restrictions (albeit for Chinook and steelhead as opposed to shad), also reduced samples in statistical weeks 35-37 of the fall Chinook run. Once these restrictions were removed, sample sizes went up in statistical weeks 38 and 39.

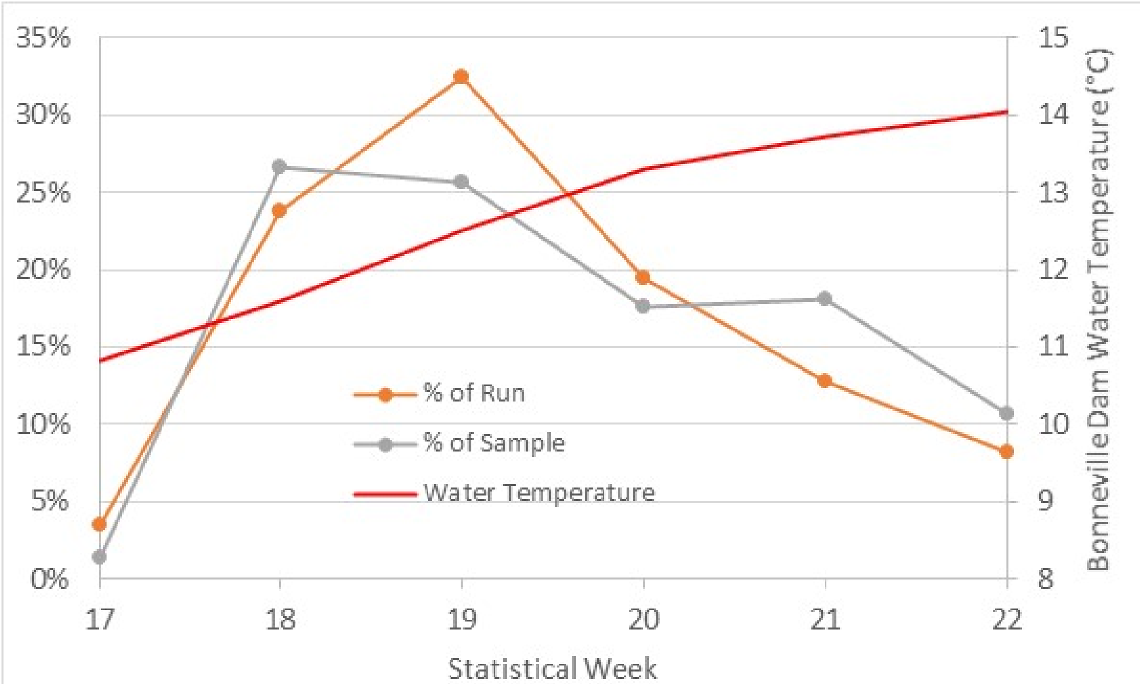

Figure 5. The weekly spring Chinook sample and run as a percentage of the total sample and run size at Bonneville Dam in 2019.

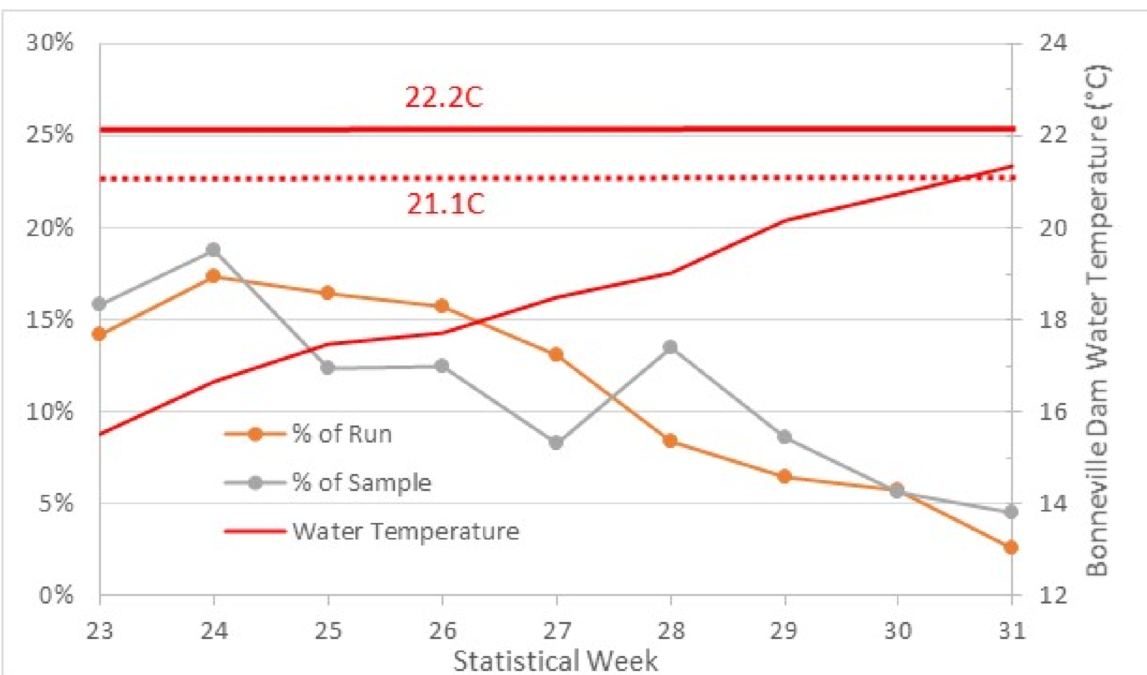

Figure 6. The weekly summer Chinook sample and run as a percentage of the total sample and run size at Bonneville Dam in 2019. AFF regulations require reduced sampling at 21.1°C with sampling halted at 22.2°C.

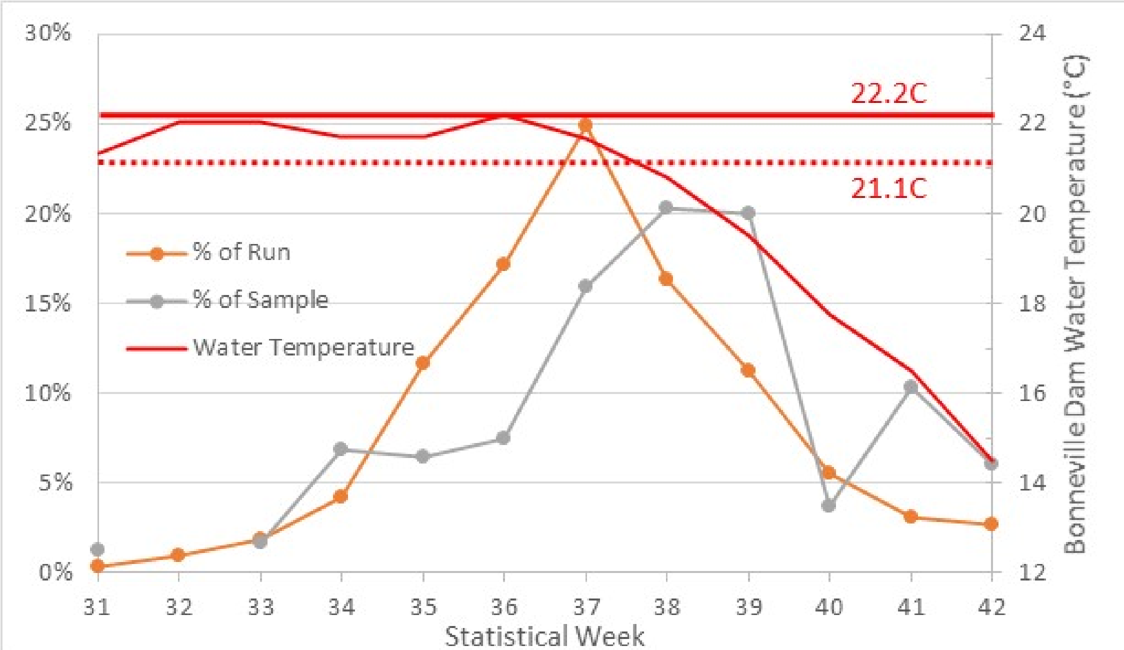

Figure 7. The weekly fall Chinook sample and run as a percentage of the total sample and run size at Bonneville Dam in 2019. AFF regulations require reduced sampling at 21.1°C with sampling halted at 22.2°C.

Detection Numbers

The tracking of 1,190 spring Chinook generated 70,791 weir detections, which were grouped into 7,865 site detections at 116 sites. The 878 summer Chinook generated 50,799 weir detections, grouped into 6,921 site detections at 85 sites, and the 1,415 fall Chinook generated 46,923 weir detections grouped into 6,329 site detections at 54 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 2020) with minijacks excluded.

Mainstem Dam Recoveries, Mortality, and Escapement Estimates

Spring Chinook were predominantly last detected upstream in terminal areas upstream of Ice Harbor Dam, summer Chinook upstream of Priest Rapids Dam, and fall Chinook in spawning areas between McNary and Ice Harbor/Priest Rapids dams (Table 4, Figures 8-10). The early run was primarily last detected downstream of McNary Dam, transitioning to a run bound for the Snake River, peaking in Week 21 (Figure 11). Beginning in early June, summer Chinook bound for above Priest Rapids dam predominated with the percentage decreasing in late July when sampling was halted. Chinook last detected downstream of McNary dam comprised the majority of the run though Statistical Week 38, with fall Chinook last detected at areas between McNary and Ice Harbor/Priest Rapids dams predominated (Table 4, Figure 10). This area is the location of Ringold and Priest Rapids hatcheries, which rear fall Chinook Salmon as well as the spawning grounds of Hanford Reach fall Chinook.

Table 4. Percentage of spring, summer, and fall Chinook Salmon tracked from Bonneville Dam detected at or upstream of Columbia and Snake River dams in 2019.

Dam	Spring Chinook	Summer Chinook	Fall Chinook
The Dalles	69.5%	91.2%	66.9%
John Day	62.1%	85.1%	54.4%
McNary	57.2%	82.2%	49.8%
Priest Rapids	14.1%	71.8%	7.2%
Rock Island	14.0%	71.4%	3.8%
Rocky Reach	9.4%	66.8%	2.7%
Wells	8.6%	50.6%	1.3%
Ice Harbor	37.6%	9.1%	10.7%
Lower Monumental	37.3%	8.9%	9.6%
Little Goose	36.2%	8.7%	9.4%
Lower Granite	35.8%	8.6%	9.4%

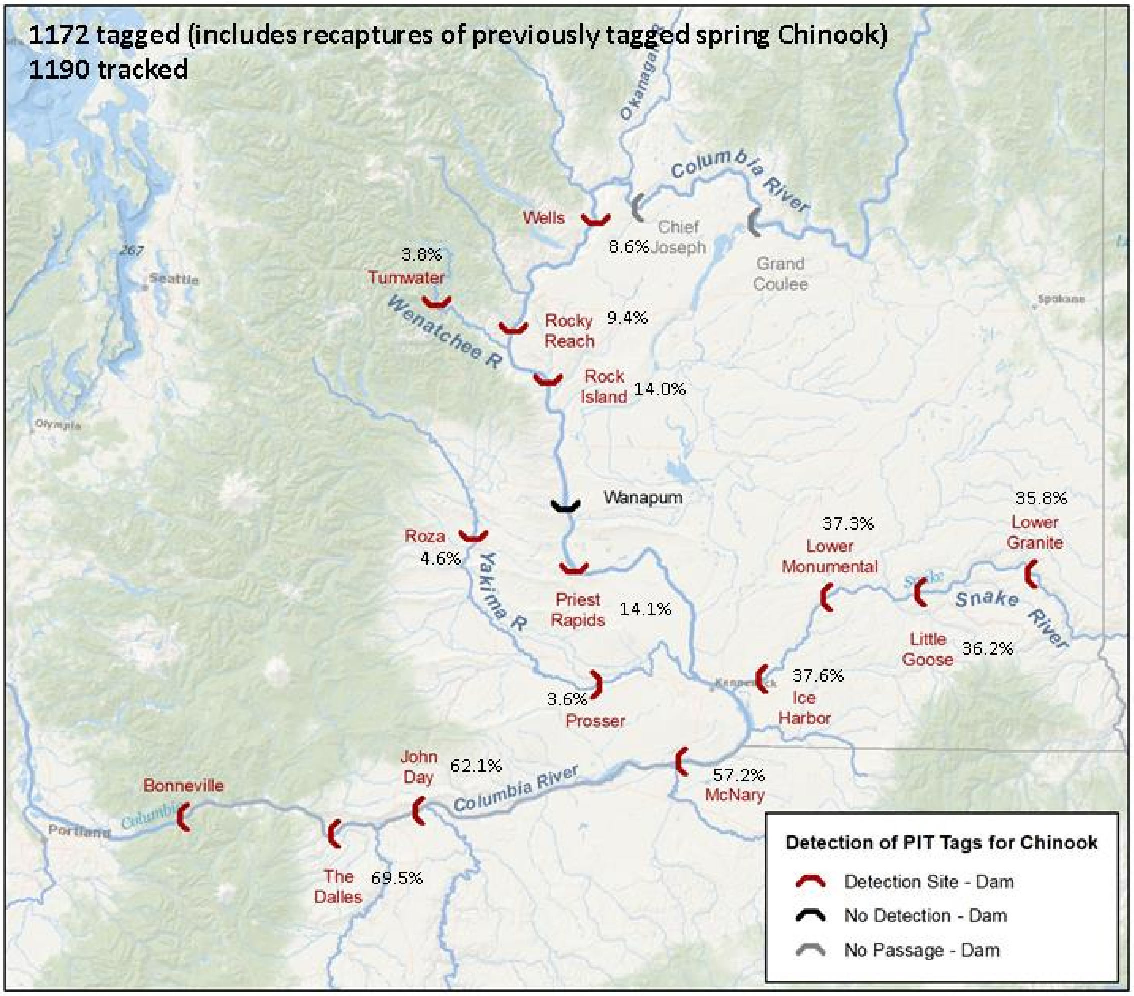

Figure 8. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of spring Chinook Salmon PIT tagged at Bonneville Dam, and the percentage of the run estimated to pass upstream dams in 2019.

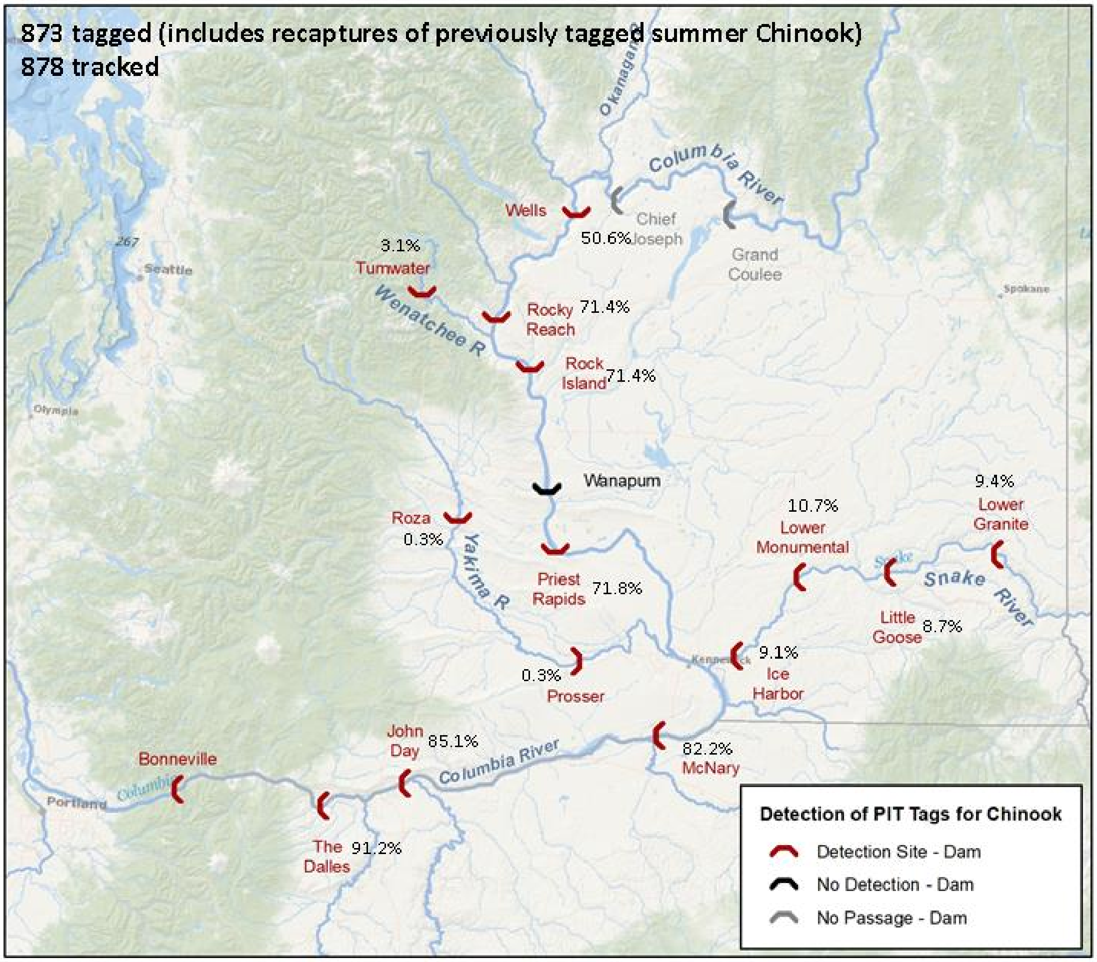

Figure 9. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of summer Chinook Salmon PIT tagged at Bonneville Dam, and the percentage of the run estimated to pass upstream dams in 2019.

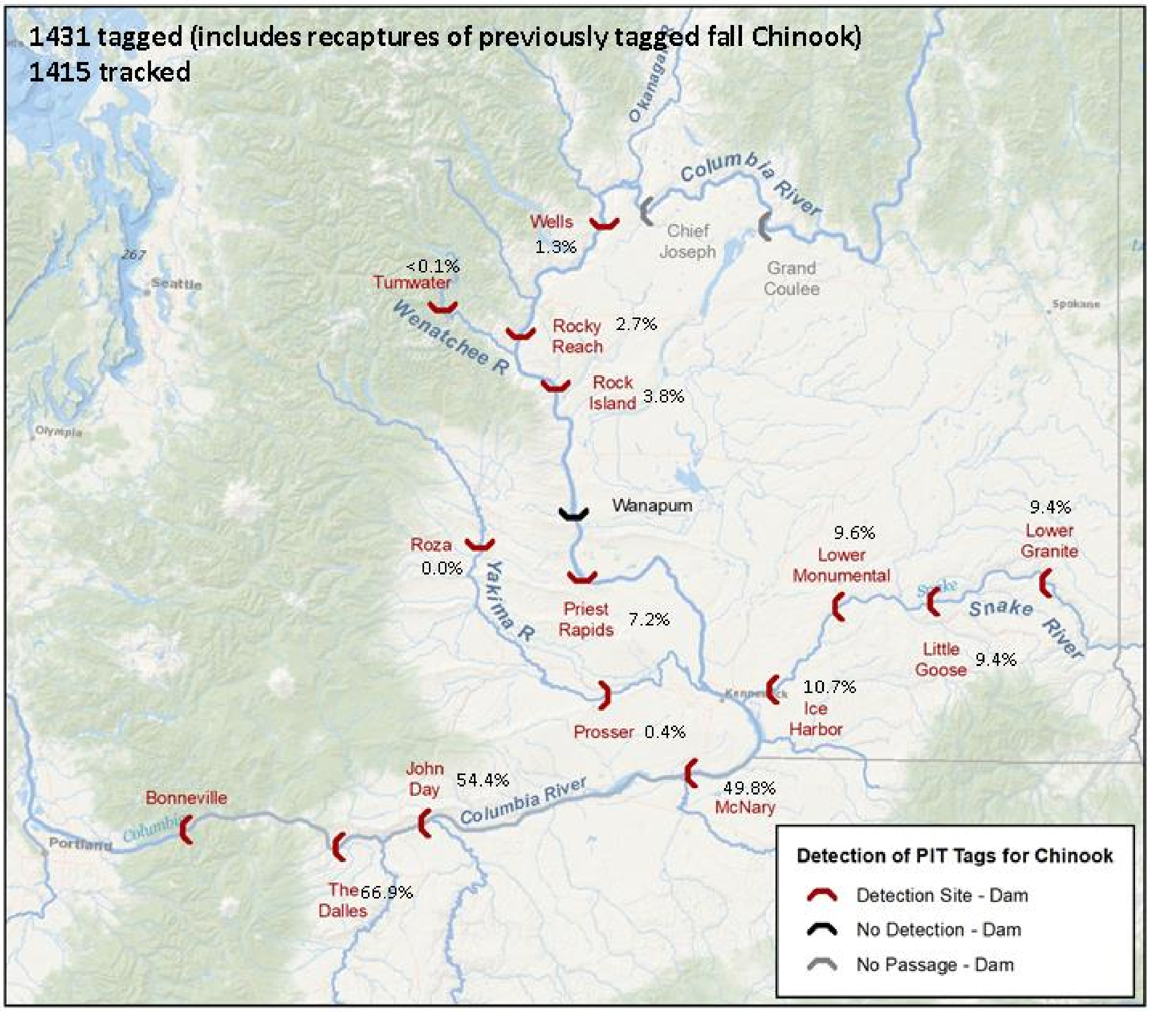

Figure 10. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of fall Chinook Salmon PIT tagged at Bonneville Dam, and the percentage of the run estimated to pass upstream dams in 2019.

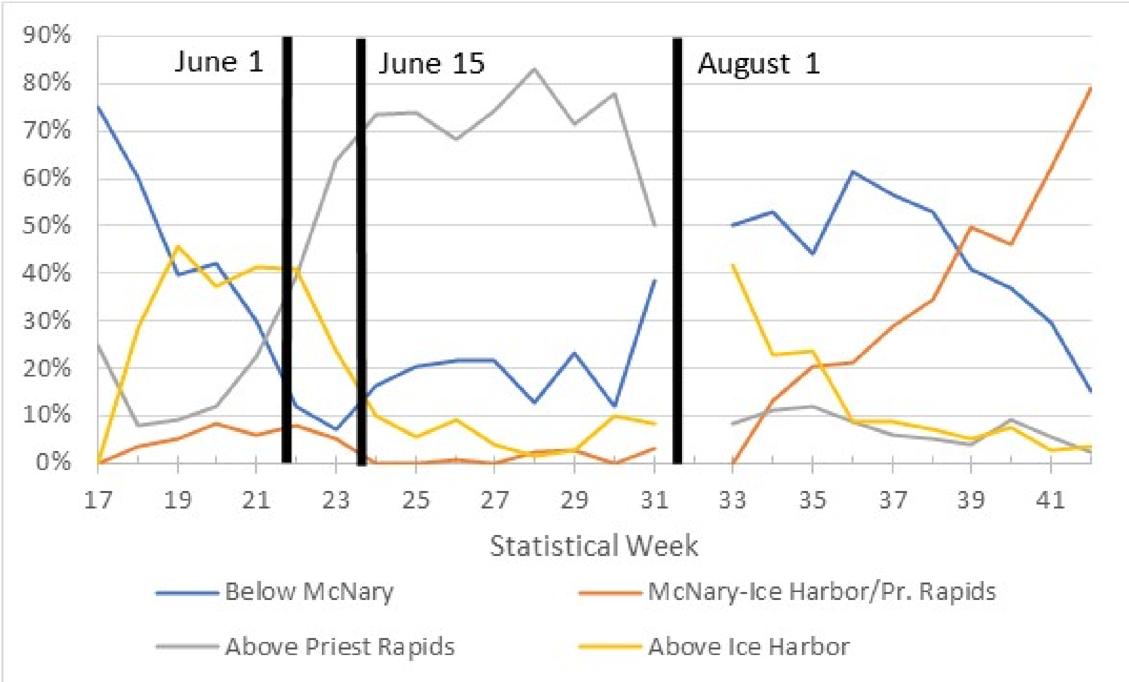

Figure 11. Distribution of final detection areas of the Columbia Basin by statistical week for Chinook Salmon PIT tagged at Bonneville Dam in 2019. Dates used to differentiate spring, summer, and fall Chinook are shown, with both June 1 and June 16 used to differentiate spring and summer Chinook.

The mean percentage of PIT tagged Chinook Salmon passing a dam without detection, excluding Rock Island Dam, was 1.9% for spring Chinook, 1.2% for summer Chinook and 0.5% for fall Chinook (Table 5). At Rock Island Dam, the percentage of upstream migrating PIT tagged Chinook missing detection was 27.5% for spring Chinook, 3.1% for summer Chinook, and 0.0% 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. 2016). The lower rates at Rock Island Dam for summer and fall Chinook in 2019 are likely attributable to modifications made at Rock Island on July 9, 2019 which will be detailed later in the Discussion section of this report. 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.

The mean deviation between total Chinook escapement estimates based on PIT tags and those estimated by visual counts was 2.6%, although individual dam estimates varied by -33.8% at Wells Dam to +14.2% at Little Goose Dam (Table 6).

Table 5. Percentage of Chinook Salmon detected upstream that missed detection at mainstem dams in 2019.

Dam	Spring	Summer	Fall
Bonneville	0.1%	0.5%	0.0%
The Dalles	0.1%	0.5%	0.1%
John Day	2.8%	2.5%	2.2%
McNary	3.1%	1.8%	0.3%
Priest Rapids	0.6%	0.3%	0.0%
Rock Island	27.5%	3.1%	0.0%
Rocky Reach	0.0%	0.0%	0.0%
Wells	0.0%	0.0%	0.0%
Ice Harbor	0.4%	1.3%	0.0%
Lower Monumental	0.7%	1.3%	0.0%
Little Goose	0.0%	0.0%	0.0%
Lower Granite	0.0%	0.0%	0.0%
Weighted Mean (by sample size) excluding Rock Island Dam	**1.9%**	**1.2%**	**0.5%**

Table 6. Spring, summer, fall, and total Chinook Salmon escapement at Columbia Basin mainstem dams upstream of Bonneville Dam in 2019. Estimates are from both PIT tag recoveries and dam counts (FPC 2020).

	Spring Chinook Salmon			Summer Chinook Salmon		
Site	Viewing Window Count	PIT Tag Estimate	Percent Difference	Viewing Window Count	PIT Tag Estimate	Percent Difference
The Dalles	42,682	43,804	-2.6%	50,145	59,935	-16.3%
John Day	38,125	41,134	-7.3%	47,116	50,145	-6.0%
McNary	35,129	36,792	-4.5%	44,304	47,116	-6.0%
Priest Rapids	8,671	8,742	-0.8%	41,063	44,304	-7.3%
Rock Island	8,606	9,571	-10.1%	42,795	41,063	4.2%
Rocky Reach	5,792	6,920	-16.3%	39,232	42,795	-8.3%
Wells	5,262	8,736	-39.8%	25,088	39,232	-36.1%
Ice Harbor	23,062	25,213	-8.5%	5,849	25,088	-76.7%
L. Monumental	22,923	26,194	-12.5%	5,392	5,849	-7.8%
Little Goose	22,205	24,582	-9.7%	6,773	5,392	25.6%
Lower Granite	21,952	23,025	-4.7%	6,592	6,773	-2.7%
Mean			**-10.6%**			**-12.5%**
	Fall Chinook Salmon			**All Chinook Salmon**		
The Dalles	214,497	207,182	3.5%	307,323	310,921	-1.2%
John Day	174,493	161,727	7.9%	259,735	253,006	2.7%
McNary	159,728	147,855	8.0%	239,161	231,763	3.2%
Priest Rapids	23,019	28,993	-20.6%	72,752	82,039	-11.3%
Rock Island	12,218	13,621	-10.3%	63,619	64,255	-1.0%
Rocky Reach	8,566	9,482	-9.7%	53,590	59,197	-9.5%
Wells	4,317	4,427	-2.5%	34,666	52,395	-33.8%
Ice Harbor	34,260	21,983	55.8%	63,171	72,284	-12.6%
L. Monumental	30,783	22,910	34.4%	59,098	54,953	7.5%
Little Goose	30,233	21,874	38.2%	59,211	51,848	14.2%
Lower Granite	29,991	21,790	37.6%	58,535	51,588	13.5%
Mean			**13.0%**			**-2.6%**

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 Priest Rapids, Rock Island, and Rocky Reach 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).

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 2019.

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 30 detections, are found in Table 8 along with estimates using visual counts. The deviations of the PIT tag escapement estimates from visual counts at these dams were generally much greater than those at mainstem dams. Much lower sample sizes than at mainstem dams likely contributed to this difference. Chinook that ultimately passed these three dams primarily passed Bonneville Dam in the spring and, to a lesser extent, in the fall (Figure 12.

Table 8. Chinook Salmon escapement, as estimated using PIT tag detections, to Tumwater, Prosser, and Roza dams in 2019

Location and River	Number of Tag Detections	Escapement Estimate from Visual Counts	Estimated Escapement Using PIT Tags	Percent Difference
Tumwater Dam, Wenatchee River	63	3016	4776	58.4%
Prosser Dam, Yakima River	46	2552	3450	35.2%
Roza Dam, Yakima River	35	2020	2370	17.3%

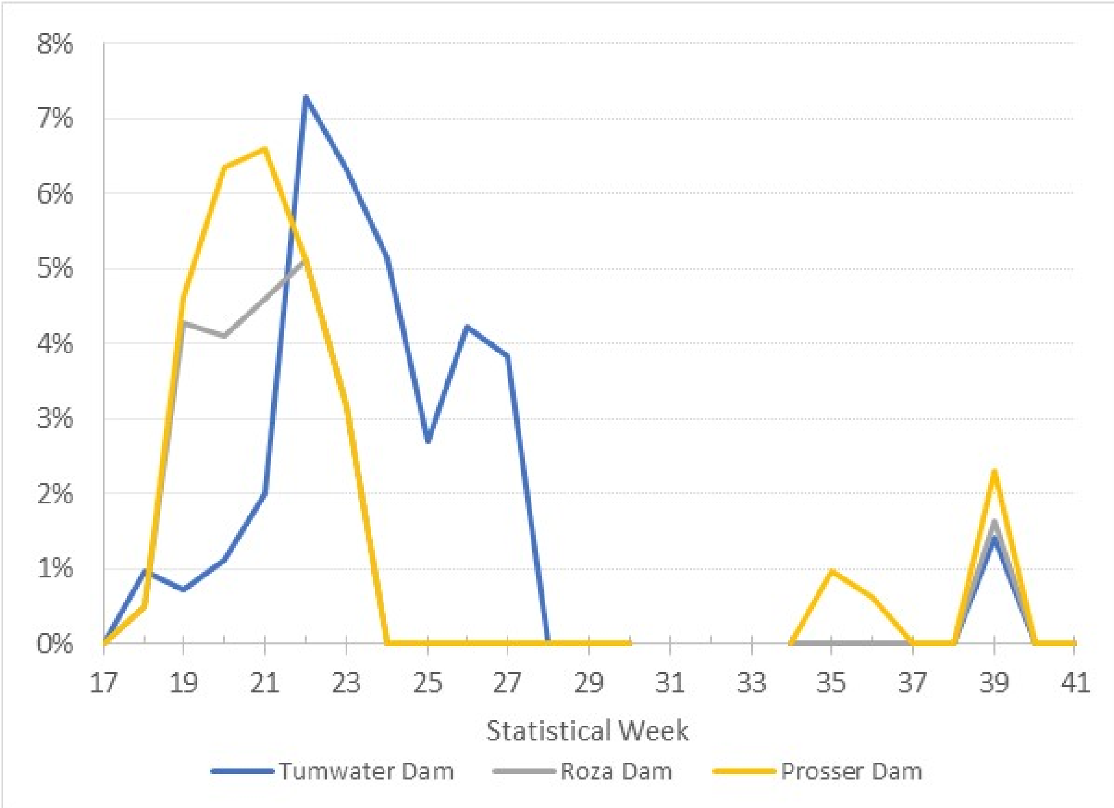

Figure 12. Percentage of Chinook Salmon by statistical week tagged at Bonneville Dam in 2019 destined for the Tumwater Dam (Wenatchee River), Prosser Dam (Yakima River) and Roza Dam (Yakima River) based on upstream PIT tag detections.

Migration Rates and Passage Time

Chinook migration rates between mainstem dams in 2019 ranged between 21.4 km/day for fall Chinook between Rock Island and Rocky Reach dams (n=21) and 54.6 km/day for fall Chinook between John Day and McNary dams (Table 9) when comparing all three races of Chinook.

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 Wells, Lower Granite, 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 2019.

		Median Migration Rate (km/day)		
Between Mainstem Dams	**Distance (km)**	**Spring Chinook**	**Summer Chinook**	**Fall Chinook**
Bonneville-The Dalles	74	37.5	37.6	36.8
The Dalles-John Day	39	40.1	35.2	41.5
John Day-McNary	123	52.4	53.3	54.6
McNary-Priest Rapids	169	38.2	35.7	26.5
Priest Rapids-Rock Island	124	28.8	31.9	27.6
Rock Island-Rocky Reach	33	31.1	31.1	21.4
Rocky Reach-Wells	67	33.7	31.3	31.1
Bonneville-John Day	113	37.7	36.8	37.6
Bonneville-McNary	236	40.3	40.0	39.8
Bonneville-Priest Rapids	405	35.8	36.7	28.7
Bonneville-Wells	596	33.0	33.0	30.8
Bonneville-Ice Harbor	304	41.3	43.5	32.3
Bonneville-Lower Granite	461	32.6	37.8	30.5
Priest Rapids-Wells	191	30.1	28.2	26.9
McNary-Ice Harbor	68	41.3	52.1	41.4
Ice Harbor-Lower Granite	157	27.1	32.1	31.5
To and Between Tributary Sites				
Rock Island - Tumwater	68	6.0	5.2	7.8
McNary - Prosser	145	32.4	12.1	9.1
Prosser - Roza	130	18.0	14.8	--
Lower Granite - South Fork Salmon (SFG)	375	20.9	38.9	--

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 2019.

	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	7.5	9.9	9.5	1.7%	0.7%	0.4%
The Dalles	0.2	0.1	0.1	3.6%	1.8%	0.9%
John Day	1.4	0.1	0.1	4.5%	2.5%	2.2%
McNary	97.0	76.0	82.8	6.7%	3.9%	5.6%
Priest Rapids	3.9	5.0	2.5	1.1%	1.0%	7.4%
Rock Island	7.8	36.6	0.1	1.5%	4.1%	15.1%
Rocky Reach	23.3	12.5	29.5	1.7%	3.6%	7.7%
Wells	240.7	121.3	85.8	37.6%	8.7%	8.7%
Ice Harbor	3.2	2.1	1.6	6.3%	6.2%	2.3%
Lower Monumental	1.2	2.6	0.2	4.7%	17.9%	9.8%
Little Goose	0.0	0.0	0.0	11.3%	5.1%	3.3%
Lower Granite	154.8	268.8	163.8	19.0%	31.6%	20.3%
Prosser	0.2	0.1	0.1	8.1%	0.0%	0.0%
Roza	2.5	67836.1[4]	–	31.2%	66.7%	0.0%
Tumwater	38.2	47.1	67.3[5]	13.9%	19.2%	0.0%

[4] Only three summer Chinook were detected at Roza Dam; one (3DD.0077C02DEB) was detected 116 times on nine days between June 25 and August 20, 2019.

[5] This fall Chinook, 3DD.003D364A48, was the first we have detected at Tumwater Dam during the years this study has been conducted. However, this fall Chinook was tagged on August 1 (the first date of the fall

Bonneville Dam Chinook Salmon Age Composition

The predominant age class for spring and summer Chinook was 1.2, comprising an estimated 83.0% of the spring Chinook and 39.3% of the summer Chinook population (Tables 11 and 12, Figure 13). The predominant age for class for fall Chinook was 0.3 at an estimated 54.5% of the population (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.x) showing the opposite trend (Figure 14). The transition from being primarily a yearling run to a subyearling run took place during the week sampling was prohibited due to temperature restrictions as the run was 64.7% yearling in Week 30 and 38.1% subyearling in Week 34 (Figure 14). One fall Chinook was aged as 2.x.

Table 11. Weekly and total age composition of spring Chinook Salmon at Bonneville Dam as estimated from scale patterns in 2019. (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			
			2016	2015	2014	
			1.1	1.2	0.4	1.3
17	3.4%	12	0.0%	91.7%	0.0%	8.3%
18	23.8%	233	0.4%	89.7%	0.0%	9.9%
19	32.4%	279	3.6%	90.3%	0.0%	6.1%
20	19.5%	192	15.1%	79.7%	0.0%	5.2%
21	12.8%	178	21.0%	68.8%	0.6%	9.7%
22	8.1%	108	18.7%	59.8%	0.0%	21.5%
Composite		**1000**	**8.4%**	**82.9%**	**0.1%**	**8.6%**

Table 12. Weekly and total age composition of summer Chinook Salmon at Bonneville Dam as estimated from scale patterns in 2019. (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								
			2017	2016		2015			2014		2013
			0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	0.5
23	14.2%	117	0.0%	0.9%	17.1%	1.7%	41.9%	0.0%	3.4%	34.2%	0.0%
24	17.4%	141	0.0%	0.0%	13.5%	2.8%	36.9%	0.7%	1.4%	43.3%	0.7%
25	16.4%	89	0.0%	1.1%	11.2%	2.2%	50.6%	0.0%	0.0%	33.7%	0.0%
26	15.7%	91	0.0%	1.1%	18.7%	2.2%	42.9%	0.0%	0.0%	35.2%	0.0%
27	13.1%	59	0.0%	3.4%	25.4%	1.7%	33.9%	0.0%	3.4%	32.2%	0.0%
28	8.4%	101	2.0%	3.0%	32.7%	1.0%	31.7%	0.0%	1.0%	28.7%	0.0%
29	6.4%	65	3.1%	4.6%	26.2%	6.2%	43.1%	0.0%	0.0%	16.9%	0.0%
30	5.7%	45	6.7%	4.4%	40.0%	4.4%	26.7%	0.0%	2.2%	15.6%	0.0%
31	2.6%	36	8.3%	8.3%	36.1%	11.1%	19.4%	2.8%	5.6%	8.3%	0.0%
Composite		**744**	**1.0%**	**1.9%**	**20.5%**	**2.7%**	**39.3%**	**0.2%**	**1.5%**	**32.3%**	**0.1%**

Chinook run at Bonneville Dam) and passed upstream so quickly that it classified as a summer Chinook at every other dam.

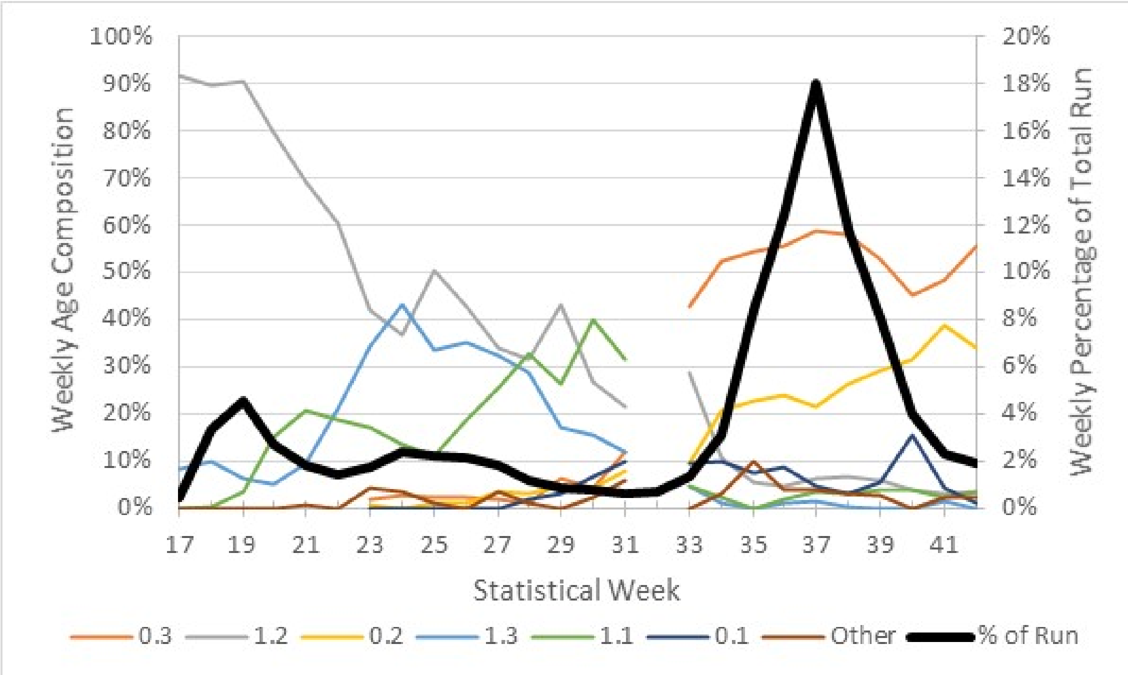

Figure 13. Weekly age composition of Chinook Salmon at Bonneville Dam as estimated from scale patterns in 2019 with weekly percentage of run.

Table 13. Weekly and total age composition of fall Chinook Salmon at Bonneville Dam as estimated from scale patterns in 2019. (Composite age composition estimates are weighted by the percentage of the run passing Bonneville Dam in each week without including Week 32 as no sampling occurred in that week.)

Week	Percent of Run	Number Ageable	Brood Year and Age Class									
			2017	2016		2015		2014			2013	
			0.1	0.2	1.1	0.3	1.2	0.4	1.3	2.2	0.5	2.3
31	0.4%	15	13.3%	6.7%	20.0%	13.3%	26.7%	0.0%	20.0%	0.0%	0.0%	0.0%
32	1.0%	AFF Closed due to temperatures at or above 22.2C, no sampling										
33	1.8%	21	9.5%	9.5%	4.8%	42.9%	28.6%	0.0%	4.8%	0.0%	0.0%	0.0%
34	4.3%	92	9.8%	20.7%	2.2%	52.2%	10.9%	1.1%	1.1%	1.1%	0.0%	1.1%
35	11.6%	92	7.6%	22.8%	0.0%	54.3%	5.4%	9.8%	0.0%	0.0%	0.0%	0.0%
36	17.2%	104	8.7%	24.0%	1.9%	55.8%	4.8%	3.8%	1.0%	0.0%	0.0%	0.0%
37	24.9%	212	4.7%	21.7%	3.3%	59.0%	6.1%	3.3%	1.4%	0.5%	0.0%	0.0%
38	16.4%	271	3.0%	26.2%	3.0%	57.9%	6.6%	3.0%	0.4%	0.0%	0.0%	0.0%
39	11.2%	268	5.6%	29.1%	3.7%	52.6%	6.0%	2.2%	0.0%	0.4%	0.4%	0.0%
40	5.5%	51	15.7%	31.4%	3.9%	45.1%	3.9%	0.0%	0.0%	0.0%	0.0%	0.0%
41	3.1%	139	4.3%	38.8%	2.2%	48.2%	2.9%	2.2%	1.4%	0.0%	0.0%	0.0%
42	2.7%	83	1.2%	33.7%	3.6%	55.4%	3.6%	2.4%	0.0%	0.0%	0.0%	0.0%
Composite	**100.0%**	**1182**	**6.3%**	**24.7%**	**2.7%**	**54.5%**	**6.2%**	**3.5%**	**0.8%**	**0.2%**	**0.0%**	**0.0%**

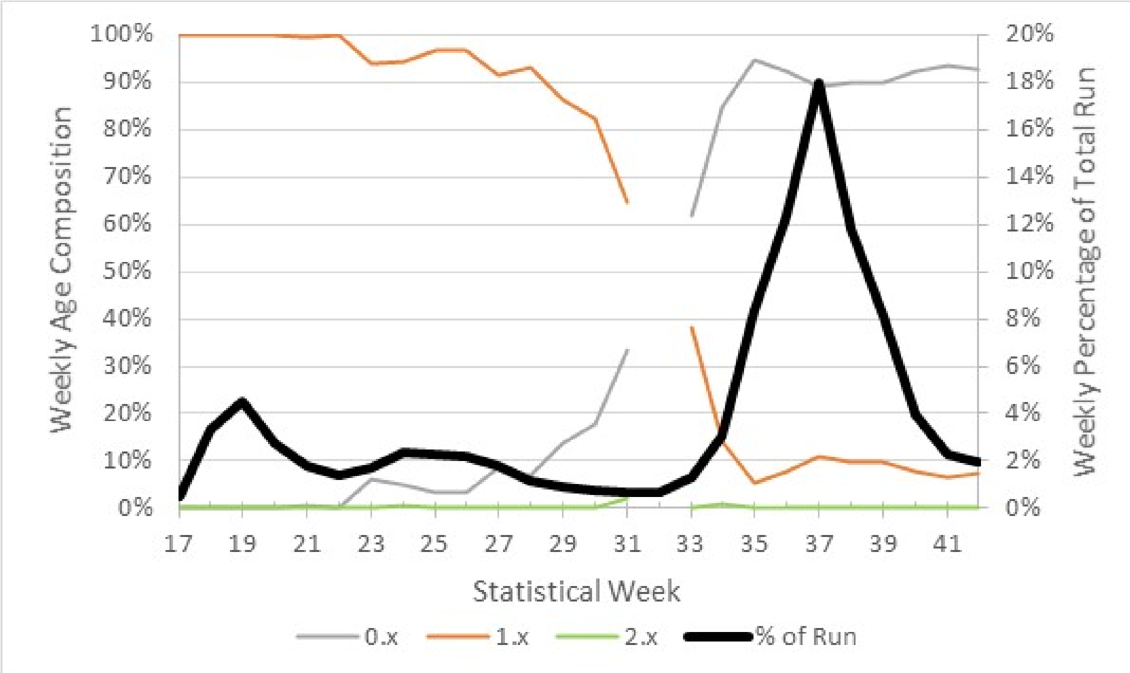

Figure 14. Weekly freshwater age composition of Chinook Salmon at Bonneville Dam as estimated from scale patterns in 2019 with weekly percentage of run.

Upstream Age and Length-at-Age Composition

Age 1.2 was the predominant age class for spring Chinook passing each mainstem dam in this study (Table 14, Figure 15). For summer Chinook Age 1.2 was predominant at all dams except for Rocky Reach where Age 1.3 was predominant and the Snake River dams where Age 1.1 formed the majority of the run (Table 14, Figure 16). Among fall Chinook, Age 0.3 was the predominant age class between Bonneville and Rocky Reach dams, Age 0.1 was predominant at Wells Dam, and Age 0.2 followed closely by 0.3 and 0.1 was predominant at the Snake River dams (Table 14, Figure 17). Length-at-age composition estimates at mainstem dam sites are summarized in Tables 15-17.

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 2019[6].

Run and Site	Ageable	Brood Year and Age Class										
		2017	2016		2015			2014		2013		
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	1068	0.0%	0.0%	8.4%	0.0%	83.0%	0.0%	0.1%	8.6%	0.0%	0.0%	0.0%
The Dalles	738	0.0%	0.0%	9.5%	0.0%	82.1%	0.0%	0.1%	8.2%	0.0%	0.0%	0.0%
John Day	666	0.0%	0.0%	9.7%	0.0%	81.8%	0.0%	0.1%	8.4%	0.0%	0.0%	0.0%
McNary	614	0.0%	0.0%	9.9%	0.0%	81.8%	0.0%	0.1%	8.1%	0.0%	0.0%	0.0%
Priest Rapids	152	0.0%	0.0%	8.4%	0.0%	82.3%	0.0%	0.3%	9.0%	0.0%	0.0%	0.0%
Rock Island	151	0.0%	0.0%	8.5%	0.0%	82.1%	0.0%	0.3%	9.1%	0.0%	0.0%	0.0%
Rocky Reach	103	0.0%	0.0%	11.2%	0.0%	79.2%	0.0%	0.0%	9.6%	0.0%	0.0%	0.0%
Wells	95	0.0%	0.0%	10.8%	0.0%	80.4%	0.0%	0.0%	8.8%	0.0%	0.0%	0.0%
Ice Harbor	407	0.0%	0.0%	10.9%	0.0%	81.4%	0.0%	0.0%	7.7%	0.0%	0.0%	0.0%
Low. Mon.	404	0.0%	0.0%	11.4%	0.0%	81.0%	0.0%	0.0%	7.7%	0.0%	0.0%	0.0%
Little Goose	393	0.0%	0.0%	10.9%	0.0%	81.4%	0.0%	0.0%	7.7%	0.0%	0.0%	0.0%
Lower Granite	389	0.0%	0.0%	11.0%	0.0%	81.5%	0.0%	0.0%	7.5%	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	744	1.0%	1.9%	20.5%	2.7%	39.3%	0.2%	1.5%	32.3%	0.1%	0.0%	0.0%
The Dalles	682	0.9%	1.9%	20.6%	2.3%	39.6%	0.2%	1.6%	32.4%	0.1%	0.5%	0.0%
John Day	637	0.8%	1.9%	22.1%	2.3%	39.4%	0.2%	1.2%	31.3%	0.1%	0.5%	0.0%
McNary	615	0.5%	2.0%	22.3%	2.2%	39.7%	0.3%	1.3%	31.1%	0.2%	0.5%	0.0%
Priest Rapids	525	0.4%	2.3%	17.1%	2.6%	38.7%	0.3%	1.3%	36.5%	0.2%	0.6%	0.0%
Rock Island	522	0.5%	2.3%	17.2%	2.6%	38.8%	0.3%	1.3%	36.3%	0.2%	0.6%	0.0%
Rocky Reach	485	0.3%	2.4%	16.8%	2.4%	37.7%	0.3%	0.7%	38.9%	0.0%	0.5%	0.0%
Wells	371	0.2%	2.6%	19.0%	3.0%	38.1%	0.4%	0.9%	35.1%	0.0%	0.6%	0.0%
Ice Harbor	76	0.0%	0.0%	57.7%	0.0%	35.5%	0.0%	2.5%	4.3%	0.0%	0.0%	0.0%
Low. Mon.	74	0.0%	0.0%	56.8%	0.0%	36.7%	0.0%	2.2%	4.3%	0.0%	0.0%	0.0%
Little Goose	73	0.0%	0.0%	57.7%	0.0%	35.5%	0.0%	2.5%	4.3%	0.0%	0.0%	0.0%
Lower Granite	72	0.0%	0.0%	57.1%	0.0%	36.0%	0.0%	2.5%	4.3%	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	1182	6.3%	24.7%	2.7%	54.5%	6.2%	0.0%	3.5%	0.8%	0.2%	0.0%	0.0%
The Dalles	929	8.1%	22.6%	3.3%	54.5%	7.5%	0.0%	3.1%	0.9%	0.1%	0.0%	0.0%
John Day	780	9.8%	23.3%	4.0%	51.9%	7.3%	0.0%	2.6%	1.0%	0.0%	0.0%	0.0%
McNary	724	10.1%	24.5%	4.3%	50.5%	6.7%	0.0%	2.8%	1.1%	0.0%	0.0%	0.0%
Priest Rapids	88	13.8%	27.5%	3.3%	41.8%	9.0%	0.0%	4.4%	0.1%	0.0%	0.0%	0.0%
Rock Island	50	12.6%	30.2%	0.9%	41.2%	11.1%	0.0%	3.9%	0.1%	0.0%	0.0%	0.0%
Rocky Reach	37	14.3%	27.2%	0.8%	43.5%	8.2%	0.0%	5.9%	0.2%	0.0%	0.0%	0.0%
Wells	21	36.3%	33.8%	0.9%	20.5%	8.4%	0.0%	0.0%	0.1%	0.0%	0.0%	0.0%
Ice Harbor	124	23.1%	27.9%	8.7%	23.8%	13.0%	0.0%	0.6%	2.8%	0.0%	0.0%	0.0%
Low. Mon.	116	23.0%	27.3%	8.3%	24.9%	13.3%	0.0%	0.6%	2.7%	0.0%	0.0%	0.0%
Little Goose	113	23.1%	27.9%	8.7%	23.8%	13.0%	0.0%	0.6%	2.8%	0.0%	0.0%	0.0%
Lower Granite	111	23.1%	28.0%	8.5%	24.0%	13.1%	0.0%	0.6%	2.8%	0.0%	0.0%	0.0%

[6] 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.

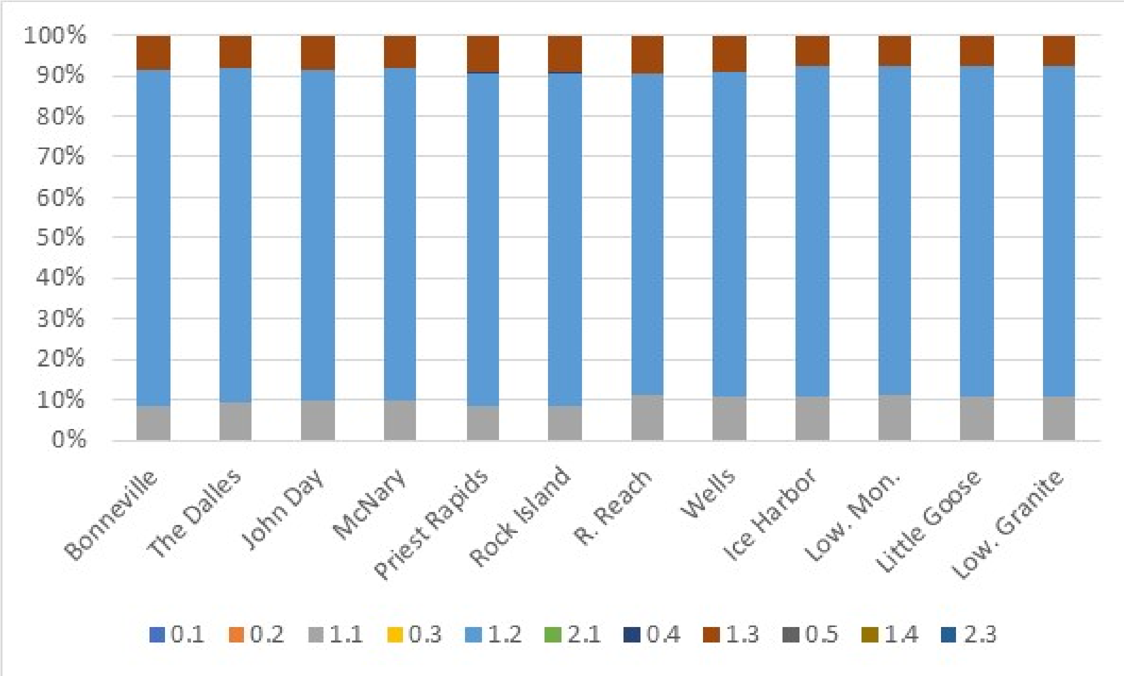

Figure 15. Spring Chinook age composition at Columbia and Snake River dams estimated using PIT tagged Chinook tracked by this project. Spring Chinook are defined as passing Bonneville Dam between April 1 and May 31, 2019.

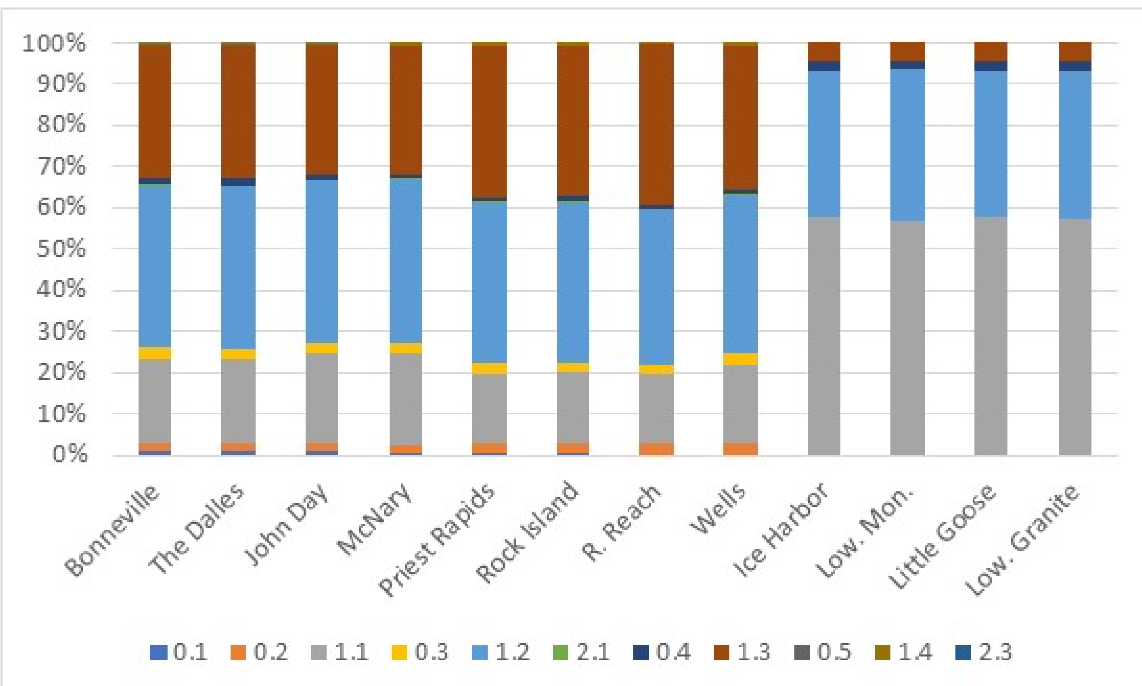

Figure 16. Summer Chinook age composition at Columbia and Snake River dams estimated using PIT tagged Chinook tracked by this project. Summer Chinook are defined as passing Bonneville Dam between June 1 and July 31, 2019.

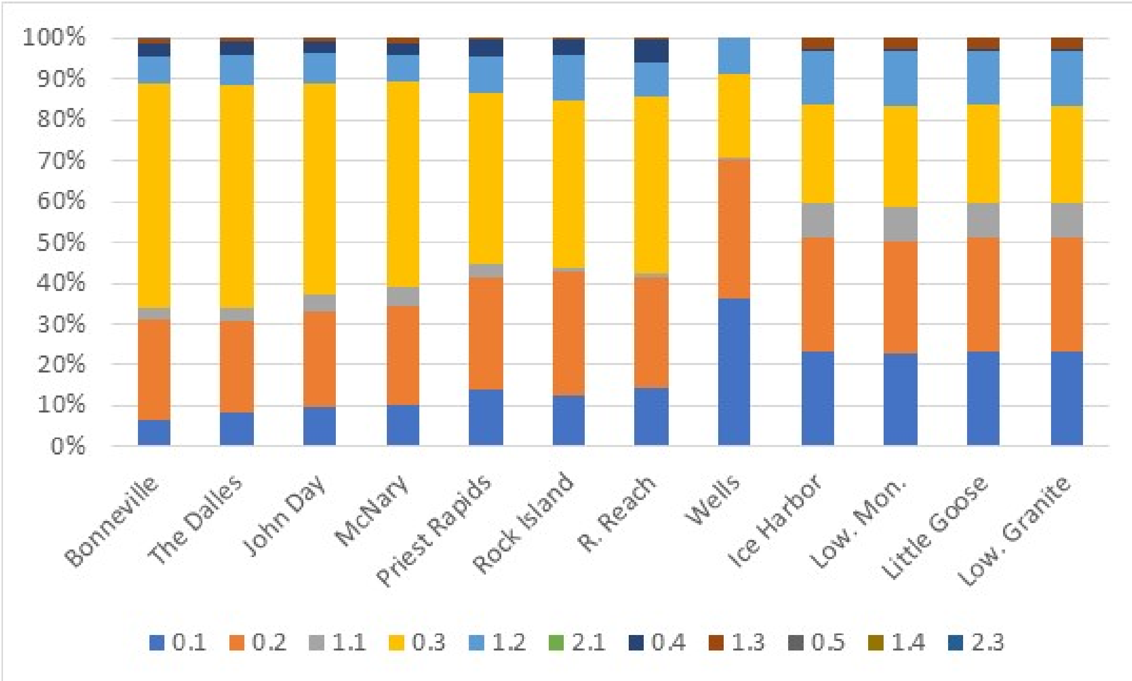

Figure 17. Fall Chinook age composition at Columbia and Snake river dams estimated using PIT tagged Chinook tracked by this project. Fall Chinook are defined as passing Bonneville Dam on or after August 1, 2019.

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 2019.

Dam	Statistic	Brood Year and Age Class										
		2017	2016		2015			2014		2013		
		0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	0.5	1.4	2.3
Bonneville	μ			49.2		70.8		93.0	84.9			
	s			3.6		5.6		–	6.3			
	n			97		806		1	90			
The Dalles	μ			49.0		70.2		93.0	85.7			
	s			3.6		5.8		–	5.4			
	n			86		583		1	68			
John Day	μ			49.0		70.2		93.0	85.8			
	s			3.4		6.0		–	5.5			
	n			81		521		1	63			
McNary	μ			49.3		70.1		93.0	86.3			
	s			3.3		6.1		–	5.4			
	n			75		480		1	58			
Priest Rapids	μ			50.0		71.4		93.0	86.8			
	s			3.9		5.5		–	5.8			
	n			14		110		1	27			
Rock Island	μ			50.0		71.4		93.0	86.8			
	s			3.9		5.5		–	5.8			
	n			14		109		1	27			
Rocky Reach	μ			49.9		70.1			86.6			
	s			4.3		5.5			5.8			
	n			12		69			22			
Wells	μ			49.4		70.0			85.7			
	s			4.0		5.5			6.3			
	n			11		67			17			
Ice Harbor	μ			49.2		70.1			86.4			
	s			3.1		6.4			4.2			
	n			52		325			30			
Lower Monumental	μ			49.2		70.1			86.4			
	s			3.2		6.4			4.2			
	n			51		323			30			
Little Goose	μ			49.1		70.2			86.4			
	s			3.2		6.3			4.2			
	n			49		315			29			
Lower Granite	μ			49.1		70.2			86.3			
	s			3.2		6.3			4.3			
	n			49		312			28			

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 2019.

Dam	Statistic	Brood Year and Age Class										
		2017	2016		2015			2014		2013		
		0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	0.5	1.4	2.3
Bonneville	μ	40.0	63.5	52.9	77.6	69.8	62.5	89.5	82.1	99.0	88.8	
	s	2.1	4.2	6.8	6.0	7.4	4.9	5.0	6.6	–	4.7	
	n	10	16	162	21	283	2	12	231	1	3	
The Dalles	μ	40.3	63.0	53.0	76.2	69.5	62.5	89.5	82.3	99.0	88.8	
	s	2.2	3.9	6.9	5.7	7.4	4.9	5.0	6.6	–	4.7	
	n	8	15	149	16	262	2	12	215	1	3	
John Day	μ	40.4	63.0	53.0	76.9	69.3	62.5	89.9	82.1	99.0	88.8	
	s	1.8	4.1	6.9	5.1	7.5	4.9	4.0	6.7	–	4.7	
	n	6	14	148	15	244	2	9	196	1	3	
McNary	μ	39.6	63.0	53.0	76.6	69.4	62.5	89.9	82.1	99.0	88.8	
	s	1.5	4.1	7.0	5.4	7.4	4.9	4.0	6.8	–	4.7	
	n	4	14	144	13	238	2	9	188	1	3	
Priest Rapids	μ	39.2	63.0	53.3	76.6	68.9	62.5	89.5	82.1	99.0	88.8	
	s	1.5	4.1	7.8	5.4	7.6	4.9	4.5	6.8		4.7	
	N	3	14	101	13	196	2	7	186	1	3	
Rock Island	μ	39.2	63.0	53.3	76.6	69.0	62.5	89.5	82.2	99.0	88.8	
	S	1.5	4.1	7.8	5.4	7.5	4.9	4.5	6.8		4.7	
	N	3	14	101	13	195	2	7	184	1	3	
Rocky Reach	μ	38.5	63.0	53.5	76.0	68.6	62.5	89.3	82.1		91.5	
	s	1.4	4.1	8.0	5.7	7.5	4.9	6.2	6.9		1.4	
	n	2	14	95	11	176	2	4	180		2	
Wells	μ	39.5	63.0	53.8	76.0	68.7	62.5	88.3	82.1		91.5	
	s	–	4.4	8.2	5.7	7.2	4.9	7.2	7.2		1.4	
	n	1	12	85	11	135	2	3	120		2	
Ice Harbor	μ			52.5		71.4		91.3	82.0			
	s			3.8		6.0		0.4	–			
	n			38		35		2	1			
Lower Monumental	μ			52.6		71.4		91.3	82.0			
	s			3.9		6.0		0.4	–			
	n			36		35		2	1			
Little Goose	μ			52.6		71.1		91.3	82.0			
	s			3.9		5.9		0.4	–			
	n			36		34		2	1			
Lower Granite	μ			52.7		71.1		91.3	82.0			
	s			3.8		5.9		0.4	–			
	n			35		34		2	1			

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 2019.

Dam	Statistic	Brood Year and Age Class										
		2017	2016		2015			2014		2013		
		0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	0.5	1.4	2.3
Bonneville	μ	44.9	64.7	58.3	77.4	72.5		86.1	79.8	95.0		82.0
	s	4.6	4.8	5.3	7.1	6.9		6.3	5.9	–		--
	n	77	359	41	717	86		40	12	1		1
The Dalles	μ	43.9	64.9	58.1	77.5	71.8		86.0	78.3	95.0		
	s	2.5	4.7	5.6	6.7	6.5		5.7	5.1	–		
	n	63	227	32	504	64		28	10	1		
John Day	μ	44.0	65.2	58.1	77.5	71.8		85.2	77.6			
	s	2.5	4.8	5.8	5.8	6.5		5.5	5.4			
	n	60	194	30	414	53		21	8			
McNary	μ	44.1	65.4	58.1	77.3	71.6		85.3	77.6			
	s	2.5	4.6	5.8	5.7	6.4		5.7	5.4			
	n	57	187	30	375	47		20	8			
Priest Rapids	μ	44.3	64.7	59.0	77.8	70.3		82.7	71.8			
	s	2.3	5.5	7.6	5.2	7.4		1.2	3.2			
	n	13	25	5	32	8		3	2			
Rock Island	μ	43.9	63.7	55.2	78.9	70.9		83.0	71.8			
	s	2.4	7.4	6.8	4.6	7.8		1.4	3.2			
	n	7	11	3	18	7		2	2			
Rocky Reach	μ	44.0	62.3	58.3	79.0	67.7		83.0	71.8			
	s	2.6	8.1	6.0	5.4	6.8		1.4	3.2			
	n	6	8	2	12	5		2	2			
Wells	μ	43.7	63.3	58.3	76.3	67.4			69.5			
	s	2.8	5.9	6.0	4.3	7.8			--			
	n	5	6	2	3	4			1			
Ice Harbor	μ	44.8	66.0	55.0	77.1	68.0		80.5	80.5			
	s	2.7	4.2	5.1	7.0	5.9		–	5.6			
	n	19	37	10	36	17		1	4			
Lower Monumental	μ	44.9	66.0	55.0	77.0	68.2		80.5	80.5			
	s	2.8	4.4	5.1	7.1	6.1		–	5.6			
	n	18	33	10	34	16		1	4			
Little Goose	μ	44.9	66.0	55.0	77.3	68.0		80.5	80.5			
	s	2.8	4.4	5.1	7.2	6.3		–	5.6			
	n	18	33	10	32	15		1	4			
Lower Granite	μ	44.9	66.0	55.2	77.3	68.0		80.5	80.5			
	s	2.8	4.4	5.4	7.2	6.3		–	5.6			
	n	18	32	9	32	15		1	4			

Fallback

Estimated fallback rates, based on Chinook Salmon reascending fish ladders or being detected downstream after ascending a fish ladder, ranged from 0.0% spring Chinook at Rock Island Dam and summer and fall Chinook at

Tumwater Dam to 29.8% for fall Chinook at Priest Rapids 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.

Of the 17 fall Chinook fallbacks estimated at Priest Rapids Dam, 14 were subsequently detected at Priest Rapids Hatchery located 4 km downstream plus one at Ringold Hatchery located 68 km downstream.

Table 18. Estimated minimum Chinook Salmon fallback rates by race at Columbia Basin dams with PIT tag detection in 2019 as estimated by PIT tags[7].

Dam	Spring Chinook	Summer Chinook	Fall Chinook
Bonneville	1.7%	0.6%	0.4%
The Dalles	6.2%	2.2%	2.1%
John Day	3.6%	1.9%	0.6%
McNary	2.7%	1.2%	1.8%
Priest Rapids	1.7%	1.9%	29.8%
Rock Island	0.0%	1.1%	7.5%
Rocky Reach	4.1%	6.5%	5.1%
Wells	4.6%	11.0%	13.0%
Ice Harbor	8.7%	12.3%	3.8%
L. Monumental	4.7%	13.9%	2.4%
Little Goose	1.2%	3.8%	10.8%
Lower Granite	9.4%	13.2%	22.0%
Tumwater	5.6%	0.0%	0.0%
Weighted Mean	**4.1%**	**3.2%**	**2.8%**

A total of 417 Chinook generated 550 fallback events at mainstem dams with adult PIT tag detection (Table 19). A total of 98 Chinook had more than one fallback event at a single dam or several dams. One Chinook fell back over mainstem dams 6 times while another fell back 5 times. Figures showing the movement of some of these Chinook are in the Appendix B (Table B1 and Figures B24 – B25). One minijack, (3DD.003D364BCC) not included in Table 19, fell back over Wells, Rocky Reach, and Rock Island dams.

[7] 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 spring, summer, and fall Chinook Salmon tagged by this project in 2019.

Number of Dams Fallen Back Over	Total Number of Chinook
1	319
2	69
3	20
4	7
5	0
6	2
Number of Chinook falling back at least once	**417**
Percentage of Chinook with at least one fallback event	**12.0%**
Total fallback events	**557**
Number of Chinook in study	**3483**
Fallback events per Chinook	**0.16**

Night Passage

Night passage (2000-0400 Pacific Standard Time) of tagged Chinook Salmon was under 10% at all mainstem dams except for summer Chinook at Little Goose Dam (Table 20). Higher percentages of night passage were estimated at tributary dams, but sample sizes are relatively small (for example, only 3 (2 at night) summer Chinook passed Prosser Dam, while 5 of 26 summer Chinook passed Tumwater Dam at night, Table 20).

Table 20. Chinook Salmon night passage (2000-0400) in 2019 at Columbia Basin dams as estimated by PIT tag detections.

Site	Spring Chinook	Summer Chinook	Fall Chinook
Bonneville	0.4%	0.5%	0.4%
The Dalles	3.8%	3.3%	2.6%
John Day	1.5%	2.0%	1.5%
McNary	0.9%	1.4%	1.4%
Priest Rapids	2.8%	2.1%	4.3%
Rock Island	7.7%	5.1%	7.5%
Rocky Reach	5.0%	3.2%	2.6%
Wells	5.5%	2.1%	4.3%
Ice Harbor	1.8%	6.2%	3.1%
Lower Monumental	1.6%	1.3%	2.4%
Little Goose	2.3%	10.3%	2.5%
Lower Granite	2.3%	0.0%	2.5%
Prosser	10.8%	33.3%	66.7%
Roza	25.0%	66.7%	NA
Tumwater	8.3%	19.2%	0.0%

Comparisons with WFRS Chinook Salmon

A total of 5,405 Chinook Salmon were detected passing through the WFRS during 2019 compared to 3520 sampled at the AFF trap (Table 21). The weekly distribution of the WFRS sample showed similar trends to that of the AFF sample, though with larger peaks due to the inability of the AFF sample to be expanded because of both logistical and regulatory sampling constraints. The peak week WFRS sample was Week 18, driven by a single day of 493 Chinook sampled, which occurred on May 2 (Figure 18). On this day 4,222 Chinook were counted on the Washington shore fish counting station - the largest count until September. However, due to low abundance of other species and low water temperatures, there were no sampling restrictions this week resulting in large sample sizes at both the AFF (Table 1) and WFRS[8]. In contrast, peak runs in Weeks 35-37 were under sampled relative to visual counts and WFRS sample sizes at the AFF due to sampling restrictions.

The weekly mean fork length for WFRS-sampled Chinook was greater than that of AFF-sampled Chinook in 9 of 13 weeks between Statistical Week 17 and 28 but in all 12 subsequent weeks the weekly fork length of AFF-sampled Chinook was greater than that of those sampled by WFRS (Figure 19, Table 21). The distribution of Chinook fork lengths was unimodal as the age composition for spring, summer, and fall Chinook had a plurality, if not a majority, of similar sized Age 4 Chinook with lesser percentages of Age 3 and Age 5 Chinook (Figure 20). The mean length for AFF-sampled Chinook was 70.7 cm compared to 69.6 cm for WFRS. A Mann Whitney test did not find a significant difference (α=0.05) between lengths of AFF and WFRS-sampled Chinook (Z=0.35, p=0.73). A Kolmogorov-Smirnov test also did not find a significant difference (α=0.05) between cumulative length distribution of AFF and WFRS-sampled Chinook (χ^2=4.26, p=0.12, Figure 21).

[8] Chinook Salmon WFRS sample sizes during Week 18 were 22, 29, 182, 493, and 187 respectively for April 29 through May 3.

Table 21. Mean length with standard deviation of Chinook Salmon by Statistical Week for Chinook sampled at the AFF and by the WFRS in 2019. Only Chinook >=36 cm fork length were included in the WFRS sample to be comparable with the AFF sampled which excluded smaller Chinook.

	AFF			WFRS				
Statistical Week	Mean	Standard Deviation	N	Mean	Standard Deviation	N with Length>36 cm)	Total N	% of Run
17	70.9	5.5	16	71.5	7.1	8	8	0.5%
18	72.2	6.0	319	72.0	7.3	913	913	3.5%
19	70.3	7.9	307	69.7	9.0	486	487	4.7%
20	68.0	10.0	210	67.7	11.1	164	165	2.9%
21	68.6	12.4	216	71.4	12.1	119	119	1.9%
22	70.6	12.4	128	73.8	13.6	33	34	1.4%
23	72.6	12.3	139	72.8	12.3	79	79	1.8%
24	74.7	11.6	165	75.5	13.5	161	161	2.5%
25	72.6	11.3	109	73.3	13.0	193	193	2.3%
26	70.6	12.1	110	74.2	12.4	201	202	2.2%
27	70.4	13.4	74	71.7	13.5	62	62	1.9%
28	66.3	14.3	119	66.2	15.0	76	76	1.2%
29	66.2	13.3	77	69.9	12.9	25	25	0.9%
30	64.4	14.1	50	63.2	12.8	14	14	0.8%
31	64.3	14.9	60	57.5	20.1	9	12	0.7%
32	AFF Closed due to temperatures at or above 22.2C, no sampling							0.7%
33	74.5	13.2	24	62.9	6.7	4	4	1.4%
34	71.0	13.2	101	69.8	16.1	148	156	3.2%
35	73.5	12.3	93	65.3	16.0	161	179	8.7%
36	71.7	12.6	108	67.8	14.6	261	269	12.9%
37	72.9	10.0	229	69.1	13.7	742	766	18.7%
38	72.4	9.5	290	68.2	13.6	873	906	8.2%
39	70.4	10.6	287	67.6	13.2	274	282	8.4%
40	66.2	13.3	54	59.8	13.8	36	39	4.1%
41	69.7	10.6	149	66.2	13.2	143	147	2.4%
42	72.1	9.4	86	65.4	13.2	99	107	2.0%
Total	**70.7**	**11.2**	**3520**[9]	**69.6**	**12.7**	**5405**	**5284**	**100.0%**

[9] Tables 3-5 show 3520 Chinook sampled, however there were no lengths for 3 of the Chinook.

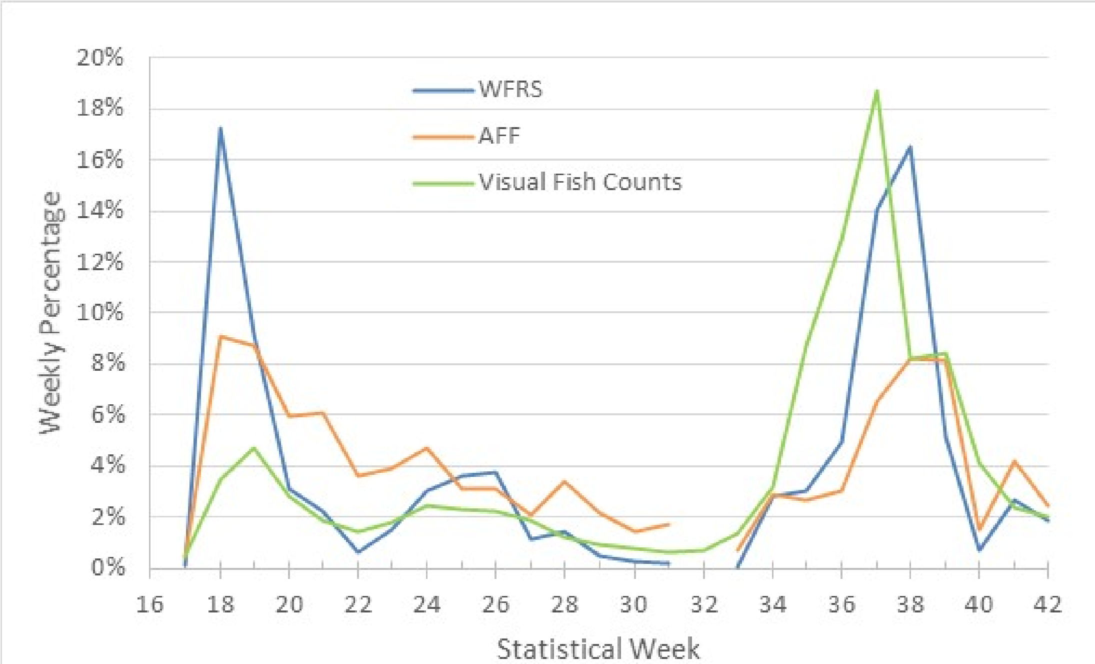

Figure 18. Comparison of the weekly percentage of the visual fish count at Bonneville Dam and the percentage of Chinook sampled in the Adult Fish Facility and by the WFRS in 2019.

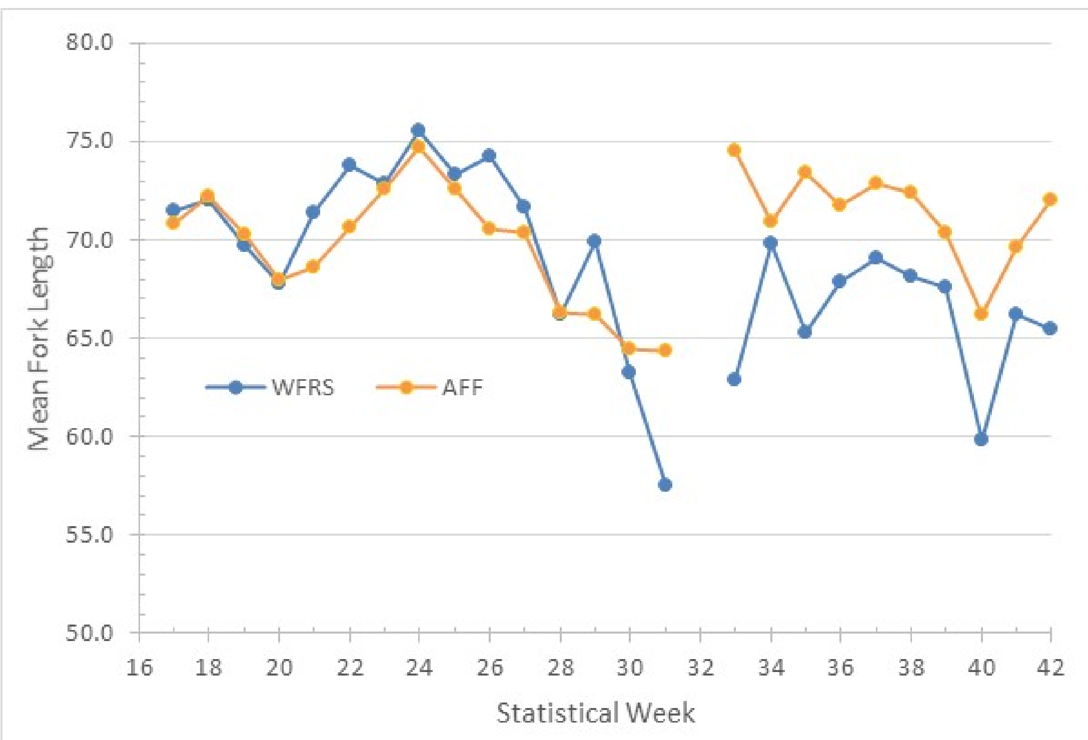

Figure 19. Mean fork length by week of WFRS and AFF-sampled Chinook Salmon at Bonneville Dam in 2019.

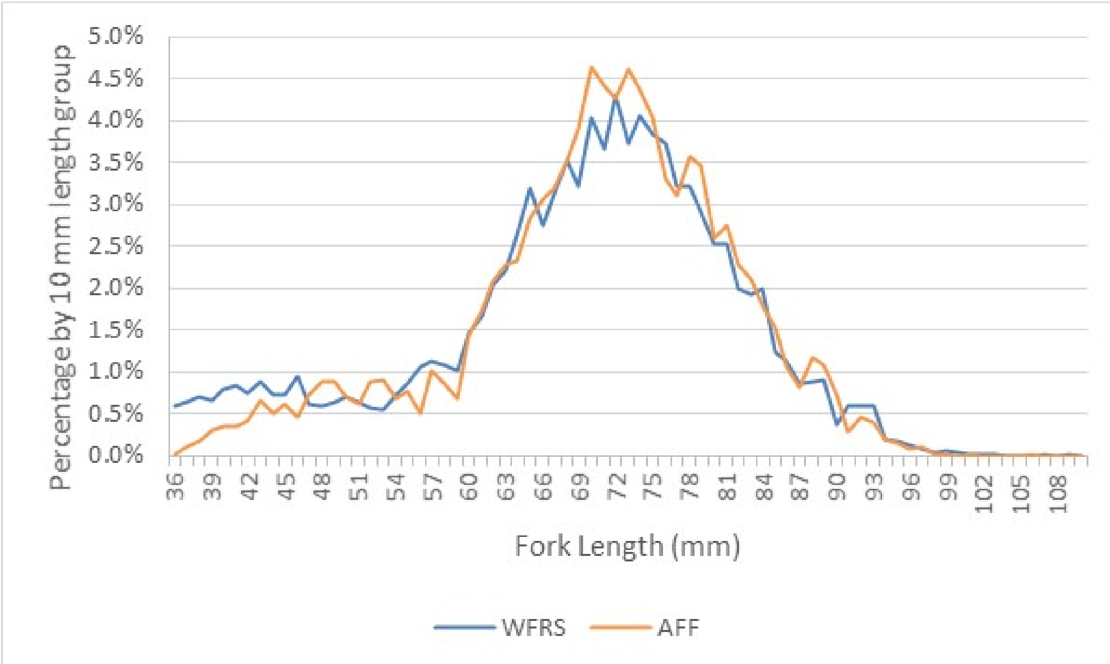

Figure 20. Fork length distribution for WFRS and AFF-sampled Chinook Salmon at Bonneville Dam in 2019.

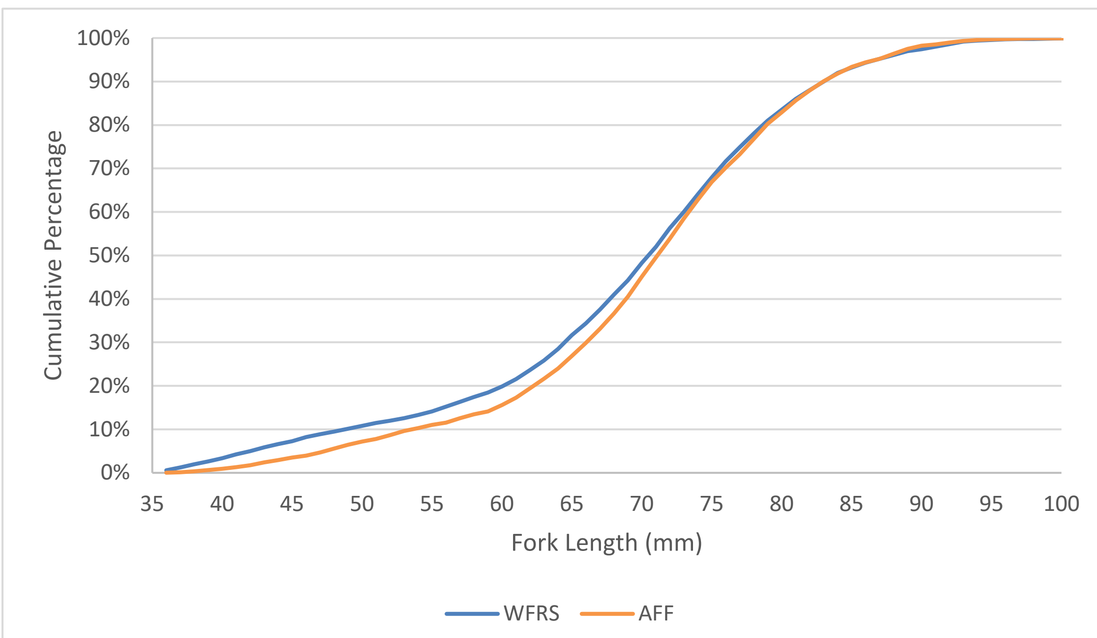

Figure 21. Cumulative fork length distribution for WFRS and AFF-sampled Chinook Salmon at Bonneville Dam in 2019.

The proportion of Chinook adipose clipped was significantly greater (α=0.05) in the AFF sample than the WFRS sample in 13 out of 25 weeks (Table 22, Figure 22), the WFRS proportion was significantly greater than the AFF proportion in 9 weeks, while there was no significant difference in 3 weeks. Over the entire sample, the percentage adipose clipped in the AFF sample (52.7%) was significantly different than that in that in the WFRS sample (50.7%, Table 22).

Table 22. Proportion of Chinook Salmon >36 cm fork length adipose clipped by week in both the AFF and WFRS samples with standard deviation and a t-statistic for the difference between the two proportions. Significant values (p=0.05) are shaded yellow with the greater proportion shaded green in those cases.

	AFF			WFRS				
Statistical Week	N	Proportion Ad Clipped	Std Dev	N	Proportion Ad Clipped	Std Dev	t-stat	P-value
17	16	0.688	0.029	8	0.875	0.041	3.22	0.002
18	319	0.812	0.001	913	0.769	0.000	23.99	0.000
19	307	0.743	0.001	486	0.722	0.001	9.23	0.000
20	210	0.695	0.002	164	0.707	0.003	2.90	0.002
21	216	0.644	0.002	119	0.613	0.004	5.83	0.000
22	128	0.633	0.004	33	0.606	0.015	1.70	0.046
23	139	0.698	0.003	79	0.646	0.006	6.83	0.000
24	165	0.721	0.003	161	0.727	0.003	1.16	0.123
25	109	0.780	0.004	193	0.767	0.002	2.24	0.013
26	110	0.773	0.004	201	0.751	0.002	3.70	0.000
27	74	0.635	0.007	62	0.597	0.008	3.16	0.001
28	119	0.664	0.004	76	0.632	0.006	3.81	0.000
29	77	0.649	0.006	25	0.600	0.020	2.30	0.012
30	50	0.560	0.010	14	0.357	0.034	5.48	0.000
31	60	0.467	0.008	9	0.444	0.055	0.39	0.348
32	AFF Closed due to temperatures at or above 22.2C, no sampling							
33	24	0.250	0.018	4	1.000	0.000	29.39	0.000
34	101	0.277	0.004	148	0.331	0.003	7.66	0.000
35	93	0.258	0.005	161	0.348	0.003	12.33	0.000
36	108	0.287	0.004	261	0.356	0.002	11.17	0.000
37	229	0.371	0.002	742	0.319	0.001	16.98	0.000
38	290	0.245	0.001	873	0.308	0.001	29.27	0.000
39	287	0.258	0.002	274	0.245	0.002	4.99	0.000
40	54	0.241	0.008	36	0.306	0.013	3.81	0.000
41	149	0.161	0.002	143	0.161	0.003	0.05	0.478
42	86	0.198	0.005	99	0.253	0.004	6.96	0.000
Total	**3520**	**0.527**	**0.000**	**5284**	**0.507**	**0.000**	**90.12**	**0.000**

Figure 22. Percentage of adipose clipped Chinook Salmon sampled at the Adult Fish Facility and by WFRS by statistical week in 2019[10].

Straying

Estimated Chinook stray rates by stock using PBT for those with more than 10 fish that were designated as either putative strays or on-target, ranged from 37.5% for Klickitat and Methow hatchery stocks to 0% for numerous other stocks (Table 23). The hatchery with the greatest number of strays was Little White Salmon with 13 strays found at locations between McNary and Rocky Reach dams with one stray each in the Tucannon and Umatilla rivers. The combined stray rate for all stocks was 6.6% with 7.2% categorized as putative overshoots.

Estimated Chinook stray rates by stock using GSI for those with more than 10 fish that were designated as either putative strays or on-target, ranged from 59.4% for the Upper Columbia Spring group to 5.9% for the Upper Salmon River group (Table 24).

[10] Note that the sample size for Week 34 in which 100% of WFRS steelhead were adipose clipped was only 4.

Table 23. Table showing final-PIT-fate categories by hatchery in 2019 using Parental Based Tagging (PBT). 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.

ColRKM	234	234	234	234	234	234	251	251	261	269	273	273	290	308	308	328	328	328	347	347
	Bonneville Dam						Bonneville Pool Sites				Hood Basin			The Dalles		Deschutes			John Day Dam	
	Bonneville Bypass	BonnevilleCorner Collector	BON PH2 Corner Collector	Bonneville-Bradford Ladder	Bonneville-WA Shore Ladder	Bonneille WA Ladder Slots	Carson Hatchery	Upper Wind River rkm 30	Little White Salmon Hatchery	Spring Creek Hatchery	Moving Falls Ladder	Hood River Mouth	Lyle Falls Fishway, Klickitat R	The Dalles-East Ladder	The Dalles-North Ladder	Deschutes River Mouth	Warm Springs River PIT array	Warm Springs Hatchery	John Day Dam-Oregon Shore	John Day Dam-WA Shore
Stock Classification Using Parental Based Tagging	B2J	BCC	BO1	BO2	BO3	BO4	CAL	WRU	LWL	SCL	MVF	HRM	LFF	TD1	TD2	DRM	WSH	SHK	JO1	JO2
Carson Hatchery			1	1		41	11	5	4					2						
Chief Joseph Hatchery (summer/Fall)						10								4	1					
Clearwater Hatchery						10								8	1				1	1
Clearwater-Powel Creek Facility						2														
Deschutes						4								5		2	3			
Dworshak Hatchery						15								8						
Eastbank Hatchery (Summer)					1	2								2					3	2
Entiat Hatchery (Summer)						1								1						
Klickitat Hatchery						2							5	1						
Little White Hatchery (fall)	1				2	145			108			3	8	14					1	
Lookingglass Hatchery - Catherine Creek						1														
Lookingglass Hatchery - Grand Ronde														1						
Lookingglass Hatchery - Imnaha						1														
Lookingglass Hatchery - Lookinglass						4								1						
Lookingglass Hatchery - Lostine						1														
McCall Hatchery			1			6								1					1	
Methow River						13								5					1	1
Nez Perce Hatchery						4									1				1	
Pahsimmeroi Hatchery						1								1					1	
Parkdale Fish Facility						6					3	3		3		1				
Priest Rapids Hatchery (fall)				1		26							2	5					6	2
Rapid River Hatchery					1	47								12	1				1	
Sawtooth Hatchery						6								1						
Snake River Fall						9								5				1	4	
Spring Creek (Hatchery)		2	2			5				8										
Umatilla						2													1	
Upper Columbia Spring						12								3					1	1
Washougal Hatchery						1														
Wells Hatchery					1	2								1	2				1	
Total	1	2	4	2	5	379	11	5	112	8	3	6	15	84	6	3	3	1	23	7

ColRKM	465	470	470	470	509	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
	Umatila	McNary			Walla Walla		Lower Monu-mental		Tucannon		Little Goose Dam		L. Granite		Clearwater							
	Three Mile Dam	McNary-Oregon Shore	McNary-WA Shore	McNary Juvenile Bypass	Nursery Bridge	Ice Harbor Dam	Lower Monumental Ladders	Lower Monumental Juv Bypass	Lower Tucannon River	Tucannon Hatchery	Little Goose Dam	Little Goose Juvenile Bypass	Lower Granite	Lower Granite Juvenile Bypass	Dworshak Hatchery	Upper Lolo Creek rkm 21	Lower Lochsa	Upper Lochsa	SF Clearwater rkm 1	SF Clearwater rkm 2	Lower Selway River	Upper Selway River
Stock Classification Using Parental Based Tagging	TMF	MC1	MC2	MCJ	NBA	ICH	LMA	LMJ	LTR	TFH	GOA	GOJ	GRA	GRJ	DWL	LC1	LRL	LRU	SC1	SC2	SW1	SW2
Carson Hatchery					1																	
Chief Joseph Hatchery (summer/Fall)		1																				
Clearwater Hatchery		1				1	1						9		5			1	11	22	2	1
Clearwater-Powel Creek Facility																						
Deschutes		1																				
Dworshak Hatchery							1						12		18	1		1	4	2		
Eastbank Hatchery (Summer)																						
Entiat Hatchery (Summer)																						
Klickitat Hatchery																						
Little White Hatchery (fall)	1	4	2						1													
Lookingglass Hatchery - Catherine Creek													1									
Lookingglass Hatchery - Grand Ronde																						
Lookingglass Hatchery - Imnaha													2									
Lookingglass Hatchery - Lookinglass													5									
Lookingglass Hatchery - Lostine																						
McCall Hatchery											1		2				1	5		1	1	
Methow River																						
Nez Perce Hatchery						1							9							4		1
Pahsimmeroi Hatchery											1		6									
Parkdale Fish Facility																						
Priest Rapids Hatchery (fall)		39	7	1		2							1									
Rapid River Hatchery		1					5				1		116									
Sawtooth Hatchery													11									
Snake River Fall		2				3	1	1	3	2		2	53	7								
Spring Creek (Hatchery)																						
Umatilla	15	1																				
Upper Columbia Spring		2																				
Washougal Hatchery																						
Wells Hatchery		1	1																			
Total	16	53	10	1	1	7	8	1	4	2	3	2	227	7	23	1	1	7	15	29	3	2

ColRKM	522	522	522	522	522	522	522	522	522	522	522	522	522	522	539	567	635	639	730	754	754	754	754	754
		Grand Ronde Basin					Salmon River					Imnaha			Yakima		Priest Rapids			Wenatchee				
	Asotin	Wenaha River Mouth	Wallow River rkm 32	Upper Grande Ronde rkm 155	Catherine Creek Weir	Upper Grande Ronde -Starkey	SF Salmon-Krassel Cr	SFk Salmon Satellite Facility	Upper Salmon rkm 437	Upper Salmon rkm 460	Redfish Lake Creek	Imnaha Weir Adult Ladder	Lower Imnaha	Lower Imnaha	Prosser Dam	Ringold Hatchery	Priest Rapids Hatchery	Priest Rapids Ladder	Rock Island Dam Ladder	Lower Wenatchee River	Icicle Creek	Leavenworth Hatchery	Tumwater Dam Ladder	Upper Chiwawa
Stock Classification Using Parental Based Tagging	ACM	WEN	WR2	UGR	CCW	UGS	KRS	STR	USE	USI	RFL	IML	IR4	IR5	PRO	RSH	PRH	PRA	RIA	LWE	ICL	LNF	TUF	CHU
Carson Hatchery																								
Chief Joseph Hatchery (summer/Fall)																								
Clearwater Hatchery																								
Clearwater-Powel Creek Facility																								
Deschutes																								
Dworshak Hatchery																								
Eastbank Hatchery (Summer)																		1	1	5	1		10	5
Entiat Hatchery (Summer)																								
Klickitat Hatchery												2		1										
Little White Hatchery (fall)															2		1							
Lookingglass Hatchery - Catherine Creek					7																			
Lookingglass Hatchery - Grand Ronde				2		5																		
Lookingglass Hatchery - Imnaha												3	1	2										
Lookingglass Hatchery - Lookinglass		3																						
Lookingglass Hatchery - Lostine			1																					
McCall Hatchery							34	2																
Methow River																								
Nez Perce Hatchery																			1					
Pahsimmeroi Hatchery									2	2														
Parkdale Fish Facility																								
Priest Rapids Hatchery (fall)																7	67	7	1					
Rapid River Hatchery																								
Sawtooth Hatchery			1						6	12	1													
Snake River Fall	1																1							
Spring Creek (Hatchery)																								
Umatilla																								
Upper Columbia Spring																					2	17		
Washougal Hatchery																								
Wells Hatchery																								
Total	1	3	2	2	7	5	34	2	8	14	1	5	1	3	2	7	69	8	3	5	3	17	10	5

ColRKM	754	754	754	754	763	763	764	778	778	778	830	830	830	843	843	843	843	843	843	858						
	Wenatchee				Rocky Reach			Entiat			Wells Dam			Methow												
	Upper Wenatchee	Lower Nason Creek	Upper Nason Creek	White River	Rocky Reach ladders	Rocky Reach Juvenile Bypass	East Bank Hatchery	Lower Entiat River	Entiat Hatchery	Upper Entiat rkm 17	Wells Dam Ladders	Wells Hatchery	Wells Juvenile Bypass	Methow	Methow River at Carlton	Upper Chewuch	Spring Creek Acclimation Pond	Methow River at Winthrop	Methow Hatchery	Lower Okanogan Weir						
Stock Classification Using Parental Based Tagging	UWE	NAL	NAU	WTL	RRF	RRJ	EBO	ENL	EHL	ENA	WEA	WEH	WEJ	LMR	MRC	CRU	SCP	MRW	MSH	OKL	Total	Neutral	On-Target	Putative Stray	Putative Overshoot	% Putative Strays/On-Target
Carson Hatchery											1										67	43	20	2	2	9.1%
Chief Joseph Hatchery (summer/Fall)						1					52	12								9	90	29	61	0	0	0.0%
Clearwater Hatchery																					75	33	42	0	0	0.0%
Clearwater-Powel Creek Facility																					2	2	0	0	0	NA
Deschutes																					15	9	5	1	0	16.7%
Dworshak Hatchery																					62	36	26	0	0	0.0%
Eastbank Hatchery (Summer)	1	4	3	1	15	1	2	1			20	12		1	2						96	12	84	0	0	0.0%
Entiat Hatchery (Summer)								4	12	1	2									1	22	2	17	1	2	5.6%
Klickitat Hatchery																					11	2	5	3	1	37.5%
Little White Hatchery (fall)					1																294	148	119	13	14	9.8%
Lookingglass Hatchery - Catherine Creek																					9	2	7	0	0	0.0%
Lookingglass Hatchery - Grand Ronde																					8	1	7	0	0	0.0%
Lookingglass Hatchery - Imnaha																					9	3	6	0	0	0.0%
Lookingglass Hatchery - Lookinglass																					13	10	3	0	0	0.0%
Lookingglass Hatchery - Lostine																					2	1	1	0	0	0.0%
McCall Hatchery																					56	12	36	8	0	18.2%
Methow River											5			2			11		2	9	49	25	15	9	0	37.5%
Nez Perce Hatchery																					22	16	5	1	0	16.7%
Pahsimmeroi Hatchery																					14	10	4	0	0	0.0%
Parkdale Fish Facility																					16	6	6	1	3	14.3%
Priest Rapids Hatchery (fall)							1				1		1								177	87	74	9	7	10.8%
Rapid River Hatchery																					185	69	116	0	0	0.0%
Sawtooth Hatchery																					38	19	19	0	0	0.0%
Snake River Fall																					95	27	60	7	1	10.4%
Spring Creek (Hatchery)																					17	9	8	0	0	0.0%
Umatilla																					19	3	15	0	1	0.0%
Upper Columbia Spring																1		1	3		43	19	24	0	0	0.0%
Washougal Hatchery																					1	1	0	0	0	NA
Wells Hatchery					2			2			31	18									62	11	18	2	31	10.0%
Total	1	4	3	1	18	2	3	7	12	1	112	42	1	3	2	1	11	1	5	19	1569	647	803	57	62	6.6%

Table 24. Table showing final-PIT-fate categories by hatchery in 2019 using Genetic Stock Identification (GSI). 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.

	Bonneville Dam					Bonneville Pool Sites				The Dalles		Deschutes					John Day Dam			Umatilla
	BonnevilleCorner Collector	BON PH2 Corner Collector	Bonneville-Bradford Ladder	Bonneville-WA Shore Ladder	Bonneille WA Ladder Slots	Little White Salmon Hatchery	Spring Creek Hatchery	Hood River Mouth	Lyle Falls Fishway, Klickitat R	The Dalles-East Ladder	The Dalles-North Ladder	Deschutes River Mouth	Deschutes Sherars Falls	Warm Springs River PIT Array	Warm Springs River PIT array	Warm Springs Hatchery	John Day Dam-Oregon Shore	John Day Dam-WA Shore	John Day River, McDonald Ferry	Three Mile Dam
Stock Classification Using Genetic Stock Identification	BCC	BO1	BO2	BO3	BO4	LWL	SCL	HRM	LFF	TD1	TD2	DRM	DSF	WSR	WSH	SHK	JO1	JO2	JD1	TMF
Cowlitz	1				5	1				2							1			
Deschutes					6					14			5	1	13	1				
Hells Canyon		2			21				1	6							9	6	1	
John Day River					3												5	4		
Klickitat									1											
MF Salmon																				
SFSalmon		1								1							4	1		
Spring Creek Tules			1	1	7		1	1		1										
Snake River Fall					18					21	2						3	1		1
Tucannon					1															
Upper Columbia Sume	1			6	137	5			1	81	11	1	1				21	13		
Upper Columbia Spring					26	5				4	1						4	5		
Upper Salmon River					1															
Yakima					3															
	2	3	1	7	228	11	1	1	3	130	14	1	6	1	13	1	47	30	1	1

	McNary Dam					Tucannon Hatchery						Clearwater							Grande Ronde				
	McNary-Oregon Shore	McNary-WA Shore	McNary Juvenile Bypass	Ice Harbor Dam	Lower Monumental Ladders	Lower Tucannon River	Middle Tucannon River	Tucannon Hatchery	Tucannon at Panjab Creek	Little Goose Dam	Lower Granite	Dworshak Hatchery	Lower Lochsa	Upper Lochsa	SF Clearwater rkm 1	SF Clearwater rkm 2	Lower Selway River	Upper Selway River	Wenaha River Mouth	Wallowa River at river km 14	Wallow River rkm 32	Catherine Creek Weir	Upper Grande Ronde -Starkey
Stock Classification Using Genetic Stock Identification	MC1	MC2	MCJ	ICH	LMA	LTR	MTR	TFH	TPJ	GOA	GRA	DWL	LRL	LRU	SC1	SC2	SW1	SW2	WEN	WR1	WR2	CCW	UGS
Cowlitz																							
Deschutes											1												
Hells Canyon					3			1			25	2		1	1	1	5	1	3	4	5		1
John Day River																				2			
Klickitat																							
MF Salmon											3												
SFSalmon											3			2									
Spring Creek Tules																							
Snake River Fall	21	21					1				23												
Tucannon							1																
Upper Columbia Sume	233	124	1	1	1	2					13												
Upper Columbia Spring									1		7	4	2	2	1	3	3				1	2	
Upper Salmon River		1								1	2												
Yakima																							
	254	146	1	1	4	2	2	1	1	1	77	6	2	5	2	4	8	1	3	6	6	2	1

	Salmon River															Imnaha		Yakima								
	EFSF Salmon River at Parks Cr.	SF Salmon-Krassel Cr	SFk Salmon Satellite Facility	Yellow Pine Pit Lake	Secesh River at Zena Cr. Ranch	Bear Valley Adult Video Weir	Big Creek at Taylor Ranch	North Fork Salmon River	Hayden Creek In-stream Array	Lower Lemhi River	Lemhi River Weir	Upper Salmon rkm 437	Upper Salmon rkm 460	Valley Creek, Upstream Site	Valley Creek, Downstream Site	Imnaha Weir Adult Ladder	Lower Imnaha	Prosser Dam	Sunnyside Instream Array	Lower Naches River	Roza Dam	Lower Teanaway	Ringold Hatchery	Priest Rapids Hatchery	Priest Rapids Ladder	Rock Island Dam Ladder
Stock Classification Using Genetic Stock Identification	ESS	KRS	STR	YPP	ZEN	BRC	TAY	NFS	HYC	LLR	LRW	USE	USI	VC1	VC2	IML	IRS	PRO	SUN	LNR	ROZ	LMT	RSH	PRH	PRA	RIA
Cowlitz																										
Deschutes																										
Hells Canyon		1		1	1	2	2	1	1		2					2	3									
John Day River																										
Klickitat																										
MF Salmon	1					2																				
SFSalmon	1	4	1	1	1												1									
Spring Creek Tules																										
Snake River Fall																								2	3	2
Tucannon																										
Upper Columbia Sume																		1					3	23	15	11
Upper Columbia Spring		3				1														1	1					
Upper Salmon River		1					2			1	2	4	4	1	1											
Yakima																			1	7	13	1				
	2	9	1	2	2	5	4	1	1	1	4	4	4	1	1	2	4	1	1	8	14	1	3	25	18	13

	Wenatchee								Entiat			Wells Dam			Methow						Okanogan								
	Lower Wenatchee River	Leavenworth Hatchery	Tumwater Dam Ladder	Lower Chiwawa River	Upper Chiwawa	Upper Wenatchee	Upper Nason Creek	White River	Entiat Hatchery	Upper Entiat rkm 17	Upper Entiat River at rkm 40.6	Wells Hatchery	Wells Dam Ladders	Wells Juvenile Bypass	Methow	Methow River at Carlton	Lwr Twisp Rvr near MSRF Ponds	Chewuch River above Winthrop	Upper Chewuch	Methow River at Winthrop	Lower Okanogan Weir	Zosel Dam Combined	Penticton Channel PIT Array						
Stock Classification Using Genetic Stock Identification	LWE	LNF	TUF	CHL	CHU	UWE	NAU	WTL	EHL	ENA	ENF	WEH	WEA	WEJ	LMR	MRC	TWR	CRW	CRU	MRW	OKL	ZSL	OKP	Total	Neutral	On-Target	Putative Stray	Putative Overshoot	% Putative Strays/On-Target
Cowlitz																								10	1	0	4	6	100.0%
Deschutes													1											42	20	20	2	0	9.1%
Hells Canyon		1	1	1							1								1		1			121	47	65	17	0	20.7%
John Day River																								14	12	0	7	0	100.0%
Klickitat																								1	0	1	0	0	0.0%
MF Salmon			1																					7	0	5	0	0	0.0%
SFSalmon																								21	7	10	3	1	23.1%
Spring Creek Tules																								12	10	1	1	0	50.0%
Snake River Fall													1	1		1								122	87	23	12	0	34.3%
Tucannon																								2	1	1	0	0	0.0%
Upper Columbia Sume	5		6			2			8	2		1	27		4	3					10	1	1	776	628	121	27	0	18.2%
Upper Columbia Spring		2	2	3	6		4	1					1		3		1	2		1	1			104	40	26	38	0	59.4%
Upper Salmon River													1											22	5	16	1	0	5.9%
Yakima																								25	3	22	0	0	0.0%
	5	3	10	4	6	2	4	1	8	2	1	1	31	1	7	4	1	2	1	1	12	1	1	1279	861	311	112	7	26.5%

RESULTS-STEELHEAD

Sample Size

A total of 820 steelhead were sampled at Bonneville Dam in 2019, of which 805 were PIT tagged (Table 25). After adding previously tagged fish (which were sampled and therefore identified for the tracking study and included in our sample) the number of steelhead tracked upstream totaled 820 (Table 25). There were no mortalities of steelhead sampled nor were there any steelhead not detected after release in 2019.

Table 25. Number of steelhead PIT tagged at Bonneville Dam and tracked past Bonneville by date and statistical week in 2019.

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
4/25-26	17	2	2	0	0	2	0	1	0
4/29, 5/1-3	18						0	0	0
5/6-10	19	1	1	0	0	1	0	0	0
5/13-5/16	20	2	2	0	0	2	0	0	0
5/20-5/24	21	2	2	0	0	2	0	0	0
5/28-31	22	2	2	0	0	2	0	2	0
6/3-6/7	23	4	4	0	0	4	0	4	0
610-6/14	24	2	2	0	0	2	0	5	0
6/17-6/21	25	5	5	0	0	5	0	5	0
6/24-6/28	26	8	8	0	0	8	0	5	0
7/1-7/4	27	15	15	0	0	15	0	4	0
7/8-7/12	28	30	30	0	0	30	0	0	0
7/15-7/19	29	61	61	0	0	61	0	0	0
7/22-7/25	30	42	42	0	0	42	0	0	1
7/29-8/1	31	70	69	1	0	70	4	0	1
No Sampling	32	AFF Closed due to temperatures at or above 22.2C					0	0	5
8/12-8/13	33	57	53	4	0	57	2	0	3
8/19-8/21, 8/23	34	75	73	2	0	75	4	0	1
8/26-8/29	35	55	51	4	0	55	4	0	1
9/4-9/6	36	25	24	1	0	25	3	0	2
9/9-9/12	37	32	32	0	0	32	4	0	1
9/16-9/20	38	67	66	1	0	67	0	4	0
9/23-9/27	39	31	31	0	0	31	0	0	0
10/1-10/4	40	70	69	1	0	70	0	0	0
10/7,10/9-11	41	93	93	0	0	93	0	0	0
10/14,15,17,18	42	69	68	1	0	69	0	0	0
Total		**820**	**805**	**15**	**0**	**820**	**21**	**30**	**15**

Distribution of Sample

The distribution of the sample over the run was relatively similar to the run distribution with three exceptions (Figure 23). The first was in Statistical weeks 30 to 33 during which the AFF was shut down one day in weeks 30 and 31, all of Week 32, and two days in Week 33 with reduced sampling four days of Week 31 and two days of Week 33. 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, which resulted in percent sampled higher than percent of run.

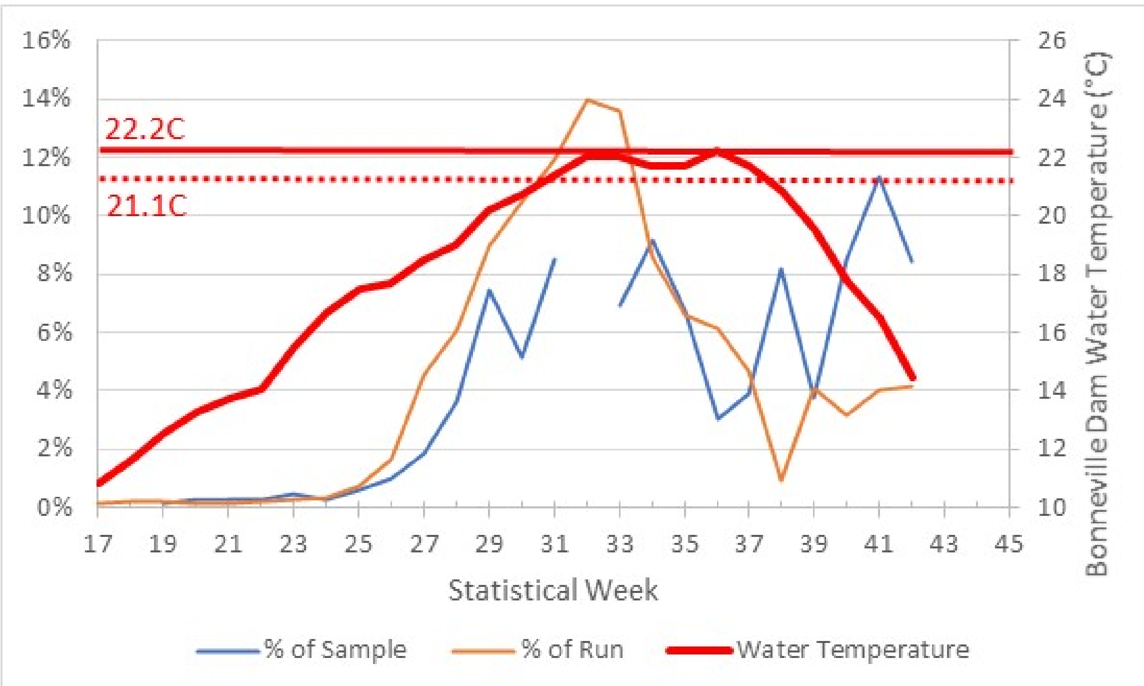

Figure 23. The weekly steelhead sample and run as a percentage of the total sample and run size at Bonneville Dam in 2019. Sampling was reduced at 21.1°C and halted at 22.2°C.

Detection Numbers

The 820 steelhead tracked in 2019 through December 31, 2020 generated 71,444 weir detections and 6,051 site detections at 136 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 38.2% of the steelhead migration passing during or prior to Statistical Week 31, the predominant age was Age r.2, comprising an estimated 20.0% of the run (Figure 24, Table 26). There were four additional age groups (1.1, 1.2, , 2.1, and 2.2) individually comprising between 16.3% and 19.9% of the run. During Week 32, when the AFF trap was shut down due to high temperatures, 11.6% of the run passed. Among steelhead passing on or after Week 33 (comprising 50.1% of the run) the predominant age class was Age 1.1 (25.8%) followed by age 1.2 (25.4%) followed by 2.1 (15.7%), and r.1 (11.2%) (Table 26).

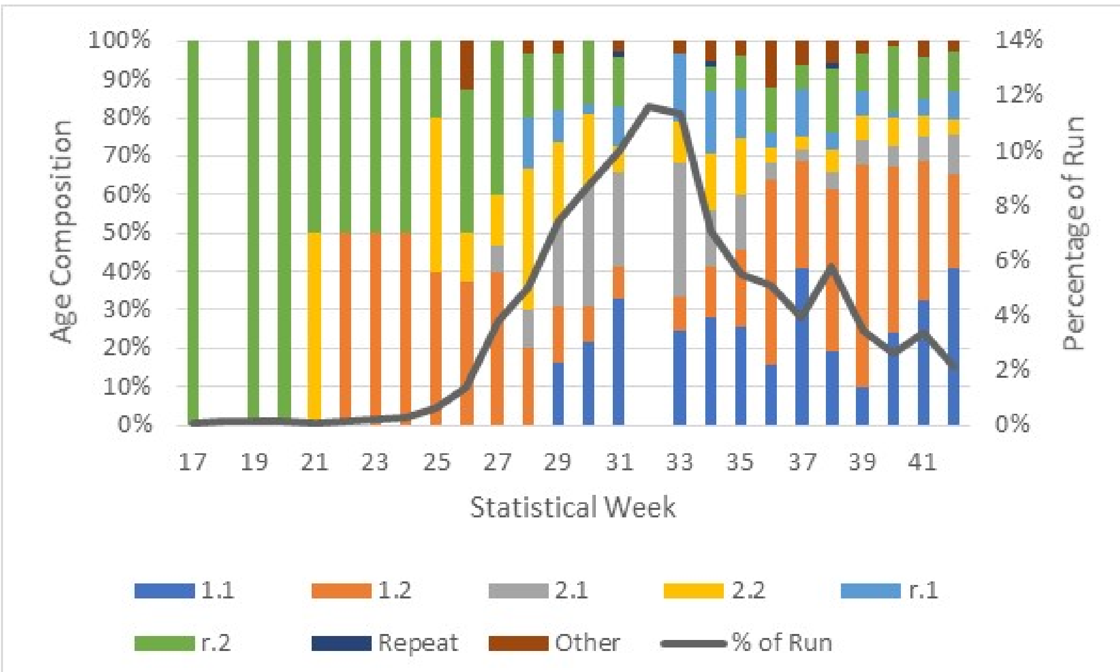

Figure 24. Weekly age composition of steelhead at Bonneville Dam as estimated from scale patterns for the five most abundant age classes in 2019 with weekly abundance.

Table 26. Weekly and total age composition of steelhead at Bonneville Dam as estimated from scale patterns in 2019 (Composite age composition estimates are weighted by the percentage of the run passing Bonneville Dam in each week.)

			Brood Year and Age Class										
			2017	2016		2015		2014		Freshwater Zone Unageable			Repeat
Week	Weight	N	1.1	1.2	2.1	2.2	3.1	2.3	3.2	r	r.1	r.2	Spawners
17	0.1%	2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%
18	0.2%		No Steelhead Sampled										
19	0.2%	1	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%
20	0.1%	2	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	100.0%	0.0%
21	0.1%	2	0.0%	0.0%	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%
22	0.2%	2	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%
23	0.2%	4	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%
24	0.3%	2	0.0%	50.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	50.0%	0.0%
25	0.6%	5	0.0%	40.0%	0.0%	40.0%	0.0%	0.0%	0.0%	0.0%	0.0%	20.0%	0.0%
26	1.4%	8	0.0%	37.5%	0.0%	12.5%	0.0%	0.0%	0.0%	12.5%	0.0%	37.5%	0.0%
27	3.8%	15	0.0%	40.0%	6.7%	13.3%	0.0%	0.0%	0.0%	0.0%	0.0%	40.0%	0.0%
28	5.0%	30	0.0%	20.0%	10.0%	36.7%	0.0%	0.0%	0.0%	3.3%	13.3%	16.7%	0.0%
29	7.5%	61	16.4%	14.8%	21.3%	21.3%	1.6%	1.6%	0.0%	0.0%	8.2%	14.8%	0.0%
30	8.7%	42	21.4%	9.5%	31.0%	19.0%	0.0%	0.0%	0.0%	0.0%	2.4%	16.7%	0.0%
31	9.9%	70	31.4%	8.6%	25.7%	7.1%	2.9%	0.0%	0.0%	0.0%	10.0%	12.9%	1.4%
32	11.6%		AFF Closed due to temperatures at or above 22.2C, no sampling										
33	11.3%	57	22.8%	8.8%	36.8%	10.5%	0.0%	0.0%	0.0%	3.5%	17.5%	0.0%	0.0%
34	7.1%	75	28.0%	13.3%	14.7%	14.7%	0.0%	0.0%	0.0%	5.3%	16.0%	6.7%	1.3%
35	5.5%	55	25.5%	20.0%	14.5%	14.5%	0.0%	0.0%	0.0%	3.6%	12.7%	9.1%	0.0%
36	5.1%	25	16.0%	44.0%	4.0%	8.0%	4.0%	0.0%	4.0%	4.0%	4.0%	12.0%	0.0%
37	3.9%	31	41.9%	29.0%	3.2%	3.2%	0.0%	0.0%	0.0%	3.2%	12.9%	6.5%	0.0%
38	5.8%	67	19.4%	41.8%	4.5%	6.0%	0.0%	0.0%	1.5%	4.5%	4.5%	16.4%	1.5%
39	3.4%	31	9.7%	54.8%	6.5%	9.7%	0.0%	0.0%	0.0%	3.2%	6.5%	9.7%	0.0%
40	2.6%	70	24.3%	42.9%	5.7%	7.1%	0.0%	0.0%	0.0%	1.4%	1.4%	17.1%	0.0%
41	3.4%	93	32.3%	36.6%	6.5%	5.4%	0.0%	0.0%	0.0%	4.3%	4.3%	10.8%	0.0%
42	2.1%	69	40.6%	24.6%	10.1%	4.3%	0.0%	0.0%	0.0%	2.9%	7.2%	10.1%	0.0%
17-31	38.2%		16.3%	16.8%	19.9%	17.8%	1.1%	0.3%	0.0%	0.9%	6.5%	20.0%	0.4%
32	11.6%		Trap Closed-No Sampling										
33-42	50.1%		25.8%	25.4%	15.7%	9.6%	0.4%	0.0%	0.5%	3.7%	11.2%	7.4%	0.2%

A higher percentage of Age 2.1 fish migrated upstream of Priest Rapids, while Age 1.2 steelhead migrated into the Snake River (Table 27, Figure 25). No returning repeat spawners were last detected upstream of Priest Rapids Dam. Upstream length-at-age estimates are in Table 28.

Table 27. Unweighted age composition of steelhead at mainstem dams in 2019.

Dam	N ageable	1.1	1.2	2.1	2.2	Other Ages (1.3,2.3,3.2)	Repeat Spawners
Bonneville	619	24.3%	26.1%	13.4%	10.9%	0.9%	0.4%
The Dalles	493	28.1%	26.4%	12.4%	8.8%	0.8%	0.5%
John Day	449	27.9%	26.8%	12.5%	8.7%	0.9%	0.5%
McNary	399	28.8%	29.0%	9.7%	7.6%	0.6%	0.4%
Priest Rapids	24	16.1%	16.1%	25.8%	19.4%	0.0%	0.0%
Rock Island	23	13.8%	17.2%	27.6%	20.7%	0.0%	0.0%
Rocky Reach	14	15.8%	15.8%	26.3%	15.8%	0.0%	0.0%
Wells	12	18.8%	12.5%	25.0%	18.8%	0.0%	0.0%
Ice Harbor	334	31.1%	31.5%	6.3%	6.3%	0.5%	0.2%
Lower Monumental	329	31.0%	31.2%	6.4%	6.4%	0.5%	0.2%
Little Goose	313	30.1%	32.5%	6.6%	6.3%	0.5%	0.2%
Lower Granite	307	29.5%	33.0%	6.7%	6.5%	0.5%	0.2%

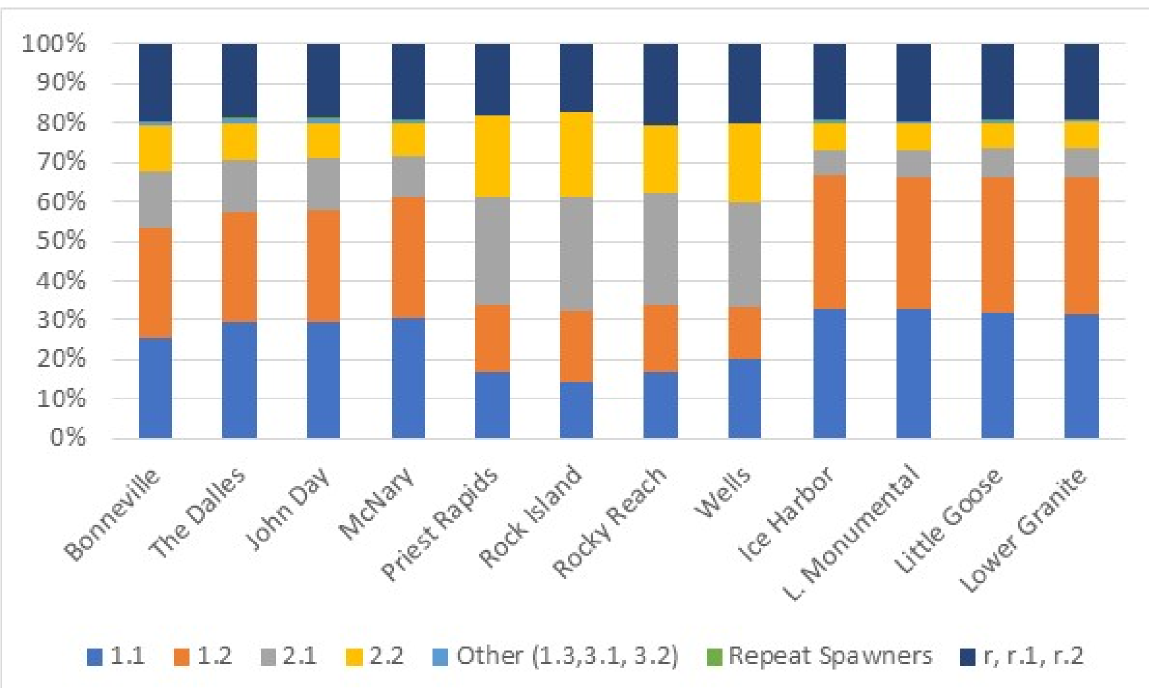

Figure 25. Unweighted age composition of steelhead at mainstem dams in 2019.

Table 28. Steelhead length-at-age composition at mainstem Columbia Basin dams, as estimated by upstream PIT tag detections of steelhead sampled at Bonneville Dam in 2019.

Dam	Statistic	Brood Year and Age										
		2017	2016		2015		2014		Unknown		Repeat Spawners	
		1.1	1.2	2.1	2.2	2.3	3.1	3.2	r.1	r.2	r.1S	2.S1
Bonneville	μ	59.5	75.3	57.7	70.8	83.0	56.8	77.0	58.5	72.5	54.0	57.0
	s	6.5	6.3	3.8	9.0	--	7.0	0.0	4.2	6.6	--	2.1
	n	199	213	110	88	1	3	2	65	108	1	2
The Dalles	μ	59.7	75.8	57.6	72.4		60.5	77.0	58.8	73.6	54.0	57.0
	s	4.9	6.4	3.6	5.0		4.2	0.0	4.4	6.8	--	2.1
	n	181	169	80	57		2	2	53	74	1	2
John Day	μ	59.8	76.2	57.8	73.0		60.5	77.0	58.7	73.5	54.0	57.0
	s	5.0	6.3	3.6	4.7		4.2	0.0	4.4	6.9	--	2.1
	n	163	157	73	51		2	2	47	64	1	2
McNary	μ	59.9	76.1	58.2	73.2		60.5	77.0	59.0	73.5	54.0	57.0
	s	5.1	6.3	3.8	4.8		4.2	--	4.4	6.9	--	2.1
	n	152	153	51	40		2	1	42	62	1	2
Priest Rapids	μ	57.5	66.8	58.8	71.5				56.1	67.5		
	s	1.0	2.5	2.0	1.9				2.1	2.8		
	n	5	5	8	6				4	2		
Rock Island	μ	57.4	66.8	58.8	71.5				56.3	67.5		
	s	1.1	2.5	2.0	1.9				2.5	2.8		
	n	4	5	8	6				3	2		
Rocky Reach	μ	57.8	68.0	58.0	70.7				56.5	67.5		
	s	0.8	2.5	1.9	2.1				3.5	2.8		
	n	3	3	5	3				2	2		
Wells	μ	57.8	69.3	57.4	70.7				59.0	67.5		
	s	0.8	1.8	1.5	2.1				--	2.8		
	n	3	2	4	3				1	2		
Ice Harbor	μ	60.0	76.7	58.6	73.1		57.5	77.0	59.4	74.2	54.0	58.5
	s	5.2	5.8	3.9	5.5		--	--	4.3	7.2	--	--
	n	131	140	32	32		1	1	33	51	1	1
Lower Monumental	μ	60.0	76.8	58.6	73.1		57.5	77.0	59.4	74.2	54.0	58.5
	s	5.3	5.8	4.1	5.5		--	--	4.3	7.2	--	--
	n	127	137	29	32		1	1	33	51	1	1
Little Goose	μ	60.0	76.8	58.4	73.4		57.5	77.0	59.8	74.6	54.0	57.0
	s	5.3	5.8	4.1	5.5		--	--	4.3	7.2	--	--
	n	121	136	28	31		1	1	31	47	1	1
Lower Granite	μ	59.9	76.8	58.6	72.9		57.5	77.0	59.5	74.3	54.0	58.5
	s	5.4	5.9	4.2	5.2		--	--	4.3	7.0	--	--
	n	114	129	27	30		1	1	30	46	1	1

Mainstem Dam Recoveries, Mortality, and Escapement Estimates

Data on tag detections was last downloaded from www.ptagis.org on December 31st, 2020. Since no sampling was permitted in weeks 31-33, the run was divided into an early run consisting of weeks 17-31 and a late run in weeks 33-42. An estimated 35.6% of the early run was last detected above Ice Harbor Dam, compared to 55.4% of the late run. Above Priest Rapids Dam the percentages were 5.7% and 5.0% respectively (Figure 26).

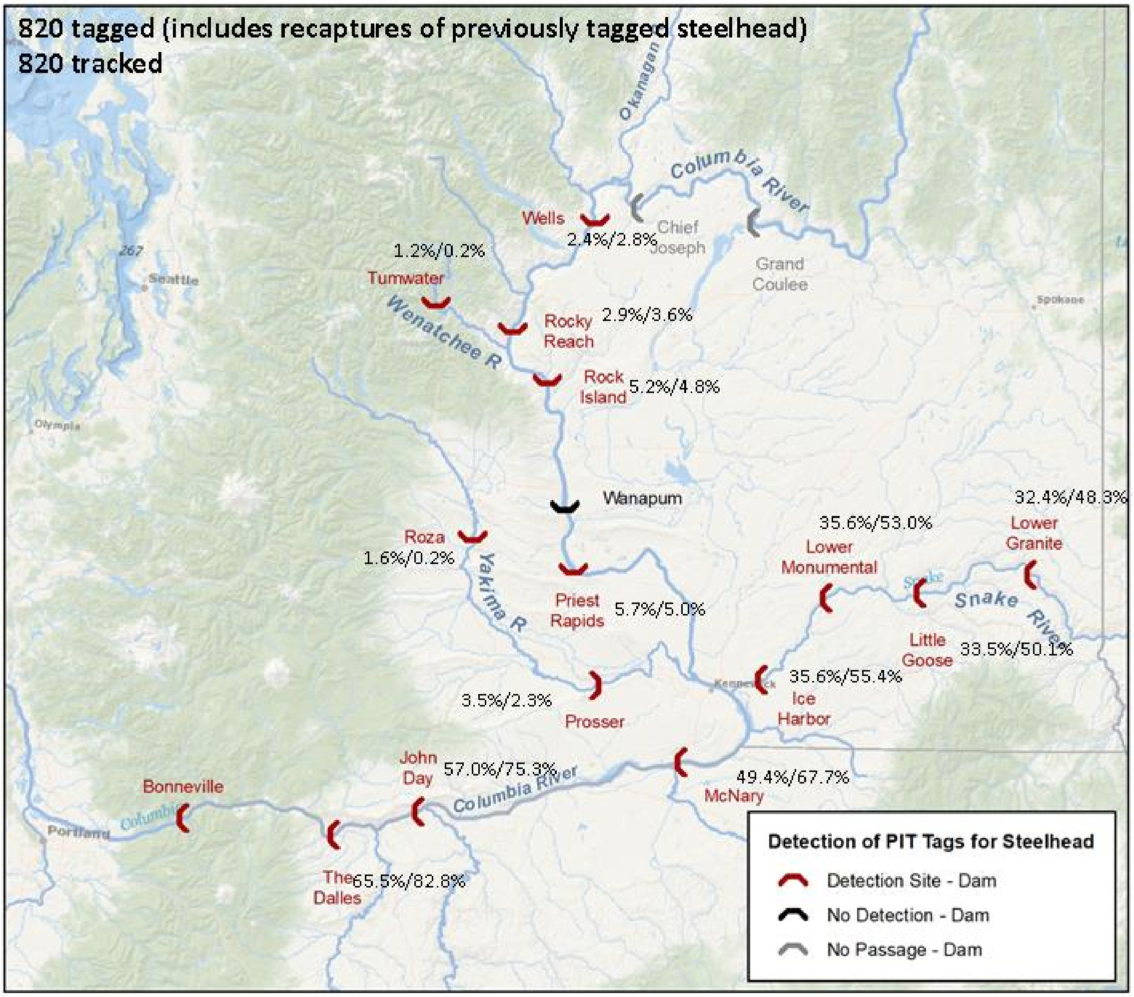

Figure 26. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of steelhead PIT tagged at Bonneville Dam, and the percentage of the early and late run estimated to pass upstream dams in 2019. The early run was in weeks 17-31 comprising 38.2% of the run; the late run was weeks 33-42 comprising 50.2% of the run. The 11.1% of the run passing in Week 32 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 29, Figures 27 and 28). None of the 15 steelhead tracked passing Bonneville Dam in weeks 17-24 were detected at or above McNary Dam. The first steelhead detected in the Snake River was tagged in Week 26 and the percentage detected increased as the run progressed.

Table 29. Most upstream detection by Statistical Week and region for steelhead tracked by this study in 2019.

Statistical Week	% of Run	Sample Size	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	0.1%	2	100.0%	0.0%	0.0%	0.0%	0.0%
18	0.2%	0	NA	NA	NA	NA	NA
19	0.2%	1	100.0%	0.0%	0.0%	0.0%	0.0%
20	0.1%	2	0.0%	100.0%	0.0%	0.0%	0.0%
21	0.1%	2	50.0%	50.0%	0.0%	0.0%	0.0%
22	0.2%	2	50.0%	50.0%	0.0%	0.0%	0.0%
23	0.2%	4	50.0%	50.0%	0.0%	0.0%	0.0%
24	0.3%	2	50.0%	50.0%	0.0%	0.0%	0.0%
25	0.6%	5	20.0%	40.0%	0.0%	40.0%	0.0%
26	1.4%	8	62.5%	25.0%	0.0%	0.0%	12.5%
27	3.8%	15	53.3%	20.0%	0.0%	6.7%	20.0%
28	5.0%	30	23.3%	23.3%	10.0%	10.0%	33.3%
29	7.5%	61	23.0%	8.2%	14.8%	9.8%	44.3%
30	8.7%	42	31.0%	4.8%	7.1%	11.9%	45.2%
31	9.9%	70	30.0%	10.0%	14.3%	1.4%	44.3%
32	11.6%	AFF Closed due to temperatures at or above 22.2C, no sampling					
33	11.3%	57	36.8%	1.8%	12.3%	12.3%	36.8%
34	7.1%	75	20.0%	8.0%	9.3%	10.7%	52.0%
35	5.5%	55	29.1%	12.7%	7.3%	1.8%	49.1%
36	5.1%	25	8.0%	0.0%	12.0%	8.0%	72.0%
37	3.9%	32	21.9%	12.5%	9.4%	3.1%	53.1%
38	5.8%	67	22.4%	3.0%	7.5%	0.0%	67.2%
39	3.4%	31	22.6%	0.0%	6.5%	3.2%	67.7%
40	2.6%	70	24.3%	5.7%	7.1%	0.0%	62.9%
41	3.4%	93	14.0%	3.2%	7.5%	0.0%	75.3%
42	2.1%	69	11.6%	8.7%	8.7%	0.0%	71.0%
Weeks 17-31	38.2%	246	32.1%	13.3%	9.6%	7.7%	37.4%
Weeks 32	11.6%	**Unknown**					
Weeks 33-42	50.1%	574	23.6%	5.1%	9.4%	5.8%	56.1%

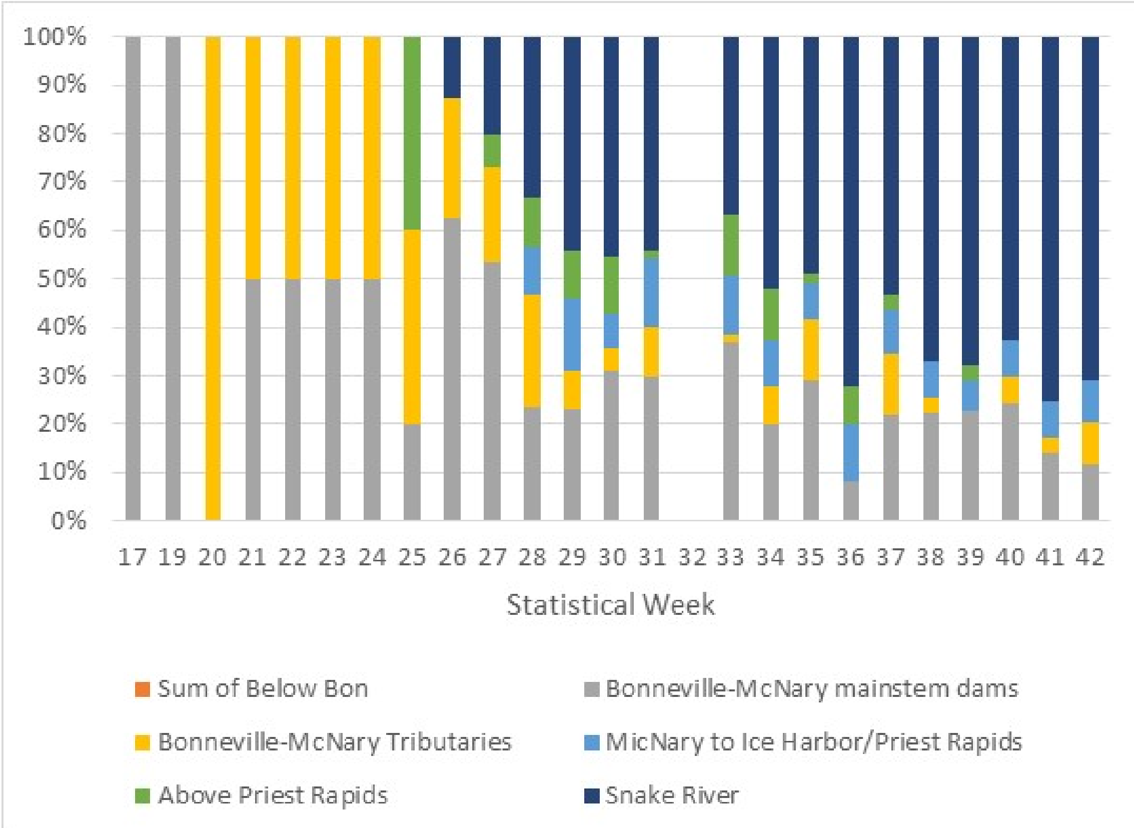

Figure 27. Most upstream detection by Statistical Week and region for steelhead tracked by this study in 2019 as a percentage of the weekly run.

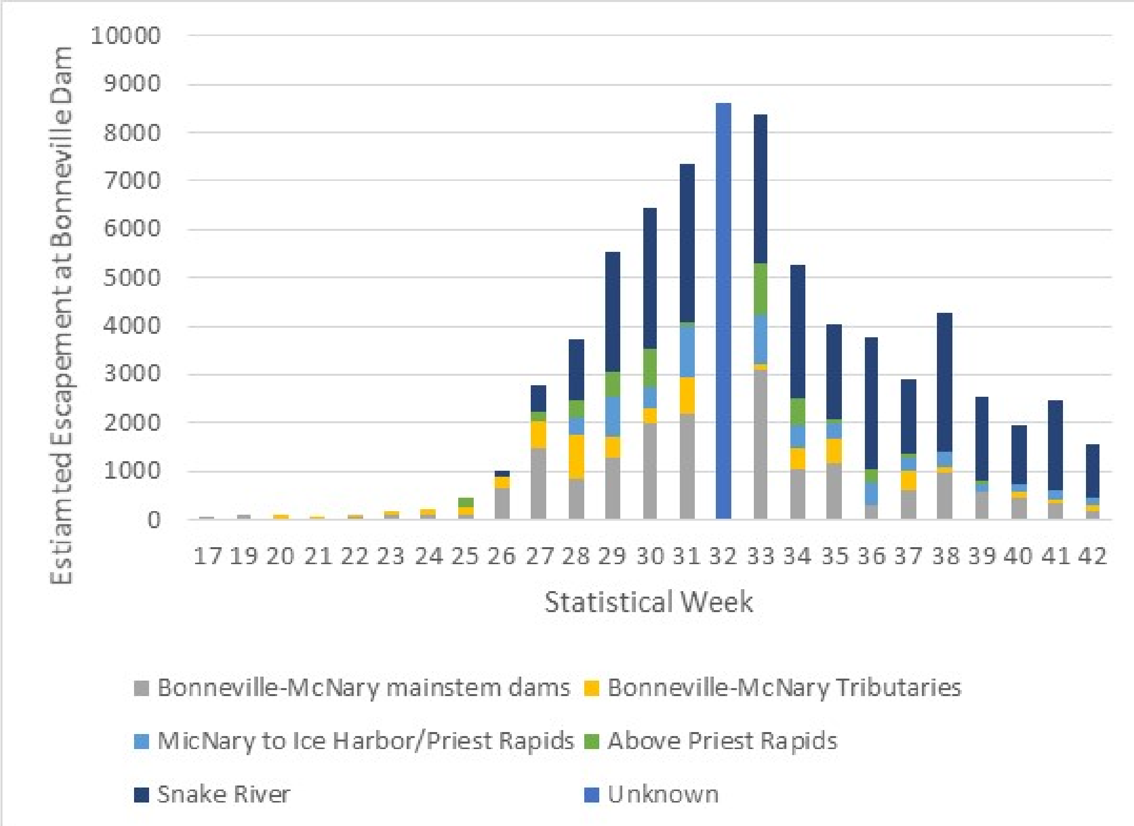

Figure 28. Most upstream detection by Statistical Week and region for steelhead tracked by this study in 2019 as estimated by numbers of fish passing Bonneville Dam by week. No sampling was conducted during Week 32.

In 2013, a PIT tag array (DRM) was installed across the width of the Deschutes River one kilometer upstream of the river's mouth and this project has frequently tracked steelhead detected at this site in the past. In 2019, a total of 10 steelhead were detected at DRM between July 15, 2019 and August 8, 2019. However, on August 9, DRM stopped detecting fish and the site has not been repaired. Of the 10 steelhead detected at DRM, three were subsequently detected in the Snake River in September 2019. None of these 10 steelhead were detected further upstream in the Deschutes River or its tributaries.

A total of 17 steelhead from this project were detected at Deschutes River rkm 71 at Sherar's Falls (DSF) between September 3, 2019 and March 24, 2020, none of which were detected at DRM. Of these 17 steelhead, 5 were subsequently detected in the Snake River.

The percentage of PIT tagged steelhead passing a dam without detection was under 1% (Table 30) at all dams except for John Day Dam at 1.6%.

Table 30. Percentages of steelhead passing a dam undetected that were subsequently detected upstream in 2019.

Dam	Percent not Detected
Bonneville	0.6%
The Dalles	0.2%
John Day	1.6%
McNary	0.4%
Priest Rapids	0.0%
Rock Island	0.0%
Rocky Reach	0.0%
Wells	0.0%
Ice Harbor	0.2%
Lower Monumental	0.5%
Little Goose	0.8%
Lower Granite	0.0%
Mean (weighted by number passing each dam)	**0.6%**

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 (39.9 km/day), while the slowest was 12.6 km/day between Bonneville and Rock Island dams (Table 31).

Table 31. Steelhead migration rate between Columbia Basin dams as estimated by PIT tag detections in 2019.

Dam Pair	Distance (km)	Median Migration Rate (km/day)
Bonneville-The Dalles	74	23.0
The Dalles-John Day	39	26.9
John Day-McNary	123	39.9
Bonneville-John Day	113	14.1
Bonneville - McNary	231	19.5
McNary - Priest Rapids	167	28.3
Priest Rapids - Rock Island	89	23.3
Rock Island - Rocky Reach	33	30.0
Rocky Reach - Wells	65	30.1
Rock Island - Tumwater	73	1.6
Bonneville – Rock Island	487	12.6
Bonneville - Wells	585	13.0
McNary - Ice Harbor	67	28.7
Ice Harbor - Lower Granite	156	23.6
Bonneville-Lower Granite	461	16.2

Weekly data for steelhead tracked by this project provides finer granularity on steelhead migration from Bonneville to McNary Dam (Table 32, Figure 29). No steelhead tracked from Bonneville Dam in weeks 17 and 19-24 were detected at

McNary Dam but those in weeks 25 through 27 generally moved quickly to McNary with mean weekly travel times of 6.5 and 7.7 days as the mean river temperature at Bonneville Dam increased to 18.9C. In Week 28, although the mean river temperature at Bonneville remained 18.9C, mean travel time increased to 21.9 days with five detections in the Deschutes. In Week 29, the mean temperature increased to 20.6C and travel time increased to 55.0 days with seven detections in the Deschutes, 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 32. 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 2019.

Week	Number Tracked from Bonneville Dam	Detected at McNary Dam	Bonneville-McNary Conversion Rate	Mean Travel Days Bonneville to McNary	Mean Temperature at Bonneville Dam	Number Detected in Deschutes River	Deschutes followed by Snake River
17	2	0	0.0%	NA	11.1	0	0
18	0	0	NA	NA	11.6	0	0
19	1	0	0.0%	NA	12.8	0	0
20	2	0	0.0%	NA	13.3	0	0
21	2	0	0.0%	NA	13.9	0	0
22	2	0	0.0%	NA	14.4	0	0
23	4	0	0.0%	NA	15.6	0	0
24	2	0	0.0%	NA	17.2	0	0
25	5	2	40.0%	7.7	17.8	0	0
26	8	1	12.5%	7.7	17.8	0	0
27	15	4	26.7%	6.5	18.9	1	0
28	30	16	53.3%	21.9	18.9	5	1
29	61	42	68.9%	55.0	20.6	7	2
30	42	25	59.5%	54.6	20.6	1	0
31	70	46	65.7%	72.7	21.7	4	3
32	AFF Closed due to temperatures at or above 22.2C, no sampling						
33	57	36	63.2%	44.0	22.2	0	0
34	75	54	72.0%	33.5	21.7	3	0
35	55	33	60.0%	30.4	21.7	4	0
36	25	23	92.0%	25.1	22.2	0	0
37	32	23	71.9%	29.3	21.7	1	0
38	67	52	77.6%	19.0	21.1	1	0
39	31	24	77.4%	12.7	20	0	0
40	70	49	70.0%	7.7	17.2	1	0
41	93	80	86.0%	14.8	16.7	1	1
42	69	57	82.6%	17.1	14.4	1	0

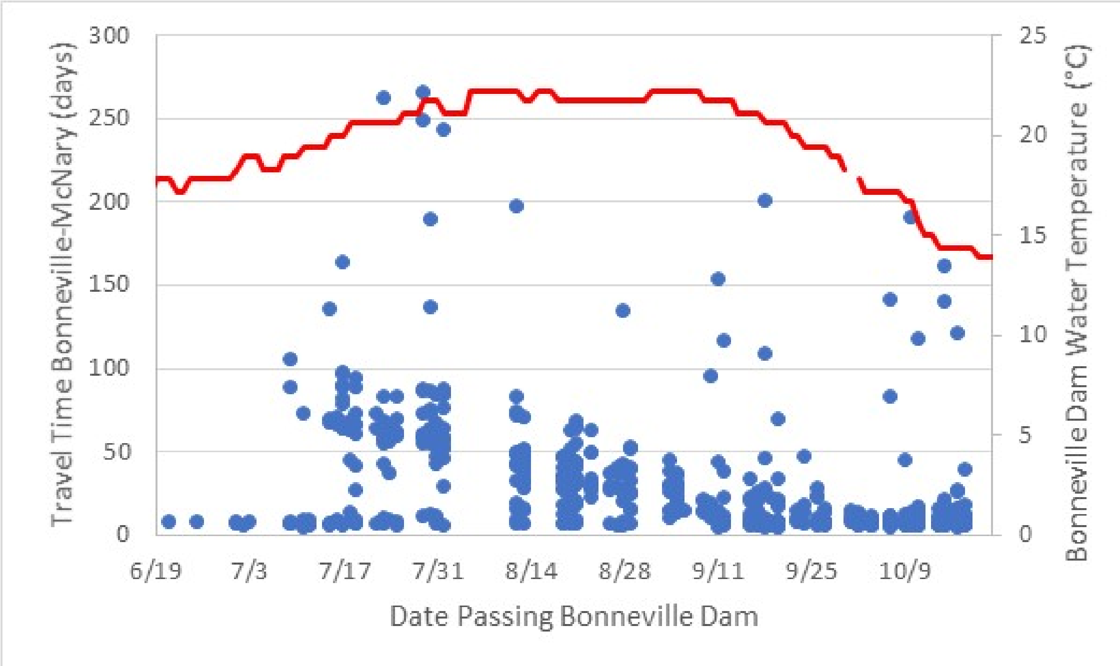

Figure 29. Steelhead travel time from Bonneville to McNary Dam by date passing Bonneville Dam in 2019.

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 33). 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 33. 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 2019.

Dam	Median Passage Time (minutes)	Percentage with more than 12 hours between first detection and last detection at a dam
Bonneville	8.2	2.2%
The Dalles	0.1	3.7%
John Day	1.1	2.6%
McNary	82.6	7.4%
Priest Rapids	4.6	5.3%
Rock Island	33.4	8.8%
Rocky Reach	9.0	8.8%
Wells	81.6	16.7%
Ice Harbor	3.4	3.1%
Lower Monumental	0.8	4.2%
Little Goose	0.0	3.0%
Lower Granite	202.8	24.2%

Fallback

Estimated minimum fallback rates based on steelhead either reascending fish ladders or steelhead subsequently detected downstream ranged from 0.4% at Bonneville Dam to 62.5% at Wells Dam in 2019 (Table 34). 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 eight times over dams (Table 35). Figures showing the movement of the steelhead with between five and eight fallbacks are in Appendix B (Figures B26 – B28).

Table 34. Estimated minimum steelhead fallback at Columbia Basin dams in 2019 as estimated by PIT tag[11] detections.

Dam	Number of Fallbacks	Percent Fallback
Bonneville	3	0.4%
The Dalles	29	4.5%
John Day	23	3.9%
McNary	33	6.3%
Priest Rapids	5	16.1%
Rock Island	4	13.8%
Rocky Reach	3	15.8%
Wells	10	62.5%
Ice Harbor	13	2.9%
Lower Monumental	13	3.0%
Little Goose	13	3.2%
Lower Granite	15	3.7%
Prosser	1	5.6%
Zosel	1	50.0%

Table 35. Frequency of fallback events for steelhead tagged by this project in 2019.

Number of Dams Fallen Back Over	Total Number of Steelhead
1	65
2	24
3	6
4	4
5	1
6	1
8	1
Number of steelhead falling back at least once	**102**
Precent of steelhead with at least one fallback event	**12.4%**
Total fallback events	**166**
Number of steelhead in study	**820**
Fallback events per steelhead	**0.20**

[11] 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 0.9% at Bonneville Dam to 24.0% at Rock Island Dam (Table 36). 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 8.2 minutes (Table 33) steelhead we sampled and tagged would be expected to pass during daytime hours.

Table 36. Estimated steelhead night passage (2000-0400 PST) at Columbia Basin dams in 2019.

Site	Percentage Night Passage
Bonneville	0.9%
The Dalles	6.8%
John Day	7.6%
McNary	6.0%
Priest Rapids	2.6%
Rock Island	20.6%
Rocky Reach	24.0%
Wells	8.3%
Ice Harbor	9.8%
Lower Monumental	10.2%
Little Goose	10.3%
Lower Granite	5.4%

B-Run Analyses

A total of 124 B-run steelhead were sampled in 2019 (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 51.4% (Figure 30, Table 37). 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 38 at 1,526 fish while the A-run steelhead peaked in Week 33 at 8,367 fish (Table 37). The percentage of B-run steelhead comprised an estimated 1.7% of the run through Week 31 but 15.7% on during 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), 98.9% of steelhead with fork lengths 78.0 cm and greater were destined for the Snake Basin, all of which passed Bonneville on or after Week 35 (Figure 31). Among the 791 steelhead sampled at Bonneville Dam where ocean age could be estimated, B-run steelhead were comprised almost entirely of two-ocean (with a few three-ocean steelhead), while

A-run steelhead were comprised of one- and two-ocean steelhead (Table 38) and no three-ocean fish.

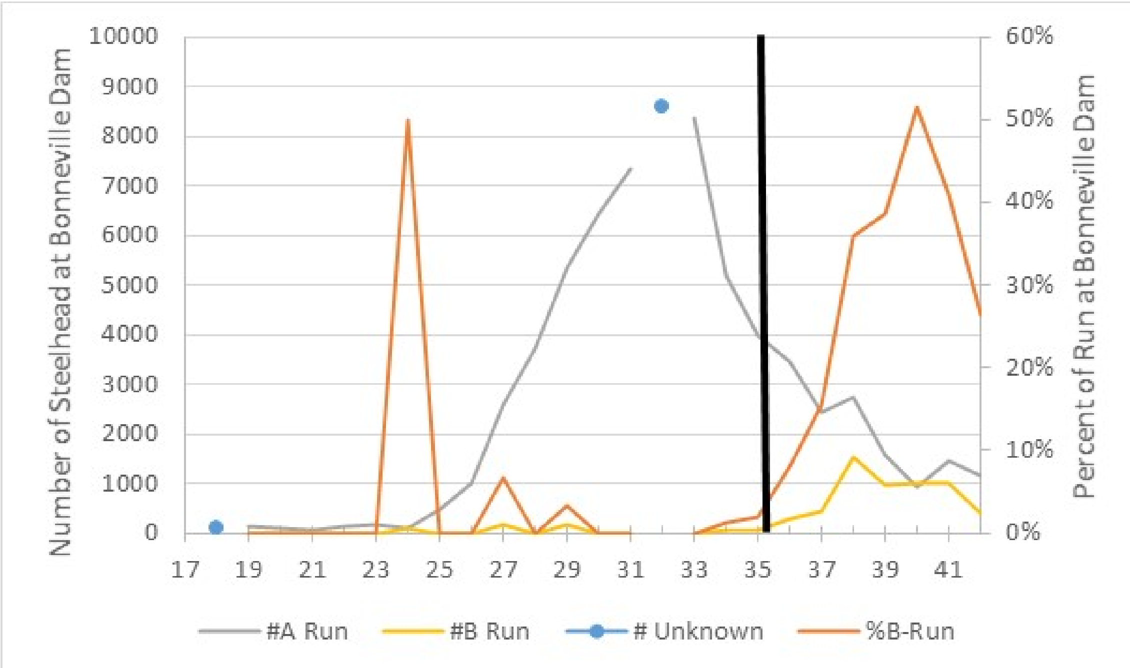

Figure 30. Percentage of B-run steelhead and estimated A- and B-run escapement at Bonneville Dam by statistical week in 2019. The vertical line shows the approximate location of August 25, which is considered the date that separates A- and B-run steelhead.

Table 37. Percentage and number of A- and B-run steelhead estimated at Bonneville Dam by Statistical Week in 2019.

Week	Percent of Run	Sample Size	B-Run Sample Size	% A Run	% B Run	# A Run	# B Run	Unknown
17	0.1%	2	0	100.0%	0.0%	69	0	0
18	0.2%	0	0	NA	NA	NA	NA	114
19	0.2%	1		100.0%	0.0%	121	0	0
20	0.1%	2		100.0%	0.0%	99	0	0
21	0.1%	2		100.0%	0.0%	69	0	0
22	0.2%	2		100.0%	0.0%	119	0	0
23	0.2%	4		100.0%	0.0%	175	0	0
24	0.3%	2	1	50.0%	50.0%	114	114	0
25	0.6%	5		100.0%	0.0%	465	0	0
26	1.4%	8		100.0%	0.0%	1020	0	0
27	3.8%	15	1	93.3%	6.7%	2598	186	0
28	5.0%	30		100.0%	0.0%	3724	0	0
29	7.5%	61	2	96.7%	3.3%	5338	181	0
30	8.7%	41		100.0%	0.0%	6439	0	0
31	9.9%	70		100.0%	0.0%	7349	0	0
32	11.6%	AFF Closed due to temperatures at or above 22.2C, no sampling						8604
33	11.3%	57		100.0%	0.0%	8367	0	0
34	7.1%	75	1	98.7%	1.3%	5184	70	0
35	5.5%	55	1	98.2%	1.8%	3975	74	0
36	5.1%	25	2	92.0%	8.0%	3463	301	0
37	3.9%	32	4	84.4%	15.6%	2439	452	0
38	5.8%	67	16	64.2%	35.8%	2735	1526	0
39	3.4%	31	12	61.3%	38.7%	1551	980	0
40	2.6%	70	34	48.6%	51.4%	940	996	0
41	3.4%	93	35	59.1%	40.9%	1469	1015	0
42	2.1%	68	15	73.5%	26.5%	1153	415	0
Weeks 17-31	38.2%	245	4	98.3%	1.7%	27699	480	114
Weeks 32	11.6%	0	NA	Unknown				8718
Weeks 33-41	50.1%	573	120	84.3%	15.7%	31277	5828	

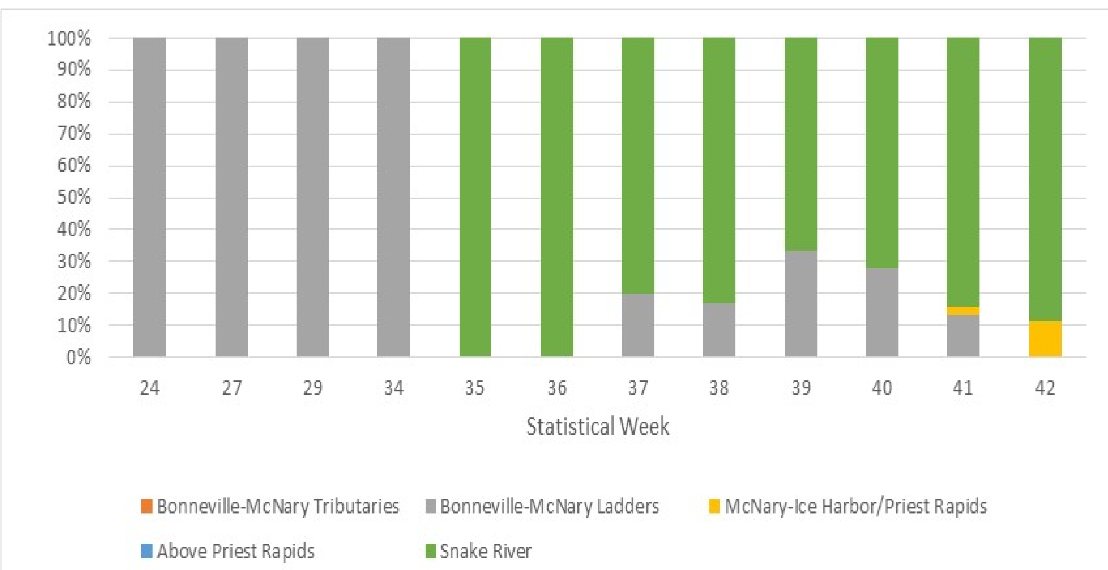

Figure 31. Most upstream detection site for B-run steelhead (≥78 cm fork length) by Statistical Week they were sampled at Bonneville Dam in 2019. There was no sampling during Week 32.

Table 38. Ocean age composition of A- (<78 cm fork length) and B-Run (≥78 cm fork length) steelhead sampled at Bonneville Dam in 2019 (weighted by run size).

Run	N	One-Ocean (x.1)	Two-Ocean (x.2)	Three Ocean (x.3)
A-Run	657	57.5%	42.5%	0.0%
B-Run	134	0.0%	99.3%	0.7%
All Steelhead	**791**	**47.8%**	**52.1%**	**0.1%**

Kelt Analyses

A total of 110 steelhead PIT tagged in 2019 were detected going downstream in the Columbia Basin in late winter, spring, and summer of 2020, presumably attempting to return to the ocean after spawning (kelts), or detected moving back upstream later in 2020, 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 (Tables 40 and B2). At the start of this study in 2020, 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 these fish spawn 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 2019, 11 steelhead were added (Tables 36 and B3) for a total of 121 kelts. Of interest is that most of these fish came out of the Tucannon River. The highest percentage of kelt passing Bonneville for weeks where more than 10 steelhead were sampled was in weeks 27 and 28 at 26.7% each (Week 24 had 100% kelt with n=2, Week 25 had 40% kelt with n=5), while the greatest number of kelt was estimated to be in Week 33 at 2,497 steelhead (Figures 32 and 33).

Table 39. Some biological and detection information on the steelhead moving in the Columbia Basin system in 2019 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. (Last 3 columns not corrected.)

					Most Upstream Site		Last Site Detected				
PIT Tag	Date Encountered at AFF	Fin Clip	Age	Fork Length	Basin and Site	Date	Basin and Site	Date	Moving Downstream at Last Detection	Upstream in Summer/Fall 2020	In Kelt Program
3DD.003D364499	7/19/2019		3.1	61	John Day (SJ2)	5/12/2020	John Day (SJ1)	5/12/2020	X		
3DD.003D36449C	7/17/2019		2.2	71	Columbia (MC1)	12/27/2019	Columbia (BCC)	5/19/2020	X		
3DD.003D36449E	7/19/2019		r.2	67.5	Walla Walla (MCD)	3/27/2020	Columbia (BCC)	4/28/2020	X		
3DD.003D36449F	7/17/2019		2.2	72.5	Columbia (MC1)	10/12/2019	Columbia (JDJ)	4/3/2020	X		
3DD.003D3644A8	7/17/2019		2.1	59.5	Yakima (TP2)	4/26/2020	Yakima (TOP)	4/29/2020	X		
3DD.003D3644AE	7/17/2019		2.1	57	Columbia (MC2)	10/4/2019	Columbia (JDJ)	5/27/2020	X		
3DD.003D3644C3	7/16/2019		2.1	61	Grande Ronde (CCW)	4/11/2020	Grande Ronde (CCU)	6/3/2020	X		
3DD.003D3644CA	7/18/2019		2.2	68.5	Wind (TC4)	4/23/2020	Wind (TRC)	5/13/2020	X		
3DD.003D3644CF	7/18/2019	AD	1.2	67	Snake (GRA)	10/8/2019	Snake (GOJ)	4/9/2020			X
3DD.003D364532	7/3/2019		2.2	69	Grande Ronde (UGR)	2/26/2020	Columbia (B2J)	5/24/2020	X		
3DD.003D364545	7/3/2019		2.1	52.5	Wind (TRC)	4/22/2020	Wind (TRC)	4/22/2020	X		
3DD.003D3645D8	7/12/2019	LM	1.2	72	Deschutes (WSR)	3/25/2020	Columbia (BCC)	5/18/2020	X		
3DD.003D3645DD	7/11/2019		2.2	64.5	Snake (GRA)	7/28/2019	Columbia (BCC)	7/8/2020	X		
3DD.003D3645E8	7/11/2019		r.2	65	Salmon (NFS)	5/13/2020	Salmon (NFS)	5/13/2020	X		X
3DD.003D364643	7/9/2019	AD	1.2	65.5	Columbia (WEA)	11/4/2019	Columbia (RRJ)	5/2/2020	X		
3DD.003D36464E	7/9/2019		2.2	72.5	Grande Ronde (UGR)	1/28/2020	Snake (GRS)	5/1/2020	X		
3DD.003D364663	7/9/2019		2.2	70.5	Columbia (MC1)	11/8/2019	Columbia (BCC)	5/19/2020	X		
3DD.003D36473D	7/2/2019		2.2	72	Columbia (PRA)	7/22/2019	Yakima (PRO)	10/18/2019	X		
3DD.003D36476B	7/12/2019		2.2	71.5	Snake (GRA)	10/23/2019	Snake (LMJ)	3/26/2020	X		X

PIT Tag	Date Encountered at AFF	Fin Clip	Age	Fork Length	Most Upstream Site		Last Site Detected		Moving Downstream at Last Detection	Upstream in Summer/Fall 2020	In Kelt Program
					Basin and Site	Date	Basin and Site	Date			
3DD.003D36476E	7/15/2019		2.2	74	Snake (GRA)	7/27/2019	Columbia (BCC)	6/7/2020	X		
3DD.003D36477D	7/12/2019	AD	2.1	55.5	Grande Ronde (MR1)	5/19/2020	Columbia (BCC)	6/7/2020	X		
3DD.003D36485A	7/1/2019		r.2	74	Grande Ronde (UGR)	1/15/2020	Snake (GRJ)	5/11/2020	X		X
3DD.003D3648A9	7/25/2019		2.2	74.5	Wind (WRU)	4/22/2020	Columbia (BCC)	4/25/2020	X		
3DD.003D3648BD	7/25/2019		2.2	62.5	Snake (GRA)	10/3/2019	Columbia (BCC)	4/16/2020	X		
3DD.003D3648C1	7/24/2019	AD	1.1	61	Snake (GRA)	10/29/2019	Snake (GRJ)	3/27/2020	X		
3DD.003D3648D2	7/30/2019		2.2	66	Yakima (SWK)	5/9/2020	Yakima (SWK)	5/9/2020	X		
3DD.003D3648D8	7/30/2019		2.1	62	Snake (GRA)	10/6/2019	Snake (ICH)	5/8/2020	X		
3DD.003D3648DE	7/29/2019		1.1	54	Snake (GRA)	9/2/2019	Snake (LMJ)	5/1/2020	X		X
3DD.003D3648EB	9/4/2019		3.1	63.5	Yakima (LNR)	4/14/2020	Yakima (LNR)	4/14/2020	X		
3DD.003D3648FA	9/4/2019		1.2	80	Clearwater (SC2)	4/4/2020	Snake (GRS)	4/10/2020	X		
3DD.003D3648FD	9/4/2019		r	68	Snake (GRA)	9/19/2019	Snake (GRS)	4/10/2020	X		
3DD.003D364905	9/4/2019		r.1	54	Okanogan (ANT)	4/30/2020	Columbia (RRJ)	5/21/2020	X		X
3DD.003D364937	8/29/2019		r.1	53.5	Grande Ronde (JOC)	5/10/2020	Snake (GOJ)	5/20/2020	X		
3DD.003D3649BD	7/19/2019		r.1	58.5	Yakima (LNR)	5/12/2020	Yakima (LNR)	5/12/2020	X		
3DD.003D3649D8	7/24/2019		2.2	67	Columbia (TD1)	10/11/2019	Columbia (B2J)	2/23/2020	X		
3DD.003D3649E6	7/19/2019		2.2	70.5	Grande Ronde (JOC)	4/30/2020	Columbia (JDJ)	5/18/2020	X		
3DD.003D3649F4	7/23/2019		r.2	65.5	Methow (GLC)	6/7/2020	Methow (GLC)	6/7/2020	X		
3DD.003D3649F7	7/22/2019		2.1	55.5	Yakima (TP2)	4/23/2020	Yakima (TOP)	4/27/2020	X		
3DD.003D364A05	7/24/2019		2.1	52.5	Grande Ronde (JOC)	4/13/2020	Grande Ronde (JOC)	4/13/2020	X		
3DD.003D364A13	8/1/2019		2.1	65	Salmon (BSC)	5/15/2020	Imnaha (IR1)	5/16/2020	X		
3DD.003D364A1C	8/1/2019		3.1	49.5	Umatilla (TMF)	4/30/2020	Columbia (BCC)	5/6/2020	X		

PIT Tag	Date Encountered at AFF	Fin Clip	Age	Fork Length	Most Upstream Site: Basin and Site	Most Upstream Site: Date	Last Site Detected: Basin and Site	Last Site Detected: Date	Moving Downstream at Last Detection	Upstream in Summer/Fall 2020	In Kelt Program
3DD.003D364A20	8/12/2019		2.1	60.5	Wenatchee (CRW)	4/26/2020	Columbia (RRJ)	5/19/2020	X		
3DD.003D364A23	8/1/2019		2.1	55.0	Columbia (MC2)	9/27/2019	Columbia (MC1)	9/10/2020		X	
3DD.003D364A27	8/1/2019		r.2	68.5	Asotin (ACB)	5/15/2020	Asotin (ACB)	5/15/2020		X	X
3DD.003D364A32	8/1/2019		1.1	53.5	Umatilla (UMW)	9/20/2019	Columbia (BCC)	5/8/2020	X		
3DD.003D364A5B	7/31/2019		r.1	56.5	Teanaway (LMT)	4/15/2020	Teanaway (LMT)	4/15/2020	X		
3DD.003D364A74	7/31/2019		2.2	69	Okanogan (SA1)	4/19/2020	Okanogan (SA1)	4/19/2020		X	X
3DD.003D364AA0	8/21/2019		2.2	71	Umatilla (TMF)	11/15/2019	Columbia (BCC)	4/25/2020	X		
3DD.003D364AA3	8/20/2019		2.1	56	Salmon (BSC)	4/22/2020	Snake (GRS)	5/19/2020	X		
3DD.003D364AA5	8/21/2019	AD	1.2	76	Salmon (USE)	3/18/2020	Columbia (BCC)	5/6/2020	X		
3DD.003D364AA8	8/21/2019		2.1	56.5	Columbia (MC2)	10/10/2019	Columbia (BCC)	4/30/2020	X		
3DD.003D364AB9	8/20/2019	LP	r.1	54	Snake (GRA)	9/18/2019	Snake (GRS)	4/13/2020	X		
3DD.003D364ADA	8/29/2019	AD	1.1	56	Snake (GRA)	9/29/2019	Snake (GRS)	5/4/2020	X		
3DD.003D364AE9	8/28/2019		2.2	70	Yakima (ROZ)	4/10/2020	Yakima (ROZ)	4/10/2020	X		
3DD.003D364B27	8/28/2019	AD	1.1	56.5	Salmon (VC2)	5/2/2020	Salmon (VC2)	5/2/2020	X		
3DD.003D364B36	8/28/2019		2.2	73	John Day (SJ2)	3/23/2020	John Day (SJ1)	4/3/2020	X		
3DD.003D364B3C	8/28/2019		2.1	57.5	Clearwater (LAP)	4/23/2020	Snake (GRS)	4/30/2020	X		
3DD.003D364B5D	8/21/2019		2.1	60	Clearwater (LAP)	4/13/2020	Clearwater (LAP)	4/13/2020	X		
3DD.003D364B69	8/26/2019		r.2	64.5	Columbia (MC1)	9/22/2019	Columbia (BO1)	5/19/2020	X		
3DD.003D364B6E	8/21/2019		r.2	62	Grande Ronde (JOC)	4/19/2020	Snake (GOJ)	4/29/2020	X		
3DD.003D364B74	8/21/2019		2.1	60	Grande Ronde (JOC)	4/22/2020	Snake (GRS)	4/27/2020	X		
3DD.003D364BA7	8/12/2019		1.1	58	Tucannon (TFH)	3/24/2020	Tucannon (MTR)	3/28/2020	X		
3DD.003D364BA8	8/19/2019		r.1	54	Okanogan (ZSL)	3/29/2020	Columbia (BCC)	5/20/2020	X		

PIT Tag	Date Encountered at AFF	Fin Clip	Age	Fork Length	Most Upstream Site		Last Site Detected		Moving Downstream at Last Detection	Upstream in Summer/Fall 2020	In Kelt Program
					Basin and Site	Date	Basin and Site	Date			
3DD.003D364BAC	8/19/2019		2.2	75.5	Grande Ronde (MR1)	3/19/2020	Grande Ronde (WR1)	5/8/2020	X		
3DD.003D364BB2	8/13/2019		2.1	59	Grande Ronde (MR1)	4/6/2020	Snake (GRJ)	5/30/2020	X		
3DD.003D364BB5	8/12/2019		2.2	77	Wenatchee (CRU)	4/22/2020	Columbia (BCC)	5/11/2020	X		
3DD.003D364BC7	8/19/2019		r.2	67	Deschutes (WSR)	4/27/2020	Deschutes (WSR)	4/27/2020	X		
3DD.003D364BCF	8/13/2019	AD	r	59.5	Tucannon (MTR)	3/16/2020	Snake (LMJ)	3/30/2020	X		
3DD.003D364BD0	8/12/2019		r.1	52	John Day (JDM)	3/29/2020	Columbia (BCC)	5/11/2020	X		
3DD.003D364BD7	8/19/2019		2.1	61	Wenatchee (WEN)	1/31/2020	Snake (GRS)	4/15/2020	X		
3DD.003D364BDC	8/13/2019		2.1	56	Clearwater (SWT)	3/6/2020	Columbia (BCC)	5/6/2020	X		
3DD.003D364BE3	8/13/2019		r.1	56	Peshastin (PEU)	5/12/2020	Peshastin (PEU)	5/12/2020	X		
3DD.003D364C01	8/13/2019		2.1	56.5	Yakima (LNR)	10/04/2019	Yakima (PRO)	9/14/2020		X	
3DD.003D364C02	8/13/2019		2.1	53.5	Columbia (MC1)	10/22/2019	Columbia (BCC)	5/9/2020	X		
3DD.003D364C05	9/11/2019		r.1	56	Tucannon (MTR)	2/28/2020	Snake (LMA)	9/26/2019	X		
3DD.003D364C1C	9/11/2019	AD	1.1	54.5	Snake (GRA)	9/24/2019	Snake (GOJ)	4/8/2020	X		X
3DD.003D364D0E	9/16/2019	AD	1.2	75	Salmon (KRS)	4/26/2020	Snake (GRS)	6/11/2020	X		
3DD.003D364D32	9/18/2019	AD	1.2	78	Snake (GRA)	10/25/2019	Snake (GRS)	4/3/2020	X		
3DD.003D364D3A	9/18/2019		1.1	56.5	Salmon (BSC)	5/2/2020	Snake (LMJ)	5/30/2020	X		
3DD.003D364D44	9/17/2019		2.1	55	Columbia (JD1)	12/26/2019	Columbia (B2J)	4/27/2020	X		X
3DD.003D364D45	9/18/2019		2.S1	58.5	Clearwater (SWT)	4/18/2020	Columbia (MCJ)	5/7/2020	X		X
3DD.003D364D7D	9/18/2019		r.2	78	Clearwater (LC2)	4/18/2020	Snake (GRS)	6/3/2020	X		X
3DD.003D364E41	9/20/2019	AD	1.2	78.5	Snake (GRA)	10/5/2019	Snake (GRS)	4/21/2020	X		
3DD.003D364E53	9/20/2019	AD	1.1	57.5	Snake (GOA)	12/4/2019	Columbia (BO3)	5/16/2020	X	X	X

PIT Tag	Date Encountered at AFF	Fin Clip	Age	Fork Length	Most Upstream Site: Basin and Site	Most Upstream Site: Date	Last Site Detected: Basin and Site	Last Site Detected: Date	Moving Downstream at Last Detection	Upstream in Summer/Fall 2020	In Kelt Program
3DD.003D364E61	9/19/2019	AD	1.2	71.5	Clearwater (SC2)	3/27/2020	Clearwater (SC1)	4/6/2020			
3DD.003D364F3F	9/24/2019		2.1	55.5	Columbia (MC1)	11/10/2019	Umatilla (TMF)	5/11/2020			
3DD.003D364F8A	9/27/2019		r.1	62.5	Clearwater (LC2)	5/8/2020	Clearwater (LC2)	5/8/2020			
3DD.003D364F9A	9/27/2019	AD	1.2	84	Snake (GRA)	10/20/2019	Snake (GRS)	4/3/2020			
3DD.003D364FAF	9/27/2019		r.2	69.5	Okanogan (SA1)	4/22/2020	Okanogan (SA0)	5/8/2020			
3DD.003D364FC1	9/27/2019	AD	1.2	71	Clearwater (LRU)	3/19/2020	Snake (GRS)	6/12/2020			
3DD.003D36500E	10/15/2019		1.1	68	Clearwater (SC1)	3/11/2020	Columbia (BCC)	6/16/2020			
3DD.003D365013	10/15/2019		r.2	73.5	Yakima (LNR)	4/16/2020	Yakima (LNR)	4/16/2020			
3DD.003D365044	10/15/2019		1.1	68	Salmon (USE)	4/23/2020	Snake (GRS)	4/30/2020			
3DD.003D36504E	10/17/2019	AD	1.1	66	Tucannon (LTR)	3/5/2020	Snake (LMJ)	3/26/2020			
3DD.003D365059	10/11/2019	AD LP	1.1	53.5	Snake (GRA)	10/26/2019	Snake (GRS)	5/4/2020			
3DD.003D36505C	10/11/2019		1.2	80	Clearwater (SC2)	3/4/2020	Columbia (BCC)	5/8/2020			
3DD.003D365069	10/15/2019		2.1	62	Columbia (TD1)	4/29/2020	Columbia (B2J)	5/5/2020			
3DD.003D36506E	10/11/2019		2.1	58.5	Yakima (PRO)	1/26/2020	Columbia (BCC)	4/27/2020			
3DD.003D365077	10/14/2019	AD	1.1	68.5	Clearwater (SC2)	3/12/2020	Clearwater (SC1)	3/30/2020			
3DD.003D365083	10/11/2019	AD	1.2	79.5	Clearwater (SC1)	4/15/2020	Snake (GRS)	4/25/2020			
3DD.003D365085	10/11/2019	AD	1.2	83	Snake (GRA)	11/17/2019	Snake (GRJ)	3/28/2020			
3DD.003D3650A2	10/11/2019	AD	1.2	77.5	Clearwater (SC2)	3/5/2020	Snake (GRS)	4/7/2020			
3DD.003D3650A4	10/14/2019		r.1	68	Clearwater (SC2)	3/29/2020	Snake (GRS)	6/11/2020			
3DD.003D3650AA	10/11/2019	AD RM	1.2	78	Clearwater (SC1)	4/6/2020	Clearwater (SC1)	4/6/2020			
3DD.003D3650D3	10/3/2019		2.1	58	Tucannon (MTR)	3/8/2020	Tucannon (LTR)	3/12/2020			

PIT Tag	Date Encountered at AFF	Fin Clip	Age	Fork Length	Most Upstream Site: Basin and Site	Most Upstream Site: Date	Last Site Detected: Basin and Site	Last Site Detected: Date	Moving Downstream at Last Detection	Upstream in Summer/Fall 2020	In Kelt Program
3DD.003D3650EA	10/3/2019		1.2	80.5	Clearwater (SC2)	4/21/2020	Clearwater (SC2)	4/21/2020			
3DD.003D365107	10/2/2019	AD	r.2	80	Clearwater (SC2)	3/16/2020	Snake (GRS)	4/26/2020			
3DD.003D36512B	10/9/2019		2.2	82	Snake (GRA)	12/4/2019	Snake (GRS)	4/13/2020			
3DD.003D365145	10/7/2019		1.1	59	Tucannon (MTR)	4/10/2020	Columbia (BCC)	4/27/2020			
3DD.003D36514B	10/4/2019	AD	1.1	58.5	Snake (GRA)	10/26/2019	Snake (GRS)	5/12/2020			
3DD.003D36523E	10/18/2019	AD	1.1	56	Snake (GRA)	11/23/2019	Snake (GOJ)	4/17/2020			
3DD.007776D14E	9/16/2019	AD	r.2	66	Snake (GRA)	10/18/2019	Snake (GRS)	4/14/2020			
3DD.0077AF45AF	8/12/2019		2.1	52	Clearwater (EPR)	5/18/2020	Snake (GRJ)	6/3/2020			
3DD.0077C0C904	6/20/2019		2.2	67	Klickitat (LKR)	2/27/2020	Klickitat (KLR)	3/29/2020			
3DD.0077C0CA77	6/25/2019		2.2	69	Grande Ronde (WR1)	4/29/2020	Grande Ronde (WR1)	4/29/2020			
3DD.0077C0F39B	6/13/2019		1.2	63	Wind (TC4)	6/23/2020	Wind (TRC)	6/24/2020			
3DD.0077C169B5	6/21/2019	AD	1.2	64	Wenatchee (CHL)	5/7/2020	Wenatchee (CHL)	5/7/2020			
3DD.0077C1E62B	6/5/2019	AD	r.2	69	Klickitat (LKR)	6/17/2019	Columbia (B2J)	2/25/2020			
3DD.0077C24338	6/10/2019		r.2	83	Hood (MVF)	10/17/2019	Columbia (BCC)	3/23/2020			
3DD.0077D04DAB	8/1/2019	AD	1.1	51.5	Grande Ronde (WR2)	3/4/2020	Grande Ronde (WR1)	4/18/2020			

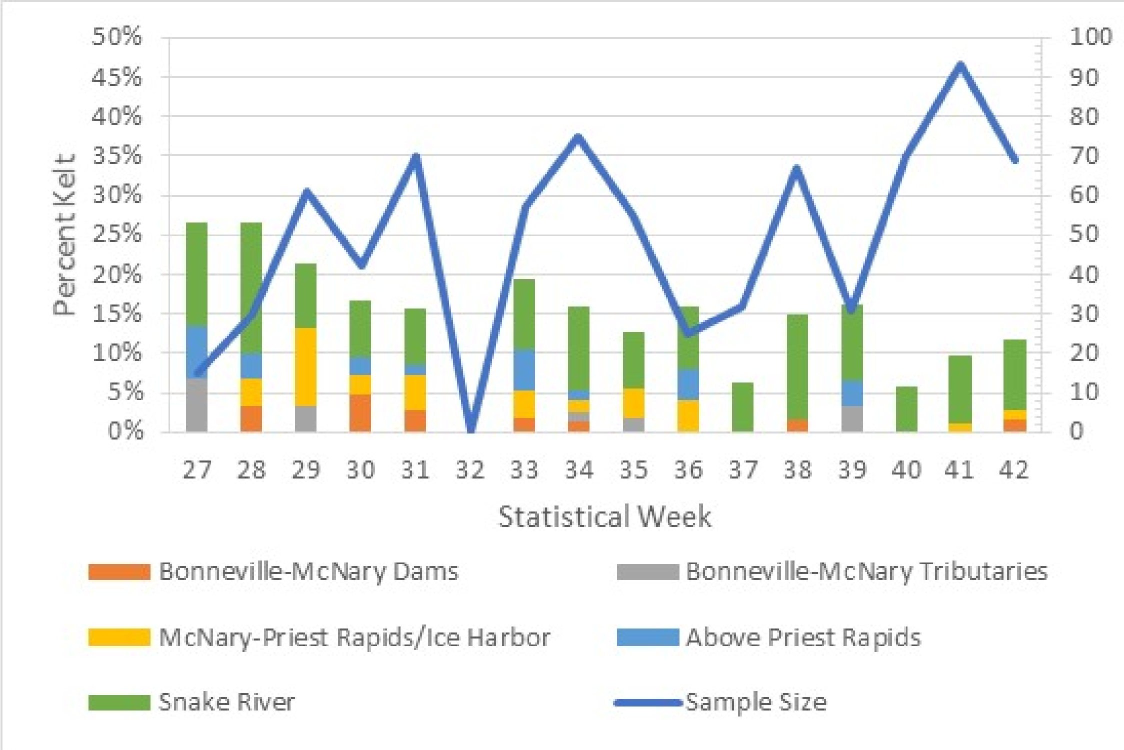

Figure 32. Percentage of run designated as kelt by week sampled in 2019 at Bonneville Dam and the most upstream detection area for those kelt for weeks where n>10. No sampling occurred in Week 32.

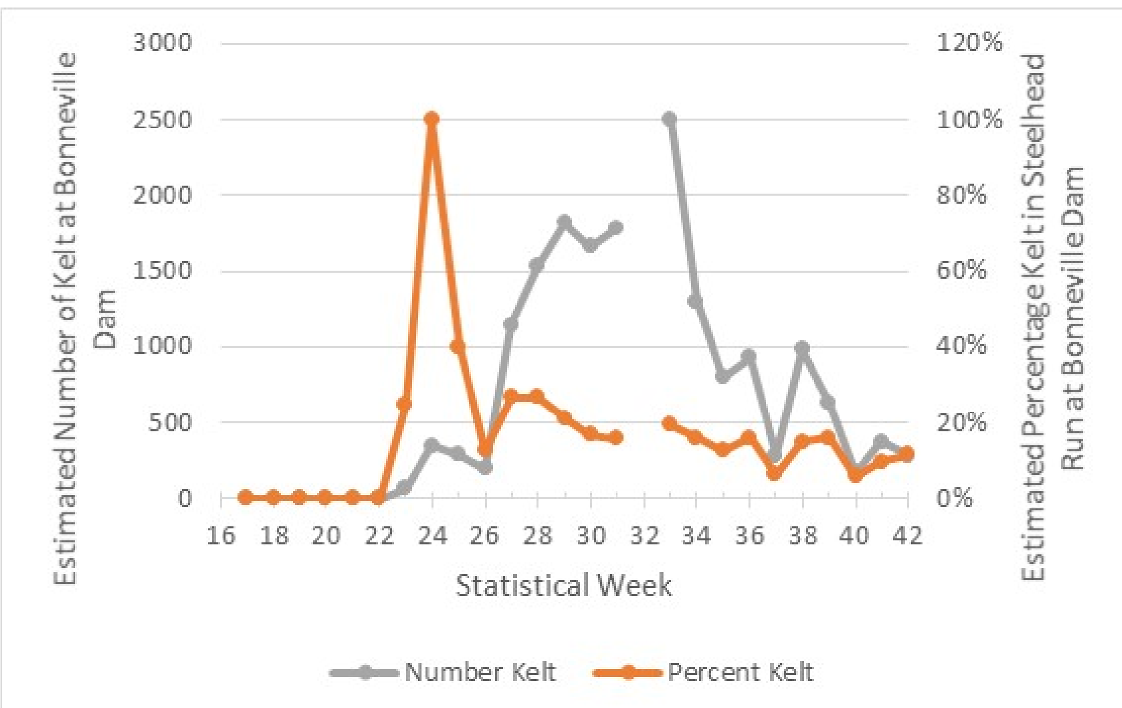

Figure 33. Percentage and number of kelt estimated to be passing Bonneville Dam by Statistical Week as estimated by this project in 2019. No sampling occurred in Week 31.

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 2019 tagged fish, the juvenile bypass at these dams detected kelts: Bonneville (6), John Day (3), McNary (1), Lower Monumental (5), Little Goose (5), Lower Granite (5), and Rocky Reach (3) (Table 40 and B2). Another major exit location for kelts is the Bonneville Dam Corner Collector, where 24 steelhead tagged by this study were last detected migrating downstream in spring and summer 2020. In addition, a new set of antennas at a Lower Granite Dam spillway (GRS) detected 33 outmigrating steelhead in 2020, for 24 of these fish it was their last detection in the system. Of the 121 identified kelts, 87 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, 3 steelhead collected by the Kelt Project were collected at Lower Granite Dam Juvenile Bypass, 5 at Prosser Dam, and 1 in Toppenish Creek (a Yakima River tributary) as they were moving downstream after spawning. Three steelhead tagged and track in 2019 behaved like repeat spawners, as they were tracked upriver, and in most cases into tributaries, during 2019 and spring of 2020, and then tracked again in either the late summer, fall, or early winter 2020, moving upstream through the Bonneville Dam fish ladders and also detected further upriver.

We have also updated information on kelts/repeat spawners from several past annual reports with data from 2016/2017/2018 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 2016 (no records), 2017 (no records), and 2018 (two records).

Table 40. 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 2009-2019. Data is categorized by last detection site.

	Tag Year										
Last site	**2019**	**2018**	**2017**	**2016**	**2015**	**2014**	**2013**	**2012**	**2011**	**2010**	**2009**
Bonneville Corner Collector	24	17	14	32	25	38	30	25	10	23	61
Bonneville Juvenile Bypass	6	2	6	1	5	3	6	5	1	4	7
Bonneville Dam Bradford Island Ladders heading downstream	1	0	0	0	2	1	3	2	0	0	0
Bonneville Dam ladders heading downstream	1	1	1	0	0	0	0	0	0	0	0
Estuary Trawl or Pile Dikes (TWX or PD7)	0	2	1	1	0	0	2	2	0	0	1
Ice Harbor Juvenile Bypass	1	0	0	2	1	0	0	0	1	6	0
Ice Harbor Ladders heading downstream	0	0	0	0	0	0	1	0	NA	NA	NA
John Day Juvenile Bypass	3	3	3	20	6	2	8	6	3	11	3
Little Goose Juvenile Bypass	5	7	5	11	5	2	9	5	11	13	6
Lower Granite Juvenile Bypass	5	11	7	5	0	3	4	3	4	10	3
Lower Monumental Juvenile Bypass	5	5	5	4	0	2	7	1	12	9	4
Lower Granite Dam adult ladders moving downstream	0	1	0	0	0	0	0	0	0	0	0
Lower Granite Spillway (new in 2019)	24	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Washington Shore McNary Dam ladder downstream	0	3	1	3	0	1	0	0	0	2	1
McNary Dam Juvenile Bypass	1	2	3	4	1	1	4	4	3	2	4
Rocky Reach Juvenile Bypass	3	9	5	1	2	10	1	0	4	6	7
Migrating downstream in tributaries	35	22	9	2	6	NA	4	3	0	0	0
Repeat spawners, at Bonneville Dam or above migrating upstream	3	0	4	4	4	5	12	1	NA	NA	NA
Trapped by CRITFC Kelt Program											
Snake Basin	3	10	6	7	5	4	11	NA	NA	NA	NA
Yakima Basin	6	4	0	1	1	6	6	1	NA	NA	NA
Total[12]	**121**	**85**	**64**	**98**	**63**	**77**	**108**	**58**	**49**	**86**	**97**
Estimated kelt as percentage of run	**14.9%**	**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	**2**	**9**	**7**	**0**	**0**	**2**	**5**	**13**	**3**	**9**	**5**
Minimum number of kelts	**123**	**94**	**71**	**98**	**63**	**79**	**113**	**71**	**52**	**95**	**102**

[12] 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 (50.8% vs. 47.3%) and lower percentage of two ocean fish (49.2% vs. 52.6%) (Table 41). The mean length of non-kelt was 67.1 cm compared to 64.7 cm for kelt.

Table 41. Ocean age composition of steelhead designated as kelt or non-kelt sampled at Bonneville Dam in 2019.

Run	Number Ageable for Ocean Age	One-Ocean (x.1)	Two-Ocean (x.2)	Three-Ocean (x.3)
Kelt	118	50.8%	49.2%	0.0%
Non-Kelt	675	47.3%	52.6%	0.1%

Comparisons with WFRS steelhead

A total of 714 steelhead were detected passing through the WFRS during 2019 compared to 820 sampled at the AFF (Table 42). The weekly distribution of the WFRS sample compared to the AFF trap sample (Figure 34) shows that a larger proportion of the steelhead trapped at the AFF than sampled by WFRS during weeks 28-30 when sample sizes of other species were relatively low and there were fewer restrictions on the number of fish that could be put in the sampling tank. After the trap shut down on the peak week of passage (Week 32), sampling restrictions, which reduced the number of fish in the sampling tank at one time, combined with the sampling of fall Chinook meant that the WFRS sampled a higher portion of the run than the at the AFF trap. As with Chinook, in Week 38 there were large numbers of steelhead sampled by WFRS relative to the visual counts or the AFF.

Table 42. Mean length with standard deviation of steelhead by Statistical Week for fish sampled at the AFF and by the WFRS in 2019.

	AFF			WFRS			
Statistical Week	Mean Length	Standard Deviation	N	Mean Length	Standard Deviation	N	% of Run
<=17	73.5	4.2	2	--	--	0	2.2
18	--	--	0	--	--	0	0.1
19	64.5	--	1	74.4	6.2	2	0.2
20	65.5	3.5	2	57.8	--	1	0.1
21	69.5	4.2	2	52.2	--	1	0.1
22	67.8	6.7	2	71.8	--	1	0.2
23	68.6	4.2	4	--	--	0	0.2
24	73.0	14.1	2	61.8	--	1	0.3
25	67.8	2.9	5	64.5	6.8	8	0.6
26	68.6	2.7	8	66.3	4.4	25	1.3
27	68.9	5.8	15	64.2	7.4	12	3.6
28	66.1	5.7	30	66.5	8.5	10	4.8
29	63.9	7.9	61	61.9	9.3	13	7.1
30	61.9	6.6	42	59.0	7.0	9	8.3
31	60.7	6.0	70	59.9	7.4	20	9.5
32	AFF Closed due to temperatures at or above 22.2C, no sampling						11.1
33	59.9	5.9	57	56.7	6.5	12	10.8
34	61.5	7.3	75	59.5	8.4	77	6.8
35	63.4	6.7	55	59.0	7.0	79	5.2
36	69.2	8.1	25	63.2	9.9	69	4.9
37	65.6	9.5	32	62.8	9.3	70	3.7
38	71.5	9.1	67	66.4	10.3	136	5.5
39	73.5	9.2	31	68.1	13.0	26	3.3
40	73.5	10.1	70	67.0	10.1	34	2.5
41	72.3	10.0	93	67.8	10.1	56	3.2
>=42	69.0	8.6	69	66.0	9.3	52	4.2
Total	**66.7**	**9.3**	**820**	**63.7**	**9.7**	**714**	**100.0**

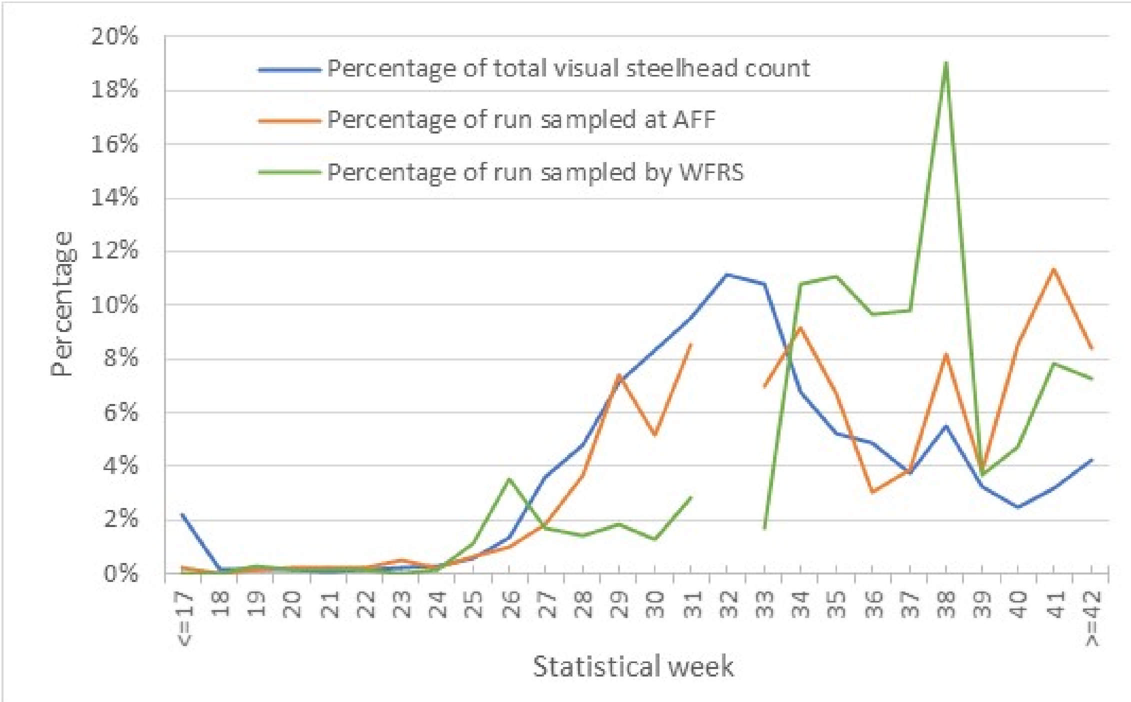

Figure 34. Comparison of the weekly percentage of the visual steelhead fish count at Bonneville Dam and the percentage of steelhead sampled in the Adult Fish Facility and by the WFRS in 2019.

Contrary to Chinook where the weekly mean fork length for WFRS-sampled Chinook was greater than that of AFF-sampled Chinook in 9 of 13 weeks, the mean length of AFF-sampled steelhead was greater than that of WFRS sampled steelhead in 15 out of 16 weeks with n>5 for both groups (Table 43, Figure 35). The mean length among all steelhead sampled was 66.7 cm for the AFF-sampled steelhead compared to 63.7 cm for the WFRS sampled steelhead (Table 42). A Mann Whitney test did not find a significant difference (Z= -0.29, p=0.77) between lengths of AFF and WFRS-sampled sockeye. A Kolmogorov-Smirnov test also did not find a significant difference between cumulative length distribution of AFF and WFRS-sampled Sockeye (χ^2=4.3, p=0.12, Figures 36 and 37).

Figure 36. Mean weekly fork length distribution for WFRS and AFF-sampled steelhead at Bonneville Dam in 2019.

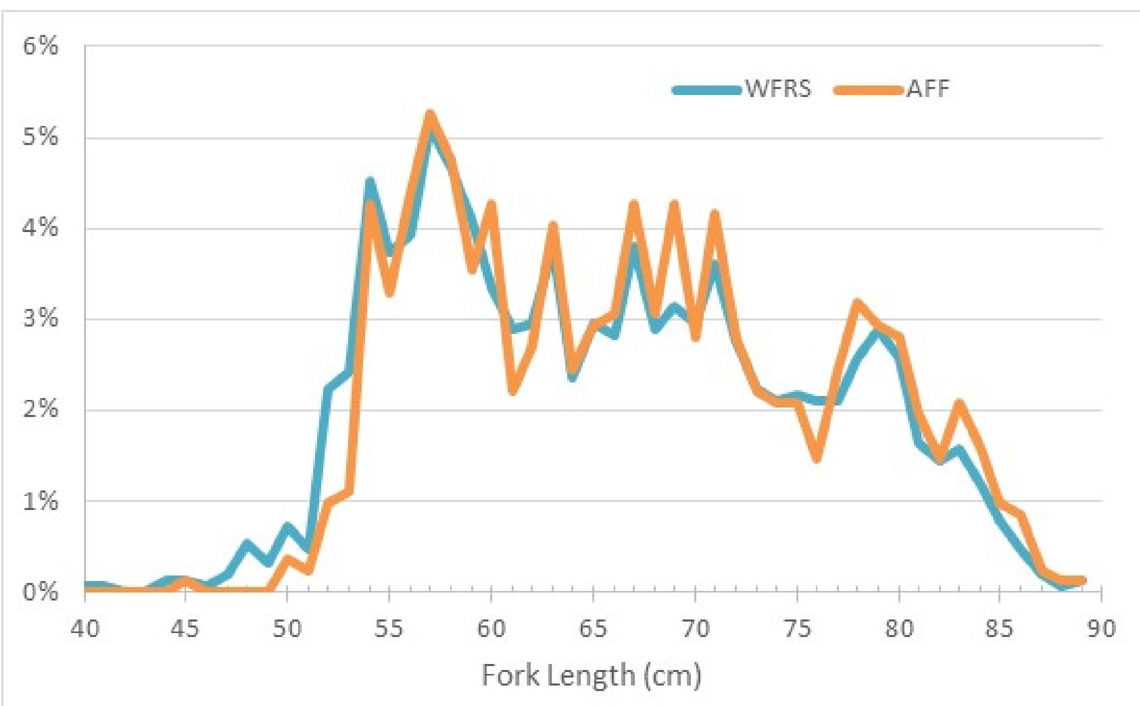

Figure 35. Fork length distribution for WFRS and AFF-sampled steelhead at Bonneville Dam in 2019.

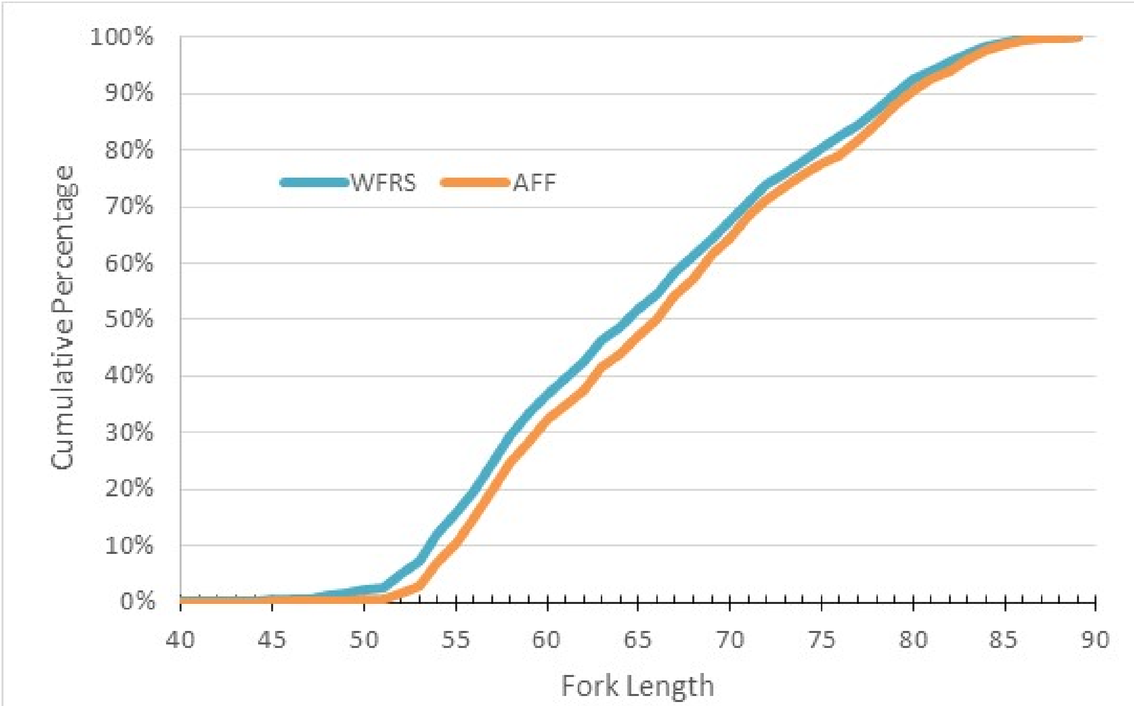

Figure 37. Cumulative mean fork length distribution for WFRS and AFF-sampled steelhead at Bonneville Dam in 2019.

The proportion of steelhead adipose clipped was significantly greater (α=0.05) in the AFF sample than the WFRS sample in seven weeks, all after Week 32, while the opposite was the case in three weeks prior to Week 32. (Table 43, Figure 38). Comparing the total proportions, there was no significant difference in the percentage adipose clipped between the WFRS and AFF samples (Table 44).

The proportion of steelhead estimated to be of B-run (>78 cm fork length) was significantly greater (α=0.05) in the AFF sample than the WFRS sample in nine weeks while the opposite was true in five of the weeks (Table 44, Figure 38). Comparing total proportions, there was a significant difference in the proportion B-run between the WFRS and AFF samples (Table 44) with the AFF sample having the highest proportion B-Run (0.154 versus 0.115).

Table 43. Proportion of steelhead >36 cm fork length adipose clipped by week in both the AFF and WFRS samples with standard error and a t-statistic for the difference between the two proportions. Significant values (p=0.05) are shaded yellow with the greater proportion shaded green in those cases.

Statistical Week	AFF			WFRS			t-stat	P-value
	N	Proportion Ad Clipped	Std Err	N	Proportion Ad Clipped	Std Err		
17	1	0.500	0.177	0	--	--	--	--
18	0	--	--	0	--	--	--	--
19	2	0.000	0.000	2	0.000	0.000	--	--
20	2	0.000	0.000	0	--	--	--	--
21	4	0.500	0.177	1	0.000	0.000	--	--
22	2	1.000	0.000	1	0.000	0.000	--	--
23	5	1.000	0.000	0	--	--	--	--
24	8	0.000	0.000	1	1.000	0.000	--	--
25	15	0.200	0.179	8	0.750	0.153	2.336	0.029
26	30	0.625	0.171	25	0.600	0.098	0.127	0.450
27	61	0.400	0.126	11	0.818	0.116	2.434	0.019
28	42	0.400	0.089	10	0.800	0.126	2.582	0.016
29	70	0.377	0.062	13	0.615	0.135	1.605	0.068
30	1	0.405	0.076	9	0.333	0.157	0.409	0.347
31	2	0.457	0.060	20	0.550	0.111	0.736	0.236
32	AFF Closed due to temperatures at or above 22.2C, no sampling							
33	57	0.404	0.065	11	0.636	0.145	1.465	0.088
34	75	0.533	0.058	76	0.382	0.056	1.893	0.031
35	55	0.600	0.066	77	0.403	0.056	2.281	0.013
36	25	0.560	0.099	66	0.470	0.061	0.773	0.221
37	32	0.688	0.082	70	0.314	0.055	3.771	0.000
38	67	0.716	0.055	131	0.313	0.041	5.901	0.000
39	31	0.677	0.084	26	0.308	0.091	2.995	0.003
40	70	0.629	0.058	34	0.324	0.080	3.086	0.002
41	93	0.710	0.047	56	0.375	0.065	4.183	0.000
42	69	0.652	0.057	51	0.451	0.070	2.230	0.015
Total	**820**	**0.561**	**0.017**	**699**	**0.592**	**0.019**	**1.232**	**0.109**

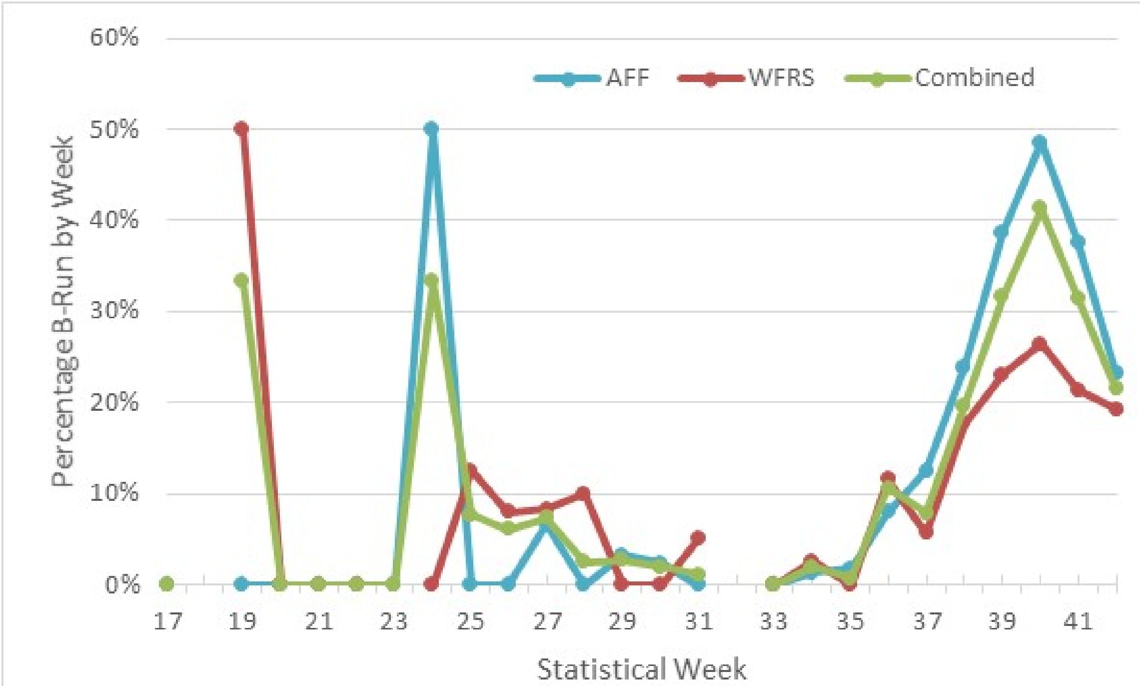

Figure 38. Percentage of steelhead estimated to be <78 cm (B-Run) sampled by the WFRS and combined with an adipose clip by Statistical Week in 2019.

Table 44. Proportion of steelhead estimated to be B-run by week in both the AFF and WFRS samples with standard error and a t-statistic for the difference between the two proportions. Significant values (p=0.05) are shaded yellow with the greater proportion shaded green in those cases.

Statistical Week	AFF			WFRS			t-stat	P-value
	N	Proportion B Run	Std Err	N	Proportion B Run	Std Err		
17	2	0.000	0.000	0	NA	NA	NA	NA
19	1	0.000	0.000	2	0.500	0.177	2.828	0.108
20	2	0.000	0.000	1	0.000	0.000	NA	NA
21	2	0.000	0.000	1	0.000	0.000	NA	NA
22	2	0.000	0.000	1	0.000	0.000	NA	NA
23	4	0.000	0.000	0	NA	NA	NA	NA
24	2	0.500	0.177	1	0.000	0.000	2.828	0.108
25	5	0.000	0.000	8	0.125	0.039	3.232	0.004
26	8	0.000	0.000	25	0.080	0.015	5.435	0.000
27	15	0.067	0.016	12	0.083	0.022	0.611	0.273
28	30	0.000	0.000	10	0.100	0.028	3.514	0.001
29	61	0.033	0.004	13	0.000	0.000	8.075	0.000
30	42	0.024	0.004	9	0.000	0.000	6.639	0.000
31	70	0.000	0.000	20	0.050	0.011	4.708	0.000
32	AFF Closed due to temperatures at or above 22.2C, no sampling							
33	57	0.000	0.000	12	0.000	0.000	NA	NA
34	75	0.013	0.002	77	0.026	0.003	3.879	0.000
35	55	0.018	0.002	79	0.000	0.000	7.554	0.000
36	25	0.080	0.015	69	0.116	0.012	1.871	0.032
37	32	0.125	0.019	70	0.057	0.006	3.330	0.001
38	67	0.239	0.022	136	0.176	0.012	2.448	0.008
39	31	0.387	0.043	26	0.231	0.035	2.841	0.003
40	70	0.486	0.030	34	0.265	0.033	4.935	0.000
41	93	0.376	0.024	56	0.214	0.022	4.889	0.000
42	69	0.232	0.021	52	0.192	0.022	1.302	0.098
Total	**820**	**0.154**	**0.005**	**714**	**0.115**	**0.004**	**6.551**	**0.000**

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 PBT, presumably the most accurate genetic stock classification (Table 45). For those fish for which PBT was not available, stock classifications were made using Genetic Stock Identification (GSI) (Table 46). The overall stray rate for PBT-classified steelhead was 7.6% and 40.2% for GSI-classified steelhead.

Table 45. Showing final-PIT-fate categories by stock as determined using PBT for fish tagged in 2019. 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.

Dam/Basin	Bonneville			Klickitat					Deschutes		John Day			McNary				Tucannon					Clearwater					Gr. Ronde		Salmon				Imnaha			Wenatchee														
Stock Classification using Parental Based Tagging (PBT)	Bonneville-Bradford Ladder	Bonneville-WA Shore Ladder	Bonneille WA Ladder Slots	Lyle Falls Fishway, Klickitat R	Klickitat River	Little Klickitat	The Dalles-Oregon Shore	The Dalles-WA Shore	Buck Hollow Creek	Sherar's Falls	John Day-Oregon Shore	John Day-WA Shore	Upper John Day River	McNary Dam-Oregon Shore	McNary Dam-WA Shore	Ice Harbor	Lower Monumental	Lower Tucannon River	Middle Tucannon River	Tucannon Fish Hatchery	Little Goose Dam	Lower Granite Dam	Sweetwater Creek	Dworshak Hatchery	Lower SF Clearwater	Lower SF Clearwater	Asotin Creek	Wallowa River (rkm 14)	Wallowa River (rkm 32)	Upper Salmon River (rkm 437)	Upper Salmon River (rkm 460)	Valley Creek	Redfish Lake	Imnaha River	Big Sheep Creek	Priest Rapids Hatchery	Tumwater Dam	Chiwawa River	Wells Dam	Methow River	Zosel Dam	Total	Neutral	On Target	Putative Stray	Putative overshoot	%Neutral	%On Target	%Putative Stray	%Putative overshoot	% Strays (strays/(strays+On target))
Columbia RKM	234	234	234	290	290	290	308	308	328	328	347	347	351	470	470	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	635	754	754	830	843	858										
PTAGIS Site	BO1	BO3	BO4	LFF	KLR	LKR	TD1	TD2	DBH	DSF	JO1	JO2	JDM	MC1	MC2	ICH	LMA	LTR	MTR	TFH	GOA	GRA	SWT	DWL	SC1	SC2	ACM	WR1	WR2	USE	USI	VC2	RFL	IR2	BSC	PRH	TUF	CHL	WEA	MRC	ZSL										
Dworshak		15					6	1			5	1		5	1		1	1			1	65		24	18	37										1						182	101	79	2	0	55.5%	43.4%	1.1%	0.0%	2.5%
Eastbank																																					1	1				2	0	2	0	0	0.0%	100.0%	0.0%	0.0%	0.0%
Grande Ronde		5					2					1	1	3		1	4		2		2	26	1				1		2													51	44	3	4	0	86.3%	5.9%	7.8%	0.0%	57.1%
MGILCS	1	1					2	1		4						1					1	7												4	1							23	14	5	4	0	60.9%	21.7%	17.4%	0.0%	44.4%
Oxbow		4					3		1					1		1						12																				22	9	12	1	0	40.9%	54.5%	4.5%	0.0%	7.7%
Pahisimmeroi		5					1									1						12								5	5											29	19	10	0	0	65.5%	34.5%	0.0%	0.0%	0.0%
Sawtooth		3					1									1						12								5	5	2	1									30	17	13	0	0	56.7%	43.3%	0.0%	0.0%	0.0%
Skamania		6	8	5	1	1	1																																			22	15	7	0	0	68.2%	31.8%	0.0%	0.0%	0.0%
S. Fork Clearwater		1					2							1				1				3			2	2																12	8	4	1	0	61.5%	30.8%	7.7%	0.0%	20.0%
Touchet																			1																							1	0	1	0	0	0.0%	100.0%	0.0%	0.0%	0.0%
Tucannon		2																	1	1		2																				6	4	2	0	0	66.7%	33.3%	0.0%	0.0%	0.0%
Umatilla												1		1																												2	1	0	0	1	50.0%	0.0%	0.0%	50.0%	0.0%
Upper Salmon																						9								5	4											18	9	9	0	0	50.0%	50.0%	0.0%	0.0%	0.0%
Wallowa		1					2															9						3	3													18	12	6	0	0	66.7%	33.3%	0.0%	0.0%	0.0%
Wells		3																																					3	1		7	3	4	0	0	42.9%	57.1%	0.0%	0.0%	0.0%
Winthrop																																									1	1	0	0	1	0	0.0%	0.0%	100.0%	0.0%	100.0%
Total																																										426	256	157	13	1	60.0%	36.8%	3.0%	0.2%	7.6%

Table 46. Showing final-PIT-fate categories by stock as determined using GSI for fish tagged in 2019. 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.

Dam/Basin+A4:BD2	Bonneville				Wind River			Hood River		Klickitat			The Dalles			Deschutes			John Day Dam		John Day River				Umatilla		McNary		Walla walla				
Stock Classification using Genetics Stock Identification (GSI)	Bonneville	Bonneville-Cascades Ladder	Bonneville-WA Shore Ladder	Bonneille WA Ladder Slots	Trout Creek	Trout Creek at 43 Road	Upper Wind River	Moving Falls Ladder	Hood River Mouth	Lyle Falls Fishway, Klickitat R	Klickitat	Little Klickitat	The Dalles-Oregon Shore	The Dalles-WA Shore	15 Mile Creek	Deschutes R. Mouth	Sherar's Falls		John Day-Oregon Shore	John Day-WA Shore	John Day River	Bridge Creek	South Fork John Day	John Day River	Three Mile Dam	Umatilla River at rkm 9	McNary Dam-Oregon Shore	McNary Dam-Washington Shore	Walla Walla River Bridge	Touchet River	Touchet River-Bolles Bridge	Mill Creek	Nursery Bridge
Columbia RKM	234	234	234	234	251	251	251	273	273	290	290	290	308	308	309	328	328	328	347	347	351	351	351	351	465	465	470	470	509	509	509	509	509
PTAGIS Site	BO1	BO2	BO3	BO4	TRC	TC4	WRU	MVF	HRM	LFF	KLR	LKR	TD1	TD2	158	DRM	DSF	WSR	JO1	JO2	JD1	BR0	SJ2	JDM	TMF	UMW	MC1	MC2	WWB	HST	BBT	MCD	NBA
Lower Columbia	1			1																													
Skamania			2	4	2	1	1	2		1																							
Willamette			1						1																								
Big White Salmon			1																														
Klickitat	1		4			1		1		3		3	2																				
MGILCS		1	33	4							1		10	3	2	2	2	4	5	5	6		2	6	5	2	18	7	1	1	2	2	1
Yakima			1	1									2			1																	
Upper Columbia			1														1								1								
SF Clearwater			2																1	1		1											
Upper Clearwater			1																								1						
SF Salmon																			1														
MF Salmon																																	
Upper Salmon													1															1					
Grand Total	2	1	47	10	2	2	1	3	1	4	1	3	15	3	2	3	3	4	8	6	6	1	2	6	7	2	19	8	1	1	2	2	1

Dam/Basin+A4:BD2			Tucannon				Clearwater								Grande Ronde								Salmon River							Imnaha		
Stock Classification using Genetics Stock Identification (GSI)	Ice Harbor Dam	Lower Monumental Dam	Middle Tucannon	Tucannon Fish Hatchery	Little Goose	Lower Granite	Lapwai Creek	Sweetwater Creek	East Fork Potlatch	Dworshak Hatchery	Lolo Creek	Lochsa River	Lower SF Clearwater	Upper Selway	Asotin Creek	Joseph Creek	Wenaha River	Minam River	Wallowa River rkm 14	Wallowa River rkm 32	Upper Grand Ronde rkm 155	Catherine Creek	EFSF Salmon River	SF Salmon-Guard Station Bridge	Panther Creek	NF Salmon	Hayden Creek	Upper Salmon River at rkm 437	Upper Salmon River at rkm 460	Lower Imaha at rkm 7	Lower Imnaha km 10	Big Sheep Creek
Columbia RKM	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	522	522	522
PTAGIS Site	ICH	LMA	MTR	TFH	GOA	GRA	LAP	SWT	EPR	DWL	LC2	LRU	SC2	SW2	ACB	JOC	WEN	MR1	WR1	WR2	UGR	CCW	ESS	KRS	PCA	NFS	HYC	USE	USI	IR1	IR2	BSC
Lower Columbia																																
Skamania																																
Willamette																																
Big White Salmon																																
Klickitat																																
MGILCS	2	1	3	1	2	26	2	2	1						2	7	2	4	1	2	4	2					1		1		2	3
Yakima						1																										
Upper Columbia						4															1											
SF Clearwater						10	1				2		1															1				
Upper Clearwater												4		1																		
SF Salmon						1																	1	1								
MF Salmon						6																										
Upper Salmon						4																			1	1				1		
Grand Total	2	1	3	1	2	52	3	2	1	1	2	4	1	1	2	7	2	4	1	2	5	2	1	1	1	1	1	2	1	1	2	3

Dam/Basin+A4:BD2	Yakima													Wenatchee					Methow				Okanogan																
Stock Classification using Genetics Stock Identification (GSI)	Prosser Dam	Satus Creek	Simcoe Creek	Toppenish Creek	Sunnyside	Lower Naches	Roza Dam	Taneum Creek	Swauk Creek	Teanaway River	Ringgold Hatchery	Priest Rapids Dam	Rock Island Dam	Peshastin Creek	Upper Peshastin Creek	Upper Wenatchee	Upper Nason Creek	Wells Dam	Gold Creek	Methow River-Carlton	Chewuch River-Winthrop	Upper Chewuch	Lower Okanogan	Loup Loup Creek	Omak Creek	Salmon Creek	Antoine Creek	Zosel Dam	Nine Mile Creek		Neutral	On-Target	Stray	Overshoot	%Neutral	%On Target	%Putative Stray	%Putative overshoot	Stray Rate
Columbia RKM	539	539	539	539	539	539	539	539	539	539	567	639	730	754	754	754	754	830	843	843	843	843	858	858	858	858	858	858	858										
PTAGIS Site	PRO	SAT	SM1	TP2	SUN	LNR	ROZ	TAN	SWK	LMT	RSH	PRA	RIA	PES	PEU	UWE	NAU	WEA	GLC	MRC	CRW	CRU	OKL	LLC	OMK	SA1	ANT	ZSL	NMC	N									
Lower Columbia																														2	0	0	0	2	0.0%	0.0%	0.0%	100.0%	
Skamania																														13	6	7	0	0	46.2%	53.8%	0.0%	0.0%	0.0%
Willamette																														2	0	0	1	1	0.0%	0.0%	50.0%	50.0%	100.0%
Big White Salmon																														1	1	0	0	0	100.0%	0.0%	0.0%	0.0%	
Klickitat																														15	5	8	0	2	33.3%	53.3%	0.0%	13.3%	0.0%
MGILCS	2				1		1	1			3	1	1	1	1			4	1	2		1		1		1			1	219	115	55	49	0	52.5%	25.1%	22.4%	0.0%	47.1%
Yakima	2	1	1	2	1	4		1	1	1		1											1					1		23	4	14	5	0	17.4%	60.9%	21.7%	0.0%	26.3%
Upper Columbia											1	1	2			1	1				1	1			1	1	1			19	1	10	8	0	5.3%	52.6%	42.1%	0.0%	44.4%
SF Clearwater																														20	14	1	5	0	70.0%	5.0%	25.0%	0.0%	83.3%
Upper Clearwater																														7	2	5	0	0	28.6%	71.4%	0.0%	0.0%	0.0%
SF Salmon																														4	2	2	0	0	50.0%	50.0%	0.0%	0.0%	0.0%
MF Salmon																														6	6	0	0	0	100.0%	0.0%	0.0%	0.0%	
Upper Salmon											1																			10	6	2	2	0	60.0%	20.0%	20.0%	0.0%	50.0%
Grand Total	4	1	1	2	2	4	1	2	1	1	5	3	3	1	1	1	1	4	1	2	1	2	1	1	1	2	1	1	1	346	162	104	70	5	47.5%	30.5%	20.5%	1.5%	40.2%

RESULTS-SOCKEYE[13]

Sample Size

In 2019, a total of 981 Sockeye Salmon were sampled for this project at the Bonneville Dam between June 3 and August 1 (Table 47). Of these, 963 were tagged, and there were 16 recaptures of Sockeye which had been previously PIT tagged in test fishery in the Columbia River Estuary (Fryer et al. 2021) plus one recapture of a CRITFC AFF-tagged Sockeye. Six Sockeye were not detected after release and there was one mortality, resulting in a total of 972 Sockeye tracked upstream (which will hereafter be referred to as Bonneville-tagged Sockeye although this includes recaptures). In 2019, sampling restrictions resulting in raised picket leads on 27 sampling days during weeks Sockeye Salmon were sampled; 23 of which were due to high shad abundance and 4 days due to high water temperatures (21.1 - 22.2C, Table 47)[14]. An additional two days of sampling were lost due to a 4-day weekly sampling limit when temperatures were between 21.1 and 22.2C in weeks 30 and 31. Temperatures exceeded 22.2C from August 2 through 11, 2019, resulting in no sampling during a period when 0.1% of the Sockeye run passed Bonneville Dam (as estimated using visual fish counts).

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 39). This is typical during the peak of the Sockeye run as available sampling hours and trapping constraints put an upper limit on how many fish we can sample in a week. In addition, trap restrictions imposed due to shad abundance from weeks 23 through 27 and due to high water temperatures in weeks 30 and 31 also reduced sample sizes (Table 47).

[13] The information presented in this section of the report is a summary of Fryer et al. 2021.
[14] Raising picket leads is required by trap regulations and decreases the number of fish going through the trap and can introduce trap biases (Fryer et al. 2011b).

Table 47. Number of Sockeye Salmon sampled, and PIT tagged at Bonneville Dam and tracked upstream by date and statistical week in 2019.

Sampling Dates	Statistical Week[15]	% of Run	Sampled (N)	Tagged	Previously Tagged: By CRITFC at AFF	Previously Tagged: Other Agencies	Mortalities	Not Detected After Tagging	Total Tracked	Days Sampling Restrictions in Effect: Reduced Sampling Temperature	Days Sampling Restrictions in Effect: Shad or Salmon Abundance	Days Sampling Restrictions in Effect: No Sampling Temperature
6/3-6/7	23	0.9	15	15	0	0	0	1	14	0	4	0
610-6/14	24	6.6	66	65	0	1	0	0	66	0	5	0
6/17-6/21	25	23.7	139	139	0	0	0	0	139	0	5	0
6/24-6/28	26	35.1	289	276	0	12	1	3	284	0	5	0
7/1-7/4	27	20.6	209	208	0	1	0	0	209	0	4	0
7/8-7/12	28	8.2	148	145	1[16]	2	0	1	146	0	0	0
7/15-7/19	29	3.1	67	67	0	0	0	0	67	0	0	0
7/22-7/25	30	1.2	28	28	0	0	0	0	28	0	0	1
7/29-8/1	31	0.6	20	20	0	0	0	1	19	4	0	1
Total			**981**	**963**	**1**	**16**	**1**	**6**	**972**	**4**	**23**	**2**

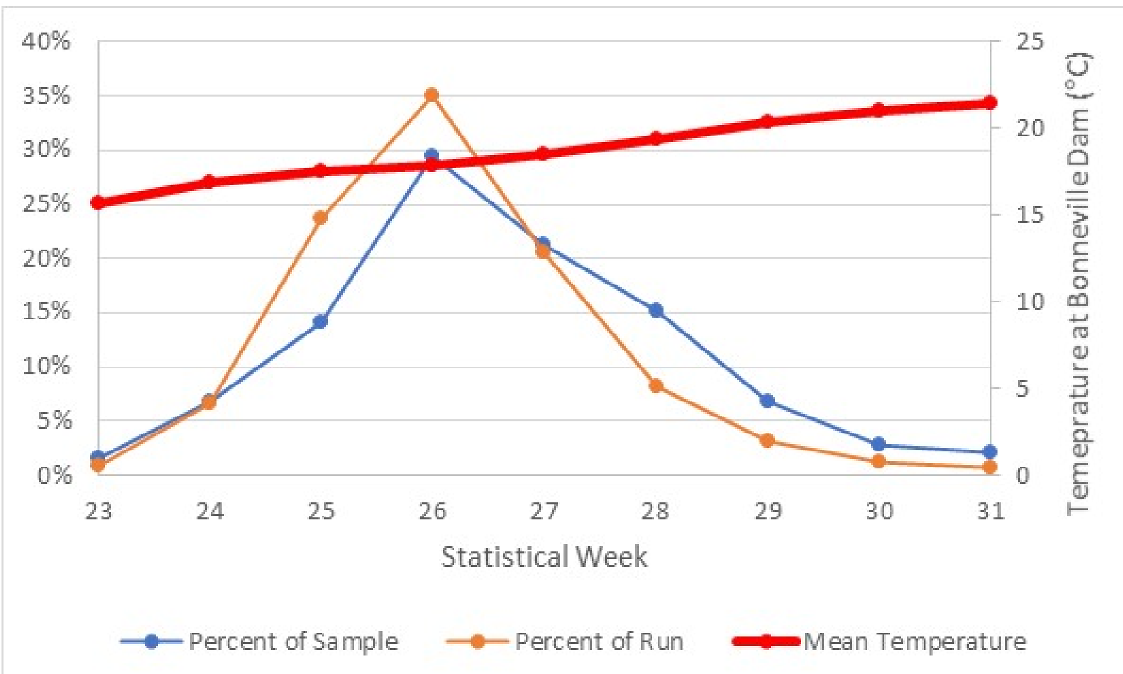

Figure 39. Weekly Sockeye Salmon and run as a percentage of total sample and run size at Bonneville Dam in 2019.

[15] Statistical weeks are sequentially numbered calendar-year weeks. Excepting the first and last week of most years, statistical weeks are seven days long beginning on Sunday and ending on Saturday. In 2019, for instance, Statistical Week 23 began on June 2 and ended on June 8.

[16] This Sockeye (3DD.003D364679) was tagged on July 9, dropped downstream in the Washington Shore ladder, and was recaptured on July 12. This second sampling event was omitted from further analysis.

The percentage of PIT tagged Sockeye Salmon missing detection at Bonneville Dam was 1.5% and ranged from 0.0% to 4.1% at upstream dams with higher rates estimated at in-stream PIT tag detection arrays (Table 48) for 2019. The dam with the highest percentage passing upstream undetected in 2019 was Rock Island Dam, although this was less than the 2006-2019 mean of 9.4% for this site. Rock Island Dam fishways have long had problems with electrical noise adversely affecting the ability of PIT tag antennas to detected PIT tags (Fryer et al. 2017).

Table 48. Percentage of Bonneville Dam PIT tagged Sockeye Salmon not detected at upstream dams and in-stream PIT tag arrays on their migration route for 2006-2019.[17].

	Percentage Not Detected by Dam and Year														
Dam/Array	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2006-2019 Mean**
Bonneville (BO1 & BO4)	0.2	2.1	0.4	0.6	0.7	0.5	1.8	0.4	0.7	1.6	2.8	0.2	1.1	1.5	1.0
The Dalles	--	--	--	--	--	--	--	1.6	0.3	0.6	0.4	2.1	0.9	0.5	0.9
John Day	--	--	--	--	--	--	--	--	--	--	--	--	2.8	3.3	3.1
McNary	3.1	6.5	10.1	5.0	3.8	1.6	12.1	2.1	3.8	1.1	2.4	5.2	2.9	2.9	4.5
Priest Rapids	0.0	0.8	0.3	0.3	0.6	0.2	0.4	0.0	0.2	0.4	0.3	0.0	0.1	0.0	0.3
Rock Island	1.3	6.8	6.9	2.6	6.2	4.4	5.4	4.4	41.5	10.2	2.9	5.9	28.3	4.1	9.4
Rocky Reach	12.3	0.7	0.2	0	0.5	0.7	1.4	0.0	0.3	0.0	0.0	0.7	0.2	0.0	1.2
Wells	--	--	--	--	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ice Harbor	--	--	0.0	20.0	0.0	--	0.0	--	12.5	0.0	0.0	0.0	0.0	0.0	3.3
Lower Monumental	--	--	--	--	--	--	--	--	--	0.0	0.0	0.0	0.0	0.0	0.0
Little Goose	--	--	--	--	--	--	--	--	--	0.0	0.0	0.0	0.0	0.0	0.0
Lower Granite	--	--	--	--	--	--	--	--	0.0	--	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	0.0
Zosel	--	--	--	--	--	98.6	83.0	87.3	0.9	0.0	1.6	74.5	57.5	0.0	44.8
LWE	--	--	--	--	--	--	--	--	48.0	17.9	54.7	49.6	68.4	33.3	45.3
UWE	--	--	--	--	--	--	--	--	52.7	24.6	9.7	9.3	9.9	3.2	18.2
OKL	--	--	--	--	--	--	--	--	68.9	13.8	59.4	47.4	50.1	66.7	51.1
OKC	--	--	--	--	--	--	--	--	--	--	16.9	--	7.7	5.3	10.0
Skaha	--	--	--	--	--	--	--	--	--	--	--	--	--	0.0	0.0

[17] No data indicates either that no antennas were installed at the site in question or that there were no detections upstream of the site.

Detection Numbers

The tracking of 972 Sockeye Salmon generated 39,394 weir detections, which were grouped into 8,456 site detections at 48 sites. Maps and table of sites found in Appendix B (Table B1 and Figures B1, B20-B23) 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 2019, at 47.4% of the run, was estimated to be Age 1.1, followed by Age 1.3 at 27.9% of the run, and Age 1.2 at 18.6% (Table 49). Among these age groups, the percentage of Age 1.1 Sockeye increased as the run progressed while Age 1.3 and 1.2 decreased; however, for none of these age groups did a linear regression find the increase significant (p=0.09, 0.08, and 0.19 respectively, Figure 40).

Table 49. Weekly and total age composition of Sockeye Salmon at Bonneville Dam as estimated from scale patterns in 2019. (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	1.2	2.1	1.3	3.1	2.2	2.3
23	0.9%	15	20.0%	33.3%	0.0%	46.7%	0.0%	0.0%	0.0%
24	6.6%	65	40.0%	21.5%	1.5%	24.6%	0.0%	12.3%	0.0%
25	23.7%	138	39.1%	20.3%	2.2%	32.6%	0.0%	5.8%	0.0%
26	35.1%	284	42.3%	19.7%	0.4%	31.7%	0.0%	5.3%	0.7%
27	20.6%	204	62.3%	13.7%	0.5%	22.5%	0.0%	1.0%	0.0%
28	8.2%	146	61.6%	17.8%	2.1%	15.1%	0.7%	2.1%	0.7%
29	3.1%	65	58.5%	16.9%	0.0%	16.9%	0.0%	7.7%	0.0%
30	1.2%	28	46.4%	21.4%	0.0%	32.1%	0.0%	0.0%	0.0%
31	0.6%	18	44.4%	16.7%	5.6%	27.8%	0.0%	5.6%	0.0%
Composite	**100.0**	**963**	**47.4%**	**18.6%**	**1.0%**	**27.9%**	**0.1%**	**4.7%**	**0.3%**

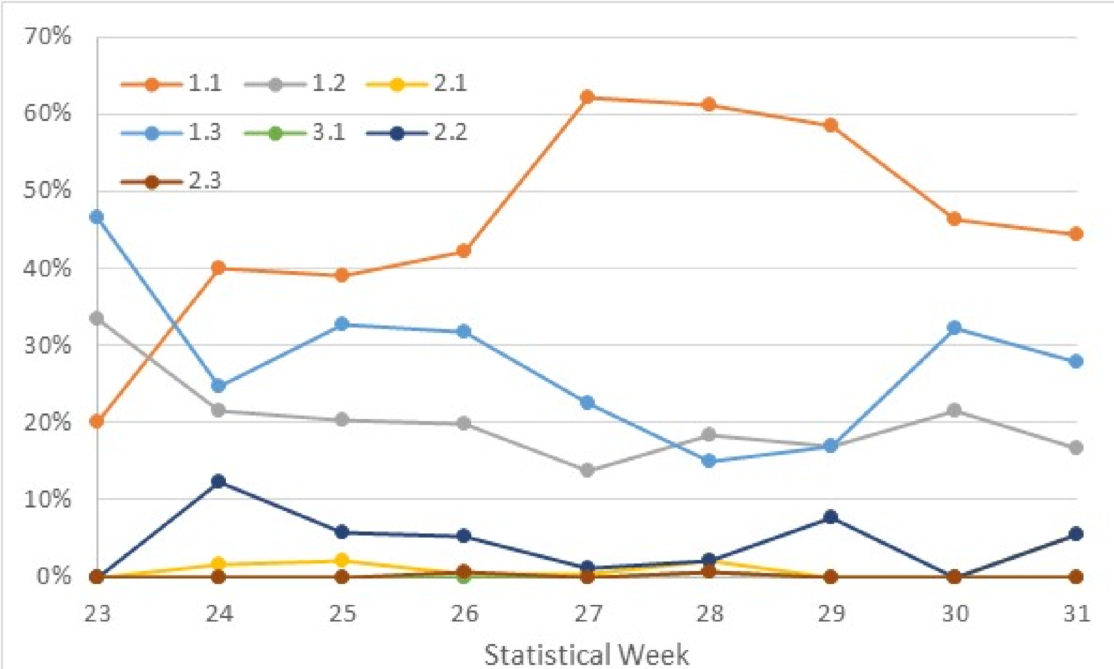

Figure 40. Weekly age composition estimates by Statistical Week for Sockeye Salmon sampled at Bonneville Dam in 2019.

Upstream Recoveries, Mortality, and Escapement

The percentage of Sockeye Salmon passing Bonneville Dam that were estimated to pass upstream dams (Figure 41) was higher in 2019 than the 2006-2019 mean to all dams except Tumwater Dam (Table 50)[18].

[18] Tumwater Dam is only passed by Wenatchee stock Sockeye Salmon so rate differences to Tumwater Dam (as well as Rocky Reach and Wells dams) also reflect annual variations in stock composition.

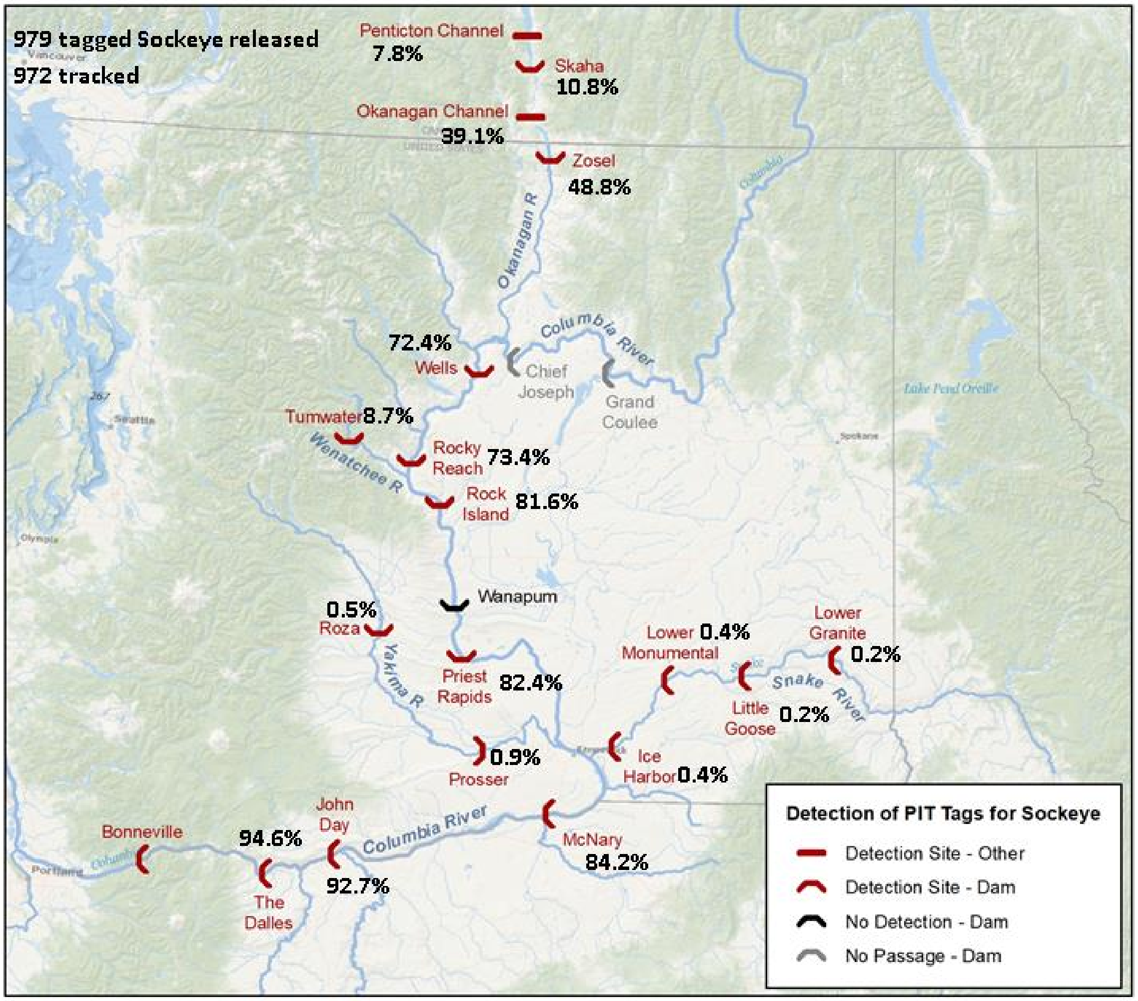

Figure 41. Map of the Columbia River Basin showing the number of fish PIT tagged at Bonneville Dam, and the percentage of the run estimated to pass upstream dams in 2019.

Table 50. Estimated survival of Sockeye Salmon PIT tagged at Bonneville Dam passing upstream dams 2006-2019. Included is the mean June 15-July 14 water temperature at Bonneville Dam.

			Percentage by Year and Mean of All Years												
Dam	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**Mean**
The Dalles	--	--	--	--	--	--	--	89.5	93.1	82.8	94.0	89.3	93.3	94.6	90.9
John Day	--	--	--	--	--	--	--	--	--	--	--	--	90.9	92.7	91.8
McNary	88.4	84.0	89.4	85.7	81.5	76.1	82.4	83.6	88.3	54.0	89.2	81.7	88.9	84.2	82.7
Priest Rapids	84.8	77.4	86.3	82.1	78.4	71.9	77.3	78.6	84.5	44.9	85.3	74.6	85.4	82.4	78.1
Rock Island	81.1	73.4	85.8	80.2	76.3	68.9	75.0	74.2	79.5	40.6	81.6	70.8	80.7	81.6	75.0
Rocky Reach	58.8	62.2	73.7	67.1	63.7	55.3	62.1	52.4	65.3	31.6	60.5	43.7	73.9	73.4	60.3
Wells	53.8	60.9	71.1	65.2	62.6	53.9	60.8	50.5	64.2	29.4	59.3	42.5	72.7	72.4	58.5
Tumwater	NA	NA	9.4	12.2	13.3	14.2	12.9	20.9	13.6	8.3	20.8	25.8	6.0	8.7	13.8
Bonneville Dam mean water temp 6/15-7/14	**18.4**	**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**	**18.0**

Mainstem Dam Recoveries, Mortality, and Escapement Estimates

Survival rates were also calculated using similar methods for returning adults from a group of juvenile Sockeye (project goal is 3000) captured and PIT tagged annually at the Rock Island Dam juvenile bypass since 2008[19] (Table 51). Both Wenatchee and Okanagan juvenile Sockeye Salmon pass this site, making it a mixed stock most similar to Sockeye tagged as adults at Bonneville Dam[20]. However, sample sizes of returning adults from the Rock Island tagging program tend to be small, with only 20 returns to Bonneville Dam in 2019 (Table 51). Those Sockeye tagged by this program which passed Bonneville Dam in 2019 had high survival rates; 100% to John Day Dam and a combined 80.0% 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 42[21]. This survival rate was greater for returning Rock Island-tagged juvenile salmon compared to Bonneville-tagged adults in 8 out of 13 years, however only in 2018 was this difference significant at $\alpha=0.05$ ($p=0.002$).

Upstream survival from Bonneville Dam to Rock Island Dam in 2019 was similar for Sockeye tagged at Bonneville Dam and for returning adults from juveniles tagged at Rock Island Dam (Figure 43). Upstream of Rock Island Dam, some differences are apparent for Rock Island-tagged Sockeye which had a higher percentage detected in the Wenatchee River (but with only n=5) and lower percentage in the Okanagan River than with Sockeye tagged as adults at Bonneville (Figure 43).

[19] Tagging of juvenile Sockeye Salmon at Rock Island Dam has occurred since 1992; however, returns from these fish were lower and there were fewer detection sites prior to 2008.

[20] Juvenile Sockeye are also tagged in the Okanagan and Wenatchee basins. However, these programs have a shorter data set in terms of years tagged with collection methods and tag numbers that have varied by year.

[21] Priest Rapids was chosen as it is the last dam with a high PIT tag detection rate passed by both Okanagan and Wenatchee Sockeye Salmon.

Table 51. Survival of Sockeye PIT tagged as smolts at Rock Island Dam, on their adult upstream migration from Bonneville Dam to upstream dams 2008-2019[22].

	Percentage by Year and Mean of All Years												
Dam	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**Mean**
# at Bonneville	38	33	130	125	121	66	155	128	35	16	32	20	74.9
# Tagged at Rock Is.	1910	2059	3528	2977	3231	2674	3131	1689	4109	2210	3332	2859	2809
The Dalles	No PIT tag detection at this site					87.9	92.9	85.9	82.9	87.5	100.0	100.0	91.0
John Day	No PIT tag detection at this Site										100.0	100.0	100.0
McNary	89.5	100	82.3	74.4	74.4	80.3	87.1	60.2	74.3	81.3	100.0	90.0	82.8
Priest Rapids	89.5	93.9	81.5	73.6	71.9	74.2	83.9	54.7	74.3	68.8	100.0	85.0	79.3
Rock Island	81.6	90.9	79.2	68.8	69.4	68.2	77.4	46.9	68.6	68.8	93.9	85.0	74.9
Rocky Reach	55.3	87.9	70.0	55.2	48.8	56.1	60.0	36.7	45.7	68.8	65.6	55.0	58.8
Wells	55.3	87.9	68.5	52.8	43.8	56.1	58.7	32.8	42.9	62.5	62.5	55.0	56.6
Tumwater	26.3	3.0	10.0	14.4	23.1	10.6	16.1	13.3	22.9	6.3	25.0	25.0	16.3

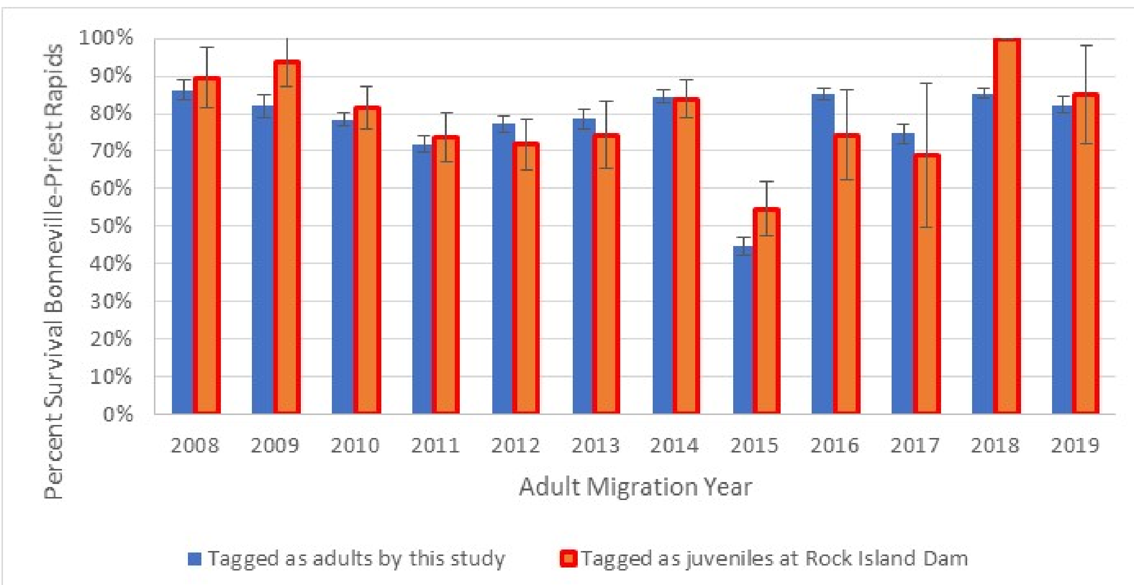

Figure 42. Annual survival rate with 90% CI from Bonneville Dam to Priest Rapids Dam for adult Sockeye Salmon tagged by this study at Bonneville Dam and for returning Sockeye Salmon tagged as juveniles at Rock Island Dam 2008-2019.

[22] Years prior to 2008 were not included due to low sample sizes for returning Sockeye tagged as juveniles at Rock Island Dam. From 2002-2007, the number of Sockeye PIT tagged at Rock Island Dam as juveniles detected returning to Bonneville ranged between one and eight fish annually. Year 2013 the first year for detection at The Dalles Dam, and 2018 the first year for John Day Dam.

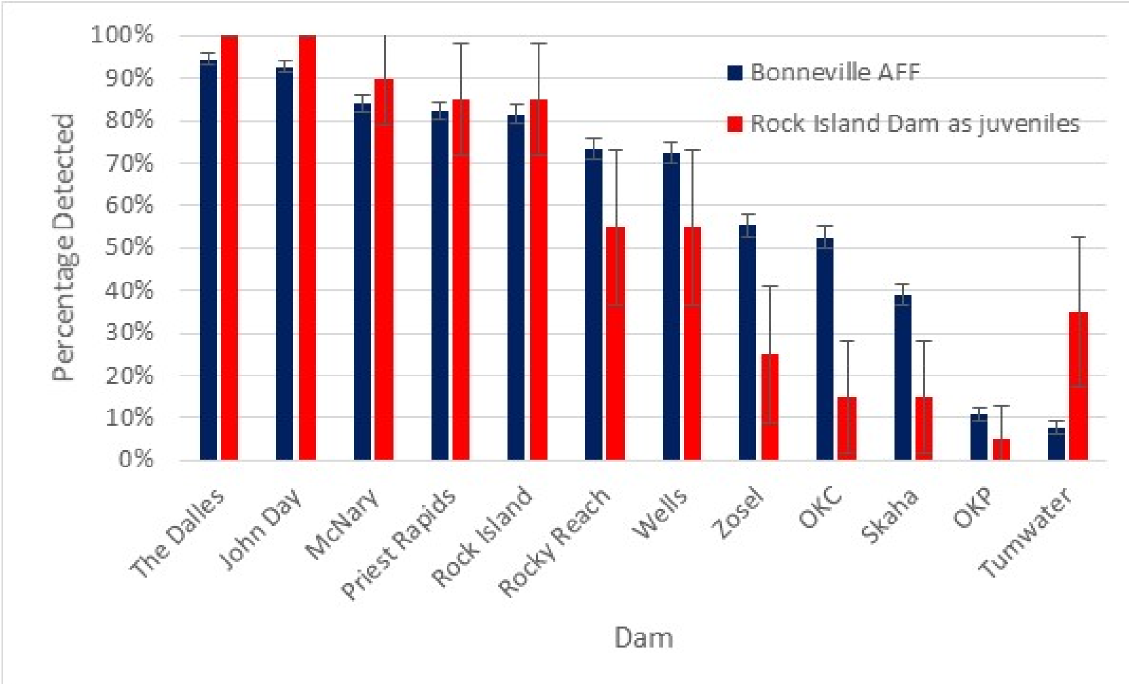

Figure 43. Estimated survival to upstream sites (with 90% CI) in 2019 for adults tagged at Bonneville Dam and for returning Sockeye tagged as juveniles at Rock Island Dam.

The estimated escapement based on upstream PIT tag detections of Bonneville-tagged Sockeye was greater than the number of Sockeye counted at The Dalles, John Day, McNary, and Priest Rapids dams, but less at Rock Island, Rocky Reach, Wells, and Tumwater dams (Table 52, Figure 44). The PIT tag estimates show a consistent decrease in Sockeye escapement estimates as the run progresses upstream which is to be expected as Sockeye drop out on the upstream migration due to fisheries and natural mortality with minor turnoff into the Deschutes and Snake rivers. However, the visual dam counts show an irregular pattern of increases and decreases as the Sockeye run progresses upstream. The Rock Island visual estimate of 58,562 was second only to Bonneville Dam (63,046), while the number of Sockeye counted at Priest Rapids Dam (45,231) immediately downstream of Rock Island Dam was less than at any other dam on the Columbia River. PIT tag estimates for Snake River and Yakima River dams were based on too few detections (one to seven) to provide meaningful comparisons with visual estimates.

Table 52. Percentage of PIT tagged Sockeye Salmon detected at upstream dams subsequent 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 2019.

Dam	Escapement Estimate Using Bonneville PIT Tagged Sockeye	Visual Dam Count	Difference Between Bonneville PIT Tag and Visual Estimates
Bonneville	--	63,046	--
The Dalles	59,618	50,687	17.6%
John Day	58,462	52,526	11.3%
McNary	53,106	51,561	2.9%
Priest Rapids	51,926	45,231	14.7%
Rock Island	51,472	58,562	-12.2%
Rocky Reach	46,271	50,464	-8.3%
Wells	45,651	49,862	-8.5%
Tumwater	5,485	8,875	-38.2%
Ice Harbor	240	320	-24.9%
L. Monumental	240	195	23.2%
Little Goose	114	84	35.9%
Lower Granite	114	81	40.9%
Prosser	587	110	433.4%
Roza	304	201	51.2%

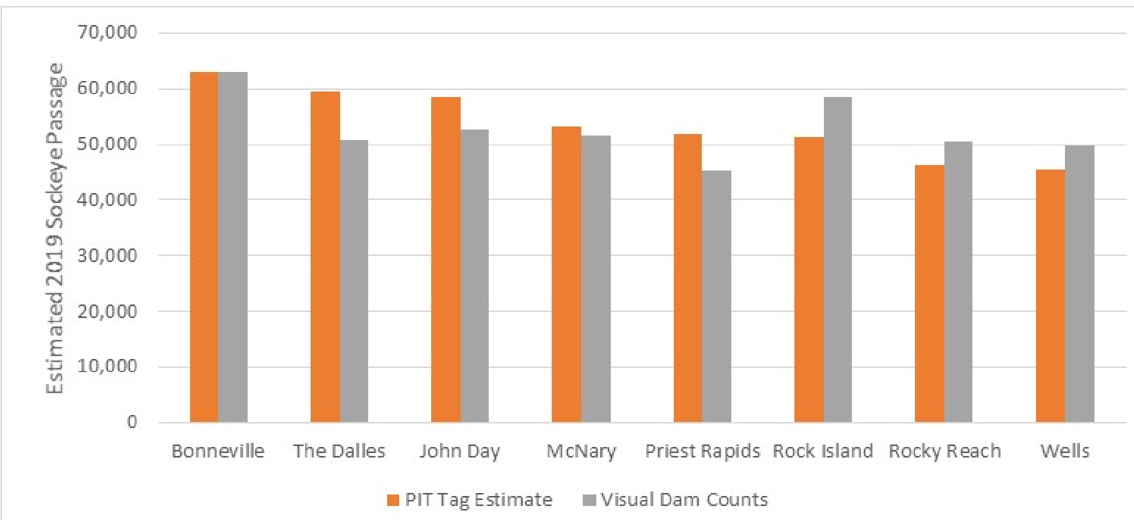

Figure 44. Estimated PIT tag and visual count estimates of escapement at Columbia River dams in 2019.

Sockeye Salmon tagged at Bonneville Dam show a significant decrease in survival to upstream dams over the period of the run in 2019 (Table 53, Figure 45). There was not a significant linear relationship to Priest Rapids Dam for Sockeye as juveniles in the Okanagan Basin (p=0.266), or as juveniles at Rock Island Dam (p=0.113).

Table 53. Sockeye Salmon survival through selected reaches by statistical week as estimated by PIT tag detections in 2019 and the p-value for a linear regression between weekly reach survival and statistical week. No p-values were estimated for returning Sockeye tagged as juveniles due to the low number of returning adults.

Statistical Week at Bonneville Dam	Survival from Bonneville for Sockeye Tagged as Adults at Bonneville Dam					Sockeye Tagged as Juveniles Survival from Bonneville-Priest Rapids		
	The Dalles	John Day	McNary	Priest Rapids	Rock Island	Wenatchee (n=1)	Okanagan (n=21)	Rock Island (n=20)
23	92.9%	92.9%	85.7%	85.7%	78.6%	--	--	100.0%
24	96.9%	93.8%	89.1%	85.9%	89.1%		100.0%	100.0%
25	97.1%	94.2%	86.9%	85.4%	84.7%		100.0%	71.4%
26	94.4%	93.3%	87.3%	85.2%	84.5%	100.0%	83.3%	100.0%
27	93.2%	93.2%	83.5%	82.0%	80.1%	--	100.0%	50.0%
28	93.7%	90.8%	77.5%	74.6%	74.6%	--	100.0%	--
29	91.0%	88.1%	71.6%	70.1%	70.1%	--	--	--
30	85.7%	67.9%	32.1%	32.1%	28.6%	--	--	--
31	77.8%	72.2%	27.8%	27.8%	27.8%	--	--	
Composite[23]	**94.6%**	**92.7%**	**84.2%**	**82.4%**	**81.6%**	**100.0%**	**95.2%**	**85.0%**
p-value	**0.010**	**0.010**	**0.004**	**0.003**	**0.007**	**--**	**0.266**	**0.113**

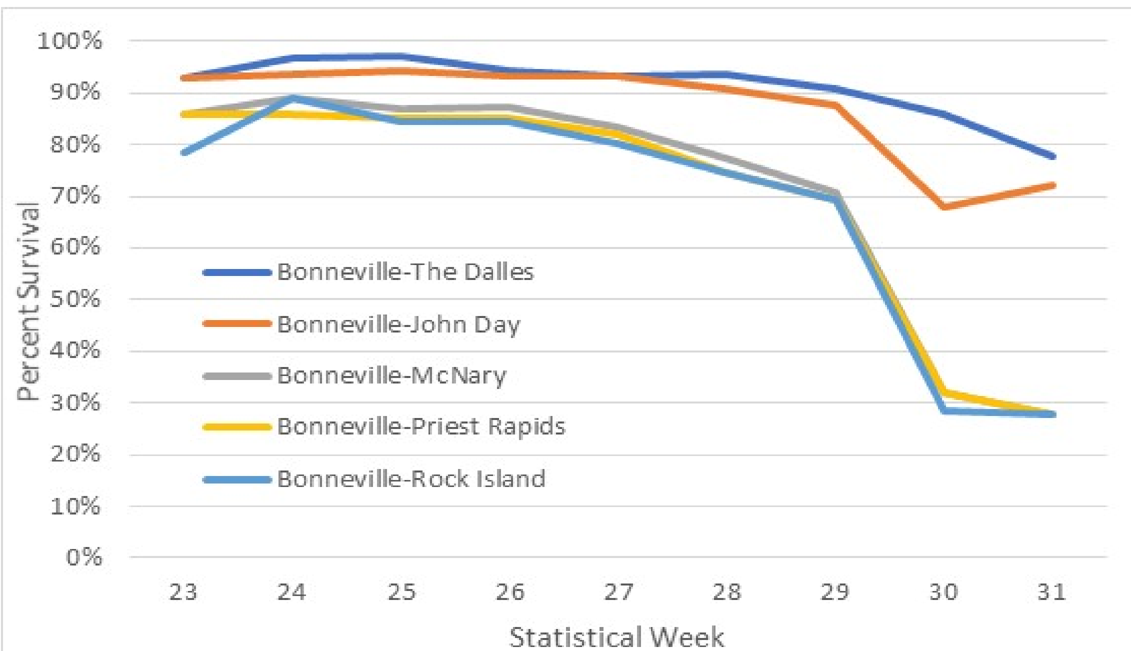

Figure 45. Survival of Sockeye Salmon PIT tagged at Bonneville Dam to The Dalles, McNary, Priest Rapids, and Rock Island dams by statistical week in 2019.

[23] Composite estimates for Bonneville Dam-are weighted by Statistical Week, juvenile estimates are unweighted.

Comparisons between survival estimates for Sockeye PIT tagged by this study at Bonneville Dam and returning adult Sockeye tagged as juveniles are of limited use due to the low returns in 2019 of adults tagged as juveniles (Table 54), particularly for the Wenatchee (n=1) and Snake (n=2).

The returning Rock Island juvenile-tagged Sockeye had high upstream survival, with 17 of the 20 (85%) passing Bonneville Dam also detected at Priest Rapids Dam. Returning Okanagan juvenile-tagged Sockeye had higher survival to all upstream dams than did Bonneville adult-tagged Sockeye from this study. Among the 2 returning Snake juvenile-tagged Sockeye, both were detected at Ice Harbor and 1 was last detected at the Redfish Lake Weir (RFL) immediately downstream of the spawning grounds. The single returning Wenatchee Sockeye Salmon detected at Bonneville was last detected on the spawning grounds for a conversion rate to the spawning grounds of 100%. Excluding that calculation, spawning ground conversion rates were highest for Bonneville adult-tagged Sockeye (46.9%), followed by returning Sockeye tagged as juveniles in the Okanagan Basin (38.1%). Sockeye tagged as juveniles at Rock Island Dam displayed the lowest conversion rates (30.0%, Table 54).

Table 54. 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 2019. Yellow shaded cells represent sites that are not on the migration route for the group tagged.

			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**	**Conversion Rate BON to PIT Arrays on Spawning Ground (%)[24]**
Okanagan	Juvenile	21	100.0	100.0	95.2	95.2	90.5	90.5	90.5	0.0	0.0	38.1
Wenatchee	Juvenile	1	100.0	100.0	100.0	100.0	100.0	0.0	0.0	100.0	0.0	100.0
Rock Island	Juvenile	20	100.0	100.0	90.0	85.0	85.0	55.0	55.0	25.0	0.0	30.0
Snake	Juvenile	2	100.0	100.0	100.0	0.0	0.0	0.0	0.0	0.0	100.0	50.0
Bonneville	Adult	1848	94.6	92.7	84.2	82.4	81.6	73.4	72.4	8.7	0.4	46.9

[24] Spawning grounds means detection at or above OKC in the Okanagan, LWE or WTL in Wenatchee, or RFL in the Snake Basin.

Migration Rates and Passage Time

Adult Sockeye Salmon travelled quickly upstream in 2019 with median migration rates between mainstem dams ranging between 31.8 and 58.7 km/day for adults tagged at Bonneville and 30.0 to 59.8 km/day for tagged juveniles returning as adults (Table 55). Maximum migration rates occurred between John Day and McNary. Migration rates from Bonneville to Wells Dam were remarkably consistent: 39.8 km/day for Bonneville-tagged and 39.6 km/day for adult returning Sockeye tagged as juveniles.

Unlike previous years, Sockeye Salmon tagged at Bonneville Dam later in the migration did not travel significantly faster than those tagged earlier in the migration, with the exception of Bonneville-Wells and Bonneville-Rock Island (α=0.05, Table 56). Median travel times between the Okanagan and Wenatchee stocks differed by 0.5 days or less for all dam pairs listed that are in the migration corridor for both stocks. Three Wenatchee Sockeye which strayed to Wells Dam had longer migration times to Rocky Reach and Wells Dam than did Okanagan Sockeye on their usual migration route.

Table 55. Median Sockeye Salmon migration rates and travel time between dams as estimated by PIT tag detections in 2019.

		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	1.64	43.5	1.31	54.6
The Dalles-John Day	39	0.88	49.2	0.98	44.2
John Day-McNary	63	2	58.7	1.96	59.8
McNary-Priest Rapids	167	4.14	40.7	4.35	38.7
Priest Rapids-Rock Island	89	2.77	32.5	2.47	36.4
Rock Island-Rocky Reach	33	1.01	31.8	1.08	30.0
Rocky Reach-Wells	65	1.79	38.1	3.08	32.6
Rock Island-Tumwater	73	9.23	7.5	9.56	7.2
Bonneville-John Day	113	2.65	43.3	2.5	46.0
Bonneville-McNary	231	4.70	49.3	4.54	51.1
Bonneville-Priest Rapids	329	8.91	44.9	8.91	44.9
Bonneville-Rock Island	487	11.88	41.3	11.85	41.4
Bonneville-Tumwater	560	22.46	24.9	21.36	26.2
Bonneville-Wells	585	14.83	39.8	14.92	39.6

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 2019 was 4.6 minutes compared to 6.7 minutes for Sockeye tagged as juveniles (Table 57). The weighted mean percentage of Sockeye taking more than 12 hours to pass a dam was also greater for Sockeye tagged as juveniles (4.0%) compared to those tagged as adults at Bonneville (2.3%, Table 57).

Table 56. 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 2019.

Statistical Week at Bonneville Dam	BON to TDA	BON to JDA	BON to MCN	BON to PRA	BON to RIA	BON to TUF	BON to RRF	BON to WEA	BON to ZSL	WEL to ZSL	RIA to TUF
23	1.9	3.1	4.9	9.6	16.3	--	15.8	20.0	23.4	6.4	15.0
24	1.8	2.9	4.8	9.4	13.9	27.1	15.0	17.9	22.5	5.7	10.0
25	1.7	2.7	4.7	9.6	13.0	22.7	13.9	17.0	30.6	12.0	9.8
26	1.7	2.7	4.7	8.9	12.7	22.8	12.9	15.9	25.5	10.2	9.2
27	1.5	2.6	4.6	8.3	12.0	21.3	12.0	14.9	20.4	7.2	9.4
28	1.6	2.5	4.6	8.8	11.0	19.2	12.5	13.8	51.6	35.8	7.5
29	1.6	2.5	4.8	9.0	11.2	29.0	12.9	14.6	43.7	28.0	12.4
30	1.9	2.8	4.8	9.1	12.0	26.6	13.3	14.3	26.9	11.5	14.6
31	1.7	3.0	5.6	10.1	12.1	--	14.8	15.3	31.6	18.6	15.0
p-value	0.49	0.47	0.24	0.97	0.01	0.81	0.27	0.01	0.25	0.13	0.47
Stock											
Okanagan	1.6	2.6	4.7	8.9	11.8	N/A	12.9	14.8	25.3	10.1	N/A
Wenatchee	1.6	2.7	4.7	9.1	12.3	22.5	14.2	23.5	N/A	N/A	9.2

Table 57. 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 2019.

	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)	**12241**	**4.6**	**2.3**	**671**	**6.7**	**4.0**

Migration Rates and Passage Time

Okanagan Sockeye Salmon tagged at Bonneville Dam passed PIT tag antennas at night (2000-0400 hours) at a higher rate than Wenatchee Sockeye

Salmon at 7 out of 8 dams where Sockeye from both stocks were detected (Table 58), with the sole exception being at The Dalles Dam. Adults tagged at Bonneville passed dams at night at a higher rate than Sockeye tagged both as juveniles at 5 out of 10 dams.

Table 58. Estimated Sockeye Salmon night passage (2000-0400) by stock at Columbia River mainstem dams, Zosel, and Tumwater dams in 2019.

Dam	Adults Tagged at Bonneville Dam			Sockeye Tagged as Juveniles
	All Adults	Okanagan	Wenatchee	
Bonneville	1.7%	1.8%	1.0%	7.1%
The Dalles	8.2%	7.3%	14.3%	6.8%
John Day	5.7%	6.0%	3.2%	4.7%
McNary	9.2%	10.1%	3.4%	2.4%
Priest Rapids	4.8%	5.1%	1.2%	2.6%
Rock Island	6.3%	6.6%	3.9%	8.3%
Rocky Reach	5.4%	5.5%	0.0%	0.0%
Wells	13.8%	13.9%	0.0%	10.0%
Tumwater	7.0%	NA	7.0%	0.0%
Zosel	53.2%	53.2%	NA	78.9%

Fallback

Fallback rates at Columbia River dams for adults tagged at Bonneville Dam in 2019 ranged from 0.2% at Bonneville Dam to 5.5% at John Day Dam (Table 59). Numbers of returning adults tagged as juveniles in 2019 were low with only 44 detected passing Bonneville Dam. Combined-stock fallback rates for returning juveniles ranged from 0% at McNary Dam to 50.0% at Lower Granite (n=2) and 15.9% at John Day Dam.

Of the 152 Sockeye tagged as adults by this project in 2019 which fell back over at least one dam, 16 fell back over two dams while 4 fell back over three dams (Table 60). Among Sockeye tagged as juveniles, the mean number of fallback events per Sockeye Salmon ranged from 0 for Sockeye tagged in the Wenatchee Basin (n=1) to 1.50 for the Snake Basin (n=2) compared to 0.21 for adult-tagged Sockeye in our Bonneville study (Table 60).

Table 59. Estimated minimum fallback rates for Sockeye Salmon at mainstem dams in 2019[25]. NA indicates Sockeye were not detected at a dam outside the range of the particular stock. The sample size (n) is the number of tagged Sockeye detected moving upstream past Bonneville Dam.

Dam	Tagged as Adult at Bonneville AFF (n=941)	Sockeye Tagged as Juveniles by Tagging Location				
		Okanagan Basin (n=21)	Rock Island Dam (n=20)	Snake Basin (n=2)	Wenatchee Basin (n=1)	Total (n=44)
Bonneville	0.2%	4.8%	0.0%	0.0%	0.0%	2.3%
The Dalles	3.1%	4.8%	5.0%	0.0%	0.0%	4.8%
John Day	5.5%	14.3%	10.0%	100.0%	0.0%	15.9%
McNary	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%
Priest Rapids	3.5%	0.0%	11.8%	NA	0.0%	5.3%
Rock Island	0.7%	0.0%	0.0%	NA	0.0%	0.0%
Rocky Reach	3.1%	0.0%	9.1%	NA	NA	3.3%
Wells	3.1%	5.3%	9.1%	NA	NA	0.0%
Tumwater	1.4%	NA	0.0%	NA	0.0%	0.0%
Zosel	3.6%	16.7%	0.0%	NA	NA	10.5%
Skaha	2.2%	0.0%	0.0%	NA	NA	0.0%
Ice Harbor	0.0%	NA	NA	0.0%	NA	0.0%
Lower Monumental	0.0%	NA	NA	0.0%	NA	0.0%
Little Goose	0.0%	NA	NA	0.0%	NA	0.0%
Lower Granite	100.0%	NA	NA	50.0%	NA	50.0%

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

Table 60. Number of fallback events by tag group for returning Sockeye tagged as juveniles and Sockeye included in our Bonneville adult tagging study in 2019.

Fallback Events	Sockeye Tagged as Adults at Bonneville Dam	Sockeye Tagged as Juveniles by Tagging Location			
		Okanagan Basin	Rock Island Dam	Snake Basin	Wenatchee Basin
1	132	5	5	1	0
2	16	0	1	1	0
3	4	1	0	0	0
≥4	0	0	0	0	0
Number of Sockeye falling back at least once	**152**	**6**	**6**	**2**	**0**
% of Sockeye with at least one fallback event	**16.2%**	**28.6%**	**30.0%**	**100.0%**	**0.0%**
Total fallback events	**176**	**8**	**7**	**3**	**0**
Number of Sockeye detected at or upstream of Bonneville Dam	**941**	**21**	**20**	**2**	**1**
Fallbacks events per Sockeye	**0.19**	**0.38**	**0.40**	**1.50**	**0.00**

Comparisons with WFRS Sockeye Salmon

A total of 1266 Sockeye Salmon were detected passing through the WFRS during 2019 compared to 977 tagged at the AFF (Table 61, Figure 46). The weekly distribution of the WFRS sample was similar to that of the run at Bonneville Dam as estimated by visual fish counts. The AFF sample under-sampled the middle of the run relative to visual fish counts and the WFRS. This was due to a limit on how many Sockeye it is possible to sample given restrictions in trap operations while also sampling Chinook and Steelhead. The AFF sample peaked at 288 Sockeye sampled in Week 26.

Table 61. Mean length with standard deviation of Sockeye Salmon by Statistical Week for Sockeye sampled at the AFF and by the WFRS in 2019.

	AFF			WFRS				% of Visual Count
Statistical Week	Mean	Standard Deviation	N	Mean	Standard Deviation	N with Length	Total N	
22				35.8	1.9	2	2	0.1%
23	48.5	7.2	15	44.1	9.1	6	6	0.9%
24	45.5	7.6	66	44.8	9.6	66	66	6.6%
25	46.4	7.2	137	44.1	8.4	255	258	23.7%
26	45.8	7.6	288	44.7	8.6	486	491	35.1%
27	43.2	7.3	209	42.3	8.1	242	247	20.6%
28	42.3	6.7	147	40.9	7.2	134	135	8.2%
29	43.4	7.2	67	41.6	8.0	41	41	3.1%
30	45.2	6.9	28	39.9	5.3	10	10	1.2%
31	44.3	8.3	20	51.0	7.9	2	2	0.4%
32	AFF Closed due to temperatures at or above 22.2C, no sampling							0.2%
33[26]	NA	NA	0	NA	NA	0	0	0.1%
34	NA	NA	0	48.5	6.3	7	7	0.0%
35	NA	NA	0	49.8	NA	1	1	0.0%
Total	**44.6**	**7.5**	**977**	**43.6**	**8.5**	**1252**	**1266**	

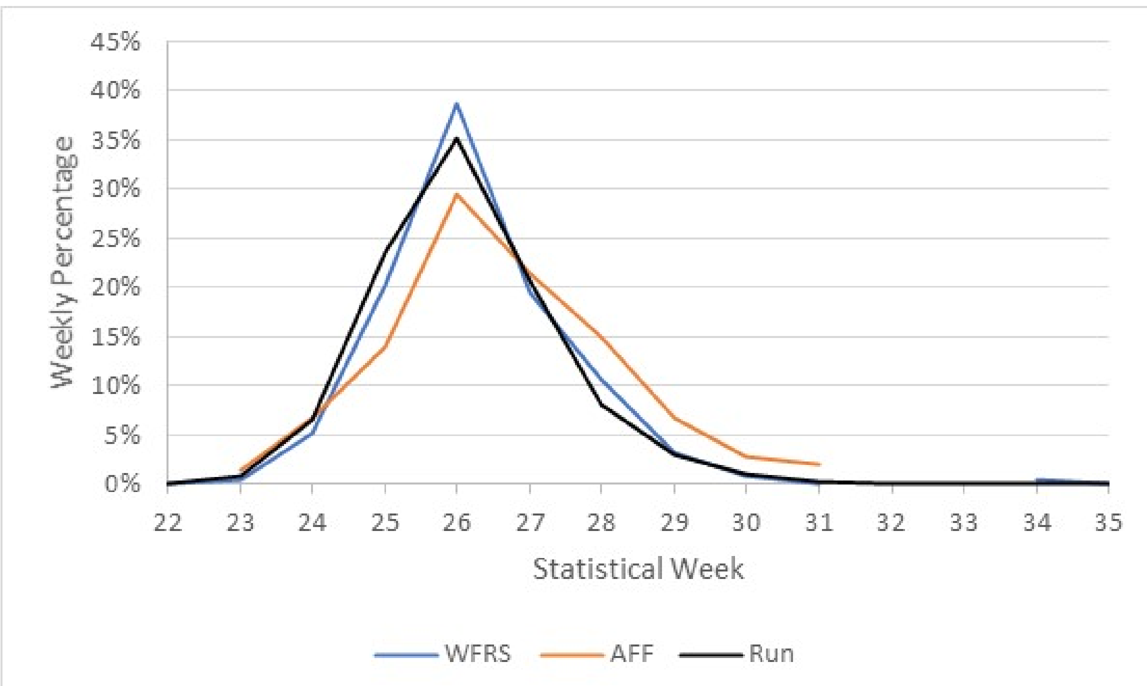

Figure 46. Comparison of the weekly percentage of the visual fish count at Bonneville Dam and the percentage of Sockeye sampled in the Adult Fish Facility and by the WFRS in 2019.

[26] AFF only operated two days due to temperatures at or above 22.2C in Week 33. No Sockeye were sampled at the AFF or by WFRS in Week 33, however, Sockeye were sampled in weeks 34-35 by the WFRS.

The weekly mean fork length for WFRS- and AFF-sampled Sockeye Salmon differed by 1.8 cm or less between weeks 24 and 29 and diverged in earlier and later weeks when sample sizes were smaller (Figure 47, Table 61). The distribution of fish size was bimodal due to the age structure of returns, which exhibited a high proportion of age 1.1 jacks averaging 34-38 cm in length in 2019, compared to 50-55 cm for 4- and 5-year old Sockeye (Figure 48). The overall mean length for AFF-sampled Sockeye was 44.6 cm compared to 43.6 cm for WFRS. A Mann Whitney test found a significant difference ($Z=4.8$, $p<0.01$) between lengths of AFF- and WFRS-sampled Sockeye. A Kolmogorov-Smirnov test also found a significant difference between cumulative length distribution of AFF- and WFRS-sampled Sockeye ($\chi^2=65.2$, $p<0.01$, Figure 49).

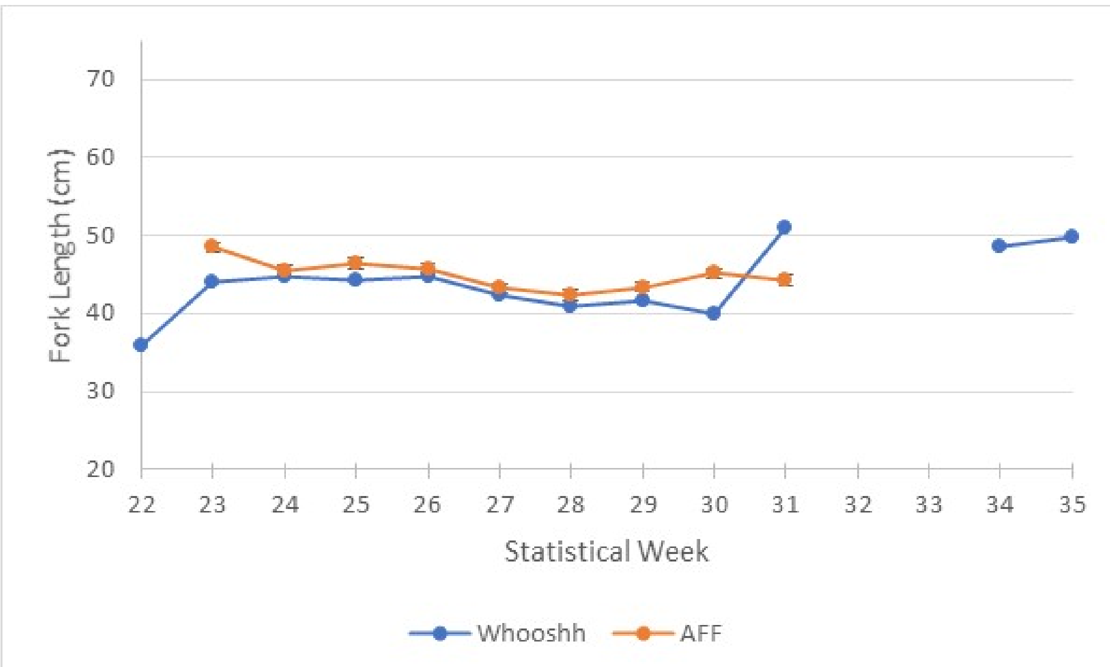

Figure 47. Weekly mean length for Sockeye Salmon sampled by the AFF and WFRS at Bonneville Dam in 2019.

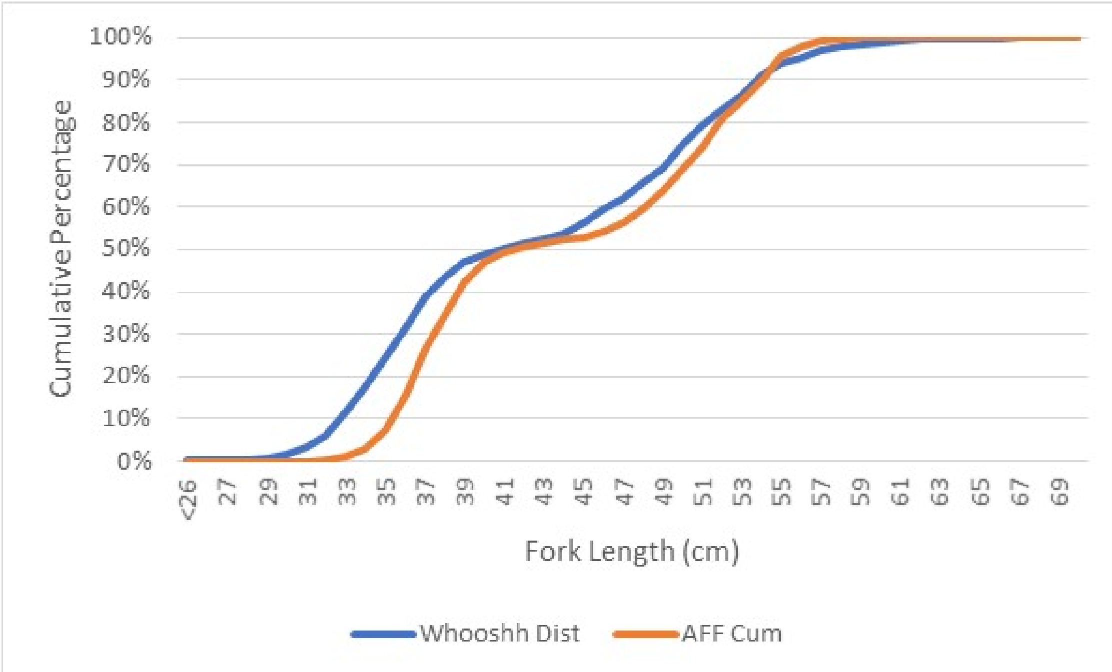

Figure 48. Length frequency distribution for Sockeye Salmon measured at Bonneville Dam by the AFF and WFRS in 2019.

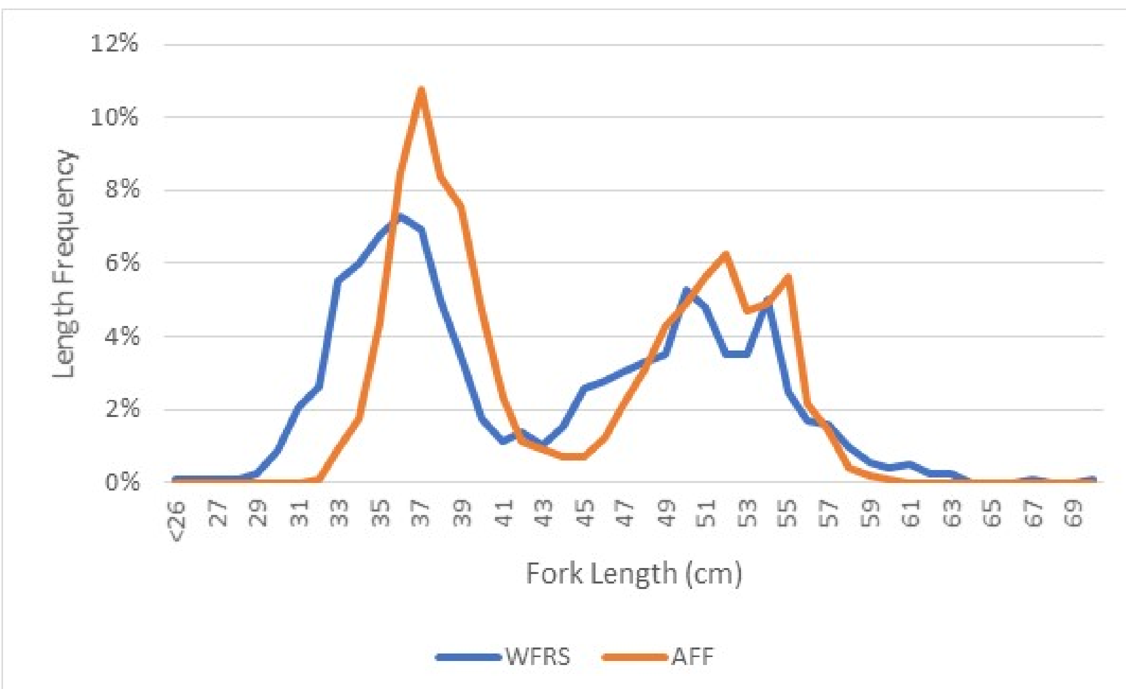

Figure 49. Cumulative length frequency distribution at Bonneville Dam for Sockeye Salmon measured by the AFF and WFRS in 2019.

Straying

The Sockeye stray rate estimated by this project is 1.4% (Table 62). Among the eight Sockeye strays in Table 62, three “strayed” to sites that were 3 km or less from its migration route (to ENL, LMR, OMK). Of the remaining four strays, two Wenatchee stock Sockeye Salmon were last detected 384 and 386 km up the Snake Basin at LRU and SW1 respectively, one Yakima Sockeye was last detected 81 km up the Wenatchee River (UWE), and one Okanagan Sockeye was last detected at rkm 45 in the Methow River (MRC).

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.

In the 2018 report, it was noted that one Sockeye Salmon last detected in the Snake Basin was classified by GSI as being of Wenatchee origin, but by PBT as of Yakima origin. It is possible that the 2019 strays into the Snake Basin were of Yakima origin even though GSI classified these fish as being of Okanagan stock.

Table 62. Showing final-PIT-fate categories by stock as determined using Genetics Stock Identification for fish tagged in 2019. 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.

	Bonneville Dam					The Dalles		Deschutes		John Day Dam			McNary				Snake		Yakima			
Genetic Stock Identification Classification	Corner Collector	OR Shore Ladder	Bradford Island Ladder	Lower WA Shore Ladder	Upper WA Shore Ladder	East Shore Ladder	West Shore Ladder	Deschutes River Mouth	Deschutes-Shears Falls	Juvenile Bypass	Oregon Shore	WA Shore	Oregon Shore	WA Shore	Juvenile Bypass	Lower Monumental Dam	Upper Lochsa River	Lower Selway River	Prosser	Roza	Priest Rapids Dam	Rock Island Dam
Columbia RKM	234	234	234	234	234	308	308	328	328	347	347	347	470	470	470	522	522	522	539	539	639	730
Stock/Site	**BCC**	**BO1**	**BO2**	**BO3**	**BO4**	**TD1**	**TD2**	**DRM**	**DSF**	**JDJ**	**JO1**	**JO2**	**MC1**	**MC2**	**MCJ**	**LMA**	**LRU**	**SW1**	**PRO**	**ROZ**	**PRA**	**RIA**
Deschutes (LBC)					4	1	1	2	1				1									
Osoyoos	1	2	1	11	39	7	5	2		1	25	6	34	8	1	1			2	1	10	4
Wenatchee				1	12	1	2				4	1	4	3			1	1	1	3	1	5
Yakima													1									
Grand Total	1	2	1	12	56	9	8	4	1	1	30	8	40	11	1	1	1	1	3	4	11	9

	Wenatchee						Rocky Reach			Wells		Methow		Okanagan								Total						
Genetic Stock Identification Classification	Lower Wenatchee	Icicle Creek	Tumwaer Dam	Upper Wenatchee	Little Wenatchee	White River	Ladders	Bypass	Lower Entiat River	Wells Hatchery	Wells Ladders	Lower Methow River	Methow River-Carlton	Lower Okanagan River	Omak River	Zosel Dam	Okanagan River-liver	McIntyre Dam	Skaha Dam	Shingle Creek	Okanagan River-Penticton	Total	Neutral	On Target	Putative Stray	Putative Overshoot	Likely Cle Elum Program	%Putative Stray/On-Target
Columbia RKM	754	754	754	754	754	754	763	763	778	829	830	843	843	858	858	858	858	858	858	858	858							
Stock/Site	**LWE**	**ICL**	**TUF**	**UWE**	**LWN**	**WTL**	**RRF**	**RRJ**	**ENL**	**WEH**	**WEA**	**LMR**	**MRC**	**OKL**	**OMK**	**ZSL**	**OKC**	**OKM**	**SKA**	**OKS**	**OKP**							
Deschutes (LBC)																						10	8	3	0	1	0	0.0%
Osoyoos							8	3	1	2	157	1	1	33	1	114	260	4	13	20	56	835	325	500	5	0	3	1.0%
Wenatchee	1	1	4	4	4	57					2											113	34	71	2	2	4	2.7%
Yakima				1																		2	1	0	1	0	0	100.0%
Grand Total	1	1	4	5	4	58	8	3	1	2	160	1	1	33	1	116	261	4	14	20	56	969	368	574	8	3	7	1.4%

DISCUSSION

This project tracked a total of 3,483 Chinook, 820 steelhead, and 972 Sockeye (Table 63) 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 2019 marked the 14^{h} year of Sockeye Salmon PIT tagging, the 13th year of Chinook Salmon PIT tagging and the 11th year of steelhead PIT tagging at Bonneville Dam. Over this time, the number of PIT tag detection sites in the Columbia Basin has continually increased, increasing our understanding about the movement of tagged salmonids. The percentage of Sockeye Salmon run tracked using PIT tags in 2019 was the most since this Accords project started in 2009, although the number tagged was below the mean annual sample size (Table 63). The percentage of number of Chinook tracked was second to only 2018 in the years since 2009. While the percentage of the steelhead tracked was the highest since this project began, the number was the lowest due to the low run size. The steelhead sample size was also reduced by temperature restricting sampling hours and picket lead operations during weeks 30 through 37, including no sampling in Week 32 which was the week of peak steelhead passage comprising 11.6% of the run.

Table 63. Total number of Chinook and Sockeye salmon and steelhead PIT tags tracked by year (includes recaptures of previously PIT tagged fish) 2009-2019.

	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%
2019	3,483	820	972	5,275	0.79%	1.06%	1.54%	0.92%
Mean	**3,246**	**1,428**	**1,177**	**5,851**	**0.48%**	**0.62%**	**0.59%**	**0.52%**
Total Sample	**35,938**	**15,104**	**12,740**	**63,788**				

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 are lagged to take into account migration times from Bonneville Dam to the upstream 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 2019 the percentage of Chinook Salmon at Bonneville Dam, which ultimately passed Ice Harbor Dam, peaked at 45.9% of the run for Statistical Week 19, which started May 5 (Figure 11). By Week 23 (which started June 2), the percentage of Chinook tagged at Bonneville that were detected at Priest Rapids Dam exceeded that at Ice Harbor, and by Week 24 (June 9), the percentage that ultimately passed Ice Harbor Dam had declined to under 10% of the run. The percentage detected above Priest Rapids Dam reached 83.2% for those Chinook tagged in Week 28 and remained above 57% through Week 31 when sampling ceased until Week 32, when the percentage of tagged Chinook above Priest Rapids Dam was only 8.3% (Figure 11).

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.

Something this project has noted continually over the years is the poor detection rate at Rock Island Dam relative to at other mainstem Columbia and Snake river dams (Tables 5 and 48) due to electrical noise adversely affecting the ability of antennas to detect PIT tags (Fryer et al. 2017). Biomark, which maintains the site for dam owner Chelan Public Utility District has made improvements over the years which has generally resulted in better detection. On July 9, 2019, Biomark made further improvements and the difference was striking. Among Sockeye Salmon detected at Priest Rapids Dam on or before July 5, 10.2% missed detection at Rock Island Dam compared to 0.2% passing on or after July 6. For Chinook salmon, among those passing Priest Rapids Dam on or before July 5, 2019, 12.8% missed detection at Rock Island Dam compared to 0.9% passing after July 6. Sockeye and Chinook take, on average, between three and four days to pass between Priest Rapids and Rock Island dams (Tables 9 and 55) which corresponds to the dates in which the improvement in detection rates were noted.

Tules, which are mature, very dark colored fall Chinook primarily bound for lower Columbia River hatcheries and tributaries, have not normally been included in our sample due to the fact that scales are very difficult to remove for aging and aging is difficult, if not impossible due to the extreme resorption of the outer part of the scales. However, in 2019, 150 Tules were sampled between weeks 34 and 40. Of these, 103 were last detected at Bonneville Dam (93 of which were at the upper antennas prior to entering Bonneville Pool), 44 were last detected at Spring Creek Hatchery, with 2 at HRM (Hood River Mouth), and 1 at The Dalles Dam.

GSI classification for Tules sampled in 2019 was 142 Spring Creek, 5 as lower Columbia Falls (which includes Lewis River Tule), and 2 Upper Columbia Summer Fall. These latter two fish, tagged in weeks 39 and 40, were likely extremely mature Chinook which had a Tule coloration. Both were last detected leaving the Bonneville Dam Washington Shore fish ladder (BO4) and were not detected further upstream. Of the 44 Tules last detected at Spring Creek Hatchery, 42 classified as Spring Creek Hatchery stock with one classifying as the aforementioned lower Columbia River fall Chinook group.

The WFRS sampling offered intriguing comparisons with the data obtained from AFF sampling. The mean length of Chinook sampled at the AFF (70.7 cm) was not significantly different from that estimated by WFRS (69.6 cm), nor was the difference between cumulative length distributions for the two samples. No significant difference in length was found for steelhead using the same tests. For Sockeye, the mean length of the WFRS and AFF sample did show a significant difference as did the cumulative length frequency distribution with the WFRS sampling smaller Sockeye. Unfortunately, we were unable to do any validation of the WFRS system by putting known-length fish through the system (e.g. by first measuring the fish in the AFF before sending them through the WFRS sampling process).

Although there were significant differences within weeks in the percentage of steelhead adipose clipped between the WFRS and AFF samples, the difference over the entire run was not significant. For Chinook, the difference in the percentage adipose clipped between AFF and WFRS samples was significant both for most weeks (though in some weeks the AFF had the larger percentage and in other weeks the WFRS sampled had the larger percentage) as well as for the overall sample. Very few Sockeye Salmon are adipose clipped, thus no comparison was made between the WFRS and AFF samples.

The WFRS comparisons with AFF data were interesting and it was hoped that Whooshh project would continue. The WFRS approval and installation happened immediately prior to the start of the 2019 sampling making pre-season testing and coordination difficult. We hoped to work more closely with Whooshh staff in 2020; however, Whooshh staff were required to remove the WFRS in January 2020 .

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). 2020. Adult fish counts online at www.fpc.org.

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. Hyatt, M. Stockwell and J. Miller. 2016. Limiting Factors of the Abundance of Okanogan and Wenatchee Sockeye Salmon in 2014. 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, 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.

Fryer, J.K., D. Kelsey, H. Wright, S. Folks, R. Bussanich, K.D. Hyatt, D. Selbie, and M.M. Stockwell. 2021. Studies into Factors Limiting the Abundance of Okanogan and Wenatchee Sockeye Salmon in 2019. Columbia River Inter-Tribal Fish Commission Technical Report 20-01 for U.S. Dept. of Energy Bonneville Power Administration Project 2008-503-00. 217p.

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 2019 Fish Passage Plan for Bonneville Adult Fish Facility. Full document can be found at http://pweb.crohms.org/tmt/documents/fpp/2019/final/FPP19_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℉, 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. <u>Winter Trapping Protocols (December 1 – March 14).</u>

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 341 active sites, 180 sites detected the fish tagged in 2019.

Site Code	Site Name	Site Description
158	Fifteenmile Ck at Eighteenmile Ck	The site is located in Fifteenmile Ck at Eighteenmile Ck confluence at rkm 4.
ACB	Asotin Cr. at Cloverland Brdg.	The site is located near Cloverland Bridge (RKM 4.5) on Asotin Creek, a tributary of the Snake 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.
ANT	Antoine Creek Instream Array	The site is located on Antoine Creek, 0.48 km upstream from the confluence with the Okanogan River. Antoine Creek enters the Okanogan River at RKM 98.5, approximately 6 km upstream from the city of Tonasket, WA.
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.
BRC	Bear Valley Adult Video Weir	Interrogation system on the existing Bear Valley Creek Chinook adult monitoring weir.
BSC	Big Sheep Creek ISA at KM 6	The site is located in Big Sheep Creek at rkm 6.
CAL	Carson NFH Adult Return Ladder	Hatchery adult spring Chinook return ladder from the Wind River to Carson NFH.
CCU	Catherine Creek at Union	This is an in-stream interrogation system located near the town of Union on Catherine Creek, at rkm 25.
CCW	Catherine Creek Ladder/Weir	Instream detection array located in the adult return fish ladder at the Catherine Creek weir.
CFJ	Clark Flat Acc. Pond	This site monitors releases from Clark Flat acclimation pond, which is located at rkm 270 on the Yakima River.
CHL	Lower Chiwawa River	Chiwawa River rkm 1, located between the Chiwawa smolt trap and the Chiwawa Acclimation Ponds.
CHU	Upper Chiwawa River	Chiwawa River rkm 12, located above the Forest Road 62 bridge and below Alder Creek.
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.
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.
DBH	Buck Hollow Ck Deschutes Trib	The site is located in Buck Hollow Creek, a trib of the Deschutes River, approximately 1/4 mile from the mouth.
DRM	Deschutes River mouth	Mouth of the Deschutes River in the west channel at Moody Island (rkm 0.46).
DRP	Dryden Acc. Pond	The site monitors releases from the Dryden Acclimation Pond outfall pipe which extends into the Wenatchee
DSF	Deschutes Sherars Falls	Site consists of two monitored weirs in the main fishway and two monitored weirs in the high flow fishway; one
DWL	Dworshak NFH adult trap	Located at the terminus of the Dworshak National Hatchery adult fish ladder in the North Fork Clearwater River.
EBO	East Bank Hatchery Outfall	Located in the East Bank Hatchery outfall channel.
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
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.
EPR	East Fork Potlatch Array	The site is located in the East Fork Potlatch River about 3 rkm from the confluence with the Potlatch River.
ESS	EFSF Salmon River at Parks Cr	East Fk South Fk Salmon River (rkm 21) near Parks Creek.
EVL	Eagle Valley Ranch - Lower	This site is located at the downstream end of a restoration zone at Eagle Valley Ranch on the Lemhi River, near rkm 16.
EVU	Eagle Valley Ranch - Upper	This site is located at the upstream end of a restoration zone at Eagle Valley Ranch on the Lemhi River, near rkm 20.
GLC	Gold Creek, Methow River	The site is located at rkm 0.18 of Gold Creek in the Methow River Basin.
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.
GRS	Lower Granite Dam Spillway	This site is located 173 rkm on the Snake River at the spillway 1 for the Lower Granite Dam.

Table B1. Continued.

Site Code	Site Name	Site Description
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 meets the Columbia 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.
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).
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.
LAP	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.
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.
LLC	Loup Loup Creek Instream Array	This site is located 0.42 km from the confluence with the Okanogan River on Loup Loup Creek which enters the Okanogan River at RKM 27.2, within the city of Malott, WA.
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.
LMT	Lower Mainstem Teanaway River	The site is located near the mouth of the Teanaway River, under the HWY 10 bridge.
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.
MCD	Mill Creek Diversion Project	The site is located in the fish bypass and passage facilities at the (Bennington) Diversion Dam and the first Division Works in the Mill Creek Diversion Project in the Walla Walla Basin, near rkm 19.
MCJ	McNary Dam Juvenile	McNary Dam Juvenile Fish Bypass/Transportation Facility.
MR1	Minam River at River KM 0.5	The site is located in the Minam River approximately 0.5 km upstream of the confluence of the Minam and Wallowa Rivers (lat 45.619623°, lon -117.726570°).
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
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.

Table B1. Continued.

Site Code	Site Name	Site Description
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.
NMC	Ninemile Creek Instream Array	The site is located on Ninemile Creek, 0.78 km upstream from the confluence with Lake Osoyoos. north of the town of Oroville, WA.
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.
OKM	McIntyre Dam	The site montiors each side of spill bay 1 at McIntyre Dam. The dam is located downstream of Vaseux Lake and upstream of Okanagan Lake, in Canada.
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.
OKS	Shingle Creek	The site is on Shingle Creek, a tributary to the Okanagan River in Canada, and is located immediately adjacent to the Okanagan Nation Alliance (ONA) Fish Hatchery.
OKV	Vaseux Creek, BC, Canada	The site is located 200m upriver from mouth of Vaseux Creek a trib of Okanogan River.
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.
PCA	Panther Creek Array	The array is on Panther Creek approximately 5 rkm from the confluence with Salmon River.
PES	Peshastin Creek	The site is at rkm 3 located on Peshastin Creek below the bridge at Smithson’s property.
PEU	Upper Peshastin Creek	This site is located at rkm 17 on Peshastin Creek.
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.
RBF	Round Butte Dam Fish Xfer Facility	The site is located at Round Butte Dam Fish Transfer Facility on the Deschutes River.
RFL	Redfish Lake Creek	The site is located on Redfish Lake Creek approximately one half mile upstream from the confluence with the Salmon River.
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.
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 KM upstream from the confluence.
SAT	Lower Satus Creek	This site is located approximately 1700 meters upstream from the confluence of the Yakima River on Satus Creek.
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.
SJ1	SF John Day (Mid)	This site is an in-stream array located on the South Fork John Day River south of Dayville on the PW Schneider Wildlife Management Area (ODFW) near rkm 10.
SJ2	SF John Day (Murderer's)	This site is located on the South Fork John Day River south of Dayville at the confluence of Murderers Creek.
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.
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.
SWK	Lower Swauk Creek	The site is located at rkm 1.8, it was originally installed at rkm 0.5 and was operational at this location from August of 2011-February of 2016.
SWT	Sweetwater Cr. Near Its Mouth	The site is an in-stream array approximately 0.1 kilometers upstream from the mouth of Sweetwater Creek.

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.
TAN	Taneum Creek Instream	The site is located on Taneum Creek. From 2010 through 2016, it was located near the mouth of the creek. In 2017, the site was relocated approximately 3 km upstream near the Taneum Canal Company diversion dam and fish screen.
TC4	Trout Creek at 43 Road Bridge	The site is at the bridge where Forest Road 43 crosses Trout Creek at rkm 11.0, a tributary of the Wind River, WA.
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.
TON	Tonasket Creek	Tonasket Creek enters the Okanogan River in Lake Osoyoos at RKM 129.4, in the town of Oroville, WA. The site is located approximately 0.4 RKM upstream from the confluence of Lake Osoyoos.
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.
TPJ	Tucannon at Panjab Creek	The site is an instream array at rkm 74.5 on the Tucannon River near the mouth of Panjab Creek.
TRC	Trout Creek, Wind River	The site is located at rkm 2 upstream from the confluence with Wind River (WA) above Hemlock Lake on Trout 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.
UMW	Umatilla R Recycled Water Fac	The site is an instream detection array in the Umatilla River adjacent to the City of Hermiston's Recycled Water Plant.
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.
WHS	Wildhorse Spring Creek	The site is located approximately 0.1 rkm upstream from the confluence with the Okanogan River.
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.
WWB	Walla Walla River Barge	Site is a floating barge anchored in place at roughly 5 rkm upstream from the mouth.
YPP	Yellow Pine Pit Lake	Site is located roughly 300ft downstream from the outlet of Yellow Pine Pit Lake in the Stibnite mine on the East Fork of the Southfork Salmon River.
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 2019 and later labeled as kelts or repeat spawners when they began migrating downstream (after March 31st) and upstream in spring, summer, or fall of 2020, presumably to and from the ocean.

Tag Year	Tag Number	First Detection After Tagging 2020 in All Seasons	Fall 2019	Winter 2019/20	Spring 2020	Summer 2020	Fall 2020	Comments
2019	3DD.003D3648A9	Upper Wind - September 18th			Upper Wind - April 22nd Bonneville Dam Corner Collector - April 25th			
2019	3DD.003D3648BD	Lower Hood - July 28th	Lower Granite - October 3rd		Penawawa Creek (Snake) - March 14th Bonneville Dam Corner Collector - April 16th			Steelhead trapped on March 14th in Penawawa Creek and labeled a kelt.
2019	3DD.003D3647B3	The Dalles East Ladder - July 24th	October 2nd		Upper Salmon - March 20th Valley Creek (Salmon) - April 13th to 18th Bonneville Dam Corner Collector - May 15th			
2019	3DD.003D36449E	The Dalles East Ladder - October 11th	Lower Walla Walla - October 18th		Mill Cr (Walla Walla) - March 20th to March 27th Bonneville Dam Corner Collector - April 28th			Steelhead captured at Bonneville on July 19th, 2019, where it was between July and October is unknown.
2019	3DD.003D364A1C	The Dalles East Ladder - October 18th	Three Miles Falls Dam (Umatilla) - October 24th		Three Miles Falls Dam - April 30th Bonneville Dam Corner Collector - May 6th			Steelhead captured at Bonneville on August 1st, 2019, where it was between August and October is unknown.
2019	3DD.003D36477D	The Dalles North Ladder - July 14th			Lower Minam - April 26th Lower Minam - May 19th Lower Granite Spillway - May 31st	Bonneville Dam Corner Collector - June 7th		Steelhead quickly entered the Snake River detected at Lower Granite Dam on July 24th.
2019	3DD.003D364663	The Dalles East Ladder - July 14th	McNary - November 8th		Bonneville Dam Corner Collector - May 19th			
2019	3DD.003D36449C	The Dalles North Ladder - July 20th		McNary - December 27th	Bonneville Dam Corner Collector - May 19rd			Unclear where steelhead was for several months between The Dalles and McNary detections.
2019	3DD.003D3645DD	The Dalles East Ladder - July 15th				Bonneville Dam Corner Collector - July 8th		Steelhead detected in July 2019 at Lower Granite Dam.
2019	3DD.003D36476E	The Dalles East Ladder - July 17th			Lower Granite Spillway - May 30th	Bonneville Dam Corner Collector - June 7th		Steelhead quickly entered the Snake River detected at Lower Granite Dam on July 27th.
2019	3DD.003D364A32	The Dalles East Ladder - August 29th	Lower Umatilla - September 20th		Bonneville Dam Corner Collector - May 8th			
2019	3DD.003D364AA0	The Dalles East Ladder - September 23rd	Three Miles Falls Dam - September 15th		Bonneville Dam Corner Collector - April 25th			
2019	3DD.003D36500E	The Dalles East Ladder - October 17th	Lower Granite - November 27th		Lower Clearwater - March 11th	Bonneville Dam Corner Collector - June 16th		
2019	3DD.003D36506E	The Dalles East Ladder - October 14th	McNary - October 18th	Prosser Dam (Yakima) - January 26th	Bonneville Dam Corner Collector - April 27th			
2019	3DD.003D364C02	The Dalles East Ladder - October 15th	McNary - October 22nd		Bonneville Dam Corner Collector - May 9th			
2019	3DD.003D364BA8	The Dalles East Ladder - September 15th	Lower Okanagan - October 1st		Zosel Dam (Okanagan) - March 29th Tonasket Creek (Okanagan) - April 18th to 30th Rocky Reach Juvenile Bypass - May 13th Bonneville Dam Corner Collector - May 20th			
2019	3DD.003D3645D8	The Dalles East Ladder - August 31st			Warm Springs - March 25th Bonneville Dam Corner Collector - May 18th			
2019	3DD.003D36505C	The Dalles East Ladder - October 13th	Lower Granite - October 22nd		Lower Clearwater - March 4th Lower Clearwater - April 22nd Lower Granite Spillway - April 26th Bonneville Dam Corner Collector - May 8th			
2019	3DD.003D364AA5	The Dalles North Ladder - September 22nd	Lower Granite -October 1st		Upper Salmon - March 18th Bonneville Dam Corner Collector - May 6th			
2019	3DD.003D364AA8	The Dalles North Ladder - August 23rd	John Day - October 17th		John Day Juvenile Bypass - April 28th Bonneville Dam Corner Collector - April 30th			
2019	3DD.003D364BD0	The Dalles East Ladder - September 9th	Three Miles Falls Dam (Umatilla) - September 19th		Upper John Day - March 22nd to 29th Bonneville Dam Corner Collector - May 11th			
2019	3DD.003D364BDC	The Dalles East Ladder - September 27th	Lower Granite - October 8th	Lapwai Creek (Clearwater) - February 10th	Sweetwater Creek (Clearwater) - March 4th to 6th Lapwai Creek (Clearwater) - April 12th Lower Granite Spillway - April 21st Bonneville Dam Corner Collector - May 6th			
2019	3DD.003D365145	The Dalles East Ladder - October 9th	Ice Harbor - October 23rd	Lower Monumental - February 13th	Middle Tucannon - April 10th Bonneville Dam Corner Collector - April 27th			
2019	3DD.003D364BB5	The Dalles East Ladder - September 9th	Lower Methow - November 2nd	Lower Methow - February 28th	Middle Methow - March 7th Lower Chewuch (Methow) - March 30th Upper Chewuch (Methow) - April 11th to 22nd Lower Chewuch (Methow) - March 30th Bonneville Dam Corner Collector - May 11th			
2019	3DD.003D364532	The Dalles East Ladder - July 5th		Upper Grande Ronde - February 26th	Bonneville Juvenile Bypass - May 24th			
2019	3DD.003D364D44	The Dalles East Ladder - September 20th	John Day - September 22nd	Lower John Day - December 26th	Bonneville Juvenile Bypass - April 27th			
2019	3DD.003D365069	The Dalles East Ladder - October 19th			Mill Creek (Columbia) - April 18th The Dalles - April 29th Bonneville Juvenile Bypass - May 5th			
2019	3DD.003D364B69	The Dalles East Ladder - September 16th	McNary - September 22nd	Threemile Dam (Umatilla) - February 1st	Threemile Dam (Umatilla) - May 14th John Day Juvenile Bypass - May 17th Bonneville Bradford Is. Ladder - May 19th			
2019	3DD.003D364E53	The Dalles East Ladder - September 30th	Lower Monumental - November 29th	Little Goose - December 4th	Bonneville WA Ladder - May 16th			Steelhead may have spawned in early spring and then entered the ocean for a short period before heading back upriver.
2019	3DD.003D36449F	The Dalles East Ladder - September 28th	Three Mile Falls Dam (Umatilla) - October 21st		Three Mile Falls Dam (Umatilla) - March 20th John Day Juvenile Bypass - April 3rd			Steelhead captured at Bonneville on July 17th, 2019. Unclear where steelhead was for several months between Bonneville and The Dalles detections.
2019	3DD.003D3649E6	The Dalles East Ladder - July 21st			Joseph Creek (Grande Ronde) - March 6th Joseph Creek (Grande Ronde) - April 30th Lower Granite Spillway - May 12th John Day Juvenile Bypass - May 18th			
2019	3DD.003D3644AE	The Dalles East Ladder - July 22nd	McNary - October 4th	John Day - January 27th	John Day Juvenile Bypass - May 27th			
2019	3DD.003D364A23	The Dalles East Ladder - August 5th	McNary - September 27th				Bonneville - September 2nd McNary - September 10th	Steelhead may have spawned in spring and then entered the ocean for a short period before heading back upriver.
2019	3DD.003D364D45	The Dalles East Ladder - September 20th	Lower Granite - September 28th		Lapwai Creek (Clearwater) - March 31st Sweetwater Creek (Clearwater) - April 6th to 18th Lapwai Creek (Clearwater) - April 18th McNary Juvenile Bypass - May 7th			

Table B2. Continued.

Tag Year	Tag Number	First Detection After Tagging 2020 in All Seasons	Fall 2019	Winter 2019/20	Spring 2020	Summer 2020	Fall 2020	Comments
2019	3DD.003D364D3A	The Dalles East Ladder - September 20th	John Day - October 26th		McNary - April 5th Lower Granite - April 17th Lower Imnaha - April 27th Big Sheep Creek (Imnaha) - May 2nd Lower Imnaha - May 24th Lower Granite Spillway - May 17th Lower Monumental Juvenile Bypass - May 30th			
2019	3DD.003D3648DE	The Dalles East Ladder - August 1st	Lower Granite - September 2nd		Lower Monumental Juvenile Bypass - May 1st			
2019	3DD.003D364C05	The Dalles North Ladder - September 15th	Lower Monumental - September 26th	Lower Tucannon - January 18th Middle Tucannon - January 28th to February 28th	Lower Tucannon - March 2nd	Bonneville - August 27th	Lower Monumental - November 19th	Steelhead spawned in spring and then may have entered the ocean for a short period before heading back upriver.
2019	3DD.003D3648D8	The Dalles North Ladder - August 3rd	Lower Granite - October 6th		Lower Granite Spillway - April 30th Ice Harbor - May 8th			
2019	3DD.003D3644CF	The Dalles East Ladder - September 22nd	Lower Granite - October 8th		Little Goose Juvenile Bypass - April 9th			
2019	3DD.003D364C1C	The Dalles East Ladder - September 13th	Lower Granite - September 14th		Lower Granite Spillway - April 4th Little Goose Juvenile Bypass - April 8th			
2019	3DD.003D364B6E	The Dalles East Ladder - September 29th	Lower Granite - October 12th		Joseph Creek (Grande Ronde) - March 18th Joseph Creek (Grande Ronde) - April 19th Little Goose Juvenile Bypass - April 29th			
2019	3DD.003D36523E	The Dalles East Ladder - October 20th	Lower Granite - November 23rd		Lower Granite Juvenile Bypass - April 12th Little Goose Juvenile Bypass - April 17th			
2019	3DD.003D364937	The Dalles East Ladder - September 26th	Lower Granite - October 10th		Joseph Creek (Grande Ronde) - April 6th Joseph Creek (Grande Ronde) - May 10th Little Goose Juvenile Bypass - May 20th			
2019	3DD.003D36485A	The Dalles North Ladder - July 3rd		Upper Grande Ronde - January 15th	Lower Granite Juvenile Bypass - May 11th			
2019	3DD.003D36464E	The Dalles East Ladder - July 12th		Upper Grande Ronde - January 28th	Lower Granite Spillway - May 1st			
2019	3DD.003D36512B	The Dalles North Ladder - October 12th	Lower Granite - November 27th	Lower Granite- December 4th	Lower Granite Spillway - April 13th			
2019	3DD.003D364D32	The Dalles East Ladder - September 30th	Lower Granite - October 25th		Lower Granite Spillway - April 3rd			
2019	3DD.003D36514B	The Dalles East Ladder - October 7th	Lower Granite - October 26th		Lower Granite Spillway - May 12th			
2019	3DD.003D3648FD	The Dalles East Ladder - September 8th			Lower Granite Spillway - April 10th			
2019	3DD.003D364B3C	The Dalles East Ladder - August 1st	Lower Granite - October 1st		Lower Granite Spillway - April 30th			
2019	3DD.007776D14E	The Dalles East Ladder - October 1st	Lower Granite - October 18th		Lower Granite Spillway - April 14th			
2019	3DD.003D364F9A	The Dalles East Ladder - September 30th	Lower Granite - October 20th		Lower Granite Spillway - April 3rd			
2019	3DD.003D364AB9	The Dalles East Ladder - August 23rd	Lower Granite - September 18th		Lower Granite Spillway - April 13th			
2019	3DD.003D364ADA	The Dalles East Ladder - September 2nd	Lower Granite - September 29th		Lower Granite Spillway - May 4th			
2019	3DD.003D3648FA	The Dalles East Ladder - September 8th	Lower Granite - November 20th	Lower SF Clearwater - January 30th	Lower SF Clearwater - April 4th Lower Granite Spillway - April 10th			
2019	3DD.003D365083	The Dalles East Ladder - October 14th	Lower Granite - October 26th		Lower SF Clearwater - April 15th Lower Granite Spillway - April 25th			
2019	3DD.003D364E41	The Dalles East Ladder - September 22nd	Lower Granite - October 5th		Lower Granite Spillway - April 21st			
2019	3DD.003D365059	The Dalles East Ladder - October 13th	Lower Granite - October 26th		Lower Granite Spillway - May 4th			
2019	3DD.003D364D7D	The Dalles East Ladder - September 20th	Lower Granite - November 27th		Lower Lolo Creek (Clearwater) - April 16th Upper Lolo Creek (Clearwater) - April 18th	Lower Granite Spillway - June 3rd		
2019	3DD.003D364FC1	The Dalles East Ladder - September 30th	Lower Granite - October 16th		Lower Lochsa (Salmon) - March 11th Upper Lochsa (Salmon) - March 19th	Lower Granite Spillway - June 12th		
2019	3DD.003D365107	The Dalles East Ladder - October 6th	Lower Granite - October 25th	Lower SF Clearwater - February 28th	Lower SF Clearwater - April 20th Lower Granite Spillway - April 7th			
2019	3DD.003D3650A2	The Dalles East Ladder - October 13th	Lower Granite - October 28th		Lower SF Clearwater - March 13th Lower Granite Spillway - April 7th			
2019	3DD.003D3650A4	The Dalles East Ladder - October 17th	Lower Granite - November 8th		Lower SF Clearwater - March 29th	Lower Granite Spillway - June 11th		
2019	3DD.003D364D0E	The Dalles East Ladder - September 18th	Lower Granite - September 27th		Krassel Creek (Salmon) - April 26th	Lower Granite Spillway - June 11th		
2019	3DD.003D365044	The Dalles East Ladder - October 13th	Lower Granite - October 30th		Upper Salmon - April 23rd Lower Granite Spillway - April 30th			
2019	3DD.003D364B74	The Dalles East Ladder - August 23rd	Lower Granite - October 21st		Joseph Creek (Grande Ronde) - April 22nd Lower Granite Spillway - April 27th			
2019	3DD.003D364AA3	The Dalles East Ladder - September 11th	Lower Granite - September 23rd		Middle Imnaha - April 9th Big Sheep Creek (Imnaha) - April 22nd Lower Granite Spillway - May 19th			
2019	3DD.003D364BD7	The Dalles North Ladder - August 22nd	Lower Granite - September 27th	Wenaha (Grande Ronde) - January 31st	Lower Granite Spillway - April 15th			
2019	3DD.003D364905	The Dalles East Ladder - September 29th	Lower Methow - October 22nd		Antione Creek (Methow) - April 10th to 30th Rocky Reach Juvenile Bypass - May 21st			
2019	3DD.003D364643	The Dalles East Ladder - July 11th	Wells - November 4th	Wells Juvenile Bypass - February 16th	Wells Hatchery Return Channel - April 16th to 24th Rocky Reach Juvenile Bypass - May 2nd			Steelhead was most likely spawning in small tribs near the Return Channel.
2019	3DD.003D364A20	The Dalles East Ladder - September 24th	Middle Methow - October 16th		Chewuch (Methow) - March 29tt to April 26th Rocky Reach Juvenile Bypass - May 19th			
2019	3DD.0077C0F39B	Lower Trout Creek (Wind) - October 21st	Middle Trout Creek (Wind) - November 24th	Middle Trout Creek (Wind) - February 27th	Middle Trout Creek (Wind) - March 1st to May 31st	Middle Trout Creek (Wind) - June 23rd Lower Trout Creek (Wind) - June 24th		
2019	3DD.003D3644CA			Lower Trout Creek (Wind) - February 28th	Middle Trout Creek (Wind) - March 10th to April 23rd Lower Trout Creek (Wind) - May 13th			Steelhead captured and tagged at Bonneville on July 18th, 2019.
2019	3DD.003D364545				Lower Trout Creek (Wind) - April 20th Lower Trout Creek (Wind) - April 22nd			Steelhead captured and tagged at Bonneville on July 3rd, 2019.
2019	3DD.003D364BC7	The Dalles North Ladder - August 23rd	Sherars Falls (Deschutes) - November 15th		Lower Warm Springs (Deschutes) - March 11th Lower Warm Springs (Deschutes) - April 27th			
2019	3DD.003D364B36	The Dalles East Ladder - September 14th	John Day - September 15th		Lower SF John Day - March 18th Middle SF John Day - March 23rd Lower SF John Day - April 3rd			
2019	3DD.003D364499	The Dalles East Ladder - July 22nd	John Day - September 29th		Lower SF John Day - March 20th Middle SF John Day - May 12th Lower SF John Day - May 12th			

Table B2. Continued.

Tag Year	Tag Number	First Detection After Tagging 2020 in All Seasons	Fall 2019	Winter 2019/20	Spring 2020	Summer 2020	Fall 2020	Comments
2019	3DD.003D364F3F	The Dalles North Ladder - September 27th	McNary - November 10th	Threemile Dam (Umatilla) - February 1st	Threemile Dam (Umatilla) - May 11th			
2019	3DD.003D3648D2	The Dalles North Ladder - October 20th	Prosser Dam (Yakima) - October 31st	Sunnyside Dam (Yakima) - February 28th	Roza Dam (Yakima) - April 22nd Swauk Creek (Yakima) - April 25th Swauk Creek (Yakima) - May 9th			Steelhead captured at Bonneville on July 30th, 2019. Unclear where steelhead was for several months between Bonneville and The Dalles detections.
2019	3DD.003D364A5B	The Dalles East Ladder - August 8th	Prosser Dam (Yakima) - October 13th	Roza Dam (Yakima) - February 27th	Lower Teanaway (Yakima) - March 20th Lower Teanaway (Yakima) - April 15th			
2019	3DD.003D364C01	The Dalles East Ladder - September 7th	Lower Naches River (Yakima) - October 4th			Bonneville - August 12th	Prosser Dam (Yakima) - Septemeber 14th	Steelhead may have spawned in spring and then entered the ocean for a short period before heading back upriver.
2019	3DD.003D3644A8	The Dalles North Ladder - July 19th	Prosser Dam (Yakima) - October 13th	Lower Toppenish (Yakima) - January 28th Middle Toppenish (Yakima) - February 9th	Middle Toppenish (Yakima) - April 7th Middle Toppenish (Yakima) - April 26th Lower Toppenish (Yakima) - April 29th			
2019	3DD.003D364BE3	The Dalles East Ladder - August 23rd	Lower Wenatchee - October 7th		Lower Peshastin (Wenatchee) - April 11th Upper Peshastin (Wenatchee) - April 27th Upper Peshastin (Wenatchee) - May 12th			
2019	3DD.0077C169B5	The Dalles East Ladder - June 24th	Tumwater Dam (Wenatchee) - October 27th		Lower Chiwawa (Wenatchee) - March 29th Lower Chiwawa (Wenatchee) - May 7th			
2019	3DD.003D3649F4	The Dalles East Ladder - September 25th	Rocky Reach - October 11th		Rocky Reach - April 11th Wells - April 15th Gold Creek (Methow) - May 16th	Gold Creek (Methow) - June 7th		
2019	3DD.003D364FAF	The Dalles North Ladder - September 29th	Wells - October 16th		Salmon Creek (Okanagan) - April 22nd Salmon Creek (Okanagan) - May 8th			
2019	3DD.003D364A74	The Dalles East Ladder - August 2nd			Salmon Creek (Okanagan) - April 10th Salmon Creek (Okanagan) - April 19th			
2019	3DD.003D3650EA	The Dalles East Ladder - October 6th	Lower Granite - October 23rd		Lower SF Clearwater - March 6th Lower SF Clearwater - April 21st			
2019	3DD.003D3650AA	The Dalles East Ladder - October 13th	Lower Granite - October 26th		Lower SF Clearwater - March 10th Lower SF Clearwater - April 6th			
2019	3DD.003D364E61	The Dalles East Ladder - September 22nd	Lower Granite - October 5th		Lower SF Clearwater - March 27th Lower SF Clearwater - April 6th			
2019	3DD.003D365077	The Dalles East Ladder - October 17th	Lower Granite - October 30th		Lower SF Clearwater - March 12th Lower SF Clearwater - March 30th			
2019	3DD.003D364F8A	The Dalles North Ladder - September 29th	Lower Granite - October 13th		Lolo Creek (Clearwater) - April 8th Lolo Creek (Clearwater) - May 8th			
2019	3DD.003D364B5D	The Dalles East Ladder - September 15th	Lower Granite - November 3rd		Lapwai Creek (Clearwater) - March 22nd Lapwai Creek (Clearwater) - April 13th			
2019	3DD.0077D04DAB	The Dalles East Ladder - September 10th	Lower Granite - September 28th	Lower Wallowa (Grande Ronde) - February 16th	Middle Wallowa (Grande Ronde) - March 4th Lower Wallowa (Grande Ronde) - April 18th			Hatchery fish released as juvenile from Big Canyon Facility on May 1st, 2018.
2019	3DD.0077C0CA77	The Dalles East Ladder - June 28th	Lower Granite - July 18th		Lower Wallowa (Grande Ronde) - April 11th Lower Wallowa (Grande Ronde) - April 29th			
2019	3DD.003D364BAC	The Dalles East Ladder - August 21st	Lower Granite - October 15th		Lower Wallowa (Grande Ronde) - March 17th Lower Minam (Grande Ronde) - March 19th Lower Wallowa (Grande Ronde) - May 8th			
2019	3DD.003D3644C3	The Dalles East Ladder - July 18th	Lower Granite - September 11th	Middle Grande Ronde - January 30th	Lower Catherine Creek (Grande Ronde) - April 9th Middle Catherine Creek (Grande Ronde) - April 9th	Lower Catherine Creek (Grande Ronde) - June 3rd		
2019	3DD.003D364A05	The Dalles North Ladder - August 3rd	Lower Granite - September 26th	Joseph Creek (Grande Ronde) - February 11th	Joseph Creek (Grande Ronde) - April 13th			
2019	3DD.003D3645E8	The Dalles East Ladder - July 13th	Lower Granite - July 22nd		NF Salmon - April 9th NF Salmon - May 13th			
2019	3DD.003D364B27	The Dalles East Ladder - September 19th	Lower Granite - October 3rd		Valley Creek (Salmon) - April 26th Valley Creek (Salmon) - May 2nd			
2019	3DD.003D364A27	The Dalles East Ladder - September 24th	Lower Granite - October 23rd		Lower Asotin - March 31st Lower Asotin - May 15th			
2019	3DD.003D364A13	The Dalles East Ladder - October 1st	Lower Granite - October 10th		Lower Imnaha - April 8th Big Sheep Creek (Imnaha) - April 11th Big Sheep Creek (Imnaha) - May 15th Lower Imnaha - May 16th			
2019	3DD.003D3649F7	The Dalles East Ladder - July 24th	Prosser Dam (Yakima) - October 22nd	Lower Toppenish Creek (Yakima) - January 28th Middle Toppenish Creek (Yakima) - February 13th	Middle Toppenish Creek (Yakima) - March 4th to April 23rd Lower Toppenish Creek (Yakima) - April 27th			Steelhead tagged at Bonneville AFF on July 22nd, 2019. Steelhead was recaptured/retained on May 4th, 2020 by CRITFC Kelt Project at Prosser Dam/Chandler Canal. Considered a kelt, by Kelt Project.
2019	3DD.0077AF45AF	The Dalles East Ladder - August 15th	John Day - September 26th	McNary - February 25th	Ice Harbor - March 3rd Lower Granite - March 26th EF Potlatch - April 19th to May 26th	Lower Granite Juvenile Bypass - June 3rd		Steelhead was captured twice in the EF Potlatch weir on April 19th and May 26th, 2020. On June 4th, 2020 kelt was sampled at Lower Granite Dam by the Kelt Project and released. Considered a Kelt by the Kelt Project.
2019	3DD.003D364BB2	The Dalles East Ladder - September 11th	Lower Granite - September 20th		Lower Wallowa (Grande Ronde) - April 5th Lower Granite Juvenile Bypass - April 30th			Steelhead tagged at Bonneville AFF on August 13th, 2019. Steelhead was recaptured/released May 31st, 2020 by CRITFC Kelt Project. Considered a kelt, by Kelt Project.
2019	3DD.003D3649BD	The Dalles East Ladder - July 22nd	Rock Island - September 8th		Prosser Dam (Yakima) - May 1st Lower Naches (Yakima) - May 12th	Prosser Dam (Yakima) - June 12th		Steelhead tagged at Bonneville AFF on July 19th, 2019. Steelhead was recaptured/retained on June 12th, 2020 at Prosser Dam by CRITFC Kelt Project. Considered a kelt, by Kelt Project.
2019	3DD.003D36473D	The Dalles East Ladder - July 4th	Prosser Dam (Yakima) - October 18th		Prosser Dam (Yakima) - May 4th			Steelhead tagged at Bonneville AFF on July 2nd, 2019. Steelhead was recaptured/retained on May 4th, 2020 at Prosser Dam by CRITFC Kelt Project. Considered a kelt, by Kelt Project.
2019	3DD.003D364AE9	The Dalles East Ladder - August 31st	Prosser Dam (Yakima) - October 23rd		Roza Dam (Yakima) - April 10th Prosser Dam (Yakima) - May 27th			Steelhead tagged at Bonneville AFF on August 28th, 2019. Steelhead was recaptured/retained on May 27th, 2019 at Prosser Dam by CRITFC Kelt Project. Considered a kelt, by Kelt Project.
2019	3DD.003D365013	The Dalles East Ladder - October 18th	McNary - October 27th		Prosser Dam (Yakima) - March 22nd Lower Naches (Yakima) - April 16th Prosser Dam (Yakima) - May 4th			Steelhead tagged at Bonneville AFF on October 15th, 2019. Steelhead was recaptured/retained on May 4th, 2020 at Prosser Dam by CRITFC Kelt Project. Considered a kelt, by Kelt Project.
2019	3DD.003D3648EB	The Dalles East Ladder - September 15th	McNary - September 19th		Middle Yakima - April 11th Lower Naches (Yakima) - April 14th Prosser Dam (Yakima) - May 11th			Steelhead tagged at Bonneville AFF on September 4th, 2019. Steelhead was recaptured/retained on May 11th, 2020 at Prosser Dam by CRITFC Kelt Project. Considered a kelt, by Kelt Project.

Key - - - Upstream | Downstream | Spawning

Table B3. Season by season activities of steelhead tagged in 2019 and later labeled as kelts or repeat spawners when they began migrating downstream (before April 1st) and upstream in spring, summer, or fall 2020, presumably to and from the ocean.

Tag Year	Tag Number	First Detection After Tagging 2019 in Spring/Summer/Fall	Fall 2019	Winter 2019/20	Spring 2020	Comments
2019	3DD.0077C24338	Moving Falls Fish Ladder (Hood) - July 7th	Moving Falls Fish Ladder (Hood) - October 17th		Bonneville Dam Corner Collector - March 23rd	
2019	3DD.003D3649D8		The Dalles East Ladder - October 11th	Bonneville Dam Corner Collector - February 23rd		Steelhead tagged at Bonneville AFF on July 24th, 2019. Where is was for several months between Bonneville and The Dalles Dam is unknown.
2019	3DD.0077C1E62B	Lyle Falls Fishway (Klickitat) - June 8th		Bonneville Dam Corner Collector - February 25th		
2019	3DD.003D36476B	The Dalles East Ladder - July 14th	Lower Granite - October 23rd	Lower Granite Spillway - January 28th Lower Tucannon - February 21st	Middle Tucannon - March 22nd Lower Monumental Juvenile Bypass- March 26th	
2019	3DD.003D364BA7	The Dalles North Ladder - September 20th	Lower Monumental - October 9th	Lower Tucannon - January 22nd Middle Tucannon - January 27th	Upper Tucannon - March 11th to 24th Middle Tucannon - March 28th	
2019	3DD.003D3650D3	The Dalles North Ladder - October 6th	Lower Monumental - October 18th	Lower Tucannon - January 23rd Middle Tucannon - February 5th	Middle Tucannon - March 8th Lower Tucannon - March 12th	
2019	3DD.003D364BCF	Bonneville Dam Corner Collector - August 13th	Lower Monumental - October 28th	Lower Tucannon - February 16th	Middle Tucannon - March 13th to 16th Lower Monumental Juvenile Bypass- March 30th	
2019	3DD.003D36504E	The Dalles East Ladder - October 19th	McNary - October 26th	Lower Monumental - January 9th	Lower Tucannon - March 5th Lower Monumental Juvenile Bypass- March 26th	
2019	3DD.003D3648C1	The Dalles East Ladder - July 28th	Lower Granite - October 29th		Lower Granite Juvenile Bypass - March 27th	Steelhead tagged at Bonneville AFF on July 24th, 2019. Steelhead was recaptured/released at Lower Granite on March 27th, 2020 by CRITFC Kelt Project. Considered a kelt, by Kelt Project.
2019	3DD.003D365085	The Dalles East Ladder - October 14th	Lower Granite - November 17th		Lower Granite Juvenile Bypass - March 28th	
2019	3DD.0077C0C904	Lower Klickitat - June 23rd		Little Klickitat - February 6th to 27th	Lower Klickitat - March 29th	

Key - - -	Upstream	Downstream	Spawning

Table B4. Season by season activities of steelhead tagged in past years 2018 (years 2017 and 2016 checked, but no new movements from fish) 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 and Spring/Summer Following Year	Fall	Winter	Spring	Comments
2018	3DD.0077BAB605	The Dalles East Ladder - September 2nd, 2018	Prosser Dam (Yakima) - November 9th, 2018		Lower Toppenish Creek (Yakima) - March 8th, 2019	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. New movements.
					Upper Toppenish Creek (Yakima) - March 17th to April 27th, 2019	
					Lower Toppenish Creek (Yakima) - April 29th, 2019	
			Prosser Dam (Yakima) - November 13th, 2019	Lower Toppenish Creek (Yakima) - January 26th, 2020		
				Upper Toppenish Creek (Yakima) - February 7th, 2020		
2018	3DD.0077BA8377	The Dalles East Ladder - July 22nd, 2018	Lower Granite - October 19th, 2018		Joseph Creek (Grande Ronde) - March 16th, 2019	Steelhead released as reconditioned from Kelt Reconditioning Project on May 1st, 2019. New movements.
					Lower Granite Juvenile - May 10th, 2019	
				Lower Granite - February 19th, 2020	Joseph Creek (Grande Ronde) - February 29th, 2020	
					Joseph Creek (Grande Ronde) - May 4th, 2020	

Key - - -	Upstream	Downstream	Spawning

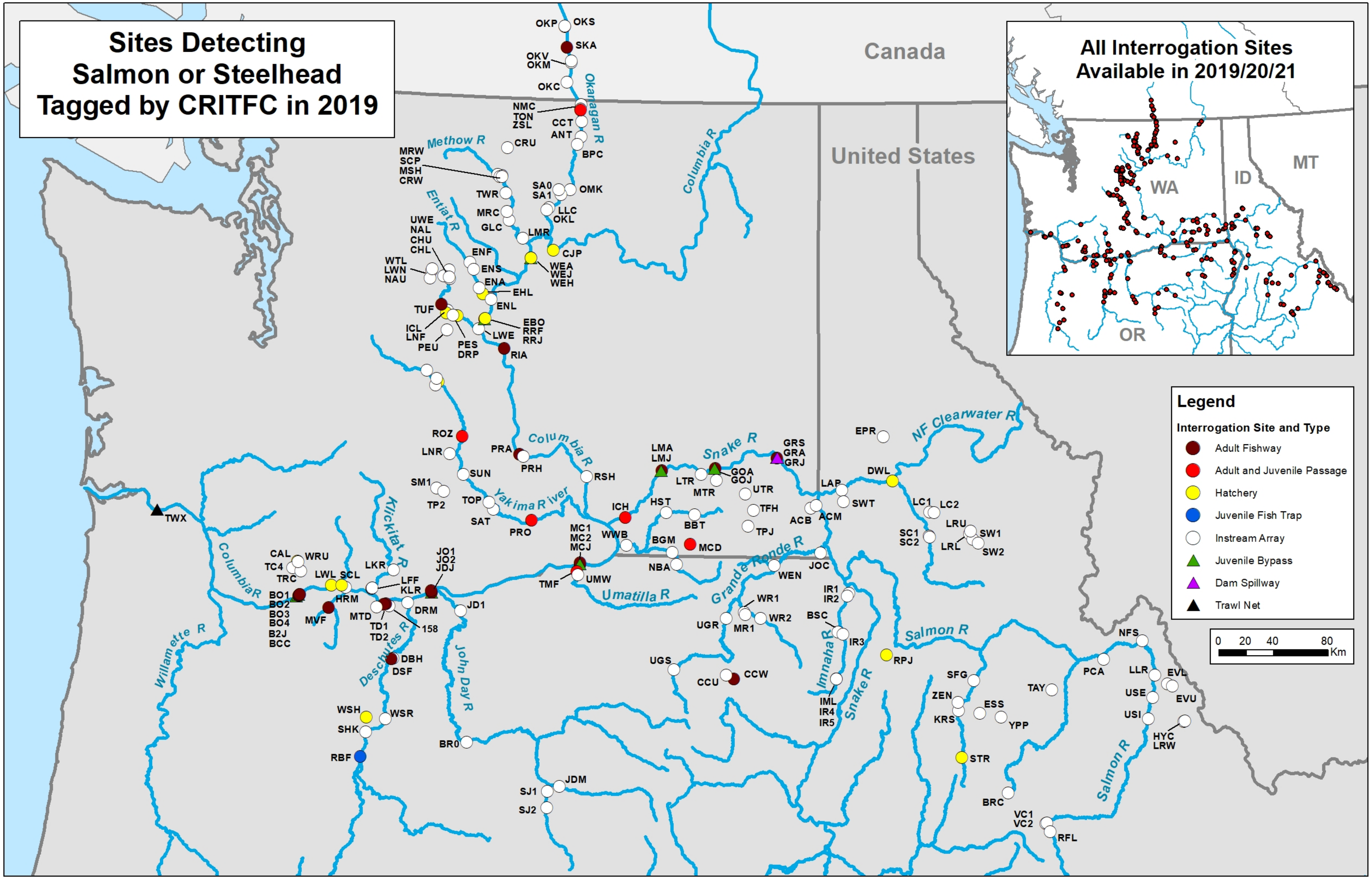

Figure B1. Map of Columbia River interrogation sites that detected Chinook and Sockeye salmon, and steelhead in 2019. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

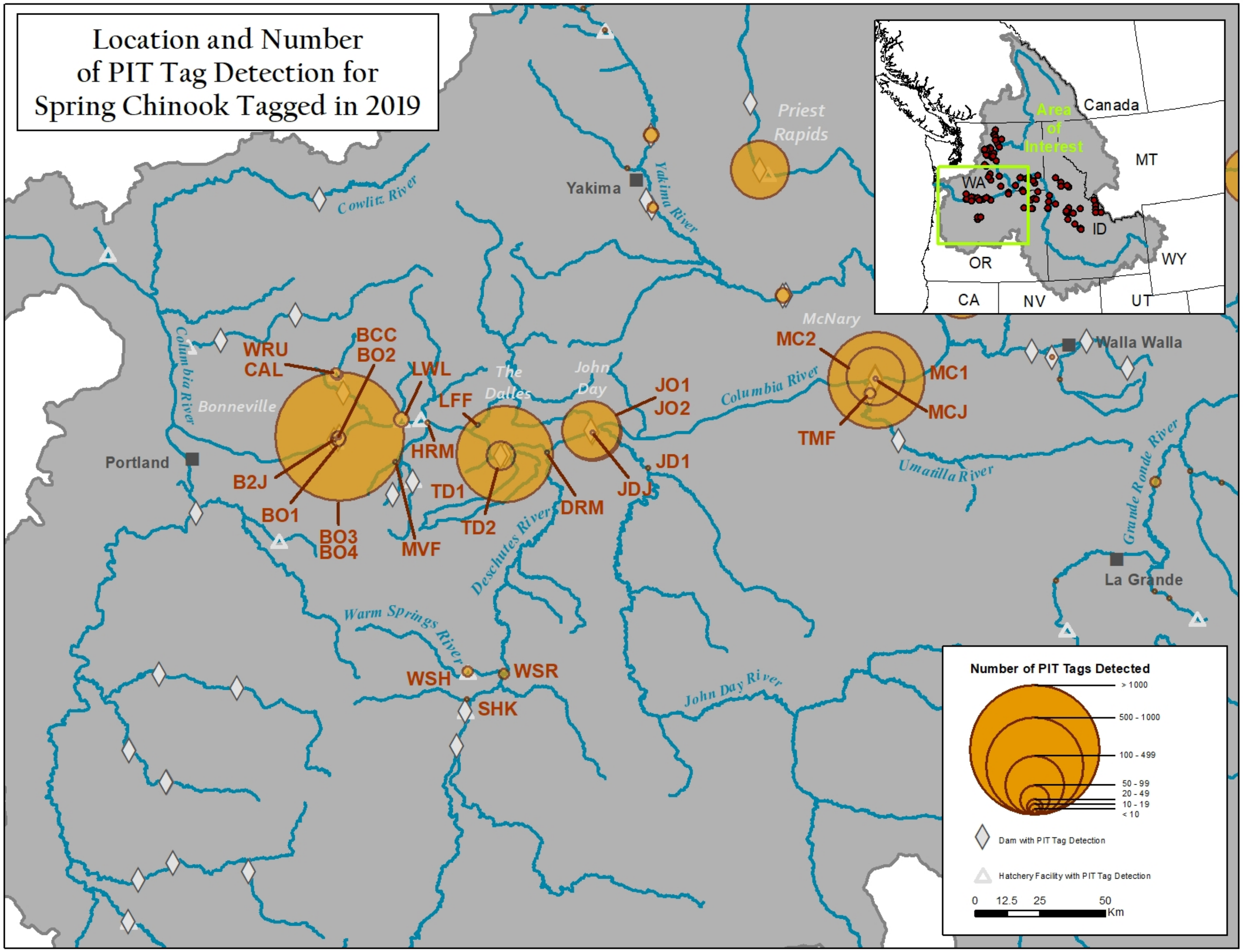

Figure B2. Map of Lower Columbia River detection sites (below Snake River) and number of spring Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January 1 to June 1.

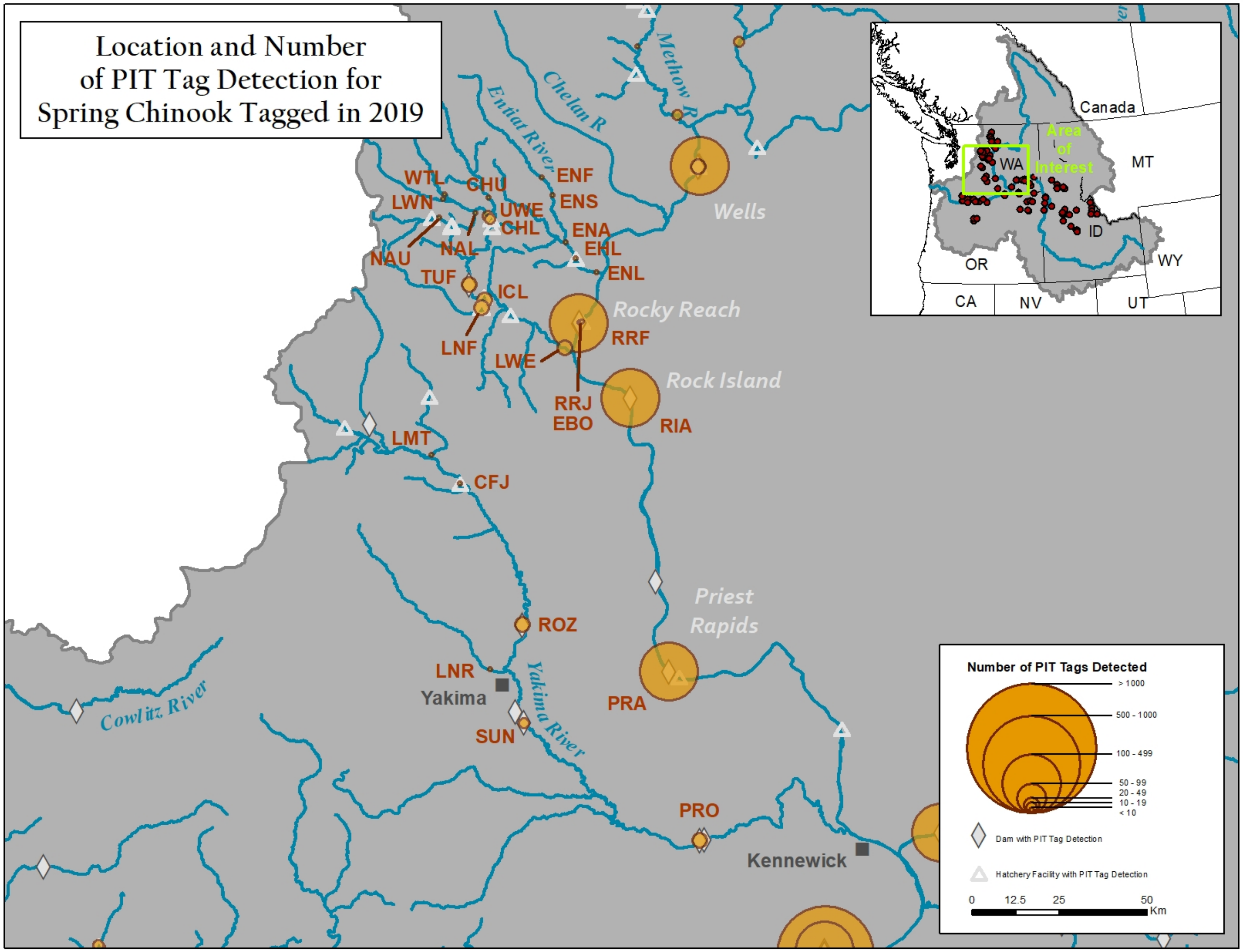

Figure B3. Map of Upper Columbia River (between the Snake River and Wells Dam) detection sites and number of spring Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January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

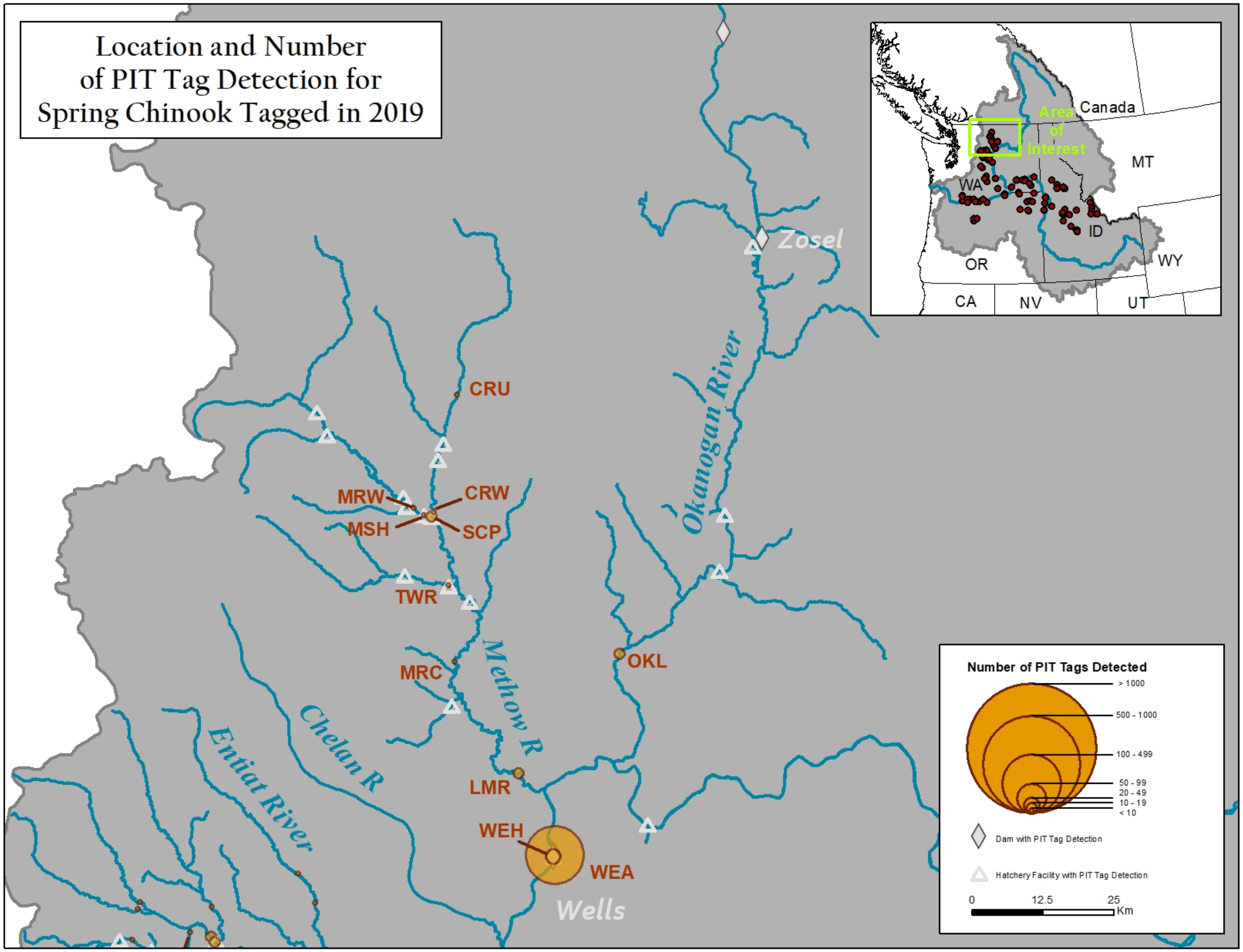

Figure B4. Map of Upper Columbia River (Wells Dam and above) detection sites and number of spring Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January 1 to June 1.

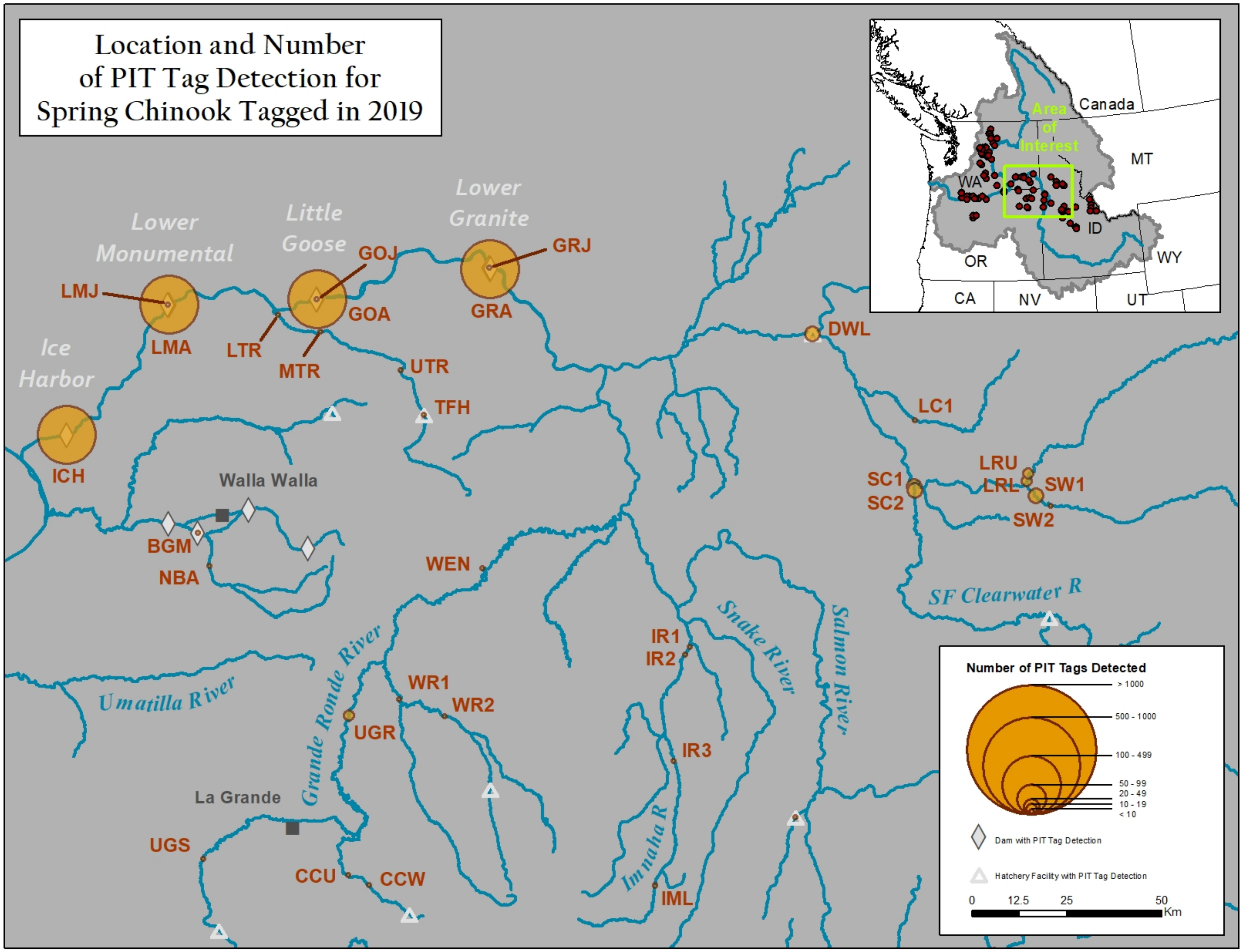

Figure B5. Map of Lower Snake River detection sites (Salmon River not included) and number of spring Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January 1 to June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

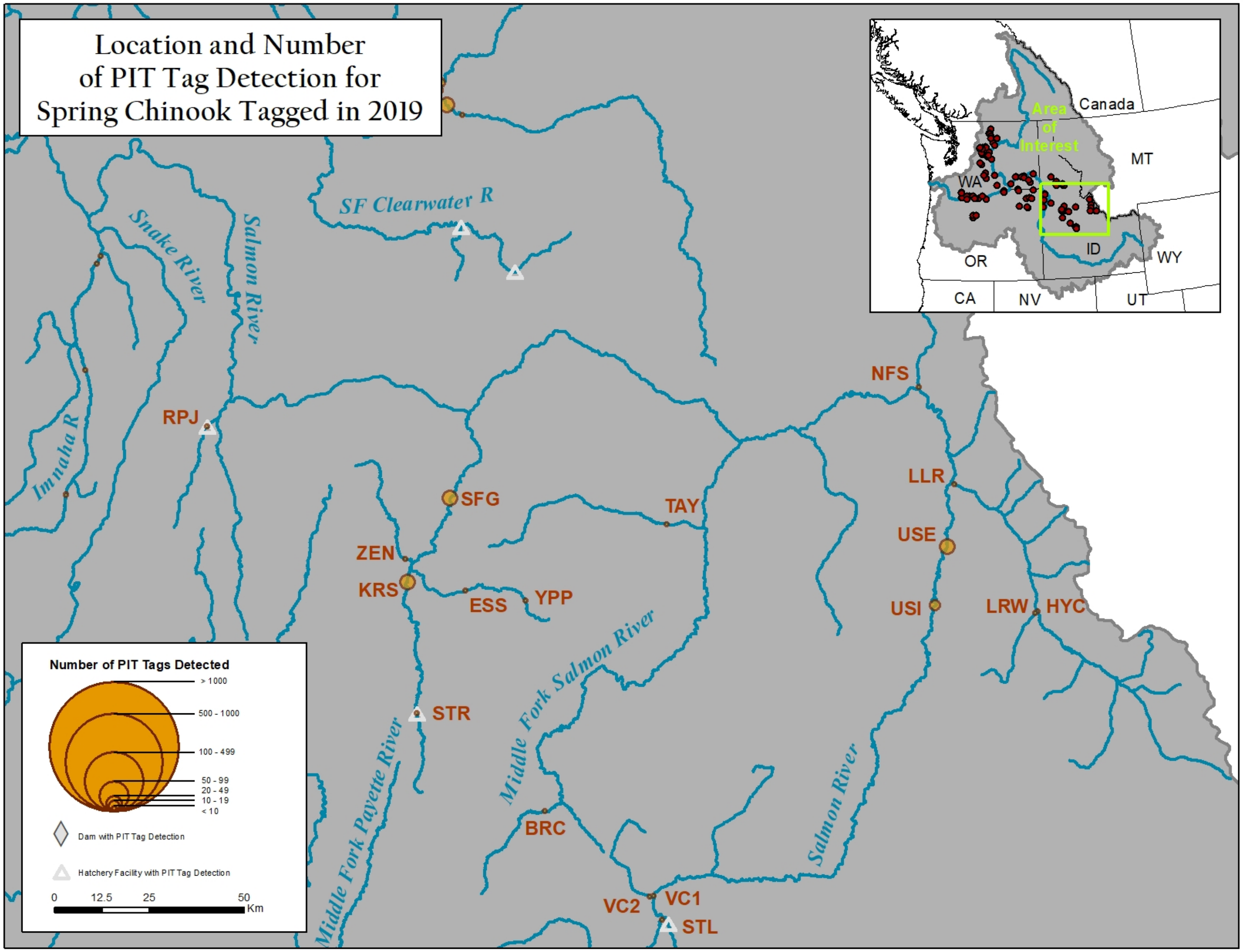

Figure B6. Map of Salmon River detection sites and number of spring Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January 1 to June 1.

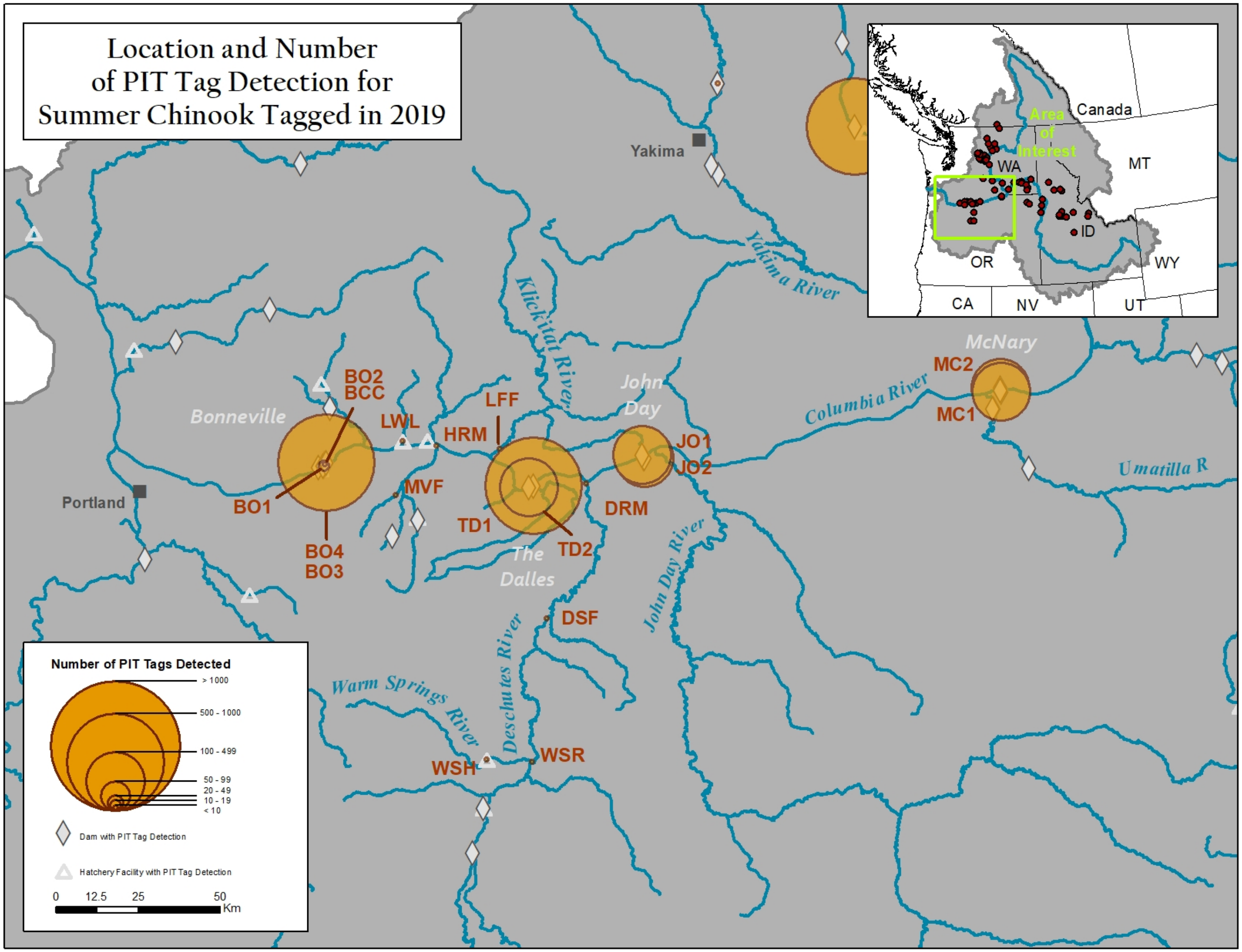

Figure B7. Map of Lower Columbia River detection sites (below Snake River) and number of summer Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June 1 to August 1.

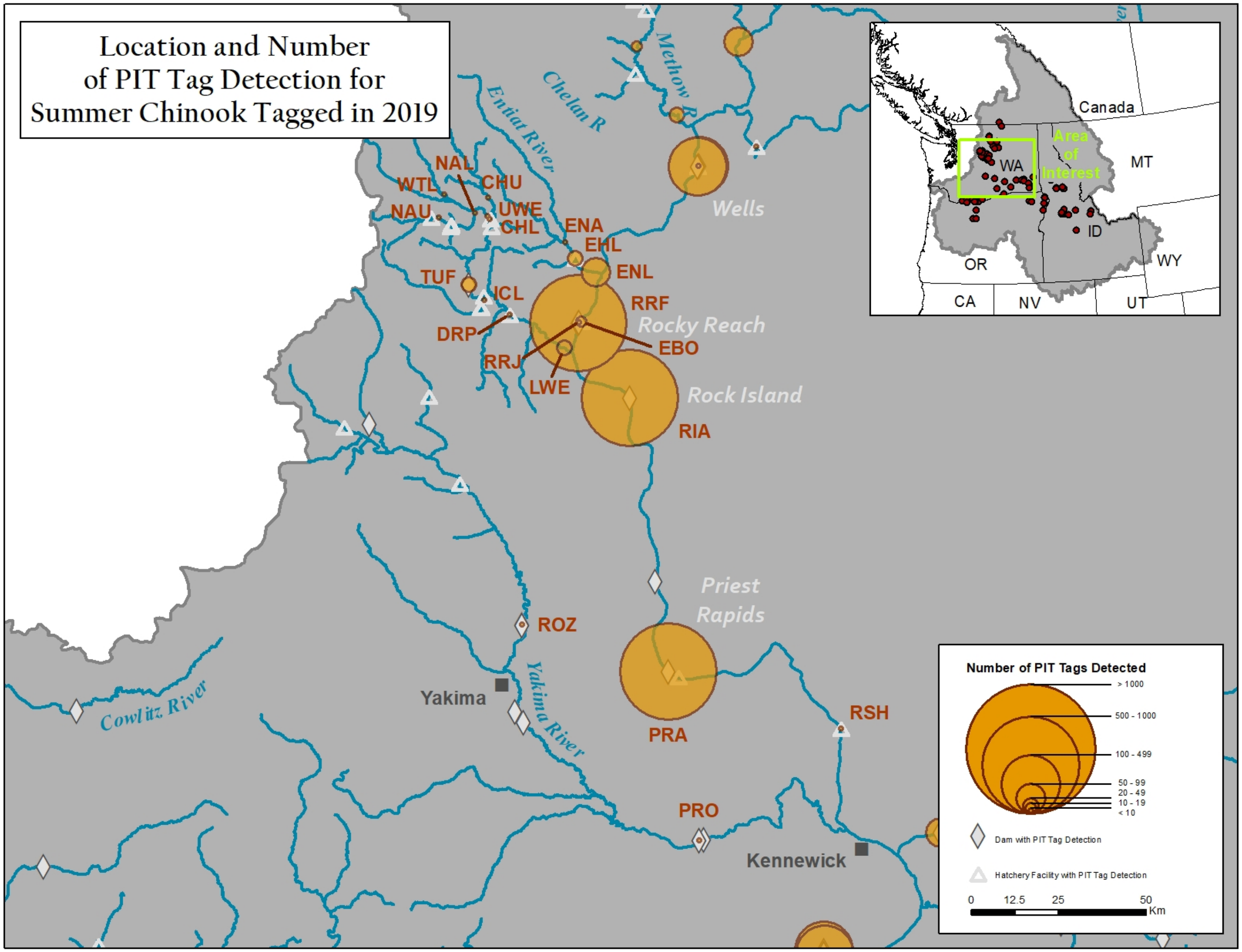

Figure B8. Map of Upper Columbia River (between the Snake River and Wells Dam) detection sites and number of summer Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June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

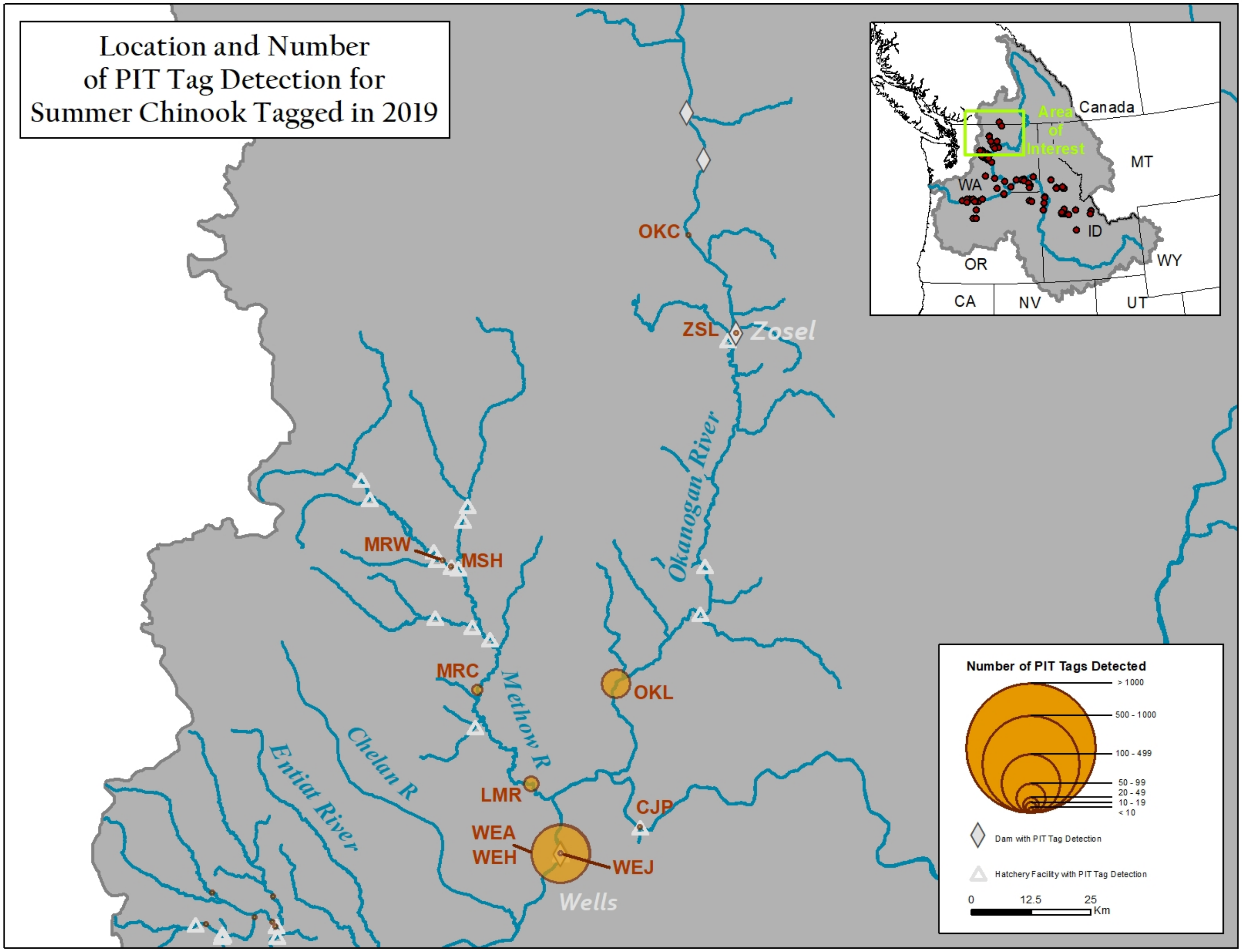

Figure B9. Map of Upper Columbia River (Wells Dam and above) detection sites and number of summer Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June 1 to August 1.

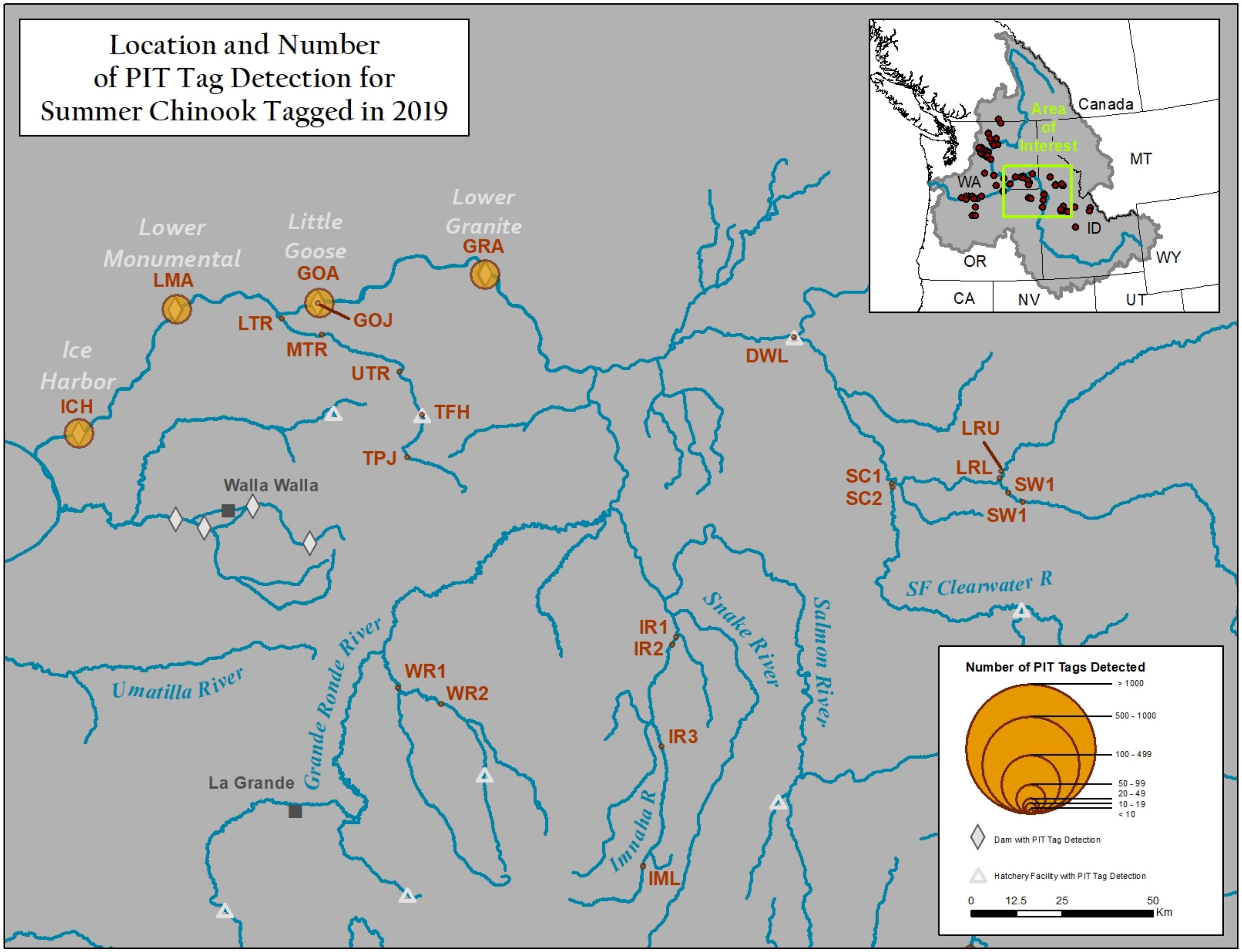

Figure B10. Map of Lower Snake River detection sites (Salmon River not included) and number of summer Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June 1 to August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

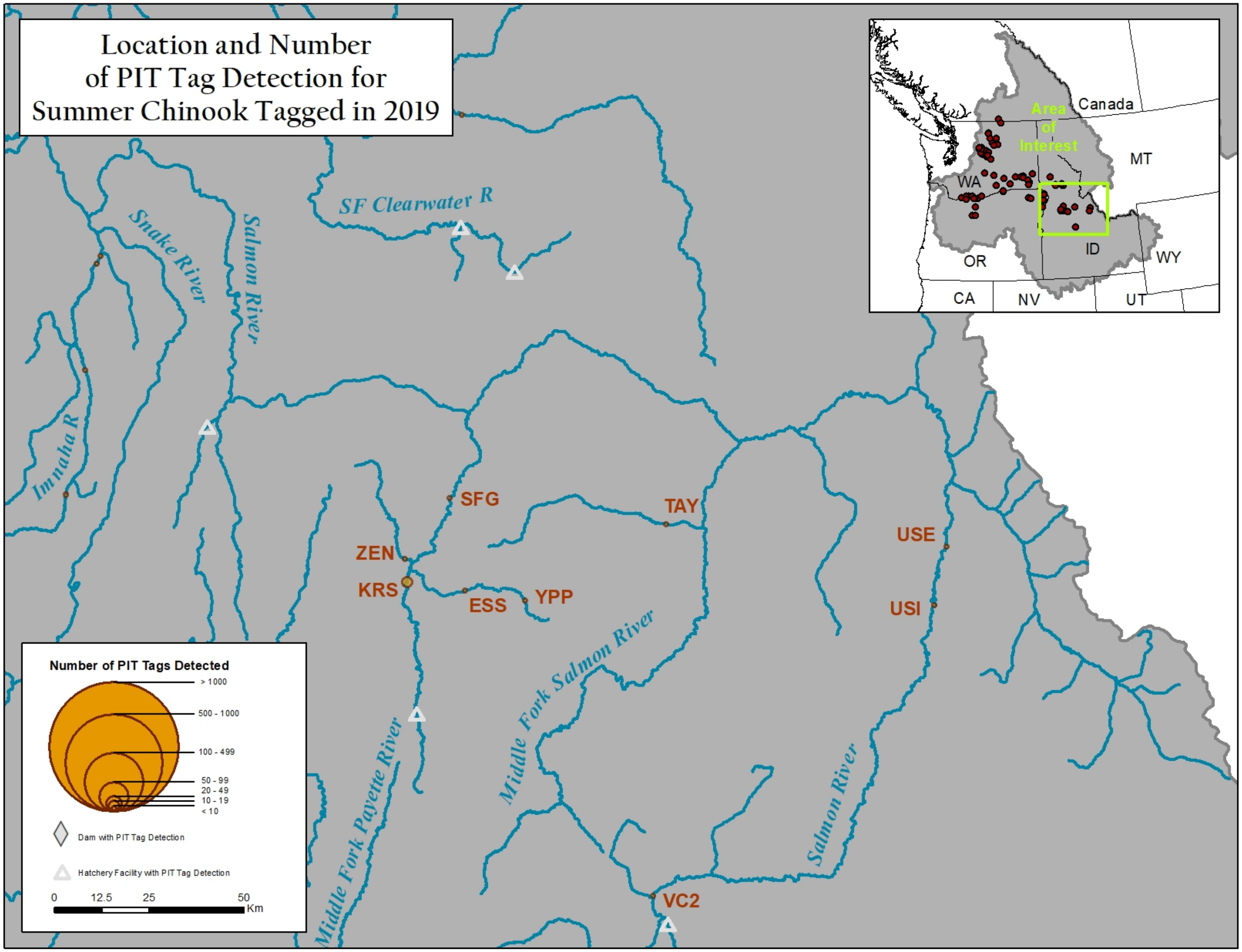

Figure B11. Map of Salmon River detection sites and number of summer Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June 1 to August 1.

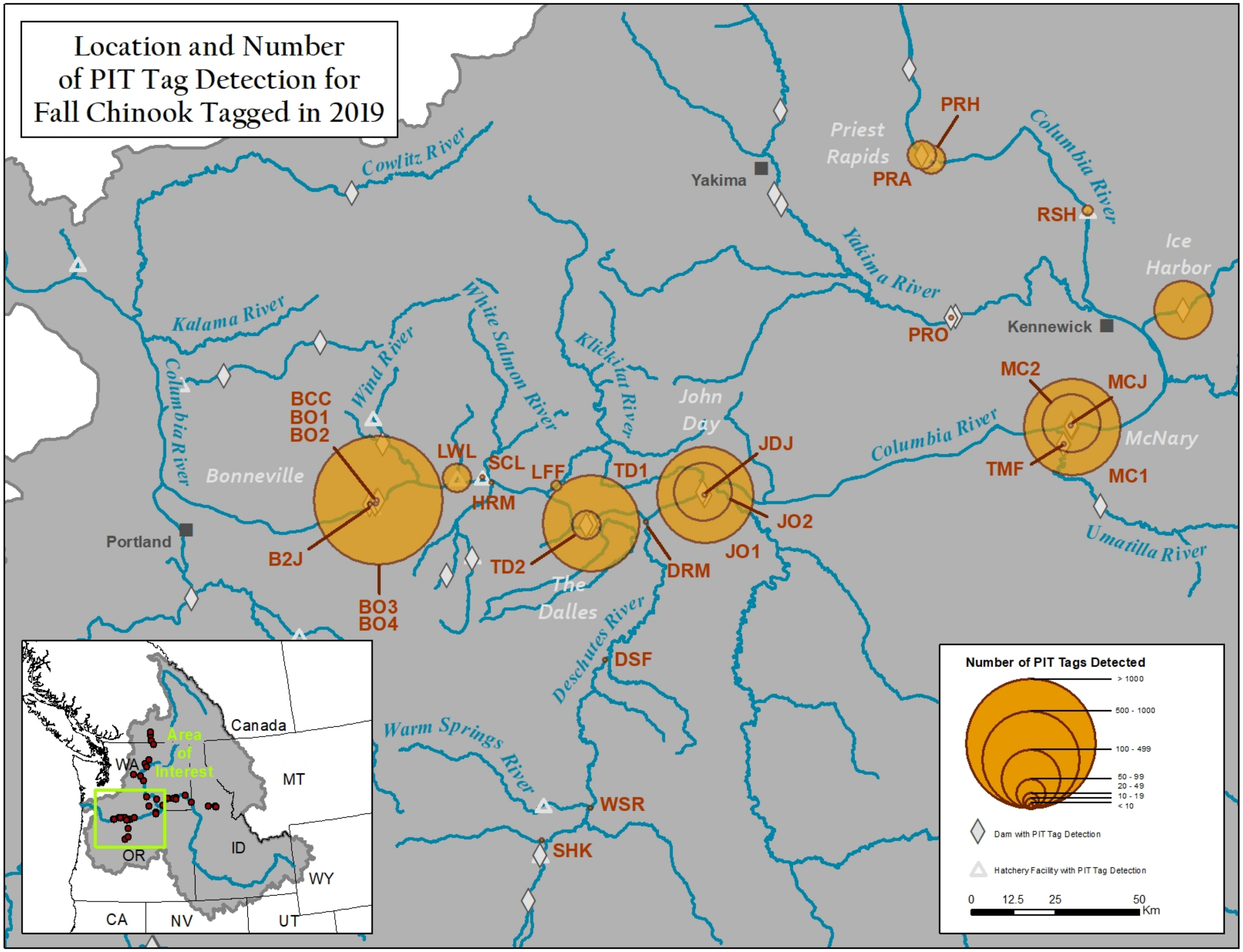

Figure B12. Map of Lower and Middle Columbia River detection sites (below Rock Island Dam) and number of fall Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Fall Chinook is defined as fish passing Bonneville Dam from August 1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

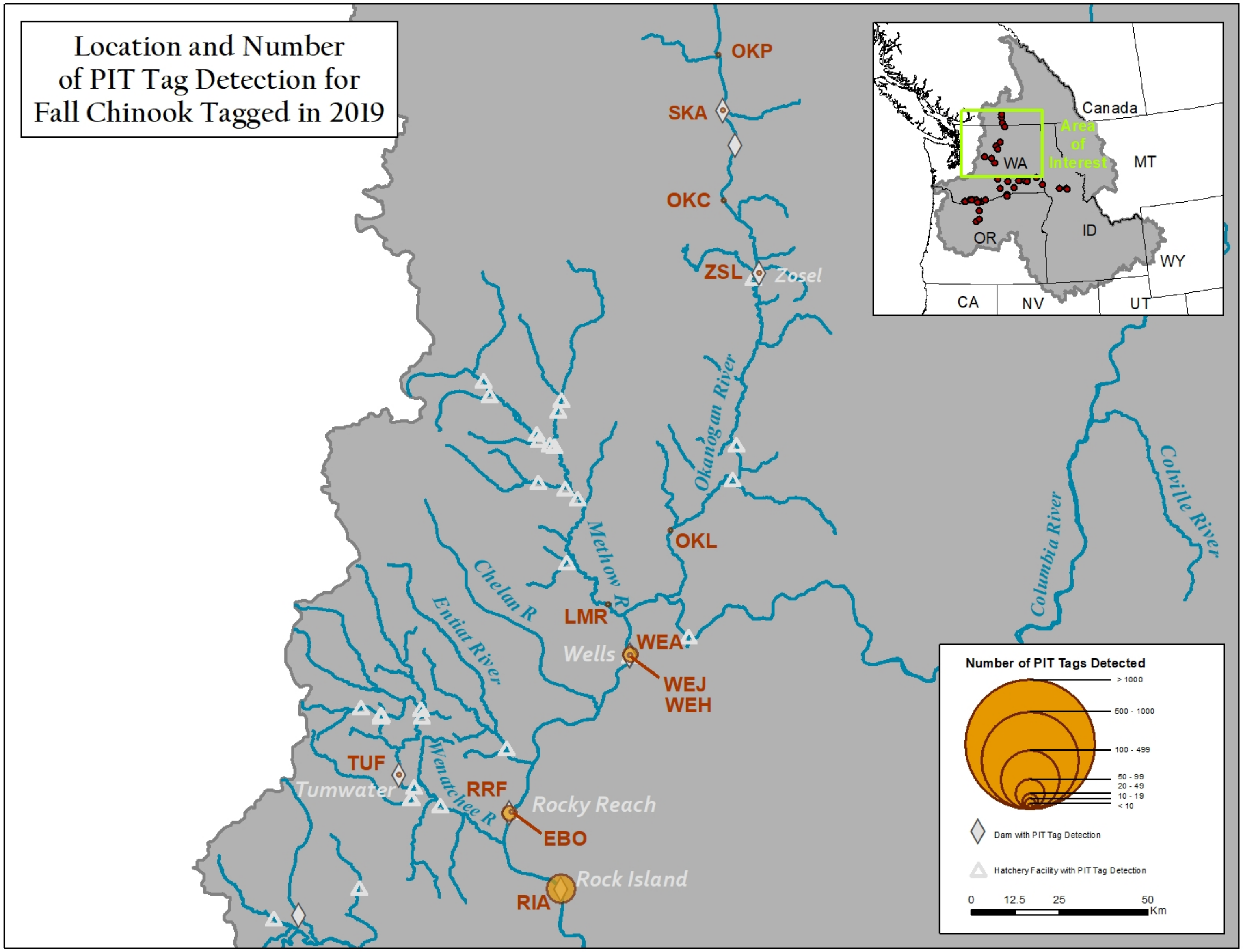

Figure B13. Map of Upper Columbia River detection sites (Rock Island Dam and above) and number of fall Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Fall Chinook is defined as fish passing Bonneville Dam from August 1 to end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

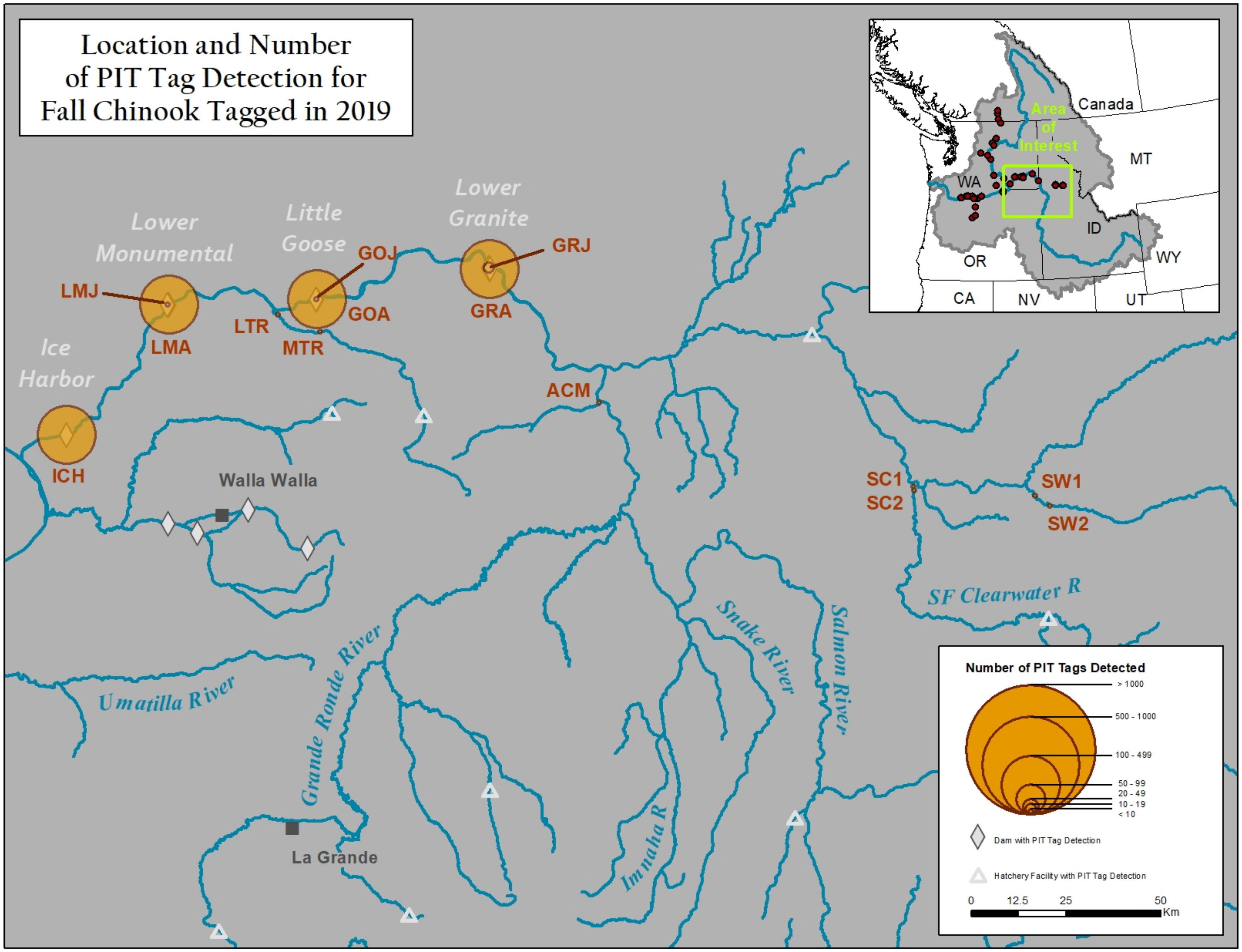

Figure B14. Map of Lower Snake River detection sites and number of fall Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Fall Chinook is defined as fish passing Bonneville Dam from August 1 to end of year.

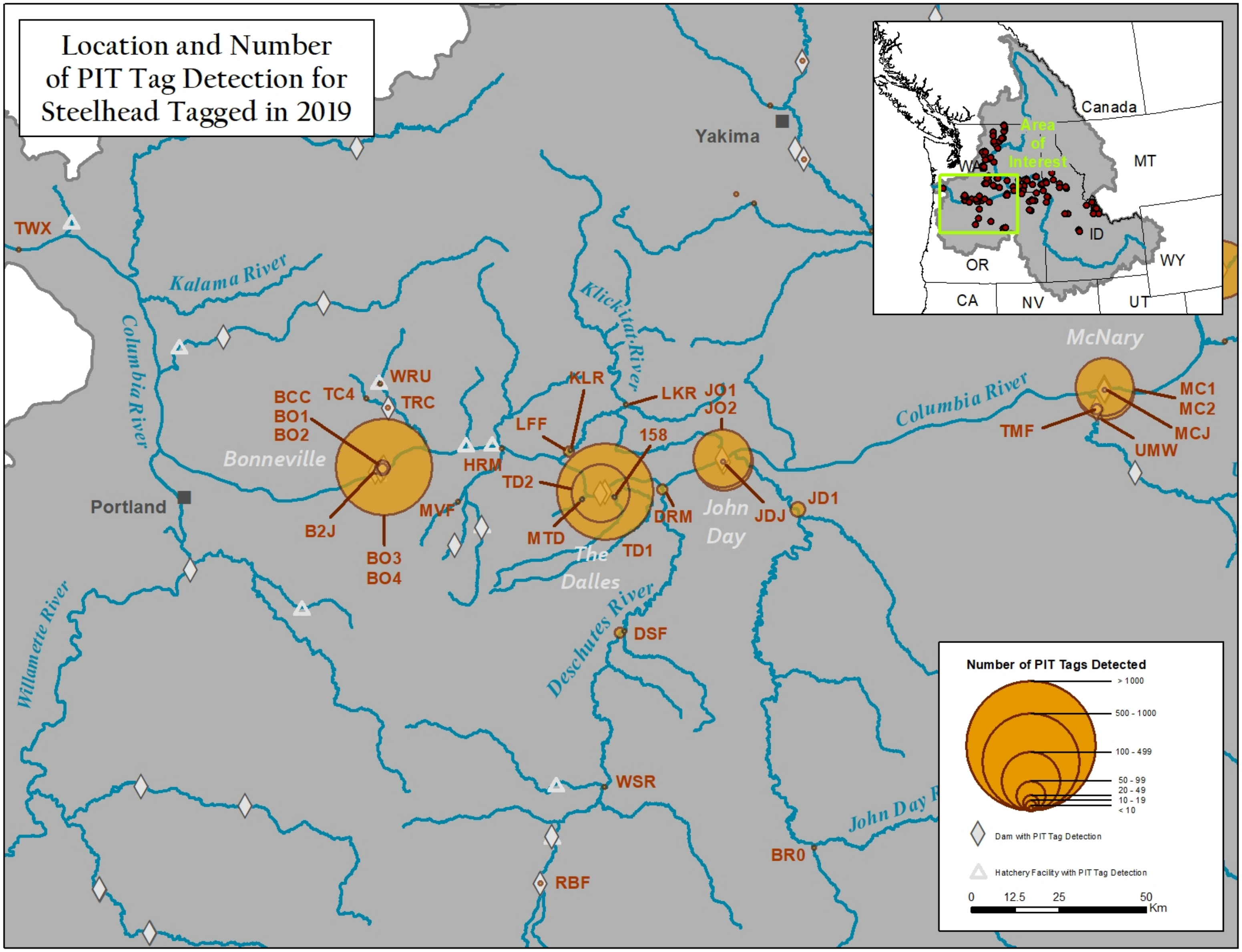

Figure B15. Map of Lower Columbia River detection sites (below Snake River) and number of steelhead detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

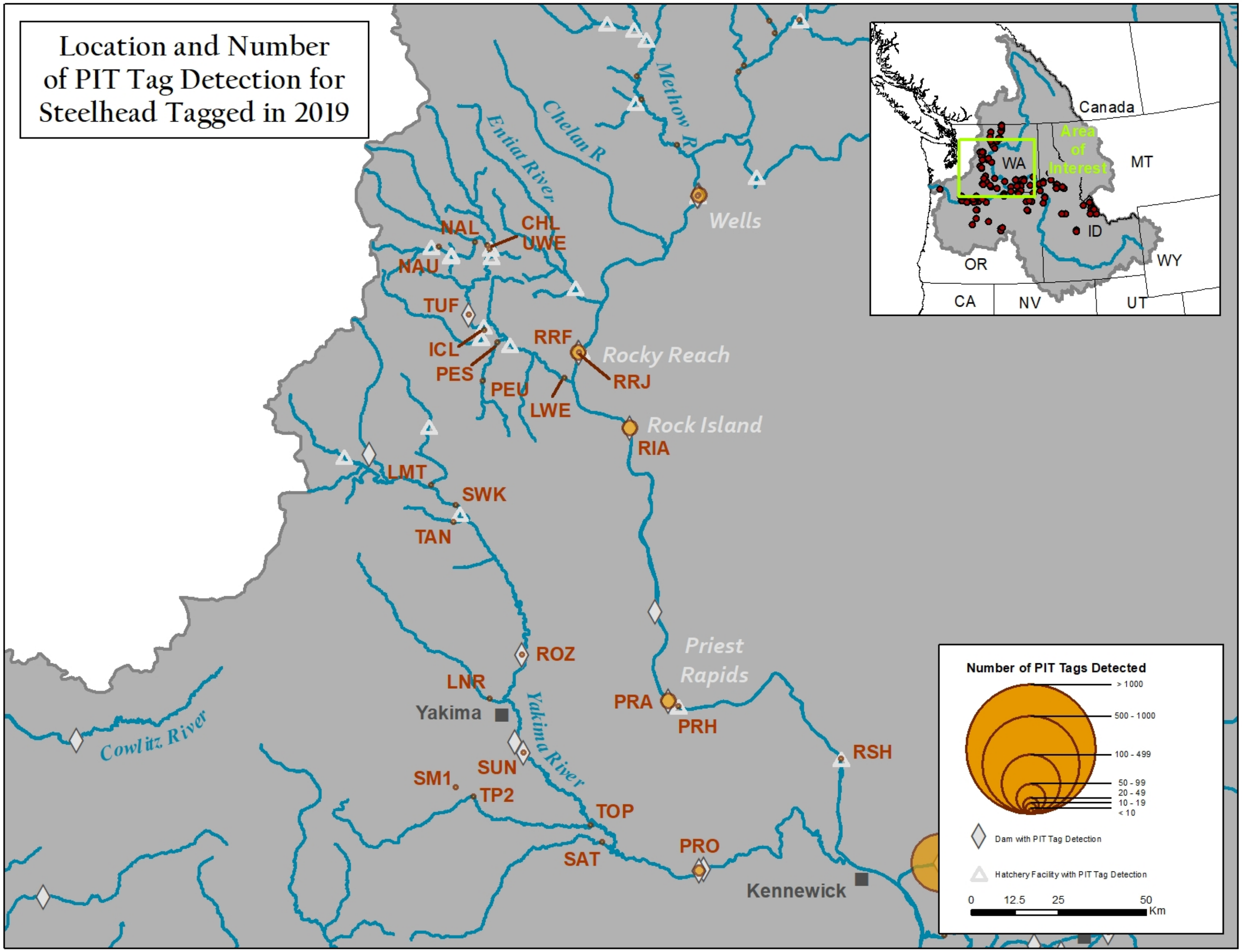

Figure B16. Map of Upper Columbia River (between the Snake River and Wells Dam) detection sites and number of steelhead detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

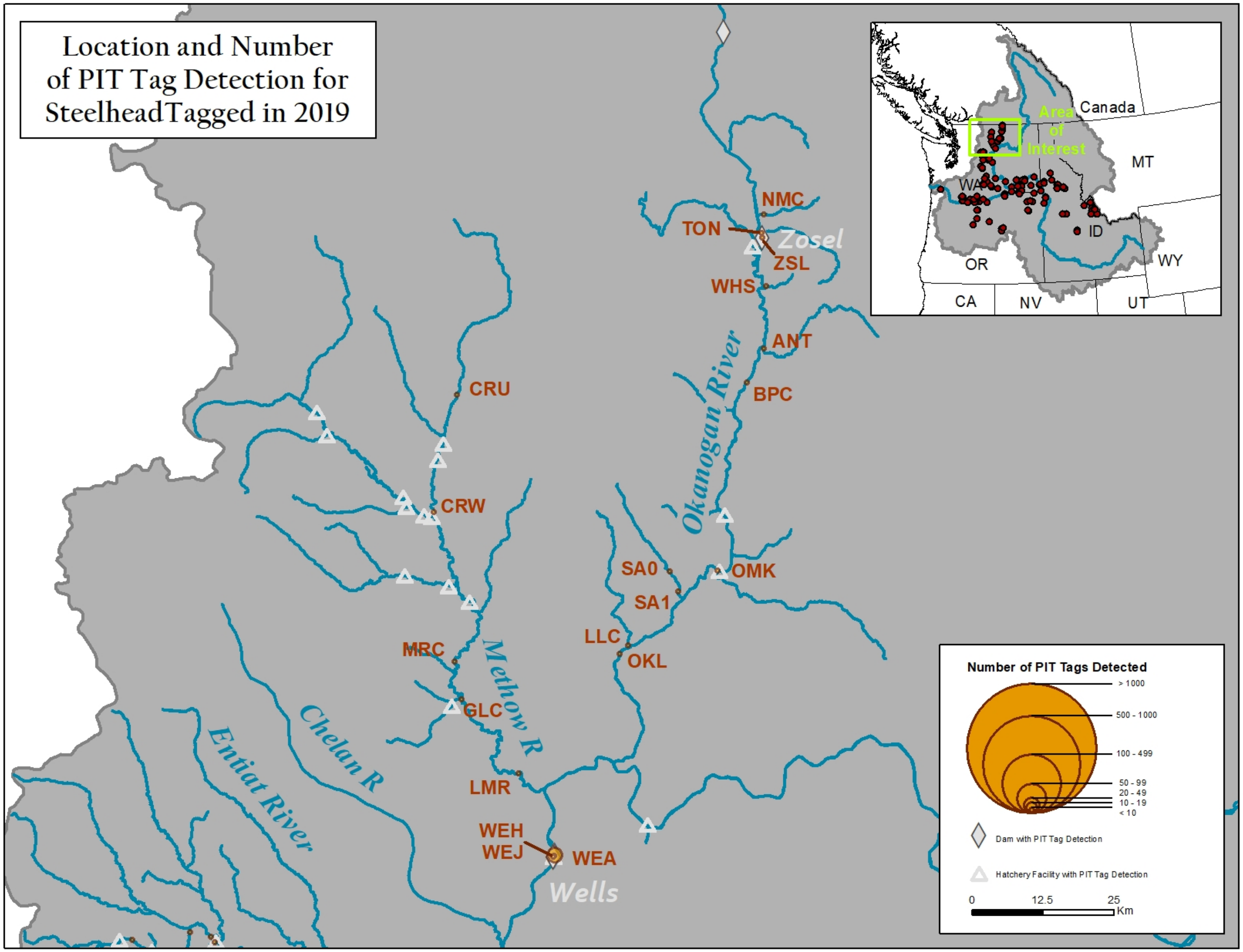

Figure B17. Map of Upper Columbia River (Wells Dam and above) detection sites and number of steelhead detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

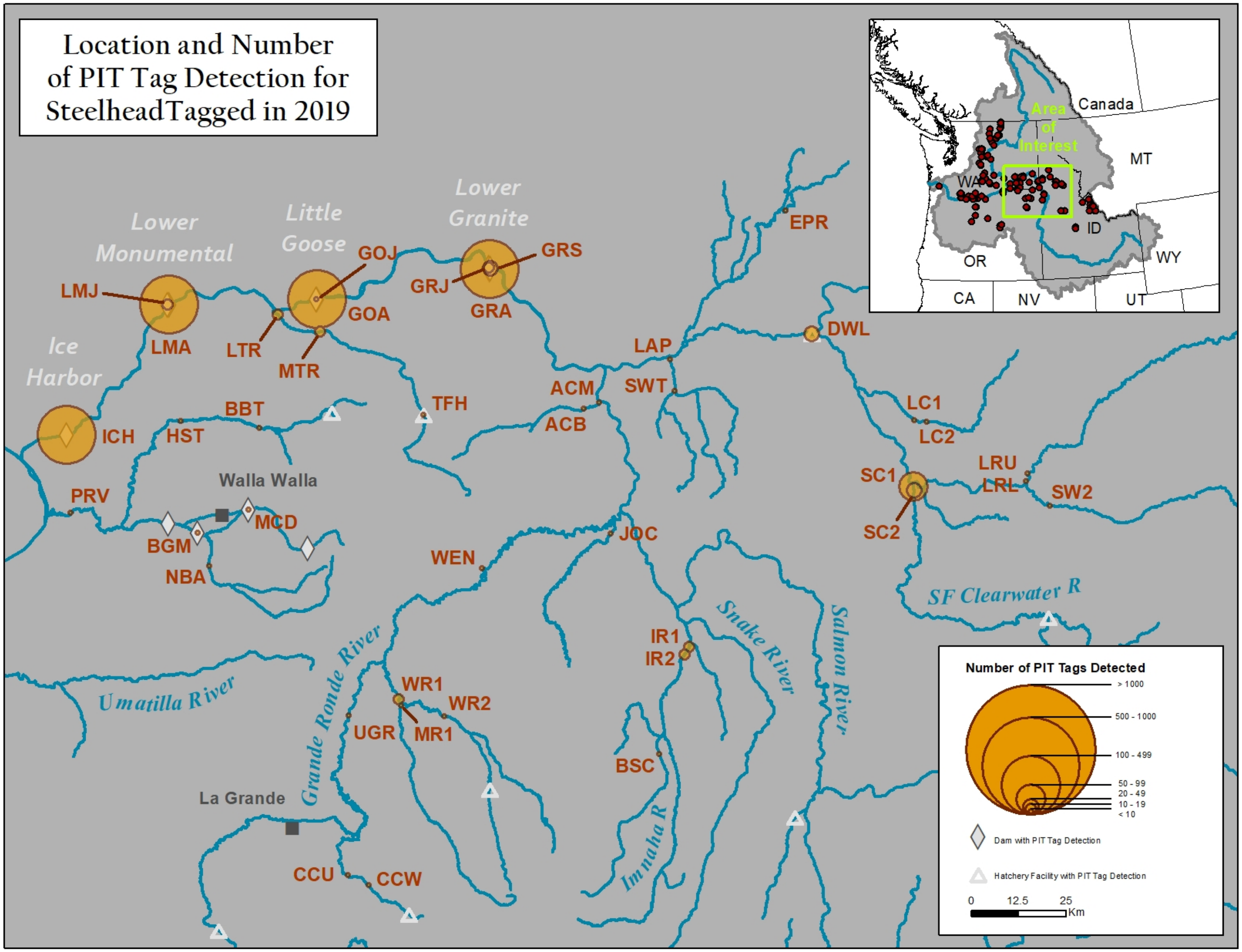

Figure B18. Map of Lower Snake River detection sites (Salmon River not included) and number of steelhead detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

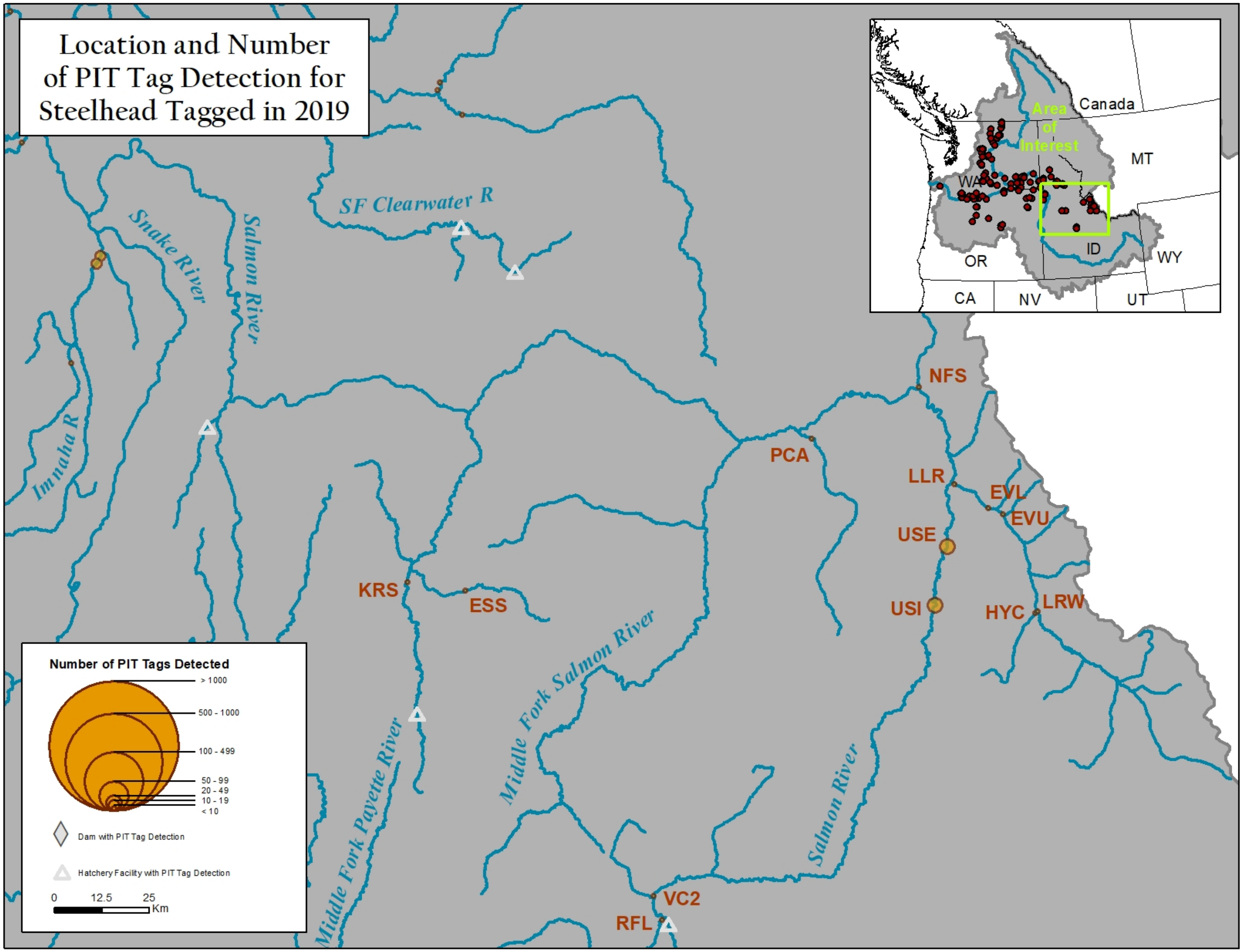

Figure B19. Map of Salmon River detection sites and number of steelhead detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

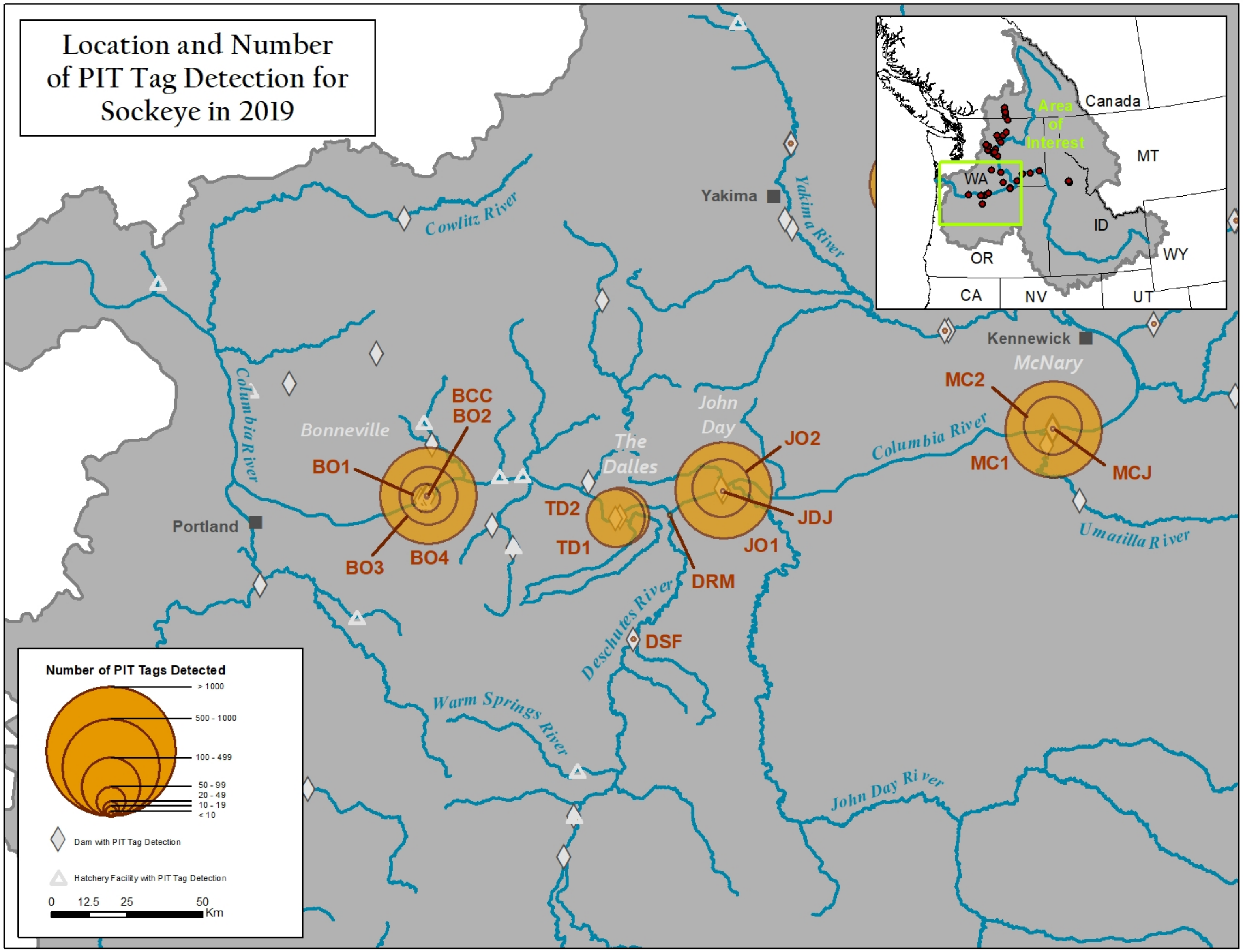

Figure B20. Map of Lower Columbia River detection sites (below Snake River) and number of Sockeye Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

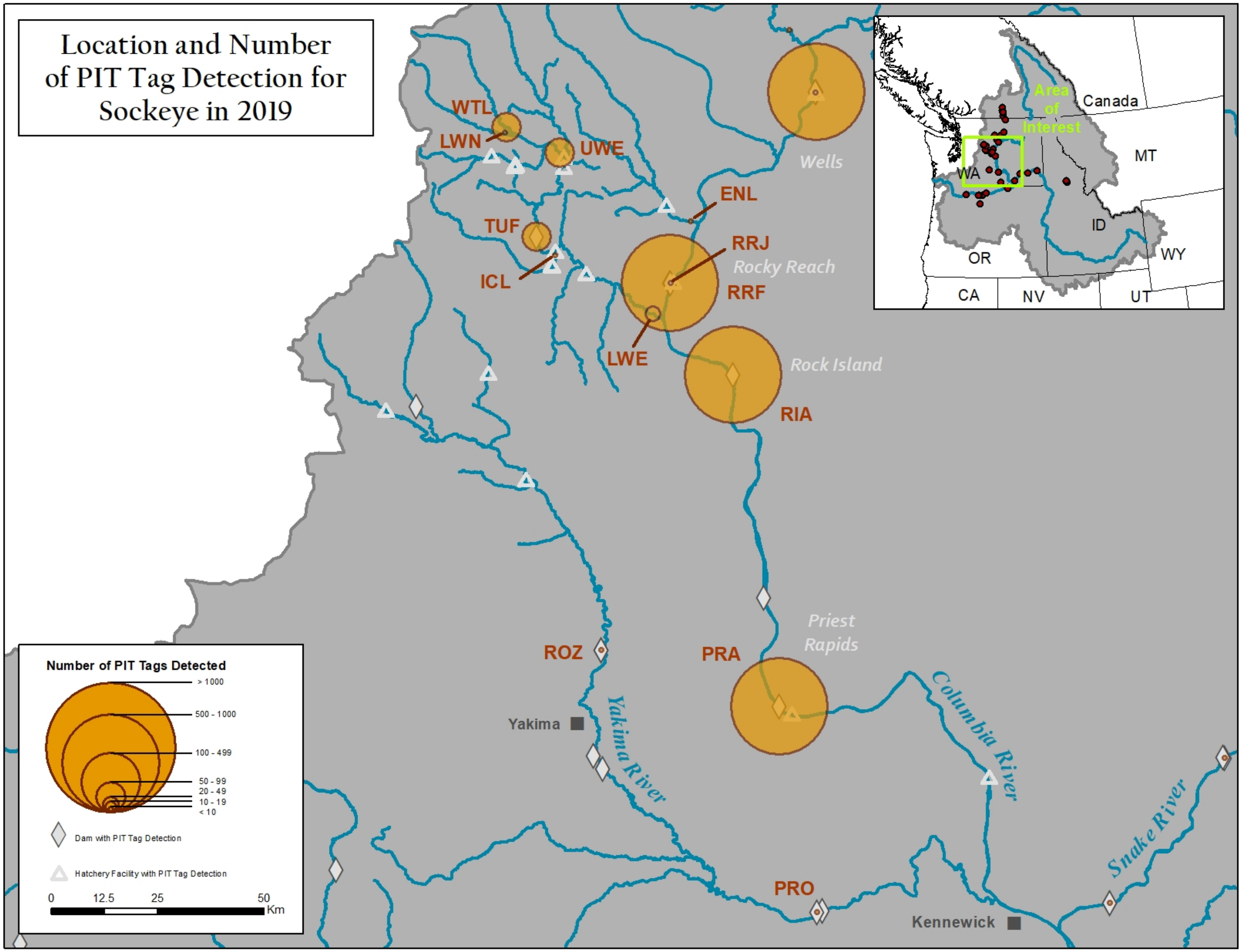

Figure B21. Map of Upper Columbia River (between the Snake River and Wells Dam) detection sites and number of Sockeye Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

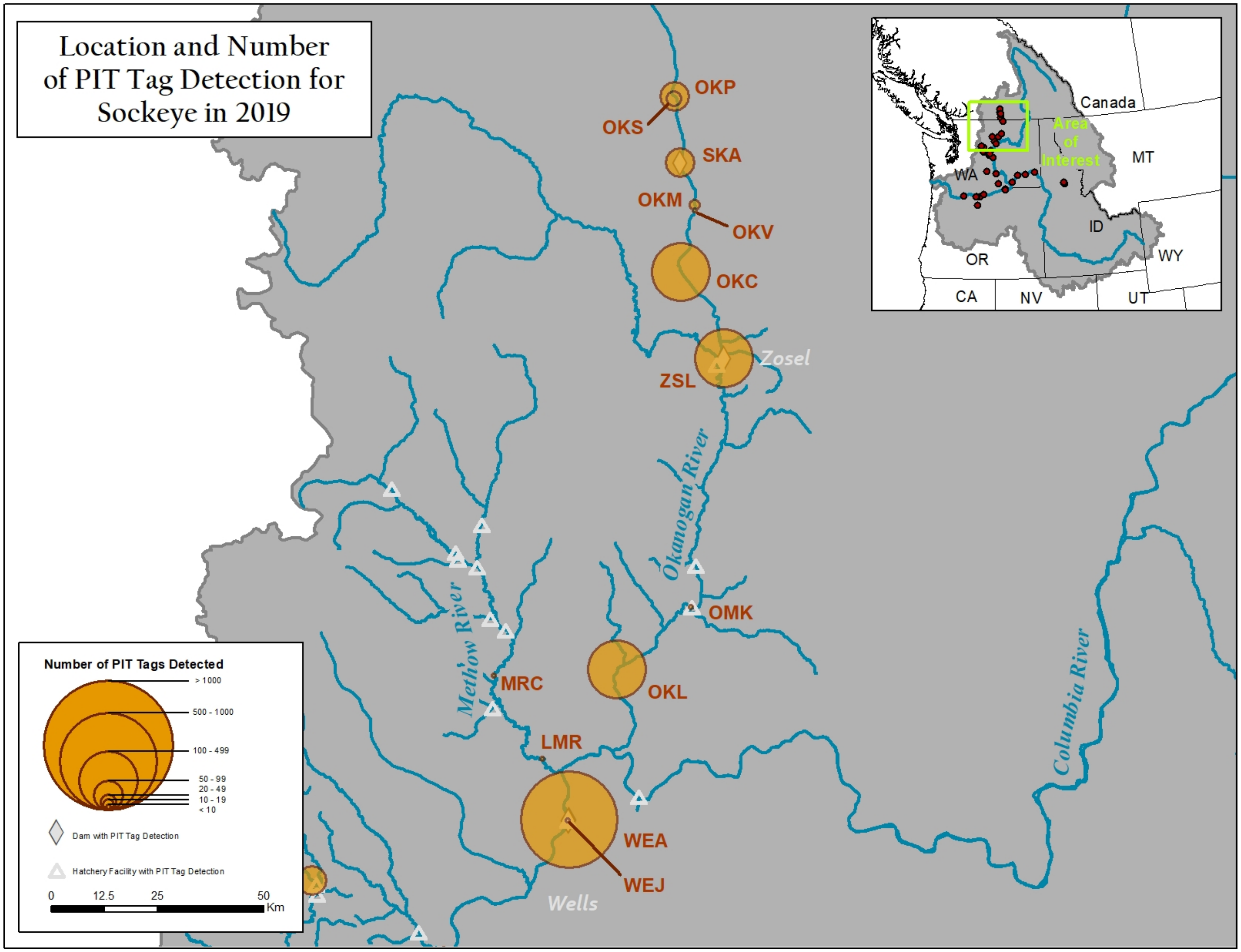

Figure B22. Map of Upper Columbia River (Wells Dam and above) detection sites and number of Sockeye Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

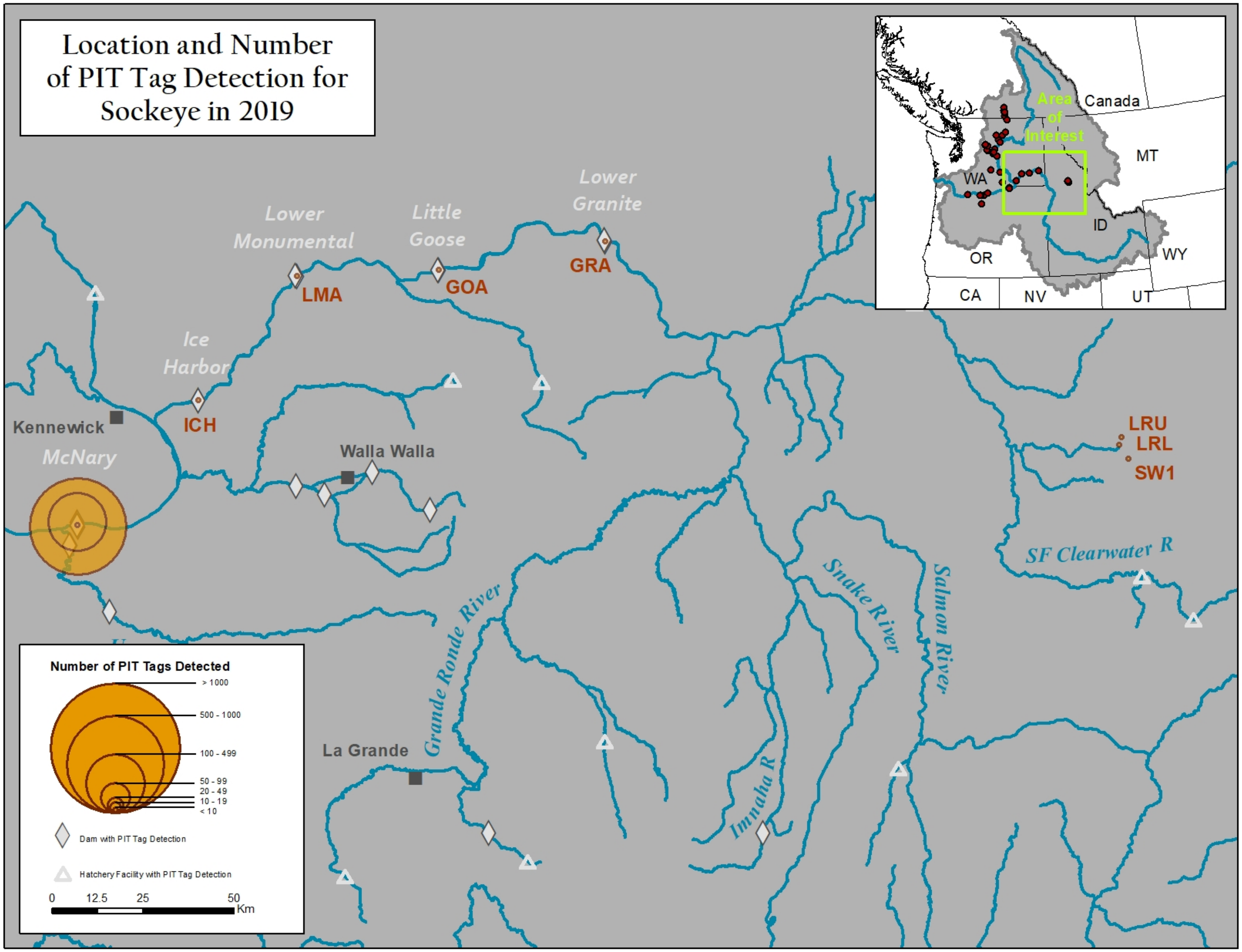

Figure B23. Map of Lower Snake River detection sites (Salmon River not included) and number of Sockeye Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

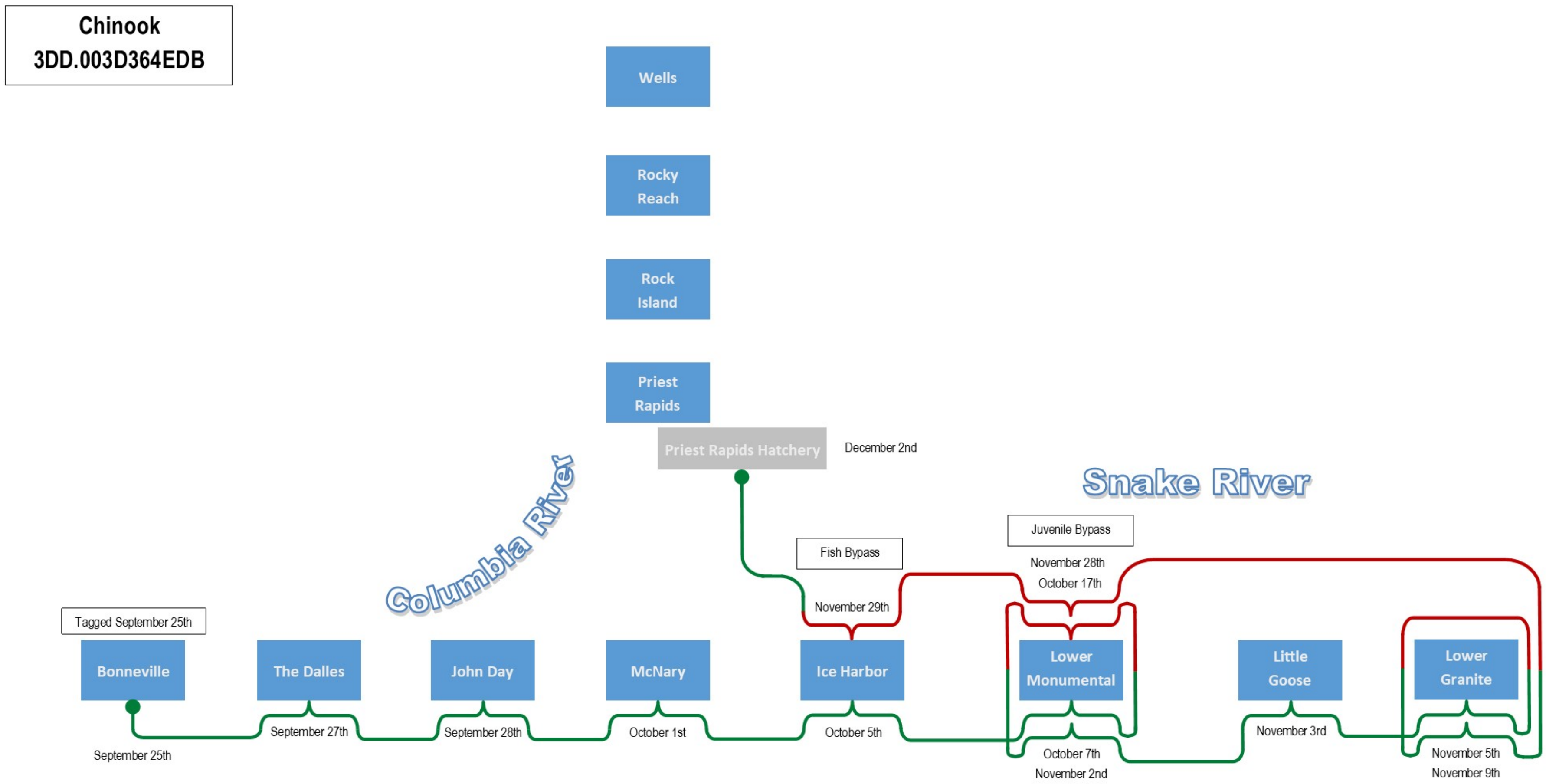

Figure B24. Chart showing the pattern and location of fall back events at mainstem dams on the Columbia and Snake rivers for Chinook Salmon with PIT tag 3DD.003D364EDB, tagged and tracked in 2019.

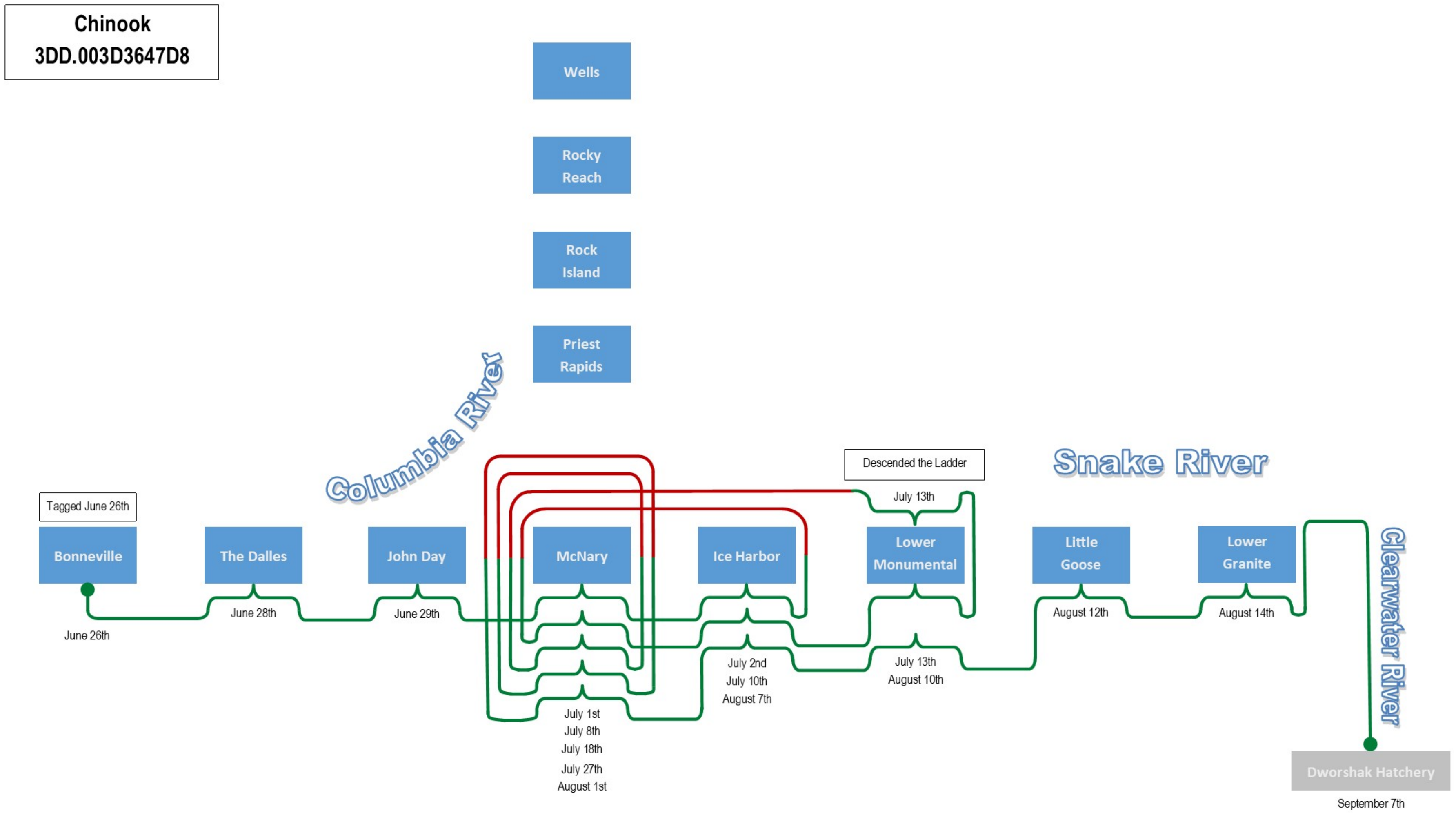

Figure B25. Chart showing the pattern and location of fall back events at mainstem dams on the Columbia and Snake rivers for Chinook Salmon with PIT tag 3DD.003D3647D8, tagged and tracked in 2019.

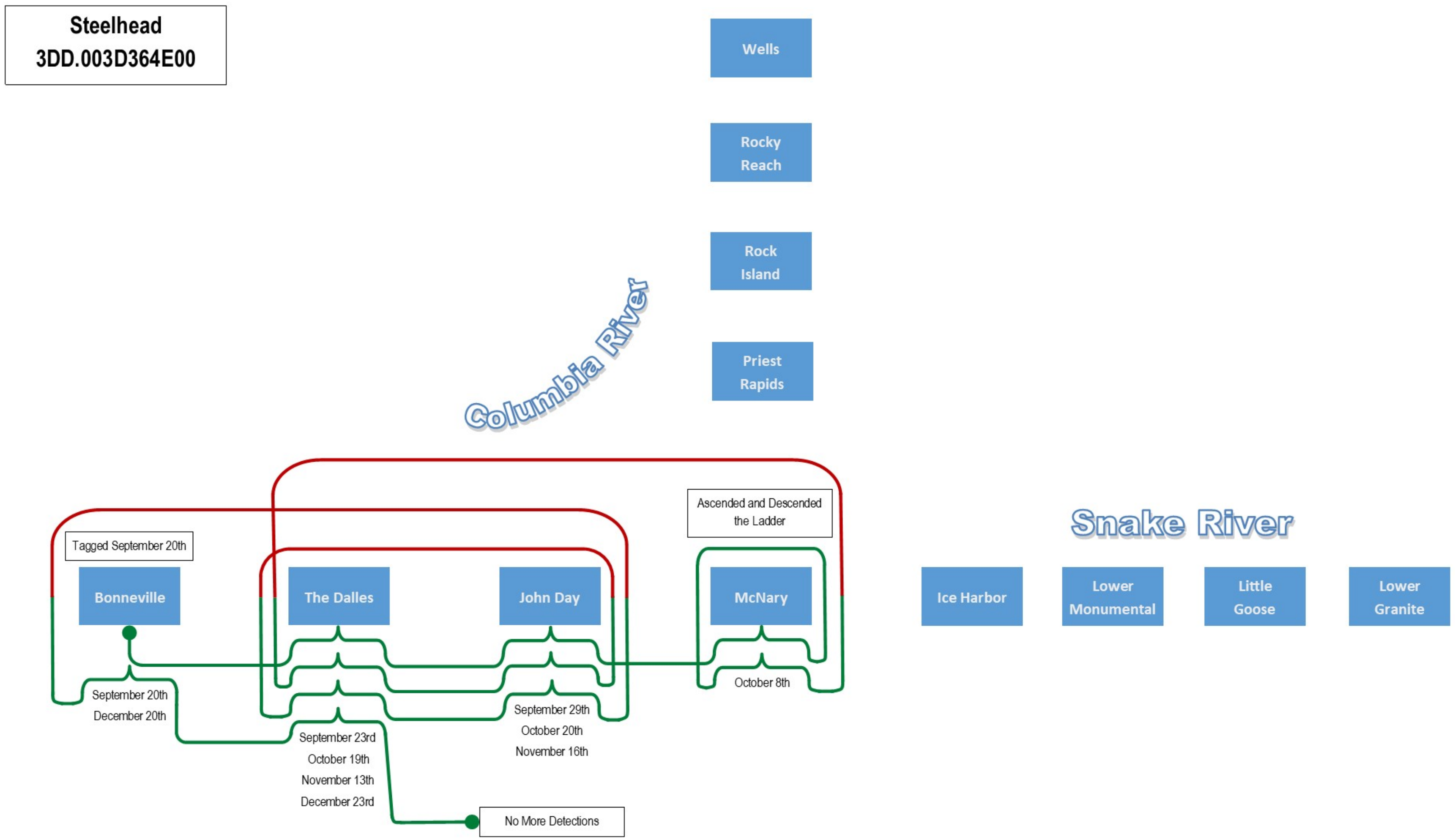

Figure B26. Chart showing the pattern and location of fall back events at mainstem dams on the Columbia and Snake rivers for steelhead with PIT tag 3DD.003D364E00, tagged and tracked in 2019.

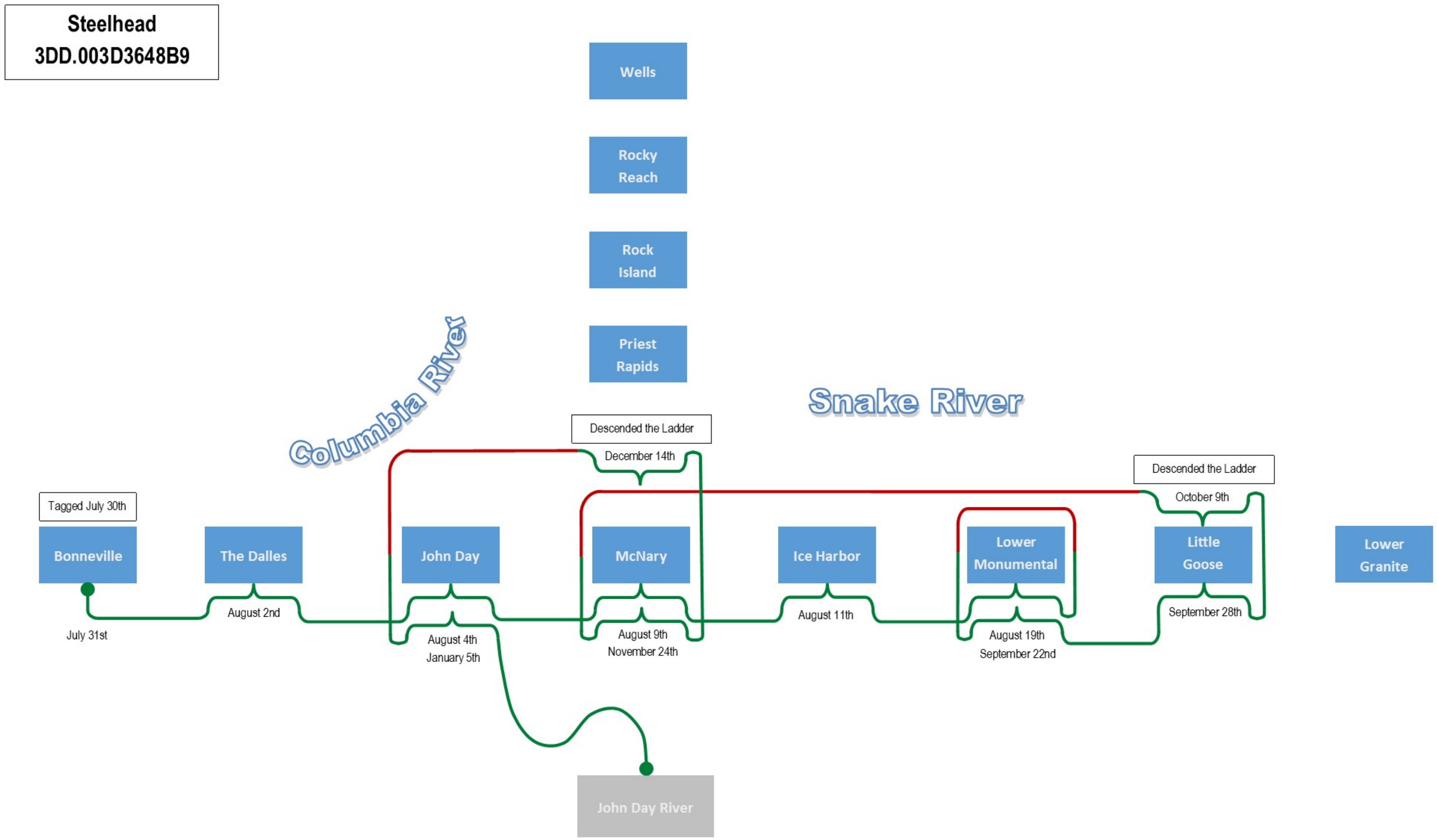

Figure B27. Chart showing the pattern and location of fall back events at mainstem dams on the Columbia and Snake rivers for steelhead with PIT tag 3DD.003D3648B9, tagged and tracked in 2019.

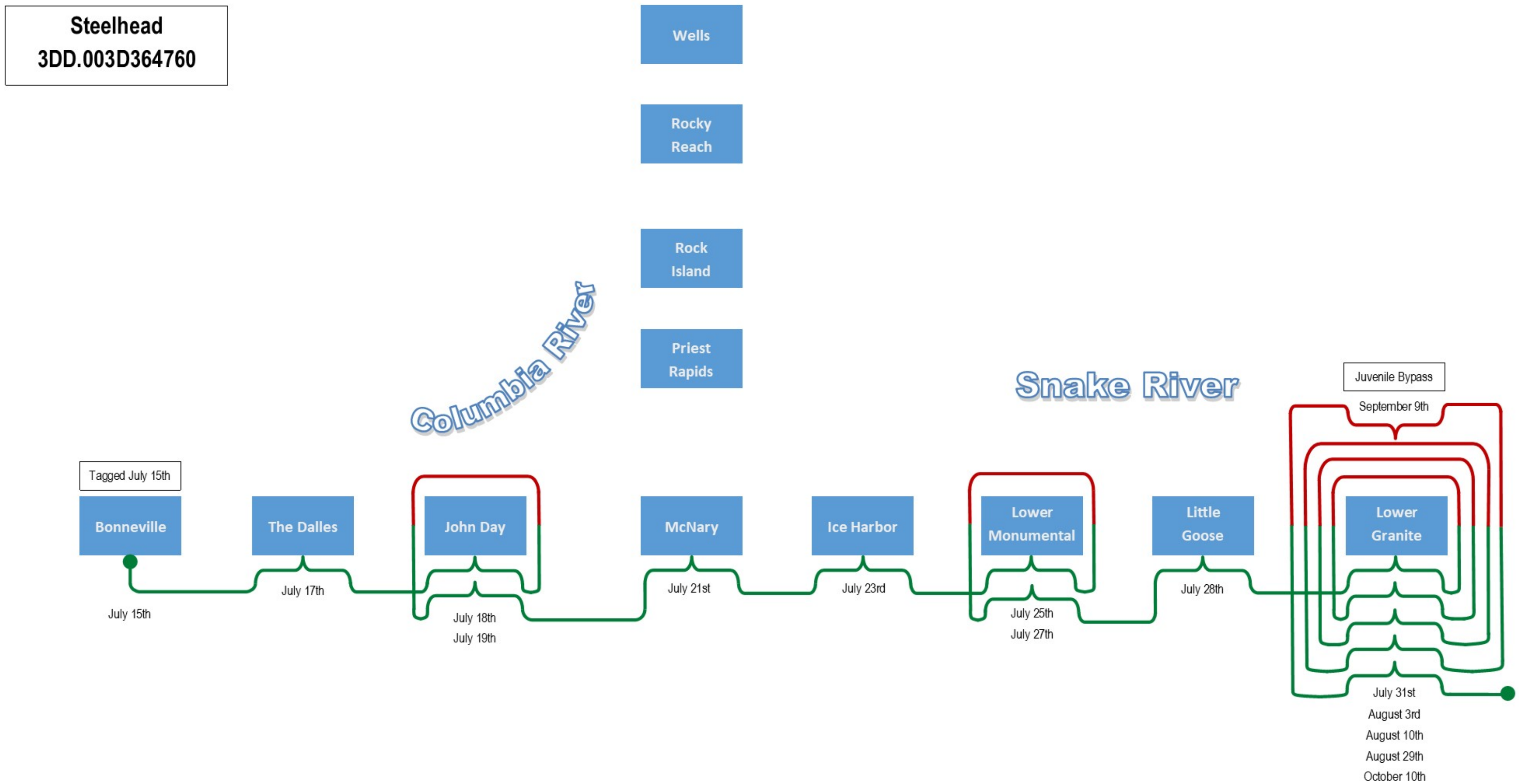

Figure B28. Chart showing the pattern and location of fall back events at mainstem dams on the Columbia and Snake rivers for steelhead with PIT tag 3DD.003D364760, tagged and tracked in 2019.