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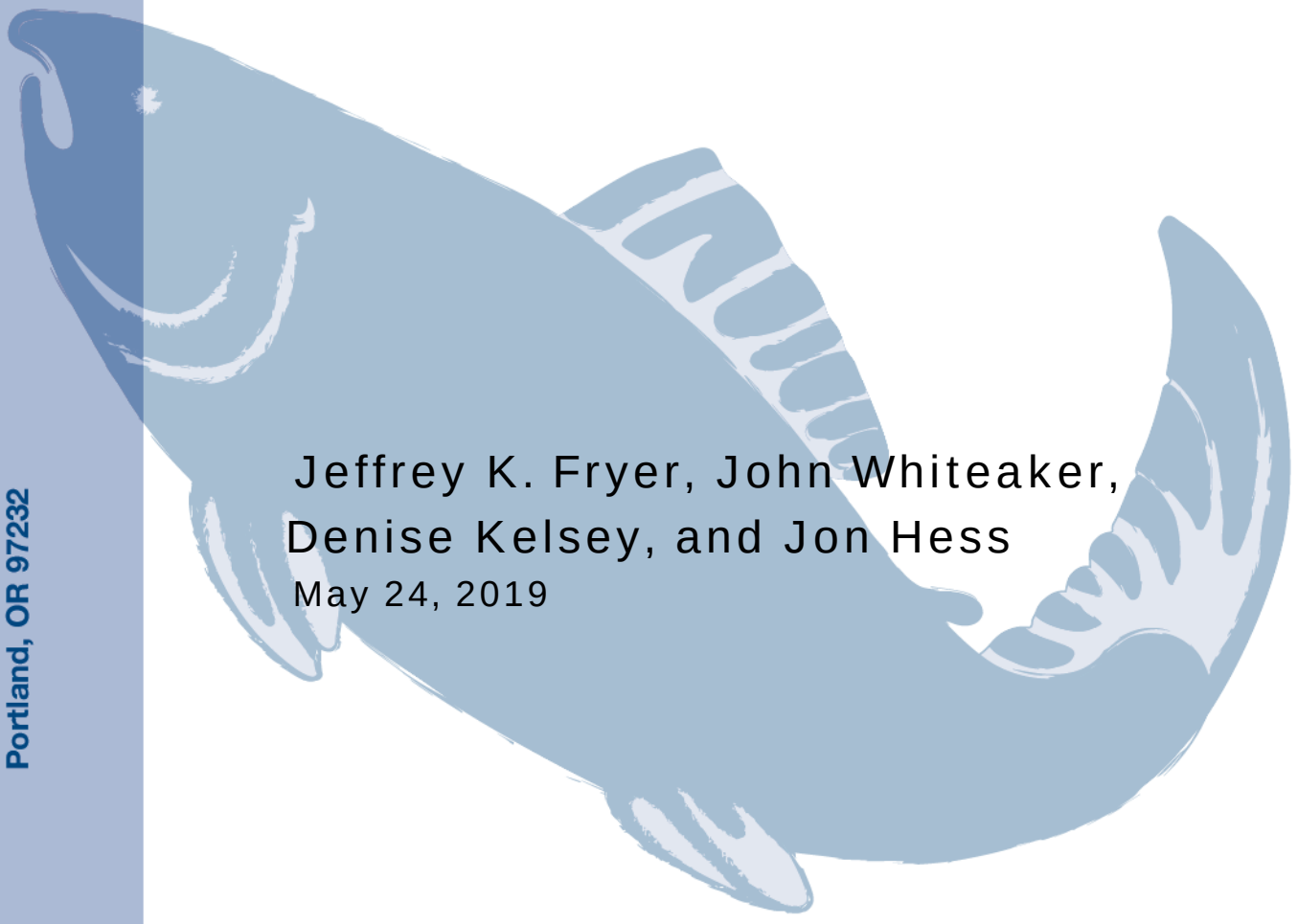
Upstream Migration Timing of Columbia Basin Chinook and Sockeye Salmon and Steelhead in 2017



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May 24, 2019

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Columbia River Inter-Tribal Fish Commission Technical Report for BPA Project 2008-518-00, Contract 76151

Report date range: 1/17–12/17

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ABSTRACT

Between April 19 and October 18, 2017, we sampled Chinook *(Oncorhynchus tshawytscha) and* Sockeye *(Oncorhynchus nerka)* salmon as well as steelhead (*Oncorhynchus mykiss)* at the Bonneville Dam Adult Fish Facility (AFF). Fish were measured for fork length, scales were collected for analysis of age, tissue samples collected for genetic analysis, and the fish were tagged with Passive Integrated Transponder (PIT) tags. These fish were tracked upstream as they passed through sites with PIT tag antennas, including fish ladders at dams, juvenile bypasses, hatcheries, weirs, as well as in-stream antennas. Total numbers of fish tracked upstream were 829 spring Chinook, 1,005 summer Chinook, 971 fall Chinook, 836 steelhead, and 1,079 Sockeye Salmon.

Chinook Salmon median migration rates between mainstem dams ranged between 18.7 km/day for fall Chinook migrating between McNary and Priest Rapids dams and 42.0 km/day for spring Chinook migrating between The Dalles and McNary dams. An estimated 31.8% of spring Chinook passed into the Snake Basin upstream of Ice Harbor Dam, while an estimated 58.0% of summer Chinook passed upstream of Priest Rapids dam into the Upper Columbia Basin. Among fall Chinook, the primary terminal area was between McNary Dam (passed by 45.0% of fall Chinook) and Ice Harbor Dam (passed by 8.6% of Fall Chinook) and Priest Rapids Dam (passed by 5.9% of all Fall Chinook). Escapement estimates for the entire Chinook run derived from PIT tag detections result in estimates differing from those estimated by visual counts by -15.8%% to -2.2% at mainstem dams.

Steelhead median migration rates reported between mainstem dams ranged from 11.2 km to 33.2 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), 83.3% 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 30.0% of the run in Statistical Week 37. The number of B-run steelhead peaked in Week 37 at 3,601 steelhead while the number of A-run (<78 cm) peaked in Week 34 at 22,728 fish. It should be noted that in Week 37, the total sample size was 10 steelhead, 3 of which were B-run. Also, sampling restrictions meant that no picket leads could be deployed in Week, 27, meaning the fish we sampled that week

entered the trap volitionally and may not have been representative of the run. A total of 64 steelhead PIT tagged and tracked in 2017 (were detected moving downstream (mostly in juvenile bypasses) after spawning, recovered or detected in kelt programs, or detected moving upstream in summer/fall 2017 or in 2018, and were designated as kelt.

A total of 1095 Sockeye Salmon were sampled in 2017 and 1079 tracked upstream. The principle age components of the run were Age 1.2 (47.6%), Age 1.3 (36.3%), and Age 1.1 (11.7%). Sockeye median migration rates between mainstem dams ranged between 28.4 and 51.7 km/day. Escapement estimates for the entire Sockeye run derived from PIT tag detections at mainstem Columbia River dams result in estimates differing from those estimated by visual counts by -18.0% to +23.4% at Columbia River dams.

ACKNOWLEDGMENTS

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INTRODUCTION

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

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

METHODS

Sampling

Chinook and Sockeye salmon and steelhead were collected from April 20 through October 18, 2017, at the Bonneville Dam Adult Fish Facility (AFF), located adjacent to the Second Powerhouse at river km 234. This facility uses a weir with four pickets to divert fish ascending the Washington shore fish ladder into the AFF collection pool. An attraction flow is used to draw fish that enter the collection pool through a false weir where they then can be selected for sampling. Fish not selected, and fish that have recovered from sampling, migrate back to the Washington shore fish ladder above the pickets. We attempted to exclude minijacks (defined as Chinook spending no winters in saltwater) from our sample by not diverting Chinook Salmon into the sampling tank that were estimated to be less than 36 cm in length, and immediately releasing without sampling any fish diverted that turned out to be less than this threshold. These small Chinook Salmon are excluded because sampling these fish would reduce our collection of larger Chinook, and other species, which are more important to managers. We also excluded from further analysis any Chinook, Steelhead, and Sockeye salmon that, based on scale analysis, did not spend a winter in saltwater.

Our use of the Bonneville Dam Adult Fish Facility is restricted by protocols established by the Fish Passage Operation and Maintenance Team (http://pweb.crohms.org/tmt/documents/fpp/2017/final/FPP17_AppG.pdf). These protocols have restrictions on the number of salmonids we can simultaneously have in our anesthetic and recovery tanks and restrict picket lead operations at higher fish abundances. At temperatures above 21.1C (70.0F), 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 22.2C (72.0F) sampling is halted until the daily average water temperature drops to 21.16C (71.9F). Picket lead deployment is also restricted when abundance of salmonids or shad is high with further restrictions when abundance occurs at high temperatures (Appendix A).

Salmon and steelhead selected for sampling were diverted into a tank where they were anesthetized, examined for tags, fin clips, wounds, and condition. They were measured for fork length, and tissue and six scales (four scales for Sockeye) 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.

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, 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. Each parallel antenna array we refer to 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 word "baffle" and "weir" is interchangeable), this is five weir detections, but only one site detection (Rock Island Dam).

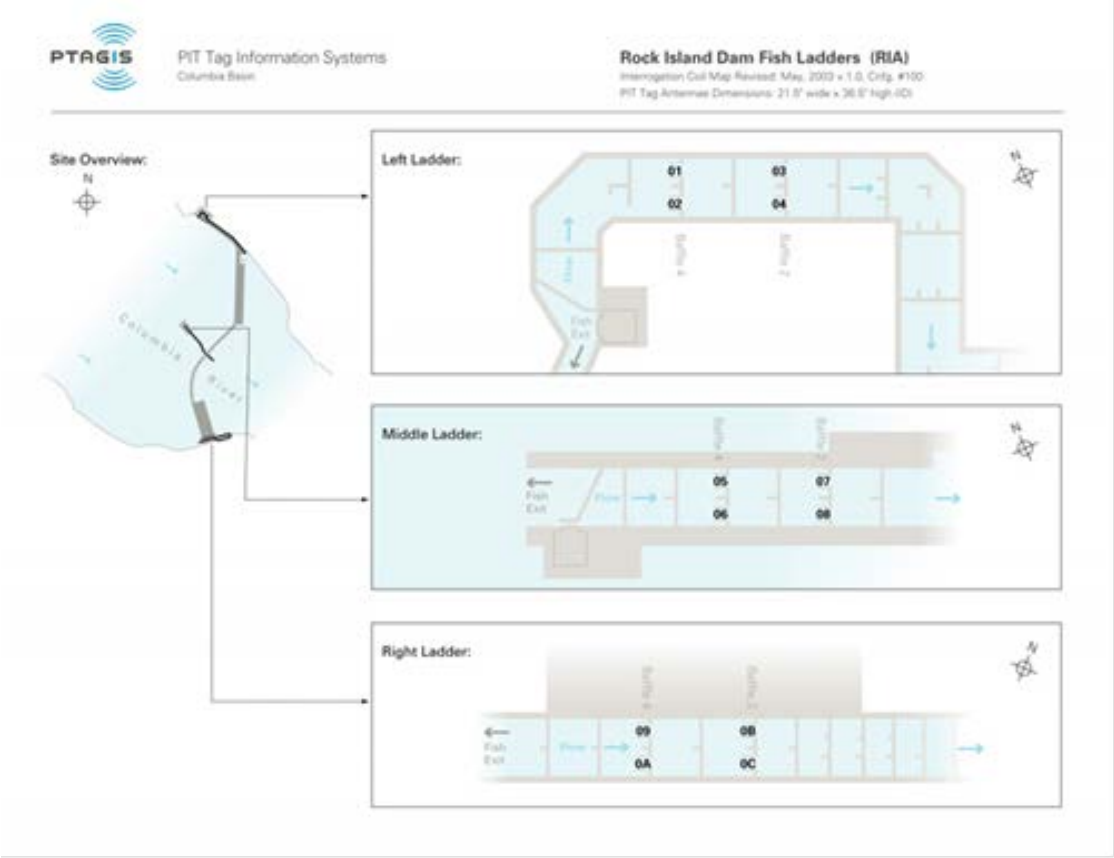

Figure 1. Example PIT tag detection configuration at Rock Island Dam showing two adjoining antennas at two weirs in each fish ladder. (Figure from www.ptagis.org.)

Site Detection Efficiencies

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

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

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

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

Age Analysis

Visual assessment of scale patterns was used to determine age composition through techniques developed for the Bonneville Stock Sampling project *(*Whiteaker and Fryer 2008, Kelsey et al. 2011*).* We used the European method for fish age description (Koo 1962) 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 2017, the PBT age was available when Chinook were being aged and that information was taken into account in estimating a scale age. This was not the case for steelhead.

Escapement

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

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

where N was the estimated escapement at a particular upstream site, *i* was the week at Bonneville Dam, B_i was the weekly count of fish passing Bonneville Dam

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

Migration Rates and Passage Times

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

Upstream Age and Length-at-Age Composition Estimates

The age composition at upstream locations was calculated as:

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

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

Fallback

Three methods were used to determine fallback, which is defined as a fish that ascends a fish ladder into the reservoir above the dam, then "falls back" to the downstream side of the dam either over the spillway, or through the navigation locks, juvenile bypass systems, or turbines. The first was if an adult salmon or steelhead was detected in the juvenile bypass system. However, on the Columbia River, only Bonneville, John Day, McNary, 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 window (which are believed to detect all passing PIT tagged fish), while

the PIT tag detectors near the entrance to the fish ladder. 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 (http://www.ptagis.org for maps of sites). Finally, a third method of defining fallback was ascertained by fish that passed an upstream PIT tag detector at a given dam, then were next observed at a site downstream of the dam in question. These methodologies will underestimate fallback as they do not include fish that fall back over a dam and are not subsequently detected.

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

Night Passage

Fish counting at Columbia Basin dams is not consistent between dams. Salmonids passing Corps of Engineers-operated dams (Bonneville, The Dalles, McNary, Ice Harbor, Lower Monumental, Little Goose and Lower Granite are counted live by observers stationed at fish ladder viewing windows from 0400 to 2000 PST with most supplemented with video counts of passage between 2000 and 0400 from June through September (http://www.nwd-wc.usace.army.mil/tmt/documents/fpp/2016/index.html) during the months 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 configeration 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 at which 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 for 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 consider fish moving between March 1st and April 1st through juvenile bypasses and the Bonneville Corner Collector as kelts, especially when tag detections indicate they have visited upper reaches of tributaries in late winter early spring.

Straying

For the first time in 2017, stray rates were estimated by comparing PIT tag movements of steelhead and Chinook with GSI/PBT results. We created a matrix of final-PIT-fate categories (neutral, on-target, putative stray, and putative overshoot). “Neutral” fates indicate movements through the mainstem river corridor on route to its expected destination (basin-of-origin, population-of-origin, or hatchery-of-origin). “On-target” fates indicate fish that were last detected at their

expected destination. “Putative stray” indicates fish that were last detected in tributaries or the mainstem that were outside of a normal route to their expected destination. “Putative overshoot” indicates when a fish may have gone into an area adjacent to its expected destination. Common examples of “putative overshoot: are Umatilla River Chinook last detected at McNary Dam and Priest Rapids Hatchery Chinook last detected at Priest Rapids Dam. The stray rate for a given stock was estimated as the number of “putative stray” fish divided by the sum of the “on-target” and “putative stray” fish for that stock. This is the template that we will build upon in future years.

RESULTS-CHINOOK

Sample Size

A total of 830 spring Chinook, 1,012 summer Chinook, and 979[1] fall Chinook Salmon were sampled in 2017 (Tables 1-3) between April 20 and October 18, 2017. Sampling restrictions due to water temperatures exceeding 21.1C reduced sampling days and hours during Statistical Week[2] 30 and 31 of the summer Chinook run and weeks 31-37 of the fall Chinook run with no sampling occurring during the entirety of Week 32 due to water temperatures exceeding 22.2C. Restrictions on the number of pickets which could be lowered to divert fish into the AFF due to fish abundance affected sampling in weeks 22, 25-27, and 34-38. A total of 817 spring Chinook, 994, summer Chinook, and 975 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 12 fall Chinook classified as minijacks, the numbers of Chinook tracked upstream and used in analysis, consisted of 829 spring Chinook, 1005 summer Chinook, and 971 fall Chinook Salmon (Table 1-3).

Table 1. Number of PIT tagged spring Chinook Salmon at Bonneville Dam and then tracked, by date and statistical week, in 2017.

Sample Dates	Week	Sampled	Tagged	Previously Tagged	Mortalities	Not Detected After Release	Total Tracked	Days Sampling Restrictions in Effect		
								Reduced Sampling-Temperature	Reduced Sampling-Shad or Salmonid	No Sampling-Temperature
4/20-21,24-26	16-17	14	14	0	0	0	14	0	0	0
5/1-5	18	138	138	0	0	0	138	0	0	0
5/8-12	19	198	193	5	0	5	198	0	0	0
5/15-19	20	131	130	1	0	1	131	0	0	0
5/22-26	21	254	248	6	0	7	253	0	1	0
5/30-31	22	95	94	1	0	1	95	0	0	0
Total		**830**	**817**	**13**	**0**	**14**	**829**	**0**	**1**	**95**

[1] After 12 Chinook were excluded as minijacks

[2] 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 2017, for instance, Statistical Week 24 began on June 11 and ended on June 17.

Table 2. Number of PIT tagged summer Chinook Salmon tracked at Bonneville Dam by date and statistical week in 2017.

Sampling Dates	Week	Sampled	Tagged	Previously Tagged	Mortalities	Not Detected After Release	Total Tracked	Days Sampling Restrictions in Effect		
								Reduced Sampling-Temperature	Reduced Sampling-Shad or Salmonid	No Sampling-Temperature
6/1-6/2	22	120	117	3	0	4	116	0	0	0
6/5-6/9	23	162	160	2	0	0	162	0	0	0
6/12-6/16	24	158	157	1	0	0	158	0	0	0
6/19-6/23	25	114	110	3	0	0	113	0	3	0
6/26-6/30	26	117	113	3	0	0	116	0	4	0
7/3,7/5-7	27	120	119	0	1	0	119	0	1	0
7/10-7/14	28	87	85	2	0	0	87	0	0	0
7/17-7/21	29	67	66	1	0	0	67	0	0	0
7/24-7/27	30	55	54	1	0	0	55	3	0	1
7/31	31	12	12	0	0	0	12	1	0	0
Total		**1012**	**994**	**16**	**1**	**20**	**1005**	**4**	**8**	**1**

Table 3. Number of PIT tagged fall Chinook Salmon tracked at Bonneville Dam by date and statistical week in 2017.

Sampling Dates	Week	Sampled	Tagged but excluded as Minijacks	Tagged	Previously Tagged	Mortalities	Not Detected After Release	Total Tracked	Days Sampling Restrictions in Effect		
									Reduced Sampling-Temperature	Reduced Sampling-Shad or Salmonid Abundance	No Sampling-Temperature
8/1	31	6	0	6	0	0	0	6	1	0	3
No Sampling	32								0	0	5
8/17	33	20	0	20	0	0	0	20	1	0	4
8/21-8/24	34	31	0	31	0	0	0	31	4	0	1
8/28-8/29, 9/1	35	70	1	69	0	0	0	69	3	0	2
9/8	36	47	0	47	0	0	0	47	1	0	3
9/11-9/14	37	222	1	217	1	3	3	214	4[3]	0	1
9/18-9/22	38	96	4	92	1	0	0	92	0	1	0
9/25-9/29	39	214	3	211	3	0	1	210	0	0	0
10/2-10/6	40	174	3	171	0	0	0	171	0	0	0
10/9-10/13	41	73	0	73	2	0	0	73	0	0	0
10/16-10/18	42	38	0	38	0	0	0	38	0	0	0
Total		**991**	**12**	**975**	**7**	**3**	4	**971**	**14**	**1**	**19**

[3] No leads could be put down due to the combination of fish abundance and temperature September 12-14.

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 2017 high temperatures curtailed sampling primarily during weeks when few Chinook were passing (Figures 2-4). For spring Chinook, the largest deviations between weekly sample proportion and run proportion was Week 19, where the sample proportion was much greater than the population proportion. For summer Chinook, the largest deviations were in weeks 25 and 26 where sampling was proportionally less than the run (due to limitations in deployment of picket leads based on abundance protocols, primarily shad, as well as efforts to maximize Sockeye sampling). Fall Chinook sampling was adversely affected in Week 37 due to limitations on picket lead deployment due to Chinook and steelhead abundance protocols as well as limits on sampling hours due to temperature restrictions.

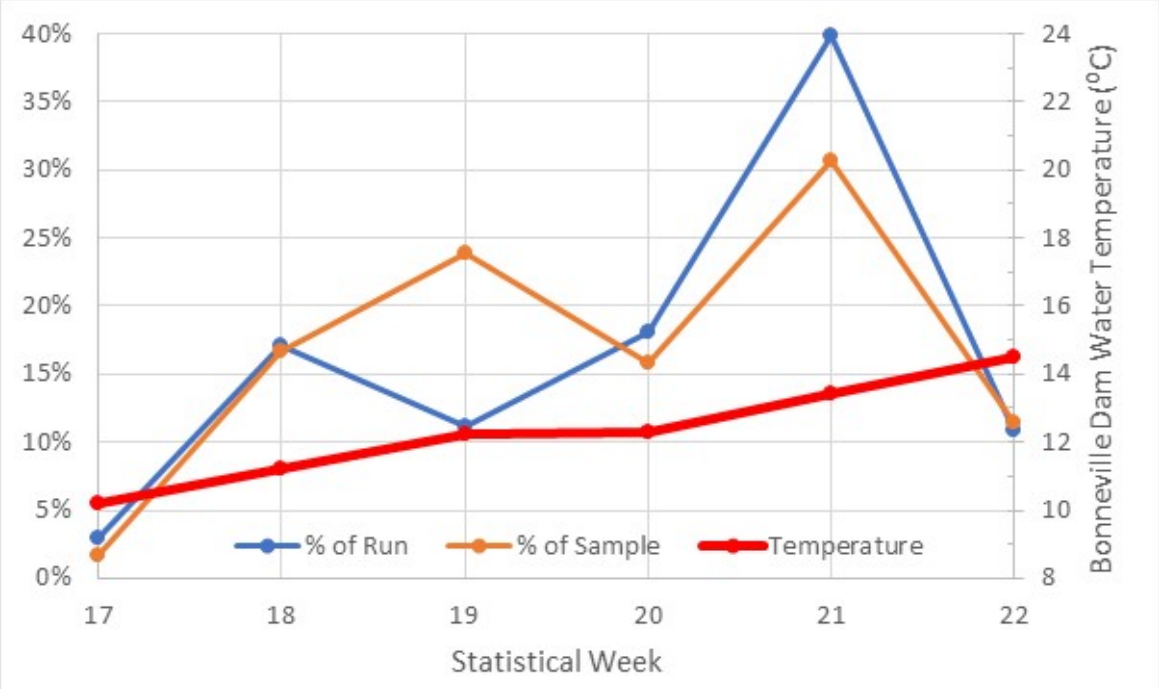

Figure 2. The weekly spring Chinook sample and run as a percentage of the total sample and run size at Bonneville Dam in 2017.

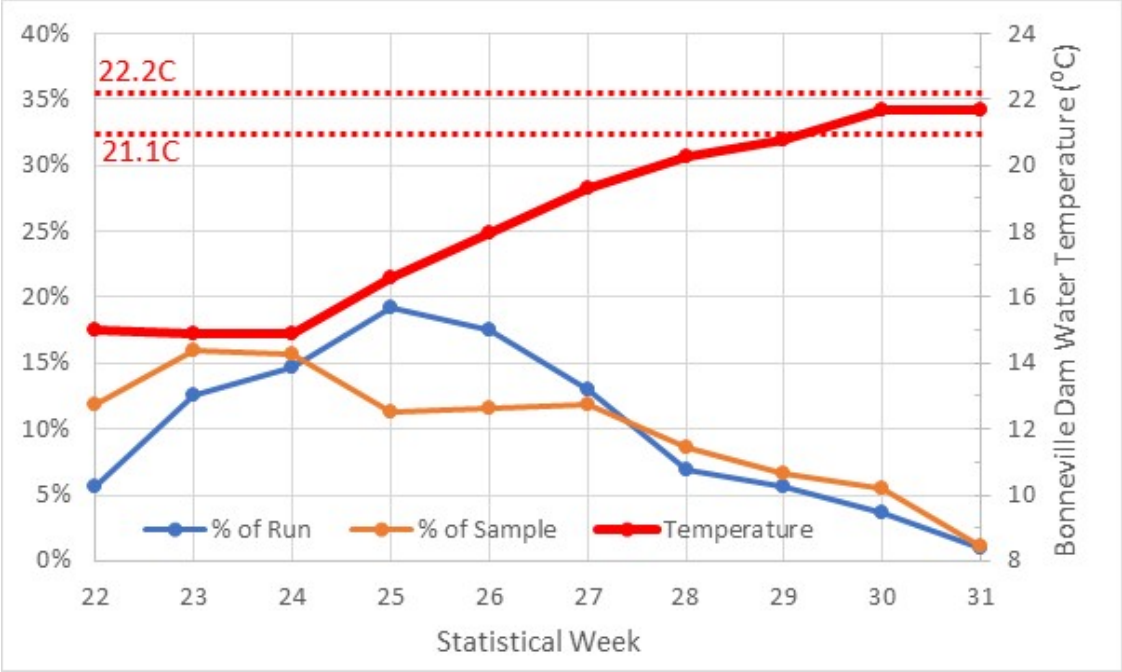

Figure 3. The weekly summer Chinook sample and run as a percentage of the total sample and run size at Bonneville Dam in 2017. Bonneville trap regulations require reduced sampling at 21.1C with sampling halted at 22.2C.

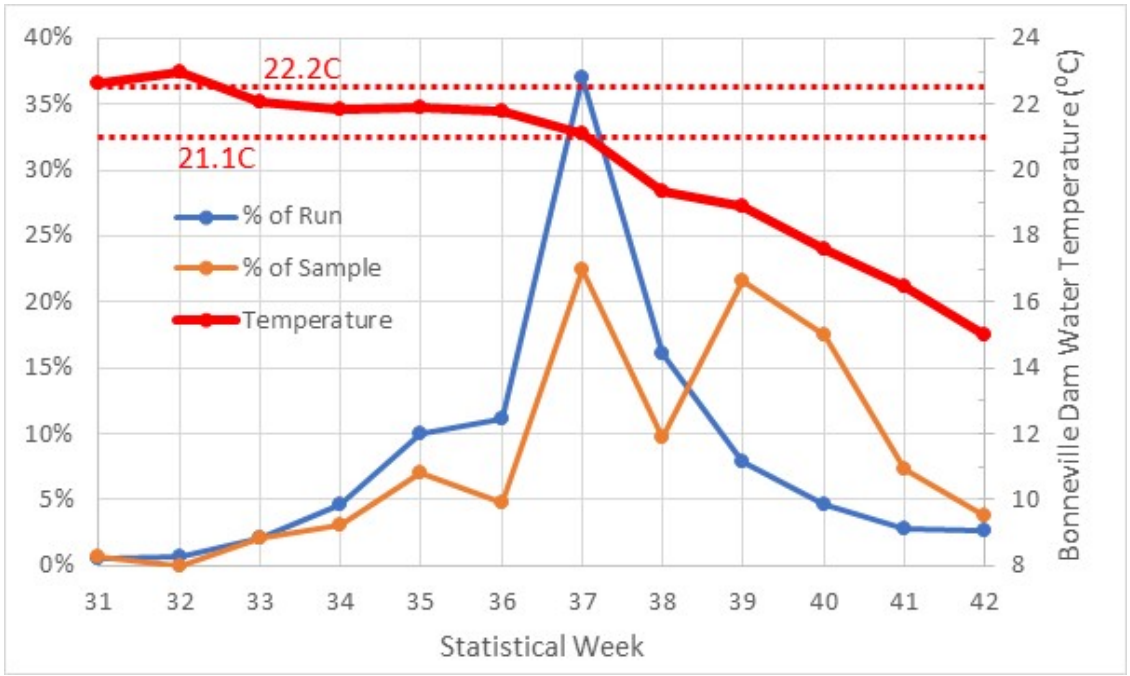

Figure 4. The weekly fall Chinook sample and run as a percentage of the total sample and run size at Bonneville Dam in 2017. Bonneville trap regulations require reduced sampling at 21.1C with sampling halted at 22.2C.

Detection Numbers

The tracking of 829 spring Chinook generated 43,484 weir detections, which were grouped into 4225 site detections at 88 sites. The 1005 summer Chinook generated 54,321 weir detections, grouped into 6024 site detections at 78 sites, and the 971 fall Chinook generated 31,919 weir detections grouped into 3630 site detections at 40 sites. Maps and table of sites found in the Appendix B (Table B1 and Figures B2-B15) 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 2017).

Age Analysis

We were able to validate our scale aging techniques by using fish sampled at Bonneville that were previously PIT tagged as juveniles for other projects or hatchery programs. In 2017, we had ageable scale patterns from 9 spring Chinook, 12 summer Chinook, and 1 fall Chinook, PIT tagged as juveniles that were sampled as returning adults by this project, all of which were aged correctly. Only the total age was compared, as it is not possible to separate freshwater and saltwater age using PIT tag data.

Mainstem Dam Recoveries, Mortality, and Escapement Estimates

Spring Chinook Salmon that traveled upstream of McNary Dam were predominantly last detected at or upstream of Ice Harbor Dam in the Snake River (Table 4, Figures 5 and 6), while summer Chinook were primarily bound for the Columbia River upstream of Priest Rapids Dam (Table 4, Figures 5 and 7). Fall Chinook were primarily last detected at areas between McNary and Ice Harbor/Priest Rapids dams (the location of Ringold and Priest Rapids hatcheries, which rear fall Chinook Salmon) as well as the Hanford Reach spawning area (Table 4, Figures 5 and 8). The percentage of all Chinook that ultimately passed Ice Harbor Dam peaked during the spring Chinook migration, Chinook passing Priest Rapids Dam peaked during the summer Chinook migration, and the percentage last detected between McNary and Ice Harbor/Priest Rapids dams peaked during the fall Chinook migration (Figure 5). The percentage last detected downstream of McNary Dam during the early fall Chinook migration with another peak at the beginning of the spring Chinook migration.

Table 4. Percentage of spring, summer, and fall Chinook Salmon tracked from Bonneville Dam detected at upstream dams in 2017.

Dam	Spring Chinook	Summer Chinook	Fall Chinook
The Dalles	64.9%	83.0%	61.5%
McNary	48.8%	71.5%	45.0%
Priest Rapids	8.1%	58.0%	5.9%
Rock Island	7.9%	55.6%	2.6%
Rocky Reach	5.4%	43.3%	2.3%
Wells	4.9%	32.7%	1.5%
Ice Harbor	31.8%	10.3%	8.6%
Lower Monumental	31.5%	10.3%	8.6%
Little Goose	31.2%	10.3%	8.0%
Lower Granite	30.6%	9.9%	7.0%

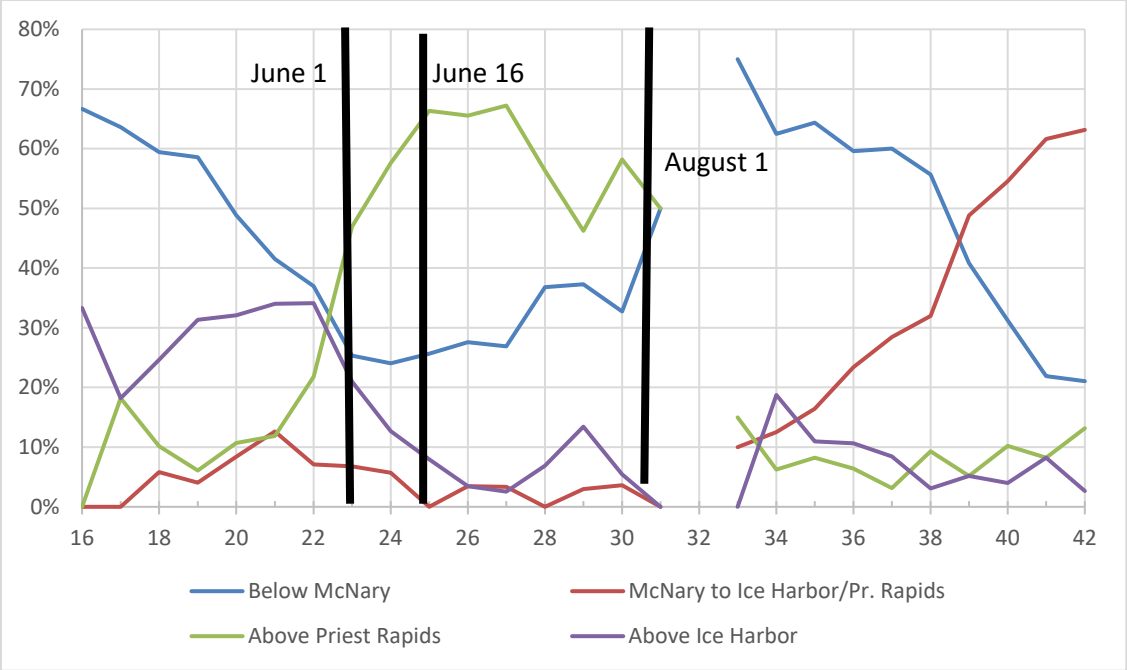

Figure 5. Distribution of final detection areas of the Columbia Basin by statistical week for Chinook Salmon PIT tagged at Bonneville Dam in 2017. Dates used to differentiate spring, summer, and fall Chinook are shown.

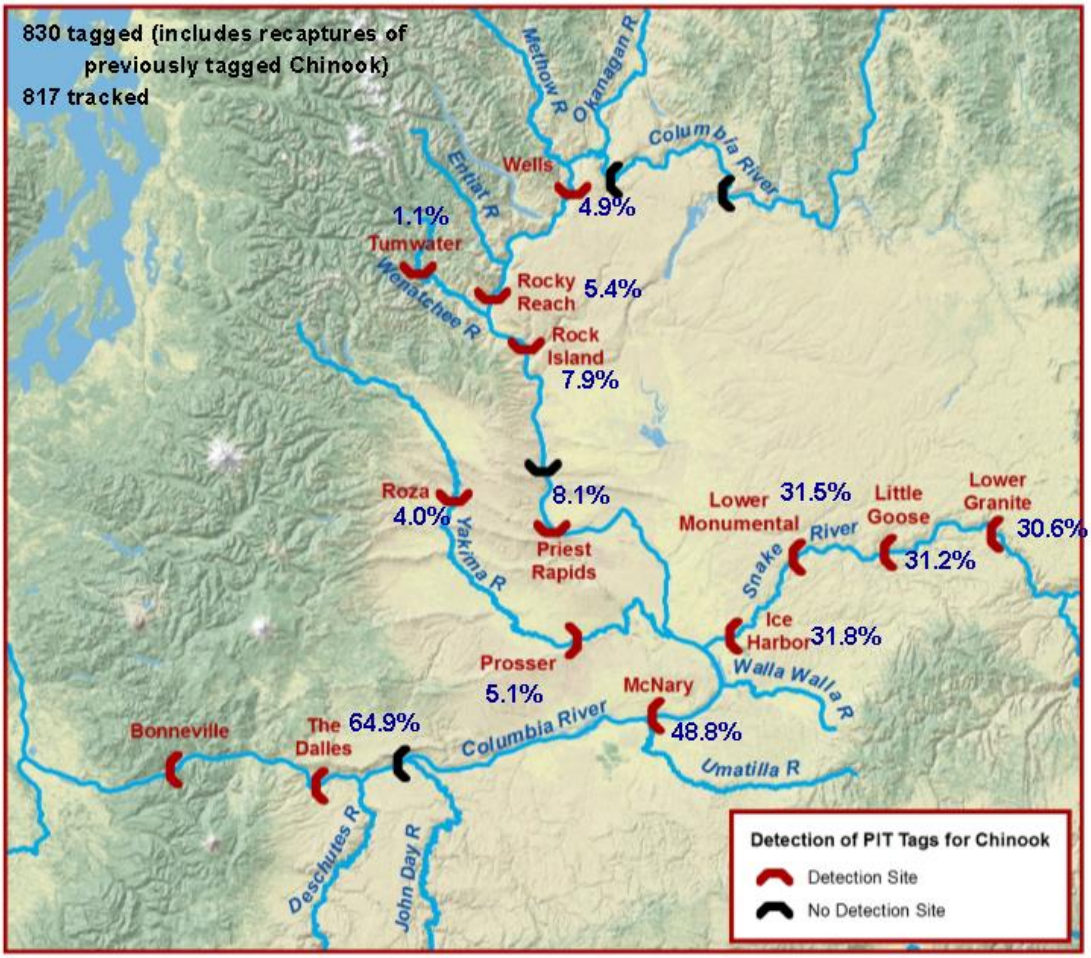

Figure 6. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of spring Chinook Salmon PIT tagged at Bonneville Dam, and the percentage of the run estimated to pass upstream dams in 2017.

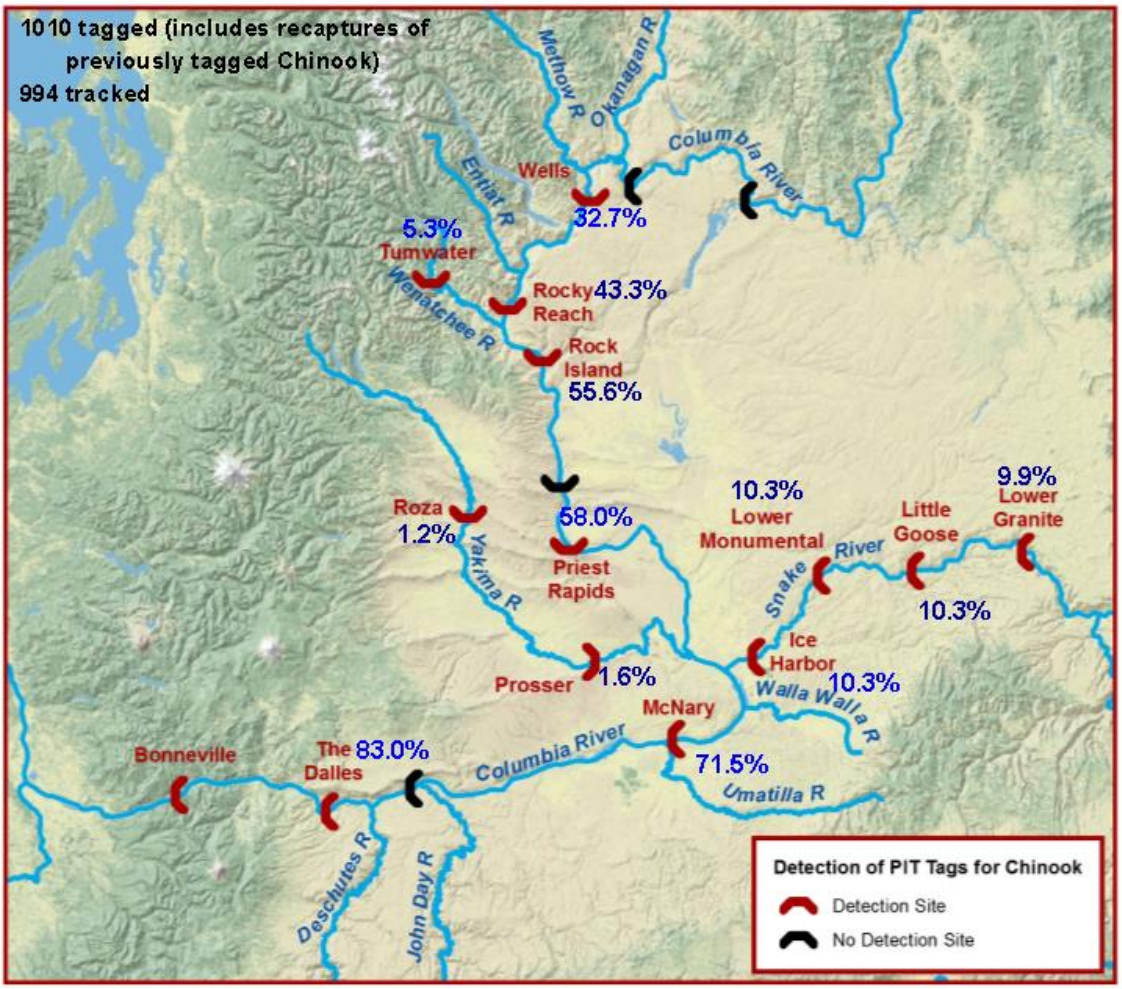

Figure 7. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of summer Chinook Salmon PIT tagged at Bonneville Dam, and the percentage of the run estimated to pass upstream dams in 2017.

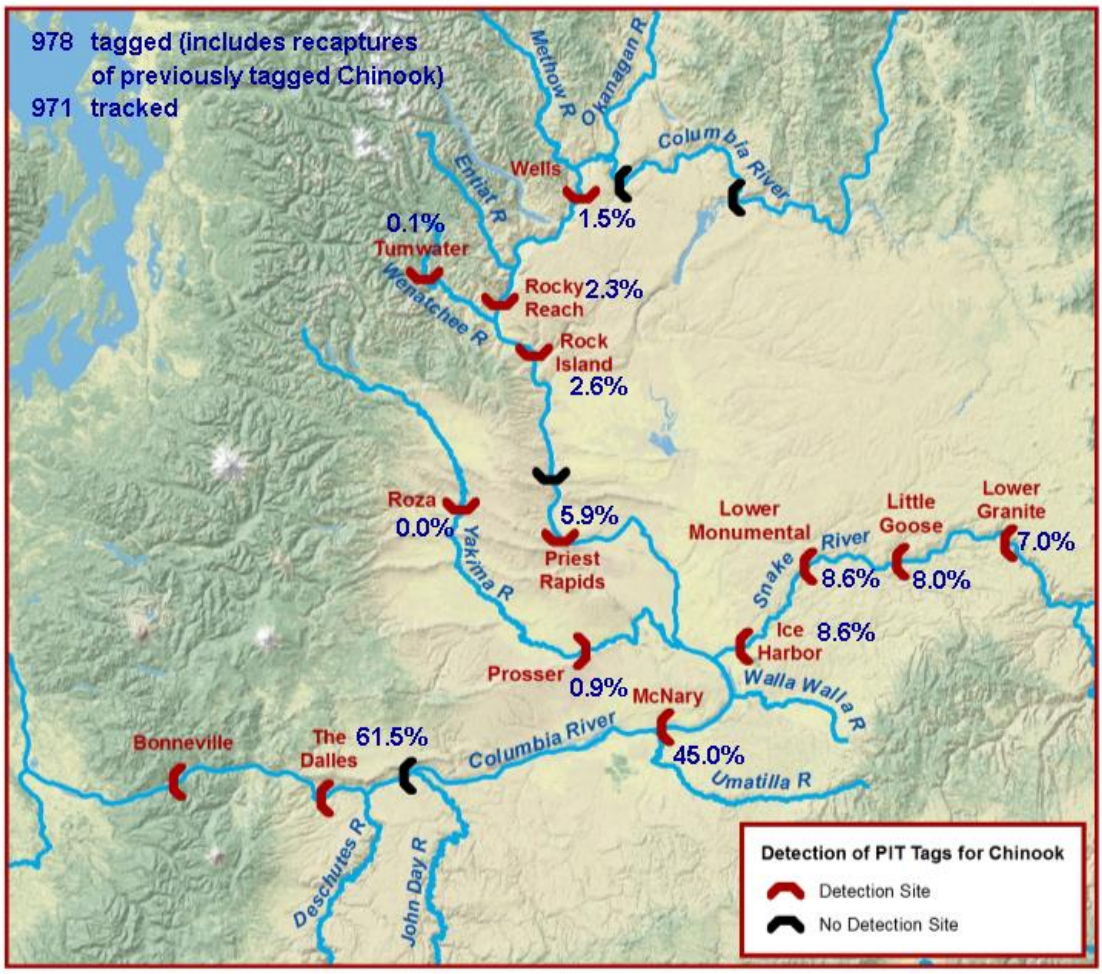

Figure 8. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of fall Chinook Salmon PIT tagged at Bonneville Dam, and the percentage of the run estimated to pass upstream dams in 2017. Twelve minijacks sampled and tagged are excluded.

Male spring and summer Chinook predominated at all dams, with the percentage of male summer Chinook estimated to be over 70% at the four Snake River Dams. For fall Chinook, the ratio was closer to 50-50 downstream of McNary Dam, with females predominating in the Snake River (Table 5).

Table 5. Percentage males at upstream dams by run as estimated by GSI in 2017.

Dam	Spring	Summer	Fall
Bonneville	57.4%	59.1%	49.0%
The Dalles	60.8%	58.4%	49.5%
McNary	59.7%	59.8%	49.5%
Priest Rapids	68.5%	56.9%	57.8%
Rock Island	69.8%	56.2%	56.7%
Rocky Reach	71.4%	56.3%	50.0%
Wells	77.4%	56.6%	38.9%
Ice Harbor	57.7%	70.6%	43.7%
Lower Monumental	57.9%	70.6%	43.7%
Little Goose	58.0%	70.6%	41.5%
Lower Granite	58.8%	70.5%	46.6%

The mean percentage of PIT tagged Chinook Salmon passing a dam without detection, excluding Rock Island Dam, was 1.3% for spring Chinook, 1.3% for summer Chinook, and 0.3% for fall chinook (Table 6). At Rock Island Dam, the rate for missed tags was 33.9% for spring Chinook, 17.8% for summer Chinook, and 7.1% for fall Chinook. High rates of missed PIT tagged fish at Rock Island Dam have also been observed in other years and are likely attributable to antenna size and electrical noise (Fryer et al. 2011). Bonneville, The Dalles, McNary, Ice Harbor, Lower Monumental, Little Goose, and Lower Granite dams all have navigation locks where it is possible that PIT tagged fish could pass upstream undetected.

Table 6. Percentage of Chinook Salmon detected upstream that missed detection at mainstem dams in 2017.

Dam	Spring	Summer	Fall
Bonneville	0.7%	2.3%	0.4%
The Dalles	0.7%	1.2%	0.0%
McNary	1.3%	1.6%	0.5%
Priest Rapids	0.0%	0.0%	0.0%
Rock Island	33.9%	17.8%	7.1%
Rocky Reach	0.0%	0.0%	0.0%
Wells	0.0%	0.0%	0.0%
Ice Harbor	1.9%	4.7%	1.4%
Lower Monumental	3.9%	1.7%	0.0%
Little Goose	0.4%	1.7%	0.0%
Lower Granite	4.4%	0.0%	0.0%
Weighted Mean (by sample size) excluding Rock Island Dam	**1.3%**	**1.3%**	**0.3%**

Total Chinook escapement estimates based on PIT tags were within 8.9% of visual counts at all mainstem dams except for Priest Rapids (-13.2%) and Lower Granite (-15.8%) dams (Table 7). PIT tag estimates were generally less than those of visual counts and were always less for total Chinook visual counts.

Table 7. Spring, summer, fall, and total Chinook Salmon escapement at Columbia Basin mainstem dams upstream of Bonneville Dam in 2017. Estimates are from both PIT tag recoveries and dam counts (FPC 2018).

	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	70,807	66,074	-6.7%	78,523	81,936	4.3%
McNary	51,312	49,629	-3.3%	61,984	70,570	13.9%
Priest Rapids	8,051	8,198	1.8%	54,741	57,237	4.6%
Rock Island	8,644	8,072	-6.6%	57,598	54,848	-4.8%
Rocky Reach	6,270	5,478	-12.6%	43,668	42,696	-2.2%
Wells	7,409	4,968	-32.9%	31,203	32,239	3.3%
Ice Harbor	35,255	32,402	-8.1%	11,371	10,131	-10.9%
Lower Monumental	36,815	32,024	-13.0%	11,604	10,131	-12.7%
Little Goose	34,933	31,738	-9.1%	12,840	10,131	-21.1%
Lower Granite	35,613	31,163	-12.5%	12,579	9,740	-22.6%
	Fall Chinook Salmon			**All Chinook Salmon**		
The Dalles	240,658	218,435	-9.2%	389,988	363,032	-6.9%
McNary	164,199	159,849	-2.6%	277,495	271,462	-2.2%
Priest Rapids	33,863	20,976	-38.1%	96,655	83,915	-13.2%
Rock Island	15,828	9,289	-41.3%	82,070	74,959	-8.7%
Rocky Reach	12,904	8,112	-37.1%	62,842	57,259	-8.9%
Wells	4,846	5,372	10.9%	43,458	41,543	-4.4%
Ice Harbor	31,450	30,583	-2.8%	78,076	74,356	-4.8%
Lower Monumental	31,834	30,583	-3.9%	80,253	74,211	-7.5%
Little Goose	29,298	28,396	-3.1%	77,071	72,973	-5.3%
Lower Granite	33,127	24,698	-25.4%	81,319	68,440	-15.8%

Major deviations between race classifications based on passage date for Chinook passing Bonneville Dam as spring Chinook (on or before May 31) but passing upstream of Priest Rapids (and other upstream dams) as summer Chinook as well as Bonneville summer Chinook passing upstream of Ice Harbor (and other upstream dams) as spring Chinook (Table 8). Of the 18 PIT tagged Chinook passing Bonneville Dam as spring Chinook that were assigned at Priest Rapids as summer Chinook, 14 passed Bonneville Dam on May 30 or 31. (If these “spring” Chinook had passed Bonneville Dam on or after June 1, they would have been considered “summer” Chinook at Bonneville Dam.) All 19 of the PIT tagged summer Chinook passing Bonneville Dam as summer Chinook, but Ice Harbor as

spring Chinook passed Bonneville Dam on June 1 or 2, just after the May 31 cutoff for spring Chinook.

Table 8. 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 2017.

Last Date Spring Run	First Date Fall Run	Race at Bonneville	Spring	Summer	Summer	Fall
		Race at Dam Listed Below	Summer	Spring	Fall	Summer
May 31	August 1	Bonneville				
June 3	August 4	The Dalles	4.8%	1.8%	0.7%	0.5%
June 8	August 9	McNary	6.0%	3.1%	1.7%	0.0%
June 13	August 14	Priest Rapids	28.6%	0.5%	2.2%	0.0%
June 17	August 18	Rock Island	36.6%	0.7%	3.0%	3.6%
June 19	August 20	Rocky Reach	30.2%	0.5%	2.9%	3.7%
June 28	August 29	Wells	15.8%	8.9%	3.6%	5.3%
June 11	August 12	Ice Harbor	4.6%	15.4%	1.6%	0.0%
June 13	August 14	Lower Monumental	6.0%	16.7%	1.6%	0.0%
June 15	August 16	Little Goose	9.0%	11.8%	2.5%	0.0%
June 17	August 18	Lower Granite	8.5%	12.9%	2.6%	0.0%

Dam escapement estimates for three tributary dams (Tumwater Dam on the Wenatchee River and Prosser and Roza dams on the Yakima River), each with more than 40 detections, are found in Table 9 alongside estimates using visual counts. The difference between the two estimates decreased as the number of tag detections increased, with the dam with the most detections (Prosser Dam) having a PIT tag estimate that only differed from visual estimates by 0.2%. Chinook passing these three tributary sites were primarily spring or summer Chinook (Figure 9).

Table 9. Estimated 2017 Chinook Salmon escapement, as estimated using PIT tag detections, to Tumwater, Prosser, and Roza dams.

Location and River	Number of Tag Detections	Escapement Estimate from Visual Counts	Estimated Escapement Using PIT Tags	Percent Difference
Tumwater Dam, Wenatchee River	60	5,774	6,416	11.1%
Prosser Dam, Yakima River	72	7,712	7,730	0.2%
Roza Dam, Yakima River	49	6,508	5,226	-19.7%

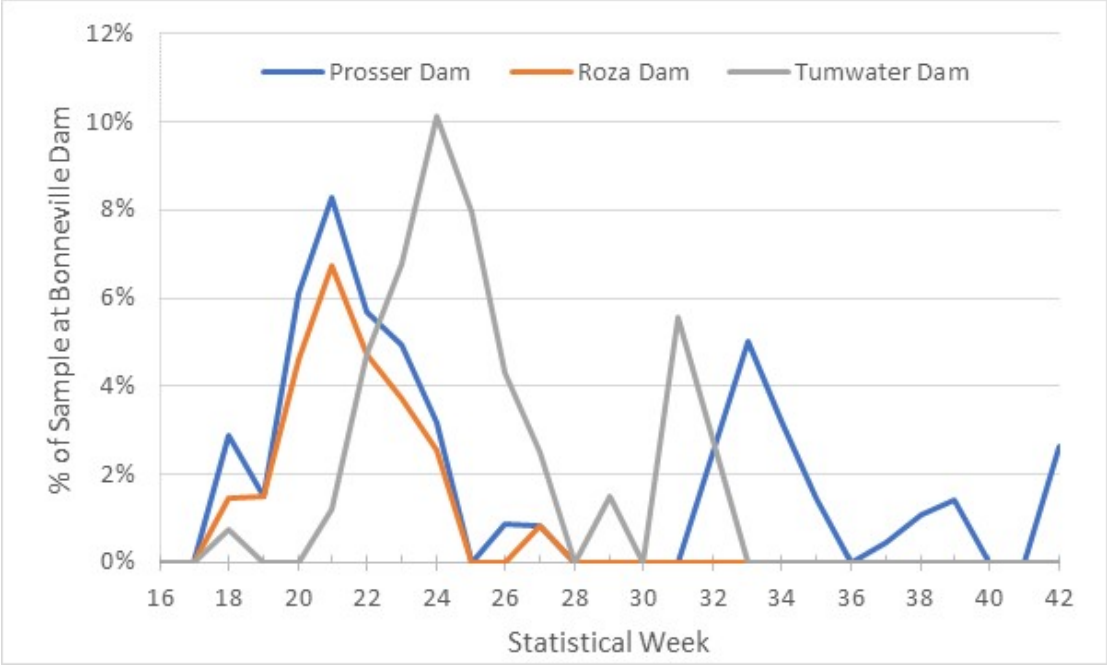

Figure 9. Percentage of Chinook Salmon by statistical week tagged at Bonneville Dam in 2017 destined for the Tumwater Dam (Wenatchee River), Prosser Dam (Yakima River) and Roza Dam (Yakima River) based on upstream PIT tag detections.

Migration Rates and Passage Time

Chinook migration rates between adjacent mainstem dams ranged between 18.7 km/day for fall Chinook between McNary and Priest Rapids dams and 42.0 km/day for spring Chinook between The Dalles and McNary dams (Table 10). Migration rates to and between tributary sites were generally faster than those in the mainstem Columbia and Snake rivers (Table 10).

Among the mainstem Columbia and Snake River dams, Chinook Salmon had the greatest median dam passage time (as determined by minutes between first detection time and last detection time at a dam) at Lower Granite, Wells, and McNary dams (Table 11). At Bonneville, Lower Granite, McNary, and Rocky Reach 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, and Tumwater, and Wells dams may also be inflated by trapping operations that take place at fish ladders at those dams.

Table 10. Chinook Salmon travel rates between Columbia Basin dams estimated using PIT tag data in 2017.

		Median Migration Rate (km/day)		
Between Mainstem Dams	Distance (km)	Spring Chinook	Summer Chinook	Fall Chinook
Bonneville-The Dalles	74	33.4	34.7	33.4
The Dalles-McNary	157	42.0	41.0	38.8
McNary-Priest Rapids	167	33.5	39.1	18.7
Priest Rapids-Rock Island	89	29.7	29.6	24.1
Rock Island-Rocky Reach	33	30.4	32.4	28.5
Rocky Reach-Wells	65	35.6	25.6	27.7
Bonneville-McNary	156	37.1	37.6	34.2
Bonneville-Priest Rapids	231	28.8	36.0	23.7
Bonneville-Wells	596	32.4	29.9	21.1
Bonneville-Ice Harbor	304	34.2	37.6	37.4
Bonneville-Lower Granite	472	27.8	32.5	34.6
Priest Rapids-Wells	191	32.9	26.9	26.4
McNary-Ice Harbor	585	35.1	34.2	35.9
Ice Harbor-Lower Granite	67	23.0	27.6	31.4
To and Between Tributary Sites				
Rock Island - Tumwater	73	2.9	3.8	3.8
McNary - Prosser	141	29.2	28.1	7.7
Prosser - Roza	133	15.6	17.3	--
Lower Granite - South Fork Salmon (SFG)	375	18.6	25.4	--

Table 11. 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 2017.

	Median Passage Time (minutes)			Percentage of run with more than 12 hours between first and last detection at a dam		
Dam	Spring Chinook	Summer Chinook	Fall Chinook	Spring Chinook	Summer Chinook	Fall Chinook
Bonneville	6.2	7	10.1	1.6%	0.6%	0.8%
The Dalles	0.1	0.1	0.1	5.3%	3.1%	0.9%
McNary	100.2	94	96.3	7.2%	4.6%	9.0%
Priest Rapids	4.6	5.2	7.65	7.9%	2.6%	5.6%
Rock Island	1.3	0.1	0.35	2.4%	3.7%	3.6%
Rocky Reach	18.5	12.4	19.4	0.0%	3.4%	7.4%
Wells	109.4	104.0	122.3	18.4%	16.6%	5.3%
Ice Harbor	2.6	2.4	2.0	6.5%	8.9%	1.4%
Lower Monumental	2.1	3.1	0.2	5.2%	10.3%	1.4%
Little Goose	0.1	0.1	0.0	12.2%	10.1%	7.6%
Lower Granite	180.4	167.9	143.8	24.7%	20.7%	22.4%
Tumwater	24.6	23.2	67.3	22.2%	12.0%	0.0%
Prosser	0.6	0.4	24.3	0.0%	0.0%	33.3%
Roza	1.5	1.2	–	33.3%	25.0%	-

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 12, Figure 10). Among summer Chinook, Age

1.2 were predominant at Bonneville, The Dalles, McNary, and Priest Rapids dams, but Age 1.1 Chinook were predominant at other dams. The Dalles, and McNary and in the Snake River, while Age 1.3 was predominant at and above Priest Rapids Dam in the Columbia River (Table 12, Figure 11). Among fall Chinook, Age 0.3 was the predominant age at Columbia River dams, but Age 0.2 was the predominant age class for Chinook passing Snake River dams (Table 12, Figure 12). Mean length-at-age composition estimates at mainstem dam sites are shown in Tables 13-15.

Table 12. 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 2017.

Run and Site	Ageable	2015	2014		2013			2012		2011	
Spring	**N**	**0.1**	**0.2**	**1.1**	**0.3**	**1.2**	**2.1**	**0.4**	**1.3**	**0.5**	**1.4**
Bonneville	672	0.0%	0.0%	22.3%	0.0%	70.6%	0.0%	0.2%	6.4%	0.0%	0.6%
The Dalles	450	0.0%	0.0%	26.2%	0.0%	66.4%	0.0%	0.2%	6.4%	0.0%	0.8%
McNary	330	0.0%	0.0%	24.6%	0.0%	67.0%	0.0%	0.3%	7.2%	0.0%	1.0%
Priest Rapids	52	0.0%	0.0%	29.3%	0.0%	49.3%	0.0%	2.0%	17.3%	0.0%	2.1%
Rock Island	51	0.0%	0.0%	29.3%	0.0%	48.4%	0.0%	2.0%	18.2%	0.0%	2.1%
Rocky Reach	33	0.0%	0.0%	28.2%	0.0%	51.3%	0.0%	3.1%	14.3%	0.0%	3.0%
Wells	29	0.0%	0.0%	29.9%	0.0%	51.7%	0.0%	0.0%	15.6%	0.0%	2.8%
Ice Harbor	223	0.0%	0.0%	24.5%	0.0%	70.2%	0.0%	0.0%	5.3%	0.0%	0.0%
Low. Mon.	222	0.0%	0.0%	24.1%	0.0%	70.6%	0.0%	0.0%	5.3%	0.0%	0.0%
Little Goose	222	0.0%	0.0%	24.1%	0.0%	70.6%	0.0%	0.0%	5.3%	0.0%	0.0%
Lower Granite	218	0.0%	0.0%	24.6%	0.0%	70.1%	0.0%	0.0%	5.3%	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**
Bonneville	862	0.2%	1.0%	14.3%	4.2%	37.4%	0.1%	7.2%	29.3%	0.1%	6.1%
The Dalles	708	0.1%	1.3%	14.9%	4.0%	35.9%	0.1%	7.7%	29.5%	0.0%	6.4%
McNary	611	0.1%	1.3%	15.1%	3.8%	36.7%	0.1%	7.0%	29.6%	0.0%	6.3%
Priest Rapids	479	0.1%	1.5%	9.0%	4.0%	36.5%	0.1%	8.0%	33.5%	0.0%	7.3%
Rock Island	458	0.1%	1.5%	37.0%	3.8%	33.1%	0.0%	8.0%	7.3%	9.0%	0.1%
Rocky Reach	356	0.2%	1.6%	37.2%	4.2%	34.2%	0.0%	7.0%	6.4%	9.1%	0.2%
Wells	283	0.2%	2.1%	39.0%	5.1%	31.2%	0.0%	7.1%	6.7%	8.4%	0.2%
Ice Harbor	105	0.0%	0.0%	57.9%	0.0%	20.7%	0.0%	1.2%	15.9%	0.0%	4.4%
Low. Mon.	105	0.0%	0.0%	57.9%	0.0%	20.7%	0.0%	1.2%	15.9%	0.0%	4.4%
Little Goose	105	0.0%	0.0%	57.9%	0.0%	20.7%	0.0%	1.2%	15.9%	0.0%	4.4%
Lower Granite	102	0.0%	0.0%	57.9%	0.0%	21.1%	0.0%	1.2%	15.5%	0.0%	4.4%
Fall	**N**	**0.1**	**0.2**	**1.1**	**0.3**	**1.2**	**2.1**	**0.4**	**1.3**	**0.5**	**1.4**
Bonneville	905	8.8%	16.8%	2.6%	33.2%	11.3%	0.2%	19.3%	6.9%	0.4%	0.6%
The Dalles	607	8.7%	21.8%	2.3%	30.2%	10.3%	0.3%	19.2%	6.3%	0.4%	0.5%
McNary	483	8.8%	23.5%	2.6%	30.8%	10.2%	0.4%	16.5%	6.0%	0.5%	0.7%
Priest Rapids	61	20.2%	16.4%	5.6%	38.2%	7.0%	0.0%	1.9%	10.6%	0.0%	0.0%
Rock Island	27	11.2%	8.3%	1.1%	49.5%	5.3%	0.0%	0.0%	24.6%	0.0%	0.0%
Rocky Reach	23	11.4%	8.7%	0.8%	71.9%	6.1%	0.0%	0.0%	1.1%	0.0%	0.0%
Wells	15	1.4%	19.0%	1.2%	68.6%	8.5%	0.0%	0.0%	1.4%	0.0%	0.0%
Ice Harbor	63	4.5%	52.9%	3.6%	14.5%	20.4%	0.8%	3.2%	0.0%	0.0%	0.0%
Low. Mon.	63	4.5%	52.9%	3.6%	14.5%	20.4%	0.8%	3.2%	0.0%	0.0%	0.0%
Little Goose	59	4.6%	55.6%	2.3%	16.7%	16.4%	0.8%	3.6%	0.0%	0.0%	0.0%
Lower Granite	53	4.6%	57.0%	2.7%	20.4%	11.1%	1.0%	3.2%	0.0%	0.0%	0.0%

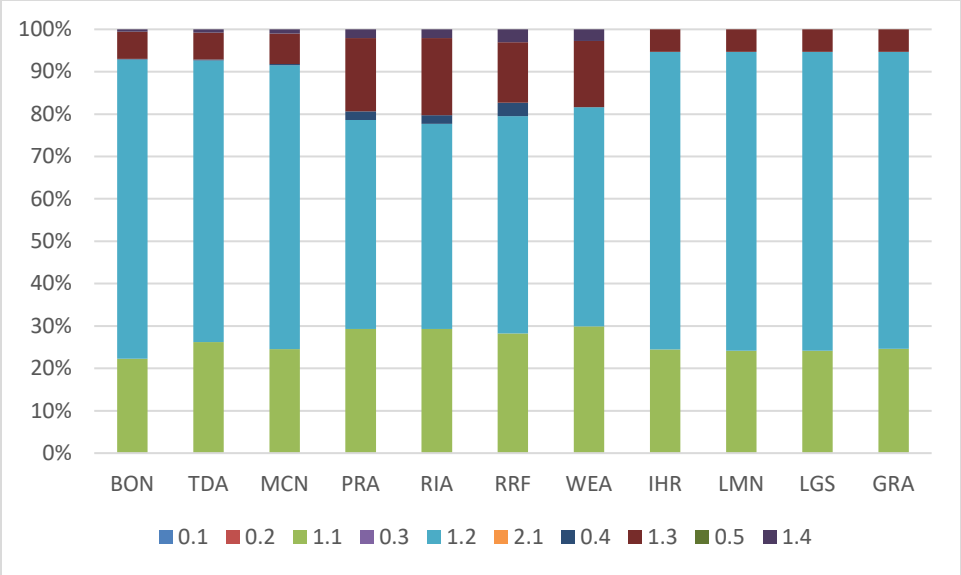

Figure 10. Spring Chinook age composition at Columbia and Snake River dams estimated using PIT tagged Chinook tracked by this project. Spring Chinook are defined as passing Bonneville Dam between April 1 and May 31, 2017.

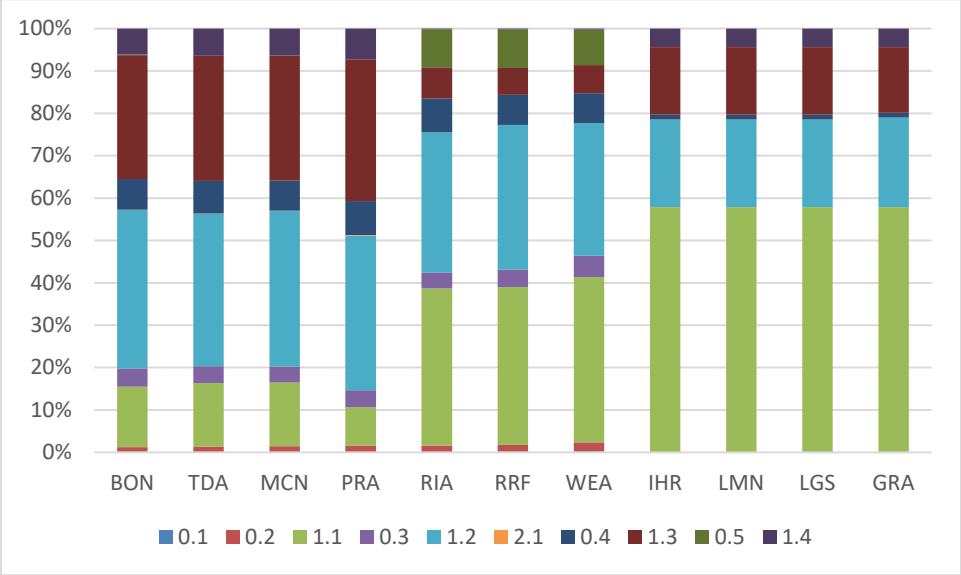

Figure 11. Summer Chinook age composition at Columbia and Snake River dams estimated using PIT tagged Chinook tracked by this project. Summer Chinook are defined as passing Bonneville Dam between June 1 and July 31, 2017.

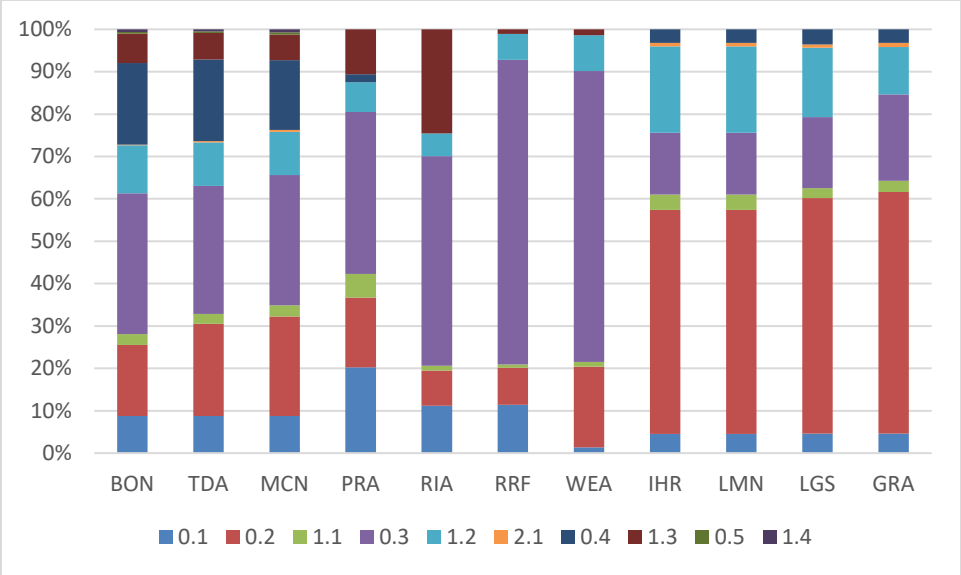

Figure 12. Fall Chinook age composition at Columbia and Snake river dams estimated using PIT tagged Chinook tracked by this project. Fall Chinook are defined as passing Bonneville Dam on or after August 1, 2017.

Table 13. Spring Chinook Salmon length-at-age composition, as estimated by PIT tag detections of fish aged using scale pattern analysis that passed Bonneville Dam on or before May 31, at Columbia and Snake River dams in 2017.

Dam	Statistic	Brood Year and Age Class									
		2015	2014		2013			2012		2011	
		0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	0.5	1.4
Bonneville	μ			53.3		72.5		96.5	87.0		85.4
	s			4.4		5.9		--	7.1		3.6
	n			137		487		1	43		4
The Dalles	μ			53.0		71.5		96.5	88.4		85.4
	s			4.3		6.3		--	6.4		3.6
	n			121		296		1	28		4
McNary	μ			52.5		71.5		96.5	88.7		85.4
	s			4.3		6.7		--	6.5		3.6
	n			82		219		1	24		4
Priest Rapids	μ			51.0		73.6		96.5	88.8		86.2
	s			4.0		5.3		--	7.5		4.0
	n			14		23		1	11		3
Rock Island	μ			51.0		73.7		96.5	88.8		86.2
	s			4.0		5.4		--	7.5		4.0
	n			14		22		1	11		3
Rocky Reach	μ			52.3		72.6		96.5	86.3		86.2
	s			4.1		5.0		--	6.6		4.0
	n			9		12		1	8		3
Wells	μ			52.3		72.7			87.1		84.3
	s			4.1		5.3			6.6		3.2
	n			9		11			7		2
Ice Harbor	μ			52.6		71.2			88.1		
	s			4.4		7.3			5.4		
	n			55		157			11		
Lower Monumental	μ			52.6		71.2			88.1		
	s			4.4		7.3			5.4		
	n			54		157			11		
Little Goose	μ			52.6		71.2			88.1		
	s			4.4		7.3			5.4		
	n			54		157			11		
Lower Granite	μ			52.6		71.1			88.1		
	s			4.4		7.4			5.4		
	n			54		153			11		

Table 14. Summer Chinook Salmon length-at-age composition, as estimated by PIT tag detections of fish aged using scale pattern analysis that passed Bonneville Dam between June 1-July 31, at Columbia and Snake River dams in 2017.

Dam	Statistic	Brood Year and Age Class									
		2015	2014		2013			2012		2011	
		0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	0.5	1.4
Bonneville	μ	42.0	64.9	53.1	75.8	71.8	59.5	87.1	82.1	105.0	84.4
	s	7.1	4.0	5.7	5.7	6.5	–	6.1	6.7	–	6.0
	n	2	8	134	35	333	1	55	244	1	49
The Dalles	μ	47.0	64.9	52.8	74.8	71.2	59.5	87.3	82.2		85.0
	s	–	4.0	5.7	5.7	6.7	–	5.6	7.1		6.0
	n	1	8	119	28	255	1	49	204		43
McNary	μ	47.0	65.1	51.7	75.1	71.0	59.5	88.0	82.3		84.6
	s	–	4.2	5.2	5.1	6.7	–	5.4	7.4		5.7
	n	1	7	103	23	223	1	39	177		37
Priest Rapids	μ	47.0	65.1	50.6	75.2	70.5	59.5	88.2	82.1		84.9
	s	–	4.2	6.1	5.2	6.9	–	5.5	7.5		5.3
	n	1	7	48	21	171	1	36	160		34
Rock Island	μ	47.0	66.1	50.7	75.6	70.5	59.5	88.2	82.2		84.9
	s	–	3.8	6.3	5.3	6.8	–	5.6	7.5		5.3
	n	1	6	45	19	166	1	35	152		33
Rocky Reach	μ	47.0	66.0	50.1	76.5	70.0	59.5	87.8	81.2		83.6
	s	–	4.2	6.1	5.3	6.7	–	5.4	6.8		5.2
	n	1	5	38	16	130	1	23	121		21
Wells	μ	47.0	66.0	50.6	76.5	70.1	59.5	87.7	81.8		83.3
	s	–	4.2	6.0	5.3	6.6	–	5.7	6.6		5.5
	n	1	5	28	16	106	1	19	89		18
Ice Harbor	μ			53.1		72.8		83.5	83.3		88.0
	s			4.1		5.5		–	7.1		--
	n			46		42		1	15		1
Lower Monumental	μ			53.1		72.8		83.5	83.3		88.0
	s			4.1		5.5		–	7.1		--
	n			46		42		1	15		1
Little Goose	μ			53.1		72.8		83.5	83.3		88.0
	s			4.1		5.5		–	7.1		--
	n			46		42		1	15		1
Lower Granite	μ			53.1		72.9		83.5	82.6		88.0
	s			4.2		5.6		–	6.7		--
	n			45		41		1	14		1

Table 15. Fall Chinook Salmon length-at-age composition, as estimated by PIT tag detections of fish aged using scale pattern analysis that passed Bonneville after July 31, for fall Chinook Salmon at Columbia and Snake River dams in 2017.

Dam	Statistic	Brood Year and Age Class									
		2015	2014		2013			2012		2011	
		0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	0.5	1.4
Bonneville	μ	44.8	64.0	55.0	74.3	72.1	58.5	85.0	81.5	83.5	84.1
	s	5.1	5.6	6.9	6.8	5.8	–	53.3	4.5	0.0	7.4
	n	67	133	21	327	107	1	176	61	3	9
The Dalles	μ	43.1	63.5	51.9	73.6	71.5	58.5	80.9	80.6	83.5	83.4
	s	3.0	5.3	6.8	7.2	5.8	–	6.0	4.7	0.0	4.1
	n	48	109	13	210	68	1	113	38	2	5
McNary	μ	43.0	63.5	53.0	73.3	71.5	58.5	80.6	80.8	83.5	83.4
	s	2.9	4.9	6.4	7.3	6.0	–	6.1	4.8	0.0	4.1
	n	35	86	10	172	57	1	85	30	2	5
Priest Rapids	μ	43.1	62.4	51.7	72.4	73.5		84.8	81.0		
	s	3.9	4.4	7.1	5.0	3.8		3.5	7.5		
	n	12	11	3	19	9		3	4		
Rock Island	μ	42.4	59.8	55.8	71.7	73.6			79.0		
	s	0.5	1.6	0.4	4.0	3.4			7.8		
	n	4	3	2	11	4			3		
Rocky Reach	μ	42.4	59.8	55.5	71.9	73.6			70.0		
	s	0.5	1.6		4.2	3.4					
	n	4	3	1	10	4			1		
Wells	μ	42.0	60.5	55.5	73.1	73.6			70.0		
	s	–	–	–	3.7	3.4			--		
	n	1	1	1	7	4			1		
Ice Harbor	μ	43.7	65.3	54.6	71.8	72.3	58.5	82.4			
	s	2.3	5.1	5.5	20.4	8.1	–	4.3			
	n	3	26	5	13	11	1	4			
Lower Monumental	μ	43.7	65.3	54.6	71.8	72.3	58.5	82.4			
	s	2.3	5.1	5.5	20.4	8.1	–	4.3			
	n	3	26	5	13	11	1	4			
Little Goose	μ	43.7	65.3	51.3	71.8	73.3	58.5	82.4			
	s	2.3	5.2	1.0	20.4	7.8	–	4.3			
	n	3	25	3	13	10	1	4			
Lower Granite	μ	43.7	64.8	51.3	71.8	71.7	58.5	80.5			
	s	2.3	5.1	1.0	20.4	5.8	–	2.6			
	n	3	23	3	13	7	1	3			

Fallback

Estimated fallback rates, based on Chinook Salmon reascending fish ladders or being detected downstream after ascending a fish ladder, ranged from a low of 0.5% for fall Chinook at Bonneville Dam to 22.4% for fall Chinook at Lower Granite (Table 16). These rates likely underestimate the true fallback rates as they do not include any fish that ascended a dam, fell back, and then were not subsequently detected.

Table 16. Estimated minimum Chinook Salmon fallback rates by race at Bonneville Dam at Columbia Basin dams with PIT tag detection in 2017 as estimated by PIT tags[4].

Dam	Spring Chinook (%)	Summer Chinook (%)	Fall Chinook (%)
Bonneville	1.4%	1.0%	0.5%
The Dalles	7.1%	3.9%	1.1%
McNary	9.2%	3.6%	1.1%
Priest Rapids	9.5%	2.0%	13.9%
Rock Island	2.4%	1.6%	3.6%
Rocky Reach	9.3%	6.3%	3.7%
Wells	7.9%	18.9%	10.5%
Ice Harbor	8.8%	13.0%	1.4%
L. Monumental	7.6%	12.7%	2.8%
Little Goose	2.0%	3.4%	13.6%
Lower Granite	15.8%	6.0%	22.4%
Mean	**7.4%**	**6.6%**	**6.8%**

A total of 341 Chinook generated 467 fallback events at mainstem dams with adult PIT tag detection (Table 17). A total of 92 Chinook had more than one fallback event at a single dam or several dams.

Fall Chinook at Lower Granite Dam had the highest fallback rate with 9 fall Chinook generating 13 fallback events out of 58 fall Chinook detected passing the site. A total of four Chinook fell back over mainstem dams a total of five times. Figures showing the movement of some of these Chinook are in the Appendix B (Table B1 and Figures B26 – B28). Although not represented in the tables because Zosel is a very small tributary dam (at high flows fish pass upstream through the spillway), one Chinook (3DD.007797648C) fell back over Zosel Dam five times, three of which were in one day.

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

Table 17. Frequency of fallback events for Chinook Salmon tagged by this project in 2017.

Number of Dams Fallen Back Over	Total Number of Chinook
1	249
2	71
3	13
4	4
5	4
Number of Chinook falling back at least once	**341**
% of Chinook with at least one fallback event	**12.2%**
Total fallback events	**466**
Number of Chinook in study	**2805**

Night Passage

Night passage (2000-0400 Pacific Standard Time) of tagged Chinook Salmon was under 10% at all mainstem dams except for fall Chinook at Wells (10.5%) and Rock Island (14.3%) dams (Table 18). At tributary dams (Prosser, Roza, and Tumwater), rates exceeded 10% except for spring Chinook at Prosser (0.0%) and Roza (9.1%) dams and summer Chinook at Tumwater (8.0%) dams. The Bonneville Dam estimate of night passage is likely biased low, due to the fact tagging occurred during morning and early afternoon hours. With a median Bonneville Dam passage time less than two hours, tagged Chinook would be expected to pass during daytime hours.

Table 18. Estimated Chinook Salmon night passage (2000-0400) in 2017 at Columbia Basin dams as estimated by PIT tag detections.

Site	(%) Spring Chinook	(%) Summer Chinook	(%) Fall Chinook
Bonneville	0.4%	0.1%	0.1%
The Dalles	1.1%	2.7%	1.8%
McNary	2.7%	2.6%	0.6%
Priest Rapids	1.6%	2.4%	2.8%
Rock Island	7.3%	4.4%	14.3%
Rocky Reach	0.0%	1.0%	0.0%
Wells	7.9%	2.4%	10.5%
Ice Harbor	1.9%	1.6%	1.4%
Lower Monumental	0.8%	0.8%	1.4%
Little Goose	3.5%	3.4%	1.5%
Lower Granite	3.2%	0.0%	1.7%
Prosser	0.0%	19.0%	44.4%
Roza	9.1%	37.5%	NA
Tumwater	22.2%	8.0%	100.0%

Straying

Estimated Chinook stray rates by stock for those with more than 10 fish that were designated as either putative strays or on-target ranged from 29.6% at Little White Salmon Hatchery to 0% at McCall, Leavenworth/Methow/Winthrop, Eastbank, and Chief Joseph hatcheries (Table 19). For this analysis, we considered all Summer Chinook hatchery populations above Priest Rapids Dam as being “on-target” if they were last detected anywhere above Priest Rapid Dam. For Little White Salmon and Priest Rapids Hatchery, we considered any Columbia River site above the Yakima River (and in the Yakima for Little White Salmon) as being on-target. Hatcheries with >10% stray rates (and 10 or more Chinook in terminal areas) were Little White Salmon (29.6% with strays in the Deschutes, Hood and Klickitat rivers) , South Fork Walla Walla Hatchery (28.6% with strays into the Snake Basin and above Wells Dam), Round Butte (25.8% with strays into the Yakima and Hood river basins and above Wells Dam) and Lyons Ferry Hatchery (11.3% with strays into the Yakima, Wenatchee, and Salmon river basins and above Wells Dam).

Table 19. Table showing final-PIT-fate categories by hatchery. Fate categories are categorized by color. Grey is neutral (meaning last detected on route to expected destinations), green is on target (meaning last detected at their expected destination), yellow is putative overshoot meaning a fish last detected in an area adjacent to its expected destination, and red is putative stray meaning a fish was last detected in tributaries or the mainstem outside their normal route to their expected destination. Stray rates are also tabulated.

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

Hatchery	Expected Run Time	Bonneville					Carson		White	Hood		Klickitat	The Dalles		Deschutes			
		BON PH2 Corner Collector	Bonneville Bradford Is. Ladder	Bonneville Cascades Is. Ladder	Bonneville WA Shore Ladder/AFF	Bonneville WA Ladder Slots	Carson NFH Adult Return Ladder	Ltl. White Salmon NFH returns	Spring Creek NFH Adult Ladder	Hood River Mouth	Moving Falls Fish Ladder	Lyle Falls Fishway	The Dalles East Fish Ladder	The Dalles North Fish Ladder	Deschutes River mouth	Deschutes Sherars Falls	Shitike Creek PIT Array	Warm Springs Hatchery
		234	234	234	234	234	251	261	269	273	273	290	308	308	328	328	328	328
		BCC	BO1	BO2	BO3	BO4	CAL	LWL	SCL	HRM	MVF	LFF	TD1	TD2	DRM	DSF	SHK	WSH
Carson National Fish Hatchery	Spring			1		65	15	30	1				1					
Clearwater Fish Hatchery	Spring					15							3					
Clearwater Fish Hatchery - Powell Facility	Spring					4												
Dworshak National Fish Hatchery	Spring					5							4				1	
Klickitat State Fish Hatchery	Spring					14						6	6					
Leavenworth/Methow/Winthrop hatcheries	Spring					5							1					
Levi George/Cle Elum (Integrated)	Spring												1					
Lookingglass Fish Hatchery - Catherine Creek	Spring					3							1					
Lookingglass Fish Hatchery - Grande Ronde	Spring					2												
Lookingglass Fish Hatchery - Lookingglass Creek	Spring																	
Lookingglass Fish Hatchery - Lostine River	Spring					1												
Lyons Ferry Fish Hatchery - Tucannon River	Spring					1							1					
Nez Perce Tribal Fish Hatchery (Spring)	Spring																	
Parkdale Fish Facility	Spring					3				2			2			5		
Rapid River Fish Hatchery	Spring	1			1	53							7					
Round Butte Fish Hatchery	Spring		2			15				4	1		13		2	12		9
Sawtooth Fish Hatchery	Spring												1					
South Fork Walla Walla facility	Spring					17							17					
Lookingglass Fish Hatchery - Imnaha River	Spring/Summer					2												
McCall Fish Hatchery - Johnson Creek	Spring/Summer																	
McCall Fish Hatchery - South Fork Salmon	Spring/Summer		1			4												
Pahsimeroi Fish Hatchery	Spring/Summer					2							1					
Chief Joseph Hatchery (Summer/Fall)	Summer	1				10							6	3				
Eastbank Fish Hatchery (Summer)	Summer					9							11	1				
Entiat National Fish Hatchery (Summer)	Summer					1												
Wells Fish Hatchery (Summer)	Summer		1		1	11							5					
Little White Salmon National Fish Hatchery (Fall)	Fall				1	54		4		2		2	8	2	1	1		
Lyons Ferry/Nez Perce hatcheries	Fall				1	11							12	2				
Priest Rapids Fish Hatchery	Fall					20							9		1			
South Fork Walla Walla facility	Fall					2							1					
	Total	2	4	1	4	330	15	34	1	8	1	8	112	8	4	18	1	9

Hatchery	Expected Run Time	John Day	Umatilla	McNary Dam			Tucannon		Ice Harbor	Lower Monumental	Goose		Lower Granite		Asotin
		John Day Dam Juvenile	Three Mile Falls Dam Combined	McNary Oregon Shore Ladder	McNary Washington Shore Ladder	McNary Dam Juvenile	Tucannon Fish Hatchery	Lower Tucannon River	Ice Harbor Dam (Combined)	Lower Monumental Adult Ladders	Little Goose Fish Ladder	Little Goose Dam Juvenile	Lower Granite Dam Adult	Lower Granite Dam Juvenile	No./So. Fk Asotin Cr. Jct. ISA
		347	465	470	470	470	522	522	522	522	522	522	522	522	522
		JDJ	TMF	MC1	MC2	MCJ	TFH	LTR	ICH	LMA	GOA	GOJ	GRA	GRJ	AFC
Carson National Fish Hatchery	Spring														
Clearwater Fish Hatchery	Spring												7	1	
Clearwater Fish Hatchery - Powell Facility	Spring									1			4		
Dworshak National Fish Hatchery	Spring									1			2		
Klickitat State Fish Hatchery	Spring			2	1										
Leavenworth/Methow/Winthrop hatcheries	Spring														
Levi George/Cle Elum (Integrated)	Spring														
Lookingglass Fish Hatchery - Catherine Creek	Spring														
Lookingglass Fish Hatchery - Grande Ronde	Spring												2		
Lookingglass Fish Hatchery - Lookingglass Creek	Spring												2		
Lookingglass Fish Hatchery - Lostine River	Spring												2		
Lyons Ferry Fish Hatchery - Tucannon River	Spring						2								
Nez Perce Tribal Fish Hatchery (Spring)	Spring												1		
Parkdale Fish Facility	Spring														
Rapid River Fish Hatchery	Spring									1	2	1	101		
Round Butte Fish Hatchery	Spring														
Sawtooth Fish Hatchery	Spring										2		8		
South Fork Walla Walla facility	Spring		20	11	4	1			1	2	1		1		1
Lookingglass Fish Hatchery - Imnaha River	Spring/Summer														
McCall Fish Hatchery - Johnson Creek	Spring/Summer														
McCall Fish Hatchery - South Fork Salmon	Spring/Summer												2		
Pahsimeroi Fish Hatchery	Spring/Summer	1											5		
Chief Joseph Hatchery (Summer/Fall)	Summer			2											
Eastbank Fish Hatchery (Summer)	Summer														
Entiat National Fish Hatchery (Summer)	Summer			1											
Wells Fish Hatchery (Summer)	Summer			1											
Little White Salmon National Fish Hatchery (Fall)	Fall			12	7								2		
Lyons Ferry/Nez Perce hatcheries	Fall			2	2			5		3	2	1	33		
Priest Rapids Fish Hatchery	Fall			13	8										
South Fork Walla Walla facility	Fall		2	2	1								1		
	Total	1	22	46	23	1	2	5	1	8	7	2	173	1	1

Hatchery	Expected Run Time	Grande Ronde		Imnaha			Clearwater								SF Salmon			Upper Salmon			
		Joseph Creek ISA @ km 3	Upper Grande Ronde at rkm 155	Imnaha River Weir Adult Ladder	Lower Imnaha River ISA @ km 7	Imnaha Weir Upstream Array	Clear Creek near Kooskia NFH	Lower SF Clearwater R at rkm 1	Lower SF Clearwater R at rkm 2	Dworshak NFH adult trap	Upper Lolo Creek at rkm 25	Lower Lochsa River Array Site	Lower Selway River Array	Sweetwater Cr. near its mouth	EFSF Salmon River at Parks Cr.	SF Salmon River at Krassel Cr.	SF Salmon Satellite Facility	Sawtooth Hatchery Adult Trap	Lower Lemhi River	Upper Salmon River at rkm 437	Upper Salmon River at rkm 460
		522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
		JOC	UGR	IML	IR1	IR5	CLC	SC1	SC2	DWL	LC2	LRL	SW1	SWT	ESS	KRS	STR	STL	LLR	USE	USI
Carson National Fish Hatchery	Spring																				
Clearwater Fish Hatchery	Spring						3	5	8	2		4	1								
Clearwater Fish Hatchery - Powell Facility	Spring						5					2									
Dworshak National Fish Hatchery	Spring						12		1	7											
Klickitat State Fish Hatchery	Spring																				
Leavenworth/Methow/Winthrop hatcheries	Spring																				
Levi George/Cle Elum (Integrated)	Spring																				
Lookingglass Fish Hatchery - Catherine Creek	Spring																				
Lookingglass Fish Hatchery - Grande Ronde	Spring		6																		
Lookingglass Fish Hatchery - Lookingglass Creek	Spring																				
Lookingglass Fish Hatchery - Lostine River	Spring																				
Lyons Ferry Fish Hatchery - Tucannon River	Spring																				
Nez Perce Tribal Fish Hatchery (Spring)	Spring										1										
Parkdale Fish Facility	Spring																				
Rapid River Fish Hatchery	Spring							3	1			1		1							
Round Butte Fish Hatchery	Spring																				
Sawtooth Fish Hatchery	Spring																	5			
South Fork Walla Walla facility	Spring																				
Lookingglass Fish Hatchery - Imnaha River	Spring/Summer			4		3															
McCall Fish Hatchery - Johnson Creek	Spring/Summer														4						
McCall Fish Hatchery - South Fork Salmon	Spring/Summer															3	8				
Pahsimeroi Fish Hatchery	Spring/Summer				1														1	1	2
Chief Joseph Hatchery (Summer/Fall)	Summer																				
Eastbank Fish Hatchery (Summer)	Summer																				
Entiat National Fish Hatchery (Summer)	Summer																				
Wells Fish Hatchery (Summer)	Summer																				
Little White Salmon National Fish Hatchery (Fall)	Fall																				
Lyons Ferry/Nez Perce hatcheries	Fall	1							3												
Priest Rapids Fish Hatchery	Fall																				
South Fork Walla Walla facility	Fall																				
	Total	1	6	4	1	3	20	8	13	9	1	7	1	1	4	3	8	5	1	1	2

Hatchery	Expected Run Time	Yakima		Ringold Hatchery	Priest Rapids		Rock Island	Wenatchee					Rocky Reach		Eastbank Hatchery	Entiat		Wells		Methow					Okanagan			
		Prosser Diversion Dam Combined	Roza Diversion Dam (Combined)	Ringold Springs Hatch. Outfall	Priest Rapids Hatchery Outfall	Priest Rapids Adult	Rock Island Adult	Lower Icicle Instream Array	Middle Icicle Instream Array	Leavenworth NFH Adult Ladder	Lower Wenatchee River	Tumwater Dam Adult Fishway	Rocky Reach Fishway	Rocky Reach Dam Juvenile	East Bank Hatchery Outfall	Entiat NFH Adult Ladder	Lower Entiat River	Wells Dam, DCPUD Adult Ladders	Wells Dam Bypass Bay Sample	Lower Methow River at Pateros	Methow River at Winthrop	Methow Fish Hatchery Outfall	Spring Creek Acclimation Pond	Lwr Twisp Rvr near MSRF Ponds	Okanagan Channel at VDS-3	Lower Okanogan Instream Array	Salmon Creek below OID Div.	Zosel Dam Combined
		539	539	567	635	639	730	754	754	754	754	754	763	763	764	778	778	830	830	843	843	843	843	843	858	858	858	858
		PRO	ROZ	RSH	PRH	PRA	RIA	ICL	ICM	LNF	LWE	TUF	RRF	RRJ	EBO	EHL	ENL	WEA	WEJ	LMR	MRW	MSH	SCP	TWR	OKC	OKL	SA0	ZSL
Carson National Fish Hatchery	Spring																	1										
Clearwater Fish Hatchery	Spring								1																			
Clearwater Fish Hatchery - Powell Facility	Spring																											
Dworshak National Fish Hatchery	Spring																											
Klickitat State Fish Hatchery	Spring																											
Leavenworth/Methow/Winthrop hatcheries	Spring					1		2		7								2			1	2	5	1	1			1
Levi George/Cle Elum (Integrated)	Spring	1	8																									
Lookingglass Fish Hatchery - Catherine Creek	Spring																											
Lookingglass Fish Hatchery - Grande Ronde	Spring																											
Lookingglass Fish Hatchery - Lookingglass Creek	Spring																											
Lookingglass Fish Hatchery - Lostine River	Spring																											
Lyons Ferry Fish Hatchery - Tucannon River	Spring																											
Nez Perce Tribal Fish Hatchery (Spring)	Spring																											
Parkdale Fish Facility	Spring																											
Rapid River Fish Hatchery	Spring																											
Round Butte Fish Hatchery	Spring		1															2										
Sawtooth Fish Hatchery	Spring																											
South Fork Walla Walla facility	Spring																	1									1	
Lookingglass Fish Hatchery - Imnaha River	Spring/Summer																											
McCall Fish Hatchery - Johnson Creek	Spring/Summer																											
McCall Fish Hatchery - South Fork Salmon	Spring/Summer																											
Pahsimeroi Fish Hatchery	Spring/Summer																											
Chief Joseph Hatchery (Summer/Fall)	Summer					4	1				1		7	1			1	29								11		
Eastbank Fish Hatchery (Summer)	Summer					2					2	1	15		2		1	27		1						7		
Entiat National Fish Hatchery (Summer)	Summer																1	1										
Wells Fish Hatchery (Summer)	Summer	2	1			2	2						4	3	1		2	56	1							1		
Little White Salmon National Fish Hatchery (Fall)	Fall	3				2	1				1	1	1					5								4		
Lyons Ferry/Nez Perce hatcheries	Fall	1									2							2										
Priest Rapids Fish Hatchery	Fall	1		7	35	8	1				1		1			1		5		2						2		
South Fork Walla Walla facility	Fall																											
	Total	8	10	7	35	19	5	2	1	7	7	2	28	4	3	1	5	131	1	3	1	2	5	1	1	25	1	1

Hatchery	Expected Run Time	Total				Percentages				
		Neutral	On Target	Putative Stray	Putative overshoot	%Neutral	%On Target	%Putative Stray	%Putative overshoot	% Strays (strays/(strays+On target))
Carson National Fish Hatchery	Spring	66	45	3		57.9%	39.5%	2.6%	0.0%	6.3%
Clearwater Fish Hatchery	Spring	26	23	1		52.0%	46.0%	2.0%	0.0%	4.2%
Clearwater Fish Hatchery - Powell Facility	Spring	9	7	0		56.3%	43.8%	0.0%	0.0%	0.0%
Dworshak National Fish Hatchery	Spring	12	20	1		36.4%	60.6%	3.0%	0.0%	4.8%
Klickitat State Fish Hatchery	Spring	14	6	3	6	48.3%	20.7%	10.3%	20.7%	33.3%
Leavenworth/Methow/Winthrop hatcheries	Spring	6	22	0	1	20.7%	75.9%	0.0%	3.4%	0.0%
Levi George/Cle Elum (Integrated)	Spring	1	9	0		10.0%	90.0%	0.0%	0.0%	0.0%
Lookingglass Fish Hatchery - Catherine Creek	Spring	4	0	0		100.0%	0.0%	0.0%	0.0%	
Lookingglass Fish Hatchery - Grande Ronde	Spring	4	6	0		40.0%	60.0%	0.0%	0.0%	0.0%
Lookingglass Fish Hatchery - Lookingglass Creek	Spring	2	0	0		100.0%	0.0%	0.0%	0.0%	
Lookingglass Fish Hatchery - Lostine River	Spring	3	0	0		100.0%	0.0%	0.0%	0.0%	
Lyons Ferry Fish Hatchery - Tucannon River	Spring	2	2	0		50.0%	50.0%	0.0%	0.0%	0.0%
Nez Perce Tribal Fish Hatchery (Spring)	Spring	1	1	0		50.0%	50.0%	0.0%	0.0%	0.0%
Parkdale Fish Facility	Spring	5	7	0		41.7%	58.3%	0.0%	0.0%	0.0%
Rapid River Fish Hatchery	Spring	167	6	0		96.5%	3.5%	0.0%	0.0%	0.0%
Round Butte Fish Hatchery	Spring	30	23	8		49.2%	37.7%	13.1%	0.0%	25.8%
Sawtooth Fish Hatchery	Spring	11	5	0		68.8%	31.3%	0.0%	0.0%	0.0%
South Fork Walla Walla facility	Spring	34	20	8	16	43.6%	25.6%	10.3%	20.5%	28.6%
Lookingglass Fish Hatchery - Imnaha River	Spring/Summer	2	7	0		22.2%	77.8%	0.0%	0.0%	0.0%
McCall Fish Hatchery - Johnson Creek	Spring/Summer	0	4	0		0.0%	100.0%	0.0%	0.0%	0.0%
McCall Fish Hatchery - South Fork Salmon	Spring/Summer	7	11	0		38.9%	61.1%	0.0%	0.0%	0.0%
Pahsimeroi Fish Hatchery	Spring/Summer	9	4	1		64.3%	28.6%	7.1%	0.0%	20.0%
Chief Joseph Hatchery (Summer/Fall)	Summer	22	55	0	0	28.6%	71.4%	0.0%	0.0%	0.0%
Eastbank Fish Hatchery (Summer)	Summer	21	58	0	0	26.6%	73.4%	0.0%	0.0%	0.0%
Entiat National Fish Hatchery (Summer)	Summer	2	2	0	0	50.0%	50.0%	0.0%	0.0%	0.0%
Wells Fish Hatchery (Summer)	Summer	19	72	3	0	20.2%	76.6%	3.2%	0.0%	4.0%
Little White Salmon National Fish Hatchery (Fall)	Fall	84	19	8		75.7%	17.1%	7.2%	0.0%	29.6%
Lyons Ferry/Nez Perce hatcheries	Fall	30	47	6		36.1%	56.6%	7.2%	0.0%	11.3%
Priest Rapids Fish Hatchery	Fall	30	62	3	0	31.6%	65.3%	3.2%	0.0%	4.6%
South Fork Walla Walla facility	Fall	3	2	1	3	33.3%	22.2%	11.1%	33.3%	33.3%
	Total	479	415	28	23	50.7%	43.9%	3.0%	2.4%	6.3%

RESULTS-STEELHEAD

Sample Size

A total of 836 steelhead were sampled at Bonneville Dam in 2017, of which 816 were PIT tagged (Table 20). One additional fish with a fork length of 45.0 cm was sampled on October 18, 2017 that was identified as a trout as it was aged as 2.0, spending no winters in saltwater, and was thus excluded from further analysis. After adding previously tagged fish (which were sampled and therefore identified for the tracking study and included in our sample) and subtracting fish that were not detected after release (possibly a result of tag shed, tag malfunction, mortality, or the fish moving downstream after tagging) or which spent no winters in the ocean, the number of steelhead tracked upstream totaled 836 (Table 20).

Table 20. Number of steelhead PIT tagged at Bonneville Dam and tracked past Bonneville by date and statistical week in 2017.

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
4/20-21	16	8	8	0	0	8	0	0	0
4/24-26	17	5	5	1	0	5	0	0	0
5/1-5	18	2	2	0	0	2	0	0	0
5/8-12	19	5	5	0	0	5	0	0	0
5/15-19	20	8	6	1	0	8	0	0	0
5/22-26	21	7	7	2	0	7	0	1	0
5/30-6/2	22	2	2	0	0	2	0	0	0
6/5-6/9	23	7	7	0	0	7	0	0	0
6/12-6/16	24	3	3	0	0	3	0	0	0
6/19-6/23	25	4	4	0	0	4	0	3	0
6/26-6/30	26	1	1	0	0	1	0	4	0
7/3,7/5-7	27	5	5	0	0	5	0	1	0
7/10-7/14	28	38	38	1	0	38	0	0	0
7/17-7/21	29	120	120	1	0	120	0	0	0
7/24-7/27	30	147	147	4	0	147	3	0	1
7/31-8/1	31	40	40	4	0	40	2	0	3
No Sampling	32						0	0	5
8/17	33	24	24	1	0	24	1	0	4
8/21-8/24	34	117	117	2	0	117	4	0	1
8/28-8/29, 9/1	35	54	54	0	0	54	3	0	2
9/8	36	13	13	0	0	13	1	0	3
9/11-9/14	37	10	10	0	0	10	4	0	1
9/18-9/22	38	51	26	0	0	51	0	1	0
9/25-9/29	39	41	41	0	0	41	0	0	0
10/2-10/6	40	44	40	2	0	44	0	0	0
10/9-10/13	41	41	35	0	0	41	0	0	0
10/16-10/18	42	39	38	1	0	39	0	0	0
Total		**836**	**816**	**20**	**0**	**836**	**18**	**10**	**20**

Distribution of Sample

Sampling restrictions in the form of restrictions on picket lead deployment and shutdowns due to high temperature resulted in low weekly sample size even in peak weeks. For the entirety of Week 37, all pickets were mostly up due to the restrictions, resulting in the sampling of only 10 steelhead in a week in which 10.2% of the steelhead run passed Bonneville Dam (Figure 13). Between weeks 35 and 37, 33.7% of the run passed while we sampled a total of 77 steelhead. Earlier in the run, the trap closure due to temperatures above 22.2C resulted in sampling no steelhead in Week 32 while 4.8% of the run passed, and we only sampled 64 steelhead over weeks 31-33 when 21.4% of the run passed Bonneville Dam.

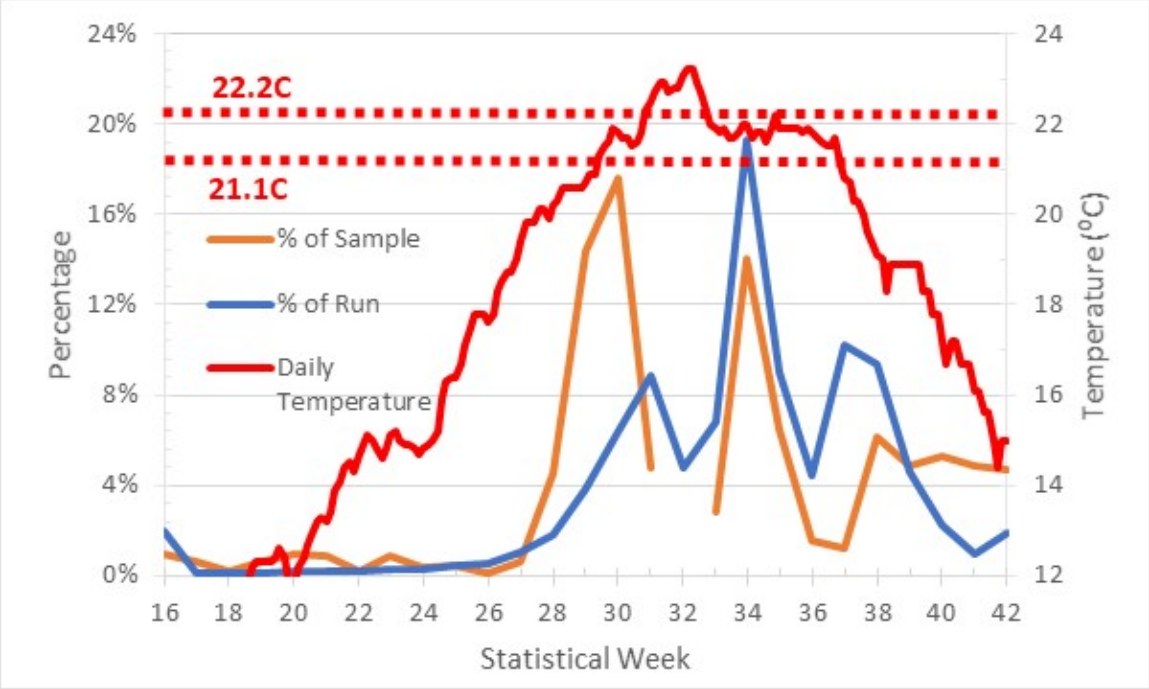

Figure 13. The weekly steelhead sample and run as a percentage of the total sample and run size at Bonneville Dam in 2017. Sampling was reduced at 21.1C and halted at 22.2C.

Detection Numbers

The 836 steelhead tracked in 2017 generated 51,385 weir detections and 5,176 site detections at 121 sites. Maps and table of sites (Table B1 and Figures B1, B16-B20) found in the Appendix B show the categorical ranges of detection numbers at the sites throughout the Columbia Basin.

Age Analysis

We were able to validate our scale aging techniques for using fish sampled at Bonneville that were previously tagged as juveniles for other projects or hatchery

programs. Our age estimates for 20 previously tagged steelhead with readable scales concurred with the information from juvenile PIT tagging. Only the total age could be compared for it was not possible to separately validate freshwater and ocean age.

In 2017 ocean age estimates were available from analysis of genetics samples collected by this study using Parental Based Tagging (PBT)[5]. Ages estimated using the scale patterns agreed with estimates using PBT for 340 out of 353 steelhead samples (Table 21). All PBT ages were from hatchery-origin steelhead. All steelhead scale ages that differed from PBT ages were changed to the PBT age.

Table 21. Comparison of age estimates using genetics and scale pattern analysis for Chinook Salmon sampled at Bonneville Dam in 2017. Green shading indicates agreement between the two methods, orange indicates the age estimates differed.

Ocean Age Using Genetic Stock ID	Ocean Age Estimated Using Scale Patterns			% Concurrence
	1	2	3	
1	224	7		97.0%
2	5	98		95.1%
3		1	18	94.7%
Total	**229**	**106**	**18**	**96.3%**

Mainstem Dam Recoveries, Mortality, and Escapement Estimates

Data on tag detections was last downloaded from www.ptagis.org on February 7, 2019. An estimated 54.9% of the steelhead run passing Bonneville Dam was last detected at or above Ice Harbor Dam, compared to only 8.1% above Priest Rapids Dam (Figure 14). The early portion of the run through Statistical Week 27 was dominated by steelhead last detected at or downstream of McNary Dam (Figure 15). Between weeks 28 and 33, with the exception of Week 32, the proportion of the run detected in the Snake River generally increased and Snake River steelhead dominated our sampled beginning in Week 34. The dominance of the Snake River component is clearer in Figure 16 where the weekly percentage of the run to upstream sites was multiplied by the number of steelhead passing in that week.

[5] Unlike with Chinook Salmon ageing, PBT data either was not available or was not used in ageing steelhead. Therefore, a comparison table is presented for steelhead, where it was not presented for Chinook.

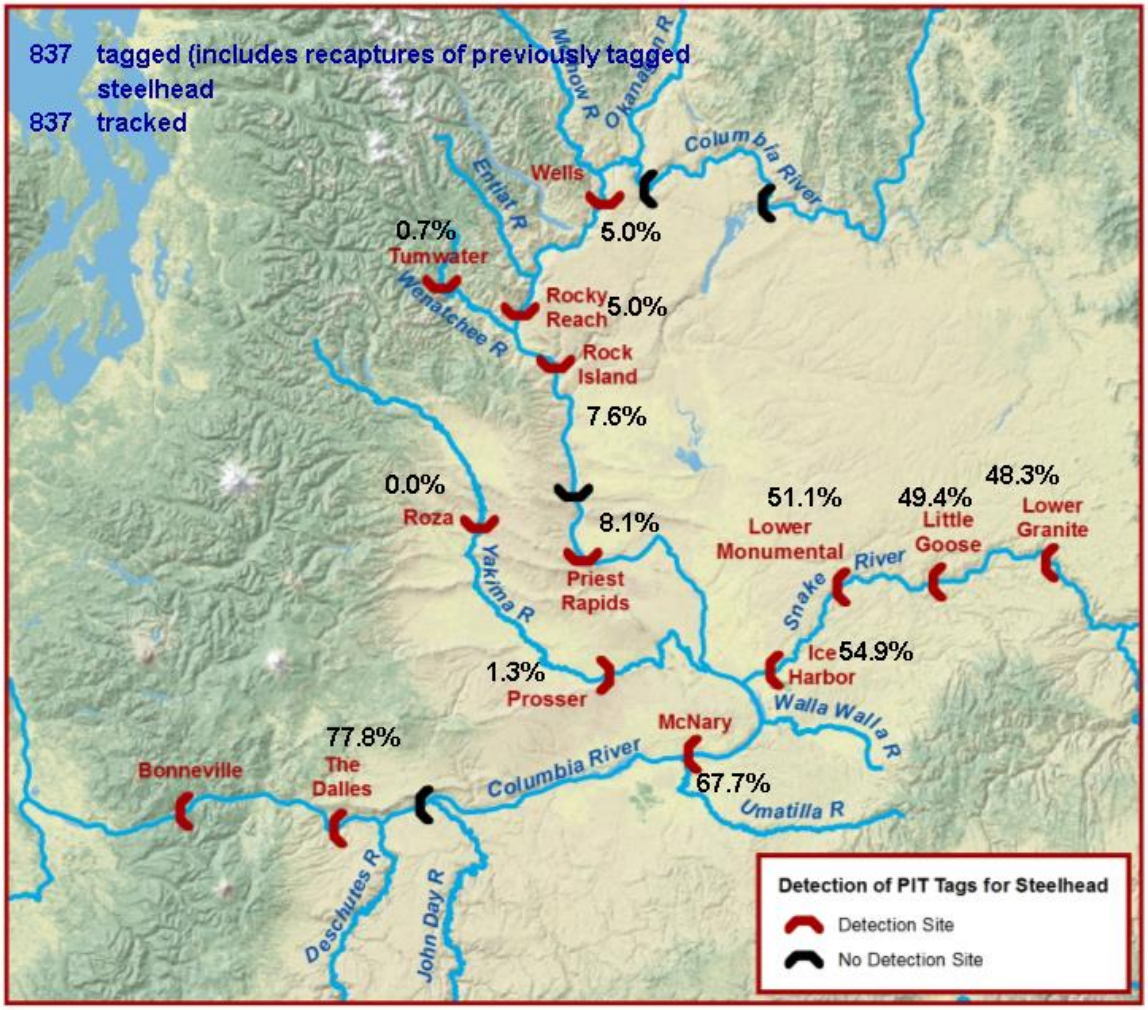

Figure 14. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of steelhead PIT tagged at Bonneville Dam, and the percentage of the run estimated to pass upstream dams in 2017.

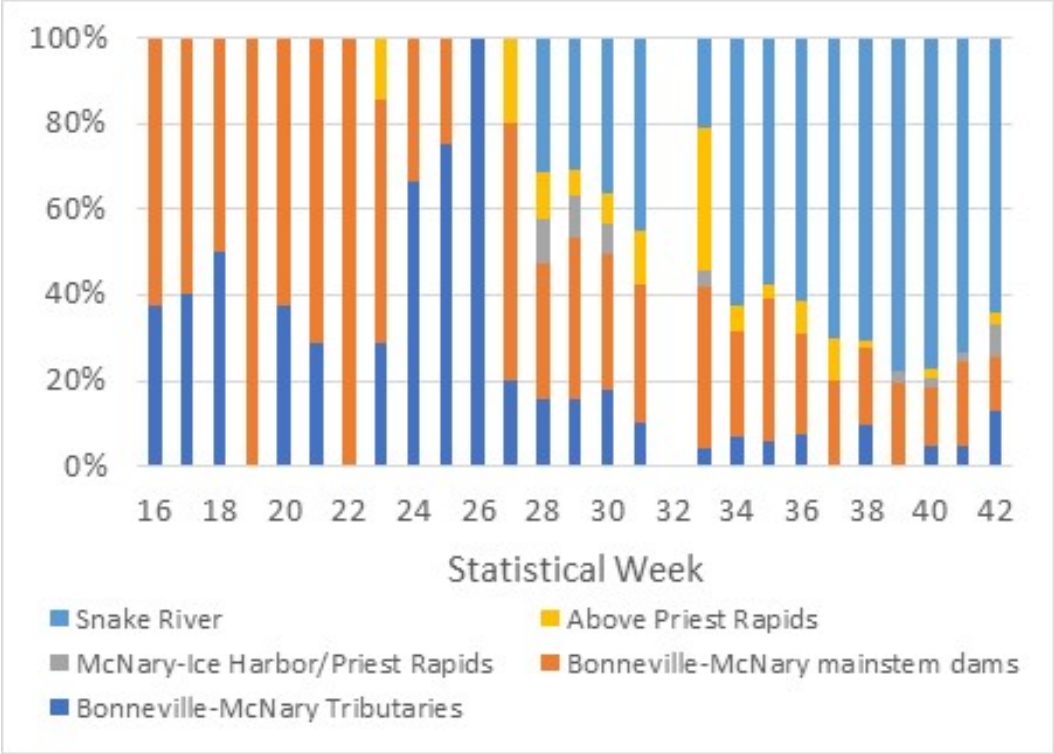

Figure 15. Distribution of final upstream detection site by statistical week for steelhead PIT tagged at Bonneville Dam in 2017 estimated as a percentage of the weekly run.

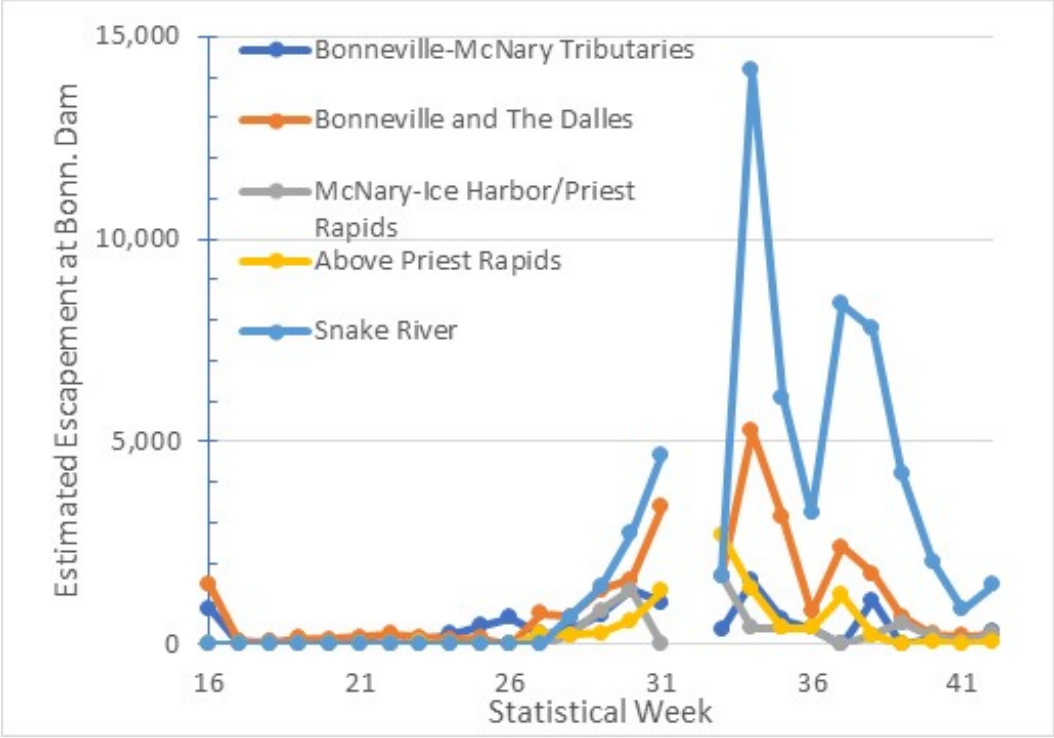

Figure 16. Distribution of final detection site by statistical week for steelhead PIT tagged at Bonneville Dam in 2017 estimated in numbers of fish passing Bonneville Dam by week.

In 2013, a PIT tag array (DRM) was installed across the width of the Deschutes River one kilometer upstream of the river's mouth. A total of 48 of the 836 steelhead tracked in 2017 by this study were detected at this site. Of these 48 steelhead, 20 fish had a most upstream detection, subsequent to detection at DRM, in the Snake River. For the other 28 fish, 2 steelhead went above Priest Rapids Dam, 4 were between McNary and Priest Rapids, 11 went into the Deschutes Basin (with 5 not being detected past DRM), and 11 went elsewhere between Bonneville and McNary dams (Figure 17). Thirty-four steelhead tagged by this project were detected upstream of DRM at Sherar's Falls PIT tag array; of these, only five of these fish were detected at DRM. Of the 34 Sherar's Falls (DSF) detections, 3 (3DD.0077BA4F99, 3DD.0077BA9FB8, and 3DD.0077BA68CF) subsequently headed back downstream to the Columbia River and were last detected upstream of Lower Granite Dam in the Snake River, one (3DD.0077BA73F7) was last detected in the John Day Basin, and 30 were last detected in the Deschutes Basin, 25 of which were last detected at DSF.

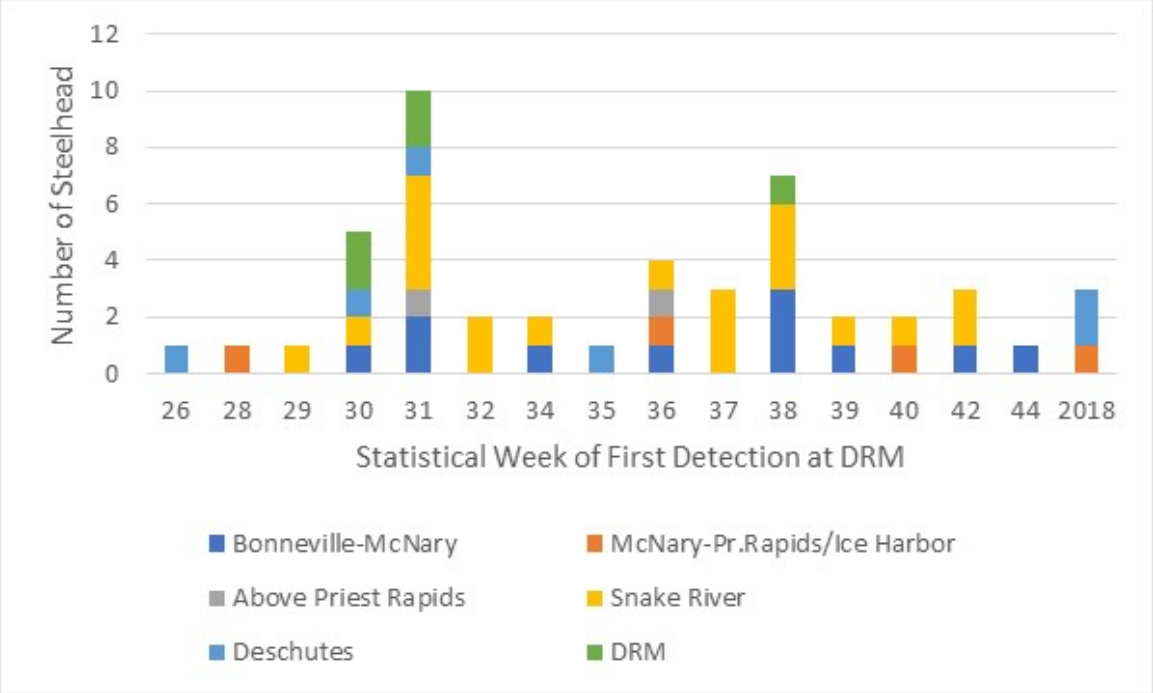

Figure 17. Distribution of final detection site by 2017 statistical week for steelhead PIT tagged at Bonneville Dam in 2017 which were detected at the Deschutes River Mouth antenna (DRM). Three steelhead had their first detection at DRM in 2018.

The percentage of PIT tagged steelhead passing a dam without detection was under 1% (Table 22) at all dams except for Rock Island which has known detection issues due to antenna size and electrical noise (Fryer et al. 2014).

Table 22. Percentages of steelhead passing a dam undetected that were subsequently detected upstream in 2017.

Dam	2017
Bonneville	0.0%
The Dalles	0.0%
McNary	0.6%
Priest Rapids	0.0%
Rock Island	4.4%
Rocky Reach	0.0%
Wells	0.0%
Ice Harbor	0.0%
Lower Monumental	0.5%
Little Goose	0.3%
Lower Granite	0.0%
Mean (weighted by number passing each dam)	**0.9%**

Migration Rates and Passage Time

The fastest median migration rate between mainstem dams, as measured in kilometers per day, was between The Dalles and McNary dams (32.2 km/day), while the slowest was 11.2 km/day between Bonneville and McNary dams (Table 23).

Table 23. Steelhead migration rate between Columbia Basin dams as estimated by PIT tag detections in 2017.

Dam Pair	Distance (km)	Median Migration Rate (km/day)
Bonneville-The Dalles	74	17.1
The Dalles-McNary	157	32.2
Bonneville - McNary	231	11.2
McNary - Priest Rapids	167	26.4
Priest Rapids - Rock Island	89	21.1
Rock Island - Rocky Reach	33	18.5
Rocky Reach - Wells	65	24.8
Rock Island - Tumwater	73	3.5
Bonneville – Rock Island	487	13.6
Bonneville - Wells	585	11.4
McNary - Ice Harbor	67	29.1
Ice Harbor - Lower Granite	156	22.9
Bonneville-Lower Granite	461	11.9

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 24). Passage times at Wells, Lower Granite, Priest Rapids, Tumwater, 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 is a reflection of the very short distance between lower-most and upper-most PIT tag

antennas.

Table 24. 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 2017.

Dam	Median Passage Time (minutes)	Percentage with more than 12 hours between first detection and last detection at a dam
Bonneville	9.1	2.1%
The Dalles	0.1	1.1%
McNary	91.3	6.3%
Priest Rapids	5.2	7.7%
Rock Island	1.6	4.3%
Rocky Reach	7.5	3.1%
Wells	96.9	20.7%
Ice Harbor	3.3	3.5%
Lower Monumental	1.1	5.1%
Little Goose	0.0	2.4%
Lower Granite	203.6	26.0%
Tumwater	87.0	28.6%
Prosser	0.0	4.3%

Upstream Age and Length-at-Age Composition

Age 1.1 steelhead had the highest abundance among all age classes in 2017 (Table 25, Figure 18) ranging from 37.8% of the run at Bonneville Dam to 46.7% of the run at Lower Granite Dam. Length-at-age composition data are found in Table 26.

Table 25. Age composition estimates of steelhead 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 2017. The "r" in age r.X means that the freshwater zone of the scale was regenerated, and therefore, the age is not possible to determine.

		2014	2013		2012			2011		2010	Unknown			Repeat Spawners
Site	n	1.1	1.2	2.1	1.3	2.2	3.1	2.3	3.2	4.2	r.1	r.2	r.3	
Bonneville	818	37.8%	10.9%	14.2%	1.3%	5.5%	0.8%	0.2%	0.8%	0.3%	18.6%	8.5%	0.3%	0.7%
The Dalles	624	42.3%	10.8%	15.3%	0.2%	5.9%	0.9%	0.0%	0.8%	0.5%	18.0%	4.8%	0.0%	0.5%
McNary	530	44.6%	9.9%	15.7%	0.2%	5.0%	1.1%	0.0%	0.8%	0.5%	16.8%	4.8%	0.0%	0.7%
Priest Rapids	52	41.9%	3.2%	28.4%	0.0%	2.5%	0.0%	0.0%	0.0%	0.0%	19.0%	5.0%	0.0%	0.0%
Rock Island	48	41.5%	3.2%	29.4%	0.0%	2.8%	0.0%	0.0%	0.0%	0.0%	17.8%	5.2%	0.0%	0.0%
Rocky Reach	32	43.7%	3.7%	29.9%	0.0%	2.6%	0.0%	0.0%	0.0%	0.0%	13.2%	6.8%	0.0%	0.0%
Wells	31	44.2%	3.7%	29.0%	0.0%	2.6%	0.0%	0.0%	0.0%	0.0%	13.2%	7.2%	0.0%	0.0%
Ice Harbor	422	46.4%	11.3%	14.7%	0.3%	3.8%	1.5%	0.0%	0.7%	0.7%	15.7%	4.7%	0.0%	0.3%
Lower Monumental	385	45.1%	12.2%	14.9%	0.3%	3.2%	1.5%	0.0%	0.7%	0.7%	16.0%	5.0%	0.0%	0.3%
Little Goose	368	46.5%	12.1%	14.0%	0.3%	3.3%	1.6%	0.0%	0.8%	0.7%	15.6%	4.6%	0.0%	0.4%
Lower Granite	355	46.7%	11.9%	13.3%	0.4%	3.4%	1.7%	0.0%	0.9%	0.8%	15.9%	4.7%	0.0%	0.4%

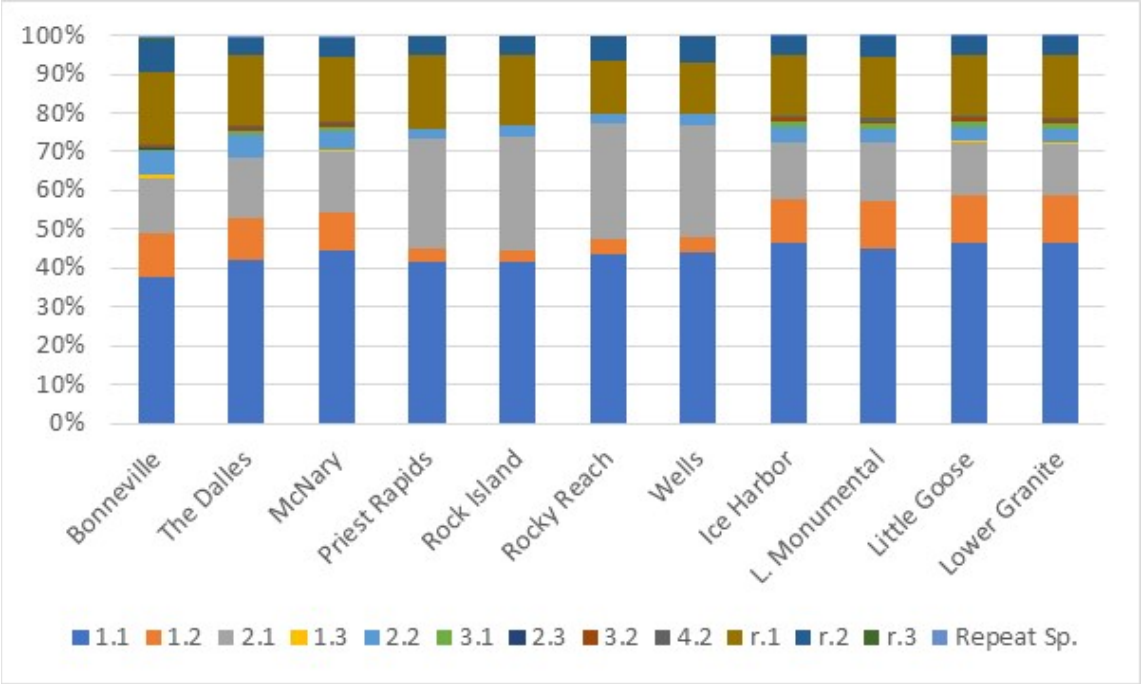

Figure 18. Steelhead age composition at Columbia and Snake River dams estimated from upstream detections of steelhead aged using scales at Bonneville Dam in 2017. The "r" in age r.X means that the freshwater zone of the scale was regenerated, and the age therefore is not possible to determine.

Table 26. Steelhead length-at-age composition at mainstem Columbia Basin dams, as estimated by upstream PIT tag detections of steelhead sampled at Bonneville Dam in 2017.

		Brood Year and Age										
Dam	Stat	2014	2013		2012			2011	2010	Unknown		
		1.1	1.2	2.1	1.3	2.2	3.1	2.3	3.2	r.1	r.2	r.3
Bonneville	μ	59.7	70.4	59.2	81.8	68.7	59.7	81.0	69.3	58.0	69.3	77.7
	s	6.0	10.3	5.7	19.2	5.3	2.3	--	4.7	6.2	10.8	2.5
	n	282	87	150	20	51	11	1	7	130	67	3
The Dalles	μ	59.9	71.2	59.0	86.5	69.1	58.9		71.1	57.6	67.8	
	s	6.1	11.6	6.2	11.6	5.2	1.5		2.2	6.6	14.4	
	n	245	59	123	4	38	9		5	103	32	
McNary	μ	60.0	73.9	58.8	86.5	70.4	58.9		71.2	57.8	68.1	
	s	6.2	6.2	6.5	11.6	5.7	1.6		3.0	7.2	15.5	
	n	220	49	102	4	26	8		3	85	27	
Priest Rapids	μ	58.1	64.5	57.2		69.2				58.7	66.6	
	s	2.5	--	13.7		2.9				3.7	3.1	
	n	17	1	20		3				7	4	
Rock Island	μ	58.3	64.5	57.1		69.2				59.9	66.6	
	s	2.5	--	14.1		2.9				3.7	3.1	
	n	16	1	19		3				5	4	
Rocky Reach	μ	58.6	64.5	55.2		70.3				56.5	67.3	
	s	2.5	--	18.5		3.2				0.0	3.3	
	n	13	1	11		2				2	3	
Wells	μ	58.6	64.5	55.2		70.3				56.5	67.3	
	s	2.5	--	19.5		3.2				0.0	3.3	
	n	13	1	10		2				2	3	
Ice Harbor	μ	60.2	74.4	59.1	86.5	72.7	59.1		69.8	57.6	67.9	
	s	6.6	6.1	3.0	11.6	5.1	1.6		2.5	8.4	19.1	
	n	190	45	50	4	15	7		2	60	18	
Lower Monumental	μ	60.1	74.4	59.2	86.5	72.9	59.1		69.8	57.6	67.9	
	s	6.6	6.1	3.0	11.6	5.5	1.6		2.5	8.5	19.1	
	n	184	45	49	4	13	7		2	59	18	
Little Goose	μ	60.0	74.8	59.1	86.5	72.9	59.1		69.8	57.5	68.5	
	s	6.7	6.2	3.1	11.6	5.5	1.6		2.5	8.7	20.2	
	n	180	42	44	4	13	7		2	56	16	
Lower Granite	μ	60.1	74.7	59.1	86.5	72.9	59.1		69.8	57.5	68.5	
	s	6.7	6.1	3.0	11.6	5.5	1.6		2.5	8.8	20.2	
	n	176	39	40	4	13	7		2	54	16	

Fallback

Estimated minimum fallback rates based on steelhead either reascending fish ladders or steelhead subsequently detected downstream, ranged from 0.5% at Bonneville to 19.2% at Priest Rapids Dam in 2017 (Table 27). 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 were detected falling back up to 7 times over dams (Table 28). Figures showing the movement of three steelhead with 6 and 7 fallbacks are in the Appendix B (Figures

B29 – B30).

Table 27. Estimated minimum steelhead fallback at Columbia Basin dams in 2017 as estimated by PIT tag[6] detections.

Dam	Percent Fallback
Bonneville	0.5%
The Dalles	1.4%
McNary	6.5%
Priest Rapids	19.2%
Rock Island	10.4%
Rocky Reach	12.5%
Wells	12.9%
Ice Harbor	5.5%
Lower Monumental	5.4%
Little Goose	6.1%
Lower Granite	5.5%

Table 28. Frequency of fallback events for steelhead tagged by this project in 2017.

Number of Dams Fallen Back Over	Total Number of Steelhead
1	42
2	32
3	12
4	3
5	1
6	1
7	1
Number of steelhead falling back at least once	**92**
% of steelhead with at least one fallback event	**11.0%**
Total fallback events	**172**
Number of steelhead in study	**837**

Night Passage

Night passage (2000-0400 Pacific Standard Time) by tagged steelhead ranged from 1.1% at Bonneville Dam to 28.3% at Wells Dam (Table 29). Given the median Bonneville Dam passage time of 9.1 minutes (Table 24), and the fact that sampling was generally conducted between 0800 and 1400, steelhead would be expected to pass during daytime hours.

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

Table 29. Estimated steelhead night passage (2000-0400 PST) at Columbia Basin dams in 2017.

Site	Percentage Night Passage
Bonneville	1.1%
The Dalles	6.1%
McNary	7.2%
Priest Rapids	1.9%
Rock Island	28.3%
Rocky Reach	9.4%
Wells	9.7%
Ice Harbor	7.2%
Lower Monumental	7.7%
Little Goose	8.0%
Lower Granite	6.3%

B-Run Analyses

A total of 46 B-run steelhead were sampled in 2017 (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 37 at 30.0% (Figure 19), a week in which only 10 steelhead were sampled. The estimated B-Run escapement at Bonneville Dam (estimated by multiplying the weekly run size using counting window data by the percentage B-run in that week estimated by this project) peaked in Week 37 at 3,601 fish while the A-run steelhead peaked in Week 34 at 22,728 fish. Overall, an estimated 6.5% of the 2017 run was B-run. Among steelhead 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), 83.3% steelhead with fork lengths 78.0 cm and greater were destined for the Snake Basin (Figure 20) with the remaining 16.7% destined for tributaries between Bonneville and McNary. Among the 804 steelhead sampled at Bonneville Dam where ocean age could be estimated, B-run steelhead were comprised entirely of two- and three-ocean steelhead, while A-run steelhead were comprised almost entirely of one- and two-ocean steelhead (Table 30). The mean length of sampled A-run steelhead was 61.8 cm compared to 82.4 cm for B-run steelhead.

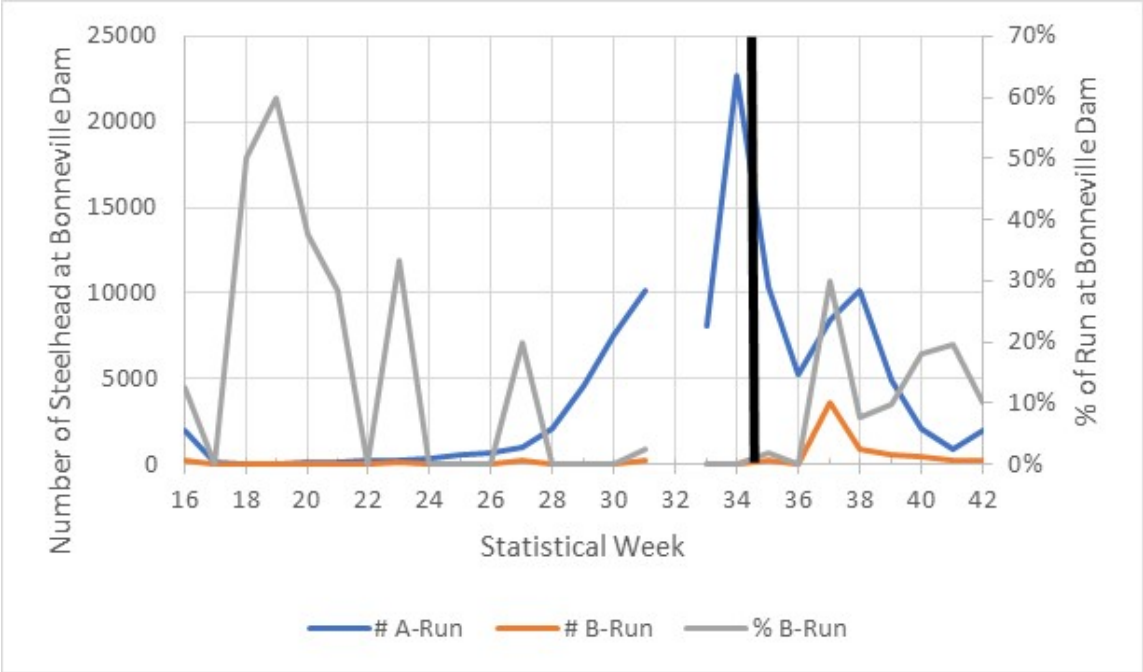

Figure 19. Percentage of B-run steelhead and estimated A- and B-run escapement at Bonneville Dam by statistical week in 2017. The vertical line shows the approximate location of August 25 which is considered the date that separates A- and B-run steelhead. Note the Week 37 estimate is based on only 10 steelhead, 3 of which were B-run.

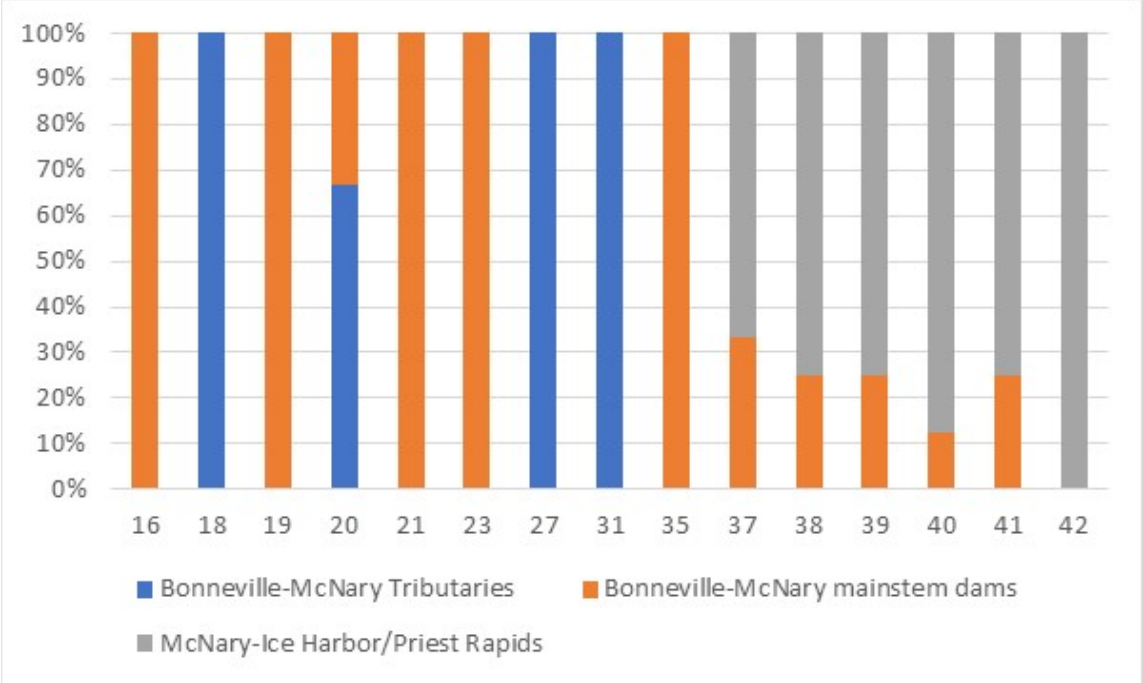

Figure 20. Most upstream detection site for B-run steelhead (≥78 cm fork length) by Statistical Week they were sampled at Bonneville Dam in 2017

Table 30. Ocean age composition of A- (<78 cm fork length) and B-Run (≥78 cm fork length) steelhead sampled at Bonneville Dam in 2017 (weighted by run size).

Run	N	One-Ocean (x.1)	Two-Ocean (x.2)	Three Ocean (x.3)
A-Run	759	77.0%	22.3%	0.7%
B-Run	45	0.0%	82.8%	17.2%
All Steelhead	**804**	**70.9%**	**27.4%**	**1.7%**

Kelt Analyses

A total of 60 steelhead PIT tagged in 2017 were either detected going downstream in the Columbia Basin in 2018, presumably in an attempt to return to the ocean after spawning (kelts) or detected moving back upstream later in 2018 or early 2019 as repeat spawners (Tables 31 and B2), after March 31st. At the start of this study in 2009, we assigned a cutoff date of March 31st, 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). 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 2017, four steelhead were added (Tables 31 and B3) for a total of 64 kelts. Six steelhead were recognized in the CRITFC Kelt Project as spawned-out and moving back downriver (collected for study – Hatch et. al. Multiple Years) (Tables 31 and B2) and were added to the list of kelts, including one steelhead that was moving out of the system before April 1st. The highest percentage of kelt passing Bonneville was in Week 28 while the greatest number of kelt was estimated to be in Week 33 (Figures 21 and 22).

Table 31. Some biological and detection information on the steelhead moving in the Columbia Basin system in 2017 that were determined to be kelts (CRITFC Kelt Project) or repeat spawners and potential kelts (because of their behavior). Please see Tables A2 and A3 for more details on the detected behavior of the steelhead.

					Most Upstream Site		Last Site Detected				
PIT Tag	Date Tagged	Fin Clip	Age	Fork Length	Basin and Site	Date	Basin and Site	Date	Comment	Detected Migrating Downstream in Spring 2018	Detected Migrating Upstream in Summer/ Fall 2018
3DD.0077BA35CE	7/11/2017		2.2	69.5	Snake (GRA)	11/9/2018	Snake (GRA)	11/9/2018	Downstream at GRJ 4/29/18	X	X
3DD.0077BA4F7A	7/11/2017	AD	r.2	68.0	Klickitat (LFF)	7/15/2017	Columbia (B2J)	4/26/2018		X	
3DD.0077BAB611	7/11/2017		r.1	55.5	Columbia (TD1)	9/22/2017	Columbia (BO4)	7/10/2018			X
3DD.0077979792	7/14/2017		r	61.0	Grande Ronde (UGS)	4/20/2018	Grande Ronde (UGR)	4/26/2018	Moving downstream in Upper Grand Ronde	X	
3DD.00779797D1	7/14/2017		2.1	53.0	Snake (GOA)	10/28/2017	Columbia (JDJ)	5/29/2018		X	
3DD.0077BA584A	7/17/2017		1.2	68.0	Yakima (PRO)	9/22/2017	Columbia (BCC)	4/27/2018		X	
3DD.0077BA9173	7/17/2017		2.1	57.5	John Day (JDM)	4/24/2018	Columbia (B2J)	5/1/2018		X	
3DD.0077BAAAEE	7/17/2017		3.1	61.0	Snake (GRA)	7/28/2017	Columbia (BCC)	6/4/2018		X	
3DD.0077BA5B53	7/18/2017		r.1	61.5	Grande Ronde (WR1)	3/29/2018	Columbia (B2J)	5/1/2018		X	
3DD.0077BAB38E	7/18/2017		2.1	55.0	Yakima (TOP)	4/23/2018	Yakima (TOP)	4/23/2018	Moving downstream in Yakima	X	
3DD.0077BAC7ED	7/18/2017		2.1	64.5	Columbia (WEA)	4/29/2018	Columbia (RRJ)	6/15/2018		X	
3DD.0077BA3ADD	7/19/2017	AD	1.1	60.0	Snake (GRA)	10/12/2017	Columbia (BCC)	5/3/2018		X	
3DD.0077BA442D	7/19/2017		r.1	62.0	Walla Walla (NBA)	1/16/2018	Walla Walla (BGM)	4/13/2018	Moving downstream in Walla Walla	X	
3DD.0077BA7048	7/19/2017		2.1	59.0	Yakima (ROZ)	4/24/2018	Columbia (BCC)	6/2/2018		X	
3DD.0077BA8D39	7/19/2017		2.1	57.5	Yakima (PRO)	9/17/2018	Yakima (PRO)	9/17/2018		X	X
3DD.0077BAC383	7/19/2017		1.1	56.0	Tucannon (PAT)	4/13/2018	Columbia (B2J)	5/5/2018		X	
3DD.00777E5003	7/20/2017		2.1	59.5	Snake (GRA)	9/27/2017	Snake (GOJ)	4/17/2018		X	
3DD.0077BA9F3F	7/20/2017		2.1	58.5	Columbia (WEA)	11/18/2017	Columbia (BCC)	6/26/2018		X	
3DD.0077BA3F7E	7/21/2017		2.1	59.0	Columbia (MC1)	8/31/2017	Columbia (MCJ)	3/29/2018		X	
3DD.0077BA7D3E	7/24/2017	AD	r.1	55.5	Salmon (USE)	4/6/2018	Snake (GRJ)	5/24/2018		X	

3DD.0077BA9FB8	7/24/2017	AD	1.1	56.0	Salmon (USE)	3/28/2018	Snake (GOJ)	5/6/2018		X	
3DD.0077BAB6BA	7/24/2017	LV	1.1	53.5	Umatilla (MWC)	5/30/2018	Umatilla (TMF)	6/4/2018	Downstream in TMF ladder	X	
3DD.0077BAC9DE	7/24/2017		r.1	58.5	Yakima (PRO)	10/25/2017	Columbia (JDJ)	5/6/2018		X	
3DD.0077BA48D6	7/25/2017		2.2	67.0	Snake (GRA)	8/27/2017	Snake (LMJ)	4/28/2018		X	
3DD.0077BA7705	7/25/2017		2.1	62.0	Clearwater (LAP)	3/13/2018	Estuary (TWX)	5/4/2018		X	
3DD.0077BA7DC0	7/25/2017		2.1	58.5	Yakima (SAT)	4/12/2018	Columbia (JDJ)	5/1/2018		X	
3DD.0077BA8EC3	7/25/2017		3.1	61.0	Snake (GRA)	9/24/2017	Snake (LMJ)	5/29/2018		X	
3DD.0077BAC7FF	7/25/2017		r.1	55.0	Columbia (MC1)	11/7/2017	Columbia (MCJ)	3/29/2018		X	
3DD.0077BAFF29	7/25/2017		2.1	56.0	Snake (GRA)	10/1/2017	Columbia (BCC)	5/12/2018		X	
3DD.00778ADB44	7/26/2017		r	58.5	Umatilla (MWC)	4/23/2016	Columbia (BCC)	4/29/2018		X	
3DD.0077BA7FBC	7/26/2017		3.2	70.0	Umatilla (UMF)	3/20/2018	Umatilla (TMF)	5/1/2018		X	
3DD.0077BA4C40	7/27/2017	AD	2.1	55.5	Wenatchee (TUF)	11/27/2017	Columbia (BCC)	5/7/2018		X	
3DD.0077BA9B91	7/27/2017		2.1	60.5	Grande Ronde (JOC)	3/30/2018	Snake (GRJ)	4/9/2018	In Kelt Program, long-term reconditioning	X	
3DD.0077BA384F	7/31/2017	AD	1.2	70.0	Snake (GRA)	10/1/2017	Columbia (MC2)	4/2/2018	Downstream in MC2 ladder	X	
3DD.0077BA4141	7/31/2017		r.1	56.5	Imnaha (BSC)	5/14/2018	Imnaha (BSC)	5/14/2018	Downstream in Big Sheep Creek	X	
3DD.0077BA54E9	7/31/2017		1.1	58.0	Wenatchee (NAL)	4/16/2018	Columbia (BCC)	6/6/2018		X	
3DD.003BE289FC	8/17/2017		1.1	57.0	Methow (TWR)	3/20/2018	Columbia (RRJ)	6/6/2018		X	
3DD.0077BA49CD	8/17/2017		2.1	55.0	Imnaha (BSC)	7/1/2018	Snake (GRJ)	7/5/2018		X	
3DD.0077BA5C0E	8/17/2017	AD	r.1	56.5	Methow (SCP)	4/29/2018	Columbia (RRJ)	5/7/2018		X	
3DD.0077BA4914	8/21/2017	AD	1.1	56.0	Imnaha (IR2)	4/6/2018	Snake (GRJ)	5/12/2018	Sampled as a Kelt by Kelt Program at Lower Granite	X	
3DD.0077BA8123	8/22/2017		2.1	56.0	Snake (GRA)	4/24/2018	Snake (GRA)	4/24/2018		X	
3DD.0077BA81CE	8/22/2017	AD	1.1	56.5	Grande Ronde (WR1)	4/11/2018	Columbia (BCC)	5/3/2018		X	
3DD.0077BA8A7A	8/22/2017	AD	r.1	60.5	Snake (GRA)	9/28/2017	Snake (LMJ)	4/28/2018		X	
3DD.0077BA3F3F	8/23/2017	AD	1.1	54.5	Snake (GRA)	10/9/2017	Snake (LMJ)	5/2/2018		X	
3DD.0077BA58CB	8/24/2017	AD	1.1	55.5	Salmon (STL)	4/7/2018	Columbia (B2J)	5/9/2018		X	

3DD.0077BAAA7F	8/24/2017	AD	1.2	64.5	Methow (LMR)	11/14/2017	Columbia (RRJ)	4/3/2018		X	
3DD.0077BA37F2	8/28/2017	AD	r	62.0	Salmon (USI)	3/23/2018	Columbia (BCC)	4/29/2018		X	
3DD.0077BAC7F0	8/29/2017		r.2	58.5	Snake (LMA)	10/10/2017	Columbia (B2J)	4/27/2018		X	
3DD.0077BA3A92	9/1/2017		2.1	58.5	Methow (TWR)	4/16/2018	Columbia (RRJ)	6/22/2018		X	
3DD.0077BA8102	9/1/2017		2.2	72.0	Snake (GRA)	9/25/2017	Snake (GOJ)	3/29/2018		X	
3DD.0077BA5908	9/8/2017	AD	1.1	62.0	Snake (GRA)	9/26/2017	Snake (GRJ)	5/10/2018	Sampled as a Kelt by Kelt Program at Lower Granite	X	
3DD.0077BAC786	9/21/2017		2.1	56.5	Snake (GRA)	10/4/2017	Snake (GRJ)	5/8/2018		X	
3DD.0077BA3EDA	9/25/2017	AD	r.2	79.5	Snake (GRA)	10/11/2017	Snake (GOA)	4/2/2018	Downstream in ladder	X	
3DD.0077BA9F5E	9/27/2017		4.2	76.5	Salmon (ZEN)	4/21/2018	Columbia (BCC)	6/1/2018		X	
3DD.0077B9F9DB	10/3/2017		2.1	60.5	Snake (GOA)	10/17/2017	Estuary (TWX)	5/3/2018		X	
3DD.0077BA3811	10/6/2017	AD	r.1	57.0	Salmon (USE)	4/6/2018	Snake (GOJ)	5/21/2018		X	
3DD.0077BA8D86	10/6/2017	AD	1.1	60.0	Walla Walla (BGM)	4/19/2018	Columbia (MCJ)	5/5/2018		X	
3DD.0077BAAC88	10/6/2017		2.2	68.0	Clearwater (SC1)	2/7/2018	Columbia (BCC)	5/5/2018		X	
3DD.0077BACB43	10/6/2017	AD	1.3	88.0	Clearwater (DWL)	2/8/2018	Clearwater (DWL)	2/8/2018	Sampled as a Kelt by Kelt Program at Lower Granite	X	
3DD.0077BACBBA	10/9/2017		1.1	67.0	Clearwater (LC2)	4/30/2018	Snake (GOJ)	5/10/2018	Sampled as a Kelt by Kelt Program at Lower Granite	X	
3DD.0077BA55A2	10/16/2017		r.1	56.5	Touchet (COP)	2/7/2019	Touchet (COP)	2/7/2019			X
3DD.0077BB2882	10/16/2017		1.1	57.5	Yakima (SAT)	3/11/2018	Columbia (BCC)	4/16/2018		X	
3DD.0077BA8165	10/17/2017	AD	r.1	59.0	Snake (GRA)	11/24/2017	Snake (LMJ)	5/10/2018		X	
Rainbow Trout											
3DD.0077BA58A2	10/18/2017	TROUT	2.0	45.0	GRA	4/6/2018	Snake (GRJ)	5/15/2018	Sampled as a Kelt by Kelt Program at Lower Granite	X	

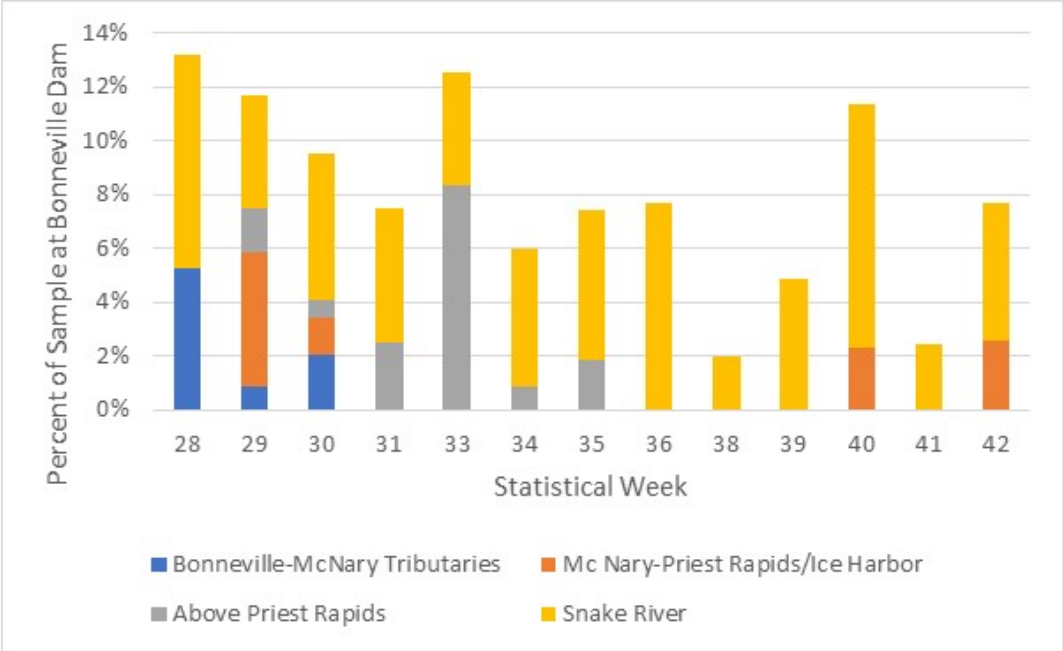

Figure 21. Percentage of run designated as kelt by week sampled in 2017 at Bonneville Dam and the most upstream detection area for those kelt.

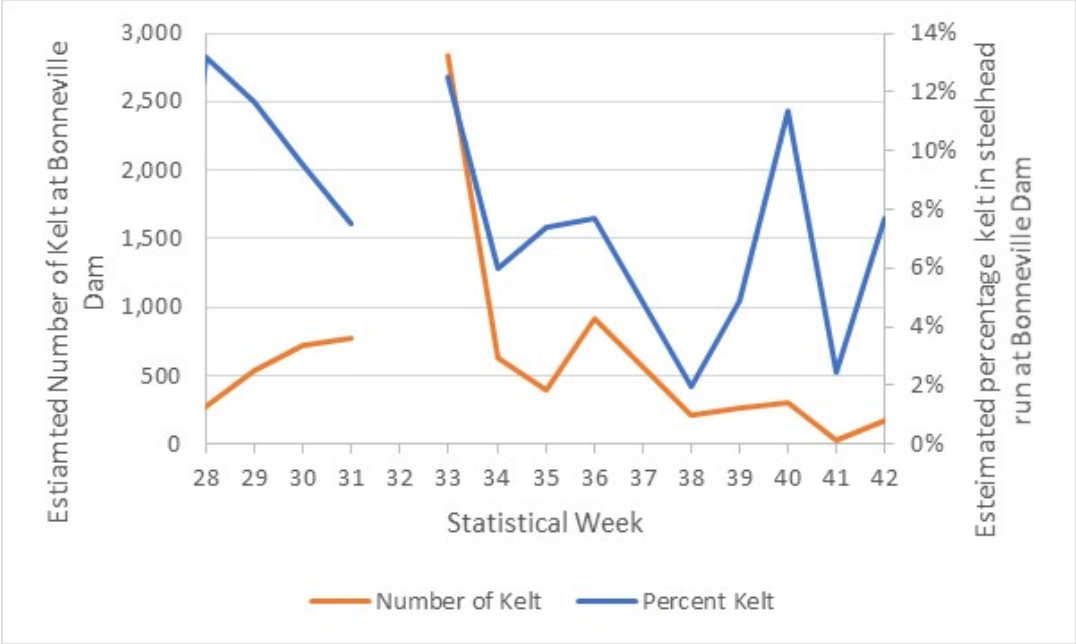

Figure 22. Percentage and number of kelt estimated to be passing Bonneville Dam by Statistical Week as estimated by this project in 2017. No kelt were observed prior to Statistical Week 28 while there was no sampling in Statistical Week 32.

Many kelts that are detected moving out of the system are detected in the juvenile bypasses (last detection location) of the major Columbia and Snake dams. For 2016, the juvenile bypass at these dams detected kelts; Bonneville (6), John Day (3), McNary (3), Lower Monumental (5), Little Goose (5), Lower Granite (7), and Rocky Reach (5) (Table 32). Another major exit location for kelts is the Bonneville Dam Corner Collector, where 14 steelhead tagged by this study were last detected migrating downstream in spring and summer 2017 (Tables 31 and B2). Of the 64 identified kelts, 39 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 all six steelhead collected by the Kelt Project where collected at Lower Granite Dam Juvenile Bypass as they were moving downstream after spawning. Four steelhead appeared to be repeat spawners as they were last seen in the spring or early summer of 2017 heading downstream, and then again in either the fall of 2017, winter 2018, or winter 2019, were detected moving upstream through the Bonneville Dam fish ladders or into tributaries.

We have also updated information on kelts/repeat spawners from past annual reports with data from 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 2014 (one record), 2015 (two records), and 2016 (six records).

Table 32. 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 2009-2017. Data is categorized by last detection site.

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

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

Among the 812 steelhead sampled at Bonneville Dam where ocean age could be estimated, when compared to non-kelt, kelt had a higher percentage of one-ocean fish (78.3% vs. 69.9%) and lower percentage of two ocean fish (20.0% vs. 27.0%). The mean length of non-kelt was 63.2 cm compared to 60.8 cm for kelt (Table 33).

Table 33. Ocean age composition of steelhead designated as kelt or non-kelt sampled at Bonneville Dam in 2017.

Run	Number Ageable	One-Ocean (x.1)	Two-Ocean (x.2)	Three Ocean (x.3)
Kelt	60	78.3%	20.0%	1.7%
Non-Kelt	752	69.9%	27.0%	3.1%

Straying

Steelhead stray rates by stock were estimated with stock classification by three different criteria. The first was for stock that could be designated by Parental Based Tagging (PBT), presumably the most accurate genetic stock classification (Table 34). For those fish for which PBT was not available, stock classifications were made using Genetic Stock Identification (GSI). This second method was further broken down into GSI>=0.8 (Table 35) and GSI<0.8 (Table 36). The overall stray rate for both the PBT-classified and GSI (>=0.8) was 4.9%, while the GSI (>0.8) was 10.8%.

Table 34. Showing final-PIT-fate categories by stock as determined using 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.

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

Stock Classification using Parental Based Tagging (PBT)	Bonneville						Hood	Lyle Falls	The Dalles		Deshutes			Three Mile Falls	McNary		Burlingame	Ice Harbor	Lower Monumental	Tucannon	Little Goose	Lower Granite
	Bonneville PH2 Juvenile	BON PH2 Corner Collector	Bonneville Bradford Is. Ladder	Bonneville Cascades Is. Ladder	Bonneville WA Shore Ladder/AFF	Bonneville WA Ladder Slots	Hood River Mouth	Lyle Falls Fishway	The Dalles East Fish Ladder	The Dalles North Fish Ladder	Deschutes River mouth	Deschutes Sherars Falls	Warm Springs River PIT Array	Three Mile Falls Dam Combined	McNary Oregon Shore Ladder	McNary Washington Shore Ladder	Burlingame Dam and Canal	Ice Harbor Dam (Combined)	Lower Monumental Adult Ladders	Middle Tucannon River	Little Goose Fish Ladder	Lower Granite Dam Adult
	234	234	234	234	234	234	273	290	308	308	328	328	328	465	470	470	509	522	522	522	522	522
	B2J	BCC	BO1	BO2	BO3	BO4	HRM	LFF	TD1	TD2	DRM	DSF	WSR	TMF	MC1	MC2	BGM	ICH	LMA	MTR	GOA	GRA
Lower Columbia					2	1	3															
Skamania		2	1		8	17	1	9														
Mid-Col. To Low. Snake	1			1	14	3			7	1	1	13	1	3	1		2	1	5	3	3	55
Upper Columbia					3				1							1						
SF Clearwater		1			7				3						1	1			2		1	45
Upper Salmon					12			1	2									1				33
Total	**1**	**3**	**1**	**1**	**46**	**21**	**4**	**10**	**13**	**1**	**1**	**13**	**1**	**3**	**2**	**2**	**2**	**2**	**7**	**3**	**4**	**133**

Stock Classification using Parental Based Tagging (PBT)	Clearwater					Grande Ronde		Salmon River				Imnaha	Prosser	Rock Island	Tumwater	Wells	Methow River					Okanogan			Total					Percentages
	Clear Creek near Kooskia NFH	Dworshak NFH adult trap	Upper Lolo Creek at rkm 25	Lower SF Clearwater R at rkm 1	Lower SF Clearwater R at rkm 2	Joseph Creek ISA @ km 3	Wallowa River at river km 14	Sawtooth Hatchery Adult Trap	Upper Salmon River at rkm 437	Upper Salmon River at rkm 460	Wimpey Creek, Lemhi R. Basin	Lower Imnaha River ISA @ km 10	Prosser Diversion Dam Combined	Rock Island Adult	Tumwater Dam Adult Fishway	Wells Dam, DCPUD Adult Ladders	Chewuch River above Winthrop	Lower Methow River at Pateros	Methow River at Carlton	Methow River at Winthrop	Lwr Twisp Rvr near MSRF Ponds	Bonaparte Creek Instream Array	Loup Loup Creek Instream Array	Omak Creek below Mission Falls	Total	Neutral	On Target	Putative Stray	Putative overshoot	Stray Rate
	522	522	522	522	522	522	522	522	522	522	522	522	539	730	754	830	843	843	843	843	843	858	858	858						
	CLC	DWL	LC2	SC1	SC2	JOC	WR1	STL	USE	USI	WPC	IR2	PRO	RIA	TUF	WEA	CRW	LMR	MRC	MRW	TWR	BPC	LLC	OBF						
Lower Columbia																									6	3	3	0	0	0.0%
Skamania																									38	28	10	0	0	0.0%
Mid-Col. To Low. Snake						1	6					3	1	1								1	1		129	30	88	11	0	11.1%
Upper Columbia															1	5	2	2	1	1	2			1	20	5	88	0	0	0.0%
SF Clearwater	1	15	3	17	13																				110	61	49	0	0	0.0%
Upper Salmon								5	5	1	1							1							62	48	12	2	0	14.3%
Total	**1**	**15**	**3**	**17**	**13**	**1**	**6**	**5**	**5**	**1**	**1**	**3**	**1**	**1**	**1**	**5**	**2**	**3**	**1**	**1**	**2**	**1**	**1**	**1**	**365**	**175**	**250**	**13**	**0**	**4.9%**

Table 35. Showing final-PIT-fate categories by stock as determined using Genetics Stock Identification (p>=0.8). Fate categories are categorized by color. Grey is neutral (meaning last detected on route to expected destinations), green is on target (meaning last detected at their expected destination), yellow is putative overshoot meaning a fish last detected in an area adjacent to its expected destination, and red is putative stray meaning a fish was last detected in tributaries or the mainstem outside their normal route to their expected destination. Stray rates are also tabulated.

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

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

Stock Classification using Genetic Stock Identification (p>=0.8)	John Day							Umatilla				McNary		Walla Walla				Ice Harbor	Lower Monumental	Tucannon	Little Goose	Lower Granite
	Thirtymile Crk John Day Basin	Bridge Creek Gauge	Bridge Creek Kiosk	John Day River, McDonald Ferry	Upper John Day River Array	Middle Fork John Day Array	SF John Day (Mid)	Maxwell Canal	Three Mile Falls Dam Combined	Umatilla R below Feed Dam	Umatilla R Recycled Water Fac	McNary Oregon Shore Ladder	McNary Washington Shore Ladder	Lower Coppei Instream Array	Nursery Bridge Adult	Pattit Creek Instream Site	Harris Bridge S F Walla Walla	Ice Harbor Dam (Combined)	Lower Monumental Adult Ladders	Middle Tucannon River	Little Goose Fish Ladder	Lower Granite Dam Adult
	351	351	351	351	351	351	351	465	465	465	465	470	470	509	509	509	509	522	522	522	522	522
	30M	BR0	BR1	JD1	JDM	MJ1	SJ1	MWC	TMF	UMF	UMW	MC1	MC2	COP	NBA	PAT	WW1	ICH	LMA	MTR	GOA	GRA
Lower Columbia																						
Skamania																						
Willamette																						
Klickitat																						1
Yakima																						
Upper Columbia												3							1			1
Clearwater												1						3				7
Salmon									1													27
Total	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**4**	**0**	**0**	**0**	**0**	**0**	**3**	**1**	**0**	**0**	**36**

Stock Classification using Genetic Stock Identification (p>=0.8)	Clearwater							Grande Ronde				Salmon						Imanah		
	Dworshak NFH adult trap	Lapwai Creek, near its mouth	Upper Lolo Creek at rkm 25	Lochsa River Upper Site	Lower SF Clearwater R at rkm 1	Lower SF Clearwater R at rkm 2	Upper Selway River Array	Joseph Creek ISA @ km 3	Upper Grande Ronde at rkm 155	Upper Grande Ronde Starkey	Wallowa River at river km 14	Cearley Creek Side Channel	Sawtooth Hatchery Adult Trap	Upper Salmon River at rkm 437	Upper Salmon River at rkm 460	Valley Creek, Downstream Site	Secesh River at Zena Cr. Ranch	Big Sheep Creek ISA at km 6	Lower Imnaha River ISA @ km 10	Upper Imnaha River ISA @ km 41
	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522	522
	DWL	LAP	LC2	LRU	SC1	SC2	SW2	JOC	UGR	UGS	WR1	CEY	STL	USE	USI	VC2	ZEN	BSC	IR2	IR3
Lower Columbia																				
Skamania																				
Willamette																				
Klickitat																				
Yakima																				
Upper Columbia																				
Clearwater	1		1	1		1	1					1								
Salmon								1					2	7	4	1	1			
Total	**1**	**0**	**1**	**1**	**0**	**1**	**1**	**1**	**0**	**0**	**0**	**1**	**2**	**7**	**4**	**1**	**1**	**0**	**0**	**0**

Stock Classification using Genetic Stock Identification (p>=0.8)	Yakima				Priest Rapids	Rock Island	Wenatchee			Rocky Reach	Wells	Methow			Total					Percentages
	Lower Satus Creek	Lower Naches River	Prosser Diversion Dam Combined	Lower Toppenish Creek	Priest Rapids Adult	Rock Island Adult	Upper Peshastin Creek	Tumwater Dam Adult Fishway	Upper Wenatchee River	Rocky Reach Fishway	Wells Dam, DCPUD Adult Ladders	Chewuch River above Winthrop	Methow River at Carlton	Lwr Twisp Rvr near MSRF Ponds	Total	Neutral	On Target	Putative Stray	Putative overshoot	Stray Rate
	539	539	539	539	639	730	754	754	754	763	830	843	843	843						
	SAT	LNR	PRO	TOP	PRA	RIA	PEU	TUF	UWE	RRF	WEA	CRW	MRC	TWR						
Lower Columbia															7	3	2	2	0	50.0%
Skamania															15	8	7	0	0	0.0%
Willamette															1	0	0	1	0	100.0%
Klickitat															7	6	0	1	0	100.0%
Yakima	3	1	1	4						1					15	6	9	0	0	0.0%
Upper Columbia								1			2		1		11	7	4	0	0	0.0%
Clearwater															21	9	12	0	0	0.0%
Salmon			1												49	6	43	0	0	0.0%
Total	**3**	**1**	**2**	**4**	**0**	**0**	**0**	**1**	**0**	**1**	**2**	**0**	**1**	**0**	**126**	**45**	**77**	**4**	**0**	**4.9%**

Table 36. Showing final-PIT-fate categories by stock as determined using Genetics Stock Identification (p<0.8). Fate categories are categorized by color. Grey is neutral (meaning last detected on route to expected destinations), green is on target (meaning last detected at their expected destination), yellow is putative overshoot meaning a fish last detected in an area adjacent to its expected destination, and red is putative stray meaning a fish was last detected in tributaries or the mainstem outside their normal route to their expected destination. Stray rates are also tabulated.

	Final Site, PTAGIS Site Name, RKm, and PTAGIS Site Code																																																		
	Bonneville			Wind	Hood	The Dalles	Deschutes			John Day	Maxwell Canal	McNary		Walla Walla		Lower Monumental	Tucannon			Little Goose	Lower Granite	Dworkshak	Asotin	Wallowa	Salmon			Imnaha		Yakima				Priest Rapids	Rock Island	Wenatchee						Methow				Omak	Total					Percentages
Stock Classification using Genetic Stock Identification (p<0.8)	Bonneville Bradford Is. Ladder	Bonneville WA Shore Ladder/AFF	Bonneville WA Ladder Slots	Upper Wind River (WA) rkm 30	Hood River Mouth	The Dalles East Fish Ladder	Deschutes River mouth	Deschutes Sherars Falls	Shitike Creek PIT Array	John Day River, McDonald Ferry	Maxwell Canal	McNary Oregon Shore Ladder	McNary Washington Shore Ladder	Nursery Bridge Adult	Walla Walla R at Pierce RV Prk	Lower Monumental Adult Ladders	Middle Tucannon River	Tucannon Fish Hatchery	Upper Tucannon River	Little Goose Fish Ladder	Lower Granite Dam Adult	Dworshak NFH adult trap	Asotin Cr. at Cloverland Brdg.	Wallowa River at river km 14	Panther Creek Array	Sawtooth Hatchery Adult Trap	Upper Salmon River at rkm 460	Big Sheep Creek ISA at km 6	Lower Imnaha River ISA @ km 10	Lower Satus Creek	Prosser Diversion Dam Combined	Roza Diversion Dam (Combined)	Lower Toppenish Creek	Priest Rapids Adult	Rock Island Adult	Upper Chiwawa River	Lower Wenatchee River	Lower Mission Creek Instream	Lower Nason Creek	Upper Peshastin Creek	Upper Wenatchee River	Chewuch River above Winthrop	Methow River at Carlton	Whitefish SC in Methow River	Spring Creek Acclimation Pond	Omak Creek above Mission Falls	Total	Neutral	On Target	Putative Stray	Putative overshoot	Stray Rate
	234	234	234	251	273	308	328	328	328	351	465	470	470	509	509	522	522	522	522	522	522	522	522	522	522	522	522	522	522	539	539	539	539	639	730	754	754	754	754	754	754	843	843	843	843	858						
	BO1	BO3	BO4	WRU	HRM	TD1	DRM	DSF	SHK	JD1	MW(	MC1	MC2	NBA	PRV	LMA	MTR	TFH	UTR	GOA	GRA	DWL	ACB	WR1	PCA	STL	USI	BSC	IR2	SAT	PRO	ROZ	TOP	PRA	RIA	CHU	LWE	MCL	NAL	PEU	UWE	CRW	MRC	MWI	SCP	OMF		0	0	0	0	
Lower Columbia		1																																													1	0	0	0	0	
Skamania				1																																											1	0	1	0	0	0.0%
Klickitat		3			1		1																																								5	0	2	0	0	0.0%
Yakima																														2		1	2		1												6	0	5	1	0	16.7%
Upper Columbia		1	1			1																															1				1	2		1		1	9	0	6	0	0	0.0%
Clearwater																						1																									1	0	1	0	0	0.0%
Salmon	1	8				2						4	1			1					13		1			2	3		2														1				40	0	18	3	0	14.3%
Total	**1**	**13**	**1**	**1**	**1**	**3**	**1**	**0**	**0**	**0**	**0**	**4**	**1**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**13**	**1**	**1**	**0**	**0**	**2**	**3**	**0**	**2**	**2**	**0**	**1**	**2**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**1**	**2**	**1**	**1**	**0**	**1**	**63**	**0**	**33**	**4**	**0**	**10.8%**

RESULTS-SOCKEYE[8]

Sample Size

In 2017 a total of 1095 Sockeye Salmon were sampled between June 2 and August 22 (Table 37). Of these, 1092 Sockeye tagged by this project, 3 sockeye were not tagged, and 2 fish died prior to release. One Sockeye was previously tagged and was added to those tracked. The result is a total sample size of 1091 tagged Sockeye Salmon, 1079 of which were detected after release and tracked. Sampling restrictions due to shad abundance resulted in picket leads being raised on eight days between Statistical weeks 25 and 27, but the number of Sockeye sampled remained high.

Table 37. Number of Sockeye Salmon sampled, and PIT tagged at Bonneville Dam and tracked upstream by date and statistical week in 2017.

							Days Sampling Restrictions in Effect[9]		
Sampling Dates	Week	Sampled	Tagged	Mortalities	Previously Tagged	Detected After Tagging and Tracked	Reduced Sampling-Temperature	Reduced Sampling-Shad or Salmon Abundance	No Sampling-Temperature
6/2,5-9	22-23	36	36	0	0	36	0	0	0
6/12-16	24	142	142	0	0	140	0	0	0
6/19-23	25	251	251	0	0	248	0	3	0
6/26-30	26	298	296	1	1	295	0	4	0
7/3,5-7	27	143	142	1	0	140	0	1	0
7/10-14	28	148	148	0	0	145	0	0	0
7/17-21	29	56	56	0	0	55	0	0	0
7/24-27 ,31,8/22	30-34	21	21	0	0	20	5	0	1
Total		**1095**	**1092**	**2**	**1**	**1079**	**5**	**8**	**1**

Age Composition

The predominant age group at 47.6% of the run was estimated to be Age 1.2 (Table 38). Other age groups with over 10% of the run were Age 1.3 and Age 1.1. In 2017, the percentage of Age 1.1 Sockeye showed a significant linear increase as the run progressed ($p<0.001$), while the percentage of Age 1.2

[8] The information presented in this section of the report is a summary of Fryer et al. 2018.
[9]For weeks 30-34, only days of sampling restrictions are summarized through July 31.

Sockeye decreased (p=0.003) and the percentage of Age 1.3 Sockeye did not show a significant linear trend (p=0.161).

Table 38. Weekly and total age composition of Sockeye Salmon at Bonneville Dam as estimated from scale patterns in 2017. Weighted by Statistical week and composite estimates are weighted by the percentage of the run passing Bonneville Dam in each week.

Statistical Week	Percentage of Run	N Ageable	Age Class					
			1.1	1.2	2.1	1.3	2.2	2.3
22-23	2.3%	35	2.9%	54.3%	0.0%	37.1%	5.7%	0.0%
24	11.9%	136	2.9%	62.5%	0.7%	33.8%	0.0%	0.0%
25	29.6%	239	5.0%	50.2%	0.8%	43.1%	0.8%	0.0%
26	30.4%	287	9.4%	50.5%	2.1%	34.8%	3.1%	0.0%
27	16.5%	135	25.9%	34.1%	4.4%	31.9%	2.2%	1.5%
28	6.4%	144	28.5%	37.5%	2.1%	30.6%	1.4%	0.0%
29	1.8%	55	23.6%	32.7%	12.7%	27.3%	3.6%	0.0%
30-34	1.0%	20	35.0%	5.0%	15.0%	35.0%	10.0%	0.0%
Composite	**100%**	**1051**	**11.7%**	**47.6%**	**2.2%**	**36.3%**	**2.0%**	**0.2%**

Detection Numbers

The tracking of 1,079 Sockeye generated 32,235 weir detections, which were grouped into 7,011 site detections at 47 sites. Of the 1,091 tagged Sockeye released in this study, 12 were not detected after release. These fish may have shed their tags, had defective tags, or died. It is also possible that these Sockeye Salmon passed downstream without being detected as Sockeye often pass over the top of weirs in the fish ladder rather than through the underwater slots where PIT tag antennas are located in the lower portions of Bonneville Dam fish ladders. It is unlikely that Sockeye Salmon pass upstream through fishways undetected as, at Bonneville Dam, they must pass a series of antennas at the upper end of both the Oregon and Washington shore fish ladders that detect very close to 100% of passing PIT tagged fish. However, at Bonneville Dam (as well as The Dalles, McNary, Ice Harbor, and Lower Granite dams) fish can pass upstream through the navigation locks without being detected at PIT tag antennas. All other dams with PIT tag detection have antennas in fish ladders that Sockeye Salmon must pass, through data from 2006-2017 indicate that PIT tagged Sockeye are missed at fish ladder sites (Table 39).

Table 39. Number and percentage of PIT tagged fish tracked by this project after sampling at Bonneville Dam not detected at dam detection sites as estimated from upstream detections in 2017 compared to 2006-2016.

	Percentage by Year												
Dam	**2017**	**2016**	**2015**	**2014**	**2013**	**2012**	**2011**	**2010**	**2009**	**2008**	**2007**	**2006**	**Mean**
Bonneville	0.2	2.8	1.6	0.7	0.4	1.8	0.5	0.7	0.6	0.4	2.1	0.2	1.0
The Dalles	2.1	0.4	0.6	0.3	1.6	--	--	--	--	--	--	--	1.0
McNary	5.2	2.4	1.1	3.8	2.1	12.1	1.6	3.8	5.0	10.1	6.5	3.1	4.7
Priest Rapids	0.0	0.3	0.4	0.2	0.0	0.4	0.2	0.6	0.3	0.3	0.8	0.0	0.3
Rock Island	5.9	2.9	10.2	41.5	4.4	5.4	4.4	6.2	2.6	6.9	6.8	1.3	8.2
Rocky Reach	0.7	0.0	0.0	0.3	0.0	1.4	0.7	0.5	0.0	0.2	0.7	12.3	1.4
Wells	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	--	--	--	--	0.0
Ice Harbor	0.0	0.0	0.0	12.5	NA	0.0	--	0.0	20.0	0.0	--	--	4.1
Lower Monumental	0.0	0.0	0.0	--	--	--	--	--	--	--	--	--	0.0
Little Goose	0.0	0.0	0.0	--	--	--	--	--	--	--	--	--	0.0
Lower Granite	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

PIT tagged Sockeye included in this study missed detection at six dams in 2017, three of which (Bonneville, The Dalles, and McNary) have navigation locks which PIT tagged fish can pass through undetected. The dam with the highest rate of missed Sockeye, Rock Island Dam, has had the highest rate of undetected fish among Columbia River dams every year since 2013, likely due to electrical noise adversely affecting the ability of PIT tag antennas to detected tags (Fryer et al. 2011). See Appendix B for detection site information and maps showing sites Sockeye were detected (Table B1 and Figures B1, B21-B25).

Mainstem Dam Recoveries, Mortality, and Escapement Estimates

Survival rates to upstream dams, as estimated from detections of Sockeye PIT tagged by this study at Bonneville Dam, are compiled in Table 40. The year 2017 had the lowest survival to The Dalles (TDA), only 89.3% since detection began in 2013 with the exception of 2015 when high mortality resulted from record high water temperatures (Fryer et al. 2017). Again excluding 2015, survival to McNary (81.7%) was the lowest since 2011.

Table 40. Survival of Sockeye PIT tagged at Bonneville Dam to The Dalles, McNary, Priest Rapids, Rock Island, Rocky Reach, Wells, and Tumwater dams 2006-2017.

	Percentage by Year and Mean of All Years												
Dam	2017	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	2006	Mean
TDA	89.3	94.0	82.8	93.1	89.5	--	--	--	--	--	--	--	91.3
MCN	81.7	89.2	54.0	88.3	83.6	82.4	76.1	81.5	85.7	89.4	84.0	88.4	84.4
PRA	74.6	85.3	44.9	84.5	78.6	77.3	71.9	78.4	82.1	86.3	77.4	84.8	80.1
RIA	70.8	81.6	40.6	79.5	74.2	75.0	68.9	76.3	80.2	85.8	73.4	81.1	77.2
RRF	43.7	60.5	31.6	65.3	52.4	62.1	55.3	63.7	67.1	73.7	62.2	58.8	62.3
WEA	42.5	59.3	29.4	64.2	50.5	60.8	53.9	62.6	65.2	71.1	60.9	53.8	60.3
TUF	25.8	20.8	8.3	13.6	20.9	12.9	14.2	13.3	12.2	9.4	NA	NA	13.8
Mean Water Temperature at Bonneville Dam													
June 15-July 14	18.1	18.8	21.3	17.9	18.2	16.4	15.8	16.6	17.9	17.0	18.2	18.3	17.8

Sockeye Salmon show a significant linear decrease in survival over the period of the run to upstream dams in 2017 (Table 41, Figure 23).

Table 41. Sockeye Salmon survival through selected reaches by statistical week as estimated by PIT tag detections in 2017 and the p-value for a linear regression between weekly reach survival and statistical week.

Statistical Week at Bonneville Dam	Reach Survival Estimated For			
	BON-TDA	BON-MCN	BON-PRD	BON-RIS
23	94.4%	86.1%	83.3%	83.3%
24	95.7%	91.4%	85.7%	84.3%
25	91.1%	85.1%	80.6%	77.0%
26	87.8%	83.7%	76.3%	73.9%
27	87.9%	78.6%	66.4%	57.1%
28	83.4%	65.5%	56.6%	53.8%
29	81.8%	47.3%	36.4%	29.1%
30-31	65.0%	10.0%	10.0%	10.0%
Composite[10]	**89.3%**	**81.7%**	**74.6%**	**70.8%**
p-value	**<0.001**	**<0.001**	**<0.001**	**<0.001**

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

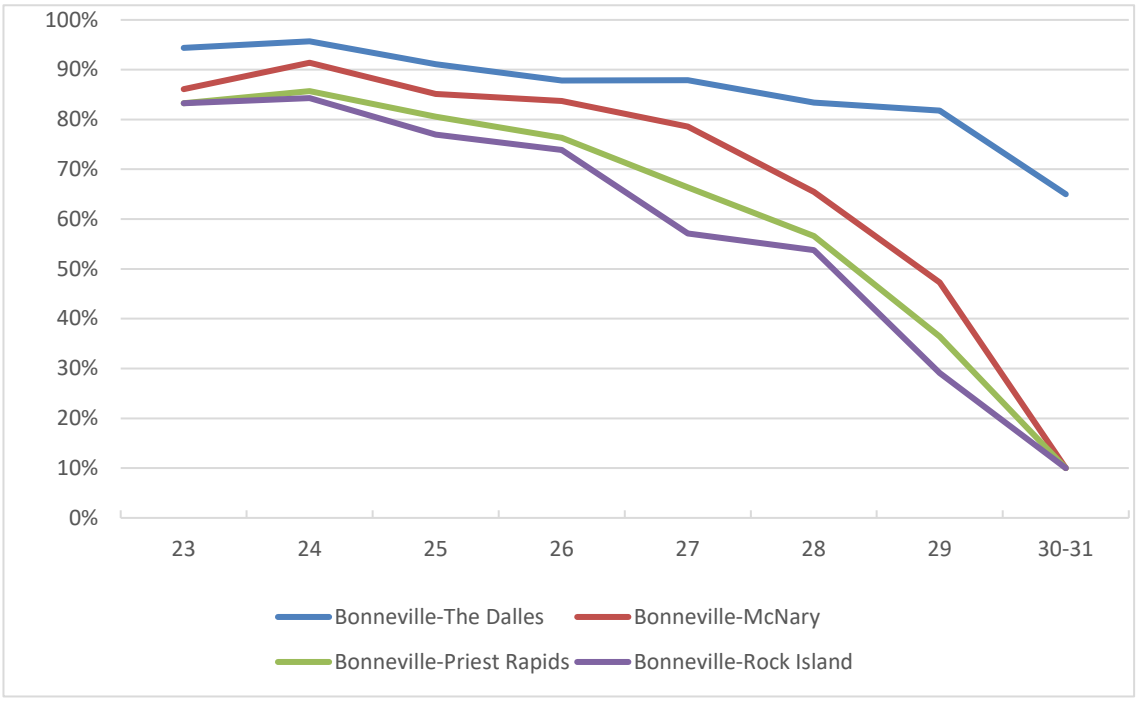

Figure 23. Survival of Sockeye Salmon PIT tagged at Bonneville Dam to The Dalles, McNary, Priest Rapids, and Rock Island dams by statistical week in 2017.

In 2017, estimated escapement based on upstream PIT tag detections was greater than the number of Sockeye counted at The Dalles and McNary dams, but less than at Priest Rapids, Rock Island, Rocky Reach, Wells, and Tumwater dams (Table 42, Figure 24). Relatively large deviations between these estimates at Ice Harbor and Prosser dams are likely explained largely by the low number of Sockeye PIT tagged by this project passing these sites.

Table 42. Percentage of PIT tagged Sockeye Salmon detected at upstream dams subsequent to tagging at Bonneville Dam to upstream dams, estimated escapement from both PIT tags and visual means, and the difference between the PIT tag and visual escapement estimate in 2017.

Dam	Estimated Percentage Reaching Dam	Estimated Escapement Using Bonneville PIT Tagged Sockeye	Visual Dam Count	Difference Between Bonneville PIT Tag and Visual Estimate
Bonneville	--	--	87,693	--
The Dalles	89.3%	78284	64058	22.2%
McNary	81.7%	71627	58022	23.4%
Priest Rapids	74.6%	65397	66670	-1.9%
Rock Island	70.8%	62058	73218	-15.2%
Rocky Reach	43.7%	38287	46701	-18.0%
Wells	42.5%	37284	42299	-11.9%
Tumwater	25.8%	22605	23851	-5.2%
Ice Harbor	0.3%	271	392	-30.8%
Prosser	0.7%	622	372	67.1%

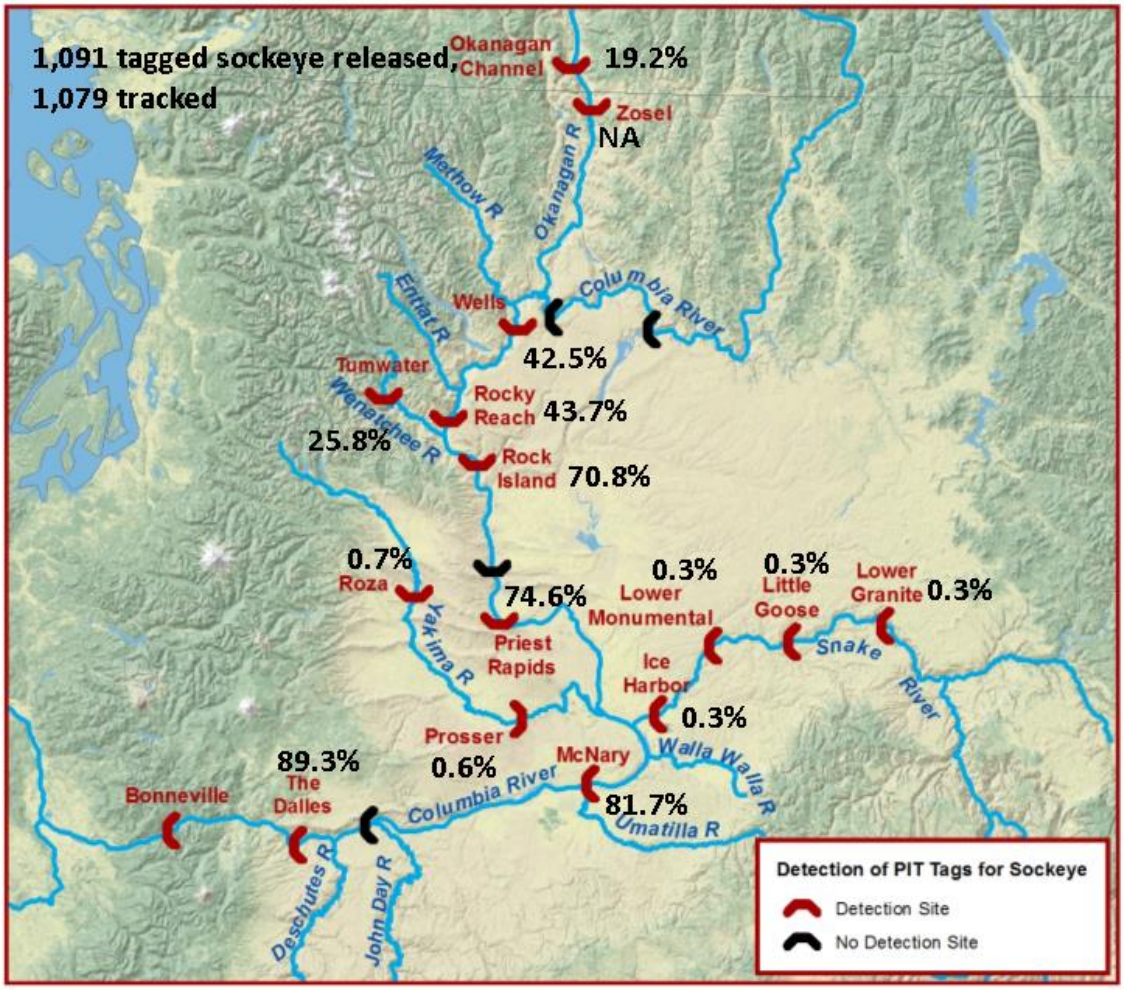

Figure 24. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of fish PIT tagged at Bonneville Dam, and the percentage of the run estimated to pass upstream dams in 2017.

Migration Rates and Passage Time

Sockeye Salmon in this study traveled quickly upstream with a median migration rates between mainstem dams ranging between 28.4 and 51.7 km/day (Table 43).

Table 43. Median Sockeye Salmon migration rates and travel time between dams as estimated by PIT tag detections in 2017.

		Tagged at Bonneville Dam	
Dam Pair	Distance (km)	Median Travel Time (days)	Median Migration Rate (km/day)
Bonneville-The Dalles	74	1.8	39.5
The Dalles-McNary	162	3.1	51.7
McNary-Priest Rapids	167	4.5	37.5
Priest Rapids-Rock Island	89	3.2	28.4
Rock Island-Rocky Reach	33	1.1	29.6
Rocky Reach-Wells	65	2.0	34.3
Rock Island-Tumwater	73	12.8	5.4
Bonneville-McNary	231	5.0	46.5
Bonneville-Priest Rapids	329	9.8	41.0
Bonneville-Rock Island	487	13.1	37.5
Bonneville-Tumwater	560	27.0	20.7
Bonneville-Wells	585	16.0	36.9

Sockeye Salmon tagged at Bonneville Dam later in the migration travel upstream faster than those tagged earlier in the migration (Table 44). This relationship was significant from Bonneville to McNary, Priest rapids, Rock Island, Tumwater, and Zosel dams in 2017.

Table 44. 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 2017.

Statistical Week at Bonneville Dam	BON-TDA	BON-MCN	BON-PRA	BON-RIA	BON-TUM	BON-RRH	BON-WEL	BON-ZSL	WEL-ZSL	RIA-TUM
22-23	1.9	5.2	12.2	17.5	34.6	16.9	19.3	102.2	2.0	4.0
24	1.9	5.6	11.0	15.0	31.1	16.1	18.6	81.1	2.6	4.7
25	1.8	5.1	10.0	13.6	28.5	14.6	16.9	55.3	3.7	5.2
26	1.7	4.8	9.1	12.1	26.0	13.0	15.0	56.6	3.5	5.5
27	1.7	4.9	9.6	12.4	24.8	13.5	15.9	64.0	3.0	6.5
28	1.8	5.0	9.1	12.6	25.0	13.1	15.6	53.5	3.9	6.4
29	1.8	4.8	9.2	12.4	24.8	13.2	14.9			5.5
30-34	1.8	5.1	9.8	13.9	28.7	14.2	16.1	48.6	4.8	5.5
p-value	**0.138**	**0.144**	**0.036**	**0.077**	**0.054**	**0.033**	**0.019**	**0.027**	**0.008**	**0.069**
Stock										
Okanagan	1.8	5.0	9.7	12.7	-	13.9	16.0	62.7	45.4	11.9
Wenatchee	1.8	5.1	9.9	14.0	27.0	14.0	19.7	-	-	12.8
Age										
1.1	1.8	4.9	9.1	11.9	NA	15.0	13.1	47.2	32.4	NA
1.2	1.8	5.0	9.4	13.0	27.6	14.0	16.5	69.9	54.3	13.2
1.3	1.8	5.1	10.0	14.0	26.8	14.7	17.0	61.6	43.4	12.2

The median passage time at Columbia River dams (where passage time is defined as the difference between the first and last detection at dam PIT arrays) for Sockeye tagged included in this study ranged between 0.1 minute at The Dalles and 11.6 minutes at Bonneville while the percentage taking more than 12 hours ranged from 0.5% at Bonneville to 3.8% at Wells Dam (Table 45). Tumwater and Lower Granite passage times were likely inflated by trapping operations. At Lower Granite, one of the three Sockeye tracked (3DD.0077997A48) took 6.5 hours from entering the fish trap until subsequent detection while a second (3DD.0077BACE36) took 4.5 hours.

Table 45. 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 2017.

	Adults Tagged at Bonneville Dam	
Dam	Median Passage (Minutes)	%>12 Hours
Bonneville	11.6	0.5%
The Dalles	0.1	2.0%
McNary	0.2	1.2%
Priest Rapids	7.0	3.2%
Rock Island	0.2	1.0%
Rocky Reach	8.5	0.9%
Wells	3.9	3.8%
Zosel	0.7	1.3%
Tumwater	41.5	11.9%
Ice Harbor	1.8	0.0%
Lower Monumental	1.3	0.0%
Little Goose	0.1	0.0%
Lower Granite	528.7	33.3%

Night Passage

Night passage rates (where night is defined as being from 2000 to 0400) ranged from 0.5% at Bonneville Dam to 17.1% at Zosel Dam (Table 46).

Table 46. Estimated Sockeye Salmon night passage (2000-0400) by stock at mainstem Columbia River dams in 2017.

Dam	Adults Tagged at Bonneville Dam		
	All Adults[11]	Okanagan	Wenatchee
Bonneville	0.5%	0.5%	0.5%
The Dalles	7.9%	7.8%	8.4%
McNary	5.8%	6.4%	5.0%
Priest Rapids	2.3%	3.4%	0.7%
Rock Island	4.9%	5.3%	4.4%
Rocky Reach	7.4%	7.3%	14.3%
Wells	10.0%	10.0%	14.3%
Tumwater	2.0%	-	2.0%
Zosel	17.1%	17.3%	-
Mean for The Dalles, McNary, Priest Rapids, and Rock Island	**5.2%**	**5.7%**	**4.6%**

Fallback

Fallback rates for adults tagged at Bonneville Dam in 2017 ranged from 0.0% at Tumwater, Zosel, and Snake River dams to 3.1% at The Dalles and Priest Rapids dams (Table 47).[12] Of the 81 Sockeye tagged by this project in 2017, which were estimated to fall back over at least one dam, 4 had multiple fallbacks (Table 48).

Table 47. Estimated dam fallback rates for Sockeye Salmon tagged at Bonneville Dam in 2017[13].

Dam	Percent Fallbacks
Bonneville	0.3%
The Dalles	3.1%
McNary	0.1%
Priest Rapids	3.1%
Rock Island	1.3%
Rocky Reach	2.6%
Wells	2.2%
Zosel	0.0%
Tumwater	0.0%
Ice Harbor	0.0%
Lower Monumental	0.0%
Little Goose	0.0%
Lower Granite	0.0%

[11] Includes Sockeye classified as stocks other than Okanagan or Wenatchee or classified as unknown.
[12] Snake River dams are excluded as only three Bonneville-tagged Sockeye were detected in the Snake River.
[13] Does not include Sockeye Salmon that fell back over a dam and were not subsequently detected.

Table 48. Number of fallback events by tag group for returning Sockeye Salmon included in our Bonneville adult tagging study in 2017.

Fallback Events	Adults Tagged at Bonneville
1	77
2	2
3	1
4	1
Number of Sockeye falling back at least once	**81**
% of Sockeye with at least one fallback event	**7.5%**
Total fallback events	**88**
Number of Sockeye in study	**1,079**
Mean number of fallback events per Sockeye	**0.08**

DISCUSSION

This study sampled 4,764, and PIT tagged 4,694, salmonids at Bonneville Dam in 2017. After excluding 12 Chinook considered minijacks (spending no winters in saltwater) and one steelhead considered a trout (which also spent no winters in saltwater), a total of 4,720 salmonids were tracked 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 2017 marked the 12th year we have been PIT tagging Sockeye Salmon, the 11th year we have tagged Chinook Salmon and the 9th year we have tagged steelhead at Bonneville Dam. Over this time, the number of PIT tag detection sites has continually increased, allowing us to learn more about the movement of tagged salmonids throughout the Columbia Basin.

For both Chinook Salmon and steelhead, there are management concerns regarding the timing of run components. One question of interest to fish managers is the definition of a summer Chinook Salmon. Traditionally, spring Chinook Salmon were defined as those migrating past Bonneville Dam through May 31, with summer Chinook Salmon passing from June 1 through July 31, and fall Chinook Salmon defined as passing on or after August 1. Dates of defining a Chinook run at upstream dams were lagged to take into account migration times from Bonneville Dam to the dam in question. However, in 2005, for management purposes the spring-summer differentiation at Bonneville Dam was moved from June 1 to June 16 (though visual counts are typically reported using the old cutoff). Managers moved this date because radio tagging studies suggested that many of the Chinook Salmon migrating in early June are from the Snake River (many spring/summer Chinook in the Snake River Basin are listed as endangered under ESA), while Chinook migrating in late June are mid-Columbia summers. Tag detection data from this project showed that in 2017 the percentage of Chinook Salmon at Bonneville Dam, which ultimately passed Ice Harbor Dam, peaked at 34.1% of the run for Statistical Week 22 which started May 28 (Figure 5). By week 23 (which started June 4), the percentage of Chinook tagged at Bonneville which were detected at Priest Rapids Dam exceeded that at Ice Harbor, and by week 25 (June 18), the percentage which ultimately passed Ice Harbor Dam had declined to 8.0% of the run. The percentage detected above Priest Rapids Dam reached 67.2% for those Chinook tagged in Week 27. In years 2010-2013, the run at Bonneville Dam transitioned over the month of June from being primarily Snake

River spring/summer to being primarily mid-Columbia summer Chinook, in 2017, as in 2014-2016 this transition started earlier in May than in the prior years.

As at Bonneville Dam, Chinook runs (spring, summer, and fall) passing dams upstream of Bonneville Dam are differentiated based on the date they pass, and these dates per dam are based on fixed migration rates assumed by managers. For instance, spring Chinook transition to summer Chinook on June 1 at Bonneville Dam, June 11 at Ice Harbor Dam and June 13 at Priest Rapids Dam. This means that the same Chinook traveling slower than expected could be classified differently at different dams. For example, a "spring" Chinook passing Bonneville Dam on May 31 would be a "summer" Chinook passing Priest Rapids Dam on June 13. Using PIT tag data, this study found that an estimated 28.6% of spring, 2.7% of the summer, and 0.0% of the fall Chinook at Bonneville Dam were classified differently at Priest Rapids Dam (Table 8). Misclassified Bonneville spring Chinook were all classified as summers, misclassified summers were classified mostly as falls, and misclassified fall Chinook were all classified as summer Chinook at Priest Rapids Dam. This study found that 4.6% of spring, 17.0% of summer, and 0.0% of the fall Chinook at Bonneville Dam were classified differently at Ice Harbor Dam. Chinook classified at Bonneville Dam as spring Chinook were misclassified as summer Chinook at Ice Harbor Dam, while Chinook classified as summer Chinook at Bonneville Dam were most commonly misclassified as spring Chinook at Ice Harbor Dam and all misclassified fall Chinook were classified as summer Chinook.

The number of fish tagged in 2017 was the lowest in the nine years since this Accords project began in 2009 (Table 49), although the percentage of the run tracked, at 0.87%, was the highest since the project began. Our sample size was adversely impacted by the closure of the Adult Fish Facility for 20 days between July and September due to high water temperatures.

Our steelhead sample, with only 836 tracked, was the smallest in the nine years of this study (Table 20) and resulted in very low sample sizes for steelhead passing during high temperatures. As noted earlier, we sampled no steelhead in Week 32 due to the AFF being closed while 4.8% of the run passed. Only 64 steelhead were sampled while 21.4% of the run passed in weeks 31-33 and between weeks 35 and 37, 33.7% of the run passed while we sampled 77 steelhead. Of particular note is Week 37 when we sampled only 10 steelhead while 10.2% of the run passed. In addition, we were required to operate the trap

with all pickets up that week (Figure 25), meaning that these fish volitionally entered the Adult Fish Facility; taking a 90 degree turn from a 20 foot wide fish ladder into a 4 foot wide channel leading to the AFF. Of these 10 steelhead sampled, 3 were ≥78 cm in length, which means that 30% (3,601 fish) of the Week 37 run was estimated as B-run steelhead. This number in one week represents almost half of what this study estimated for the entire B-run.

Table 49. Total number of Chinook and Sockeye salmon and steelhead PIT tags tracked by year (includes recaptures of previously PIT tagged fish) 2009-2017.

	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%
Total	**32,458**	**14,284**	**11,766**	**57,684**	**0.43%**	**0.56%**	**0.52%**	**0.46%**

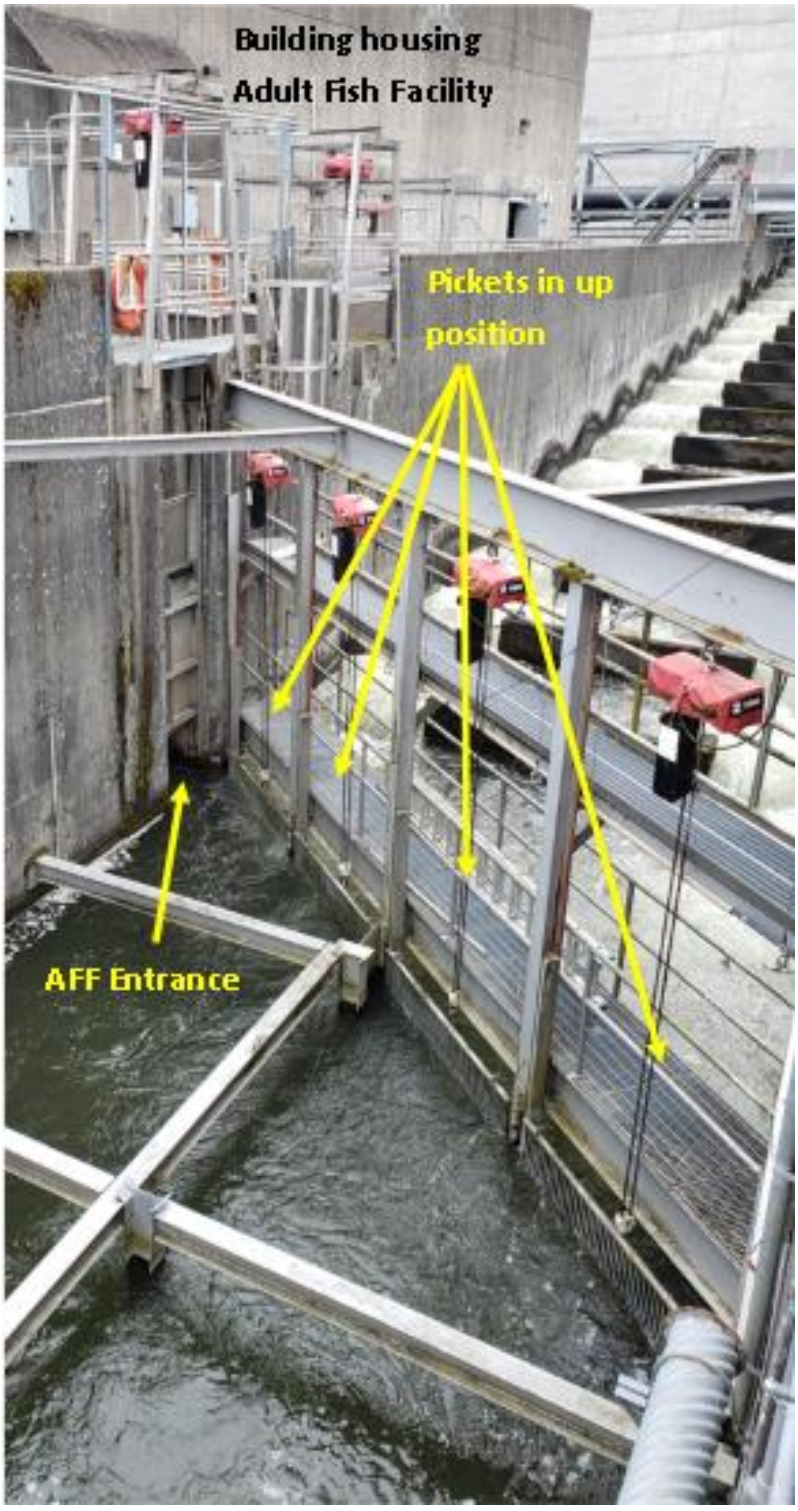

Figure 25. Picture showing the pickets diverting fish into the Bonneville Dam AFF from the Washington Shore Fish Ladder.

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APPENDIX A

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

1. BONNEVILLE DAM ADULT FISH FACILITY

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

1.1. General Facility Protocols.

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

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

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

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

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

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

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

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

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

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

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

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

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

1.2. Notification & Documentation.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

APPENDIX B

Table B1. List of PTAGIS interrogation sites (three letter code, name, and description) to use with maps that follow. Out of 308 active sites, 159 sites detected the fish tagged in 2017.

Site Code	Site Name	Site Description
158	Instream Remote Detection System	Instream detection arrays spanning the confluence of Eightmile Creek and Fifteenmile Creek.
15D	Fifteenmile Ck at Dry Ck	Instream detection arrays spanning the confluence of Fifteenmile Creek and Dry Creek.
30M	Thirtymile Crk John Day Basin	This site is located at rkm 0.5 on Thirtymile, a tributary to the John Day River.
ACB	Asotin Cr. at Cloverland Brdg.	The site is located near Cloverland Bridge (RKM 4.5) on Asotin Creek.
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.
AFC	No./So. Fk Asotin Cr. Jct. ISA	Instream detection arrays spanning the confluence of NF and SF of Asotin Creek.
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	The site is located 0.08 km from the confluence with the Okanogan River.
BR0	Bridge Creek Gauge	The site is located near the USGS flow gauge on Bridge Creek.
BR1	Bridge Creek Kiosk	The site is located at the John Day Fossil Beds National Monument on Bridge Creek.
BRC	Bear Valley Adult Video Weir	Interrogation system on the existing Bear Valley Creek Chinook adult monitoring weir.
BSC	Big Sheep Creek ISA at km 6	In-stream detection system located in Big Sheep Creek at river km 6 (N 45.50649, W -116.85067).
CAL	Carson NFH Adult Return Ladder	Hatchery adult spring Chinook return ladder from the Wind River to Carson NFH.
CCW	Catherine Creek Ladder/Weir	Instream detection array located in the adult return fish ladder at the Catherine Creek weir.
CEY	Cearley Creek Side Channel	Instream array in the creek a small tributary of the Yankee Fork of the Salmon River, Idaho and flows into a newly constructed side channel and then into the Yankee Fork main stem.
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.
CLC	Clear Creek near Kooskia NFH	Instream detection array located in lower Clear Creek, a tributary to the Clearwater River, just downstream of Kooskia National Fish Hatchery.
COP	Lower Coppei Instream Array	The site is located at RKM 0.8 on Coppei Creek.
CRW	Chewuch River above Winthrop	Chewuch River at river km 1, above Winthrop, WA.
DRM	Deschutes River mouth	Mouth of the Deschutes River in the west channel at Moody Island (rkm 0.46).
DSF	Sherars Falls Fish Ladder	Site consists of two monitored weirs in the main fishway and two monitored weirs in the high flow fishway.
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.
EFD	East Fork Diversion Fishway	Located in a fish ladder at a irrigation diversion site for the East Fork Irrigation District on the East Fork of the Hood River.
EHL	Entiat NFH Adult Ladder	This adult interrogation site is located in the Entiat National Fish Hatchery adult ladder.
ENA	Upper Entiat River at rkm 17.1	The site is located approximately 400 meters above the mouth of the Mad River near the township of Ardenvoir at river kilometer 17.1.
ENF	Upper Entiat River at rkm 40.6	The site is located approximately 600 meters below the beginning of Forest Service Property within the upper portion of the Entiat River at rkm 40.6.
ENL	Lower Entiat River	Entiat River rkm 2, located immediately upstream of Entiat, WA.
ENM	Middle Entiat River	Entiat River rkm 26, below the McKenzie Diversion Dam.
ESS	EFSF Salmon River at Parks Cr	East Fk South Fk Salmon River (rkm 21) near Parks Creek.
GOA	Little Goose Fish Ladder	Adult Fishway at Little Goose Dam.
GOJ	Little Goose Dam Juvenile	Little Goose Dam Juvenile Fish Bypass/Transportation Facility.
GRA	Lower Granite Dam Adult	Lower Granite Dam Adult Fishway and Fish Trap.
GRJ	Lower Granite Dam Juvenile	Lower Granite Dam Juvenile Fish Bypass/Transportation Facility.
HRM	Hood River Mouth	Located at the mouth of the Hood River against the west side jetty just inside the bar where the Hood River meets the Columbia River.
HST	Touchet River at Harvey Shaw	The site is located at RKM 50 on the Touchet River.
ICH	Ice Harbor Dam (Combined)	Ice Harbor Dam Adult Fishways (both) and Full Flow Bypass.
ICL	Lower Icicle Instream Array	Located at rkm 0.4 on Icicle Creek (Wenatchee River Basin), near Leavenworth, WA.
ICM	Middle Icicle Instream Array	The site is located at RKM 7 on Icicle Creek.
IML	Imnaha River Weir Adult Ladder	Located in the adult return fish ladder at the Imnaha River weir. Site is on public land.
IR1	Lower Imnaha River ISA at km 7	Lower Imnaha River at river km 7 (N 45.761162, W -116.750658).
IR2	Lower Imnaha River ISA at km 10	Lower Imnaha River at river km 10 (N 45.742839 W -116.764563).
IR3	Upper Imnaha River ISA at km 41	Upper Imnaha River at river km 41 (N 45.49004 W 116.80393).
IR4	Imnaha Weir Downstream Array	Located downstream of the Oregon Dept. of Fish and Wildlife (ODFW) fish weir on the Imnaha River.
IR5	Imnaha Weir Upstream Array	Located upstream of the Oregon Dept. of Fish and Wildlife (ODFW) fish weir on the Imnaha River.

Table B1. Continued.

Site Code	Site Name	Site Description
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 South Fish Ladder	The interrogation site at the John Day Dam south fish ladder.
JOC	Joseph Creek ISA at km 3	Joseph Creek, Grande Ronde basin at river km 3 (N 46.030016, W -117.016042).
JOH	Johnson Creek	The site is located approximately 0.2 km upstream from the confluence of the Okanogan River.
KRS	SF Salmon River at Krassel Cr.	The site is located near Krassel Creek at rkm 65 on the South Fork Salmon River.
LAP	Lapwai Creek, near its mouth	In-stream detection system consisting of three arrays located in Lapwai 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 site is located approximately 0.4 kilometers upstream from the confluence with the Klickitat River.
LLC	Loup Loup Creek Instream Array	The site is located 0.42 km from the confluence with the Okanogan River.
LLR	Lower Lemhi River	Lower Lemhi River in Salmon, ID.
LMA	Lower Monumental Adult Ladders	This interrogation site is in both ladders at Lower Monumental Dam.
LMJ	Lower Monumental Dam Juvenile	Lower Monumental Dam Juvenile Fish Bypass/Transportation Facility.
LMR	Lower Methow River at Pateros	Lower Methow River near the WDFW 'Miller Hole' access site on the lower Methow River immediately upstream of Pateros, WA.
LNF	Leavenworth NFH Adult Ladder	Located in the Leavenworth National Fish Hatcheries adult ladder and holding pond.
LNR	Lower Naches River	The site is located at rkm 5.3 on the lower Naches River, 700 meters below Nelson Dam.
LRL	Lower Lochsa River Array Site	The site is located in lower 1km of the mainstem Lochsa River.
LRU	Lochsa River Upper Site	The 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.
MC1	McNary Oregon Shore Ladder	Oregon Shore Adult Fishway at McNary Dam.
MC2	McNary Washington Shore Ladder	Washington Shore Adult Fishway at McNary Dam.
MCJ	McNary Dam Juvenile	McNary Dam Juvenile Fish Bypass/Transportation Facility.
MCL	Lower Mission Creek Instream	Instream PIT tag detection system located at rkm 0.7 on Mission Creek (Wenatchee River Basin), near Cashmere, WA.
MDR	McDonald Road Bridge	Middle Walla Walla River at McDonald Road Bridge.
MJ1	Middle Fork John Day Array	The Middle Fork John Day Array is near the current confluence with Mosquito Creek on Malheur National Forest Service Land.
MRC	Methow River at Carlton	Located in the mainstem Methow River near the town of Carlton at rkm 45.
MRW	Methow River at Winthrop	Methow River. During 2009 and early 2010, the array was located at river km 81, above Winthrop, WA near Winthrop National Fish Hatchery. In Sept. 2010 it was moved upstream to its new location below Wolf Creek on the mainstem Methow River, at river km 85.
MSH	Methow Fish Hatchery Outfall	On the outlet of the Washington Department of Fish and Wildlife (WDFW) Methow Hatchery located on the Methow River at Rk 82.3 from the confluence with the Columbia River.
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.
MWC	Maxwell Canal	Maxwell Canal is located at rkm 24 on the Umatilla River.
MWF	Whitefish SC in Methow River	PIT tag interrogators at the entrance and exit of Whitefish Island side channel (rkm 76).
NAL	Lower Nason Creek	Nason Creek rkm 1, located within Lake Wenatchee State Park.
NBA	Nursery Bridge Adult	Nursery Bridge Dam Fishways (both), Walla Walla River at Milton-Freewater, OR.
OBF	Omak Creek below Mission Falls	The site is located approximately 9.90 KM upstream from the confluence of the Okanogan River.
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.
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 OMK site is located on Omak Creek, 0.24 km from the confluence with the Okanogan River.
PAT	Pattit Creek Instream Site	Instream PIT tag interrogation site at RKM 1.3 on Pattit Creek a tributary to the Touchet River.
PCA	Panther Creek Array	The site is located at rkm 5 on Panther Creek tributary to Salmon River.
PD7	Columbia River Estuary rkm 70	The array (PD7) is located at river km 70 (46.14661N, -123.379867W).
PES	Peshastin Creek	The site is located at rkm 3 located on Peshastin Creek below the bridge at Smithson's property.
PEU	Upper Peshastin Creek	The 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.
PRV	Walla Walla R at Pierce RV Prk	Lower Walla Walla River at Pierce Green Valley RV Park.

Table B1. Continued.

Site Code	Site Name	Site Description
RIA	Rock Island Adult	Rock Island Dam Adult Fishways (all three).
ROZ	Roza Diversion Dam (Combined)	Roza Dam Smolt Bypass.
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.	The site is located approximately 6.35 KM upstream from the confluence of the Okanogan River.
SAT	Lower Satus Creek	The site is located approximately 1700 meters upstream from the confluence of Satus Creek with the Yakima River at rkm 112.
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)	The site is located on the South Fork John Day River south of Dayville on the PW Schneider Wildlife Management Area (ODFW).
STL	Sawtooth Hatchery Adult Trap	Ladder of the Sawtooth Hatchery adult fish trap.
STR	SF Salmon Satellite Facility	Ladder of the South Fork Salmon River adult fish trap.
SW1	Lower Selway River Array	The 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	The PIT tag array is located 13 rkm upstream of the mouth of the Selway River.
SWC	Swale Creek Array	The PIT tag array is located approximately 100 m upstream from the confluence with the Klickitat River.
SWT	Sweetwater Cr. near its mouth	The sites is located approximately 0.1 kilometers upstream from the mouth of Sweetwater Creek, a tributary to Clearwater River.
TAY	Big Creek at Taylor Ranch	Centered around the bridge at Taylor Ranch, Big Creek, ID.
TD1	The Dalles East Fish Ladder	East Fish Ladder at The Dalles Dam.
TD2	The Dalles North Fish Ladder	North Fish Ladder at The Dalles Dam.
TFH	Tucannon Fish Hatchery	The Tucannon Fish Hatchery site is located about 200 feet above the Tucannon Fish Hatchery Adult Trap and Water Intake System on the Tucannon River, at River Kilometer 59.4.
TMF	Three Mile Falls Dam Combined	Adult Fishway and Juvenile Bypass/subsampling facility at Three Mile Falls Dam.
TOP	Lower Toppenish Creek	The site is located approximately 1700 meters upstream from the confluence of Toppenish Creek a tributary to the Yakima River.
TR1	Lower Trout Cr - Deschutes	Lower Trout Creek is located at RKM 0.7 upstream from the confluence with the Deschutes River on privately owned land.
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	The array is near the upper Grande Ronde weir at Starkey, approximately 291 rkm.
UMF	Umatilla River below Feed Dam	The array is located in the Umatilla River about 150 feet downstream of Feed Diversion Dam.
UMW	Umatilla R Recycled Water Fac	The array is located in the Umatilla River adjacent to the City of Hermiston's Recycled Water Plant, approximately rkm 9.
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.
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).
WEJ	Wells Dam Bypass Bay Sample	The system is located in Bypass Bay 2 on the right (west) side of Wells dam on the Columbia River, Washington.
WFC	Wolf Creek, Methow River	Instream detector on Wolf Creek, Methow River Basin
WHC	Lwr White Creek, Klickitat Bsn	Instream interrogation system in White Creek (Klickitat River Basin) approximately 150 meters upstream from the mouth.
WPC	Wimpey Creek, Lemhi R. Basin	The site is approximately 70 meters upstream of the confluence with the Lemhi 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°).
WRU	Upper Wind River (WA) rkm 30	At rkm 30 of the Wind River, WA. The site is at the FR3065 bridge over the Wind River.
WSH	Warm Springs Hatchery	Adult Fishway at Warm Springs NFH.
WSR	Warm Springs River PIT Array	The Warm Springs River PIT tag array is installed end-to-end across the entire river channel.
WTL	White River, Wenatchee Basin	A permanent instream PIT tag interrogation site at RKM 2.88 on the White River.
WW1	Harris Bridge S F Walla Walla	Site is located on the South Fork Walla Walla River approximately 13 kilometers upstream from the confluence with the North Fork Walla Walla River.
YFK	Yankee Fork Salmon River	The site is located 3.14 river kilometers upstream from the confluence with the Salmon River at an elevation of 1855m.
ZEN	Secesh River at Zena Cr Ranch	Near the Zena Creek Ranch.
ZSL	Zosel Dam Adult Fishways	Zosel Dam is located at Okanogan River km 132, approximately 3 km downstream from the outlet of Lake Osoyoos

Table B2. Season by season activities of steelhead tagged in 2017 and later labeled as kelts or repeat spawners when they began migrating downstream (after March 31st) and upstream in spring, summer, or fall of 2017/18, and winter 2018/19 presumably to and from the ocean.

Tag Year	Tag Number	First Detection After Tagging 2017 in Spring/Summer/Fall	Fall 2017	Winter 2017/18	Spring 2018	Summer 2018	Fall 2018	Winter 2018/19	Comments
2017	3DD.0077B9F9DB	The Dalles East Ladder - October 6th	Little Goose - October 17th	Little Goose Juvenile - December 4th	Bonneville Dam Corner Collector - May 1st Estuary Trawl - May 3rd				
2017	3DD.0077BA7705	The Dalles North Ladder - September 18th	Lower Granite - October 1st	Lapwai Creek (Clearwater) - January 30th Lapwai Creek (Clearwater) - February 22nd	Lapwai Creek (Clearwater) - March 13th Estuary Trawl - May 4th				
2017	3DD.0078ADB44	The Dalles East Ladder - September 20th	Three Mile Falls (Umatilla) - November 26th	Three Mile Falls (Umatilla) - December 3rd	John Day Juvenile Bypass - April 27th Bonneville Dam Corner Collector - April 29th				Steelhead captured at Bonneville on July 26th, where it was between July and September is unknown.
2017	3DD.0077BAAC88	The Dalles East Ladder - October 6th	Lower Granite - October 22nd	Lower SF Clearwater - February 7th	Bonneville Dam Corner Collector - May 5th				
2017	3DD.0077BA37F2	The Dalles North Ladder - August 31st	Lower Granite - September 23rd		Bonneville Dam Corner Collector - April 29th				
2017	3DD.0077BAFF29	The Dalles East Ladder - September 21st	Lower Granite - October 1st		Bonneville Dam Corner Collector - May 12th				Steelhead was captured at Lower Granite on October 1st.
2017	3DD.0077BA4C40	The Dalles East Ladder - August 26th	Tumwater Dam (Wenatchee) - November 27th		Bonneville Dam Corner Collector - May 7th				Steelhead captured at Dryden Dam (Wenatchee) on October 25th.
2017	3DD.0077BA3ADD	The Dalles East Ladder - July 22nd	Lower Granite - October 12th		Bonneville Dam Corner Collector - May 3rd				Steelhead was captured at Lower Granite on October 11th.
2017	3DD.0077BA54E9	The Dalles East Ladder - August 28th	Lower Wenatchee River - September 11th		Nason Creek (Wenatchee) - April 16th	Bonneville Dam Corner Collector - June 6th			Steelhead captured at Tumwater Dam (Wenatchee) on October 29th.
2017	3DD.0077BA9F5E	The Dalles East Ladder - September 29th	Lower Granite - October 11th		Secesh River (Salmon) - April 21st	Bonneville Dam Corner Collector - June 1st			Steelhead was captured at Lower Granite on October 11th.
2017	3DD.0077BA9F3F	The Dalles East Ladder - July 23rd	Wells - November 18th		Rocky Reach Juvenile Bypass - April 12th Lower Wenatchee River - April 12th Icicle Creek - April 23rd to May 28th	Bonneville Dam Corner Collector - June 26th			Steelhead captured in Wells Dam trapping on August 20th.
2017	3DD.0077BA8D39	The Dalles East Ladder - September 16th	Prosser Dam (Yakima) - October 27th		Bonneville Dam Corner Collector - April 21st	Bonneville Dam WA Ladder - July 17th	Prosser Dam (Yakima) - September 17th		Unknown if steelhead left for the ocean, between April and July.
2017	3DD.0077BAAAEE	The Dalles East Ladder - July 20th				Bonneville Dam Corner Collector - June 4th			Steelhead captured at Lower Granite Dam July 28th, detected in the Lookingglass Hatchery (Deschutes) Ladder on May 1st, and then captured at the Lookingglass Creek weir on May 1st.
2017	3DD.0077BA7048	The Dalles East Ladder - July 21st	Prosser Dam (Yakima) - November 1st		Roza Dam (Yakima) - April 24th	Bonneville Dam Corner Collector - June 2nd			Steelhead captured at Roza Dam April 30th.
2017	3DD.0077BB2882	The Dalles East Ladder - October 18th		Lower Status Creek (Yakima) - December 31st	Lower Status Creek (Yakima) - March 11th Bonneville Dam Corner Collector - April 16th				
2017	3DD.0077BA81CE	The Dalles North Ladder - August 25th	Lower Granite - November 10th		Lower Wallow River (Grande Ronde) - April 11th Bonneville Dam Corner Collector - May 3rd				
2017	3DD.0077BA584A	The Dalles East Ladder - July 19th	Prosser Dam (Yakima) - September 22nd		Bonneville Dam Corner Collector - April 27th				
2017	3DD.0077BAB611	The Dalles East Ladder - September 22nd				Bonneville WA Ladder - July 10th			Unknown if steelhead left for the ocean, between September and July.
2017	3DD.0077BA9173	The Dalles East Ladder - August 30th	McNary - September 10th		Upper John Day River - March 20th to April 24th Bonneville Juvenile Bypass - May 1st				
2017	3DD.0077BA5B53	The Dalles East Ladder - July 22nd Lower Granite - August 16th			Lower Wallow River (Grande Ronde) - March 29th Bonneville Juvenile Bypass - May 1st				Steelhead was captured at Lower Granite on August 16th
2017	3DD.0077BA58CB	The Dalles North Ladder - September 22nd	Lower Granite - October 3rd		Upper Salmon River - April 7th Bonneville Juvenile Bypass - May 9th				Steelhead detected at the Sawtooth Hatchery Trap.
2017	3DD.0077BA4F7A	Lyle Falls Fishway (Klickitat) - June 12th - July 15th			Bonneville Juvenile Bypass - May 26th				
2017	3DD.0077BAC7F0	The Dalles East Ladder - September 22nd	McNary - October 27th		John Day Juvenile Bypass - April 21st Bonneville Juvenile Bypass - April 27th				
2017	3DD.0077BAC383	The Dalles East Ladder - October 21st	Lower Walla Walla River - November 26th		Pattit Creek (Walla Walla) - April 11th to 13th John Day Juvenile Bypass - May 4th Bonneville Juvenile Bypass - May 5th				
2017	3DD.0077BA7DC0	The Dalles East Ladder - September 22nd	Prosser Dam (Yakima) - November 17th	Satus Creek (Yakima) - January 12th	Satus Creek (Yakima) - April 12th John Day Juvenile Bypass - May 1st				Steelhead tagged on July 25th, where it was between July and September is unknown.
2017	3DD.00779797D1	The Dalles East Ladder - July 18th	Little Goose - October 28th		McNary - April 16th Ice Harbor - April 18th John Day Juvenile Bypass - May 29th				
2017	3DD.0077BAC9DE	The Dalles East Ladder - September 11th	Prosser Dam (Yakima) - October 25th		John Day Juvenile Bypass - May 6th				Steelhead tagged on July 25th, where it was between July and September is unknown.
2017	3DD.0077BA384F	The Dalles East Ladder - August 3rd	Little Goose Juvenile Bypass November 25th	Upper Tucannon River - January 19th Middle Tucannon River - January 5th	Lower Monumental - March 19th McNary - April 2nd				
2017	3DD.0077BA8D86	The Dalles East Ladder - October 10th	McNary - October 30th	Lower Walla Walla River - January 25th	Middle Walla Walla River - April 10th to 19th McNary Juvenile Bypass - May 5th				
2017	3DD.0077BA48D6	The Dalles East Ladder - July 31st Lower Granite - August 27th			Lower Monumental Juvenile Bypass - April 28th				Steelhead was captured at Lower Granite on August 15th.
2017	3DD.0077BA3F3F	The Dalles East Ladder - September 23rd	Lower Granite - October 9th		Lower Monumental Juvenile Bypass - May 2nd				
2017	3DD.0077BA8EC3	The Dalles East Ladder - September 11th	Lower Granite - September 24th		Lower Monumental Juvenile Bypass - May 29th				
2017	3DD.0077BA8165	The Dalles East Ladder - October 21st	Lower Granite - November 24th		Lower Monumental Juvenile Bypass - May 10th				
2017	3DD.0077BA8A7A	The Dalles North Ladder - August 11th	Lower Granite - September 28th		Lower Monumental Juvenile Bypass - April 28th				
2017	3DD.0077BA3811	The Dalles East Ladder - October 8th	Lower Granite - October 28th		Upper Salmon River - April 6th Little Goose Juvenile Bypass - May 21st				
2017	3DD.0077BA9FB8	Lyle Falls Fishway (Klickitat) - July 31st	Lower Granite - November 2nd		Upper Salmon River - March 28th Little Goose Juvenile Bypass - May 6th				Steelhead was captured at Lower Granite on November 2nd.
2017	3DD.00777E5003	The Dalles East Ladder - September 16th	Lower Granite - September 27th		Little Goose Juvenile Bypass - April 17th				Steelhead was captured at Lower Granite on September 27th.
2017	3DD.0077BA3EDA	The Dalles East Ladder - September 28th	Lower Granite - October 11th		Little Goose Ladder - April 2nd				
2017	3DD.0077BA35CE	The Dalles East Ladder - July 16th	Lower Granite - October 3rd		Lower Granite Juvenile Bypass - April 29th		Lower Granite - November 9th		Steelhead was captured at Lower Granite on October 3rd, 2017. Unknown if steelhead left for the ocean.
2017	3DD.0077BA7D3E	The Dalles East Ladder - September 23rd	Lower Granite - October 11th		Upper Salmon River - April 6th Lower Granite Juvenile Bypass - May 24th				
2017	3DD.0077BA49CD	The Dalles East Ladder - August 19th	Lower Granite - October 9th		Lower Imnaha River - April 5th Big Sheep (Imnaha) - April 12th	Big Sheep (Imnaha) - July 1st Lower Granite Juvenile Bypass - July 5th			
2017	3DD.0077BA4141	The Dalles East Ladder - September 17th	Lower Granite - October 2nd		Lower Imnaha River - March 20th Big Sheep (Imnaha) - March 28th Big Sheep (Imnaha) - May 14th				
2017	3DD.0077BAC786	The Dalles East Ladder - September 23rd	Lower Granite - October 4th		Lower Granite Juvenile Bypass - May 8th				
2017	3DD.0077BA8123	The Dalles East Ladder - September 8th	Lower Granite - November 19th		Lower Granite - April 24th				
2017	3DD.0077BAAA7F	The Dalles East Ladder - September 2nd	Lower Methow River - November 14th		Rocky Reach Juvenile Bypass - April 3rd				
2017	3DD.0077BAC7ED	The Dalles North Ladder - July 23rd			Wells - April 29th Upper Entiat River - May 12th	Rocky Reach Juvenile Bypass - June 15th			

Table B2 (Continued).

Tag Year	Tag Number	First Detection After Tagging 2017 in Spring/Summer/Fall	Fall 2017	Winter 2017/18	Spring 2018	Summer 2018	Fall 2018	Winter 2018/19	Comments
2017	3DD.0077BA5C0E	The Dalles East Ladder - August 26th	Lower Methow River - November 3rd		Spring Creek (Methow) - April 19th to 29th Rocky Reach Juvenile Bypass - May 7th				
2017	3DD.003BE289FC	The Dalles East Ladder - September 3rd	Lower Methow River - November 26th	Lower Methow River - January 3rd	Lower Twisp River (Methow) March 20th	Rocky Reach Juvenile Bypass - June 6th			
2017	3DD.0077BA3A92	The Dalles East Ladder - September 14th	Rocky Reach - Oct 21st		Wells - April 11th Lower Twisp River (Methow) April 16th 20th	Rocky Reach Juvenile Bypass - June 22nd			Steelhead was captured at Wells on October 1st, 2017, and Twisp Weir on April 11th and 26th.
2017	3DD.0077BA7FBC	The Dalles East Ladder - October 18th			Three Mile Falls Dam (Umatilla) - March 17th Three Mile Falls Dam (Umatilla) - May 1st				Steelhead was tagged at Bonneville AFF on July 26th, but did not pass The Dalles until October and was not detected between the dates.
2017	3DD.0077BAB6BA	Lyle Falls Fishway (Klickitat) - July 29th	McNary - November 5th		Maxwell Canal (Umatilla) - May 30th	Three Mile Falls Dam (Umatilla) - June 4th			
2017	3DD.0077979792	The Dalles North Ladder - July 30th	Lower Granite - November 4th	Upper Grande Ronde - January 17th	Upper Grande Ronde - March 22nd Upper Grande Ronde - April 20th Upper Grande Ronde - April 26th				
2017	3DD.0077BAB38E	The Dalles North Ladder - August 29th	Lower Toppenish Creek (Yakima) - November 22nd - 30th	Lower Toppenish Creek (Yakima) - February 3rd	Lower Toppenish Creek (Yakima) - April 23rd				
2017	3DD.0077BA55A2	The Dalles East Ladder - October 18th	McNary - October 21st	Lower Walla Walla - December 21st Lower Coppei (Touchet) - January 29th	Lower Coppei (Touchet) - April 27th		Bonneville WA Ladder - September 9th Lower Walla Walla - November 26th	Lower Touchet (Walla Walla) - January 20th Lower Coppei (Touchet) - February 3rd	
2017	3DD.0077BA442D	The Dalles North Ladder - October 19th	Middle Walla Walla River - November 30th	Middle Walla Walla River - January 16th	Middle Walla Walla River - April 13th				Fish was tagged at Bonneville on July 19th, 2017, but not seen at The Dallas until October.
2017	3DD.0077BA4914	The Dalles North Ladder - September 19th	Lower Granite - October 5th		Lower Imnaha River - April 6th Lower Granite - May 12th				Steelhead tagged at Bonneville AFF on August 21st, 2017 and was also recaptured/released May 12th, 2018 by CRITFC Kelt Project. Considered a kelt, by Kelt Project.
2017	3DD.0077BACB43	The Dalles North Ladder - October 8th	Lower Granite - November 22nd	Dworshak NFH (Clearwater) - February 8th					Steelhead tagged at Bonneville AFF on October 6th, 2017 and was captured in February, 2018 by CRITFC Kelt Project. Considered a kelt, by Kelt Project.
2017	3DD.0077BA9B91	The Dalles East Ladder -July 29th	Lower Granite - October 3rd	Joseph Creek (Grande Ronde) - February 4th - 21st	Joseph Creek (Grande Ronde) - March 10th - 30th Lower Granite Juvenile Bypass - April 9th				Steelhead tagged at Bonneville AFF on July 27th, 2017 and was also recaptured/retained on April 9th, 2018 by CRITFC Kelt Project. Considered a kelt, by Kelt Project.
2017	3DD.0077BA5908	The Dalles East Ladder - September 15th	Lower Granite - September 26th		Lower Granite Juvenile Bypass - April 10th				Steelhead tagged at Bonneville AFF on September 8th, 2017. Steelhead was recaptured/released at Lower Granite on September 26th on upstream migration at trap, and then again May 10/11th, 2018 by CRITFC Kelt Project. Considered a kelt, by Kelt Project.
2017	3DD.0077BACBBA	The Dalles East Ladder - October 11th	Little Goose - November 7th	Lower Granite - December 1st	Lolo Creek (Clearwater) - April 13th to 30th Lower Granite Juvenile Bypass - May 7th Little Goose Juvenile Bypass - May 10th				Steelhead tagged at Bonneville AFF on October 9th, 2017. Steelhead was recaptured/released at Lower Granite on May 7/8th, 2018 by CRITFC Kelt Project. Considered a kelt, by Kelt Project.
2017	3DD.0077BA58A2	The Dalles East Ladder - Oct 21st	Lower Monumental - November 16th		Little Goose - March 21st Lower Granite - April 6th Lower Granite Juvenile Bypass - May 15th				Steelhead tagged at Bonneville AFF on October 18th, 2017. Steelhead was recaptured/released at Lower Granite on May 15/16th, 2018 by CRITFC Kelt Project. Considered a kelt, by Kelt Project.

Key - - - Upstream | Downstream | Spawning

Table B3. Season by season activities of steelhead tagged in 2017 and later labeled as kelts or repeat spawners when they began migrating downstream (before April 1st) and upstream in spring, summer, or fall of 2017, and winter, spring 2018 presumably to and from the ocean.

Tag Year	Tag Number	First Detection After Tagging 2017 in Spring/Summer/Fall	Fall 2017	Winter 2017/18	Spring 2018	Comments
2017	3DD.0077BA3F7E	The Dalles East Ladder - August 20th McNary - August 31st			McNary Juvenile Bypass - March 29th	
2017	3DD.0077BA8102	The Dalles East Ladder - September 4th	Lower Granite - September 25th		Little Goose Juvenile Bypass - March 29th	
2017	3DD.0077BAC7FF	The Dalles East Ladder - July 27th	McNary - November 7th		McNary Juvenile Bypass - March 29th	

Key - - - Upstream | Downstream | Spawning

Table B4. Season by season activities of steelhead tagged in 2014, 2015, and 2016 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 2017/18/19.

Tag Year	Tag Number	First Detection After Tagging in Spring/Summer/Fall	Fall	Winter	Spring	Comments
2014	3DD.00773B3ED0	The Dalles East Ladder - October 9th, 2014	Lower Granite - November 2nd, 2014	Joseph Creek (Grande Ronde) - February 8th	Joseph Creek (Grande Ronde) - March 14th, 2015	Tagged July 31st, 2014. Assume fish went back to the ocean. Recovered in carcasses monitoring in Joseph Creek on April it currently appears it was in Joseph Creek on April 10th.
					Joseph Creek (Grande Ronde) - March 10th, 2017	
2015	3DD.00775E761F	The Dalles East Ladder - October 28th, 2015		Lower Umatilla River - January 20th, 2016		Tagged August 18th, 2015. Assume the fish spent some months in the ocean between January and October.
			The Dalles East Ladder - October 11th, 2016			
2015	3DD.00775E7525	The Dalles East Ladder - September 3rd, 2015	Lower Methow River - September 20th, 2015	Middle Methow River - February 29th, 2016		Tagged September 1st, 2015. Fish may have spent some time in the ocean between migration years, but was also part of the Kelt Program and was released into the Methow River November 13th , 2017.
					Middle Methow River - March 24th, 2018	
2016	3DD.0077972340	The Dalles East Ladder - July 15th, 2016	Prosser Dam (Yakima) - October 11th, 2016			Tagged July 11th, 2016. Steelhead was collected on May 15th, 2017 for the CRITFC Kelt Project for reconditioning. It was released and recaptured October 24th, 2017. Has new movements since last reported.
					Prosser Dam (Yakima) - May 15th, 2017	
			Prosser Dam (Yakima) - October 27th, 2017		Sunnyside (Yakima) - April 5th, 2018	
					Bonneville Dam Corner Collector - May 25th, 2018	
2016	3DD.00778A6FCA	The Dalles East Ladder - August 22nd, 2016	McNary - September 25th, 2016	Lower Walla Walla River - February 5th, 2017		Tagged August 18th, 2016. Fish likely spent months in the ocean between Summer 2016 and Summer 2018.
				Lower John Day River - February 22nd, 2017		
		Bonneville WA Ladder - July 4th, 2018	John Day - October 3rd, 2018	Lower John Day River - January 24th, 2019		
2016	3DD.00779937A4	The Dalles East Ladder - July 3rd, 2016			Lower Imnaha River - March 17th, 2017	Tagged June 30th, 2016. Fish was not detected moving out of the Snake River, likely stayed in freshwater.
					Big Sheep (Imnaha) - March 28th, 2017	
			Lower Granite - November 1st, 2018			
2016	3DD.00778BB5AB	The Dalles North Ladder - August 3rd, 2016	Prosser Dam (Yakima) - October 10th, 2016			Tagged August 1st, 2016. Fish likely spent months in the ocean between Summer 2016 and Summer 2018.
		Bonneville WA Ladder - July 12th, 2018	Prosser Dam (Yakima) - November 28th, 2018			
2016	3DD.00775DC2C4	Bonneville WA Ladder - May 23rd, 2016				Tagged May 23rd, 2016. Fish likely spent months in the ocean between Spring 2016 and Spring 2018.
		Bonneville WA Ladder - July 4th, 2018				
2016	3DD.00778B1870	The Dalles East Ladder - August 13th, 2016		Warm Springs River (Deschutes) - February 21st,	Warm Springs River (Deschutes) - April 12th, 2017	Tagged August 10th, 2016. Assume the fish spent some months in the ocean between April and October.
			Bonneville Bradford Island - October 12th, 2017		Warm Springs Hatchery (Deschutes) - March 30th,	

Key - - - Upstream | Downstream | Spawning

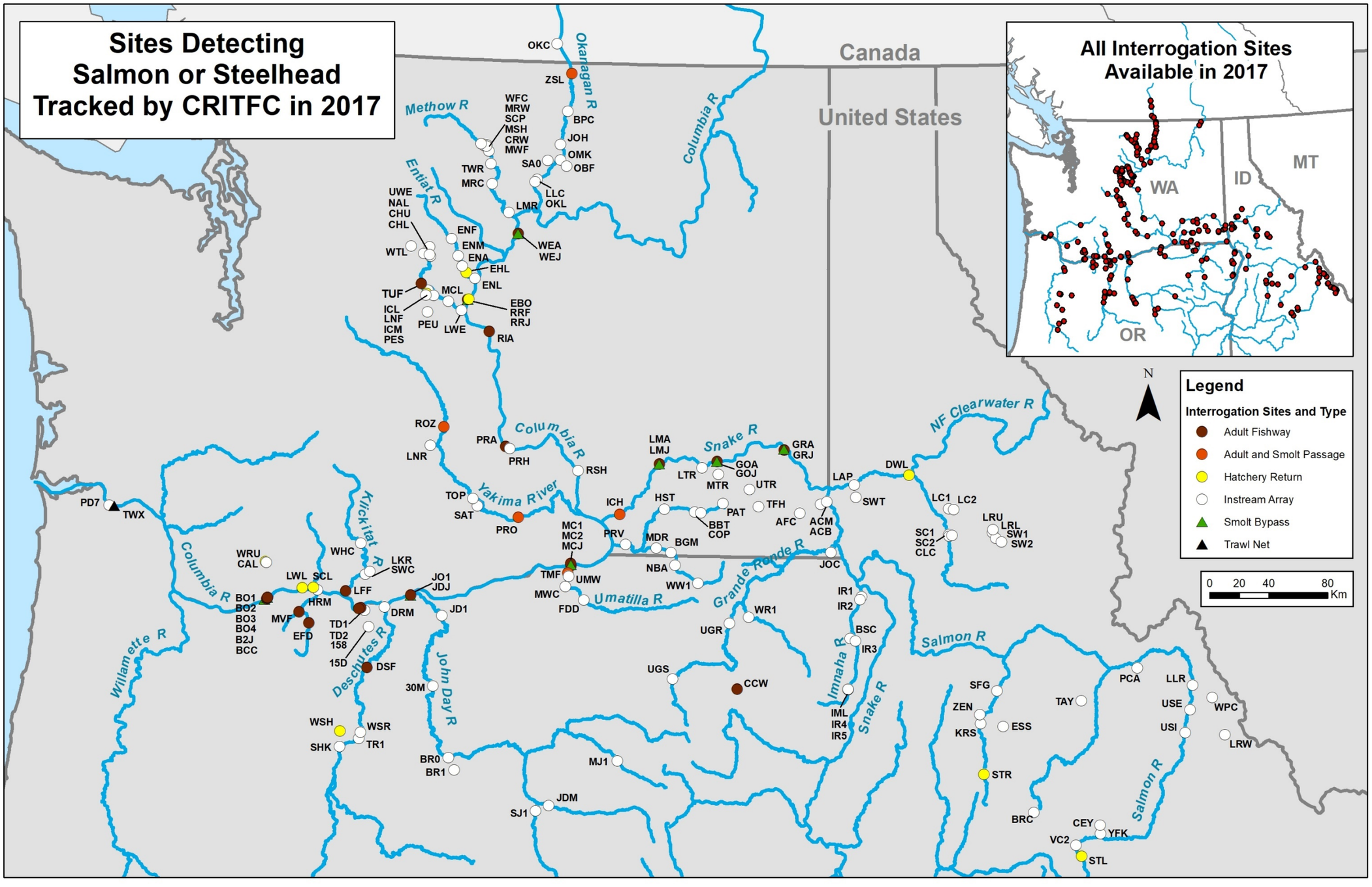

Figure B1. Map of Columbia River interrogation sites that detected Chinook and Sockeye salmon, and steelhead in 2017. Table B1 in Appendix B lists the PTAGIS sites full name and the three-letter codes on this map.

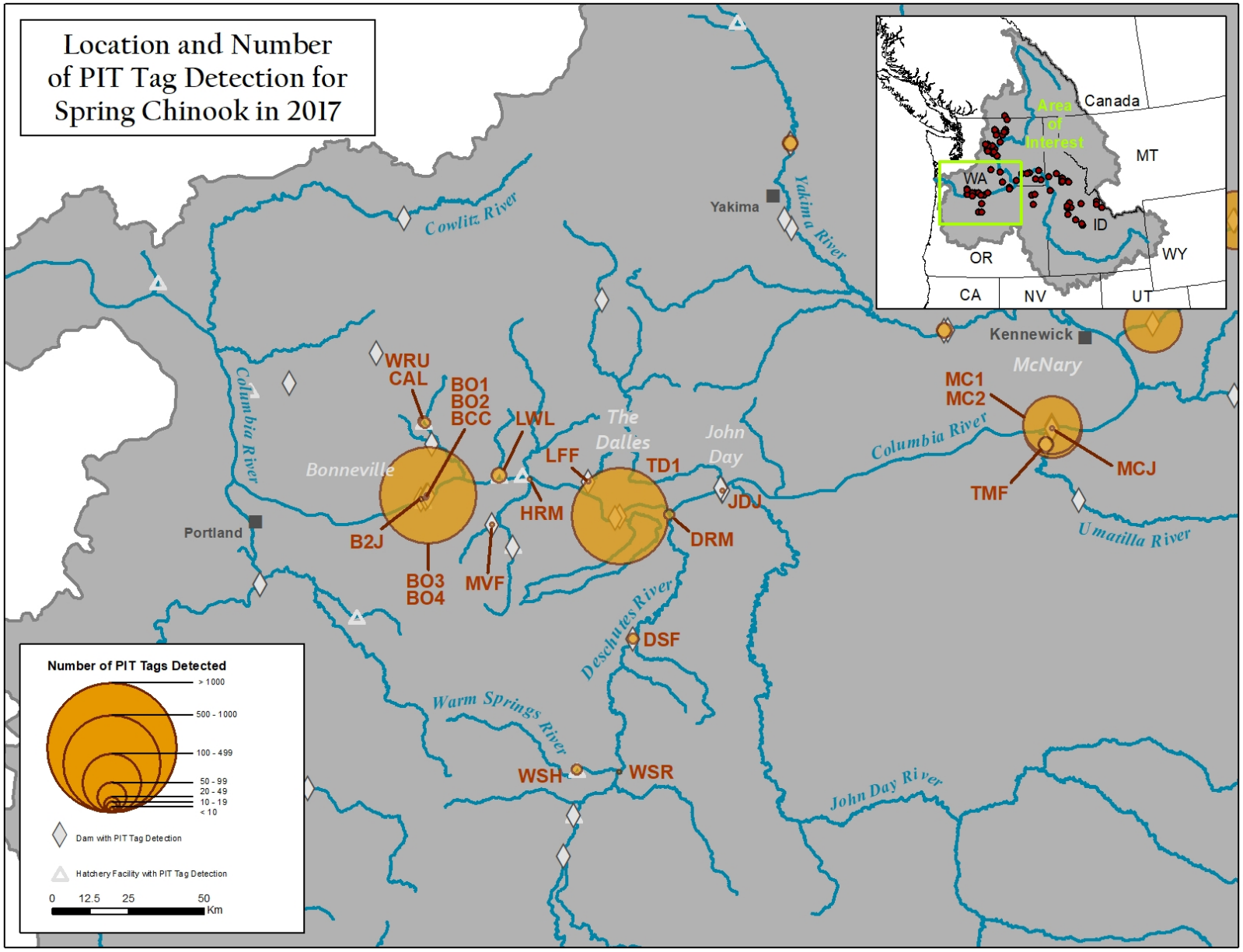

Figure B2. Map of Lower Columbia River detection sites (below Snake River) and number of spring Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January 1 to June 1.

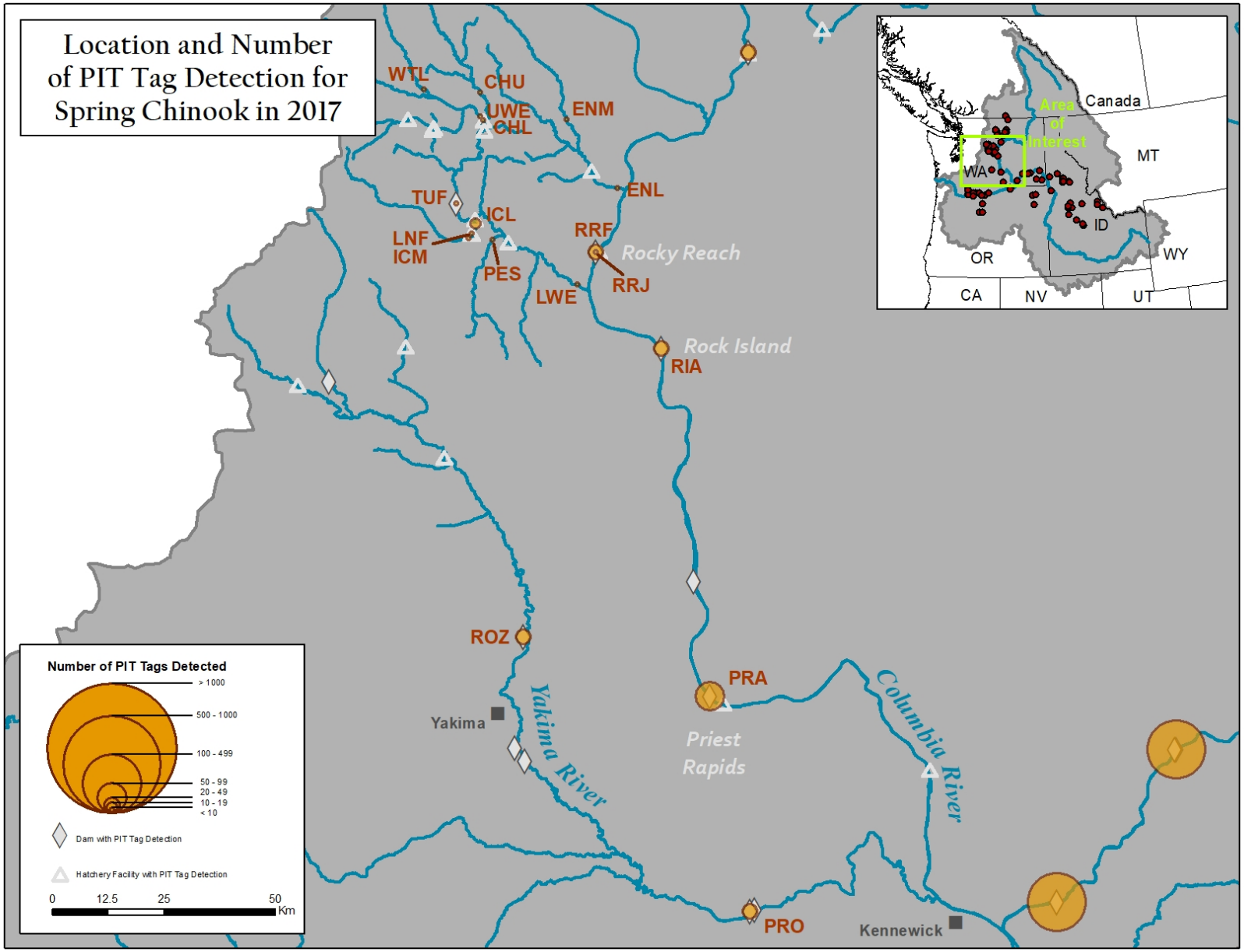

Figure B3. Map of Upper Columbia River (between the Snake River and Wells Dam) detection sites and number of spring Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January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

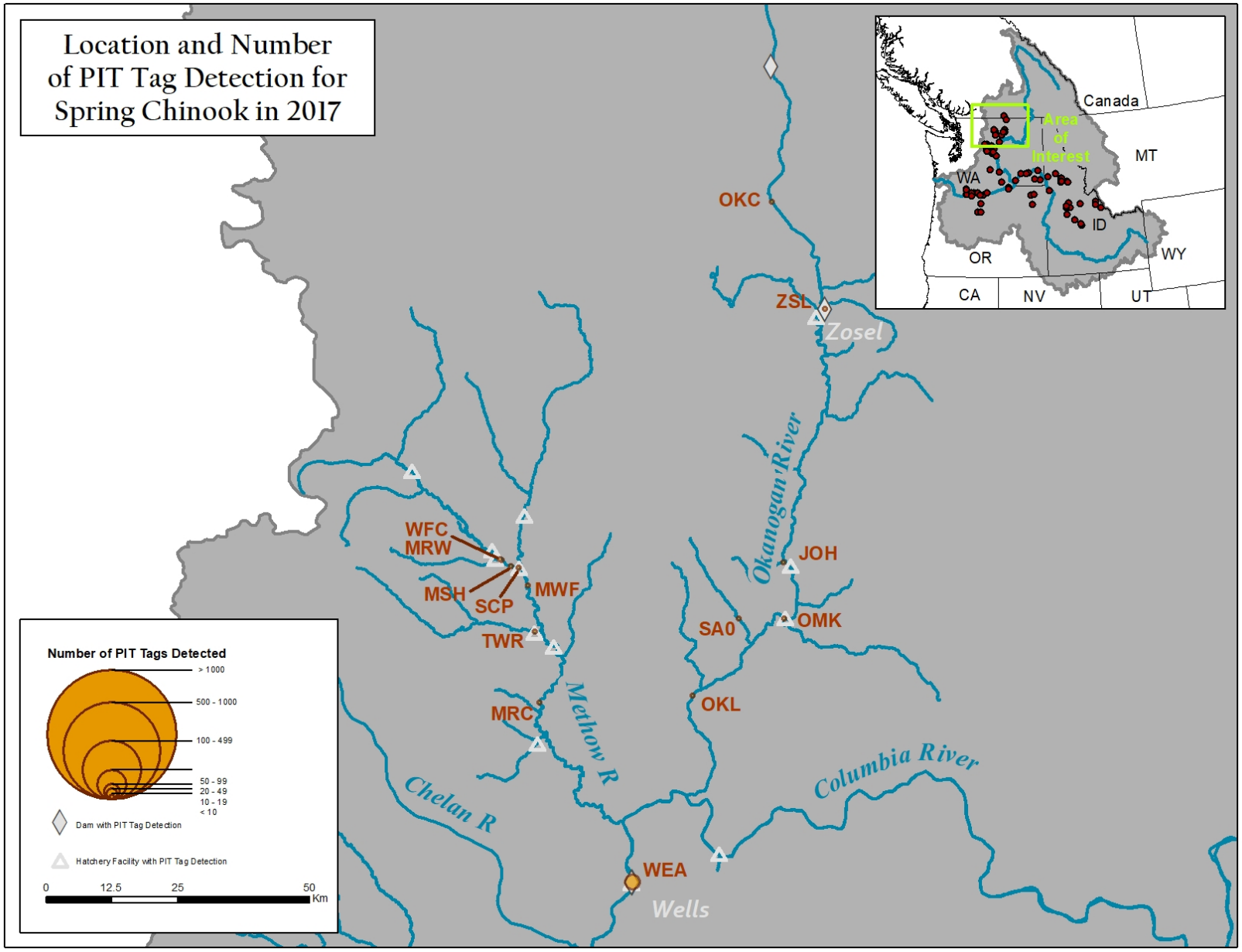

Figure B4. Map of Upper Columbia River (Wells Dam and above) detection sites and number of spring Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January 1 to June 1.

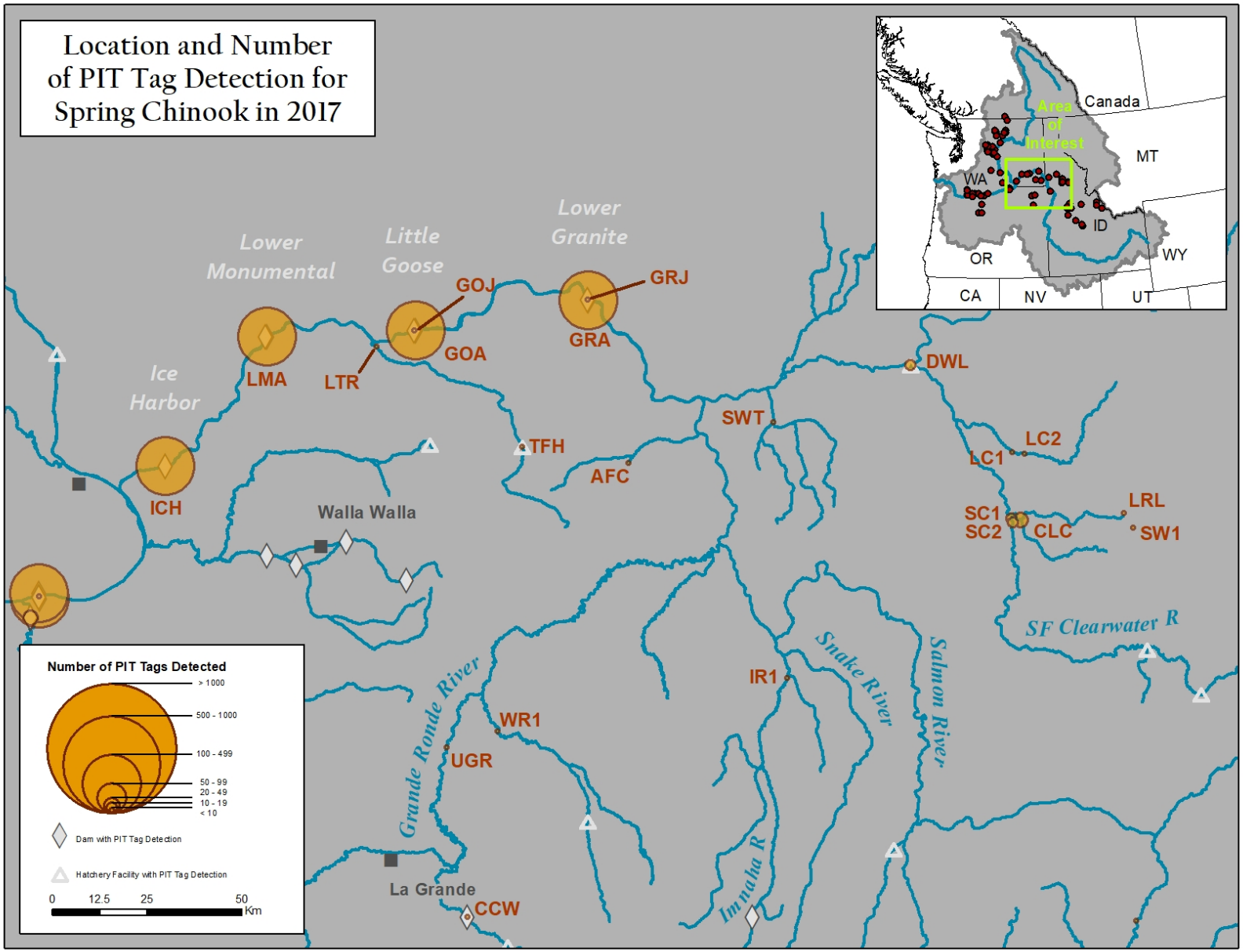

Figure B5. Map of Lower Snake River detection sites (Salmon River not included) and number of spring Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January 1 to June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

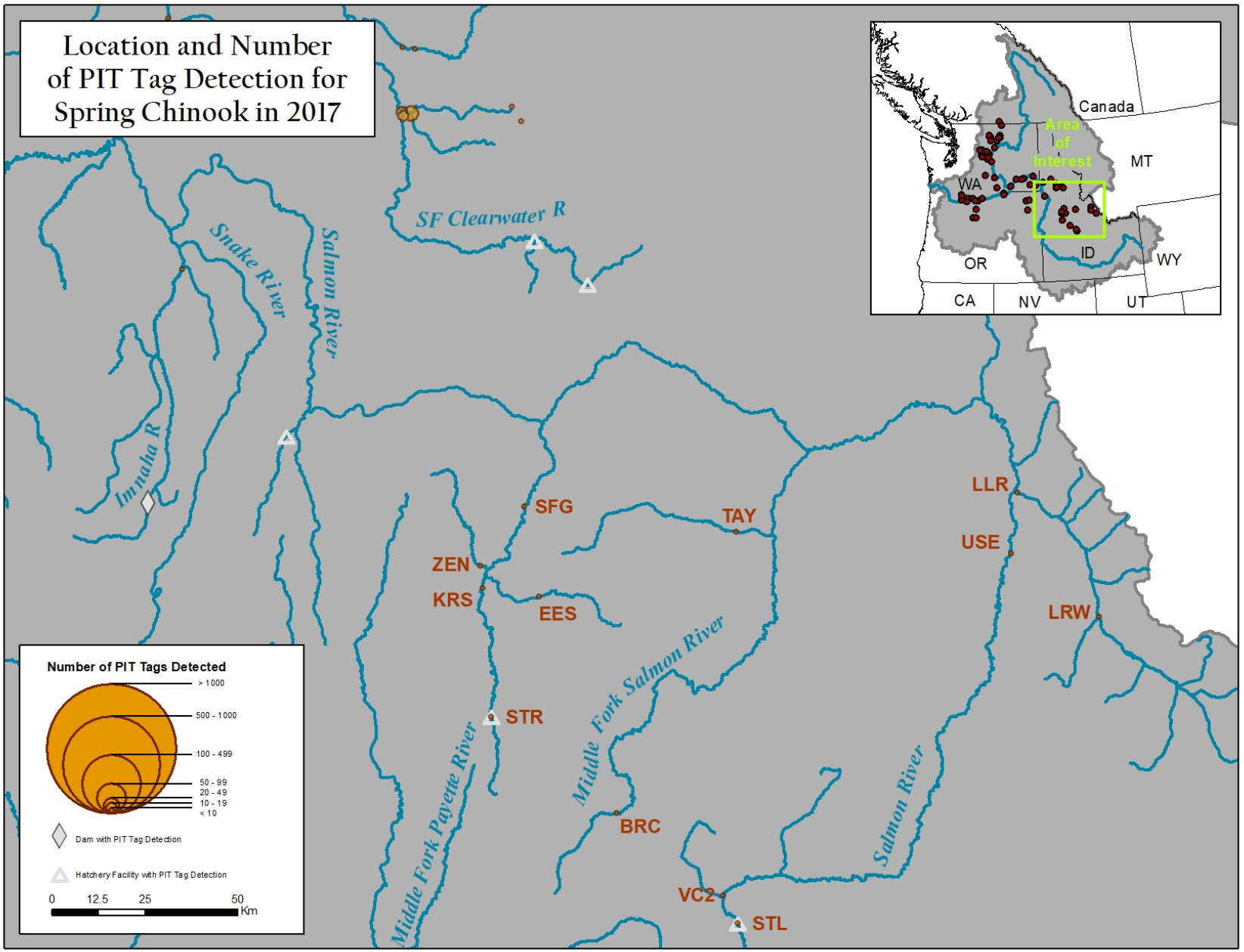

Figure B6. Map of Salmon River detection sites and number of spring Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January 1 to June 1.

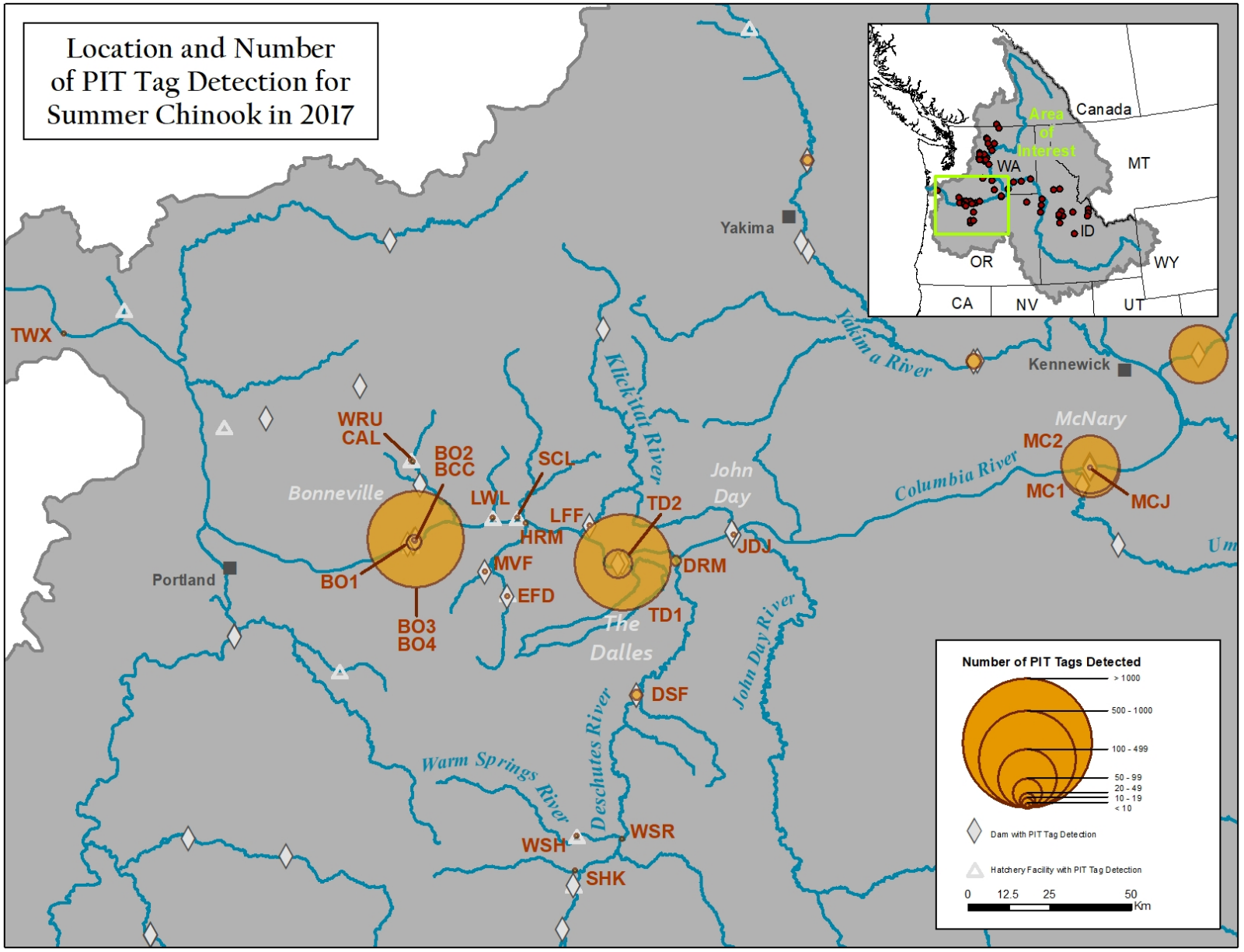

Figure B7. Map of Lower Columbia River detection sites (below Snake River) and number of summer Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June 1 to August 1.

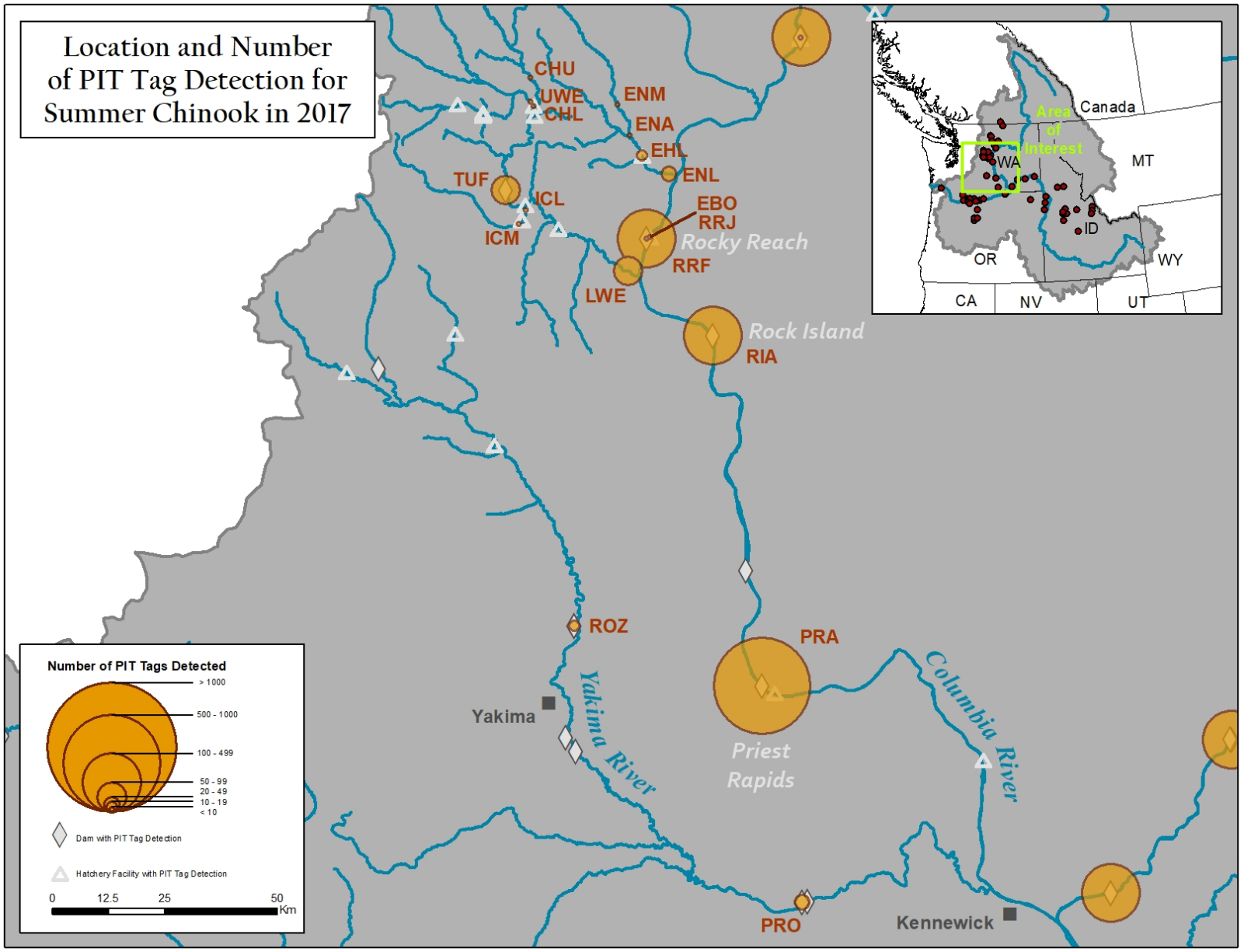

Figure B8. Map of Upper Columbia River (between the Snake River and Wells Dam) detection sites and number of summer Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June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

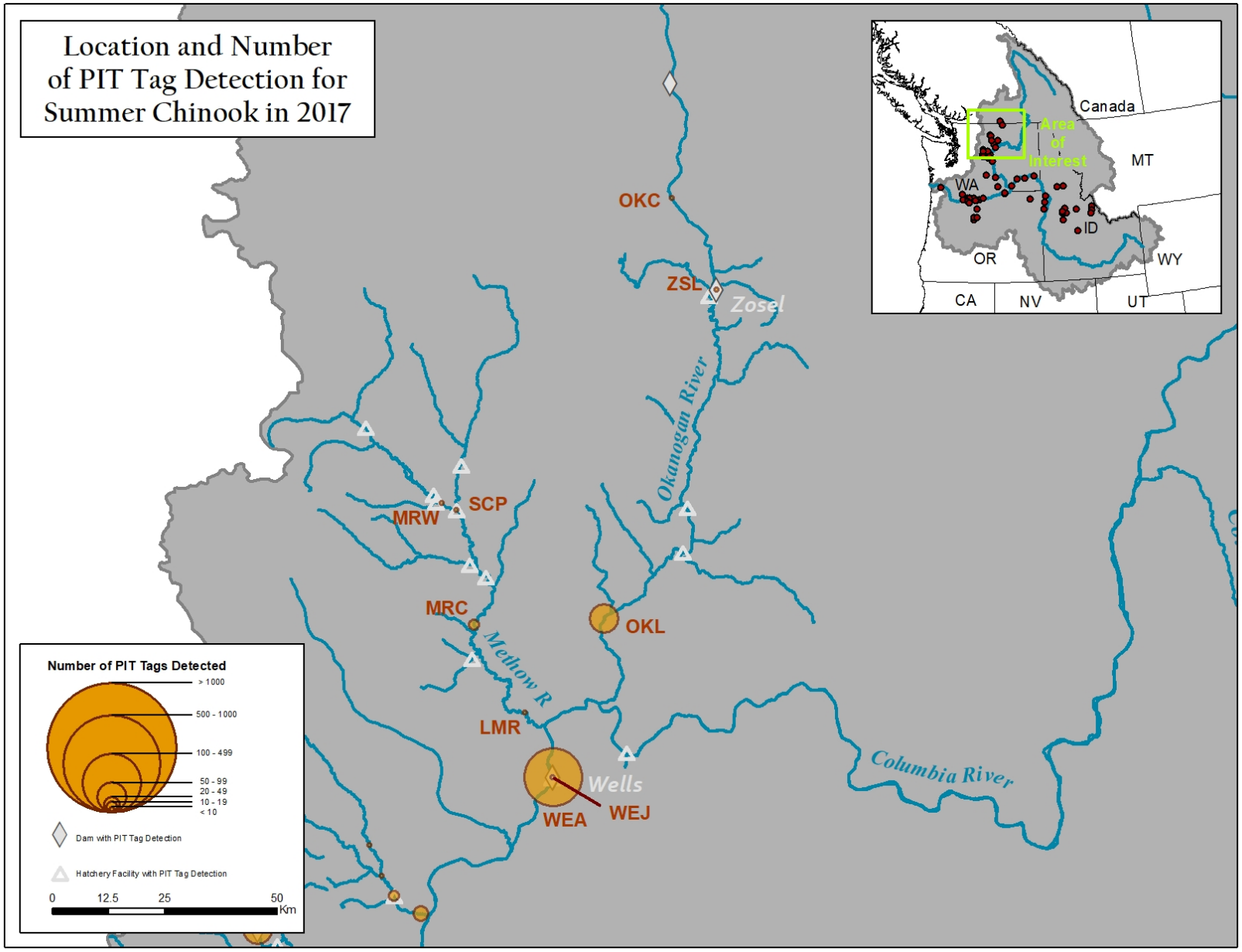

Figure B9. Map of Upper Columbia River (Wells Dam and above) detection sites and number of summer Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June 1 to August 1.

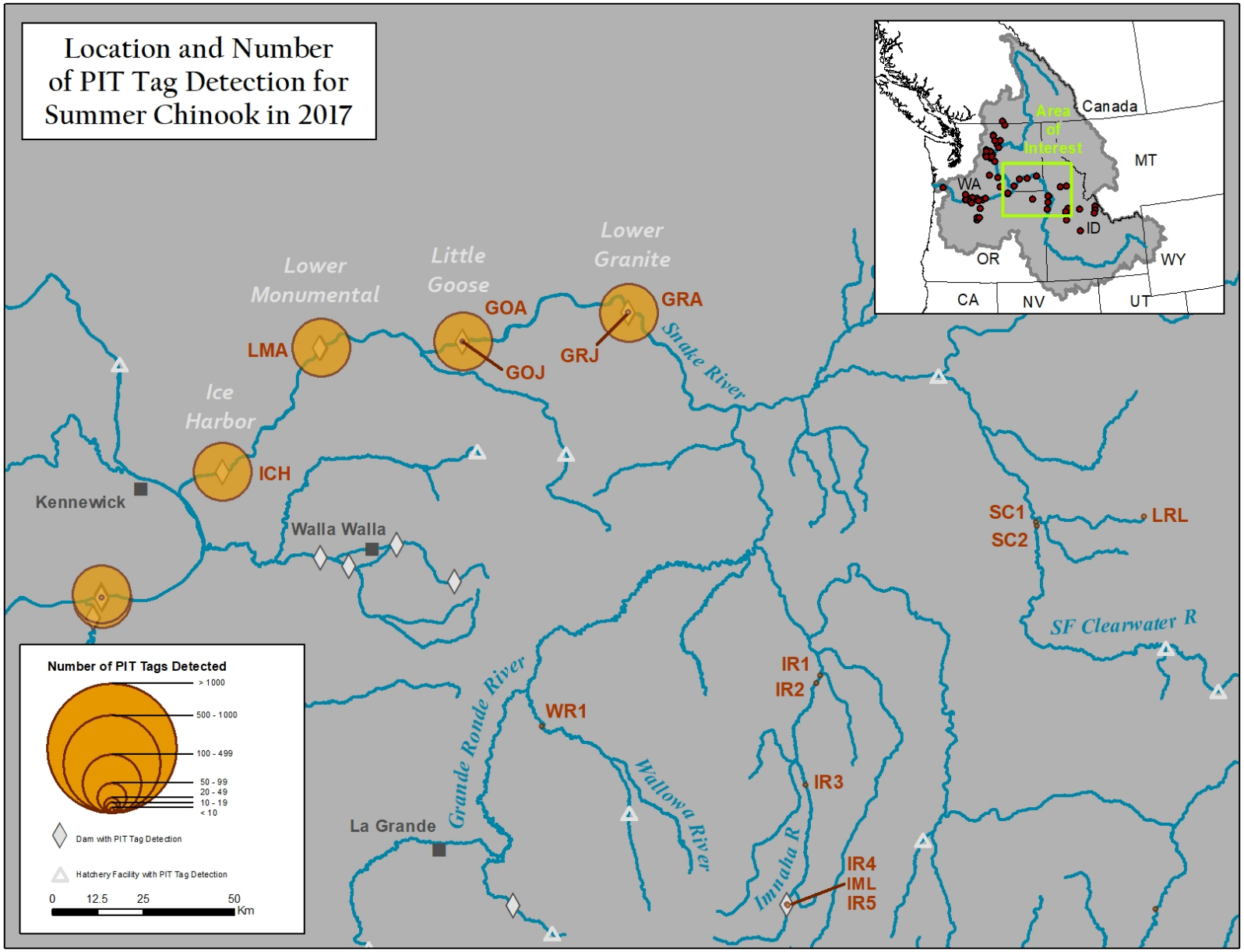

Figure B10. Map of Lower Snake River detection sites (Salmon River not included) and number of summer Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June 1 to August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

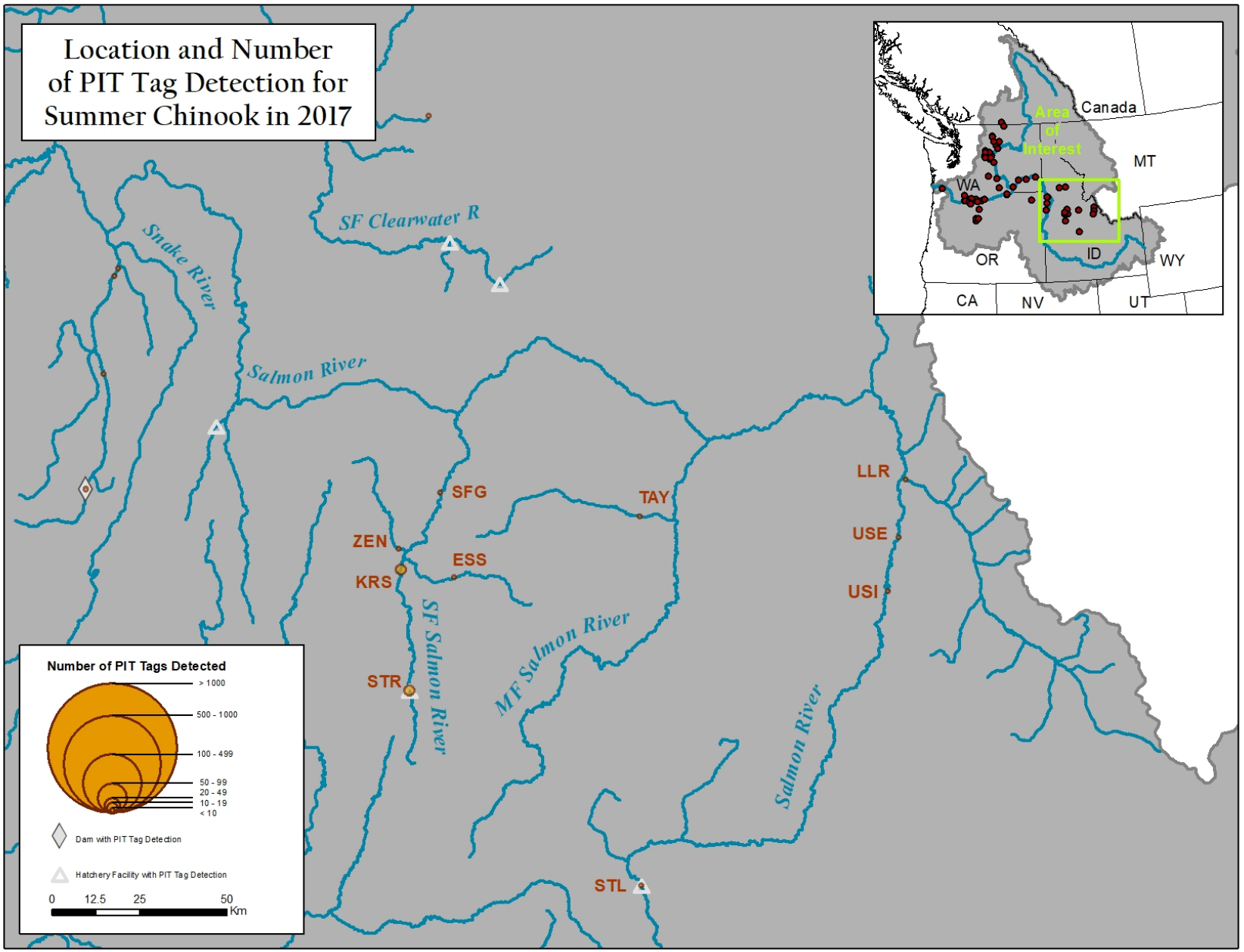

Figure B11. Map of Salmon River detection sites and number of summer Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June 1 to August 1.

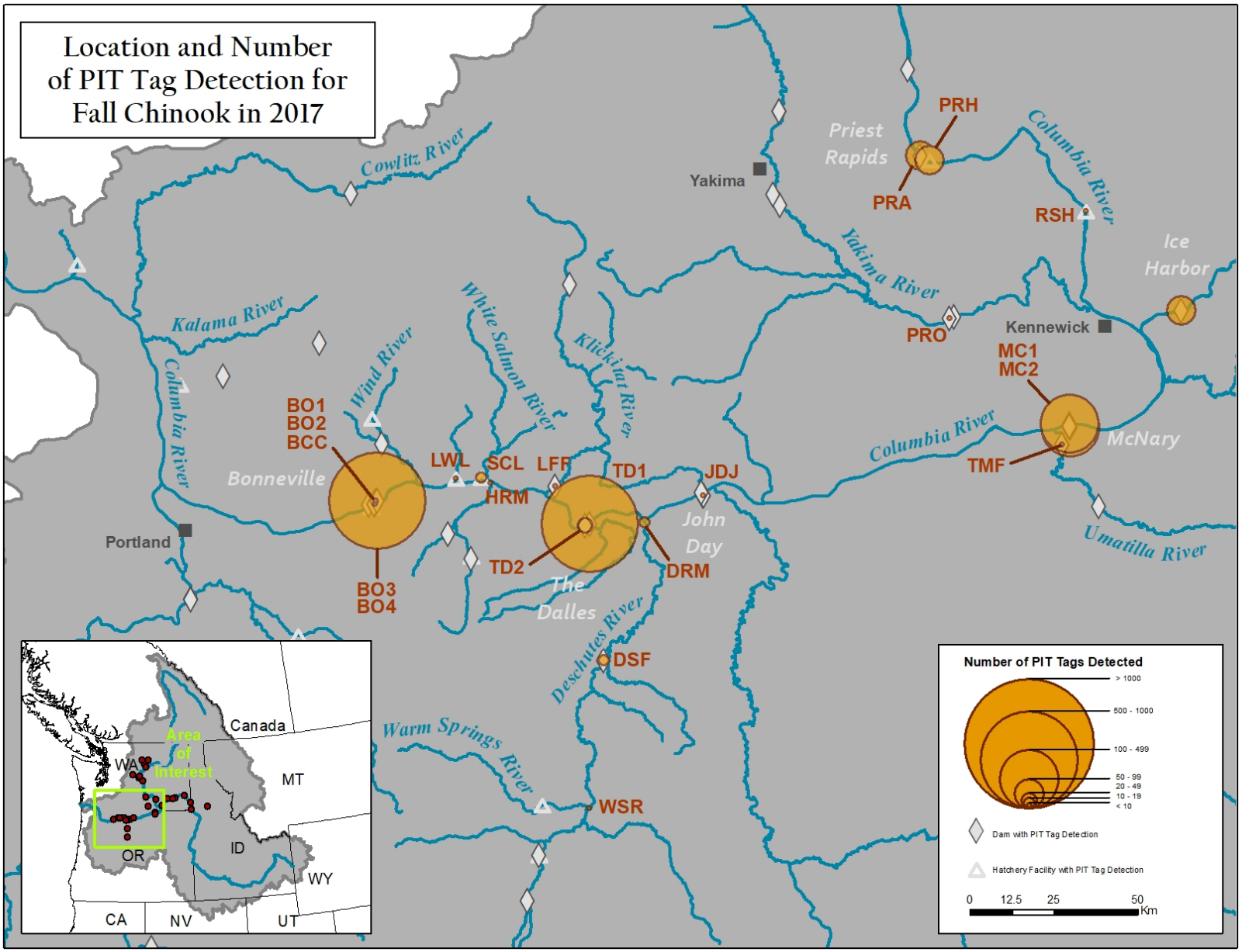

Figure B12. Map of Lower and Middle Columbia River detection sites (below Rock Island Dam) and number of fall Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Fall Chinook is defined as fish passing Bonneville Dam from August 1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

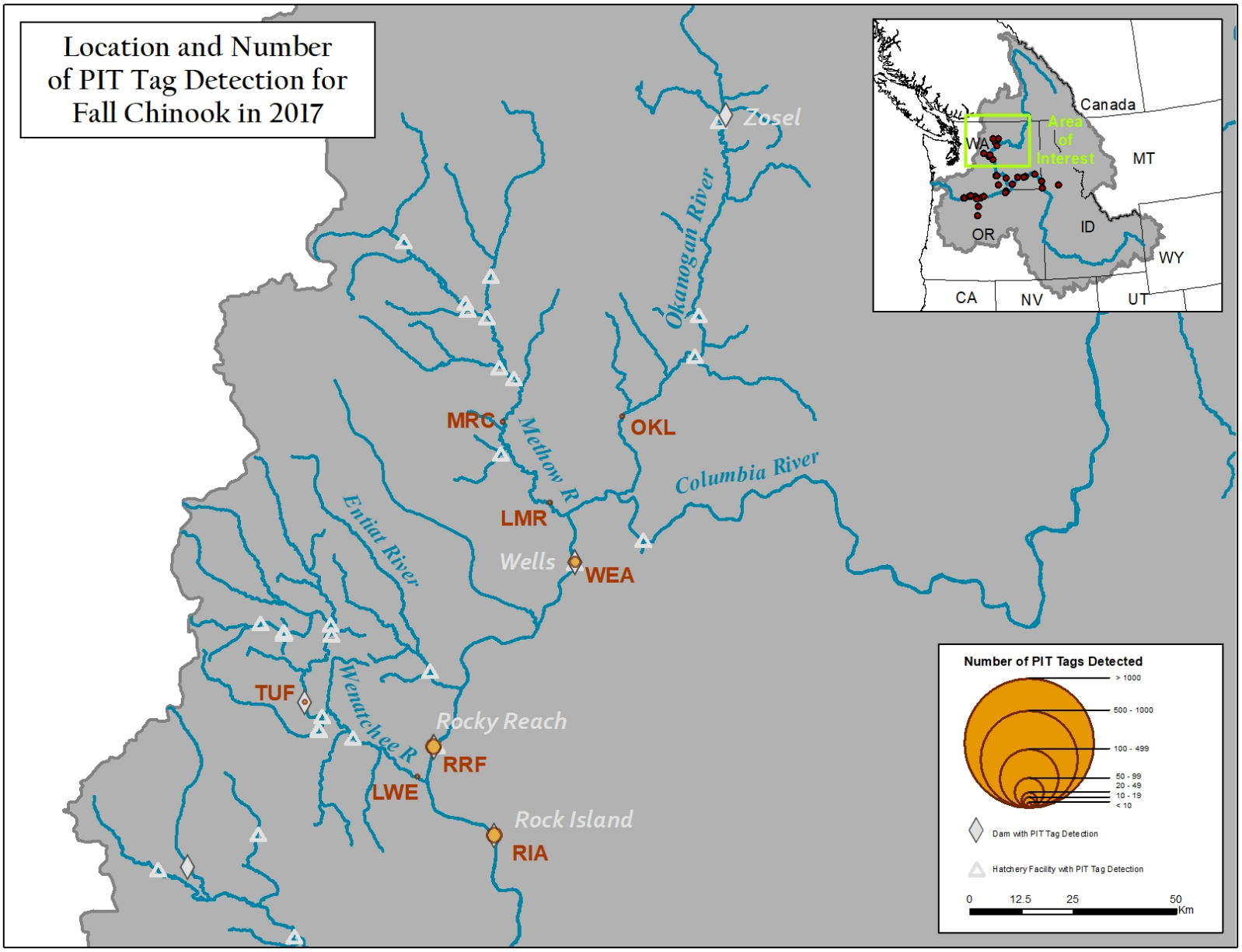

Figure B13. Map of Upper Columbia River detection sites (Rock Island Dam and above) and number of fall Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Fall Chinook is defined as fish passing Bonneville Dam from August 1 to end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

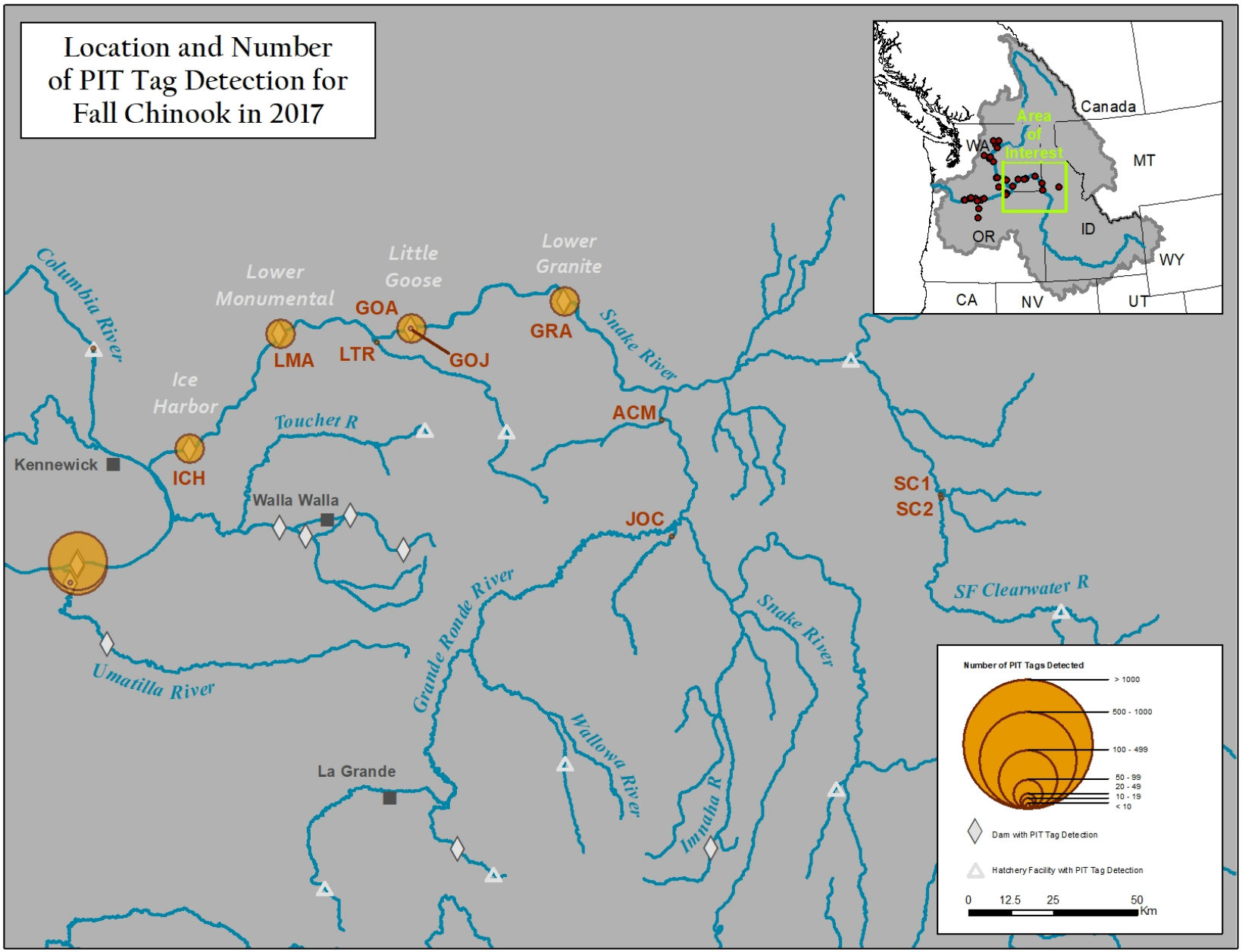

Figure B14. Map of Lower Snake River detection sites and number of fall Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Fall Chinook is defined as fish passing Bonneville Dam from August 1 to end of year.

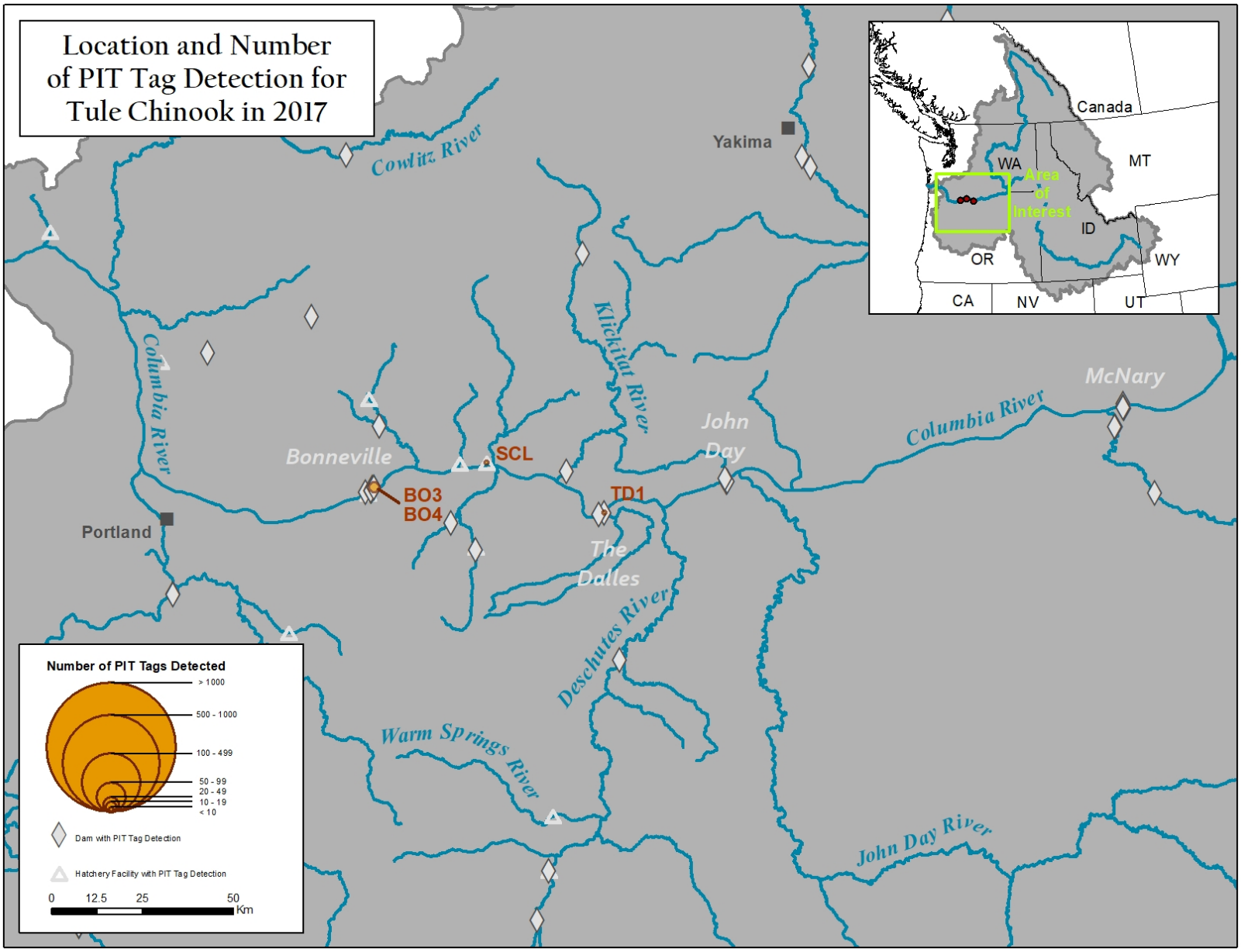

Figure B15. Map of Lower Columbia River detection sites (below Snake River) and number of Tule Chinook Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map. Tule Chinook is defined as fish passing Bonneville Dam in the fall and maturation (showing spawning colors).

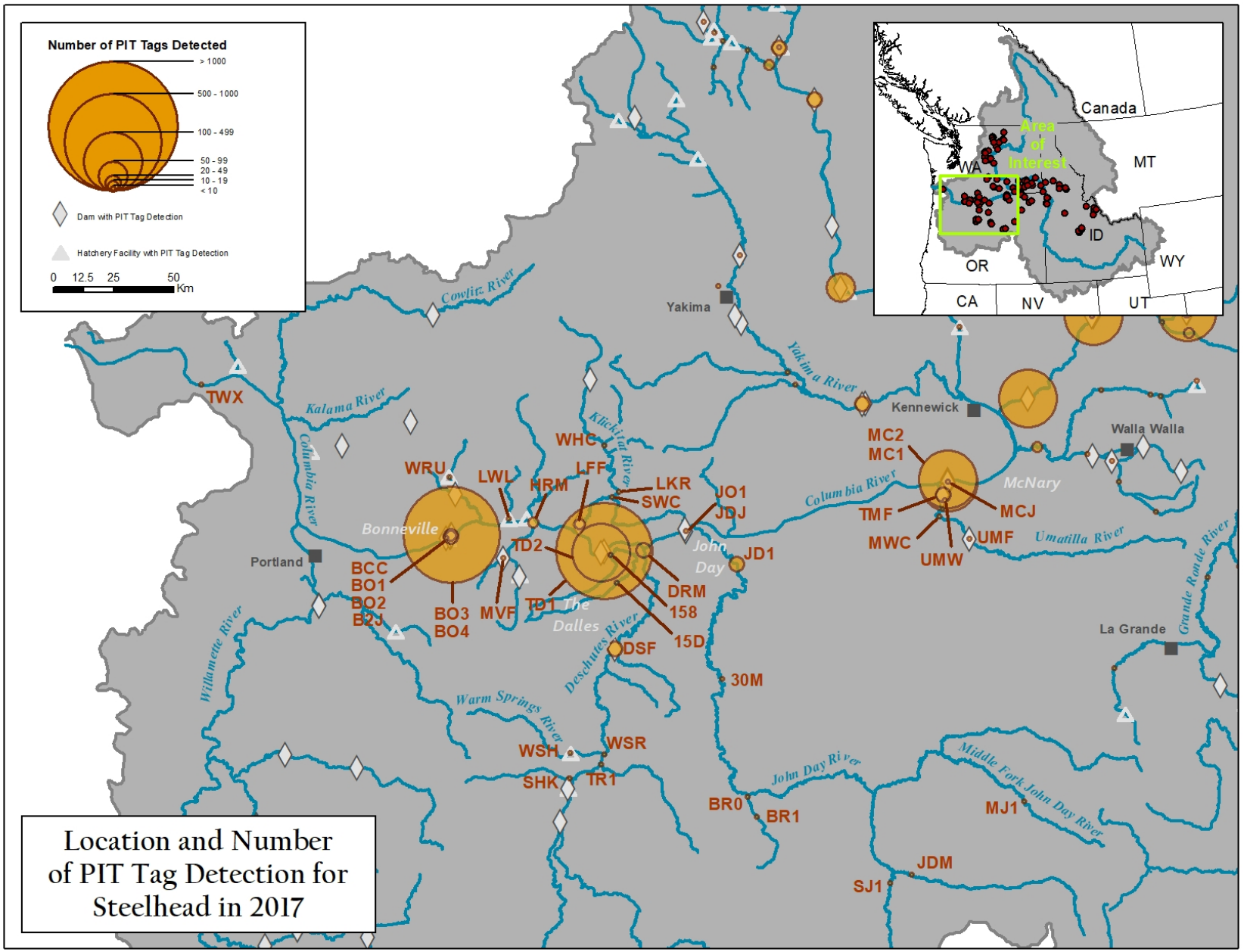

Figure B16. Map of Lower Columbia River detection sites (below Snake River) and number of steelhead detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

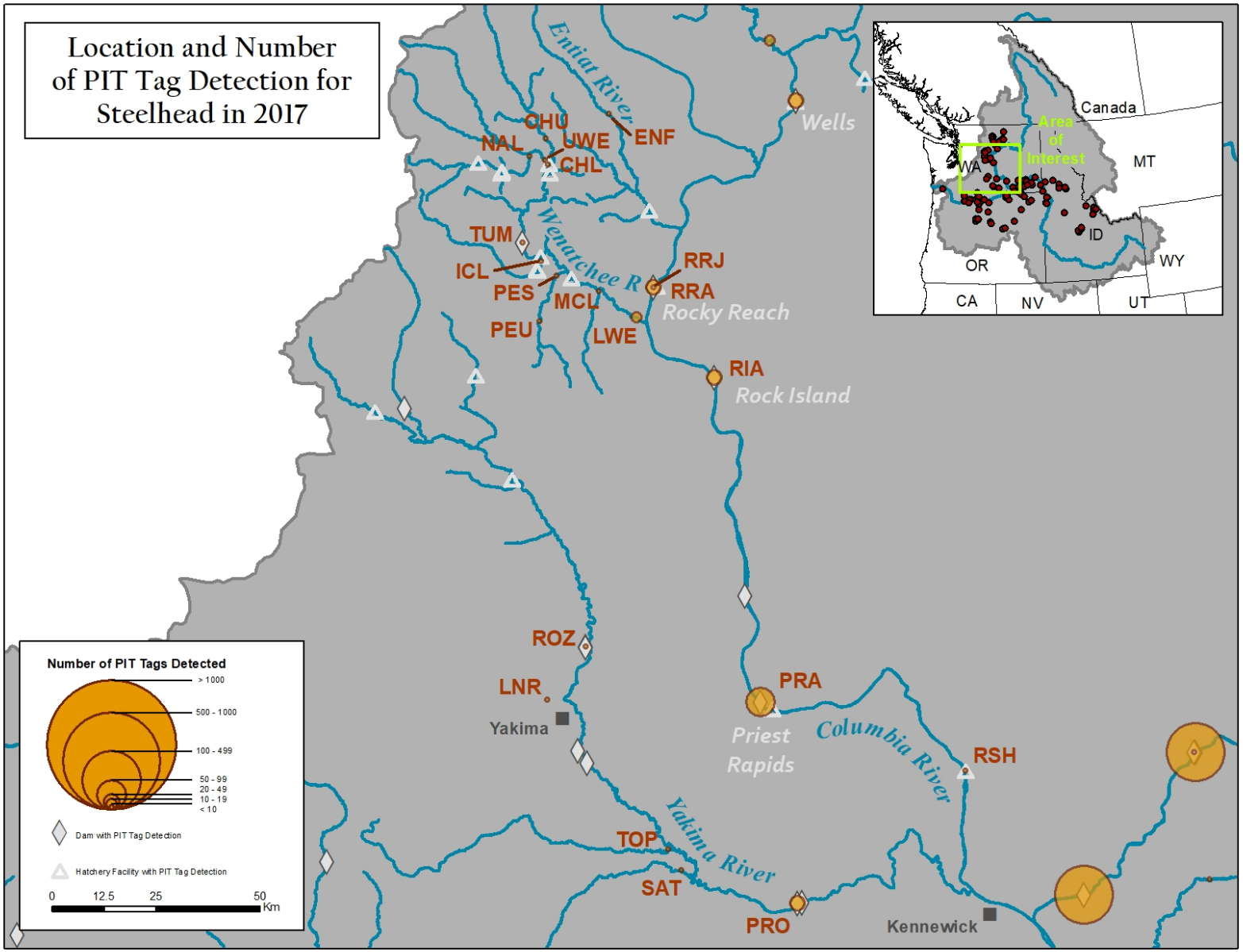

Figure B17. Map of Upper Columbia River (between the Snake River and Wells Dam) detection sites and number of steelhead detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

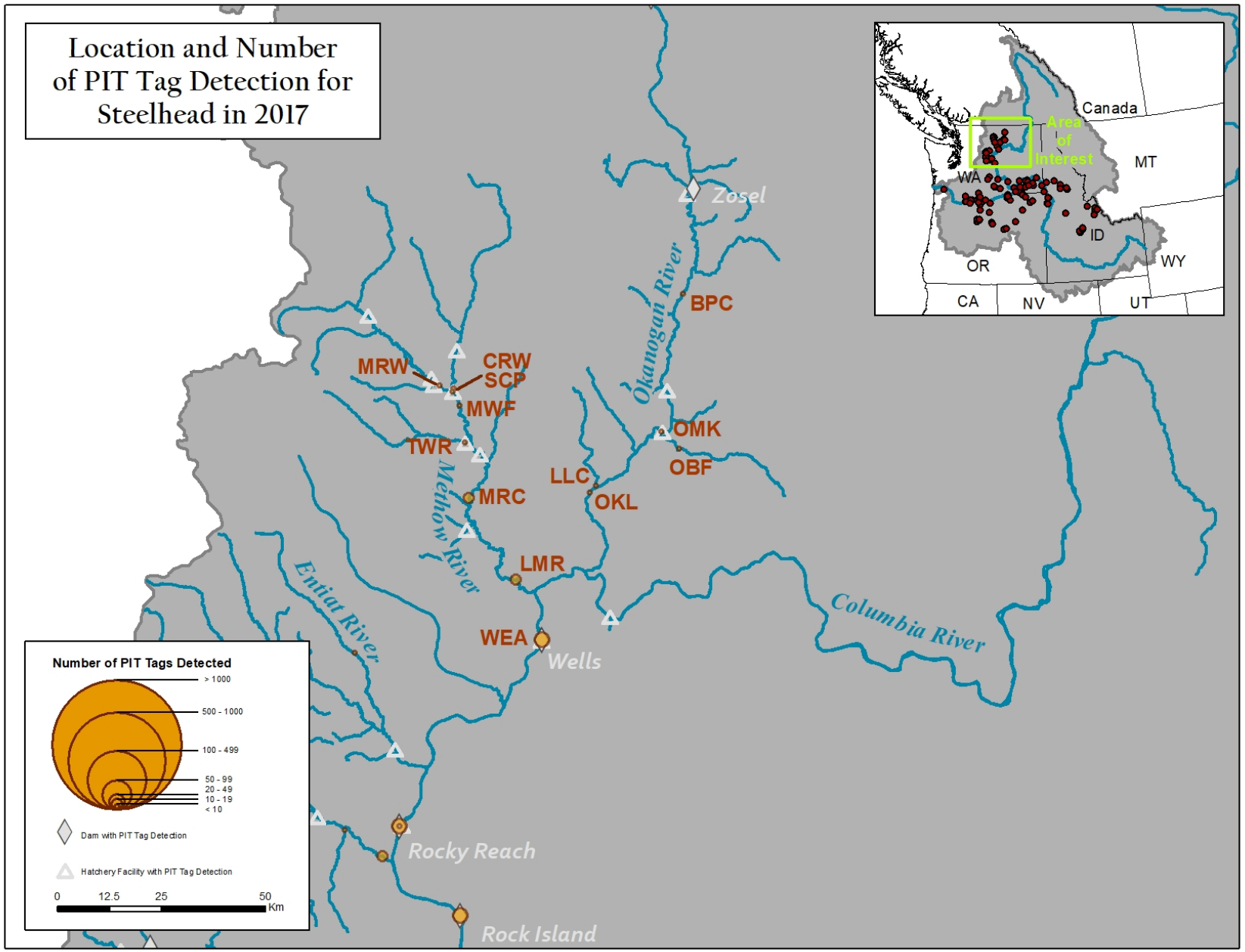

Figure B18. Map of Upper Columbia River (Wells Dam and above) detection sites and number of steelhead detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

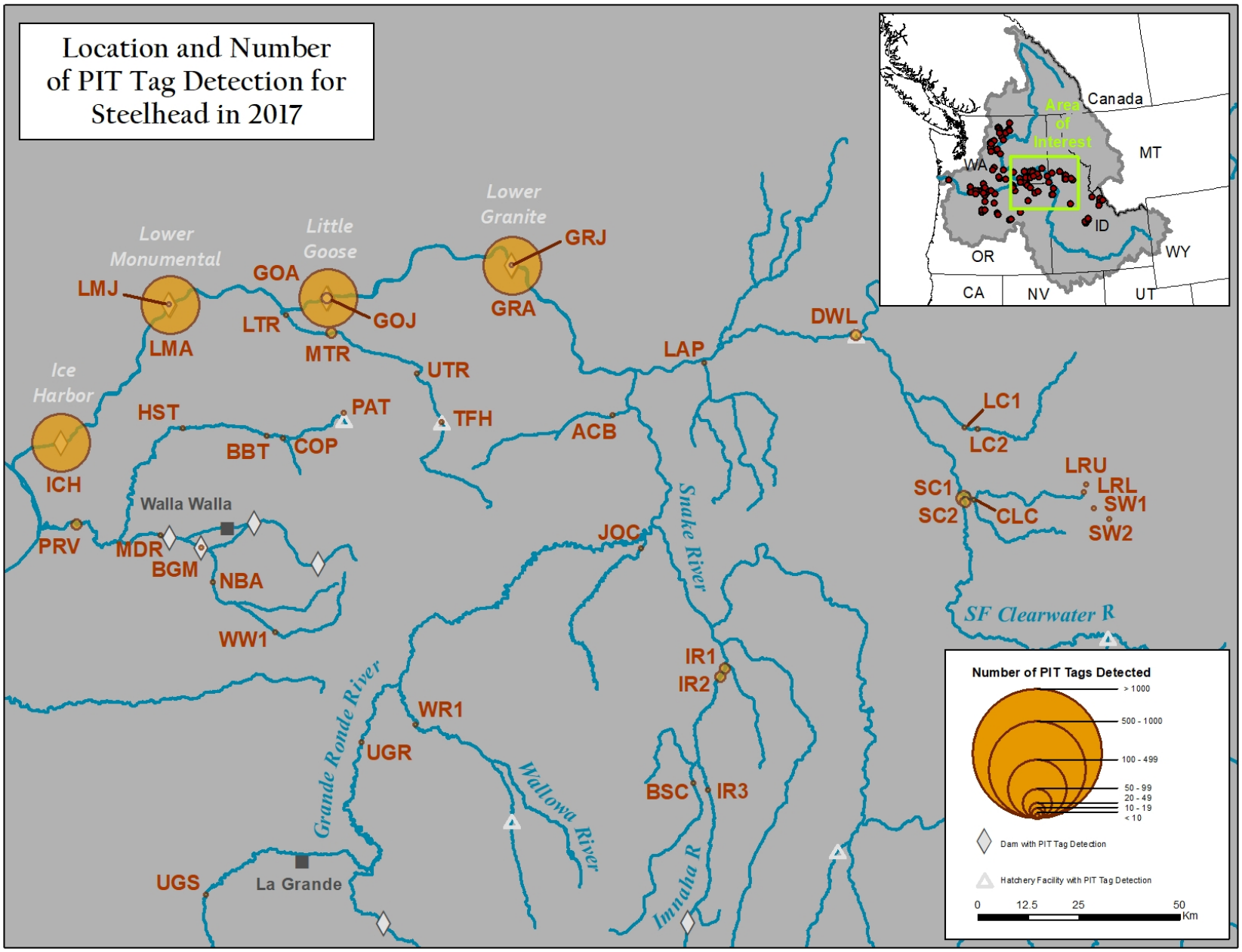

Figure B19. Map of Lower Snake River detection sites (Salmon River not included) and number of steelhead detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

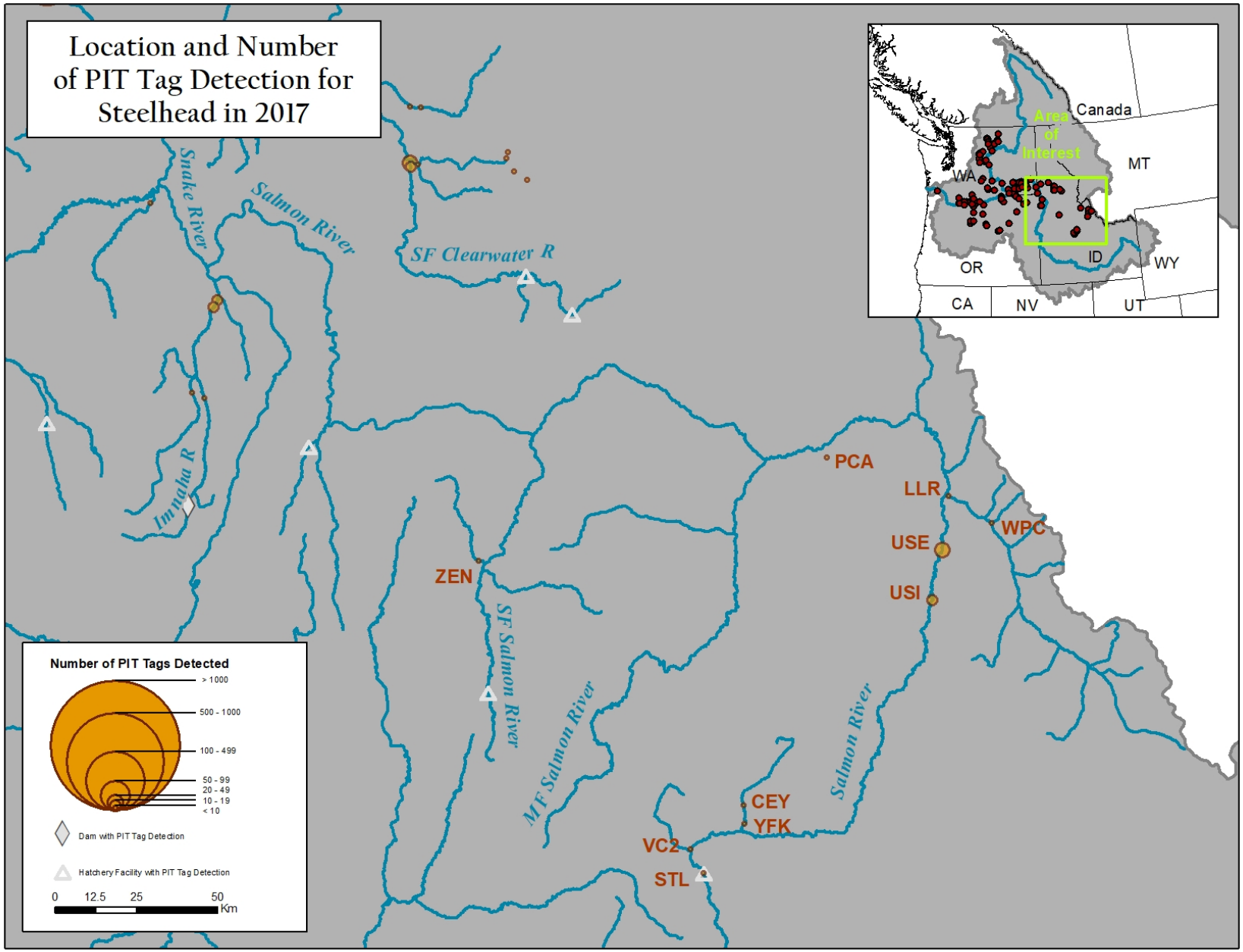

Figure B20. Map of Salmon River detection sites and number of steelhead detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

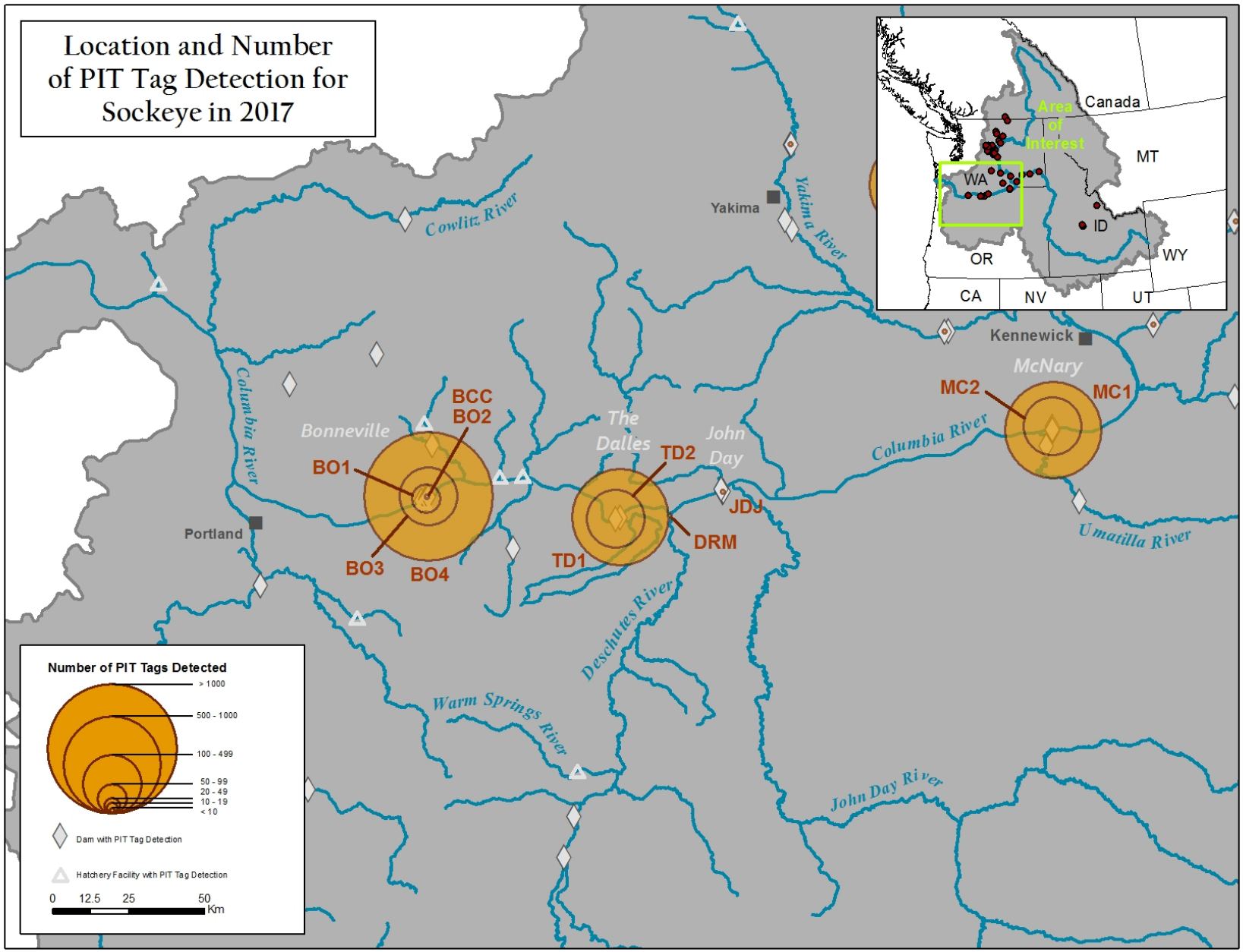

Figure B21. Map of Lower Columbia River detection sites (below Snake River) and number of Sockeye Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

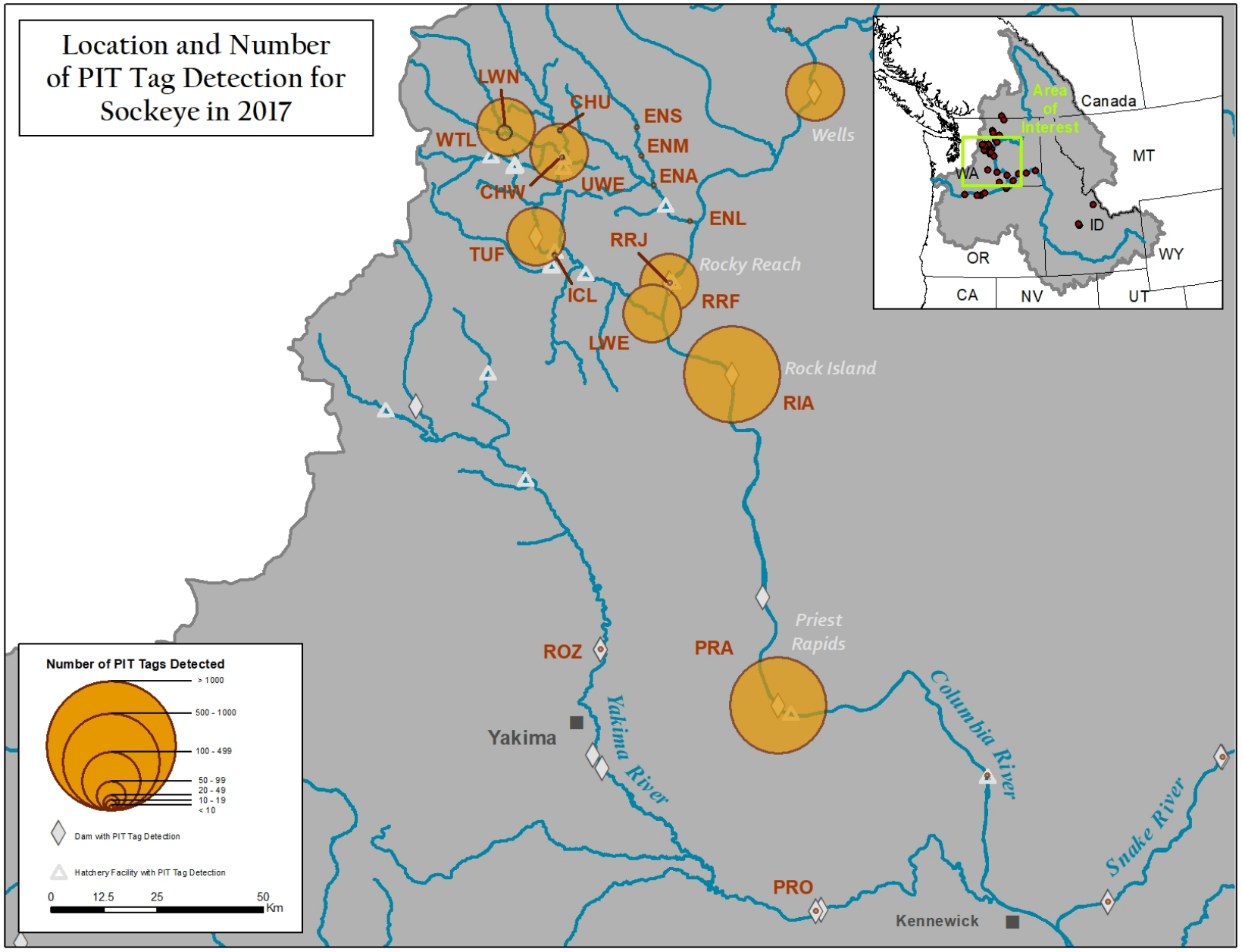

Figure B22. Map of Upper Columbia River (between the Snake River and Wells Dam) detection sites and number of Sockeye Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

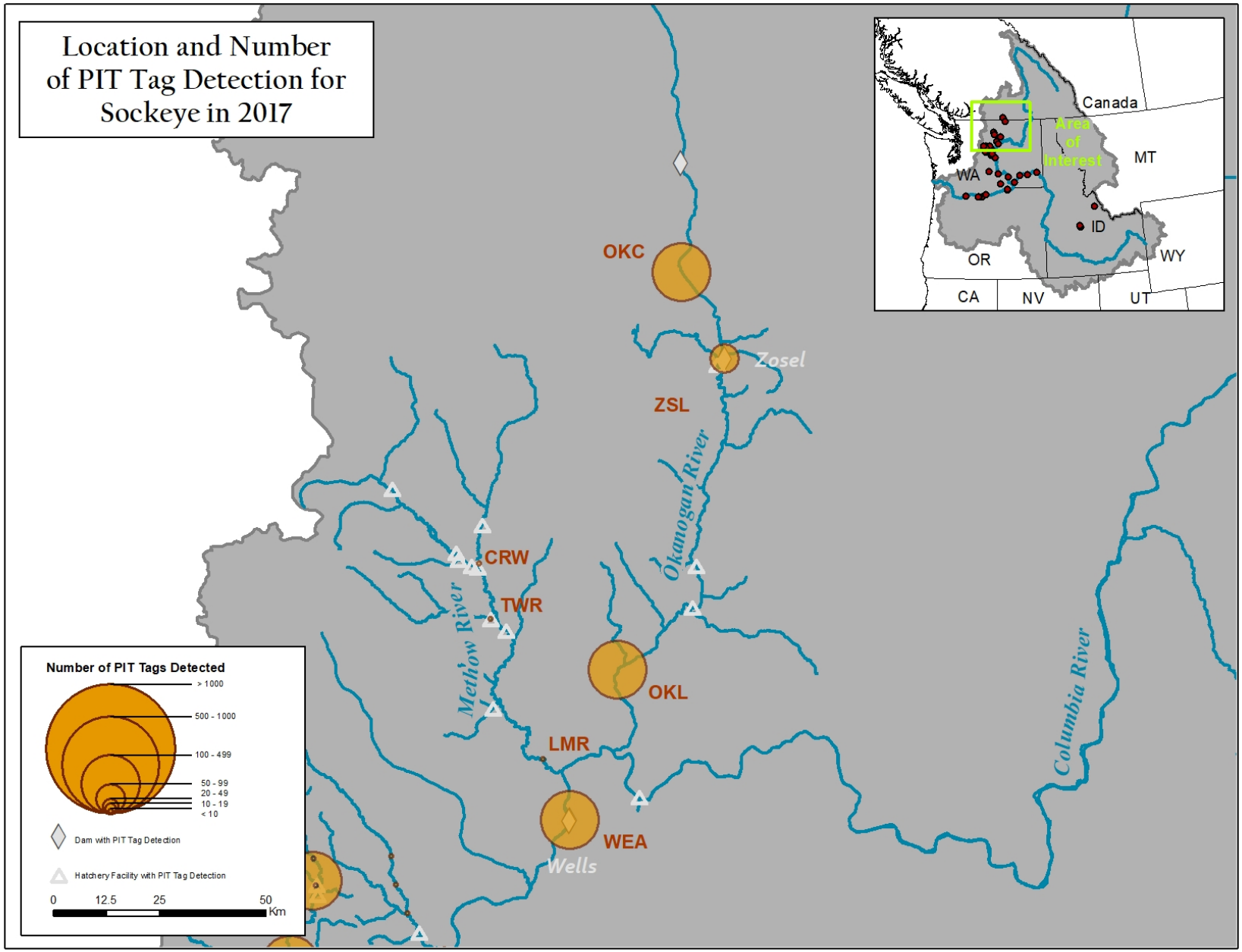

Figure B23. Map of Upper Columbia River (Wells Dam and above) detection sites and number of Sockeye Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

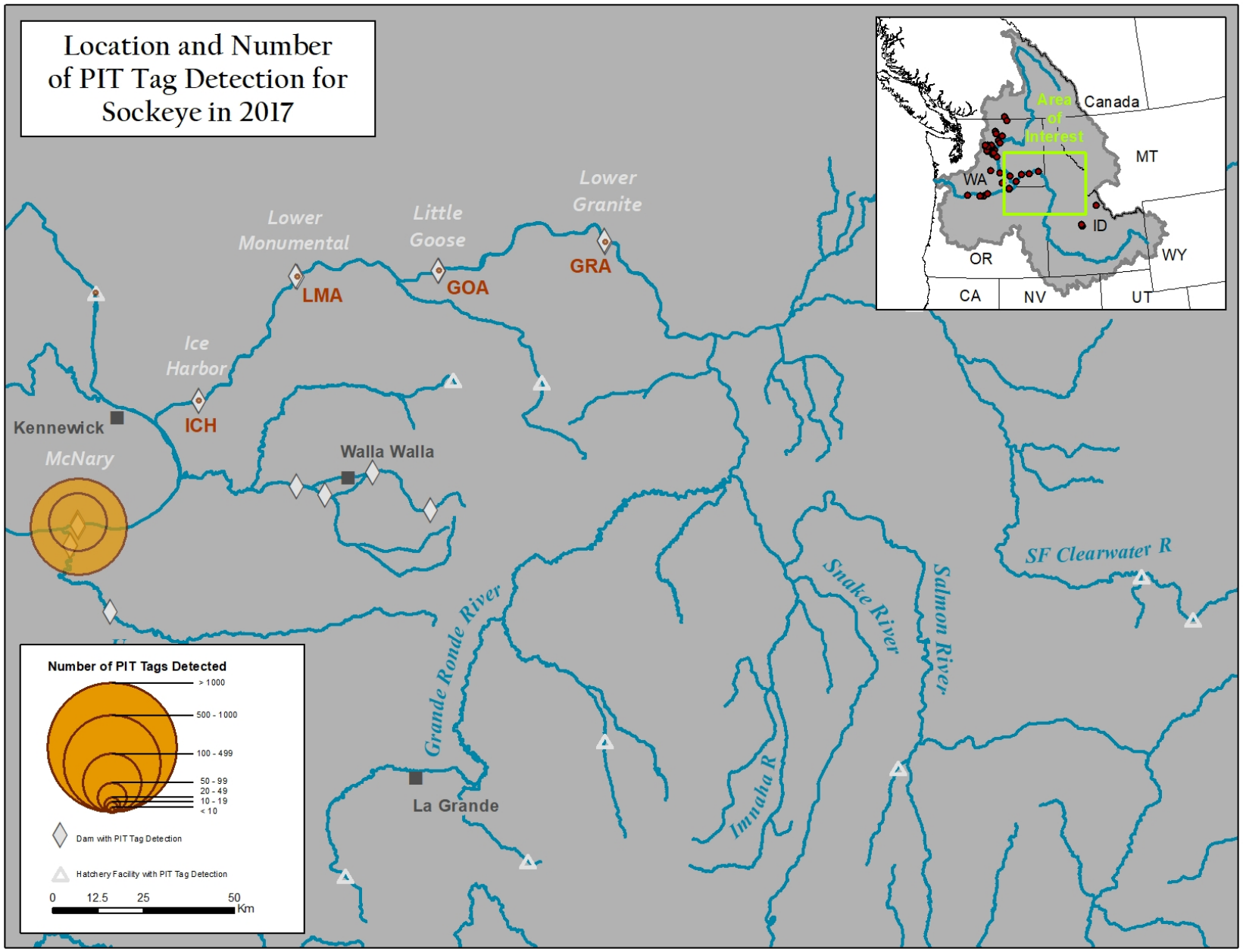

Figure B24. Map of Lower Snake River detection sites (Salmon River not included) and number of Sockeye Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

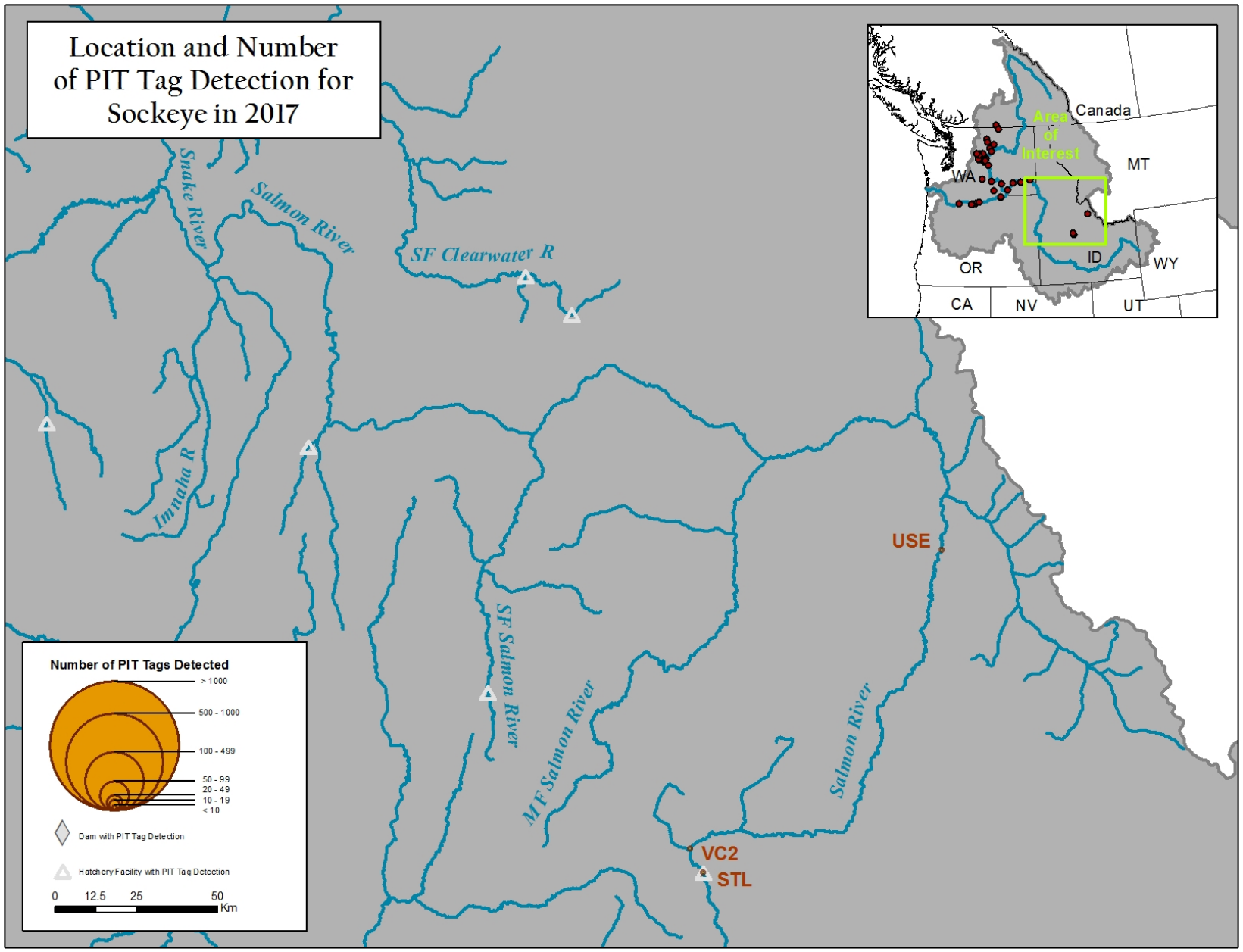

Figure B25. Map of Salmon River detection sites and number of Sockeye Salmon detected. Table B1 in Appendix B lists the PTAGIS sites' full name and the three-letter codes on this map.

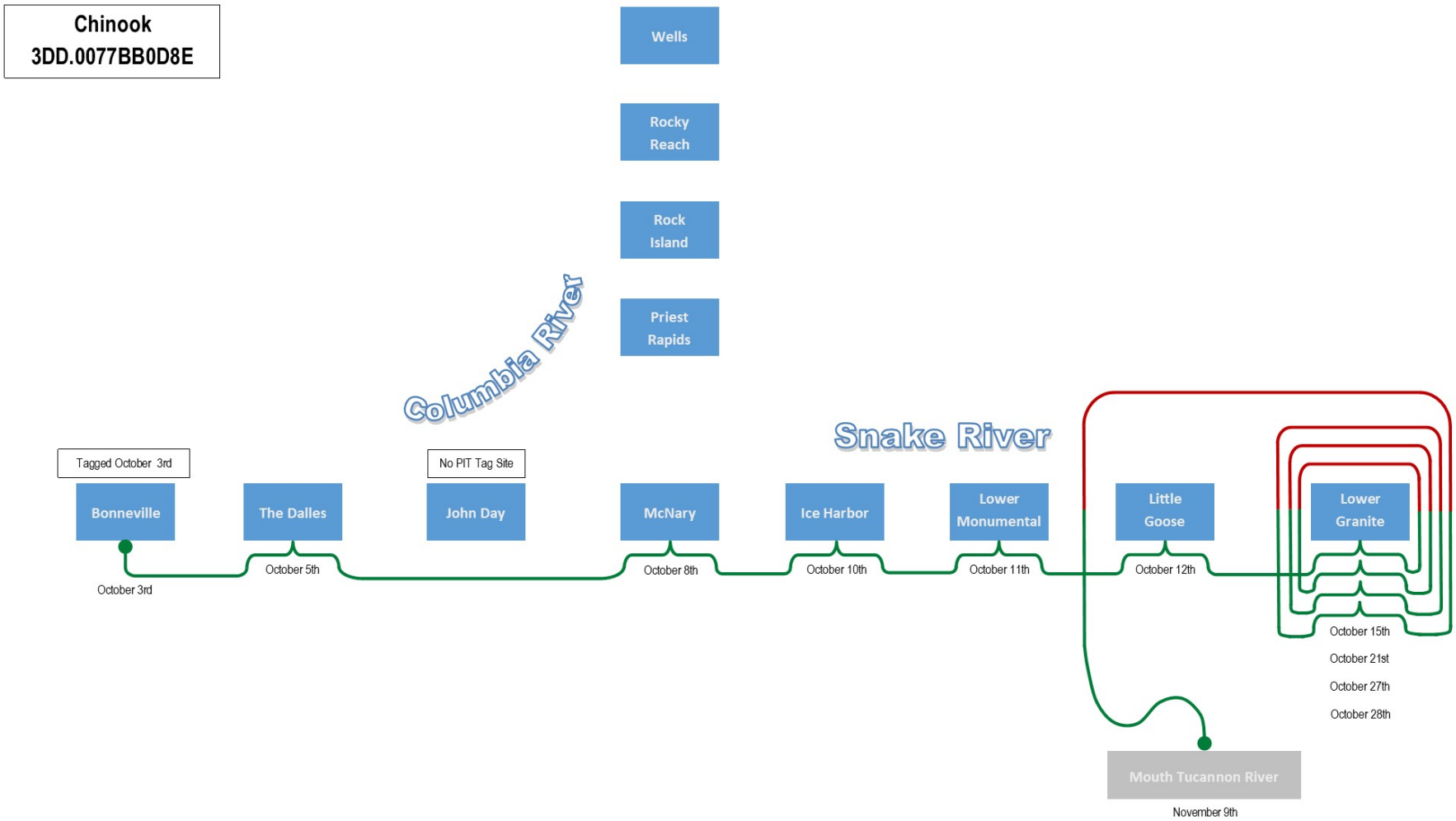

Figure B26. Chart showing the pattern and location of fall back events at mainstem dams on the Columbia and Snake rivers for Chinook Salmon with PIT tag 3DD.0077BB0D8E, tagged and tracked in 2017.

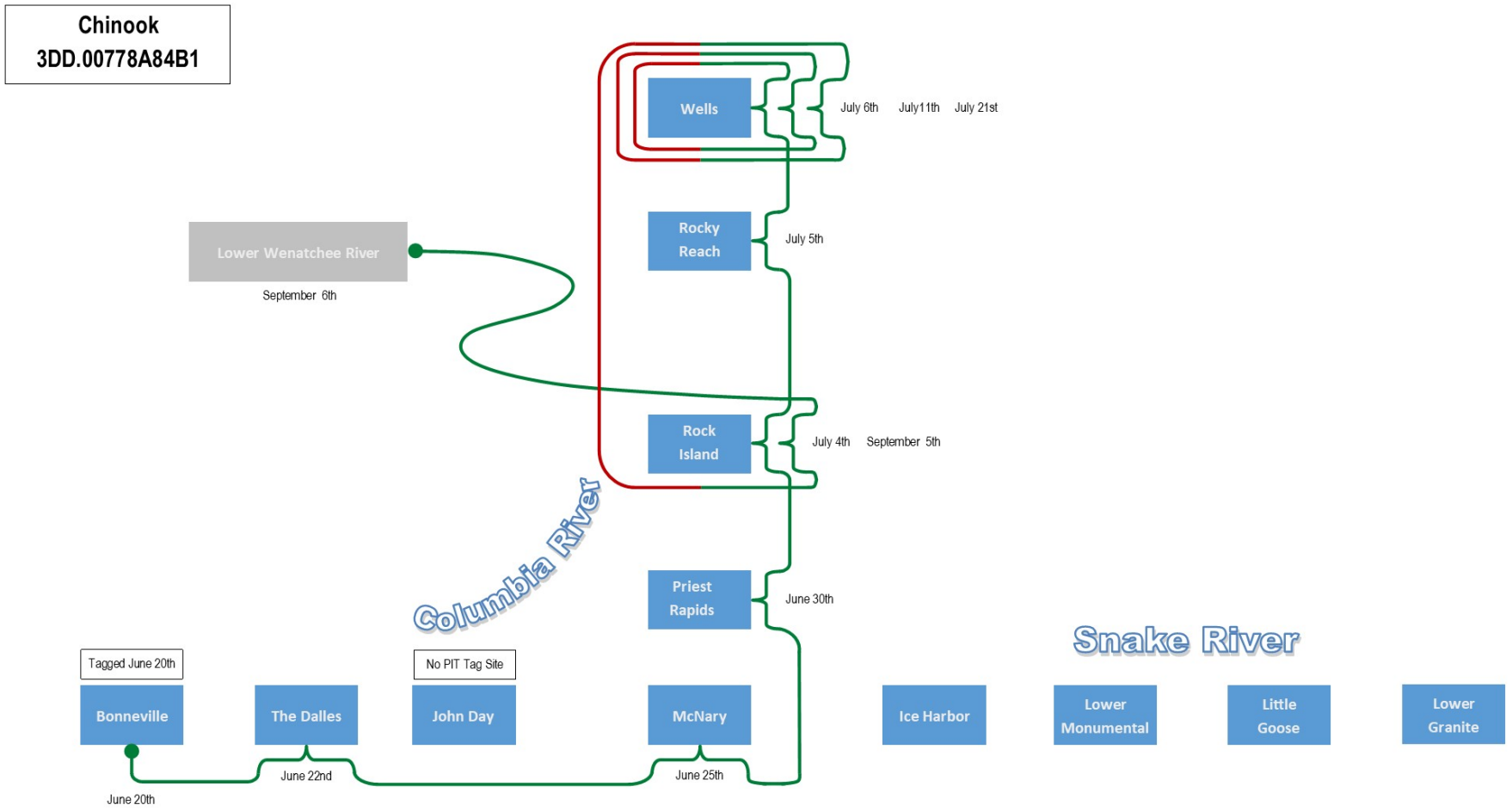

Figure B27. Chart showing the pattern and location of fall back events at mainstem dams on the Columbia and Snake rivers for Chinook Salmon with PIT tag 3DD.00778A84B1, tagged and tracked in 2017.

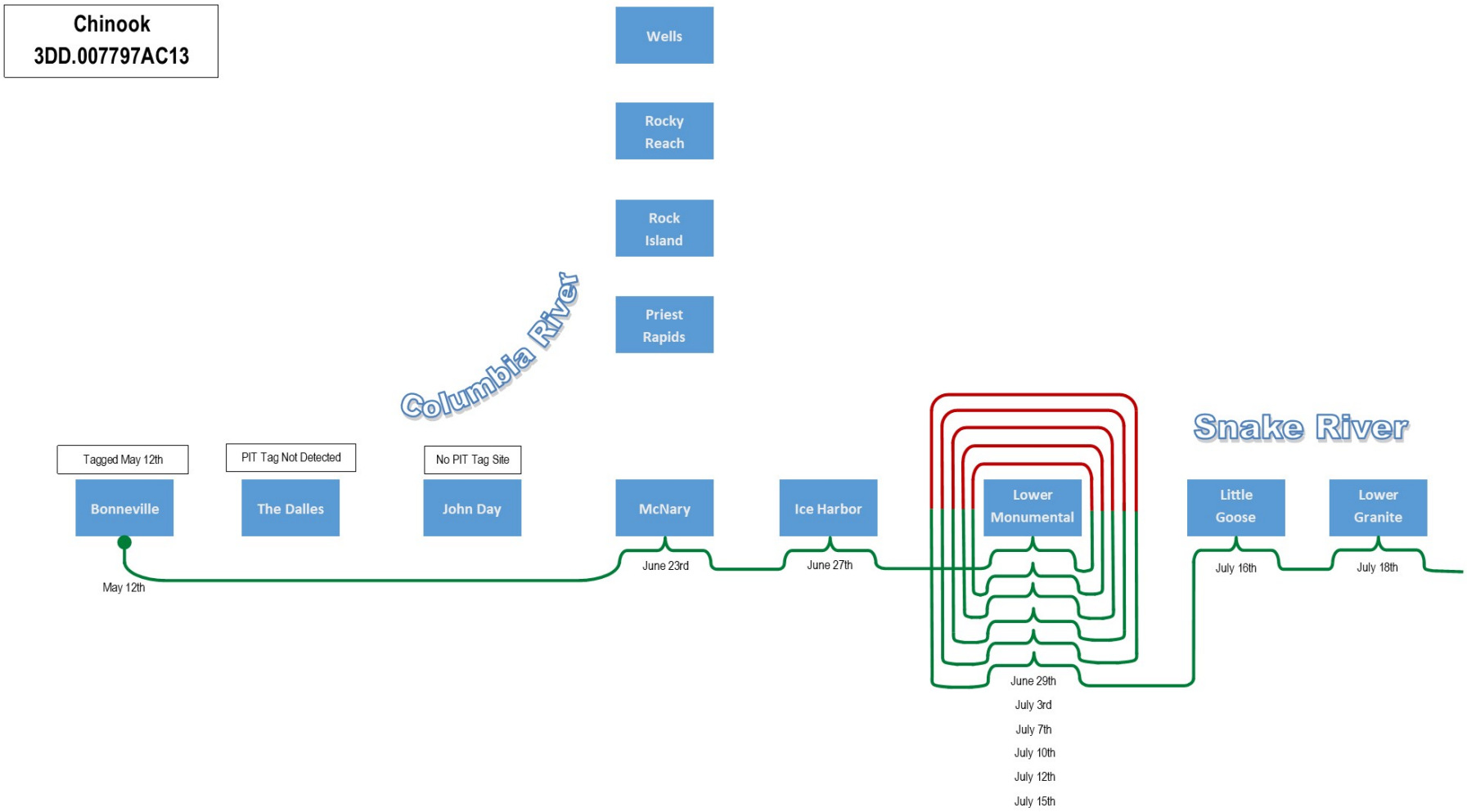

Figure B28. Chart showing the pattern and location of fall back events at mainstem dams on the Columbia and Snake rivers for Chinook Salmon with PIT tag 3DD.007797AC13, tagged and tracked in 2017.

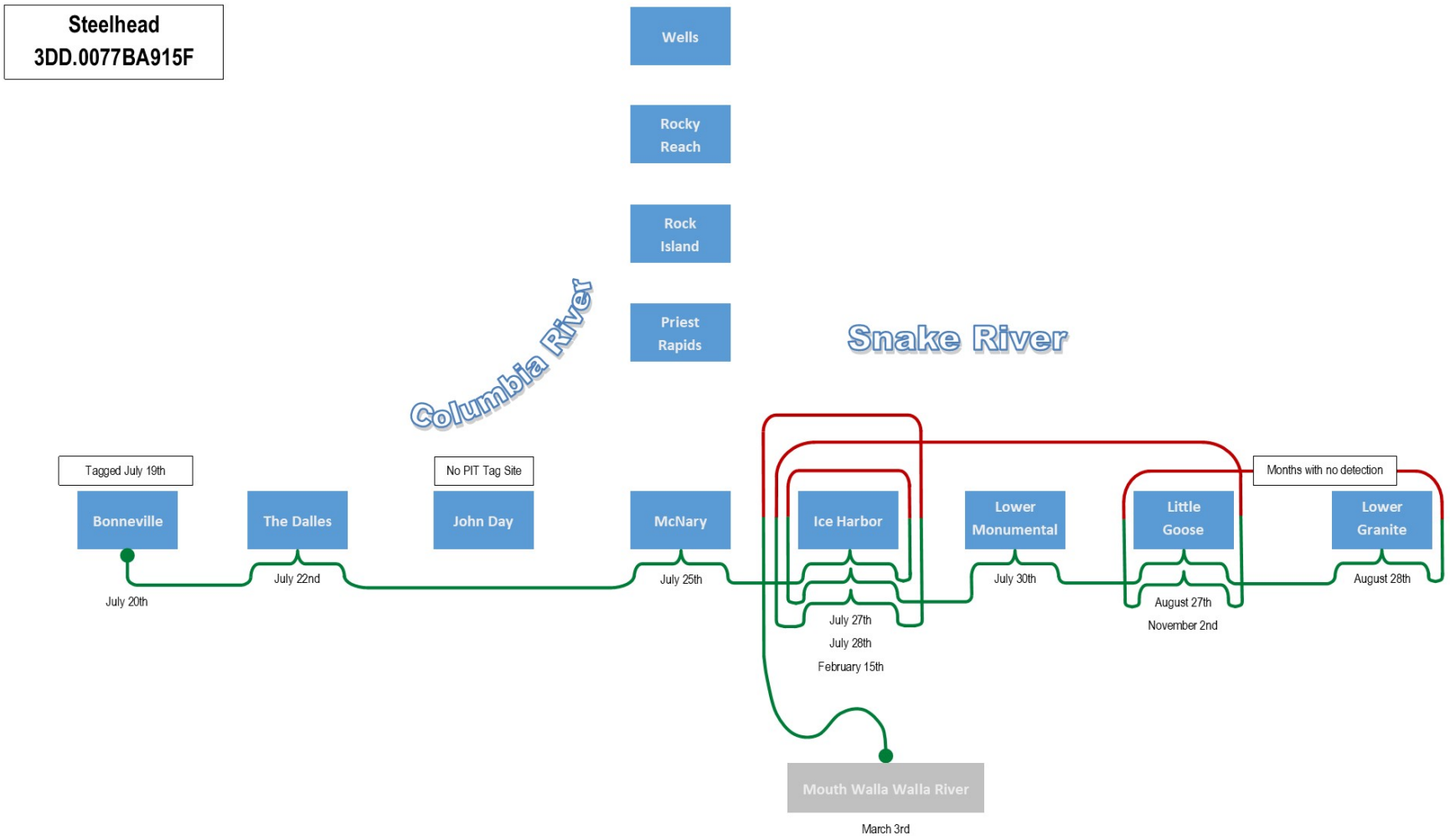

Figure B29. Chart showing the pattern and location of fall back events at mainstem dams on the Columbia and Snake rivers for steelhead with PIT tag 3DD.0077BA915F, tagged and tracked in 2017.

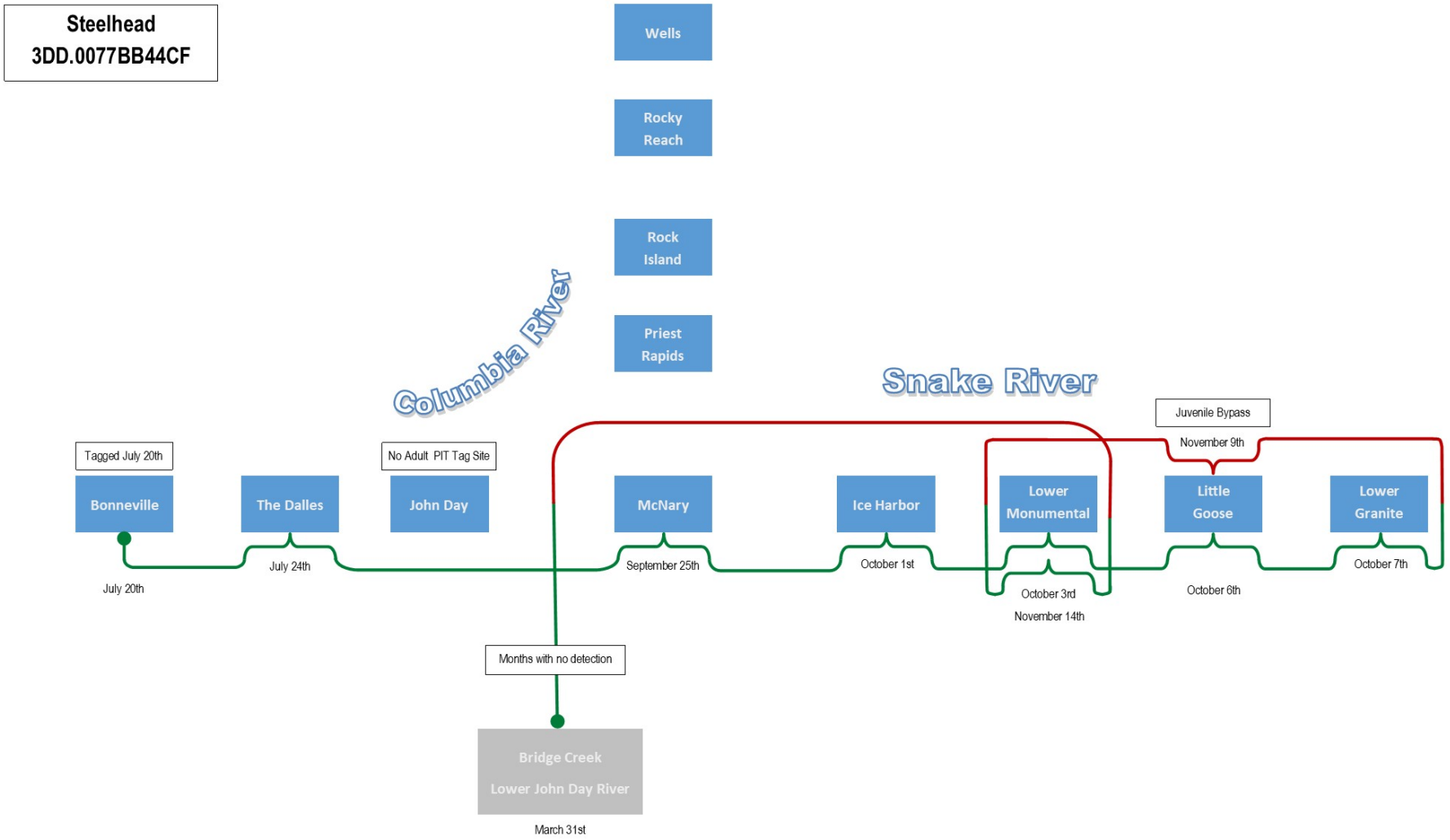

Figure B30. Chart showing the pattern and location of fall back events at mainstem dams on the Columbia and Snake rivers for steelhead with PIT tag 3DD.0077BB44CF, tagged and tracked in 2017.