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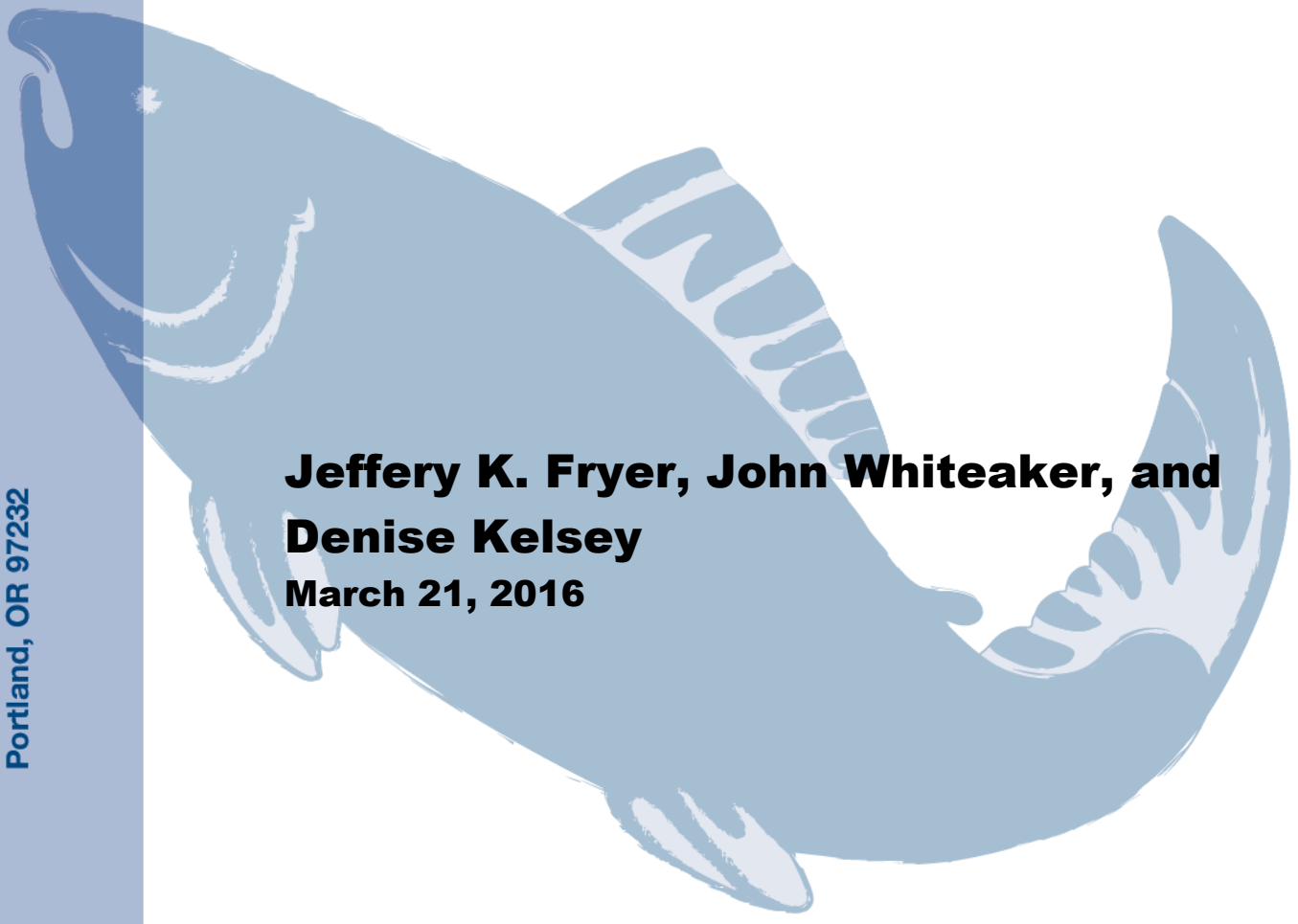
CRITFC

TECHNICAL REPORT 16-01

Upstream Migration Timing of Columbia Basin Chinook and Sockeye Salmon and Steelhead in 2014



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March 21, 2016

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

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ABSTRACT

In 2014, we sampled Sockeye and Chinook salmon as well as steelhead at the Bonneville Dam Adult Fish Facility. Fish were measured for length and scales collected for later analysis for age 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 1508 spring Chinook, 962 summer Chinook, 1375 fall Chinook, 1400 Sockeye salmon, and 1717 steelhead.

Chinook migration rates between mainstem dams ranged between 21.2 and 41.9 km/day. Most spring Chinook Salmon that traveled upstream of McNary Dam were last detected in the Snake River, most summer Chinook were last detected in the Columbia River upstream of Priest Rapids Dam, and a plurality of fall Chinook were last detected upstream of McNary Dam but downstream of Priest Rapids and Ice Harbor dams. Escapement estimates for the entire Chinook run derived from PIT tag detections result in estimates differing from those estimated by visual counts by -12.9% to +14.8% at mainstem dams.

Steelhead median rates between mainstem dams ranged from 19.9 km to 49.5 km/day. Steelhead classified as B-run (greater or equal to 78 cm fork length) were overwhelmingly last detected in the Snake River. Based on the data reported, the percentage of steelhead classified as B-run at Bonneville Dam reached its highest level on our last week of sampling the week of September 21 at 61.2, with the estimated weekly number of B-run steelhead peaking the week of September 14, 2014 at 14393 fish. A total of 77 PIT tagged steelhead tracked in 2014 were detected moving downstream (mostly in juvenile bypasses) after in 2014 presumably in an attempt to return to the ocean after spawning or detected moving upstream and were designated as kelt.

The estimated stock composition of Sockeye Salmon passing Bonneville Dam based on where PIT tagged Sockeye were last detected was 81.1% Okanogan, 17.5% Wenatchee, 0.4% Yakima, and 1.0% Snake River. The mean migration rate between Bonneville and Rock Island Dam was 40.0 km per day.

Sockeye passing Bonneville Dam later in the migration traveled upstream faster than those earlier in the migration.

ACKNOWLEDGMENTS

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INTRODUCTION

Since 1985, the Columbia River Inter-Tribal Fish Commission (CRITFC) has, using Pacific Salmon Commission (PSC) funding, sampled Chinook and Sockeye salmon at Bonneville Dam to determine age, length-at-age, and, in the case of Sockeye Salmon stock identification (Fryer 2009). In 2004, CRITFC took over a similar long-running steelhead 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 that we sample at Bonneville Dam, we can track tagged fish upstream providing valuable information on migration timing and survival rates. PIT tags can provide much of the same information as radio tags, but at minimal expense. With the reduced cost greater numbers of fish can be tagged, thus increasing the sample size and the small tag reduces the impact on the tagged fish. Unlike radio tags, 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, either at hatcheries, tributary smolt traps, or at dam juvenile bypasses. These efforts predominantly study the effects of the downstream juvenile migration, but rarely tag a sufficient number of juveniles 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 the dam, this study tags salmonid stocks that have not previously been tagged and monitored.

METHODS

Sampling

Chinook and Sockeye salmon, as well as steelhead, were PIT tagged from April 15 through October 17, 2014, at the Bonneville Dam Adult Fish Facility (AFF), located adjacent to the Second Powerhouse at river km 235. 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.

Our use of the AFF is restricted by protocols established by the Fish Passage Operation and Maintenance Coordination Team (http://www.nwd-wc.usace.army.mil/tmt/documents/fpp/2012/final/FPP12_23_App-G_Adult-Trap-BON-IHR-LWG_022212.pdf). These protocols have general 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, sampling is restricted to four days per week from 0600-1030 hours, the number of salmonids in the anesthetic tank is reduced and picket lead operations are changed to divert fewer fish into the AFF. Above 22C sampling is halted until temperatures drop to 21.9C

Salmon and steelhead selected for sampling were diverted into an anesthetic tank where they were anesthetized, examined for tags, fin clips, wounds, and condition. They were measured for length, and tissue and six scales (four scales for Sockeye) collected for later genetic and age analysis (Whiteaker and Fryer 2008, Kelsey et. al 2011). Fish were scanned for PIT tags. If no tags were detected, standard techniques were used to inject PIT tags through 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.

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, McNary, Priest Rapids, Rock Island, Rocky

Reach, and Wells dams on the Columbia River; Ice Harbor, and Lower Granite dams on the Snake River) as well as in numerous tributaries and hatcheries in the Columbia Basin (Appendix Table A5 and Figure A1). PIT tag data is uploaded to www.ptagis.org, which is then accessible to users of the site.

Upstream Detection

At each site with PIT tag detection, PIT tagged salmon typically pass by a weir with one or more antennas. Salmon can be detected more than once as the pass over or through each weir. Each individual detection will subsequently be referred to as a "weir detection". The combination of all detections at the many 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.

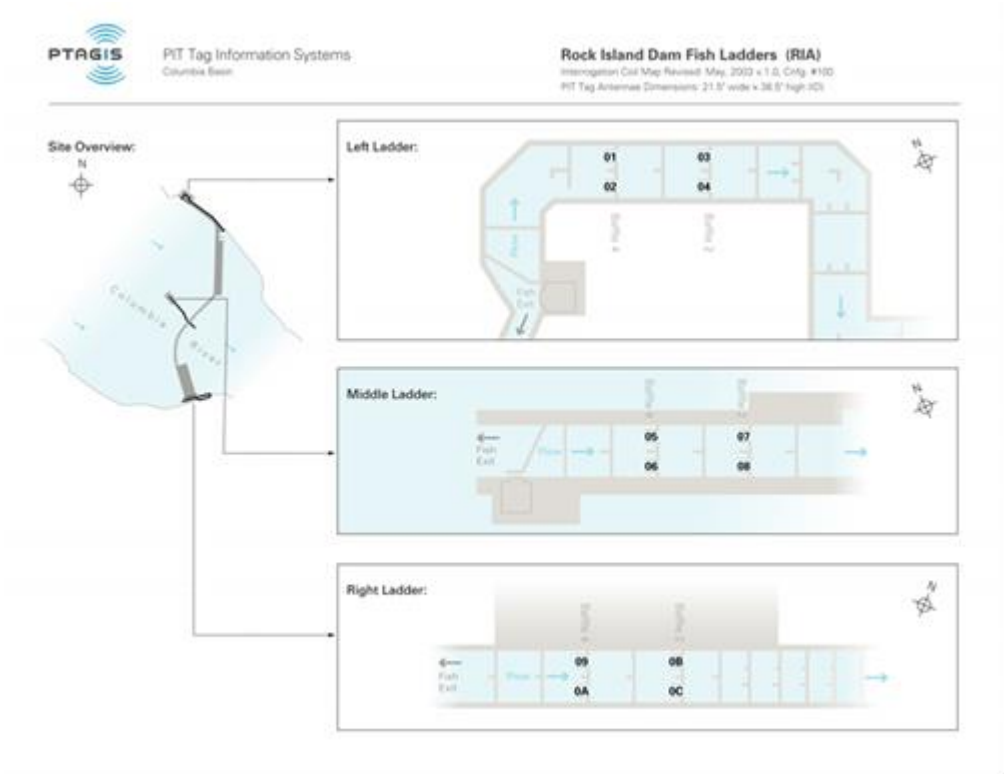

Figure 1. Example PIT tag detection configuration at Rock Island Dam showing two adjoining antennas at two weirs in each fish ladder. (Figure from www.ptagis.org.)

Salmon 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).

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, 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 fish 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.

If a fish is detected at one detection weir in a given fish ladder, it should also be detected at the rest of the weirs with PIT tag detection in that same ladder. This allows a probability of detection at the individual weirs in a ladder to be calculated by comparing it with other weirs in that same ladder. Detection probabilities were calculated as:

$$Pi = 1 - \prod_i (1 - \frac{N_i}{T})$$

where N_i is the number of fish detected at a given weir and T is the total number of fish detected by any weir at that ladder. This data was tabulated and is presented in the Appendix, Tables A1 – A3.

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.

The origin and age of Chinook and steelhead previously PIT tagged in other projects and sampled in this project could be determined by querying PTAGIS for the tag code, thus providing a validation of age since release. Very few Sockeye Salmon are tagged as juveniles making it difficult to sample sufficient returning adults to validate ages for this species.

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, due to the fact that 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 detection 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 detectors 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, 2014 were not considered fallbacks; rather they were considered kelts on their way downstream.

Night Passage

Fish counting at Columbia Basin dams is not consistent between dams. Salmonids passing Bonneville, McNary, Ice Harbor, and Lower Granite dams are counted live by observers stationed at fish ladder viewing windows from 0400 to 2000 PST (http://www.nwd-wc.usace.army.mil/tmt/documents/fpp/2012/index.html), while 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 steelheads are thought to only be produced in the Clearwater, Middle Fork Salmon 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 and return in another year to spawn again; these fish are known as kelt. 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.

Sockeye Stock Classification

Columbia Basin Sockeye Salmon consist of two major runs returning to the Okanogan and Wenatchee basins and one very small run returning to the Snake River that is listed under the Endangered Species Act. In addition, there are efforts underway to reintroduce Sockeye to former habitat in the Deschutes and Yakima basins. Given the relatively small number of geographically separated stocks, Sockeye PIT tagged at Bonneville Dam can be classified by stock based on the point where they were last detected. Those individuals last observed at or upstream of Rocky Reach Dam were classified as Okanogan stock, those last observed at or upstream of Tumwater Dam were classified as Wenatchee stock, and those last observed at or upstream of Ice Harbor Dam were classified as Snake River stock. Sockeye Salmon last detected in the Deschutes, Entiat, or Yakima basins were considered as belonging to those stocks. Those last observed downstream of all these sites were classified as unknown and were also considered mortalities. Sockeye (as well as other species tagged) never detected after release were subtracted from the number of fish tracked for subsequent analysis.

RESULTS-CHINOOK

Sample Size

A total of 1477 spring Chinook, 962 summer Chinook, and 1375 fall Chinook Salmon were PIT tagged in 2014 (Tables 1-3) between April 15 and October 17, 2014. Sampling restrictions due to water temperatures exceeding 21.1C reduced sampling days and hours during Statistical weeks 30 and 31 of the summer Chinook run and weeks 32, 33, 36, 37, and 38 the fall Chinook run. Sampling was not allowed during weeks 34 and 35 of the fall Chinook Salmon run. 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 (due to shed tags, mortalities, malfunctioning tags, or PIT tagged Chinook missing PIT tag antennas, the numbers of Chinook tracked upstream consisted of 1508 spring Chinook, 982 summer Chinook, and 1379 fall Chinook Salmon (Table 1-3).

Table 1. Number of PIT tagged spring Chinook Salmon tracked at Bonneville Dam by date and statistical week in 2014.

Dates	Week	Sampled	Tagged	Previously Tagged	Not Detected After Release	Total Tracked	Days Temperature Restrictions in Effect	
							Reduced Sampling	No Sampling
4/15-4/18	16	116	115	1	0	116	0	0
4/21-25	17	251	247	2	0	249	0	0
4/28-30,5/2	18	233	231	2	0	233	0	0
5/5,6,8,9	19	182	174	8	1	181	0	0
5/12-5/16	20	250	240	9	1	248	0	0
5/19-23	21	268	262	6	0	268	0	0
5/27-5/30	22	214	208	6	1	213	0	0
Total		**1514**	**1477**	**34**	**3**	**1508**	**0**	**0**

Distribution of Sample

Compared to the distribution of the Chinook run past Bonneville Dam as determined by visual counts, spring Chinook were under-sampled early during the peak weeks of the run (Statistical weeks 19-20) and over-sampled late in the run (Figure 2). Summer Chinook were over-sampled early in the run while under-sampled during the middle of the run (Figure 3). Fall Chinook were under-sampled during the beginning and middle of the run (when temperature restrictions adversely impacted sampling) and over-sampled at the end of the run (Figure 4). A total of 7.1% of the fall Chinook run passed Bonneville Dam during

weeks 34 and 35 when no sampling was allowed due to temperatures exceeding 22.2C. During week 37, 33.3% of the fall Chinook run passed Bonneville Dam, but sampling restrictions resulted in our sample size being only 65 fish, or 5.5% of the run.

Table 2. Number of PIT tagged summer Chinook Salmon tracked at Bonneville Dam by date and statistical week in 2014.

Dates	Week	Sampled	Tagged	Previously Tagged	Not Detected After Release	Total Tracked	Days Temperature Restrictions in Effect	
							Reduced Sampling	No Sampling
6/2-6/6	23	275	270	5	0	275	0	0
6/9-6/13	24	251	244	7	0	251	0	0
6/16-6/20	25	111	109	2	1	110	0	0
6/23,25-27	26	50	47	3	0	50	0	0
6/30,7/1-7/3	27	58	58	0	0	58	0	0
7/7-7/11	28	60	57	3	1	59	0	0
7/14-18	29	89	87	2	1	88	0	0
7/21-25	30	43	42	1	0	43	2	0
7/28-7/31	31	48	48	0	0	48	1	0
Total		**985**	**962**	**23**	**3**	**982**	**3**	**0**

Table 3. Number of PIT tagged fall Chinook Salmon tracked at Bonneville Dam by date and statistical week in 2014.

Dates	Week	Sampled	Tagged	Previously Tagged	Not Detected After Release	Total Tracked	Days Temperature Restrictions in Effect	
							Reduced sampling	No sampling
8/1	31	12	11	0	0	11	0	0
8/5-8	32	34	34	0	0	34	4	1
8/11-12	33	12	12	0	0	12	2	3
No sampling	34							5
No Sampling	35							5
9/2-5	36	225	222	1	0	223	4	1
9/8	37	65	64	1	0	65	1	4
9/16-19	38	210	210	0	0	210	4	1
9/22-26	39	242	240	2	0	242	0	0
9/29-10/3	40	209	209	0	0	209	0	0
10/6-10	41	247	246	0	0	246	0	0
10/13-17	42	127	127	0	0	127	0	0
Total		**1383**	**1375**	**4**	**0**	**1379**	**15**	**20**

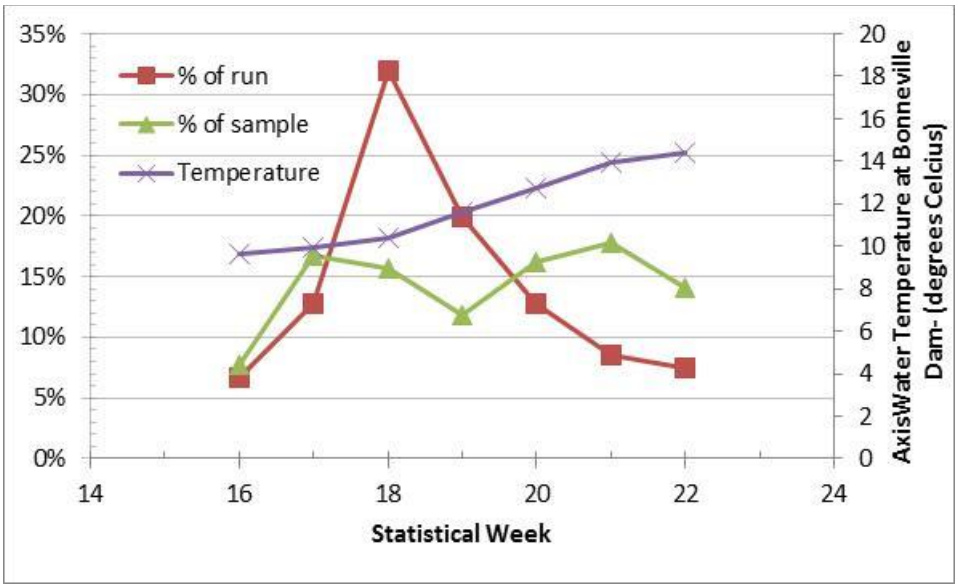

Figure 2. The weekly spring Chinook sample and run as a percentage of the total sample and run size at Bonneville Dam in 2014.

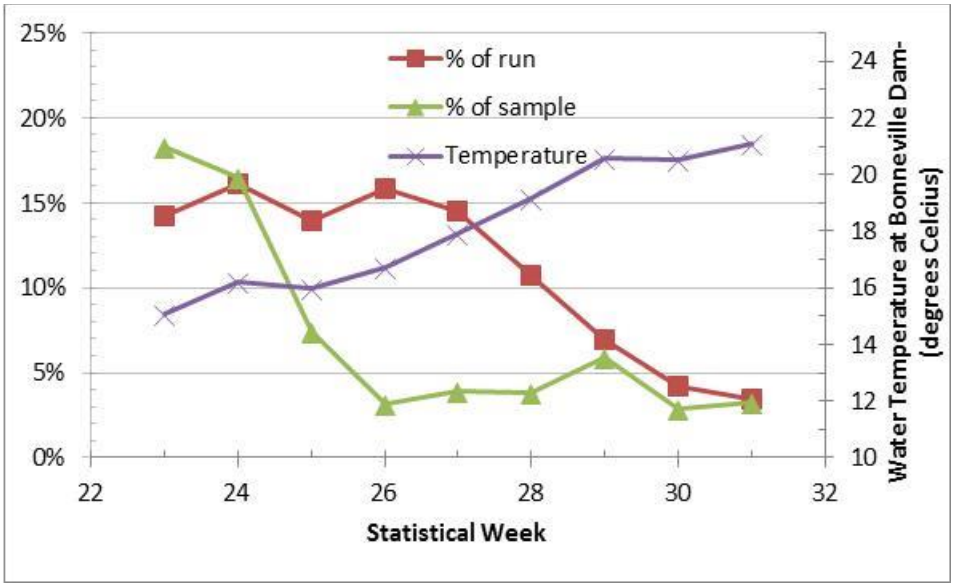

Figure 3. The weekly summer Chinook sample and run as a percentage of the total sample and run size at Bonneville Dam in 2014.

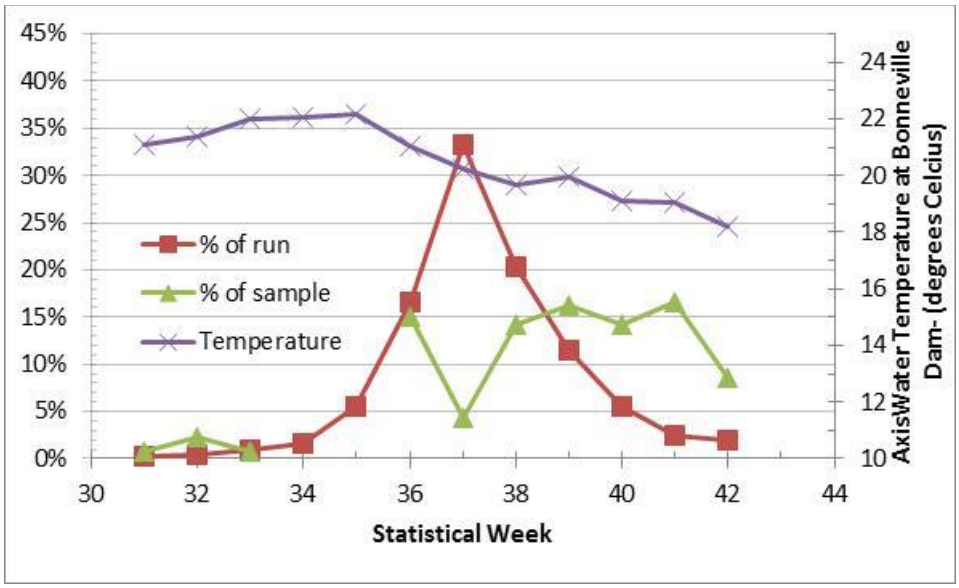

Figure 4. The weekly fall Chinook sample and run as a percentage of the total sample and run size at Bonneville Dam in 2014. (Note that there was no sampling during Statistical Weeks 34 and 35 due to water temperatures above 21.1C.)

Detection Numbers

The tracking of 1508 spring Chinook generated 87,450 weir detections, which were grouped into 12,795 site detections at 104 sites. The 982 summer Chinook generated 60,280 weir detections, grouped into 8,891 site detections at 74 sites, and the 1,379 fall Chinook generated 50,112 weir detections grouped into 8,462 site detections at 42 sites. Maps found in the Appendix (Figure A1-A14) 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 2015).

Age Analysis

We are able to validate our scale aging techniques by using fish sampled at Bonneville for this project that were previously tagged as juveniles for other projects or hatchery programs. We had ageable scale patterns from 29 spring Chinook, 22 summer Chinook, and 4 fall Chinook PIT tagged as juveniles by other tagging programs. Of these, all Spring and Fall Chinook were aged correctly and 21 out of 22 summer Chinook. Only the total age was compared as it is not possible to separate freshwater and saltwater age using PIT tag data.

In 2014, data were also available on total ages from genetics samples

collected as part of this project. Scale pattern age estimates were in agreement with those estimated using genetics 99.2% of the time (Table 4).

Table 4. Comparison of total age estimates using genetics and scale pattern analysis for Chinook Salmon sampled at Bonneville Dam in 2014. Green shading indicates agreement between the two methods, orange indicates the age estimates differed.

Age Estimated Using Genetic Stock ID	Total Age Estimated Using Scale Patterns				% Concurrence
	Age 3	Age 4	Age 5	Unageable	
Age 3	151	1	2	18	98.1%
Age 4	0	470	1	77	99.8%
Age 5	0	1	15	1	93.8%
Total	**151**	**472**	**18**	**96**	**99.2%**

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. In general these small Chinook Salmon are excluded due to lack of importance to fishery managers and the fact that sampling these fish would reduce our sample of larger Chinook and other species which are important to managers. However, three Chinook Salmon greater than 36 cm in length were sampled which were estimated to spend no winters in saltwater. All three were aged as Age 1.0. Although these fish were PIT tagged, they were excluded from analyses subsequently presented in this study except to indicate their last known location. Two minijacks were last detected at Priest Rapids hatchery while the third was last detected in the Okanagan River in Canada at site OKL.

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 5, Figures 5 and 6), while summer Chinook were primarily bound for the Columbia River upstream of Priest Rapids Dam (Table 5, Figures 5 and 7). Fall Chinook were primarily last detected at areas between McNary and Ice Harbor/Priest Rapids dams which are where the Hanford Reach and Priest Rapids Hatchery are located (Table 5, Figures 5 and 8). Over the first half of the entire Chinook run, the percentage of Chinook Salmon passing Priest Rapids

Dam steadily increased, while the percentage of those last detected below McNary Dam (site of the significant fisheries) decreased (Figure 5). The percentage of all Chinook that ultimately passed Ice Harbor Dam peaked during the Spring Chinook migration. The majority of the fall Chinook run, after Statistical Week 38, was last detected in-between McNary and Priest Rapids/Ice Harbor dams which is the spawning grounds for the Hanford Reach fall Chinook, as well as the location of Ringold and Priest Rapids hatcheries, which rear fall Chinook Salmon.

Table 5. Percentage of spring, summer, and fall Chinook Salmon tracked from Bonneville Dam detected at upstream dams and the percentage lost due to tributary escapement, tag loss, harvest, spawning, or mortality between dams in 2014.

Dam	Spring Chinook	Summer Chinook	Fall Chinook
Bonneville	100.0%	100.0%	100.0%
The Dalles	77.8%	85.7%	62.0%
McNary	63.9%	78.6%	49.3%
Priest Rapids	10.6%	57.0%	13.1%
Rock Island	10.3%	53.7%	6.5%
Rocky Reach	5.9%	44.4%	5.5%
Wells	5.6%	40.0%	5.1%
Ice Harbor	43.7%	19.3%	6.4%
Lower Monumental	43.0%	19.3%	6.1%
Little Goose	43.0%	19.1%	6.1%
Lower Granite	41.8%	17.5%	5.9%

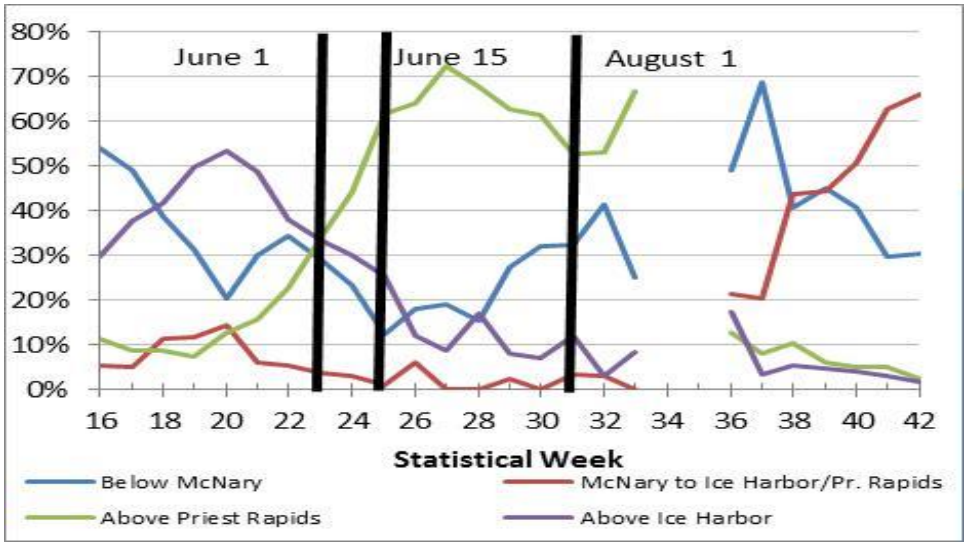

Figure 5. Distribution of final detection areas of the Columbia Basin by statistical week for Chinook Salmon PIT tagged at Bonneville Dam in 2014.

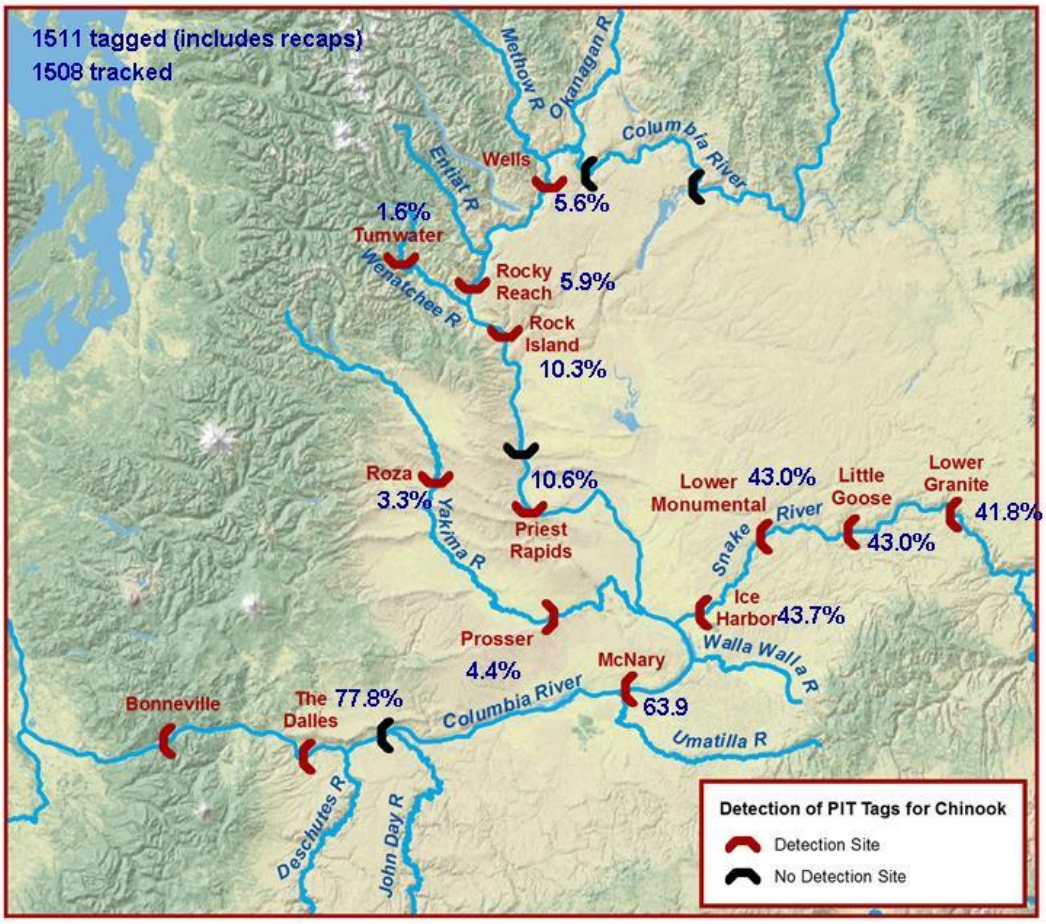

Figure 6. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of spring Chinook Salmon PIT tagged at Bonneville Dam, and the percentage of the run estimated to pass upstream dams in 2014.

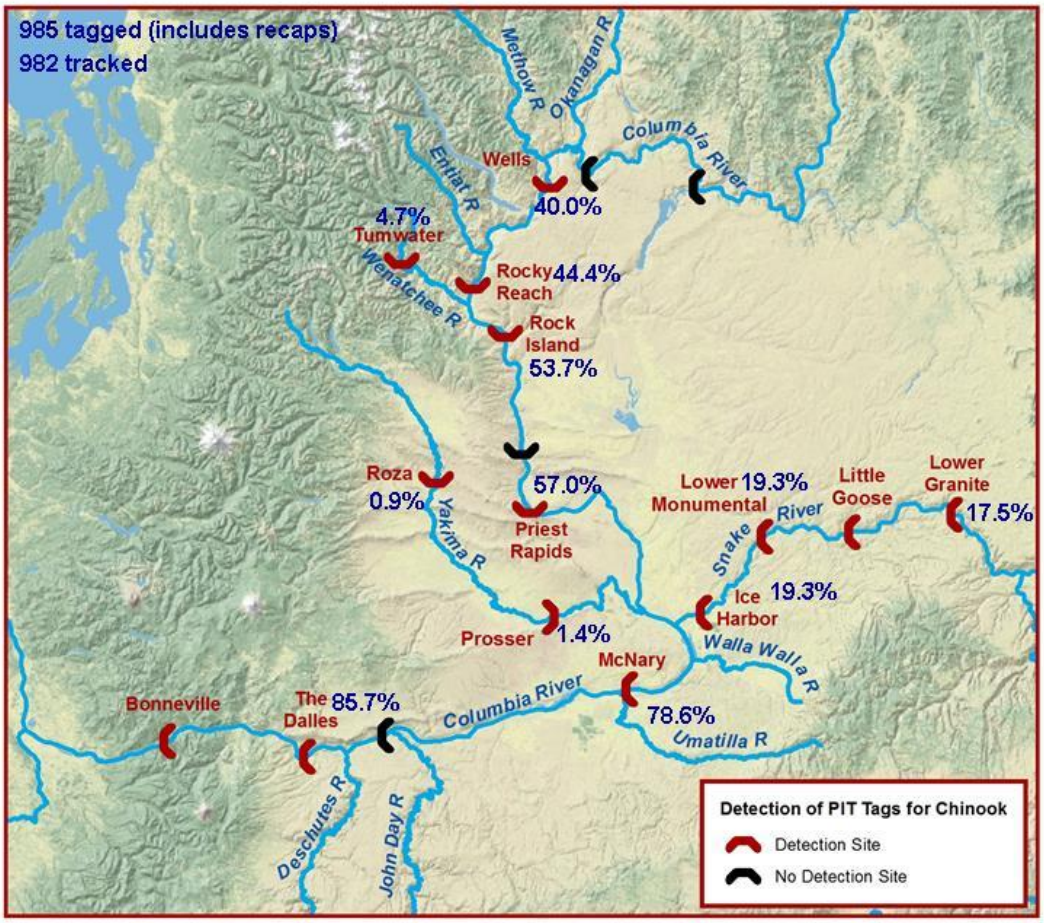

Figure 7. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of summer Chinook Salmon PIT tagged at Bonneville Dam, and the percentage of the run estimated to pass upstream dams in 2014.

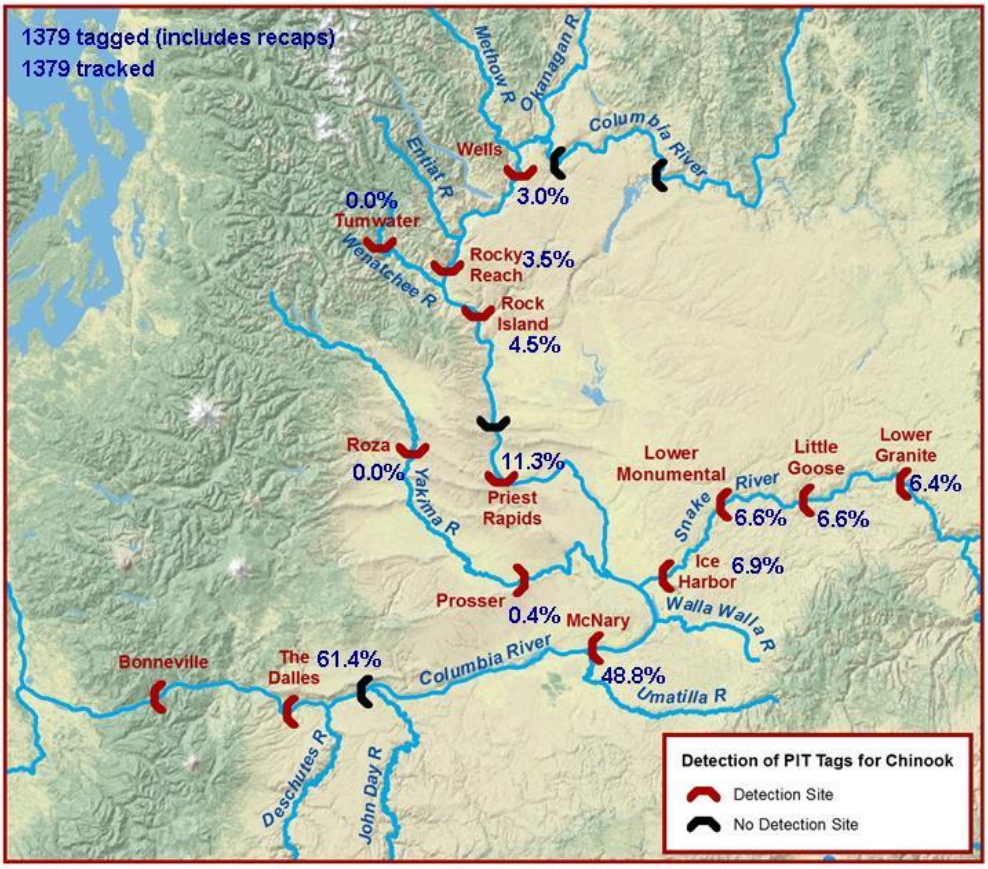

Figure 8. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of fall Chinook Salmon PIT tagged at Bonneville Dam, and the percentage of the run estimated to pass upstream dams in 2014.

The mean percentage of PIT tagged Chinook Salmon documented passing a dam without detection, with the exception of Rock Island Dam, was 0.8% for spring Chinook, 0.7% for summer Chinook, and 0.3% for fall chinook (Table 6). At Rock Island Dam, the rate missed ranged from 19.7% to 36.8%. 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 salmon could pass upstream undetected. Rates of detection efficiency of individual weirs within ladders at dams listed in Table 6 are found in the Appendix (Table A1).

Escapement estimates for the entire Chinook run derived from PIT tag detections result in estimates that are within 15% of visual counts (Table 7). The greatest difference was with fall Chinook at Wells Dam where the PIT tag

estimate was 187.9% greater than the visual count.

Table 6. Percentage of Chinook Salmon detected upstream that missed detection at mainstem dams in 2014.

Dam	Spring	Summer	Fall
Bonneville	0.5%	0.2%	0.4%
The Dalles	0.5%	0.6%	0.0%
McNary	0.9%	1.2%	0.1%
Priest Rapids	1.1%	0.6%	0.0%
Rock Island	21.2%	36.8%	19.7%
Rocky Reach	0.0%	0.0%	0.0%
Wells	0.0%	0.0%	0.0%
Ice Harbor	1.4%	0.4%	2.4%
Lower Monumental	0.9%	0.9%	2.6%
Little Goose	2.3%	4.2%	3.8%
Lower Granite	0.0%	0.0%	0.0%
Weighted Mean (by sample size) Excluding Rock Island	**0.8%**	**0.7%**	**0.3%**

Table 7. Chinook Salmon escapement by run at Columbia Basin mainstem dams upstream of Bonneville Dam in 2014. Estimates are from both PIT tag recoveries and dam counts (FPC 2015) and the differences between the two estimates are displayed.

	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	164,222	166,622	1.5%	115,659	115,819	0.1%
McNary	123,180	136,936	11.2%	104,996	106,200	1.1%
Priest Rapids	26,391	22,804	-13.6%	83,323	76,982	-7.6%
Rock Island	26,181	21,983	-16.0%	84,476	72,515	-14.2%
Rocky Reach	14,753	12,662	-14.2%	63,586	59,966	-5.7%
Wells	17,921	12,066	-32.7%	55,244	53,991	-2.3%
Ice Harbor	91,726	93,663	2.1%	21,907	26,126	19.3%
Lower Monumental	93,962	92,202	-1.9%	24,200	26,055	7.7%
Little Goose	91,615	92,202	0.6%	24,535	25,810	5.2%
Lower Granite	92,899	89,573	-3.6%	21,774	23,608	8.4%
	Fall Chinook Salmon			**All Chinook Salmon**		
The Dalles	625,568	608,056	-2.8%	905,449	890,498	-1.7%
McNary	486,896	483,317	-0.7%	715,072	726,454	1.6%
Priest Rapids	133,041	111,558	-16.1%	242,755	211,345	-12.9%
Rock Island	34,447	44,638	29.6%	145,104	139,136	-4.1%
Rocky Reach	24,829	34,396	38.5%	103,168	107,025	3.7%
Wells	10,341	29,772	187.9%	83,506	95,829	14.8%
Ice Harbor	79,333	68,009	-14.3%	192,966	187,798	-2.7%
Little Goose	75,238	65,347	-13.1%	193,400	183,604	-5.1%
Lower Monumental	69,217	65,347	-5.6%	185,367	183,359	-1.1%
Lower Granite	80,494	62,895	-21.9%	195,167	176,075	-9.8%

Between 10.9% and 27.1% of “spring Chinook” (as determined at tagging at Bonneville Dam) passing dams upstream of Priest Rapids Dam would have been counted as summer Chinook at those dams (Table 8). Conversely, 11.1% to 17.3% of summer Chinook reaching Ice Harbor to Lower Granite dams would be identified as spring Chinook based on passage date for those four dams.

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 2014.

Last Date Spring Run	First Date Fall Run	Race at Bonneville	Spring	Spring	Summer	Summer	Fall
		Race at Dam Listed Below	Summer	Fall	Spring	Fall	Summer
May 31	August 1	Bonneville					
June 3	August 4	The Dalles	1.3%	0.0%	0.0%	0.4%	0.8%
June 8	August 9	McNary	3.6%	0.0%	1.5%	0.8%	1.1%
June 13	August 14	Priest Rapids	20.9%	0.0%	0.0%	0.6%	7.9%
June 17	August 18	Rock Island	23.3%	0.0%	0.0%	4.2%	20.0%
June 19	August 20	Rocky Reach	27.1%	0.0%	0.3%	0.8%	52.3%
June 28	August 29	Wells	10.9%	0.0%	8.4%	1.5%	72.2%
June 11	August 12	Ice Harbor	1.1%	0.0%	12.7%	1.3%	1.3%
June 13	August 14	Lower Monumental	1.3%	0.0%	17.3%	2.2%	1.4%
June 15	August 16	Little Goose	3.2%	0.0%	11.1%	2.8%	1.4%
June 17	August 18	Lower Granite	3.4%	0.0%	13.9%	4.3%	1.4%

Tributary escapement estimates for three sites, each with more than 70 detections, are found in Table 9 alongside estimates using visual counts. Chinook passing all three sites were primarily spring or summer (Figure 9).

Table 9. Estimated 2014 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 Trap or Visual Counts	Estimated Escapement Using PIT Tags	Difference (%) Between Estimates
Tumwater Dam	79	10,194	9,800	3.9%
Prosser Dam	111	19,556	20,219	-3.4%
Roza Dam	79	8,005	11,223	40.2%

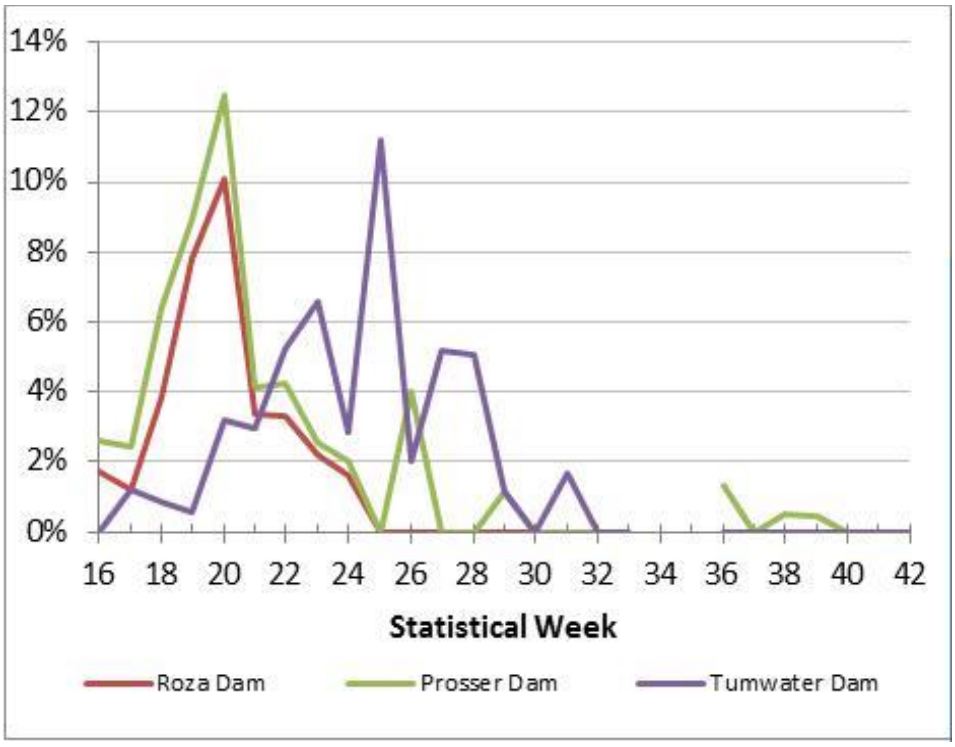

Figure 9. Percentage of Chinook Salmon by statistical week tagged at Bonneville Dam in 2014 destined for the Tumwater Dam (Wenatchee River), Prosser Dam (Yakima River) and Roza Dam (Yakima River) based on upstream PIT tag detections.

Migration Rates and Passage Time

Chinook migration rates between mainstem dams ranged between 21.2 and 43.0 km/day (Table 10). Migration rates to and between tributary sites were generally less than those in the 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 Wells, Bonneville, McNary, and Lower Granite dams (Table 11). At these dams there is a much greater distance between the furthest downstream and furthest upstream PIT tag detection antennas than at all 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 both Lower Granite, Bonneville, Priest Rapids, and Wells dams may also be inflated, because at all four sites, fish may take time to recover from sampling before moving upstream.

Table 10. Chinook Salmon travel rates between Columbia Basin dams estimated using PIT tag data in 2014.

		Median Migration Rate (km/day)		
Between Mainstem Dams	**Distance (km)**	**Spring Chinook**	**Summer Chinook**	**Fall Chinook**
Bonneville-The Dalles	74	33.8	35.8	34.4
The Dalles-McNary	157	41.9	40.7	40.6
Bonneville – McNary	231	38.2	38.3	38.4
McNary - Priest Rapids	167	28.4	35.3	28.0
Priest Rapids - Rock Island	89	22.9	26.4	26.8
Rock Island - Rocky Reach	33	24.2	27.6	21.2
Rocky Reach – Wells	65	28.5	30.7	30.7
Bonneville - Rock Island	487	26.8	30.3	37.2
Bonneville – Wells	585	25.5	29.7	34.0
McNary - Ice Harbor	67	34.6	35.9	43.0
Ice Harbor - Lower Granite	156	33.1	31.6	31.6
To and Between Tributary Sites				
Rock Island - Tumwater	73	3.0	3.2	--
McNary - Prosser	141	28.5	24.6	13.1
Prosser - Roza	133	12.2	18.7	--
Lower Granite - South Fork Salmon (SFG)	375	20.3	31.6	--

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 2014.

	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	71.7	83.7	83.1	7.2%	4.7%	6.3%
The Dalles	0.1	0.1	0.1	3.0%	3.2%	2.7%
McNary	105.9	82.3	70.1	7.5%	7.3%	4.5%
Priest Rapids	3.8	5.1	3.2	1.6%	2.9%	14.2%
Rock Island	13.5	16.9	15.5	9.0%	3.6%	10.0%
Rocky Reach	24.5	10.5	19.5	15.0%	4.3%	4.5%
Wells	114.5	109.3	64.6	19.8%	11.1%	2.8%
Ice Harbor	3.0	2.3	2.0	2.5%	7.0%	3.8%
Lower Monumental	0.2	0.2	0.2	4.1%	7.1%	2.7%
Little Goose	0.1	0.1	0.0	5.2%	3.7%	2.7%
Lower Granite	82.9	71.3	102.3	10.9%	12.4%	24.3%
Tumwater	8.3	5.3	NA	18.2%	6.5%	NA
Prosser	15.7	11.1	51.2	1.1%	0.0%	40.0%
Roza	0.7	1.9	NA	11.6%	20.0%	NA

Upstream Age and Length-at-Age Composition

Age 1.2 was the predominant age class for spring Chinook at all mainstem dams in this study (Table 12, Figure 10). Among summer Chinook, Age 1.1 Chinook were predominant in the Snake River, while Age 0.3 and 1.2 (both Age 4 from the 2010 brood year) Chinook were predominant above Priest Rapids

Dam (Table 12, Figure 11). Among fall Chinook, Age 0.2 was the most abundant age class in the Snake River with Age 0.3 predominate elsewhere (Table 12, Figure 12). Mean length-at-age composition estimates at mainstem dam sites are given in Tables 13-15.

Table 12. Age composition estimates (%) as estimated by PIT tag detections at mainstem dams of fish aged using scale pattern analysis from scales collected at Bonneville Dam, for spring, summer, and fall Chinook Salmon in 2014.

		Brood Year and Age Class										
Run, Site, Number		**2012**	**2011**		**2010**		**2009**			**2008**		
Spring	**Age-able**	**0.1**	**0.2**	**1.1**	**0.3**	**1.2**	**0.4**	**1.3**	**2.2**	**0.5**	**1.4**	**2.3**
Bonneville	1223	0.0%	0.1%	12.1%	0.2%	81.8%	0.0%	5.6%	0.1%	0.0%	0.1%	0.0%
The Dalles	1010	0.0%	0.0%	12.9%	0.1%	81.2%	0.1%	5.4%	0.2%	0.0%	0.1%	0.0%
McNary	842	0.0%	0.1%	13.6%	0.1%	80.8%	0.1%	5.3%	0.0%	0.0%	0.1%	0.0%
Priest Rapids	157	0.0%	0.0%	18.1%	0.5%	71.4%	0.2%	9.5%	0.0%	0.0%	0.3%	0.0%
Rock Island	151	0.0%	0.0%	19.5%	0.5%	69.8%	0.2%	9.7%	0.0%	0.0%	0.4%	0.0%
Rocky Reach	84	0.0%	0.0%	23.4%	0.8%	64.4%	0.0%	11.0%	0.0%	0.0%	0.3%	0.0%
Wells	79	0.0%	0.0%	24.2%	1.0%	64.2%	0.0%	10.7%	0.0%	0.0%	0.0%	0.0%
Ice Harbor	579	0.0%	0.1%	12.7%	0.0%	83.0%	0.0%	4.2%	0.0%	0.0%	0.0%	0.0%
Low. Mon.	569	0.0%	0.1%	12.6%	0.0%	83.0%	0.0%	4.3%	0.0%	0.0%	0.0%	0.0%
Little Goose	569	0.0%	0.1%	12.6%	0.0%	83.0%	0.0%	4.3%	0.0%	0.0%	0.0%	0.0%
Lower Granite	552	0.0%	0.1%	12.3%	0.0%	83.6%	0.0%	4.0%	0.0%	0.0%	0.0%	0.0%
Summer	**Age-able**	**0.1**	**0.2**	**1.1**	**0.3**	**1.2**	**0.4**	**1.3**	**2.2**	**0.5**	**1.4**	**2.3**
Bonneville	863	2.6%	2.1%	16.8%	26.1%	35.6%	4.5%	11.7%	0.3%	0.1%	0.2%	0.1%
The Dalles	729	3.2%	2.3%	17.9%	26.0%	34.3%	4.5%	11.2%	0.3%	0.0%	0.2%	0.0%
McNary	653	3.6%	2.4%	18.6%	25.6%	33.9%	4.2%	11.0%	0.3%	0.0%	0.2%	0.0%
Priest Rapids	437	3.6%	2.3%	8.9%	31.1%	32.0%	6.3%	15.0%	0.6%	0.0%	0.2%	0.0%
Rock Island	416	3.7%	2.4%	9.1%	31.2%	31.7%	6.1%	14.9%	0.6%	0.0%	0.2%	0.0%
Rocky Reach	337	3.8%	2.2%	9.0%	30.4%	34.4%	4.9%	14.4%	0.8%	0.0%	0.0%	0.0%
Wells	306	3.7%	2.4%	8.8%	31.3%	33.8%	5.4%	13.8%	0.9%	0.0%	0.0%	0.0%
Ice Harbor	198	3.8%	0.0%	54.4%	8.9%	32.4%	0.2%	0.4%	0.0%	0.0%	0.0%	0.0%
Low. Mon.	197	3.8%	0.0%	54.4%	8.9%	32.3%	0.2%	0.4%	0.0%	0.0%	0.0%	0.0%
Little Goose	196	2.7%	0.0%	55.3%	9.0%	32.3%	0.2%	0.4%	0.0%	0.0%	0.0%	0.0%
Lower Granite	180	1.5%	0.0%	56.3%	9.4%	32.1%	0.3%	0.4%	0.0%	0.0%	0.0%	0.0%
Fall	**Age-able**	**0.1**	**0.2**	**1.1**	**0.3**	**1.2**	**0.4**	**1.3**	**2.2**	**0.5**	**1.4**	**2.3**
Bonneville	1273	5.5%	17.2%	1.1%	62.1%	2.6%	10.3%	1.0%	0.0%	0.0%	0.0%	0.0%
The Dalles	919	5.3%	20.4%	1.0%	62.3%	1.9%	8.4%	0.8%	0.0%	0.0%	0.0%	0.0%
McNary	757	5.6%	22.8%	1.2%	59.6%	2.0%	8.4%	1.0%	0.0%	0.0%	0.0%	0.0%
Priest Rapids	118	7.2%	18.3%	0.2%	63.4%	0.8%	10.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Ice Harbor	71	7.0%	40.4%	5.4%	36.5%	8.3%	2.4%	0.0%	0.0%	0.0%	0.0%	0.0%
Low. Mon.	66	8.1%	40.2%	5.5%	34.1%	9.8%	2.4%	0.0%	0.0%	0.0%	0.0%	0.0%
Little Goose	66	8.1%	40.2%	5.5%	34.1%	9.8%	2.4%	0.0%	0.0%	0.0%	0.0%	0.0%
Lower Granite	60	7.8%	41.3%	5.2%	35.3%	7.9%	2.5%	0.0%	0.0%	0.0%	0.0%	0.0%

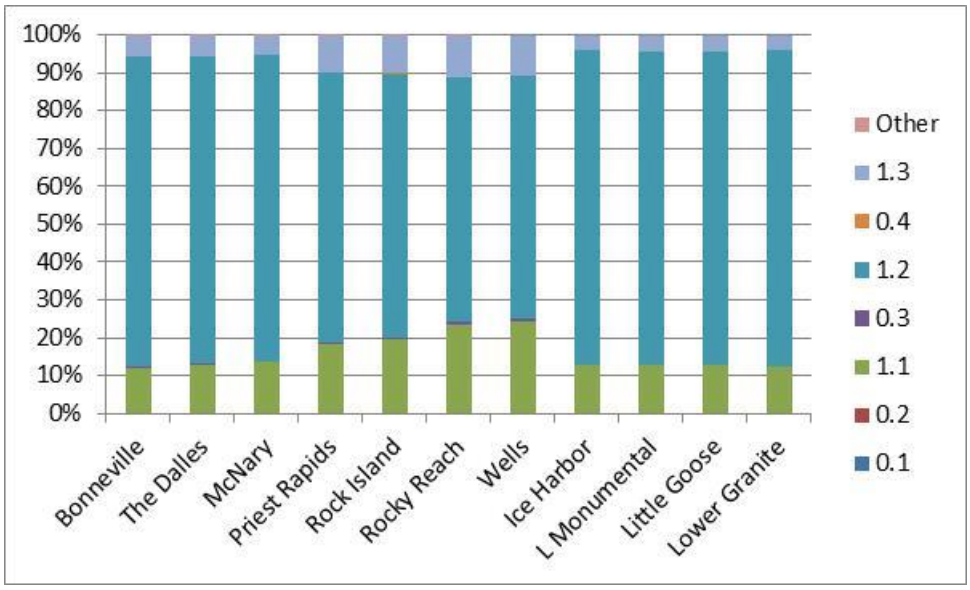

Figure 10. Spring Chinook age composition at Columbia and Snake river dams estimated using PIT tagged Chinook tracked by this project. Spring Chinook are defined as passing Bonneville Dam between April 1 and May 31, 2014.

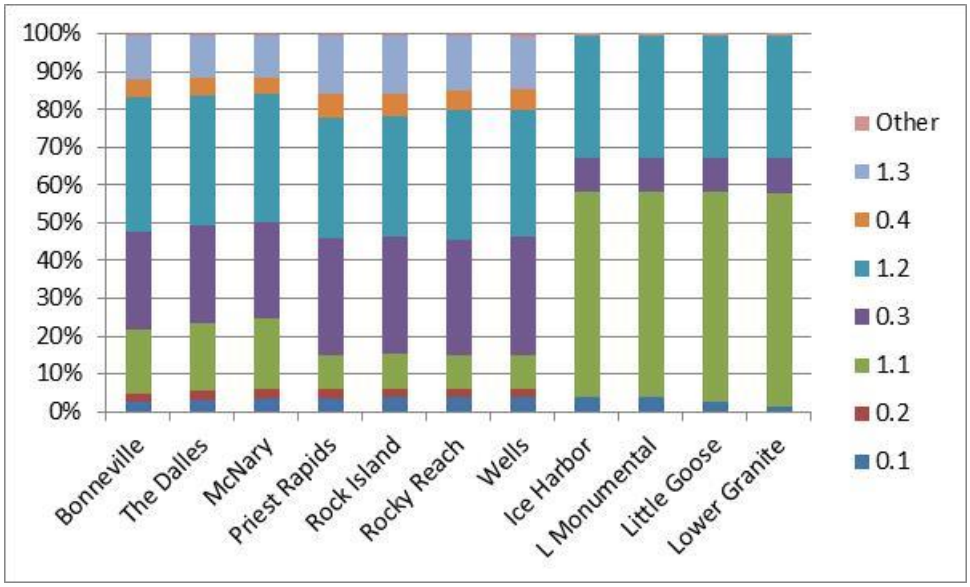

Figure 11. Summer Chinook age composition at Columbia and Snake river dams estimated using PIT tagged Chinook tracked by this project. Summer Chinook are defined as passing Bonneville Dam between June 1 and July 31, 2014.

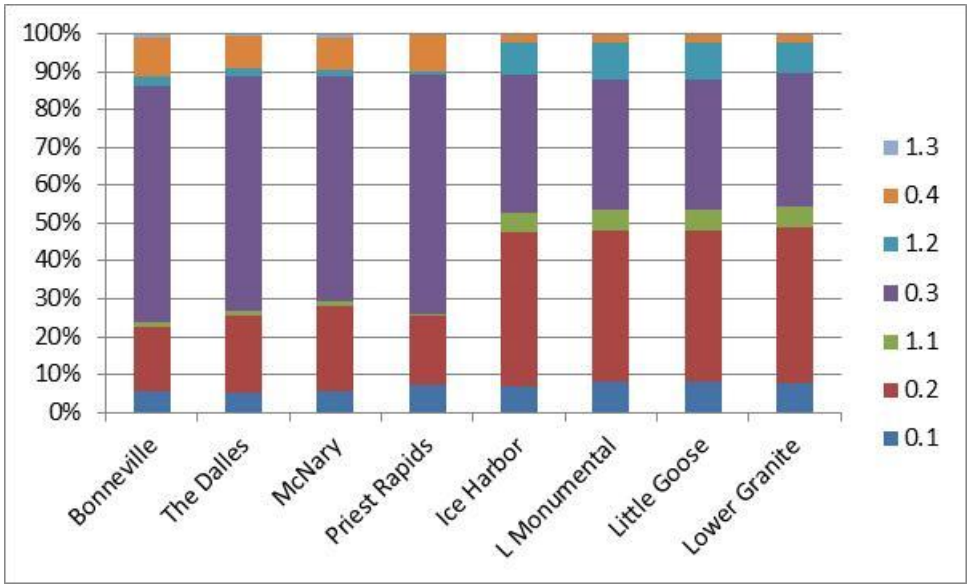

Figure 12. Fall Chinook age composition at Columbia and Snake river dams estimated using PIT tagged Chinook tracked by this project. Fall Chinook are defined as passing Bonneville Dam on or after August 1, 2014.

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 2014.

Dam	Statistic	Brood Year and Age Class						
		2012	2011		2010		2009	
		0.1	0.2	1.1	0.3	1.2	0.4	1.3
Bonneville	μ		67.5	50.4	76.5	73.2	93.5	83.9
	s		2.8	5.4	4.8	5.0	--	4.9
	n		2	197	5	938	1	77
The Dalles	μ		69.5	50.3	78.3	73.0	93.5	84.3
	s			5.5	1.1	5.2	--	5.1
	n		1	186	2	752	1	65
McNary	μ		69.5	50.4	78.3	73.2	93.5	84.4
	s		--	5.6	1.1	4.6	--	4.9
	n		1	168	2	614	1	54
Priest Rapids	μ			49.8	78.3	74.9	93.5	85.5
	s			3.8	1.1	5.4	--	4.5
	n			30	2	93	1	29
Rock Island	μ			49.8	78.3	74.8	93.5	85.7
	s			3.8	1.1	5.4	--	4.5
	n			30	2	89	1	27
Rocky Reach	μ			49.5	78.3	74.1		85.4
	s			4.2	1.1	6.2		4.8
	n			22	2	42		17
Wells	μ			49.5	78.3	74.6		85.6
	s			4.2	1.1	5.9		4.8
	n			22	2	40		15
Ice Harbor	μ		69.5	50.7		73.1		83.6
	s		--	4.0		4.2		5.2
	n		1	111		445		22
Lower Monumental	μ		69.5	50.7		73.1		83.6
	s		--	3.9		4.2		5.2
	n		1	108		438		22
Little Goose	μ		69.5	50.7		73.1		83.6
	s		--	3.9		4.2		5.2
	n		1	108		438		22
Lower Granite	μ		69.5	50.5		73.1		83.8
	s		--	3.7		4.2		5.3
	n		1	101		429		21

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 2014.

Dam	Statistic	Brood Year and Age Class						
		2012	2011		2010		2009	
		0.1	0.2	1.1	0.3	1.2	0.4	1.3
Bonneville	μ	44.0	63.2	53.2	79.5	74.2	87.7	84.2
	s	3.3	5.0	9.1	6.1	7.1	6.0	5.0
	n	24	13	143	192	341	42	101
The Dalles	μ	44.0	62.9	53.7	79.7	73.8	88.2	83.9
	s	3.3	5.1	8.1	5.9	7.5	6.2	5.2
	n	24	12	132	162	276	34	84
McNary	μ	44.0	62.9	53.6	79.7	73.6	88.2	83.8
	s	3.4	5.4	8.2	6.0	7.7	6.2	5.3
	n	23	11	125	141	247	31	70
Priest Rapids	μ	43.7	62.9	52.5	79.8	72.1	88.4	84.2
	s	3.3	5.9	5.3	6.0	9.1	6.2	4.7
	n	20	9	39	129	140	30	66
Rock Island	μ	43.7	62.9	52.4	79.8	71.8	88.2	84.1
	s	3.3	5.9	5.2	6.1	9.1	6.3	4.3
	n	20	9	38	122	133	29	61
Rocky Reach	μ	43.8	64.6	52.2	79.5	71.2	86.5	83.6
	s	3.3	4.7	5.3	6.1	9.4	6.2	4.2
	n	19	7	31	99	115	16	47
Wells	μ	43.4	64.6	52.3	79.7	70.9	86.5	83.4
	s	3.5	4.7	4.6	6.0	9.7	6.2	4.4
	n	16	7	27	94	102	16	41
Ice Harbor	μ	45.8		54.1	78.1	75.8	84.0	79.8
	s	4.3		9.5	3.8	4.7	--	0.4
	n	3		81	10	101	1	2
Lower Monumental	μ	45.8		54.1	78.1	75.7	84.0	79.8
	s	4.3		9.5	3.8	4.7	--	0.4
	n	3		81	10	100	1	2
Little Goose	μ	48.3		54.1	78.1	75.7	84.0	79.8
	s	1.1		9.5	3.8	4.7	--	0.4
	n	2		81	10	100	1	2
Lower Granite	μ	47.5		54.5	78.1	75.5	84.0	79.8
	s	--		7.5	3.8	4.7	--	0.4
	n	1		74	10	92	1	2

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 31st, for fall Chinook Salmon at Columbia and Snake River dams in 2014.

Dam	Statistic	Brood Year and Age Class						
		2012	2011		2010		2009	
		0.1	0.2	1.1	0.3	1.2	0.4	1.3
Bonneville	μ	46.3	63.1	55.9	76.1	72.5	82.9	80.0
	s	4.2	7.0	4.7	6.2	5.6	5.7	4.3
	n	78	186	26	816	33	122	12
The Dalles	μ	46.3	62.3	56.5	75.7	72.0	82.7	81.5
	s	4.1	7.2	4.5	6.0	5.9	5.9	3.6
	n	64	146	21	576	20	83	9
McNary	μ	46.4	62.2	56.4	75.5	72.7	82.6	80.4
	s	4.3	7.5	4.6	6.2	5.5	6.4	2.2
	n	55	134	20	466	15	61	6
Priest Rapids	μ	45.0	59.8	53.6	76.0	71.0	86.0	
	s	3.3	4.2	3.3	5.9	–	4.4	
	n	19	24	10	58	1	6	
Rock Island	μ	44.7	58.8	53.6	74.7		86.0	
	s	3.7	1.9	3.3	6.1		2.1	
	n	15	8	10	15		2	
Rocky Reach	μ	44.9	59.4	53.2	73.8		86.0	
	s	3.8	1.2	3.3	6.8		2.1	
	n	14	7	9	9		2	
Wells	μ	44.4	59.5	53.2	70.8		87.5	
	s	3.3	1.5	3.3	5.8		–	
	n	13	5	9	6		1	
Ice Harbor	μ	44.9	63.1	58.3	74.5	70.4	85.5	
	s	5.4	4.6	3.4	5.9	6.0	3.8	
	n	6	24	6	25	7	3	
Lower Monumental	μ	44.9	62.8	58.3	75.4	70.4	85.5	
	s	5.4	4.5	3.4	5.8	6.0	3.8	
	n	6	23	6	21	7	3	
Little Goose	μ	44.9	62.8	58.3	75.4	70.4	85.5	
	s	5.4	4.5	3.4	5.8	6.0	3.8	
	n	6	23	6	21	7	3	
Lower Granite	μ	43.0	63.0	57.8	75.3	70.9	85.5	
	s	3.0	4.5	3.5	5.9	4.1	3.8	
	n	5	22	5	20	5	3	

Fallback

Estimated fallback rates, based on Chinook Salmon reascending fish ladders or being detected downstream after ascending a fish ladder, ranged from 0% to 36.2% (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 in 2014 as estimated by PIT tags[a].

Dam	Spring Chinook (%)	Summer Chinook (%)	Fall Chinook (%)
Bonneville	1.9%	1.0%	1.4%
The Dalles	4.0%	4.4%	3.0%
McNary	4.6%	0.8%	1.5%
Priest Rapids	1.6%	2.5%	36.2%
Rock Island	4.9%	0.7%	9.4%
Rocky Reach	14.0%	7.8%	4.5%
Wells	13.9%	18.3%	2.8%
Ice Harbor	1.5%	2.1%	0.3%
L. Monumental	1.7%	0.6%	0.1%
Little Goose	3.5%	1.0%	0.3%
Lower Granite	3.5%	1.4%	0.7%
Tumwater	0	0	0
Prosser	0.0%	0.0%	0.1%
Roza	0	0	0
Weighted Mean-All Sites	**4.5%**	**4.4%**	**3.6%**
Weights-Columbia and Snake Dams Only	**4.6%**	**4.1%**	**3.6%**

A total of 659 Chinook generated 1237 fallback events (Table 17). Six Chinook had six fallback events each. Fall Chinook at Priest Rapids Dam had the highest fallback rate with 33 fall Chinook generating 46 fallback events out of 237 fall Chinook detected passing the site. A total of 28 fall Chinook passed Priest Rapids dam before being detected downstream at the Priest Rapids Hatchery channel PIT tag array, with one of these making this trip twice. Three fall Chinook ascended Priest Rapids Dam three times with six ascending twice.

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

Table 17. Number of Chinook salmon tagged by this project estimated to have fallen back over dams with the number of fallbacks in 2014.

Number of Dams Fallen Back Over	Total Number of Chinook
1	322
2	98
3	30
4	8
5	1
6	1
8	1
Total	**461**

Night Passage

Night passage (2000-0400 Pacific Standard Time) of tagged Chinook Salmon was under 10% at all dams except for spring Chinook at Rocky Reach Dam and at the Roza and Tumwater tributary dams (Table 18) The Bonneville Dam estimate of night passage is likely biased low, due to the fact that tagging occurred during morning and early afternoon hours and that the median Bonneville Dam passage time is less than two hours, tagged Chinook would be expected to pass during daytime hours.

Table 18. Estimated Chinook Salmon night passage (2000-0400) in 2014 at Columbia Basin dams as estimated by PIT tag detections.

Site	Spring Chinook (%)	Summer Chinook (%)	Fall Chinook (%)
Bonneville	0.9%	2.4%	0.2%
The Dalles	4.2%	8.8%	1.9%
McNary	2.9%	7.3%	0.8%
Priest Rapids	2.7%	3.1%	0.7%
Rock Island	6.8%	7.4%	2.3%
Rocky Reach	11.2%	3.8%	0.0%
Wells	3.0%	4.7%	0.7%
Ice Harbor	1.7%	4.5%	1.1%
Lower Monumental	2.8%	2.5%	0.0%
Little Goose	2.5%	6.0%	0.0%
Lower Granite	6.6%	5.7%	1.3%
Prosser	3.3%	7.7%	16.7%
Roza	26.1%	10.5%	NA
Tumwater	27.3%	9.7%	NA

RESULTS-STEELHEAD

Sample Size

A total of 1728 steelhead were PIT tagged in 2014 (Table 19). 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), the number of steelhead tracked upstream totaled 1717 (Table 19).

Table 19. Number of steelhead PIT tagged at Bonneville Dam and tracked past Bonneville by date and statistical week in 2014.

Dates	Week	Sampled	PIT Tagged	Previously Tagged	Not Detected After Release	Total Tracked	Days Temperature Restrictions in Effect	
							Reduced Hours	No Sampling
4/15-4/18	16	8	8	0	0	8	0	0
4/21-25	17	5	4	1	0	5	0	0
4/28-30,5/2	18	7	7	0	0	7	0	0
5/5,6,8,9	19	8	7	1	0	8	0	0
5/12-5/16	20	17	16	1	0	17	0	0
5/19-23	21	15	13	2	0	15	0	0
5/27-5/30	22	10	10	0	0	10	0	0
6/2-6/6	23	20	20	0	0	20	0	0
6/9-6/13	24	16	16	0	0	16	0	0
6/16-6/20	25	19	19	0	1	18	0	0
6/23,25-27	26	14	13	1	0	14	0	0
6/30,7/1-7/3	27	28	26	2	0	28	0	0
7/7-7/11	28	69	69	0	0	69	0	0
7/14-18	29	142	138	4	1	141	0	0
7/21-25	30	280	268	12	0	280	0	0
7/28-7/31, 8/1	31	265	257	6	0	263	0	0
8/5-8	32	201	195	5	0	200	4	1
8/11-12	33	96	93	3	1	95	2	3
No sampling	34-35							5
9/2-5	36	54	53	1	0	54	4	1
9/8	37	17	16	1	0	17	1	4
9/16-19	38	58	58	0	0	58	4	1
9/22-26	39	121	120	1	1	120	0	0
9/29-10/3	40	105	104	1	3	102	0	0
10/6-10	41	80	77	2	0	79	0	0
10/13-17	42	73	72	1	0	73	0	0
Total		**1728**	**1679**	**45**	**7**	**1717**	**19**	**21**

Distribution of Sample

As has often been the case with our steelhead sampling program, we undersampled the peak of the run. During Statistical weeks 33-38 when 47.6% of the steelhead run passed, sampling restrictions imposed due to high water temperatures resulted in a sample size of only 225 steelhead or 13.0% of our sample (Table 19, Figure 13). No sampling was conducted during weeks 34 and 35 when 12.7% of the run passed.

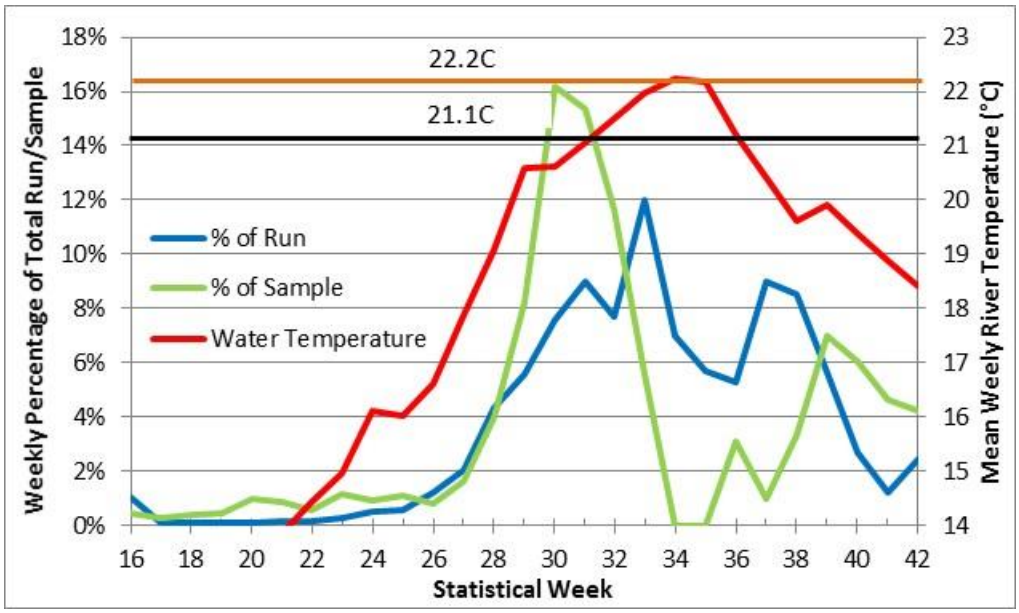

Figure 13. The weekly steelhead sample and run as a percentage of the total sample and run size at Bonneville Dam in 2014. High water temperatures prevented sampling Statistical Weeks 34-35. Sampling is halted when temperatues exceed 21.1C (black line) and halted at 22.2C (orange line).

Detection Numbers

The 1276 steelhead tracked in 2014 generated 94,062 weir detections and 10,442 site detections at 132 sites. Maps (Figure A15-A19) found in the Appendix 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 by using fish sampled at Bonneville for this project that were previously tagged as juveniles for other projects or hatchery programs. Age estimates, from ageable scale patterns, for 41 out of 42 steelhead, that had been previously PIT tagged, were correctly aged (97.6%). Only the total age could be compared for it was not

possible to separately validate freshwater and ocean age.

In 2014 data was also available on the ocean age from genetics samples collected as part of this project. Ages estimated using the scale patterns agreed with estimates using GSI for 815 out of 821 steelhead samples (Table 20). All GSI ages were from hatchery-origin steelhead.

Table 20. Comparison of age estimates using genetics and scale pattern analysis for Chinook Salmon sampled at Bonneville Dam in 2014. 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	268	3	0	98.9%
2	3	546	0	99.5%
3			1	100.0%
Total	**271**	**549**	**1**	**99.2%**

Mainstem Dam Recoveries, Mortality, and Escapement Estimates

Data on tag detections was last downloaded from www.ptagis.org on September 18, 2015. An estimated 49.6% of the steelhead run passing Bonneville Dam prior to August 16 was last detected upstream of Ice Harbor Dam compared to 69.5% after sampling resumed after the closure of the Adult Fish Facility the week of August 31 (Table 21, Figure 14). In contrast, 9.6% of the earlier portion of the run was last detected upstream of Priest Rapids Dam compared to 1.7% of the later portion of the run (Figure 14). The proportion of steelhead bound for the Snake River steadily increased as the run progressed (Figures 15 and 16).

Table 21. Percentage of steelhead run passing upstream dams prior to, and after, temperature restrictions closed the Bonneville Adult Fish Facility in 2014

	Portion of Steelhead Run Relative to Entire Run		
	Early (52.5%)	Late (34.8%)	Middle (12.7%)
Dates	Through August 16	On or After August 31	August 17-30
The Dalles	75.3%	87.2%	No Sampling
McNary	60.3%	77.9%	No Sampling
Priest Rapids	9.6%	1.7%	No Sampling
Rock Island	8.0%	1.4%	No Sampling
Rocky Reach	6.3%	0.9%	No Sampling
Wells	5.4%	0.9%	No Sampling
Ice Harbor	41.3%	69.5%	No Sampling
Lower Monumental	39.3%	65.6%	No Sampling
Little Goose	35.5%	64.5%	No Sampling
Lower Granite	33.0%	63.4%	No Sampling
Tumwater	0.6%	0.0%	No Sampling
Prosser	1.8%	0.4%	No Sampling
Roza	0.2%	0.0%	No Sampling

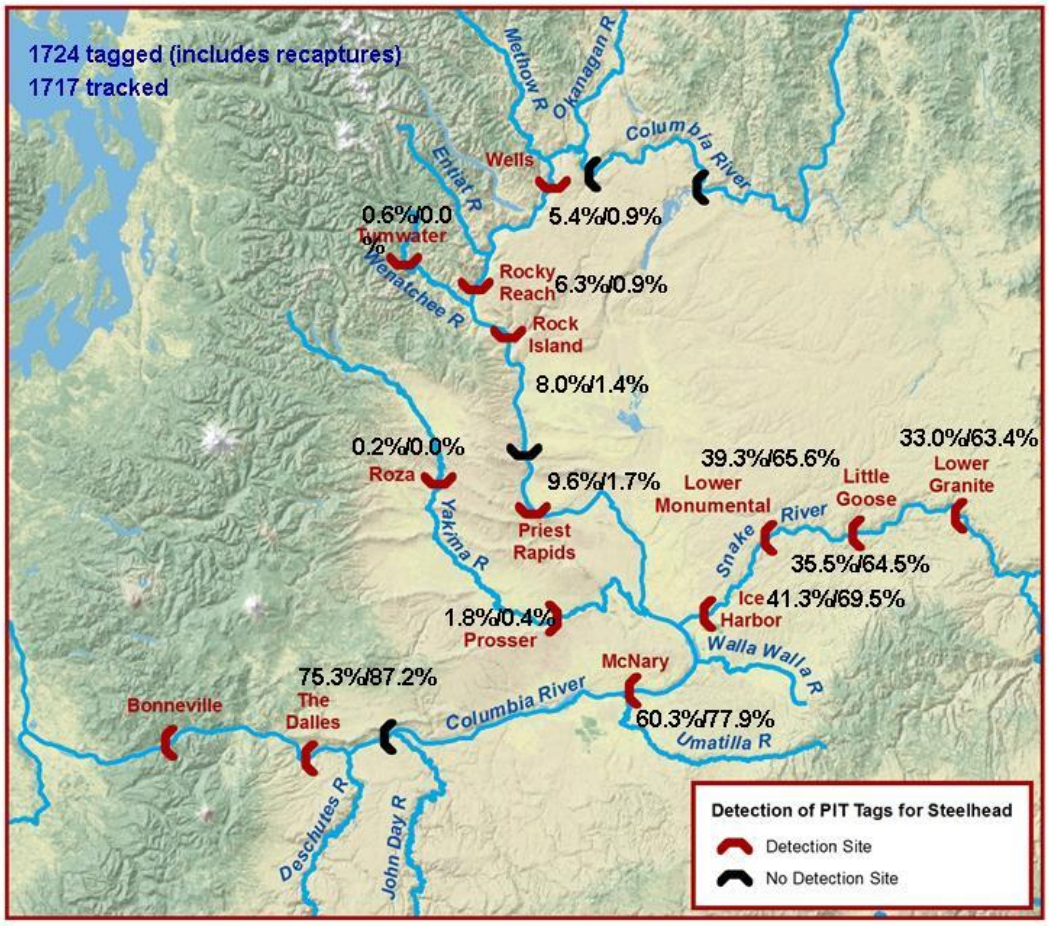

Figure 14. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of steelhead PIT tagged at Bonneville Dam, and the percentage of the run estimated to pass upstream dams in 2014. Percentages are presented for the portion of the run up to Statistical Week 33 followed by the portion of the run on or after Statistical Week 36.

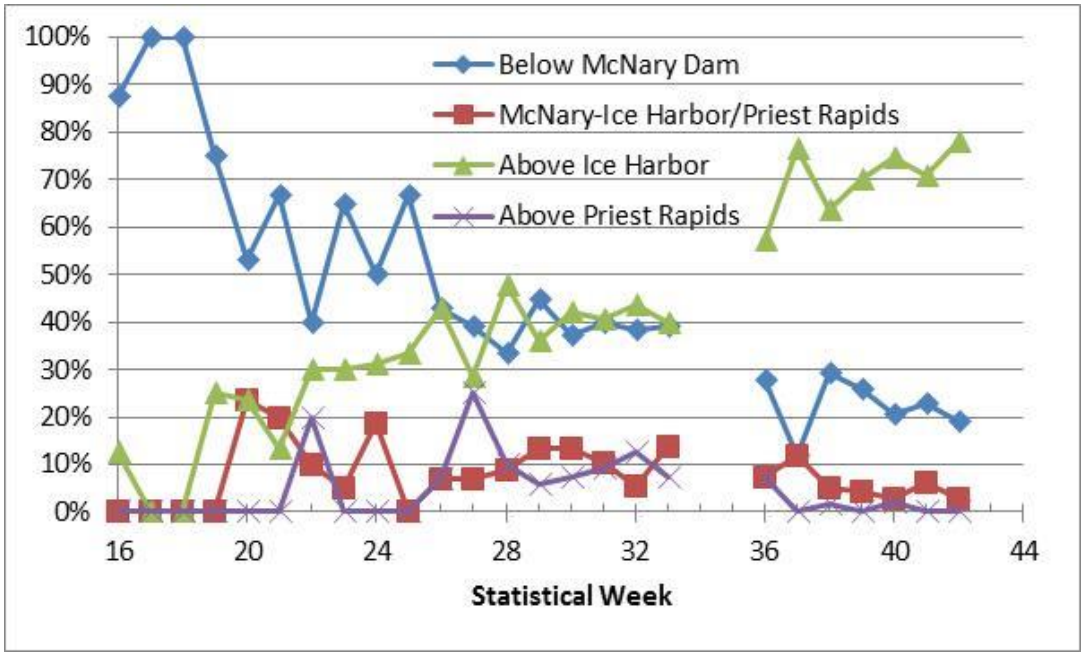

Figure 15. Distribution of final upstream detection site by statistical week for steelhead PIT tagged at Bonneville Dam in 2014 estimated as a percentage of the weekly sample.[b]

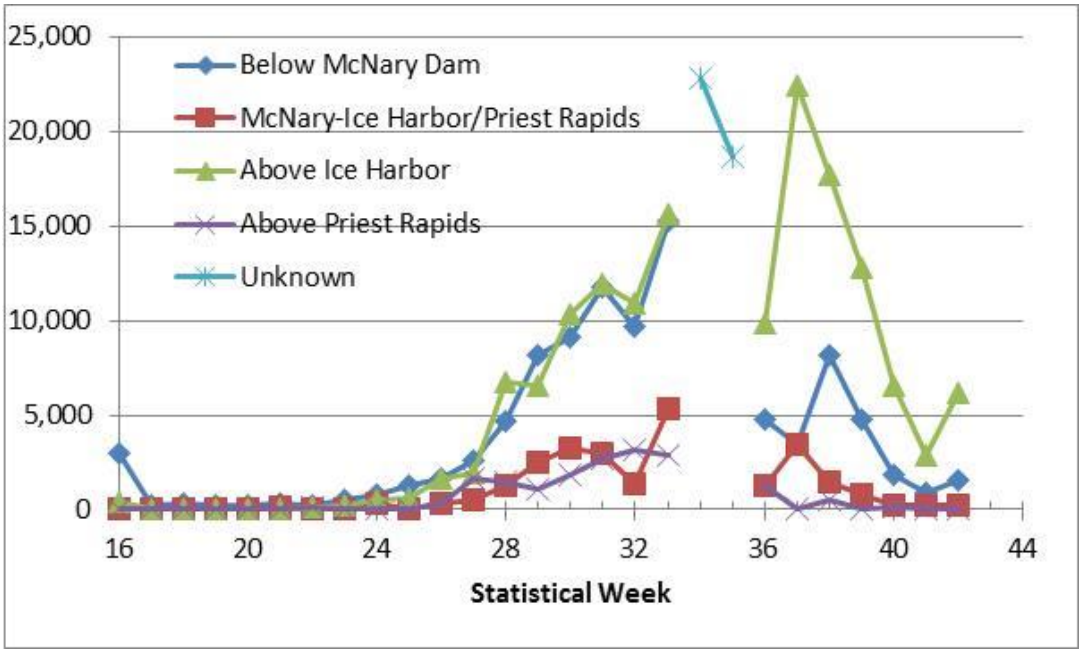

Figure 16. Distribution of final detection site by statistical week for steelhead PIT tagged at Bonneville Dam in 2014 estimated in numbers of fish passing Bonneville Dam by week.

[b] Note that the point indicating that 100% of those fish in Statistical Week 26 were last detected between Bonneville and McNary dams is based on only six steelhead sampled that week.

In 2013, a PIT tag site was installed just upstream of the mouth of the Deschutes River (DRM). A total of 182 of the 1717 steelhead tagged and tracked, in 2014, by this study were detected at this site. Of these 182 steelhead, the most upstream detection of 83 were in the Snake River, 9 steelhead above Priest Rapids Dam, 24 between McNary and Priest Rapids, 48 in Deschutes Basin (with 36 not being detected past DRM), and 15 elsewhere between Bonneville and McNary dams (Figure 17).

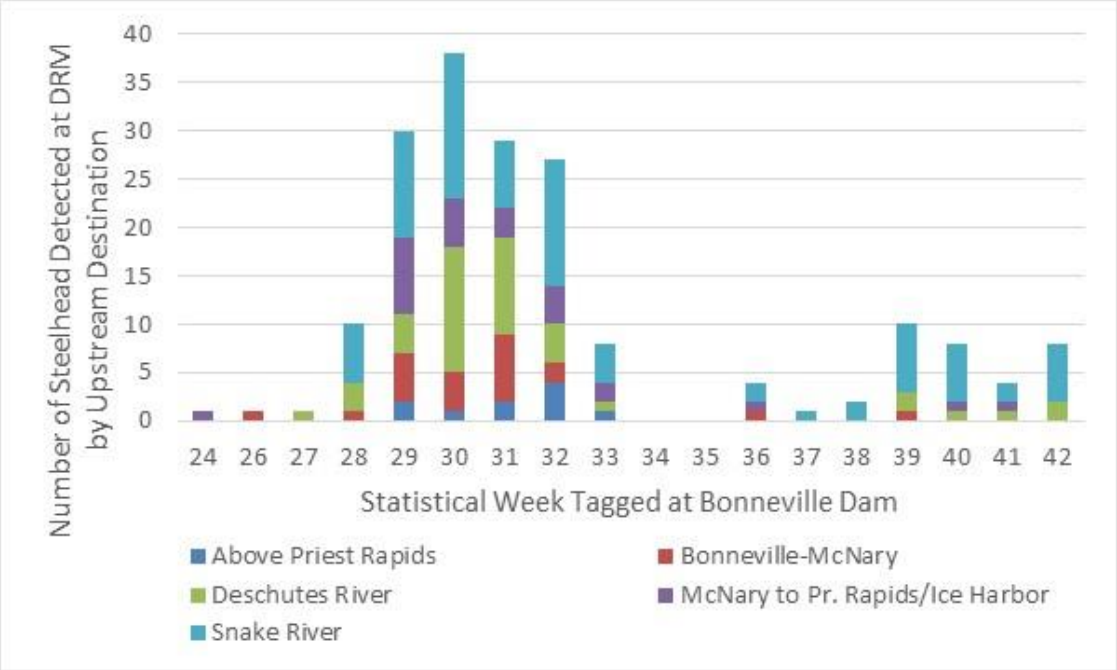

Figure 17. Distribution of final detection site by statistical week for steelhead PIT tagged at Bonneville Dam which were detected the Deschutes River Mouth detection antenna (DRM) in 2014.

As with Chinook Salmon, the percentage of PIT tagged steelhead passing a dam without detection was generally under 1% (Table 22) with the exception of Rock Island Dam, which has known detection issues due to antenna size and electrical noise (Fryer et al. 2012).

Table 22. Percentages of steelhead passing a dam undetected that were subsequently detected at an upstream dam in 2014.

Dam	Percent Undetected
Bonneville	0.9%
The Dalles	0.3%
McNary	0.5%
Priest Rapids	1.0%
Rock Island	35.2%
Rocky Reach	0.0%
Wells	0.0%
Ice Harbor	0.8%
Lower Monumental	0.7%
Little Goose	3.2%
Lower Granite	0.4%
Mean (weighted by number passing each dam)	**1.4%**

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 (34.6 km/day), while the slowest was 17.7 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 2014

Steelhead		
Dam Pair	**Distance (km)**	**Median Migration Rate (km/day)**
Bonneville-The Dalles	74	24.6
The Dalles-McNary	157	34.6
Bonneville - McNary	231	17.7
McNary - Priest Rapids	167	49.5
Priest Rapids - Rock Island	89	19.9
Rock Island - Rocky Reach	33	21.4
Rocky Reach - Wells	65	25.2
Rock Island - Tumwater	73	6.9
Bonneville – Rock Island	487	17.8
Bonneville - Wells	585	19.5
McNary - Ice Harbor	67	32.8
Ice Harbor - Lower Granite	156	20.3

Median steelhead passage times (Table 24) at the mainstem dams, as measured from first to last detection within the ladders, were generally less than for Chinook Salmon (Table 11). Wells, Lower Granite, McNary, and Bonneville dams had the greatest median passage time among mainstem Columbia Basin dams. Passage times at Wells, Lower Granite, Priest Rapids, and Tumwater dams may be inflated because of fish trapping programs, while the time at

Bonneville Dam may be increased due to steelhead taking some time to recover after sampling and tagging.

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 2014.

Dam	Median Passage Time (minutes)	Percentage with more than 12 hours between first detection and last detection at a dam
Bonneville	71.1	4.9%
The Dalles	0.2	0.0%
McNary	81.4	5.6%
Priest Rapids	4.2	0.3%
Rock Island	5.3	0.4%
Rocky Reach	8.3	0.6%
Wells	93.6	6.5%
Ice Harbor	3.5	0.2%
Lower Monumental	0.3	0.0%
Little Goose	0.0	0.0%
Lower Granite	81.1	5.6%
Tumwater	3.7	0.3%

Upstream Age and Length-at-Age Composition

Age 1.2 steelhead had the highest abundance among all age classes in 2014 (Table 25, Figure 18). Length-at-age composition data are found in Table 26.

Table 25. Age composition estimates for steelhead at upstream Columbia and Snake River dams (%) in 2014. These were estimated from scale patterns of steelhead sampled at Bonneville Dam[c].

		2011	2010		2009			2008		Unknown				Repeat Spawners
Site	n	1.1	1.2	2.1	1.3	2.2	3.1	2.3	3.2	r	r.1	r.2	r.3	
Bonneville	1712	17.2%	33.1%	9.1%	0.4%	15.8%	0.2%	0.1%	0.5%	0.9%	9.6%	12.6%	0.2%	1.5%
The Dalles	1338	17.8%	32.6%	9.3%	0.3%	16.7%	0.1%	0.1%	0.6%	0.9%	9.3%	12.0%	0.1%	1.6%
McNary	1106	18.1%	33.5%	8.6%	0.3%	15.9%	0.1%	0.1%	0.5%	0.9%	9.9%	11.8%	0.1%	1.4%
Priest Rapids	117	23.1%	30.8%	7.7%	0.0%	16.2%	0.0%	0.0%	0.9%	2.6%	7.7%	11.1%	0.0%	0.0%
Rock Island	95	22.1%	32.6%	6.3%	0.0%	17.9%	0.0%	0.0%	0.0%	3.2%	7.4%	10.5%	0.0%	0.0%
Rocky Reach	76	22.4%	31.6%	3.9%	0.0%	21.1%	0.0%	0.0%	0.0%	2.6%	7.9%	10.5%	0.0%	0.0%
Wells	68	23.5%	33.8%	4.4%	0.0%	19.1%	0.0%	0.0%	0.0%	2.9%	8.8%	7.4%	0.0%	0.0%
Ice Harbor	849	18.8%	37.1%	6.0%	0.4%	13.1%	0.1%	0.1%	0.6%	0.7%	9.8%	13.1%	0.1%	0.1%
Lower Granite	718	18.7%	37.7%	5.2%	0.4%	13.8%	0.1%	0.1%	0.7%	0.6%	9.3%	13.1%	0.1%	0.1%

[c] Unlike in previous years, age composition estimates are not weighted by week due to the unrepresentative nature of the sample in 2014 caused by Adult Fish Facility trap restrictions.

Table 26. Steelhead length-at-age composition, as estimated by PIT tag detections of fish aged from scales at Bonneville Dam in 2014.

		Brood Year and Age Class										
Dam	Statistic	2011	2010		2009			2008		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	56.3	73.6	56.8	85.8	70.4	52.8	87.0	70.9	56.3	70.9	78.8
	s	3.7	7.3	3.6	5.7	5.7	1.6	--	3.9	4.3	9.4	6.2
	n	294	567	156	6	271	3	1	8	164	216	3
McNary	μ	56.2	74.2	56.8	87.4	70.4	52.5	87.0	70.9	55.7	70.4	75.0
	s	3.7	7.4	3.5	3.8	5.6	2.1	--	3.9	3.2	10.1	--
	n	238	436	125	4	223	2	1	8	125	160	1
Priest Rapids	μ	56.2	74.6	56.9	89.2	71.1	54.0	87.0	71.8	55.6	70.9	75.0
	s	3.6	7.3	3.5	1.5	6.0	--	--	3.9	3.2	10.9	--
	n	200	371	95	3	176	1	1	6	109	131	1
Rock Island	μ	56.3	69.7	57.5		68.2			70.5	55.2	69.3	
	s	3.5	4.0	4.5		4.6			--	2.0	4.0	
	n	27	36	9	0	19	0	0	1	9	13	0
Rocky Reach	μ	56.1	70.1	57.6		68.1				55.2	69.5	
	s	3.3	4.0	5.3		4.9				2.3	3.1	
	n	21	31	6	0	17	0	0	0	7	10	0
Wells	μ	55.8	70.1	60.2		68.5				55.2	68.9	
	s	3.3	4.3	5.5		4.8				2.5	3.3	
	n	17	24	3	0	16	0	0	0	6	8	0
Ice Harbor	μ	55.7	70.1	60.2		69.0				55.2	69.6	
	s	3.4	4.4	5.5		4.7				2.5	3.4	
	n	16	23	3	0	13	0	0	0	6	5	0
Lower Granite	μ	56.1	75.3	57.4	89.2	72.5	54.0	87.0	71.2	55.6	71.3	75.0
	s	3.6	7.0	3.6	1.5	6.4	--	--	4.1	3.3	11.7	--
	n	160	315	51	3	111	1	1	5	83	111	1

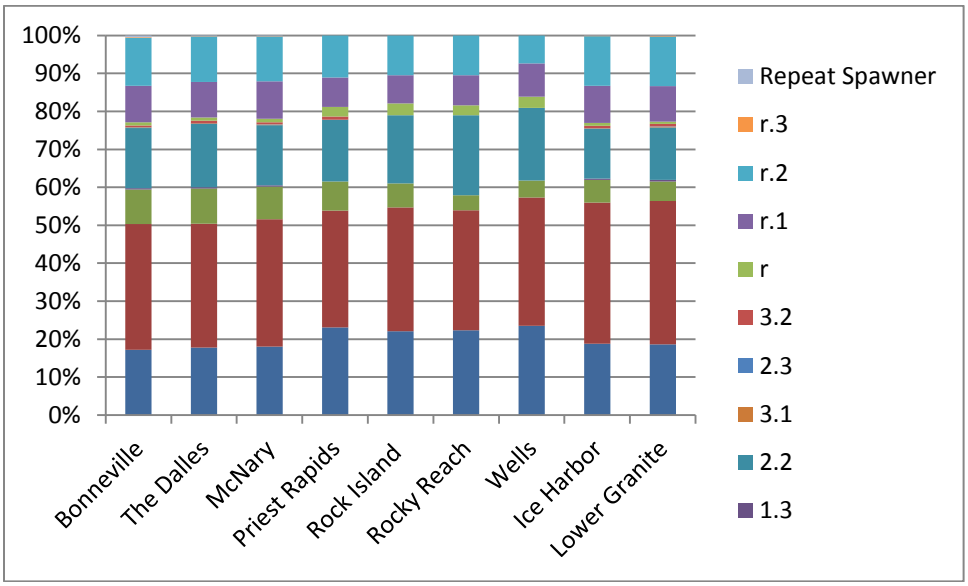

Figure 18. Steelhead age composition at Columbia and Snake river dams estimated from upstream detections of steelhead aged using scales at Bonneville Dam in 2014. RS are repeat spawners. The "r" in age r.X means that the freshwater zone of the scale was regenerated and the age therefore not possible to determine.

Fallback

Estimated minimum fallback rates based on steelhead either reascending fish ladders or steelhead subsequently detected downstream ranged from 2.3% to 34.2% (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. The highest rate of fallback was 34.2% at Priest Rapids Dam.

Table 27. Estimated minimum steelhead fallback at Columbia Basin dams in 2014 as estimated by PIT tag[d] detections.

Dam	Percent Fallback%
Bonneville	2.3%
The Dalles	6.3%
McNary	8.0%
Priest Rapids	34.2%
Rock Island	15.8%
Rocky Reach	11.8%
Wells	8.8%
Ice Harbor	8.1%
Lower Monumental	7.4%
Little Goose	8.6%
Lower Granite	3.5%

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

Night Passage

Night passage (2000-0400 Pacific Standard Time) by tagged steelhead ranged from 3.5% at Bonneville Dam to 10.0% at Lower Monumental Dam (Table 28). Given the median Bonneville Dam passage time of 60.4 minutes (Table 24), steelhead would be expected to pass during daytime hours.

Table 28. Estimated steelhead night passage (2000-0400) at Columbia Basin dams in 2014.

Site	Percentage Night Passage
Bonneville	3.5%
The Dalles	4.9%
McNary	4.9%
Priest Rapids	5.1%
Rock Island	9.2%
Rocky Reach	5.2%
Wells	7.4%
Ice Harbor	7.7%
Lower Monumental	10.0%
Little Goose	8.8%
Lower Granite	6.8%

B-Run Analyses

A total of 267 B-run steelhead were sampled (where B-run is defined as steelhead greater than or equal to 78.0 cm fork length). The percentage of steelhead sampled and tagged that were classified as B-run peaked in Statistical Week 39 at 61.2% of the run (Figure 19). 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 40 at 14,393 fish. An estimated 0.9% of the run during or before Statistical Week 33 was B-run compared to 42.5% during or after Statistical Week 36. 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), steelhead with fork lengths 78.0 cm and greater were almost entirely destined for the Snake River (Figure 20).

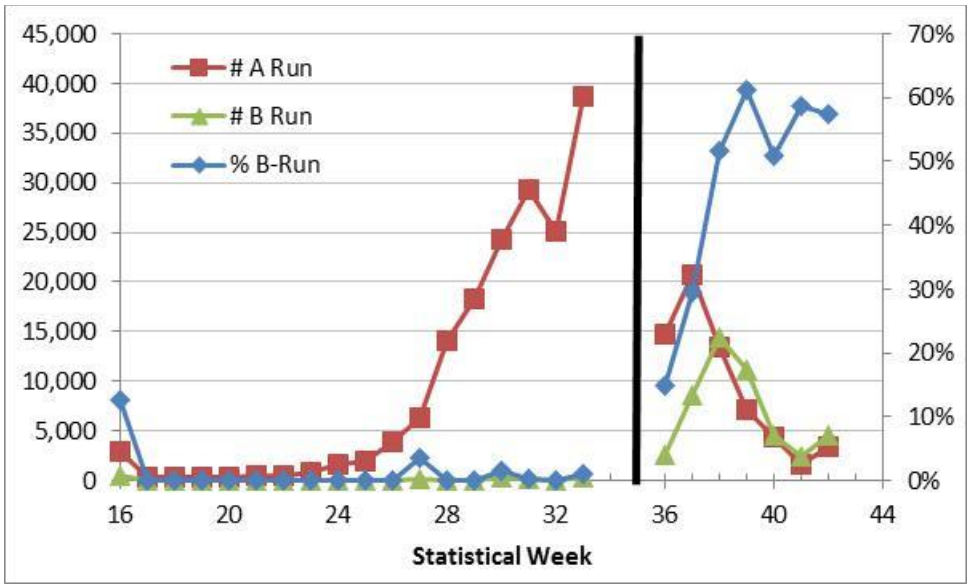

Figure 19. Percentage of B-run steelhead and estimated A- and B-run escapement at Bonneville Dam by statistical week in 2014. August 25 is noted as it is considered the date that separates A- and B-run steelhead.

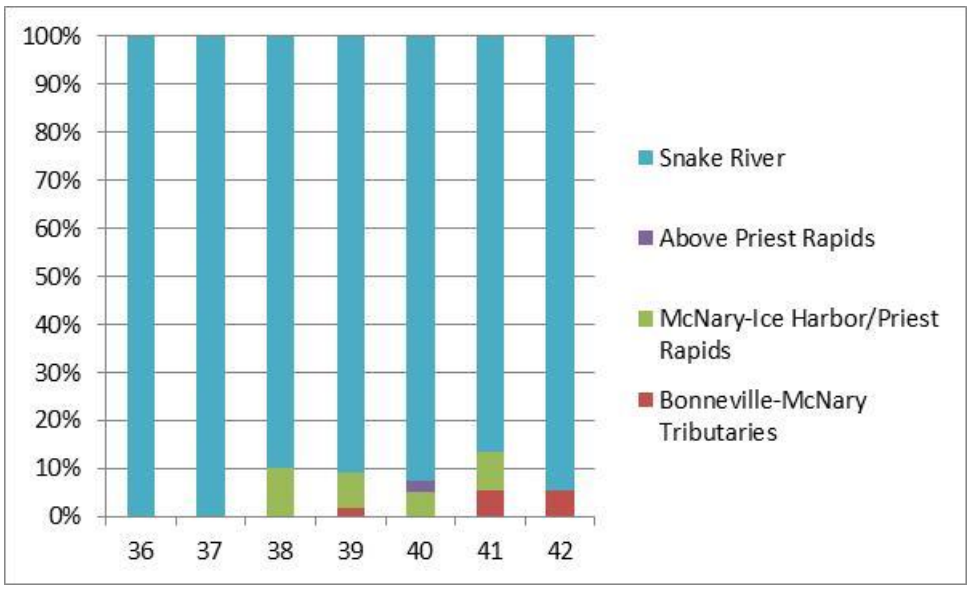

Figure 20. Final detection site for B-run steelhead (≥78 cm fork length) by Statistical Week they were sampled at Bonneville Dam in 2014. Weeks with fewer than five B-run steelhead sampled are omitted.

Kelt Analyses

A total of 71 steelhead PIT tagged and tracked in 2014 were either detected going downstream in the Columbia Basin after March 31, 2015, presumably in an attempt to return to the ocean after spawning (kelts), or

detected moving back upstream later in 2015 as repeat spawners. Ten of the steelhead were recognized in the CRITFC Kelt Project as spawned-out and moving back downriver (collected for study – Hatch et. al. *Multiple Years*) (Figure 21, Table 29, Table A5). In addition, since a multitude of detection sites are now available, we decided to look at fish moving before March 31st to determine if any steelhead were exhibiting kelt behavior, that might be missed by our standard March 31st cutoff date. We found 8 fish, tagged in 2014 that, were detected moving out of the system in juvenile bypasses at mainstem dams, most after visiting upper areas of tributaries in the Winter of 2014/2015 (Figure 21, Appendix Table A6). These additional fish expand the count to 77 fish tagged in 2014 determined to be kelts.

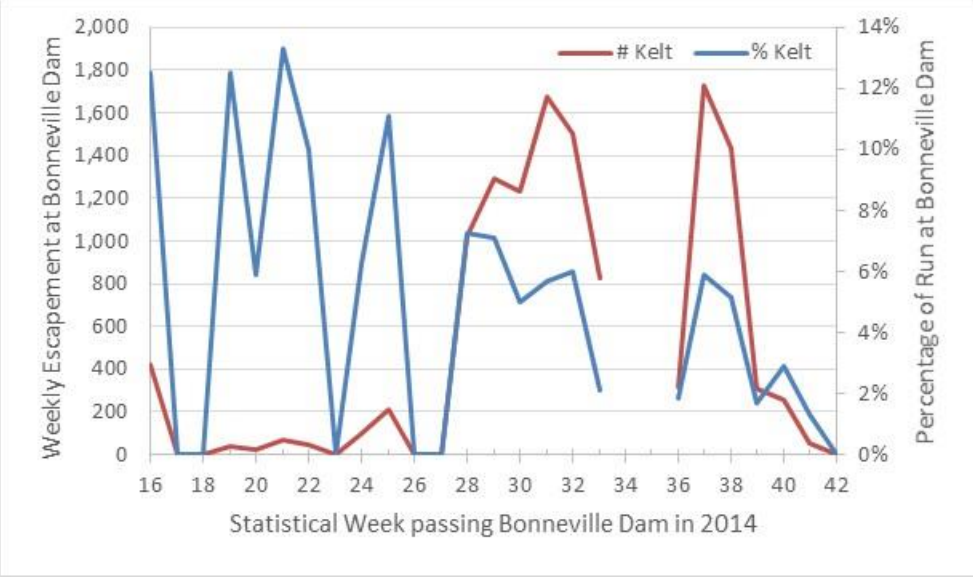

Figure 21. Percentage and number of steelhead by statistical week as sampled at Bonneville Dam in 2014 which were designated as kelt.

Table 29. Some biological and detection information on the steelhead moving in the Columbia Basin system in 2014 that were determined to be kelts (CRITFC Kelt Project), or repeat spawners and potential kelts (because of their behavior). Please see Tables A5-7 for more details on the detected behavior of the steelhead.

					Most Upstream Site		Last Site Detected				
PIT Tag	Date Tagged	Age	Fin Clip	Fork Length	Basin and Site	Date	Basin and Site	Date	Comment	Down-stream Spring 15	Upstream Spring 15
384.3B23AF2472	4/16	1.2	AD	62.0	Columbia (BO3)	04/15/15	Columbia (BO4)	04/15/15	Repeat Spawner	X	
384.3B23AFBCF9	5/6	1.2	AD	72.0	Klickitat (LFF)	05/17/14	Columbia (BCC)	03/16/15		X	
384.3B23AF8A1D	5/12	2.2S		71.5	Columbia (BO2)	07/13/15	Columbia (BO4)	07/14/15	Repeat Spawner		X
384.3B23ADD743	5/20	r.2		67.0	Klickitat (LFF)	05/24/14	Columbia (BCC)	04/22/15		X	
384.3B23ADF7D7	5/23	r.1		66.0	Columbia (BO1)	03/29/15	Columbia (BO1)	03/29/15		X	
384.3B23AD8D7E	5/28	r.2		65.0	Columbia (WEA)	06/19/14	Columbia (RRJ)	04/11/15		X	
3D9.1C2E03A59F	6/11	1.2	AD	67.0	Snake (LMA)	08/09/14	Walla Walla (PRV)	09/06/15	Repeat Spawner		X
384.3B23ADA9E6	6/17	2.2		73.5	Snake (LMA)	06/28/14	Columbia (BCC)	03/20/15		X	
3DD.0077390B58	6/19	r.2		67.0	Salmon (LAP)	02/09/15	Columbia (BCC)	05/21/15		X	
3DD.00773B116A	7/8	2.2		66.0	Columbia (MC1)	07/21/14	Columbia (BCC)	05/01/15		X	
3DD.00773A414E	7/9	1.2	AD	67.5	Snake (GRA)	09/20/14	Snake (GRA)	09/20/14	In Kelt Program		
3DD.00773AFAC5	7/9	2.2		69.0	Yakima (SAT)	03/01/15	Columbia (TD1)	08/15/15	Repeat Spawner		X
3DD.00773AB74E	7/10	r.2	AD	68.0	Tucannon (BBT)	02/23/15	Columbia (B2J)	04/03/15		X	
3DD.00773B7875	7/11	2.1		54.0	Methow (BVC)	04/02/15	Columbia (RIA)	06/07/15			
3DD.00773AE101	7/14	2.2		65.0	Deschutes (DRM)	09/10/15	Deschutes (DRM)	09/10/15	Repeat Spawner		X
3DD.00773AC548	7/16	2.1		61.5	Klickitat (LFF)	07/19/14	Columbia (BCC)	04/23/15		X	
3DD.00773BC92D	7/16	1.1	AD	55.0	Salmon (USI)	03/15/15	Columbia (BCC)	05/05/15		X	
3DD.00773AB5DD	7/16	r.1		63.5	Wind (WRU)	02/27/15	Columbia (BCC)	04/22/15		X	
3DD.00773B4FFA	7/16	2.1		56.0	Yakima (TOP)	04/07/15	Yakima (TOP)	04/07/15	In Kelt Program		
3DD.00773B5512	7/17	2.2		67.0	Columbia (MC1)	08/01/14	Columbia (BCC)	04/19/15		X	
3DD.00773B5527	7/18	r.1		55.0	Clearwater (MIS)	04/18/15	Columbia (B2J)	06/13/15		X	
3DD.00773AC2F7	7/18	r.1		51.0	Deschutes (DRM)	12/31/14	Columbia (BCC)	04/14/15		X	
3DD.00773AC73F	7/18	r.2		72.0	Snake (GRA)	08/22/14	Columbia (BCC)	05/29/15		X	

3DD.00773BCD15	7/18	1.2		67.0	Salmon (USE)	03/14/15	Columbia (BCC)	05/14/15		X	
3DD.00773B6FD3	7/21	r.2		65.5	Tucannon (BBT)	04/26/15	Columbia (BCC)	05/13/15		X	
3DD.00773AE22A	7/21	r.2		68.5	Columbia (WEA)	11/04/14	Columbia (BCC)	06/03/15		X	
3DD.00773B01A0	7/22	2.2		68.5	Deschutes (WSH)	05/09/15	Columbia (BCC)	05/23/15		X	
3DD.00773A9EE8	7/22	r.2		73.5	Methow (CRW)	03/30/15	Columbia (RRJ)	05/11/15		X	
3DD.00773B0F83	7/23	2.2		65.0	Columbia (MC1)	08/30/14	Columbia (BCC)	05/13/15		X	
3DD.00773ADDA5	7/23	2.1		55.0	Yakima (PRO)	03/08/15	Yakima (PRO)	03/08/15	In Kelt Program		
3DD.00773B5F26	7/24	2.1		56.5	Snake (ICH)	09/20/14	Columbia (BCC)	05/23/15		X	
3DD.00773B6417	7/24	r.1		57.5	Walla Walla (BGM)	03/27/15	Columbia (JDJ)	04/05/15		X	
3DD.00773ADDE1	7/24	2.2		64.5	Umatilla (FDD)	01/25/15	Columbia (JDJ)	04/09/15		X	
3DD.00773BA199	7/25	2.2		72.0	Snake (GRA)	09/14/14	Columbia (BCC)	04/22/15		X	
3DD.00773AEBB3	7/25	2.1		59.5	Columbia (MC1)	10/31/14	Columbia (BCC)	05/10/15		X	
3DD.00773BBFE3	7/25	2.1		58.5	Columbia (MC2)	08/04/14	Columbia (BCC)	05/08/15		X	
3DD.00773BAE8B	7/25	2.1		58.0	Columbia (MC1)	09/21/14	John Day (JD1)	11/07/14	Repeat Spawner		
3DD.00773AB71C	7/25	2.1		57.5	Yakima (TOP)	04/06/15	Yakima (TOP)	04/06/15	In Kelt Program		
3DD.00773BA48D	7/28	r.2		66.5	Snake (GRA)	09/19/14	Columbia (BCC)	04/23/15		X	
3DD.00773B431B	7/28	2.2		75.5	Grand Ronde (JOC)	03/20/15	Snake (GRJ)	03/25/15		X	
3DD.00773B4F78	7/28	2.2		67.5	Yakima (SCP)	04/05/15	Columbia (RRJ)	04/29/15		X	
3DD.00773B6CE5	7/29	1.1	AD	55.5	Snake (GRA)	10/13/14	Snake (GOJ)	04/12/15		X	
3DD.00773B0C58	7/29	1.1	AD	56.0	Snake (GRA)	09/25/14	Snake (LMJ)	04/10/15		X	
3DD.00773B5F17	7/29	1.1		57.5	Salmon (USI)	10/19/14	Snake (LMJ)	05/17/15	In Kelt Program	X	
3DD.00773B7AB8	7/29	r.2		69.0	Yakima (SAT)	04/03/15	Yakima (SAT)	04/03/15	In Kelt Program		
3DD.00773B2D13	7/30	2.1		59.0	Snake (ICH)	03/27/15	Columbia (BCC)	05/18/15		X	
3DD.00773AB573	7/30	2.2		66.0	Columbia (MC2)	10/28/14	Columbia (BCC)	04/12/15		X	
3DD.00773A9EE3	7/30	1.1		59.0	Columbia (PRA)	08/17/14	Yakima (PRO)	04/16/15	In Kelt Program		
3D6.000B38ABDD	7/30	1.2	LV	68.0	Columbia (WEA)	09/14/14	Columbia (RRJ)	04/11/15		X	
3DD.00773B9FF0	7/31	2.2		65.5	Entiat (ENL)	02/11/15	Columbia (BCC)	05/08/15		X	
3DD.00773AB587	7/31	2.2		69.5	Deschutes (TR2)	01/29/15	Columbia (BCC)	04/20/15		X	

3DD.00773B85E2	8/1	r.1		60.0	Imnaha (IR2)	04/21/15	Columbia (BCC)	05/25/15		X	
3DD.00773B926E	8/1	r.2	AD	66.5	Salmon (USE)	03/30/15	Columbia (BCC)	05/29/15		X	
3DD.00773AD073	8/5	2.2		73.0	Columbia (TD1)	09/06/14	Columbia (B2J)	03/28/15		X	
3DD.00773BB0D3	8/5	2.1		51.5	Yakima (PRO)	10/04/14	Columbia (BCC)	05/30/15		X	
3DD.00773BCE53	8/6	1.1	AD	52.5	Snake (GOA)	10/29/14	Snake (GOJ)	03/24/15		X	
3DD.00773BA8F4	8/6	r.2		69.0	Grand Ronde (JOC)	03/20/15	Grand Ronde (JOC)	03/20/15	In Kelt Program		
3DD.00773AD3B5	8/6	r.1		58.5	Methow (TWR)	04/22/15	Columbia (RRJ)	05/05/15		X	
3DD.00773B9534	8/6	1.1		49.0	Okanogan (ZSL)	04/22/15	Columbia (RRJ)	05/13/15		X	
3DD.00773AAF1D	8/7	1.2		68.0	Umatilla (FDC)	03/04/15	Columbia (BCC)	03/31/15		X	
3DD.00773BA2DA	8/7	2.2		64.0	Snake (GRA)	11/03/14	Columbia (BCC)	05/13/15		X	
3DD.00773B6282	8/7	1.2		70.0	Salmon (USI)	03/11/15	Columbia (BCC)	05/06/15		X	
3DD.00773AF096	8/8	2.1		54.0	Yakima (PRO)	10/01/14	Yakima (PRO)	10/01/14	In Kelt Program		
3DD.00773A9809	8/8	1.1		54.0	Methow (MWF)	04/29/15	Columbia (RRJ)	05/20/15		X	
3DD.00773B86FF	8/8	2.2		74.5	Columbia (WEA)	09/17/14	Columbia (RRJ)	04/21/15		X	
3DD.00773B76ED	8/11	1.2	AD	64.0	Snake (GRA)	10/12/14	Snake (LMJ)	04/20/15		X	
3DD.00773B07B8	8/12	2.2		74.0	Snake (GRA)	10/03/14	Snake (GRJ)	03/27/15		X	
3DD.00773B2D17	9/5	r.2		73.0	Columbia (RIA)	10/05/14	Columbia (BCC)	05/03/15		X	
3DD.00773AA263	9/8	2.2		69.0	Tucannon (BBT)	02/21/15	Columbia (BCC)	04/12/15		X	
3DD.00773B9225	9/17	1.2		70.0	Methow (MWF)	04/10/15	Columbia (RRJ)	04/27/15		X	
3DD.00773B8494	9/18	2.2		81.0	Snake (GRA)	10/15/14	Columbia (BCC)	05/22/15		X	
3DD.00773B6278	9/19	2.2		75.0	Walla Walla (NBA)	03/30/15	Columbia (MC2)	04/12/15			
3DD.00773B8C03	9/23	1.2	AD	76.0	Clearwater (CLC)	04/03/15	Snake (GOJ)	04/27/15	In Kelt Program	X	
3DD.00773B0776	9/25	1.1	AD	55.0	Salmon (USI)	03/31/15	Columbia (MCJ)	05/22/15		X	
3DD.00773B5173	9/29	1.1		55.5	Salmon (LRW)	04/25/15	Columbia (BCC)	05/21/15		X	
3DD.00773BA83A	9/30	2.1		54.5	Snake (GRA)	10/26/14	Columbia (BCC)	05/13/15		X	
3DD.00773AE2A5	10/2	1.2	AD	79.0	Salmon (USE)	03/23/15	Columbia (BCC)	05/12/15		X	
3DD.00773AD7AA	10/8	2.2		67.5	Klickitat (LFF)	10/20/14	Columbia (BCC)	04/26/15		X	
3DD.00773B5D73	10/17	2.2		80.5	Clearwater (SC1)	02/23/15	Snake (GRJ)	03/22/15		X	

Many kelts that are detected moving out of the system are detected in the juvenile bypasses (last detection location) of the major dams such as Bonneville (3), John Day (2), McNary (1), Ice Harbor (0), Lower Monumental (2 + 1 in Kelt Program), Little Goose (2 + 1 in Kelt Program), Lower Granite (3) and Rocky Reach (10). Another major exit location for kelts is Bonneville's Corner Collector, which had 38 steelhead use it in 2015 (Table 30).

In recent years, many more detection systems have been added to the tributaries of the Columbia and Snake Basins and therefore more of the kelts are detected moving in and out of the tributaries of the Columbia. For 2014, 35 of the steelhead identified as kelts or repeat spawners were detected entering and/or leaving major rivers of the Columbia and Snake Basins, and 28 of these fish were detected in upper regions and creeks of the tributaries, presumably to spawn (Table A5 and Figure A1 - map of all detection locations).

We have also updated information of several kelts/repeat spawners from past annual reports (2013, 2012 and 2011) with data from 2014/2015 movements (Table A7). Some steelhead already identified as kelts or repeat spawners in the reports have new information added, others are newly added because they were detected a year or two later moving upriver again to spawn. Usually, up to three past years of tagged steelhead have appeared in the detection system, however for years 2014/2015, steelhead tagged in 2013 were the only group detected moving in the system.

Table 30. PIT tagged steelhead in 2009-2014 tracked from Bonneville Dam last detected moving downstream after March 31 of the year after sampling, listed by last downstream detection site. Eight more fish were added, that were moving downstream before March 31 and 5 more fish added that migrated upstream passed Bonneville Dam late in 2015 after spending the 2014 year in the Columbia System and possibly the ocean (repeat spawners).

Last site	2014	2013	2012	2011	2010	2009
Bonneville Corner Collector	38	30	25	10	23	61
Bonneville Juvenile Bypass	3	6	5	1	4	7
Bonneville Dam Bradford Island Ladders heading downstream	1	3	2	0	0	0
Estuary Trawl	0	2	2	0	0	1
Ice Harbor Juvenile Bypass	0	0	0	1	6	0
Ice Harbor Ladders heading downstream	0	1	0	NA	NA	NA
John Day Juvenile Bypass	2	8	6	3	11	3
Little Goose Juvenile Bypass	2	9	5	11	13	6
Lower Granite Juvenile Bypass	3	4	3	4	10	3
Lower Monumental Juvenile Bypass	2	7	1	12	9	4
Lower Monumental Fish Ladders moving downstream	0	0	0	0	0	0
Lower Washington Shore McNary Dam ladder, likely moving downstream.	1	0	0	0	2	1
McNary Dam Juvenile Bypass	1	4	4	3	2	4
Rocky Reach Juvenile Bypass	10	1	0	4	6	7
Migrating downstream in tributaries	NA	4	3	0	0	0
Repeat spawners, passed Bonneville Dam twice migrating upstream	5	12	1	NA	NA	NA
Trapped by CRITFC kelt program						
Snake Basin	4	11	NA	NA	NA	NA
Yakima Basin	6	6	1	NA	NA	NA
Total	**77**	**108**	**58**	**49**	**86**	**97**
Percent of steelhead tracked last moving downstream	**4.5%**	**7.2%**	**4.0%**	**3.1%**	**5.2%**	**4.8%**
Additional steelhead detected migrating upstream in subsequent migration year	**8**	**16**	**11**	**5**	**9**	**NA**
Minimum Number of Kelt	**85**	**124**	**69**	**54**	**95**	**97**

RESULTS-SOCKEYE[e]

Sample Size

A total of 1420 Sockeye Salmon were sampled for this project between May 16 and August 7, 2014 (Table 31). Of these, two were not tagged or the tags were unreadable, and four died prior to release. Four Sockeye were previously tagged and added to the 1410 Sockeye tagged, released and tracked.

Of these 1414 Sockeye included in this study, 14 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 Salmon 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 through four PIT tag antennas on the Washington shore ladder or three antennas on the Oregon shore ladder near the fish counting window that detect very close to 100% of passing PIT tagged fish (Appendix 1). However, at Bonneville Dam (as well as The Dalles, McNary, Ice Harbor, and Lower Granite dams) fish can pass upstream through the navigation locks. All other dams with PIT tag detection have antennas in fish ladders that Sockeye Salmon must pass through, however data from 2006-2014 indicates that PIT tagged Sockeye Salmon are missed, although the percentage is normally low (Table 32) with the exception of Rock Island Dam as noted in previous years. The percentage missed at Ice Harbor Dam was 12.5% but this is based on only eight Sockeye.

The predominant age group was Age 1.2, followed by Age 1.1 and 1.3 (Table 33). The percentage of Age 1.1 Sockeye increased as the run progressed while Age 1.2 Sockeye decreased.

[e] The information presented in this section of the report is a summary of Fryer et al. 2016.

Table 31. Number of Sockeye Salmon sampled and PIT tagged at Bonneville Dam and tracked upstream by date and statistical week in 2014.

Sampling Dates	Statistical Week	Sampled (n)	Tagged	Mortalities	Previously Tagged	Detected After Tagging and Tracked
5/16,29,6/2,4-6	21-23	16	16	0	0	15
6/9-6/13	24	110	110	0	0	110
6/16-6/20	25	269	268	0	0	268
6/23-6/27	26	300	299	0	0	296
6/30,7/1-3	27	230	229	0	0	228
7/7-7/11	28	259	256	0	1	255
7/14-7/18	29	146	146	2	0	141
7/21-25	30	59	59	0	0	58
7/28-31, 8/1	31	22	22	1	2	21
8/5-7	32	9	9	1	1	8
Total		**1420**	**1414**	**4**	**4**	**1400**

Table 32. Number and percentage of PIT tagged fish not detected at dam detection sites as estimated from upstream detections in 2014 compared to 2006-2013.

Dam	2014	2013	2012	2011	2010	2009	2008	2007	2006
Bonneville	0.7%	0.4%	1.8%	0.5%	0.7%	0.6%	0.4%	2.1%	0.2%
The Dalles	0.3%	1.6%							
McNary	3.8%	2.1%	12.1%	1.6%	3.8%	5.0%	10.1%	6.5%	3.1%
Priest Rapids	0.2%	0.0%	0.4%	0.2%	0.6%	0.3%	0.3%	0.8%	0.0%
Rock Island	41.5%	4.4%	5.4%	4.4%	6.2%	2.6%	6.9%	6.8%	1.3%
Rocky Reach	0.3%	0.0%	1.4%	0.7%	0.5%	0.0%	0.2%	0.7%	12.3%
Wells	0.0%	0.0%	0.0%	0.0%	0.0%				
Ice Harbor	12.5%		0.0%	NA	0.0%	20.0%	0.0%		
Lower Granite	0.0%								
Tumwater	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%			

Table 33. Weekly and total age composition of Sockeye Salmon at Bonneville Dam as estimated from scale patterns in 2014.

Statistical Week	N Ageable	Age Class				
		1.1	1.2	2.1	1.3	2.2
23	14	0.0%	85.7%	0.0%	14.3%	0.0%
24	107	4.7%	93.5%	0.0%	1.9%	0.0%
25	265	4.2%	91.7%	0.0%	2.3%	1.9%
26	295	10.2%	89.5%	0.0%	0.0%	0.3%
27	225	14.2%	84.0%	0.0%	0.4%	1.3%
28	255	23.5%	75.7%	0.4%	0.4%	0.0%
29	144	27.1%	72.2%	0.0%	0.7%	0.0%
30	58	25.9%	74.1%	0.0%	0.0%	0.0%
31	31	38.7%	58.1%	0.0%	3.2%	0.0%
Composite	**1394**	**14.2%**	**84.4%**	**0.1%**	**0.6%**	**0.7%**
Std. Dev.		**1.0%**	**1.1%**	**0.1%**	**0.2%**	**0.4%**

Upstream Recoveries, Mortality, and Escapement

Based on PIT tag detections, an estimated 88.3% of Sockeye Salmon passing Bonneville Dam also passed McNary Dam (Figure 22). The Dalles Dam and McNary dams estimated by PIT tags deployed by this project were within 2.5% of visual counts (Table 34). However, at dams upstream of Priest Rapids Dam, PIT tag estimates of escapement were between 8.2% and 19.7% less than visual dam counts. We did estimate higher escapements than visual counts at Ice Harbor and Lower Granite dams but sample sizes (seven and six PIT tagged Sockeye respectively) were very small.

Table 34. Percentage of PIT tagged Sockeye Salmon detected at upstream dams subsequent to tagging at upstream dams, estimated escapement from both PIT tags and visual means, and the difference between the PIT tag and visual escapement estimate in 2014.

Dam	Estimated Percentage Reaching Dam	Estimated Escapement Using Bonneville PIT Tagged Sockeye	Visual Dam Count	Difference Between Bonneville PIT Tag and Visual Estimate
Bonneville		614,179	614,179	
The Dalles	93.1%	571,731	586,188	-2.5%
McNary	88.3%	542,199	546,012	-0.7%
Priest Rapids[f]	84.5%	519,258	608,142	-14.6%
Rock Island	79.5%	488,025	581,121	-16.0%
Rocky Reach	65.3%	401,259	492,892	-18.6%
Wells	64.2%	394,000	490,804	-19.7%
Zosel	48.6%	298,582	325,277	-8.2%
Tumwater	13.6%	83,564	99,899	-16.4%
Ice Harbor	0.7%	4,479	2,392	87.3%
Lower Granite	0.6%	3,571	2,786	28.2%

[f] 11 tagged Sockeye were last detected at the Priest Rapids adult fish trap, and presumably among the 10,000 Sockeye collected for a Cle Elum Lake Sockeye reintroduction program, are not included. Trapped fish are trapped downstream of the fish ladder so would not be expected to be included in Priest Dam visual counts.

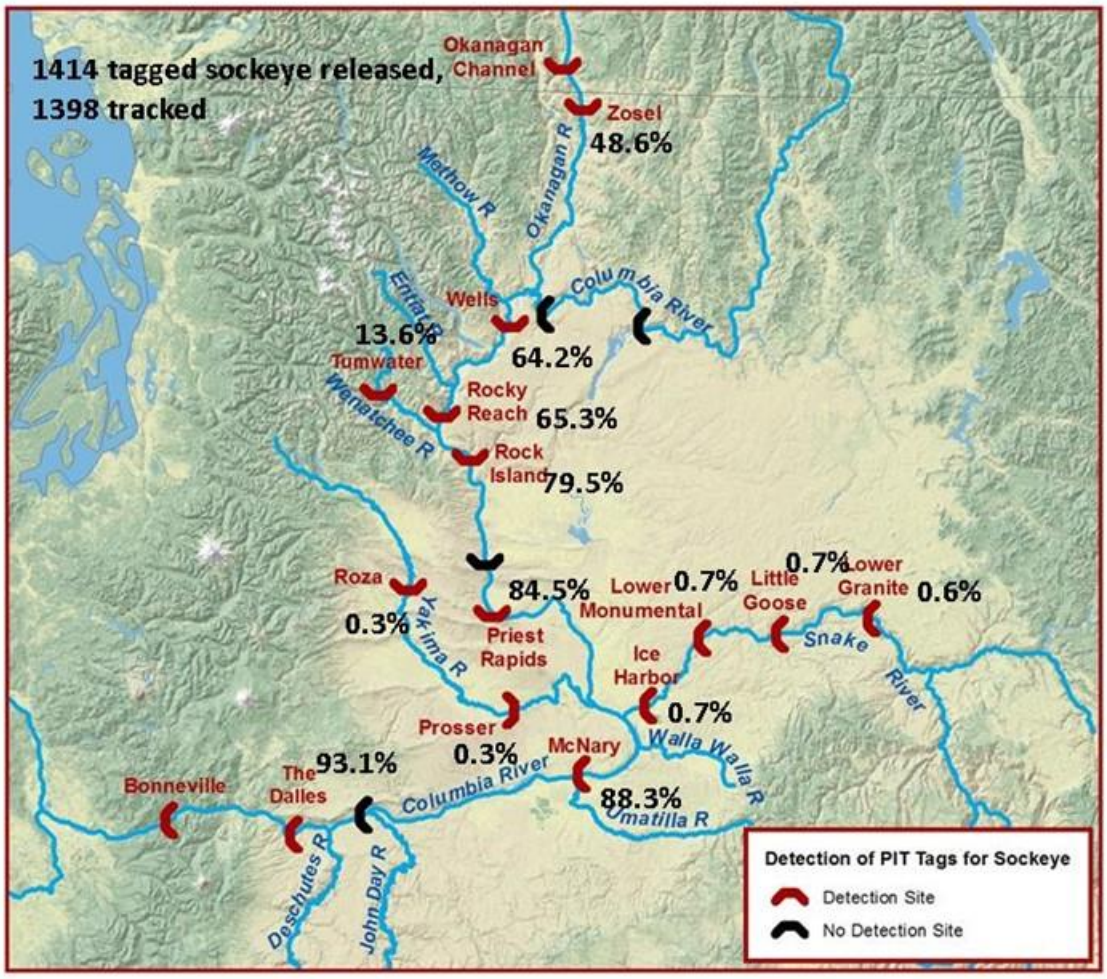

Figure 22. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of fish PIT tagged at Bonneville Dam, and the percentage of the run estimated to pass upstream dams in 2014.

As in most years of this study, and also true in 2014, survival from Bonneville to McNary, Priest Rapids, and Rock Island dams showed a significant linear decrease with week sampled and tagged at Bonneville Dam (Table 35, Figure 23). There was also a significant linear decrease for survival to The Dalles but survival from Rocky Reach to Wells dam was not significantly related to statistical week tagged at Bonneville Dam. The percentage of Age 1.1 Sockeye surviving to Rock Island Dam (81.3%) was greater than that for Age 1.2 (79.5%) Sockeye Salmon (Figure 24).

Table 35. Sockeye Salmon survival through selected reaches by statistical week as estimated by PIT tag detections in 2014 and the p-value for a linear regression between weekly reach survival and statistical week.

Statistical Week at Bonneville Dam	Bonneville-The Dalles	Bonneville-McNary	Bonneville-Priest Rapids[g]	Bonneville-Rock Island	Rocky Reach-Wells
23	100.0%	87.5%	81.3%	81.3%	100.0%
24	95.5%	94.5%	92.7%	91.8%	98.8%
25	92.9%	90.3%	89.2%	82.5%	97.7%
26	95.6%	91.2%	87.8%	82.4%	98.4%
27	92.5%	89.4%	85.0%	79.7%	98.7%
28	95.7%	89.8%	86.7%	82.7%	97.3%
29	79.1%	64.7%	55.4%	51.1%	98.5%
30	75.9%	58.6%	55.2%	46.6%	96.0%
Composite	**93.1%**	**88.3%**	**84.5%**	**79.5%**	**98.2%**
P-value	**0.016**	**0.057**	**0.009**	**0.004**	**0.446**

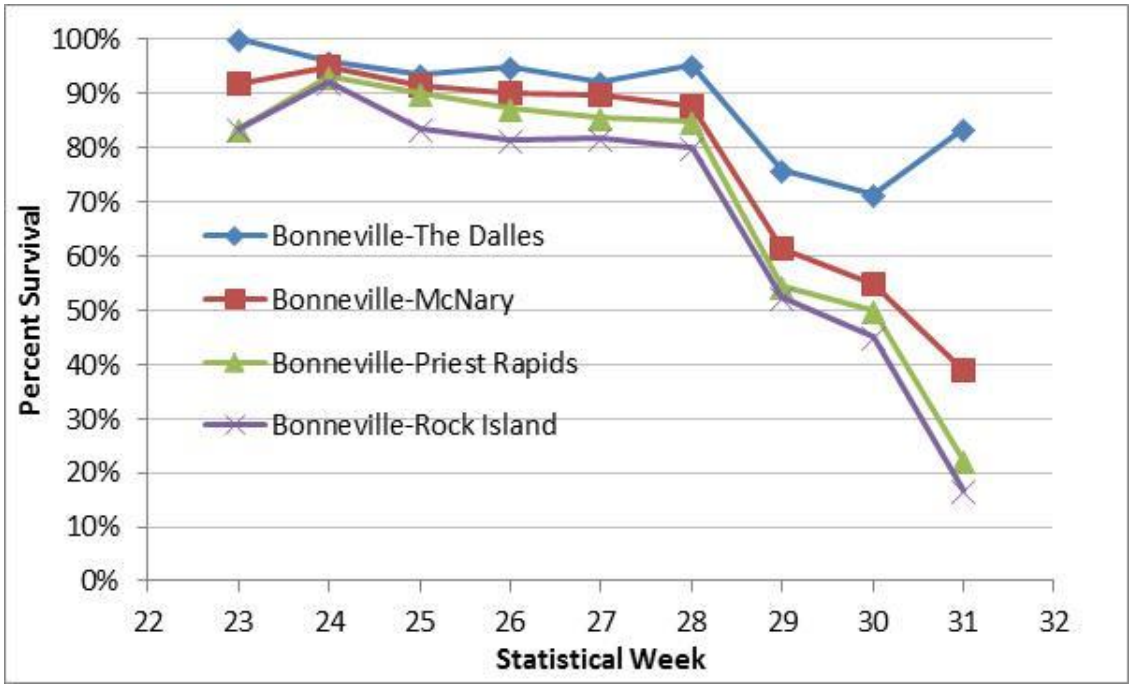

Figure 23. Survival of Sockeye Salmon PIT tagged at Bonneville Dam to The Dalles, McNary, Priest Rapids, and Rock Island dams by statistical week in 2014.

[g] Includes Sockeye Salmon only detected in the Priest Rapids Dam trap that likely were collected for the Cle Elum Sockeye reintroduction project.

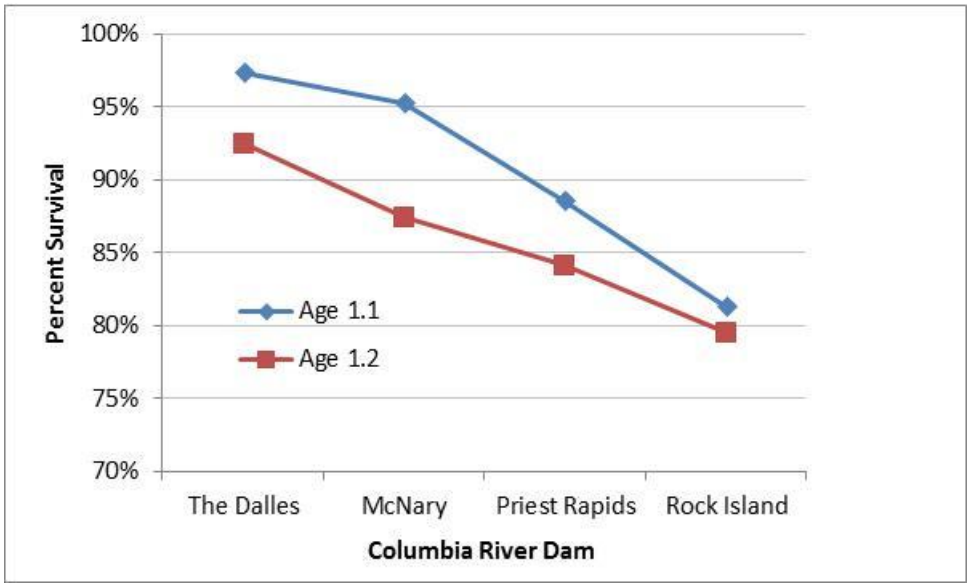

Figure 24. Survival of Sockeye Salmon PIT tagged at Bonneville Dam to The Dalles, McNary, Priest Rapids, and Rock Island dams age group in 2014.

Stock Composition

The percentage of the run that was comprised of the Wenatchee Sockeye Salmon stock was highest during the middle of the run at Bonneville Dam when compared to the beginning and end of the run (Table 36). The overall stock composition estimate at Bonneville Dam was 17.5% Wenatchee, 81.1% Okanagan, 1.0% Snake River, and 0.4% Yakima. Removing the Snake River and Yakima components results in an estimate above Priest Rapids Dam of 82.3% Okanagan and 17.7% Wenatchee, which is within 2.7 percentage points of estimates derived from dam counts (Table 36).

Nine Sockeye Salmon last detected in the Wenatchee River strayed up the Columbia past the confluence with the Wenatchee River prior to returning to the Wenatchee River. These nine Sockeye Salmon were all detected at Rocky Reach Dam with one of these also detected at Wells Dam. There were no Sockeye detected at Tumwater Dam on the Wenatchee River that were subsequently detected anywhere downstream of Tumwater Dam (including in the Columbia River upstream of the Wenatchee River). Among the seven Sockeye detected at Ice Harbor Dam, one (PIT Tag code 3DD.00773AB80D) passed upstream of Priest Rapids Dam before falling back over Priest Rapids and turning up the Snake River. This is the first time that this study has observed this behavior but our Snake River Sockeye Salmon sample size is always very small.

Table 36. Weekly and composite Sockeye Salmon stock composition at Bonneville Dam as estimated by PIT tags in 2014 and a comparison to stock composition estimates estimated using visual dam counts

Statistical Week and Dates	Run Size from Bonneville Dam visual counts	PIT tags deployed at Bonneville	% Okanagan	% Wenatchee	% Snake	% Yakima[h]
23 (May 16-June 6)	1,528	16	92.3%	7.7%	0.0%	0.0%
24 (June 9-13)	17,986	110	85.0%	15.0%	0.0%	0.0%
25 (June 16-20)	67,754	269	79.2%	20.4%	0.0%	0.5%
26 (June 23-27)	181,833	300	77.2%	22.0%	0.8%	0.0%
27 (June 30-July 3)	189,166	230	80.5%	17.3%	1.6%	0.5%
28 (July 7-11)	110,316	259	86.3%	12.7%	0.5%	0.5%
29 (July 14-18)	33,124	146	87.7%	9.6%	1.4%	1.4%
30 (July 21-25)	9,465	59	88.9%	11.1%	0.0%	0.0%
31 (July 28-Aug 1)	2,123	31	83.3%	0.0%	16.7%	0.0%
Composite	**613,295**	**1,420**	**81.1%**	**17.5%**	**1.0%**	**0.4%**
Visual Fish Counts at dams (using difference between Rock Island and Rocky Reach counts to estimate proportion Wenatchee)			84.8%	15.2%		
Visual Fish Counts at dams (Tumwater count to estimate the proportion Wenatchee)			82.2%	17.2%		

A total of 10 Sockeye Salmon PIT tagged at Bonneville Dam were adipose clipped[i] with an additional four Sockeye Salmon maxillary clipped (Table 37). Of these Sockeye, six were last detected in the Wenatchee Basin, three in the Okanagan Basin, two in the Snake Basin, two at McNary Dam, and one at Priest Rapids Dam.

[h] Excludes four sockeye that were transported from Priest Rapids Dam to Cle Elum Lake and were subsequently detected at Prosser or Roza dams.
[i] Juvenile Sockeye Salmon are adipose clipped in Snake River and Lake Wenatchee hatchery programs.

Table 37. Last detection site of clipped Sockeye Salmon tagged at Bonneville Dam in 2014.

Last Detection Site	Left Ventral	Right Maxillary Clip	Adipose Clipped
McNary Dam	1	0	1
Priest Rapids Dam	0	0	1
Upper Wenatchee River (UWE)	0	0	4
Wenatchee spawning grounds (WTL)	0	0	2
Zosel Dam	1	1	0
Okanagan spawning grounds (OKC)	0	1	0
Lower Granite Dam	0	0	1
Upper Salmon River (USE)	0	0	1
Total	**2**	**2**	**10**

Migration Rates and Passage Time

Adult Sockeye Salmon travel quickly upstream with a median migration rates between mainstem dams ranging between 28.5 and 53.7 km/day for Sockeye tagged at Bonneville Dam (Table 38). Returning adults tagged as smolts generally have comparable migration rates, with their median migration rate from Bonneville to Rock Island Dam being 0.5 km per day greater than Sockeye tagged as adults (Table 38).

Sockeye Salmon tagged at Bonneville Dam later in the migration travel upstream faster than those earlier in the migration (Table 39). There is a significant (α=0.05) linear relationship between statistical week passing Bonneville Dam and migration time from Bonneville Dam to all upstream dams in Table 39 except for Rock Island Dam where the low PIT tag detection rate likely resulted in a high travel time for those Sockeye tagged in week 31. The median difference in travel time from Bonneville Dam to all upstream mainstem dams except Rocky Reach Dam (where only four Sockeye classified as Wenatchee stock were detected) was one day or less between the two major stocks (Table 39. Age 1.1 Sockeye salmon traveled fastest upstream, followed by Age 1.2 and 1.3 Sockeye salmon.

Table 38. Median Sockeye Salmon migration rates and travel time between dams as estimated by PIT tag detections in 2014.

		Tagged at Bonneville Dam		Adults Tagged as Juveniles	
Dam Pair	Distance (km)	Median Travel Time (days)	Median Migration Rate (km/day)	Median Travel Time (days)	Median Migration Rate (km/day)
Bonneville-The Dalles	74	1.8	41.6	1.7	43.7
The Dalles-McNary	162	3.0	53.7	3.1	51.6
McNary-Priest Rapids	167	3.8	44.0	3.8	44.4
Priest Rapids-Rock Island	89	3.1	28.5	3.1	28.3
Rock Island-Rocky Reach	33	1.0	31.6	0.9	35.3
Rocky Reach-Wells	65	1.8	36.1	1.7	39.3
Rock Island-Tumwater	73	9.4	7.8	10.2	7.2
Bonneville-McNary	231	4.8	47.7	4.9	47.1
Bonneville-Rock Island	487	12.2	40.0	12.0	40.5
Bonneville-Tumwater	560	22.9	24.4	22.2	25.2
Bonneville-Wells	585	14.9	39.4	14.0	41.7

Table 39. Adult Sockeye Salmon travel median 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 2014.

Statistical Week at Bonneville Dam	BON-TDA	BON-MCN	BON-PRA	BON-RIA	BON-TUM	BON-RRH	BON-WEL	BON-ZSL	WEL-ZSL	RIA-TUF
23	2.0	6.7	12.6	19.2	39.7	20.2	22.7	44.8	20.9	
24	1.9	5.7	10.8	14.6	31.8	16.9	19.3	40.7	21.4	13.9
25	1.9	5.0	9.5	13.1	24.9	14.7	16.7	34.5	16.8	10.3
26	1.9	4.8	8.8	12.1	21.0	12.9	14.7	28.6	13.5	9.0
27	1.8	4.8	8.1	10.9	18.1	11.9	13.8	22.8	8.1	6.7
28	1.4	4.5	7.8	10.8	20.0	11.7	13.6	17.5	4.1	7.6
29	1.6	4.3	8.0	11.2	18.9	12.1	13.8	41.8	27.7	6.7
30	1.7	4.9	8.9	11.5	25.0	12.1	13.8	36.7	23.7	
31	1.4	4.9	8.9	19.9		13.2	15.1			
P-value	**0.01**	**0.03**	**0.03**	**0.70**	**0.04**	**0.01**	**0.01**	**0.24**	**0.64**	**0.07**
Stock										
Okanagan	1.8	4.8	8.7	12.9	NA!	12.9	14.9	25.9	11.1	NA
Wenatchee	1.8	5.0	9.2	13.9	22.9	14.9	14.9	NA	NA	9.4
Unknown[j]	1.8	4.8	9.0	13.0	NA	20.8	23.1	NA	NA	NA
Age										
1.1	1.8	4.8	8.5	10.9	20.0	12.5	14.0	23.1	8.0	NA
1.2	1.8	4.9	8.8	13.2	22.6	13.0	15.0	27.0	11.7	9.1
1.3	2.2	6.0	11.0	15.2	28.6	17.1	19.9	31.5	13.3	10.1

[j] Unknown stock Sockeye Salmon are those that passed Bonneville but were not detected at Tumwater, Rocky Reach, Wells, Ice Harbor, or Lower Granite dams.

The median passage time at a dam (defined as the difference between the first and last detection at a dam) for Sockeye tagged at Bonneville Dam and those tagged as smolt was generally under five minutes (Table 40). Exceptions were at dams with adult trapping which may delay upstream migration (Bonneville, Priest Rapids, Wells, Tumwater, and Lower Granite dams) and dams with PIT tag antennas distributed through a higher proportion of the length of the fish ladder (e.g. Bonneville, McNary, Priest Rapids, and Wells dams). For example, Bonneville Dam, unlike many dams which only have PIT tag antennas in the upper ladder, has an extensive array of antennas that include the lower ladders resulting in earlier detection than most other dams and thus a more complete record of passage times in the ladders. Even with the tendency of sockeye salmon to use the unmonitored overflow orifices, they often hit at least one PIT tag monitored underwater orifice on their passage through fish ladders. Median passage time for Sockeye tagged as juveniles was generally similar to those tagged as part of this project. Exceptions were Bonneville Dam, where it is possible that impacts of our tagging delayed passage and the Snake River where sample sizes of adults tagged at Bonneville Dam were very small.

Table 40. 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 2014.

	Adults Tagged at Bonneville Dam		Previously Tagged as Juveniles	
Dam	Median Passage (Minutes)	%>12 Hours	Median Passage (Minutes)	%>12 Hours
Bonneville	63.57	4.4%	15.02	4.3%
The Dalles	0.10	2.2%	0.12	7.4%
McNary	0.13	0.8%	0.13	0.2%
Priest Rapids	7.10	3.6%	6.95	1.6%
Rock Island	2.10	0.6%	2.17	1.2%
Rocky Reach	4.67	1.6%	4.72	0.0%
Wells	11.19	3.9%	7.83	3.6%
Zosel	0.6	2.7%	0.40	1.2%
Tumwater	6.05	6.3%	6.53	8.1%
Ice Harbor	4.72	0.0%	5.15	9.1%
Lower Monumental	0.25	0.0%	0.19	12.3%
Little Goose	0.05	14.3%	90.58	8.8%
Lower Granite	69.31	33.3%	94.27	28.6%

Night Passage

Okanagan Sockeye Salmon stock tagged at Bonneville Dam passed PIT tag antennas at night (2000-0400 hours) at a higher rate than Wenatchee Sockeye Salmon stock at 8 out of 10 sites where Sockeye from both stocks were

detected (Table 41). Okanagan stock Sockeye Salmon had among the highest night passage rates in natal areas (9.5% at Wells Dam, 23.5% at Zosel Dam, and 19.2% at the Okanagan Channel (OKC)). The Bonneville Dam Washington shore estimate of night passage is likely biased low because tagging occurred between about 0800 and 1300 hours, and with a median passage time of 64 minutes from tagging to final detection at Bonneville Dam (Table 41), fish would be expected to pass the counting window prior to 2000 hours.

Table 41. Estimated Sockeye Salmon night passage (2000-0400) by stock at mainstem Columbia River dams in 2014.

Dam	Adults Tagged at Bonneville Dam				Sockeye Tagged as Juveniles
	Okanagan Stock	Wenatchee Stock	Unknown	All Adults	
Bonneville-OR shore	11.8%	0.0%	0.0%	8.0%	4.6%
Bonneville-WA shore	0.3%	0.0%	1.0%	0.4%	2.4%
The Dalles-OR shore	9.8%	2.3%	9.5%	8.7%	7.3%
The Dalles, WA shore	3.5%	0.0%	13.3%	6.1%	4.9%
McNary-OR shore	4.0%	7.0%	5.8%	4.5%	5.8%
McNary-WA shore	7.1%	7.3%	10.3%	7.5%	8.6%
Priest Rapids	4.1%	1.1%	1.5%	3.4%	1.6%
Rock Island	3.4%	0.0%	0.0%	2.9%	9.9%
Rocky Reach	4.4%	0.0%	0.0%	4.4%	2.8%
Wells	9.5%	0.0%	0.0%	9.5%	6.7%
Tumwater		3.4%		3.4%	4.3%
Zosel	23.5%			23.5%	24.7%
Okanagan Channel	19.2%			19.2%	33.3%

Fallback

Fallback rates for adults tagged at Bonneville Dam ranged from 0.0% at Ice Harbor and Lower Monumental dams to 16.7% at Lower Granite Dam (Table 42). Fallback rates of Sockeye tagged as juveniles were generally higher than those tagged as adults, reaching a high of 32.7% at Lower Granite Dam. Fallback rates for all four Snake River dams were greater than 12% for Sockeye tagged as juveniles. Of the 346 returning Sockeye, 154 (44.5%) fell back at least once, with two falling back 10 times (Table 43). The mean number of fallbacks per Sockeye Salmon for Snake River Sockeye was 1.05 compared to 0.09 to 0.12 for the other juvenile groups and 0.12 for Sockeye in our Bonneville study.

Table 42. Estimated fallback rates for Sockeye Salmon at dams in 2014[k].

Dam	Adults Tagged at Bonneville	Tagged as Juveniles
Bonneville	1.4%	15.0%
The Dalles	3.9%	19.1%
McNary	0.7%	0.6%
Priest Rapids	3.6%	2.6%
Rock Island	0.6%	3.7%
Rocky Reach	1.7%	5.6%
Wells	1.7%	3.6%
Tumwater	0.0%	0.0%
Zosel	2.7%	6.6%
Ice Harbor	0.0%	12.3%
Lower Monumental	0.0%	17.1%
Little Goose	14.3%	15.1%
Lower Granite	16.7%	32.7%

Table 43. Number of fallback events by tag group for returning Sockeye tagged as juveniles and Sockeye included in our Bonneville adult tagging study in 2014.

	Sockeye Tagged as Juveniles by Tagging Location				Adults Tagged at Bonneville
Fallback events	**Okanagan**	**Rock Island**	**Snake**	**Wenatchee**	
1	7	12	73	3	109
2	0	1	32	1	15
3	0	0	15	1	4
4	0	0	16	0	1
5	0	0	5	0	0
6	0	0	5	0	0
7	0	0	6	0	0
10	0	0	2	0	1
Number of Sockeye falling back at least once	**7**	**13**	**154**	**5**	**130**
% of Sockeye with at least one fallback event	10.4%	8.4%	44.5%	5.7%	9.3%
Total fallback events	7	14	363	8	165
Number of Sockeye in study	67	155	346	87	1400
Fallbacks events per Sockeye	0.10	0.09	1.05	0.09	0.12

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

DISCUSSION

This study sampled and PIT tagged 6,907 salmonids at Bonneville Dam in 2014 and then tracked these fish 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 2014 marked the 9th year we have been tagging Sockeye Salmon, the 8th year we have tagged Chinook and the 6th year we have PIT 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.

Excluding Rock Island Dam, the percentage of salmonids passing mainstem dams undetected was generally under 2% for Chinook, steelhead, and Sockeye.

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 2014 the percentage of Chinook Salmon at Bonneville Dam which ultimately passed Ice Harbor Dam peaked at 53.2% of the run for the week starting May 11, declining to 8.6% for the week starting June 29, 2014 and ranged between 7.0% and 16.9% in July. The portion of the run bound for upstream of Priest Rapids Dam over the same period increased from 12.5% to 72.5%. While 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 2014 this transition started earlier in May than it has in the past.

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 instance, 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 20.9% of spring, 0.6% of the summer, and 7.9% 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 as falls, and misclassified fall Chinook were all classified as summer Chinook at Priest Rapids Dam. This study found that 1.1% of spring, 14.0% of summer, and 1.3% of fall Chinook at Bonneville Dam were classified differently at Ice Harbor Dam. Chinook classified at Bonneville Dam as spring Chinook were classified differently most commonly as summer Chinook at Ice Harbor Dam while Chinook classified as summer Chinook at Bonneville Dam were most commonly classified differently as spring Chinook at Ice Harbor Dam and all fall Chinook were classified as summer Chinook.

Escapement estimates using PIT tag data for mainstem dam passage varied from the traditional methods (i.e. visual counts) and ranged from -12.9% to +14.8% for the entire Chinook Salmon run (Table 7); however there was considerably greater variation when looking at individual runs. Escapement estimates for Sockeye Salmon at Columbia River dams differ between the methods by -19.7% to -0.7% (Table 34). Many factors can cause these discrepancies, including inaccuracies of visual or video counts, fallback/reascension rates, tagging effects, and a biased sample of fish being PIT tagged. Tagging additional adults, as well as better detection in terminal areas, would likely improve the precision and accuracy of stock specific escapement and survival estimates.

The number of fish tagged in 2014 was the highest in the six years of this project (Table 44). This was primarily due to an increased steelhead and

sockeye abundance which resulted in our steelhead sample increasing by 34.6% and our sockeye sample by 81.3%.

Table 44. Total number of Chinook and Sockeye salmon and steelhead PIT tags tracked by year (includes recaptures of previously PIT tagged fish).

	Total Tracked				Percent of Run Tracked			
Year	Chinook	Steelhead	Sockeye	Total	Chinook	Steelhead	Sockeye	Total
2009	2968	2485	838	6291	0.42%	0.41%	0.47%	0.42%
2010	2579	1741	913	5233	0.29%	0.42%	0.24%	0.31%
2011	3253	1377	763	5393	0.38%	0.37%	0.41%	0.38%
2012	3438	1451	1601	6496	0.50%	0.62%	0.31%	0.45%
2013	3406	1276	772	5454	0.26%	0.55%	0.42%	0.32%
2014	3869	1717	1400	6986	0.27%	0.63%	0.27%	0.33%

REFERENCES

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

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

FPC (Fish Passage Center). 2015 and 2014. Adult fish counts online at www.fpc.org.

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

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

Fryer, J.K., H. Wright, S. Folks, R. Bussanich, K. Hyatt, and J. Miller. 2016. Studies into Factors Limiting the Abundance of Okanogan and Wenatchee Sockeye Salmon in 2015. U.S. Dept. of Energy Bonneville Power Administration Report Project #2008-503-00.

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

Kelsey D., J. Mainord, J. Whiteaker, and J.K. Fryer. 2011. Age and length composition of Columbia Basin Chinook and Sockeye salmon and steelhead at Bonneville Dam in 2009. Columbia River Inter-Tribal Fish Commission Technical Report.

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

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

APPENDIX

Table A1. Probability of tag detection at PIT tag detectors by weir at Columbia Basin fish ladders, and the overall probability of detection, for Chinook Salmon in 2014. Right or left is determined by looking downstream at the dams, thus the right bank at Wells would be the west bank.

Dam, Site, Tag Type, and Number		Weir and Probability of Detection at Weir				Overall Detection Probability
Bonneville	**N**	**1**	**2**	**3**	**4**	
BO1	85	88.2	94.1	96.5	98.8	100.0
BO4	3773	97.7	97.9	98.1	98.8	100.0
The Dalles	**N**	**1**	**2**			
TD1	2585	99.8	99.8			100.0
	N	**1**	**2**			
TD2	397	99.7	100.0			100.0
McNary	**N**	**1**	**2**			
MC1	1463	94.5	99.9			100.0
		1	**2**	**3**		
MC2	995	98.9	99.8	97.4		100.0
Priest Rapids	**N**	**1-2**	**3-4**			
East	603	99.7	99.7			100.0
		5-6	**7-8**			
West	194	34.5	100.0			100.0
Rock Island	**N**	**1-2**	**3-4**			
Left (east)	204	100.0	100.0			100.0
		5-6	**7-8**			
Middle	84	98.8	100.0			100.0
		09-0A	**0B-0C**			
Right (west)	71	87.3	69.0			96.1
Rocky Reach	**N**	**0**	**1-2**	**3-4**		
	596	99.8	98.5	96.4		100.0
Wells	**N**	**1-2**	**3-4**			
Left (east)	371	99.4	99.7			100.0
		5-6	**7-8**			
Right (west)	134	100.0	99.3			100.0
Ice Harbor	**N**	**438**	**437**	**436**	**435**	
South	576	100.0	100.0	100.0	100.0	100.0
North	213	100.0	98..0	100.0	100.0	100.0
Lower Granite	**N**	**733**	**732**	**731**	**730**	
	899	99.9	100.0	100.0	99.8	100.0
Tumwater	**N**	**A1**	**A2**			
	79	100.0	100.0			100.0

Table A2. Probability of tag detection at PIT tag detectors by weir at mainstem Columbia Basin fish ladders, and the overall probability of detection, for steelhead in 2014. Right or left is determined by looking downstream at the dams, thus the right bank at Wells would be the west bank.

Dam, Site, Tag Type, and Number		Weir and Probability of Detection at Weir				Overall Detection Probability
Bonneville	**N**	**1**	**2**	**3**	**4**	
BO4 (North)	1650	97.8	98.4	98.7	99.1	100.0
BO1 (South)	67	97.0	98.5	97.0	98.5	100.0
The Dalles	**N**	**1**	**2**			
TD1 (South)	1118	99.8	99.6			100.0
TD2 (North)	167	100.0	100.0			100.0
McNary	**N**	**1**	**2**	**3**		
MC1 (South)	748	99.3	99.9			100.0
MC2 (North)	281	97.5	100.0	97.9		100.0
Priest Rapids	**N**	**1-2**	**3-4**			
East	100	97.0	100.0			100.0
		5-6	**7-8**			
West	19	63.2	100.0			100.0
Rock Island	**N**	**1-2**	**3-4**			
Left (east)	7	100.0	100.0			100.0
		5-6	**7-8**			
Middle	20	100.0	95.0			100.0
		09-0A	**0B-0C**			
Right (west)	26	92.3	73.1			97.9%
Rocky Reach	**N**	**1-2**	**3-4**			
	76	98.7	85.5			99.8
Wells	**N**	**1-2**	**3-4**			
Left (east)	36	100.0	97.2			100.0
		5-6	**7-8**			
Right (west)	31	100.0	100.0			100.0
Ice Harbor	**N**	**438**	**437**	**436**	**435**	
South	704	99.7	99.6	100.0	99.9	100.0
North	161	99.4	100.0	99.4	98.8	100.0
Lower Granite	717	99.9	99.7	99.9	99.7	100.0

Table A3. Probability of tag detection at PIT tag detectors by antenna at mainstem Columbia Basin fish ladders, and the overall probability of detection, for Sockeye Salmon in 2014.

Dam, Site, Tag Type, and Number		Antenna and Probability of Detection at Antenna				Overall Detection Probability
Bonneville	**N**	**1**	**2**	**3**	**4**	
BO1	25	96.0	100.0	100.0	100.0	100.0
BO4	1369	99.3	99.1	99.1	100.0	100.0
The Dalles	**N**	**1**	**2**			
TD1 (Oregon)	1162	100.0	100.0			100.0
TD2 (Washington)	131	100.0	98.5			100.0
McNary	**N**	**1**	**2**	**3**		
MC1 (Oregon)	511	99.4	100.0			100.0
MC2 (Washington)	649	100.0	99.8	95.5		100.0
Priest Rapids	**N**	**Upper**	**Lower**			
West	34	100.0	97.1			100.0
East	567	99.8	100.0			100.0
Rock Island	**N**	**Upper**	**Lower**			
Left	270	77.0	98.2			99.6
Middle	114	81.6	94.7			99.0
Right	39	79.5	59.0			91.6
Rocky Reach	**N**	**180**	**Upper**	**Lower**		
Right	888	99.4	99.8	98.8		100.0
Wells	**N**	**Upper**	**Lower**			
Left	383	100.0	100.0			100.0
Right	492	99.8	99.8			100.0
Tumwater	**N**	**Upper**	**Lower**			
Left	175	100.0	100.0			100.0

Right or left is determined by looking downstream at the dams, thus the right bank at Wells would be the west bank.

Table A4. 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 2014.

Site Code	Site Name	Site Description
158	Fifteenmile Ck at Eightmile Cr	At the confluence of Eightmile and Fifteenmile Creeks. Site is on private land.
ACB	Asotin Cr at Cloverland Bridge	Mainstem of Asotin Creek above the George Creek confluence, underneath the Cloverland Bridge, 4.6 km upstream from the mouth of 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	Asotin Creek ISA at North/South fk junction	Instream detectors on Asotin Creek at the junction of the North and South forks.
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.
BHL	Adult Fishway at BONH	In-stream detection system consisting of a tandem array located in Bonneville Hatchery Ladder.
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	On Bonaparte Creek, which enters the Okanogan River at RKM 91.2, within the city of Tonasket, WA. Located 0.08 km from the confluence with the Okanogan River.
BR0	Bridge Creek Gauge	Located near the USGS flow gauge site on Bridge Creek.
BR1	Bridge Creek Kiosk	Located at the John Day Fossil Beds National Monument on Bridge Creek.
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).
BVC	Beaver Creek, Methow River	In-stream arrays on Beaver Creek, Methow River Basin.
CAL	Carson NFH Adult Return Ladder	Hatchery adult spring Chinook return ladder from the Wind River to Carson NFH.
CCP	Catherine Creek Acc. Pond	Catherine Creek Acclimation Pond
CCW	Catherine Creek Ladder/Weir	Instream detection array located in the adult return fish ladder at the Catherine Creek weir.
CFF	Castile Falls Fishway	Castile Falls Fishway.
CFJ	Clark Flat Acclimation Ponds	Clark Flat Acclimation Pond outfall.
CHL	Lower Chiwawa River	Chiwawa River rkm 1, located between the Chiwawa smolt trap and the Chiwawa Acclimation Ponds.
CHP	Chiwawa Acc. Pond	Chiwawa Acclimation Pond, Wenatchee River Basin
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.
COC	Cow Creek ISA at stream mouth	Instream detectors on Cow Creek at river km 0.5.
CRU	Upper Chewuch Instream Array	Instream PIT tag interrogation site at RKM 28.35 on the Chewuch River.
CRW	Chewuch River above Winthrop	Chewuch River at river km 1, above Winthrop, WA.
DBH	Buck Hollow Ck Deschutes Trib	Instream detection array in Buck Hollow Creek, a tributary to the Decshutes River.
DBO	Bakeoven Cr Deschutes Trib	The site is approximately 1/4 mile from the mouth of Bakeoven Creek. Site is on private land.
DRM	Deschutes River mouth	Mouth of the Deschutes River in the west channel at Moody Island (rkm 0.46).
DWL	Dworshak NFH adult trap	Located at the terminus of the Dworshak National Hatchery adult fish ladder in the North Fork Clearwater 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.
ENS	Upper Entiat River at rkm 35.7	The site is located approximately 4.3 km above Stormy Creek at river kilometer 35.7 and near the entrance of the Riverwood subdivision.
ESJ	Easton Acc. Pond	Easton Acclimation Pond Outfall
ESS	EFSF Salmon River at Parks Cr	East Fk South Fk Salmon River (rkm 21) near Parks Creek.
EWC	Early Winters Creek rkm 0.36	This site is located at rkm 0.36 on Early Winters Creek (Methow River Basin), located near Early Winters Campground.
FDC	Feed Canal	Feed Canal, on the Umatilla River at rkm 47.
FDD	Feed Diversion Dam	Feed Diversion Dam, at Umatilla River rkm 47.
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.
HLM	Potlatch River near Helmer	Potlatch River near Helmer.
HYC	Hayden Creek Instream Array	Lower section of Hayden Creek, in the Lemhi River Basin.
ICH	Ice Harbor Dam (Combined)	Ice Harbor Dam Adult Fishways (both) and Full Flow Bypass.

Table A4. Continued.

Site Code	Site Name	Site Description
ICL	Lower Icicle Instream Array	Located at rkm 0.4 on Icicle Creek (Wenatchee River Basin), near Leavenworth, WA.
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).
JCJ	Jack Creek Acclimation Pond	Jack Creek Acclimation Pond outfall.
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.
JOC	Joseph Creek ISA at km 3	Joseph Creek, Grande Ronde basin at river km 3 (N 46.030016, W -117.016042).
KRS	SF Salmon River at Krassel Cr	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.
LBT	Little Bridge Creek (Twisp R.)	The site is on Little Bridge Creek, just upstream (200m) from its confluence with the Twisp River.
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.
LLC	Loup Loup Creek Instream Array	Loup Loup Creek trib of the Okanogan River at RKM 27.2, within the city of Malott, WA. The LLC 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.
LMT	Lower Mainstem Teanaway River	Instream array at km 0.4 on the Teanaway River, upper Yakima River Basin.
LNF	Leavenworth NFH Adult Ladder	Located in the Leavenworth National Fish Hatcheries adult ladder and holding pond.
LOR	Lost River at rkm 0.81	A permanent instream PIT tag detection system located at rkm 0.81 on the Lost River (Methow River Basin), located near the Lost River Airport.
LRW	Lemhi River Weir	Lemhi River above the mouth of Hayden Creek and below the IDFG weir.
LTR	Lower Tucannon River	Near the mouth of the Tucannon River. The upstream array group was located at an abandoned railroad bridge abutment upstream of Hwy 261 on the Tucannon River downstream from Starbuck. The CO in-stream array was relocated below the Hwy 261 bridge on Sept. 29, 2010.
LWE	Lower Wenatchee River	Wenatchee River rkm 2.
LWL	Ltl. White Salmon NFH returns	Adult fish ladder allowing passage from the Little White Salmon River into the adult holding ponds at Little White Salmon NFH.
LWN	Little Wenatchee River	Little Wenatchee River rkm 4, located at the old fish weir site.
MAD	Mad River, Entiat River Basin	Mad River rkm 1, located at Ardenvoir, WA.
MC1	McNary Oregon Shore Ladder	Oregon Shore Adult Fishway at McNary Dam.
MC2	McNary Washington Shore Ladder	Washington Shore Adult Fishway at McNary Dam.
MCD	Mill Creek Diversion Project	Fish bypass and passage facilities at the (Bennington) Diversion Dam and the first Division Works in the Mill Creek Diversion Project in the Walla Walla Basin.
MCJ	McNary Dam Juvenile	McNary Dam Juvenile Fish Bypass/Transportation Facility.
MCL	Lower Mission Creek Instream	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.
MIS	Mission Creek	This is an instream interrogation system approximately 0.1 kilometers upstream from the mouth of Mission Creek.
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.
MRT	Methow River at Twisp	Methow River at river km 67, above the Twisp River.
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.
MWC	Maxwell Canal	Maxwell Canal is located at rkm 24 on the Umatilla River.
MWF	Whitefish SC in Methow River	Site is at the entrance and exit of Whitefish Island side channel (rkm 76).
NAL	Lower Nason Creek	Nason Creek rkm 1, located within Lake Wenatchee State Park.
NAU	Upper Nason Creek	Nason Creek rkm 19 (Wenatchee River Basin).
NBA	Nursery Bridge Adult	Nursery Bridge Dam Fishways (both), Walla Walla River at Milton-Freewater, OR.
NFT	North Fork Teanaway River	Located at rkm 0.2 on North Fork Teanaway river near Cle Elum, WA.
OKC	Okanagan Channel at VDS-3	The OKC site is located in the Okanagan (Canadian spelling) Channel at 310th Avenue/Road 18 upstream from Osoyoos Lake.
OKL	Lower Okanogan Instream Array	Site at RKM 24.9 on the mainstem Okanogan River, upstream of Chiliwist area in Okanogan County.
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.
ORB	Oasis Road Bridge	In-stream arrays at Oasis Road Bridge, lower Walla Walla River.

Table A4. Continued.

Site Code	Site Name	Site Description
PES	Peshastin Creek	Instream interrogation system at rkm 3 on the Peshastin River (Wenatchee River Basin), located just below the bridge at Smithson's property.
PRA	Priest Rapids Adult	Priest Rapids Dam Adult Fishways (both).
PRH	Priest Rapids Hatchery Outfall	Priest Rapids Hatchery outfall channel. The site is located just upstream of the typical point of inundation in the channel.
PRO	Prosser Diversion Dam Combined	Adult Fishways (all three) and Juvenile Bypass/Sampling Facility at Prosser Dam.
PRV	Walla Walla R at Pierce RV Prk	Lower Walla Walla River at Pierce Green Valley RV Park.
RCL	Rock Creek (WA) at rkm 5	Rock Creek (WA) at rkm 5 near the Yakama Nation Longhouse.
RCS	Rock Creek (WA) at rkm 14	Rock Creek (WA) at rkm 14 at the confluence of Rock and Squaw Creeks.
RIA	Rock Island Adult	Rock Island Dam Adult Fishways (all three).
ROZ	Roza Diversion Dam (Combined)	Roza Dam Smolt Bypass.
RPJ	Rapid River Hatchery Pond	Rapid River Hatchery (IDFG) outfall.
RRF	Rocky Reach Fishway	Rocky Reach Dam Adult Fishway.
RRJ	Rocky Reach Dam Juvenile	Juvenile Fish Bypass Surface Collector.
SA1	Salmon Creek Instream Array	Salmon Creek, 2.9 km upstream of the confluence with the Okanogan River.
SAT	Lower Satus Creek	On Satus Creek approximately 1700 meters upstream from the confluence of Satus Creek with the Yakima River at rkm 112, based on 2011 aerial photography.
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)	Located on the South Fork John Day River south of Dayville on the PW Schneider Wildlife Management Area (ODFW).
SJ2	SF John Day (Murderer's)	Located on the South Fork John Day River south of Dayville. This site is on property split between the PW Schneider Wildlife Management Area (ODFW) and Bureau of Land Management at the confluence of the South Fork John Day River and Murderers Creek.
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.
SWT	Sweetwater Cr. near its mouth	Approximately 0.1 kilometers upstream from the mouth of Sweetwater Creek.
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	On Toppenish Creek located approximately 1700 meters upstream from the confluence of Toppenish Creek with the Yakima River at rkm 130, based on 2011 aerial photography.
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.
TR2	Trout/Antelope Cr - Deschutes	Trout and Antelope Creek array is located at RKM 20.7 upstream from the confluence with the Deschutes River on privately owned land.
TRC	Trout Creek, Wind River	Trout Creek located at river km 2 on Trout Creek, in the Wind River (WA.) Basin above Hemlock Lake.
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).
USE	Upper Salmon River at rkm 437	Located in the Salmon River at river km 522.303.437 (N45.028939 W-113.915892).
USI	Upper Salmon River at rkm 460	Located in the mainstem Salmon River at river km 522.303.460 (N44.890380 W-113.962575).
UTR	Upper Tucannon River	The Upper Tucannon River site is located about 200 yards above Don Howards House on the Tucannon River, at River Kilometer 53.2.
UWE	Upper Wenatchee River	Located at rkm 81.2 on the Wenatchee River, near Plain, WA.
VC1	Valley Creek, Upstream Site	Located on Valley Creek at Stanley, ID., in the Upper Salmon River.
VC2	Valley Creek, Downstream Site	Located on Valley Creek below Stanley, ID., in the Upper Salmon River.
WEA	Wells Dam, DCPUD Adult Ladders	Wells Dam Adult Fishways (both).
WFC	Lwr White Creek, Klickitat Bsn	This is an instream interrogation system in White Creek (Klickitat River Basin) approximately 150 meters upstream from the mouth.
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	Harris County Park Bridge, South Fork Walla Walla River.
WW2	SF Walla Walla at Bear Creek	Bear Creek, South 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.
YHC	Yellowhawk Creek	Yellowhawk Creek in-stream detection site, between Mill Creek and Walla Walla R.
ZEN	Secesh River at Zena Cr Ranch	Near the Zena Creek Ranch.
ZSL	Zosel Dam Adult Fishways	Zosel Dam is located at Okanogan River km 132, approximately 3 km downstream from the outlet of Lake Osoyoos in the town of Oroville, Washington.

Table A5. Season by season activities of steelhead tagged in 2014 and later labeled as kelts or repeat spawners when they began migrating downstream and upstream (after March 31st) in spring, summer, or fall of 2015, presumably to and from the ocean.

Tag Year	Tag Number	First Detection After Tagging 2014 in Spring/Summer/Fall	Fall 2014	Winter 2014/15	Spring 2015	Summer 2015	Fall 2015	Comments
2014	3DD.00773AA263	The Dalles East Ladder - October 8th	Lower Walla Walla River - November 27th	Touchet River - February 21st	Lower Walla Walla River - March 13th Bonneville Dam Corner Collector - May 24th			
2014	384.3B23ADD743	Lyle Falls - May 24th			Bonneville Dam Corner Collector - April 22nd			
2014	3DD.00773AE2A5	The Dalles East Ladder - October 4th	Lower Granite - October 14th		Upper Salmon - March 23rd Bonneville Dam Corner Collector - May 12th			
2014	3DD.00773AE22A	The Dalles East Ladder - July 24th	Wells - November 4th		Lower Entiat - April 20th Upper Entiat - April 26th Middle Entiat - April 29th to May 4th	Bonneville Dam Corner Collector - June 3rd		
2014	3DD.0077390B58	The Dalles East Ladder - June 21st	Lower Granite - June 30th	Lapwai Creek (Clearwater) - February 9th	Bonneville Dam Corner Collector - May 21st			
2014	3DD.00773AAF1D	The Dalles East Ladder - September 26th	McNary - October 3rd		Threemile Dam - March 17th Bonneville Dam Corner Collector - March 31st			
2014	3DD.00773AB573	The Dalles East Ladder - August 1st	McNary - October 28th		Bonneville Dam Corner Collector - April 12th			
2014	3DD.00773AB587	The Dalles East Ladder - August 2nd		Trout/Antelope Cr (Deschutes) - December 24th to February 7th	Bonneville Dam Corner Collector - April 20th			
2014	3DD.00773B6FD3	The Dalles East Ladder - September 12th			McNary - March 7th Touchet River - March 30th to April 26th Walla Walla River - May 6th Bonneville Dam Corner Collector - May 13th			
2014	3DD.00773AB5DD	Wind River - July 19th	Upper Wind River - November 24th	Upper Wind River - February 5th to 27th	Bonneville Dam Corner Collector - April 22nd			
2014	3DD.00773B85E2	The Dalles East Ladder - September 2nd	Lower Granite - September 20th		Lower Imnaha - March 17th Imnaha - March 28th to April 21st Lower Imnaha - May 6th Bonneville Dam Corner Collector - May 25th			
2014	3DD.00773B0F83	The Dalles East Ladder - July 31st		Three Mile Dam - December 28th	Three Mile Dam - May 9th Bonneville Dam Corner Collector - May 13th			
2014	3DD.00773B2D13	The Dalles East Ladder - October 4th	Ice Harbor - October 12th		Ice Harbor -March 27th Bonneville Dam Corner Collector - May 18th			
2014	3DD.00773AC2F7	The Dalles North Ladder - August 31st		Deschutes River Mouth - December 31st	Bonneville Dam Corner Collector - April 14th			
2014	3DD.00773B01A0	The Dalles East Ladder - July 25th			Warm Springs River - May 9th Warm Springs Hatchery - May 9th Warm Springs River - May 15th Bonneville Dam Corner Collector - May 23rd			This steelhead returned to a hatchery.
2014	3DD.00773B5173	The Dalles East Ladder - October 1st	Lower Monumental - October 8th		Lower Lemhi - March 17th Lemhi - April 10th to 25th Lower Lemhi - April 26th Bonneville Dam Corner Collector - May 21st			
2014	3DD.00773AD7AA	Lyle Falls - October 20th			Bonneville Dam Corner Collector - April 26th			
2014	3DD.00773BA199	The Dalles East Ladder - July 28th	Lower Granite - September 14th		Bonneville Dam Corner Collector - April 22nd			
2014	3DD.00773B8494	The Dalles East Ladder - September 21st	Lower Granite - October 15th		Bonneville Dam Corner Collector - May 22nd			
2014	3DD.00773AC548	Lyle Falls - July 19th			Bonneville Dam Corner Collector - April 23rd			
2014	3DD.00773B9FF0	The Dalles East Ladder - August 2nd	Lower Entiat - August 28th	Lower Entiat - February 11th	Bonneville Dam Corner Collector - May 8th			
2014	3DD.00773BA2DA	The Dalles East Ladder - August 10th	Lower Granite - November 3rd		Bonneville Dam Corner Collector - May 13th			
2014	3DD.00773B6282	The Dalles East Ladder - September 4th	Lower Granite - September 13th		Upper Salmon March 11th Bonneville Dam Corner Collector - May 6th			
2014	3DD.00773AEBB3	The Dalles East Ladder - July 31st	John Day River - November 29th		Bonneville Dam Corner Collector - May 10th			
2014	3DD.00773BCD15	The Dalles East Ladder - July 25th	Lower Granite - October 2nd		Upper Salmon - February 14th Bonneville Dam Corner Collector - May 14th			
2014	3DD.00773B2D17	The Dalles East Ladder - September 7th	Little Goose - November 8th		Lower Granite - March 17th Bonneville Dam Corner Collector - May 3rd			
2014	3DD.00773B926E	The Dalles East Ladder - August 3rd	Lower Granite - October 27th		Upper Salmon - March 30th Bonneville Dam Corner Collector - May 29th			
2014	3DD.00773BC92D	The Dalles East Ladder - July 19th	Lower Granite - September 2nd		Upper Salmon March 14th Bonneville Dam Corner Collector - May 5th			
2014	3DD.00773B116A	The Dalles East Ladder - July 10th			Bonneville Dam Corner Collector - May 1st			
2014	3DD.00773B5F26	The Dalles East Ladder - September 12th	Ice Harbor - September 20th		Bonneville Dam Corner Collector - May 23rd			
2014	3DD.00773BBFE3	The Dalles East Ladder - July 29th			Bonneville Dam Corner Collector - May 8th			
2014	3DD.00773BB0D3	The Dalles East Ladder - August 7th	Prosser Dam (Yakima) - October 4th		Bonneville Dam Corner Collector - May 30th			
2014	3DD.00773B5512	The Dalles East Ladder - July 20th	John Day River - November 29th		Bonneville Dam Corner Collector - April 19th			

Table A5 (Continued).

Tag Year	Tag Number	First Detection After Tagging 2014 in Spring/Summer/Fall	Fall 2014	Winter 2014/15	Spring 2015	Summer 2015	Fall 2015	Comments
2014	3DD.00773BA48D	The Dalles East Ladder - July 30th	Lower Monumental - November 12th	Walla Walla River - December 10th	Touchet River - March 20th to April 2nd Bonneville Dam Corner Collector - April 23rd			
2014	3DD.00773BA83A	The Dalles East Ladder - October 3rd	Lower Granite - October 26th		Upper Tucannon - April 24th Bonneville Dam Corner Collector - May 13th			
2014	3DD.00773AB74E	The Dalles East Ladder - July 12th		Touchet River - February 23rd	Bonneville Juvenile Bypass - April 3rd			
2014	3DD.00773B5527	The Dalles East Ladder - July 27th	Lower Granite - September 22nd		Lapwai Creek (Clearwater) - March 13th Sweetwater and Mission Creeks (Lapwai) - April 9th to May 17th Lapwai Creek (Clearwater) - May 18th	McNary Juvenile Bypass - June 6th Bonneville Juvenile Bypass - June 13th		
2014	384.3B23AF8A1D	Wind River - July 31st				Bonneville Cascade Is. Ladder - July 13th		May have spent time in the ocean before returning.
2014	3D9.1C2E03A59F	The Dalles North Ladder - June 15th	Ice Harbor - September 13th			Bonneville Bradford Is. Ladder - July 27th	Walla Walla River - September 6th	May have spent time in the ocean before returning.
2014	384.3B23AF2472	Oak Springs Hatchery - May 19th			Bonneville Washington Ladder - April 15th Hood River - May 1st			May have spent time in the ocean before returning and was recaptured twice; at the hatchery and Hood River.
2014	3DD.00773BAE8B	The Dalles East Ladder - September 18th	John Day River - November 7th				Bonneville Bradford Island - October 27th The Dalles East Ladder - October 29th	May have spent time in the ocean before returning.
2014	3DD.00773AFAC5	The Dalles East Ladder - July 11th	McNary - November 28th	Prosser Dam (Yakima) - December 10th Lower Status Creek - January 25th	Lower Status Creek - March 1st Bonneville Dam Corner Collector - April 12th	Bonneville Washington Ladder - August 13th	Prosser Dam (Yakima) - November 11th	May have spent time in the ocean before returning.
2014	3DD.00773B6417	The Dalles East Ladder - July 27th	Lower Walla Walla River - November 26th	Middle Walla Walla River - February 20th	Lower Walla Walla River - March 31st John Day Dam Juvenile Bypass - April 5th			
2014	3DD.00773ADDE1	The Dalles East Ladder - July 27th		Feed Diversion Dam (Umatilla) - January 25th	John Day Dam Juvenile Bypass - April 9th			
2014	3DD.00773B0776	The Dalles East Ladder - October 27th	Lower Granite - November 19th		Upper Salmon - March 31st McNary Juvenile Bypass - May 22nd			
2014	3DD.00773B6278	The Dalles East Ladder - September 22nd	McNary - November 29th	Middle Walla Walla River - February 6th	Middle Walla Walla River - March 11th to April 1st Lower Walla Walla River - April 9th McNary - April 12th			
2014	3DD.00773B5F17	The Dalles East Ladder - August 3rd	Upper Salmon River - October 19th		EF Salmon River - March 28th Lower Monumental Juvenile Bypass - May 17th			Steelhead was recaptured and released at Lower Granite Dam for the CRITFC Kelt Project May 10th - considered a kelt.
2014	3DD.00773B0C58	Bonneville Bradford Is. Ladder - July 31st	Lower Granite - September 25th		Lower Monumental Juvenile Bypass - April 10th			
2014	3DD.00773B76ED	Bonneville Washington Shore Ladder - August 12th	Lower Granite - October 12th		Lower Monumental Juvenile Bypass - April 20th			
2014	3DD.00773B6CE5	The Dalles North Ladder - October 1st			Little Goose Juvenile Bypass - April 12th			
2014	3DD.00773B8C03	The Dalles East Ladder - September 29th			Lower Granite - March 22nd Lower Clearwater - March 28th Clear Creek (Clearwater) - March 29th to April 3rd Little Goose Juvenile Bypass - April 27th			Steelhead was recaptured and released at Lower Granite Dam for the CRITFC Kelt Project April 24th - considered a kelt.
2014	3DD.00773A414E	The Dalles East Ladder - July 11th	Lower Granite - September 20th		Wallowa Hatchery - February 28th			Steelhead was recaptured and released at Lower Granite Dam for the CRITFC Kelt Project April 3rd - considered a kelt.
2014	3DD.00773BA8F4	Bonneville Bradford Is. Ladder - August 8th	Lower Granite - October 1st		Joseph Creek (Grande Ronde) - March 13th to 20th			Steelhead was recaptured and released at Lower Granite Dam for the CRITFC Kelt Project March 31st - considered a kelt.
2014	3DD.00773B86FF	The Dalles East Ladder - September 1st	Wells - September 17th		Middle Methow River - April 6th Rocky Reach Juvenile Bypass - April 21st			
2014	3D6.000B38ABDD	The Dalles North Ladder - August 4th	Wells - September 14th		Rocky Reach Juvenile Bypass - April 11th			
2014	384.3B23AD8D7E	The Dalles East Ladder - May 31st		Upper Entiat River - December 2nd	Upper Entiat River - March 14th Rocky Reach Juvenile Bypass - April 11th			
2014	3DD.00773AD3B5	The Dalles East Ladder - August 9th	Wells - November 1st		Lower Twisp River - April 21st Rocky Reach Juvenile Bypass - May 5th			
2014	3DD.00773B9225	The Dalles East Ladder - September 20th	Wells - October 4th		Methow River - April 10th Rocky Reach Juvenile Bypass - April 27th			
2014	3DD.00773A9809	The Dalles North Ladder - August 11th	Lower Methow River - October 31st		Methow River - April 20th Rocky Reach Juvenile Bypass - May 17th			
2014	3DD.00773A9EE8	The Dalles East Ladder - September 22nd	Lower Methow River - November 19th		Chewuch River - March 30th Rocky Reach Juvenile Bypass - May 11th			
2014	3DD.00773B9534	The Dalles East Ladder - August 8th	Lower Methow River - November 7th		Spring Creek Acclimation Pond (Methow) - April 5th Methow River - April 18th Rocky Reach Juvenile Bypass - April 29th			Steelhead may have spent time in a hatchery facility.
2014	3DD.00773B4F78	The Dalles East Ladder - July 31st	Lower Methow River - September 6th		Zosel Dam (Okanagan) - April 22nd Salmon Creek (Okanagan) - May 9th Rocky Reach Juvenile Bypass - May 13th			
2014	3DD.00773B7875	The Dalles East Ladder - July 13th			Beaver Creek (Methow) - April 2nd	Rocky Reach Juvenile Bypass - June 7th		
2014	3DD.00773A9EE3	The Dalles North Ladder - August 1st	Prosser Dam (Yakima) - October 6th		Prosser Dam (Yakima) - April 20th			Steelhead collected in CRITFC Kelt Project at Lower Granite Dam.
2014	3DD.00773AF096	The Dalles East Ladder - August 10th	Prosser Dam (Yakima) - October 1st		Mouth of Yakima River - May 11th			Steelhead collected in CRITFC Kelt Project at Prosser Dam for reconditioning.
2014	3DD.00773ADDA5	The Dalles East Ladder - July 27th	McNary - November 13th		Prosser Dam (Yakima) - March 8th Prosser Dam (Yakima) - May 22nd		Prosser Dam (Yakima) - November 5th	Steelhead collected in CRITFC Kelt Project at Prosser Dam for reconditioning. Released from project November 5th, 2015.
2014	3DD.00773AB71C	The Dalles North Ladder - - July 27th	Prosser Dam (Yakima) - November 6th	Lower Toppenish Creek (Yakima) - January 10th	Simcoe Creek (Yakima) - March 31st Lower Toppenish Creek (Yakima) - April 6th Prosser Dam (Yakima) - April 13th		Prosser Dam (Yakima) - November 5th	Steelhead collected in CRITFC Kelt Project at Prosser Dam for reconditioning. Released from project November 5th, 2015.
2014	3DD.00773B4FFA	The Dalles North Ladder - September 11th	Prosser Dam (Yakima) - September 21st	Lower Toppenish Creek (Yakima) - January 30th	Simcoe Creek (Yakima) - March 16th Lower Toppenish Creek (Yakima) - April 7th Mouth of Yakima River - April 20th			Steelhead collected in CRITFC Kelt Project at Prosser Dam for reconditioning.
2014	3DD.00773B7AB8	The Dalles East Ladder - August 1st	Prosser Dam (Yakima) - November 1st	Lower Satus Creek (Yakima) - February 11th	Lower Satus Creek (Yakima) - April 3rd Mouth of Yakima River - April 13th			Steelhead collected in CRITFC Kelt Project at Prosser Dam for reconditioning.

Key - - - Upstream | Downstream | Spawning

Table A6. Season by season activities of steelhead tagged in 2014 and later labeled as kelts or repeat spawners when they began migrating downstream and upstream (before March 31st) in spring, summer, or fall of 2015, presumably to and from the ocean.

Tag Year	Tag Number	First Detection After Tagging 2014 in Spring/Summer/Fall	Summer 2014	Fall 2014	Winter 2014/15	Spring 2015	Comments
2014	384.3B23ADA9E6	The Dalles East Ladder - June 20th	Lower Monumental - June 28th			Bonneville Dam Corner Collector - March 20th	
2014	384.3B23ADF7D7	Bonneville Washington Shore Ladder - May 23rd				Bonneville Bradford Ladder - March 29th	
2014	384.3B23AFBCF9	Lyle Falls Fishway - May 17th				Bonneville Dam Corner Collector - March 16th	
2014	3DD.00773AD073	The Dalles East Ladder - September 6th			Lyle Falls Fishway - December 8th	Bonneville Juvenile Bypass - March 28th	
2014	3DD.00773B07B8	The Dalles East Ladder - September 13th		Lower Granite - October 3rd		Lower Granite Juvenile Bypass - March 27th	
2014	3DD.00773B431B	The Dalles East Ladder - August 31st		Joseph Creek (Grande Ronde) - November 27th	Joseph Creek (Grande Ronde) - February 7th	Lower Granite Juvenile Bypass - March 25th	
2014	3DD.00773B5D73	The Dalles North Ladder - October 23rd			Lower SF Clearwater - February 11th Lower SF Clearwater - February 23rd	Lower Granite Juvenile Bypass - March 22nd	
2014	3DD.00773BCE53	The Dalles East Ladder - September 4th		Little Goose - October 29th		Little Goose Juvenile Bypass - March 24th	

Key - - - Upstream | Downstream | Spawning

Table A7. Season by season activities of steelhead tagged in 2013 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 the 2013 report table is included here as behavioral detections became available in 2014/2015

Tag Year	Tag Number	First Detection After Tagging 2014 in Spring/Summer/Fall	Fall 2013	Winter 2013/14	Spring 2014	Summer 2014	Fall 2014	Winter 2014/15	Spring 2015	Summer 2015	Fall 2015	Comments
2013	384.3B23AD99BF	Bonneville Washington Shore Ladder - August 15th	Prosser Dam (Yakima) - September 22nd		Bonneville Dam Corner Collector - May 16th	The Dalles East Ladder - August 4th			McNary - March 28th Prosser Dam (Yakima) - April 2nd			May have spent a few months in the ocean before returning.
2013	384.3B23AD8E50	Wells - August 29th			Lower Entiat - March 15th	Bonneville Washington Shore Ladder - August 16th Priest Rapids - August 28th	Lower Entiat - October 21st		Mad River (Entiat) - March 30th Rocky Reach - April 19th			May have spent a few months in the ocean before returning.
2013	384.3B23ADB947	Bonneville Washington Shore Ladder - August 6th	Lower Granite Dam - September 18th							Bonneville Cascade - July 28th The Dalles North Ladder - July 30th	Deschutes River Mouth - September 3rd Lower Granite - September 15th	New steelhead added.
2013	384.3B23AD9CD0	Bonneville Washington Shore Ladder - August 14th	Rocky Reach - September 19th		Lower Entiat - April 6th Upper Entiat - April 23rd Rocky Reach Juvenile Bypass - May 15th		Bonneville Bradford Is. - September 24th Rocky Reach - October 15th		Lower Entiat - April 9th Upper and Middle Entiat - April 17th to May 5th Lower Entiat - May 5th			May have spent a few months in the ocean before returning.
2013	384.3B23ADD434	The Dalles East Ladder - August 22nd	Upper Salmon River - November 10th	Upper Salmon River - December 2nd	Valley Creek (Salmon) - May 10th					Bonneville Bradford Is. - June 22nd Lower Granite - July 16th	Upper Salmon River - October 15th	New steelhead added.
2013	384.3B23ADF01C	Lower Methow River - August 22nd					Winthrop NFH - October 15th		Rocky Reach Juvenile Bypass - May 6th			New steelhead added. Steelhead collected as a kelt in CRITFC Kelt Project.
2013	384.3B23ADF9E2	Bonneville Washington Shore Ladder - August 9th	Lower Granite - October 4th				Bonneville Cascades Is. Ladder - October 15th Lower Granite - October 31st		Bonneville Dam Corner Collector - May 22nd			May have spent a few months in the ocean before returning.
2013	3D9.1C2E034EB9	The Dalles North Ladder - July 25th	McNary - October 3rd		Middle John Day River - April 8th					Bonneville Washington Shore Ladder - August 4th Deschutes River Mouth - August 6th		New steelhead added.

Key - - - Upstream | Downstream | Spawning

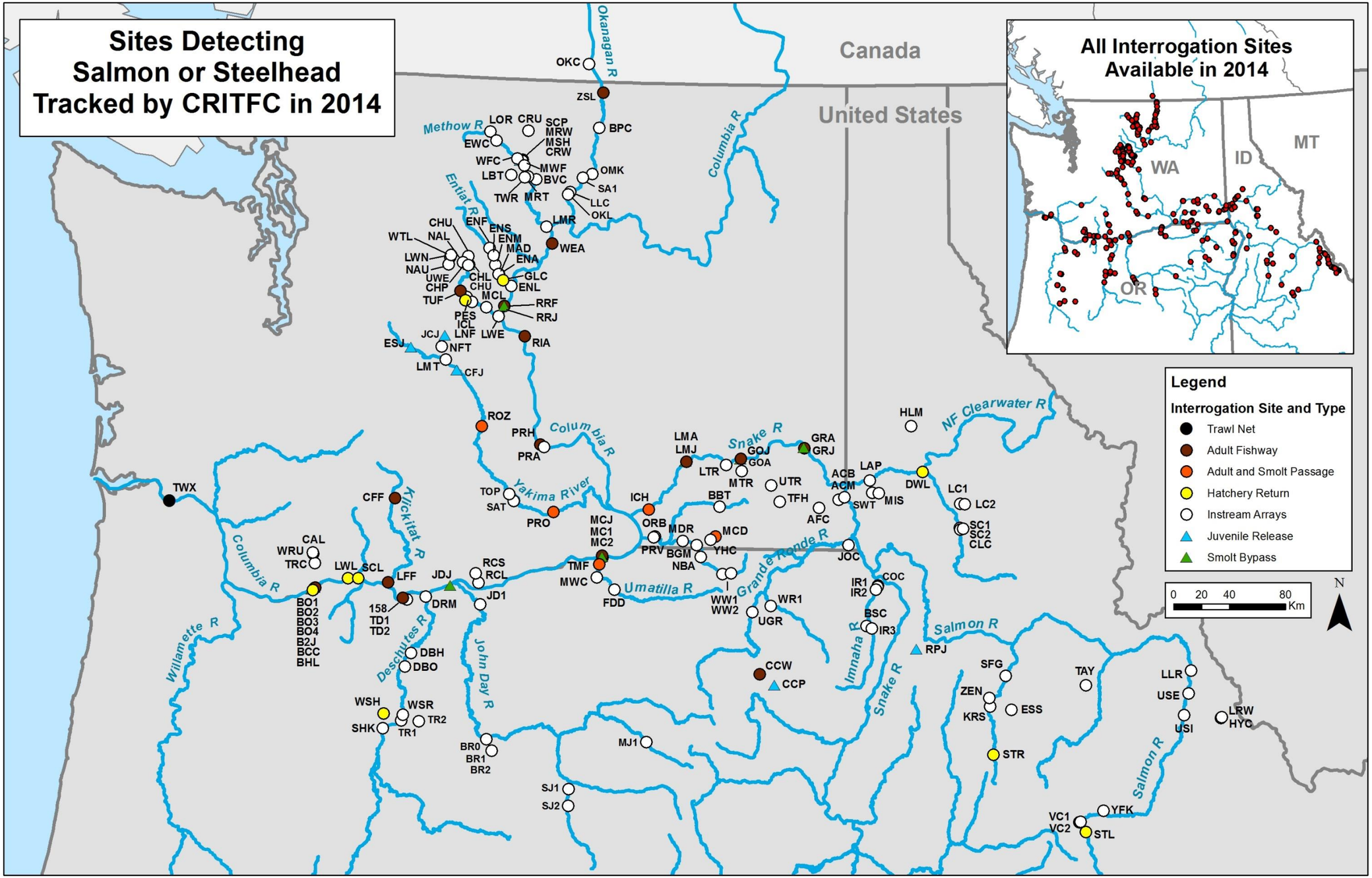

Figure A1. Map of Columbia River interrogation sites that detected Chinook and Sockeye salmon, and steelhead in 2014. Table A4 in the Appendix lists the PTAGIS sites full name and the three-letter codes on this map.

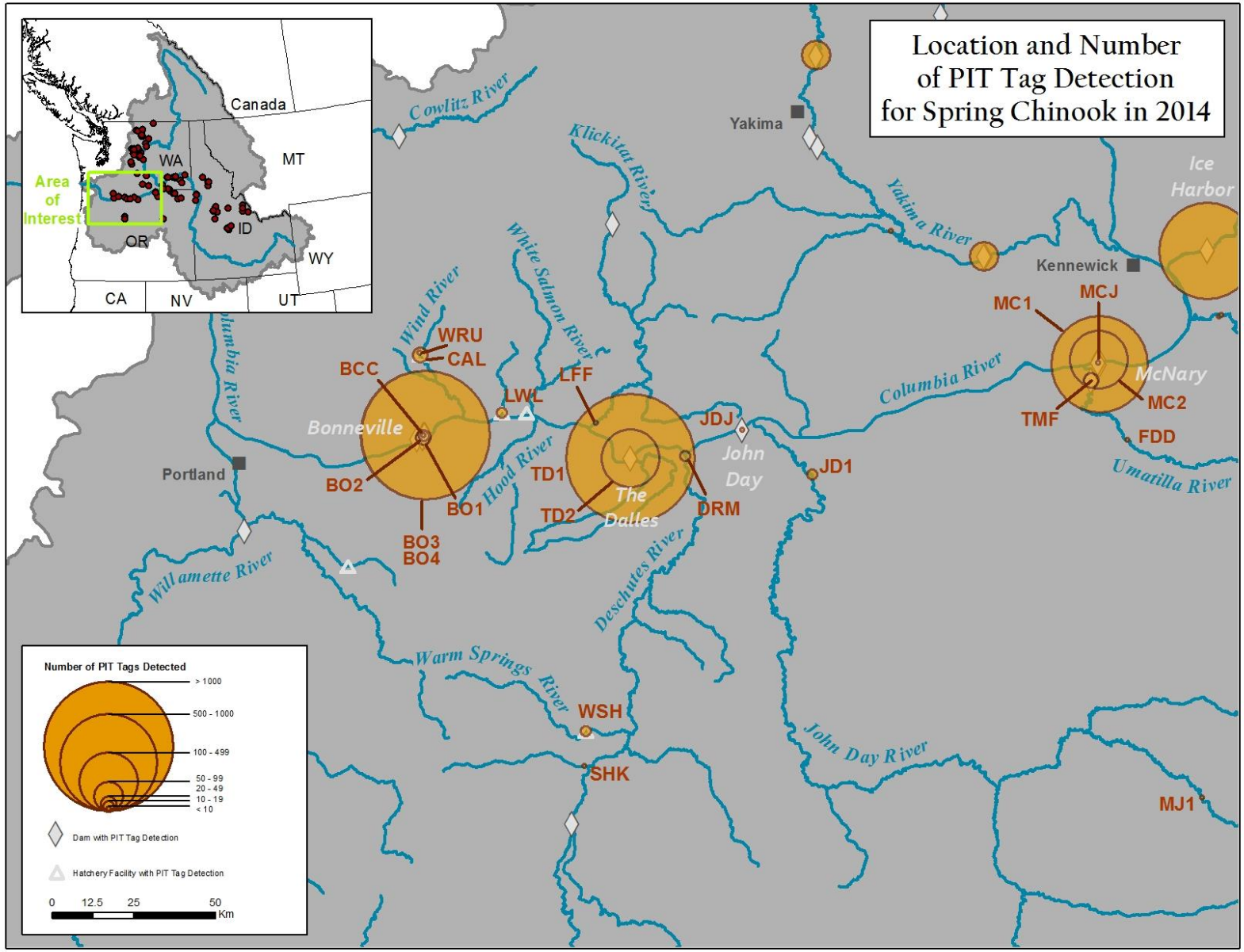

Figure A2. Map of Lower Columbia River detection sites and number of spring Chinook salmon detected. Table A4 in the Appendix lists the PTAGIS sites' full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January 1 to June 1.

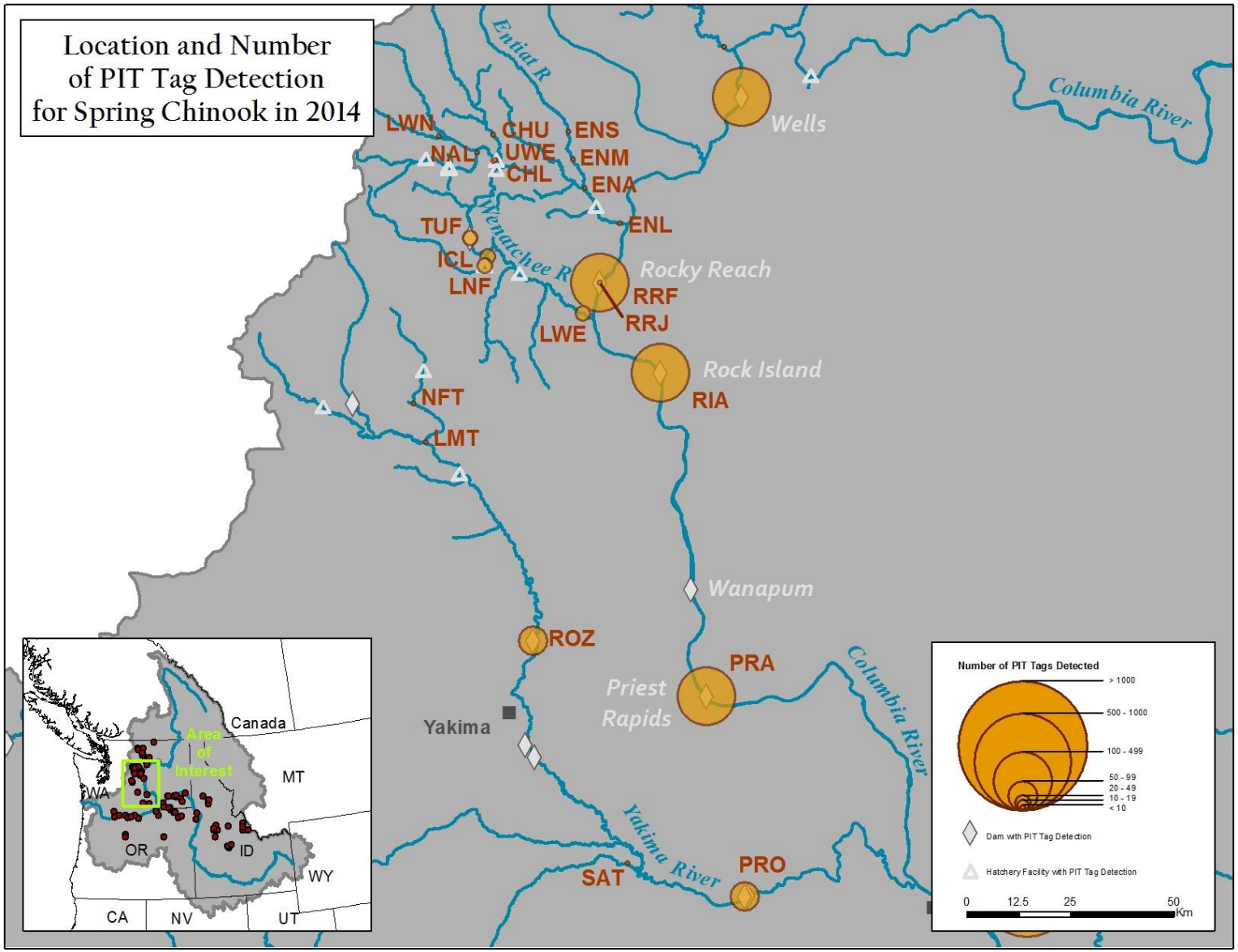

Figure A3. Map of Upper Columbia River (between the Snake River and Wells Dam) detection sites and number of spring Chinook salmon detected. Table A4 in the Appendix lists the PTAGIS sites' full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January 1 to June 1.

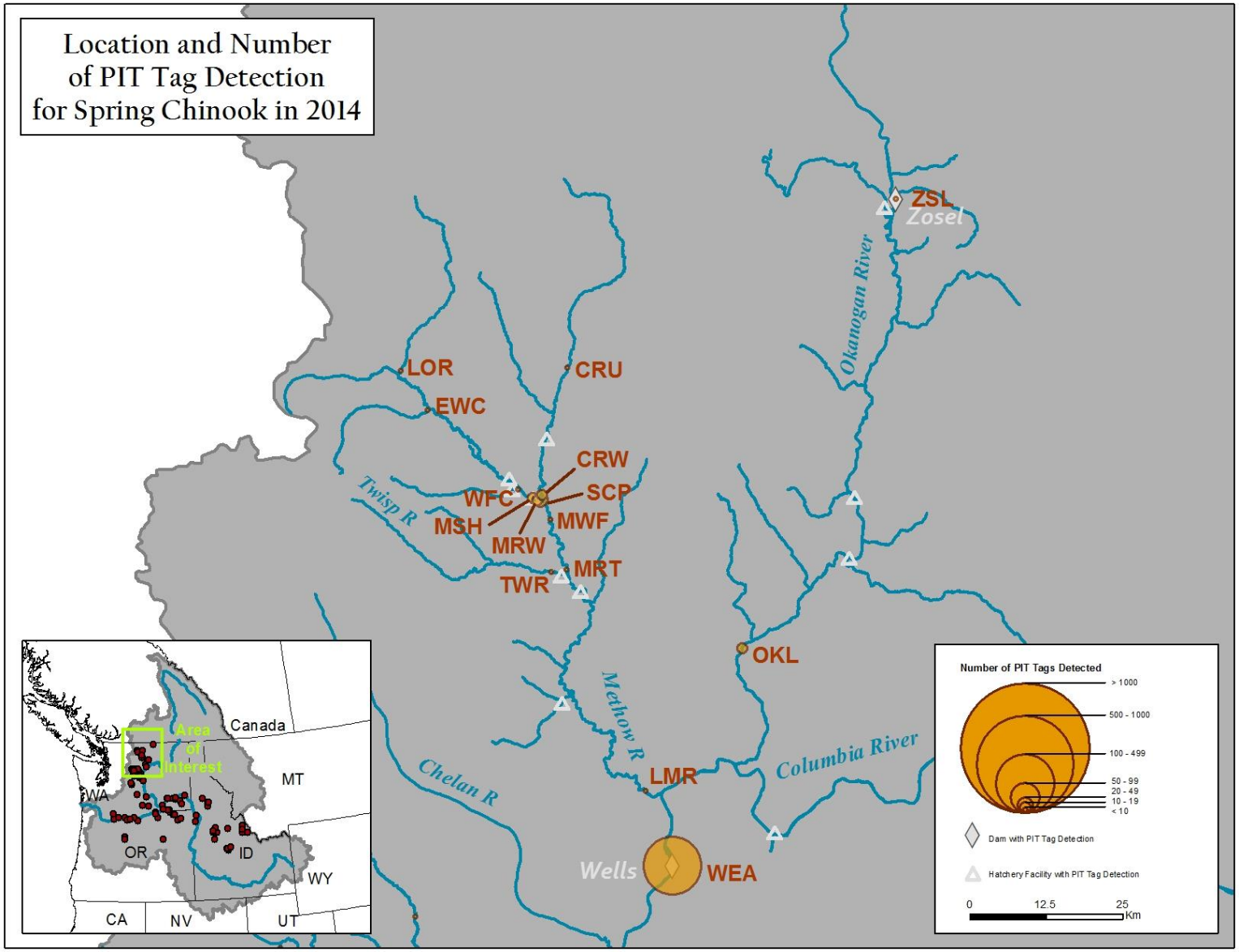

Figure A4. Map of Upper Columbia River (Wells Dam and above) detection sites and number of spring Chinook salmon detected. Table A4 in the Appendix lists the PTAGIS sites' full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January 1 to June 1.

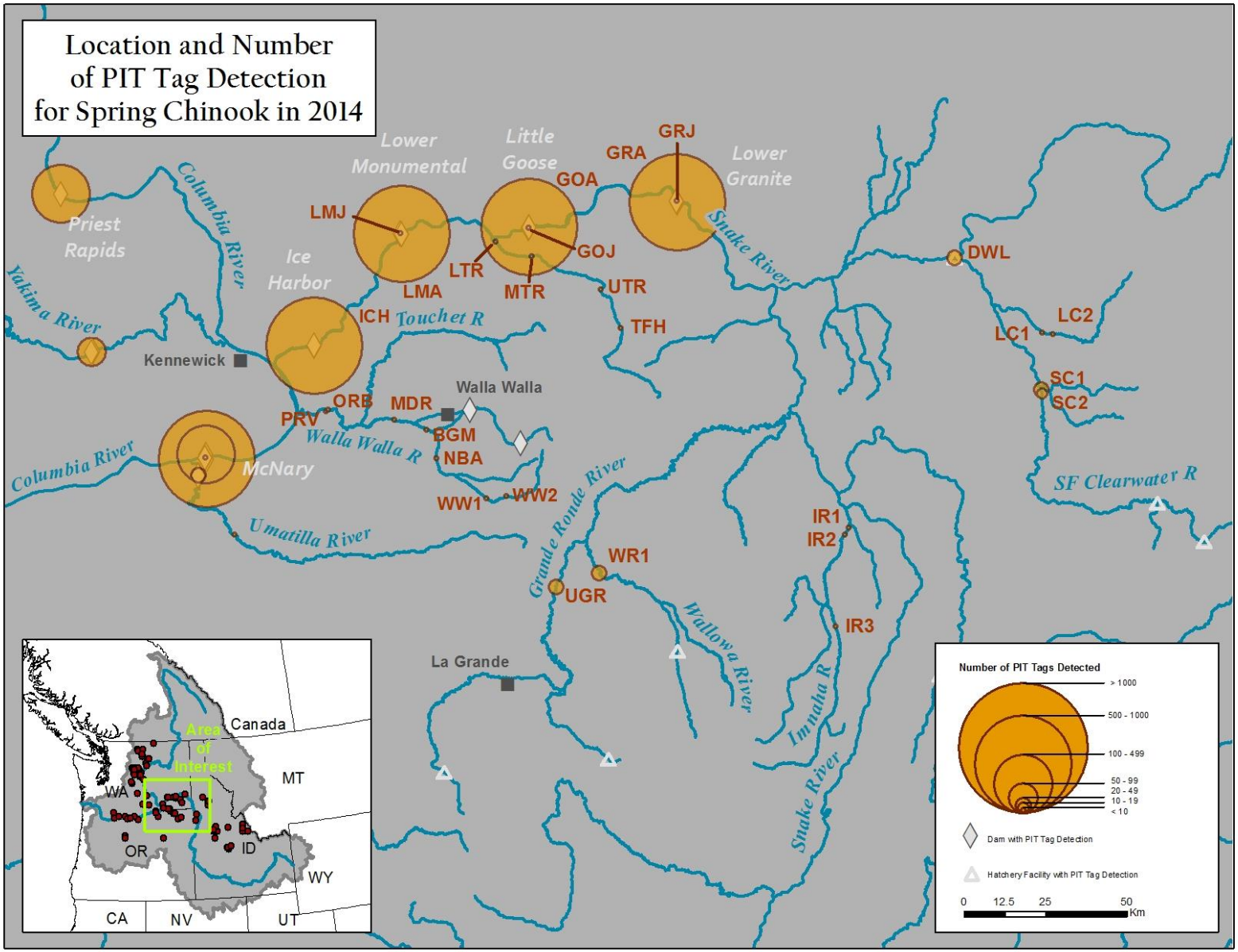

Figure A5. Map of Lower Snake River detection sites and number of spring Chinook salmon detected. Table A4 in the Appendix lists the PTAGIS sites' full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January 1 to June 1.

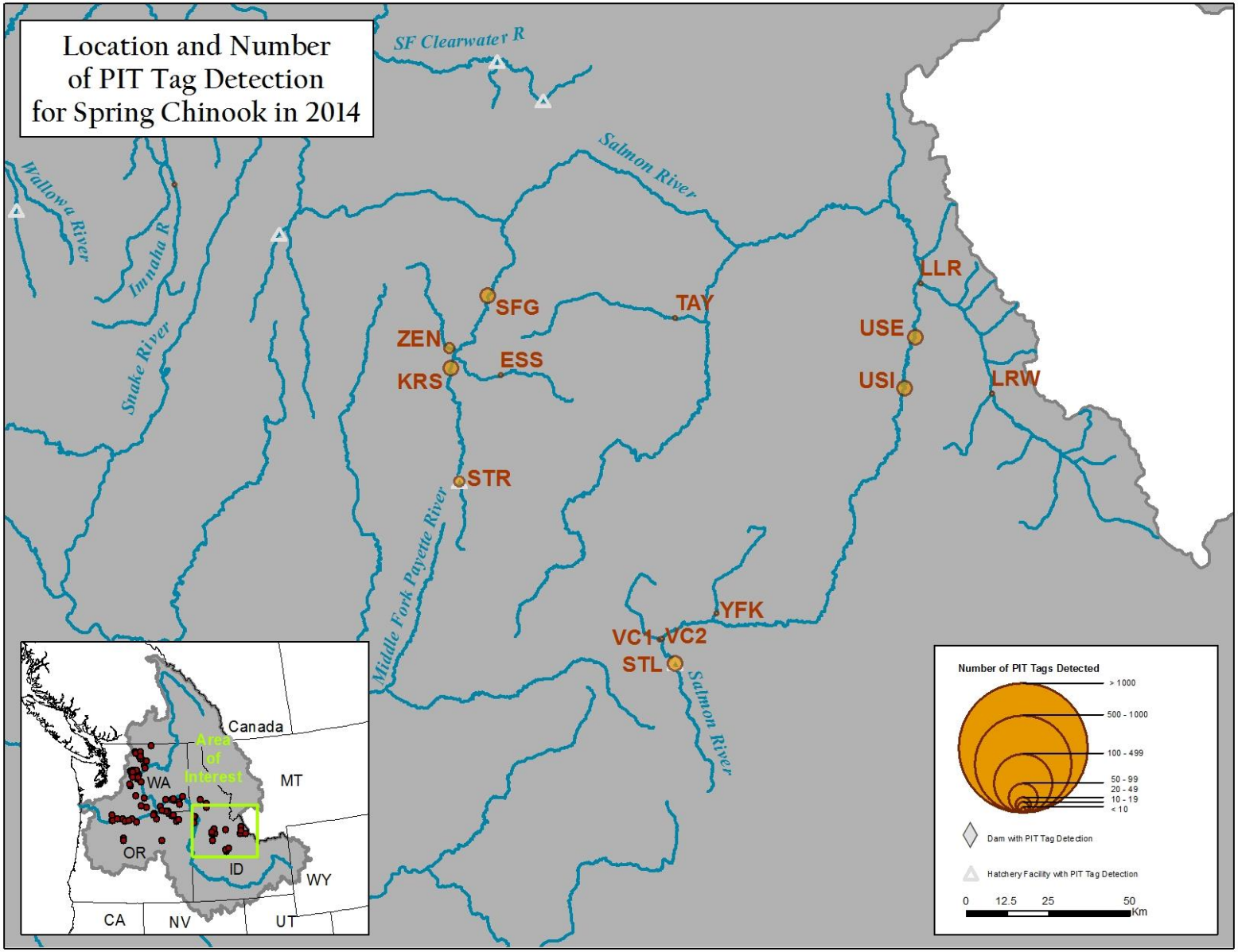

Figure A6. Map of Salmon River detection sites and number of spring Chinook salmon detected. Table A4 in the Appendix lists the PTAGIS sites' full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January 1 to June 1.

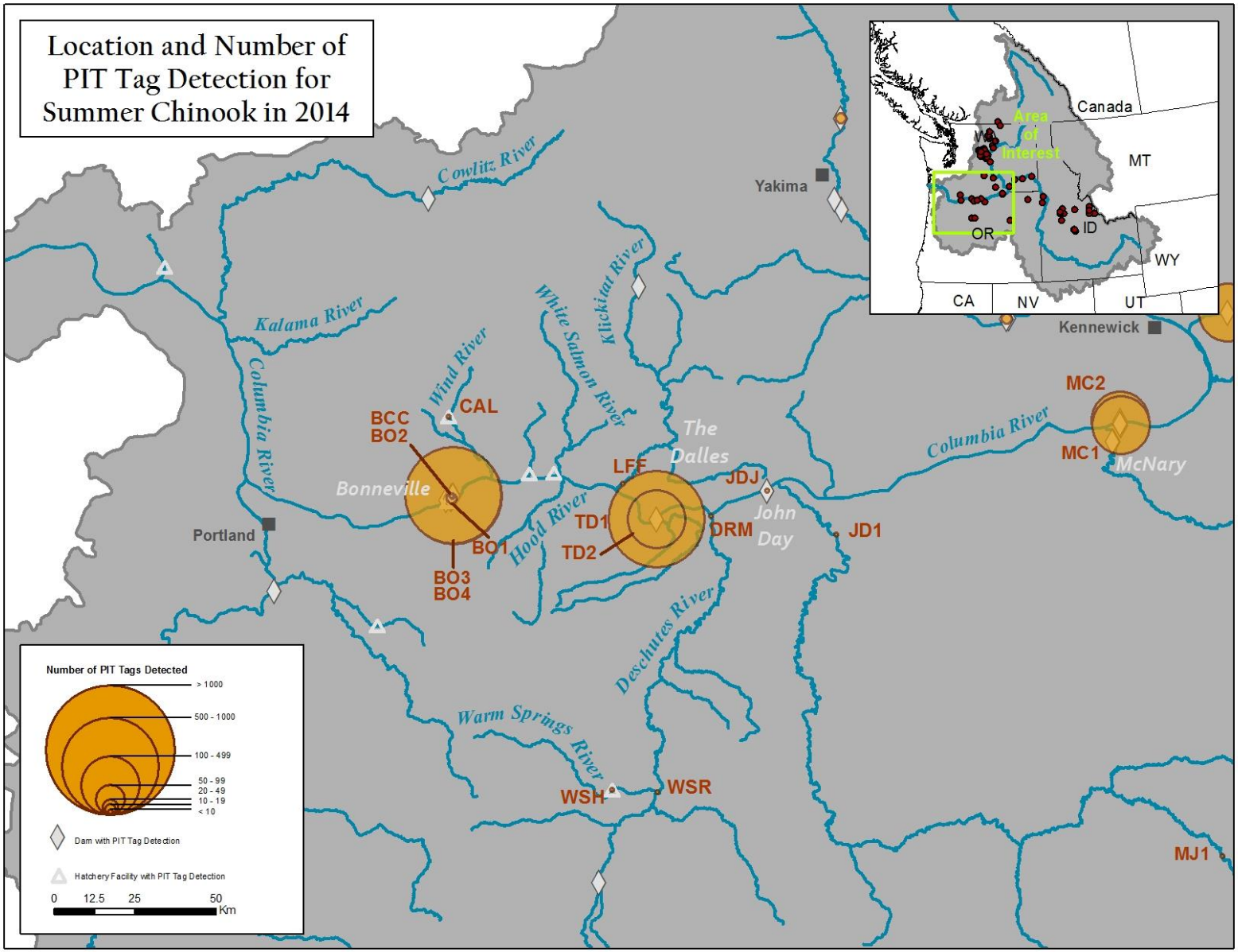

Figure A7. Map of Lower Columbia River detection sites and number of summer Chinook salmon detected. Table A4 in the Appendix lists the PTAGIS sites' full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June 1 to August 1.

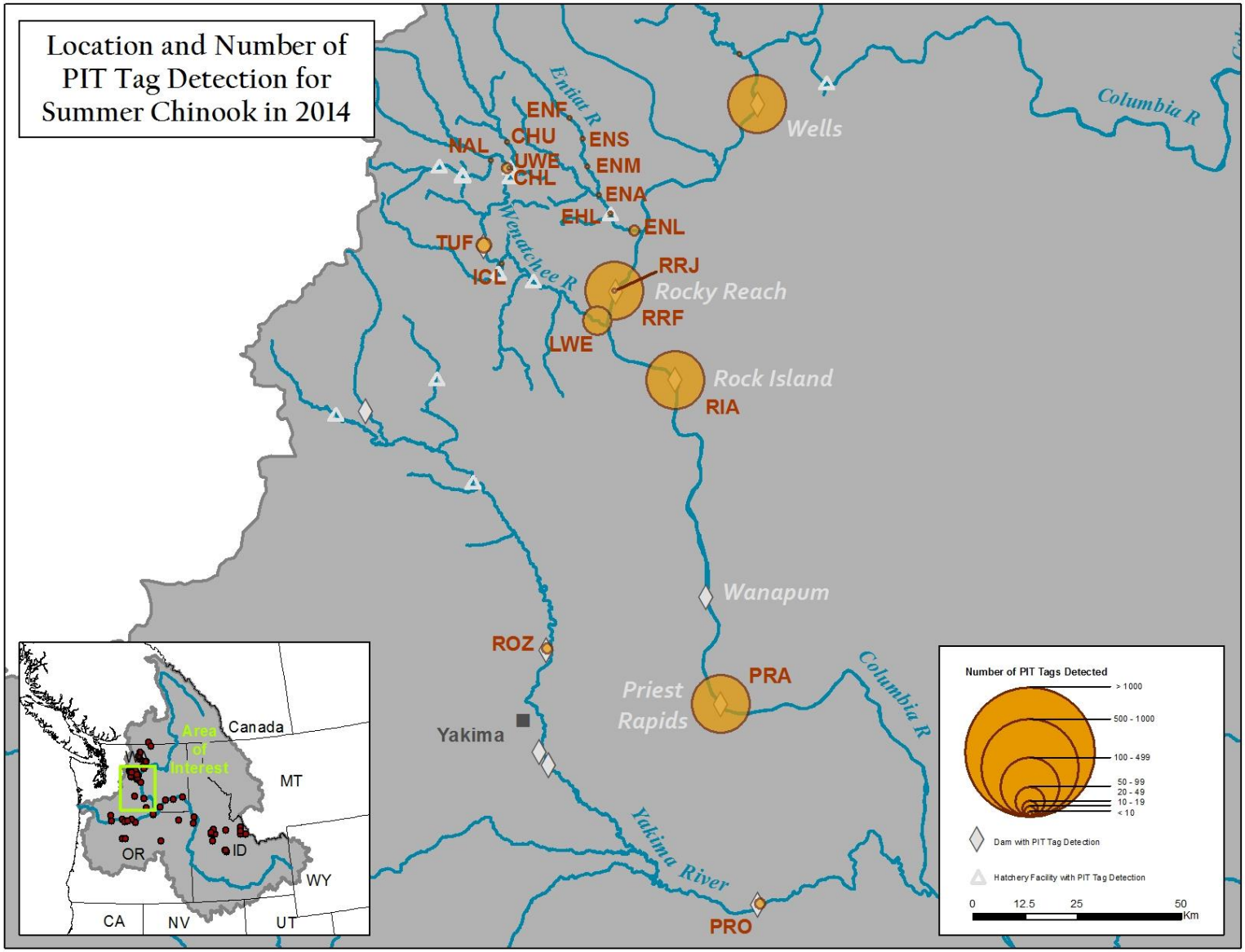

Figure A8. Map of Upper Columbia River (between the Snake River and Wells Dam) detection sites and number of summer Chinook salmon detected. Table A4 in the Appendix lists the PTAGIS sites' full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June 1 to August 1.

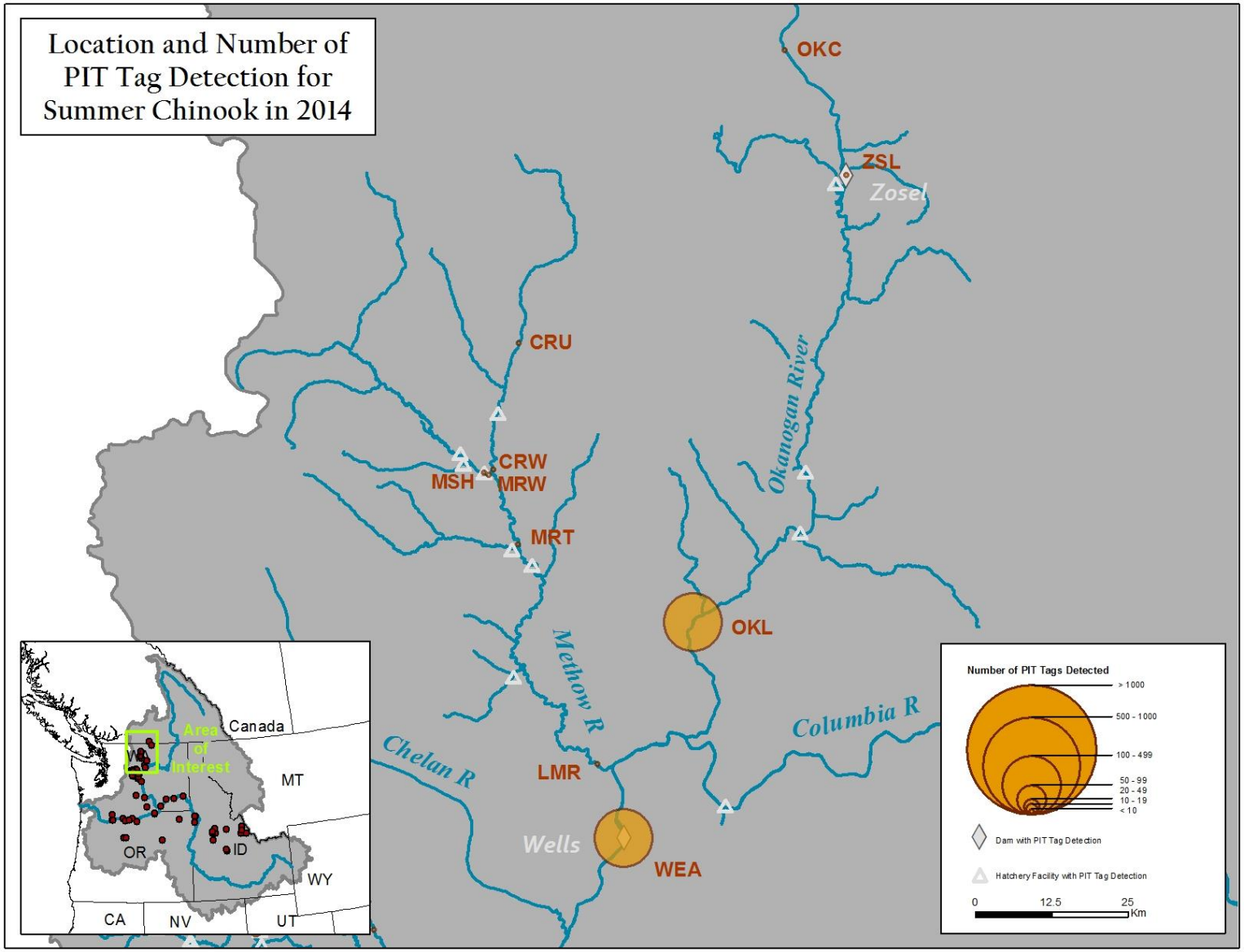

Figure A9. Map of Upper Columbia River (Wells Dam and above) detection sites and number of summer Chinook salmon detected. Table A4 in the Appendix lists the PTAGIS sites' full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June 1 to August 1.

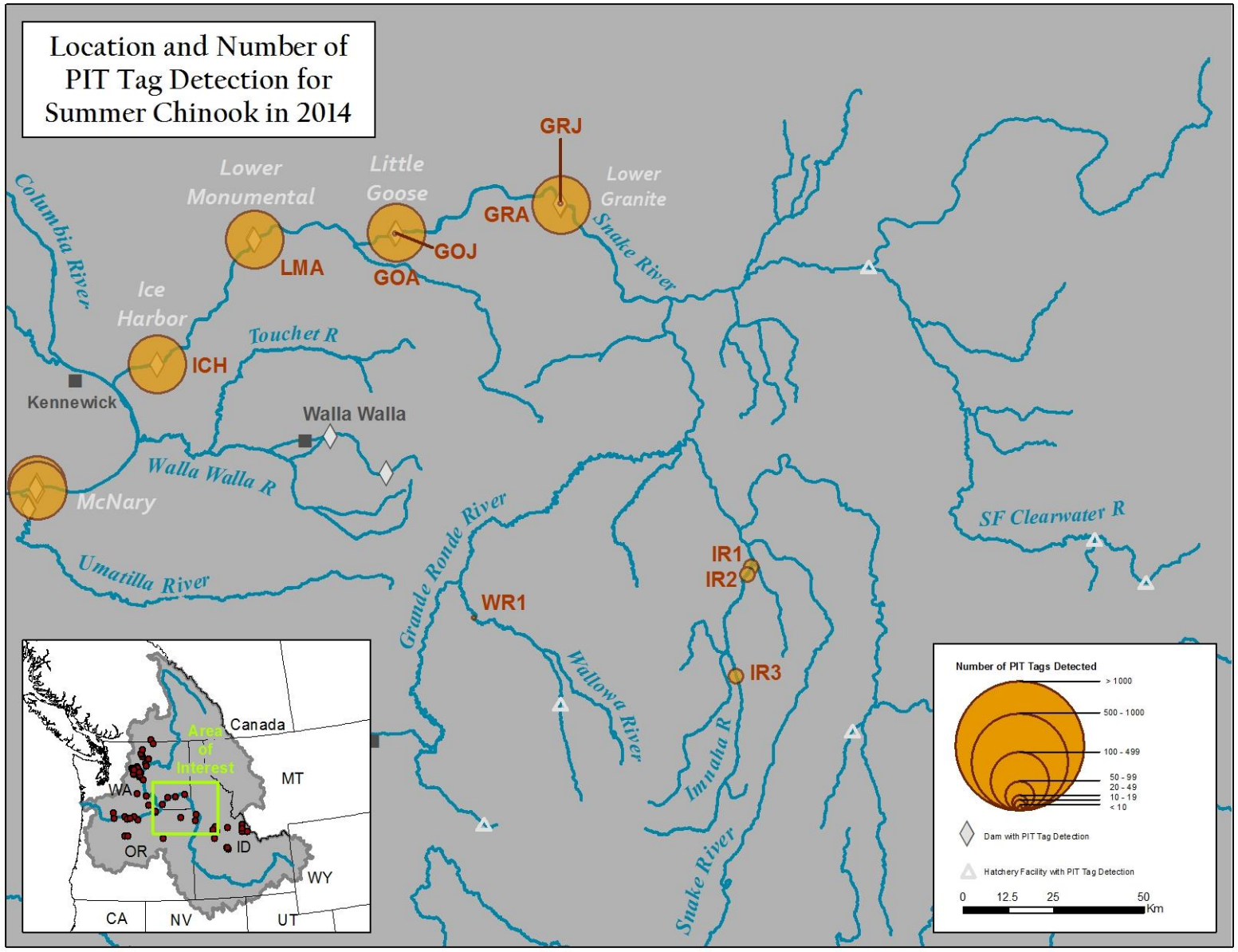

Figure A10. Map of Lower Snake River detection sites and number of summer Chinook salmon detected. Table A4 in the Appendix lists the PTAGIS sites' full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June 1 to August 1.

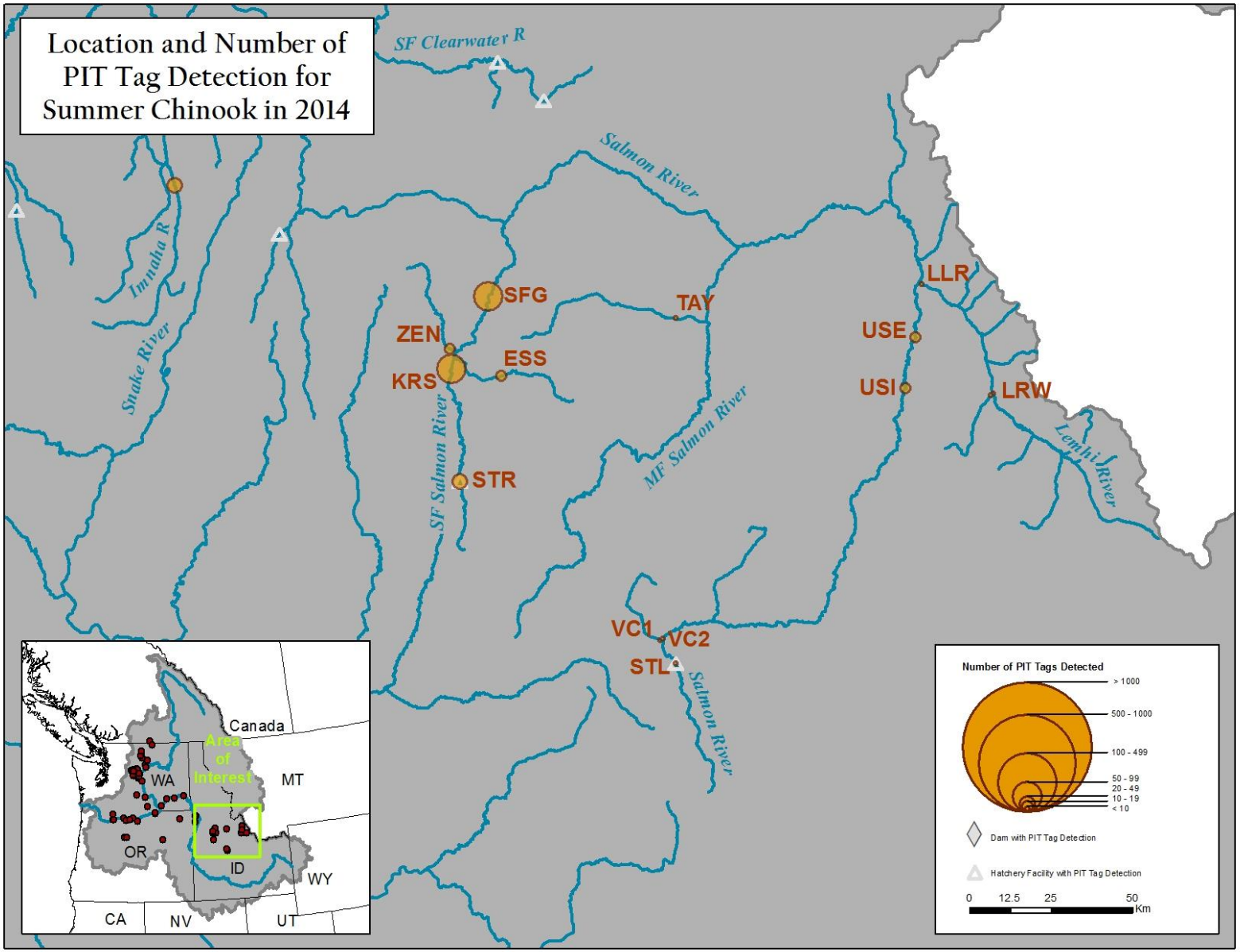

Figure A11. Map of Salmon River detection sites and number of summer Chinook salmon detected. Table A4 in the Appendix lists the PTAGIS sites' full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June 1 to August 1.

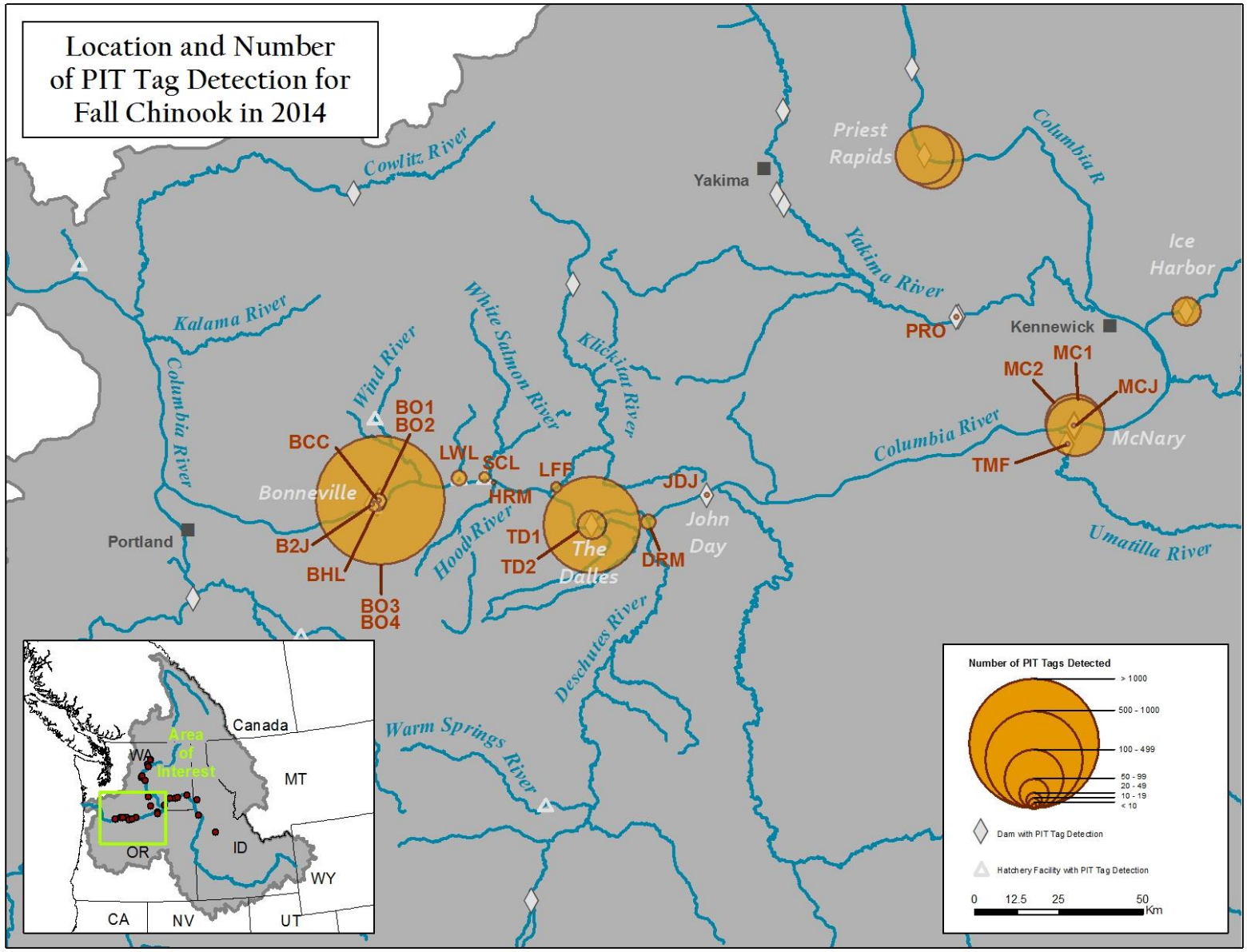

Figure A12. Map of Lower Columbia River detection sites and number of fall Chinook salmon detected. Table A4 in the Appendix lists the PTAGIS sites' full name and the three-letter codes on this map. Fall Chinook is defined as fish passing Bonneville Dam from August 1 to end of year.

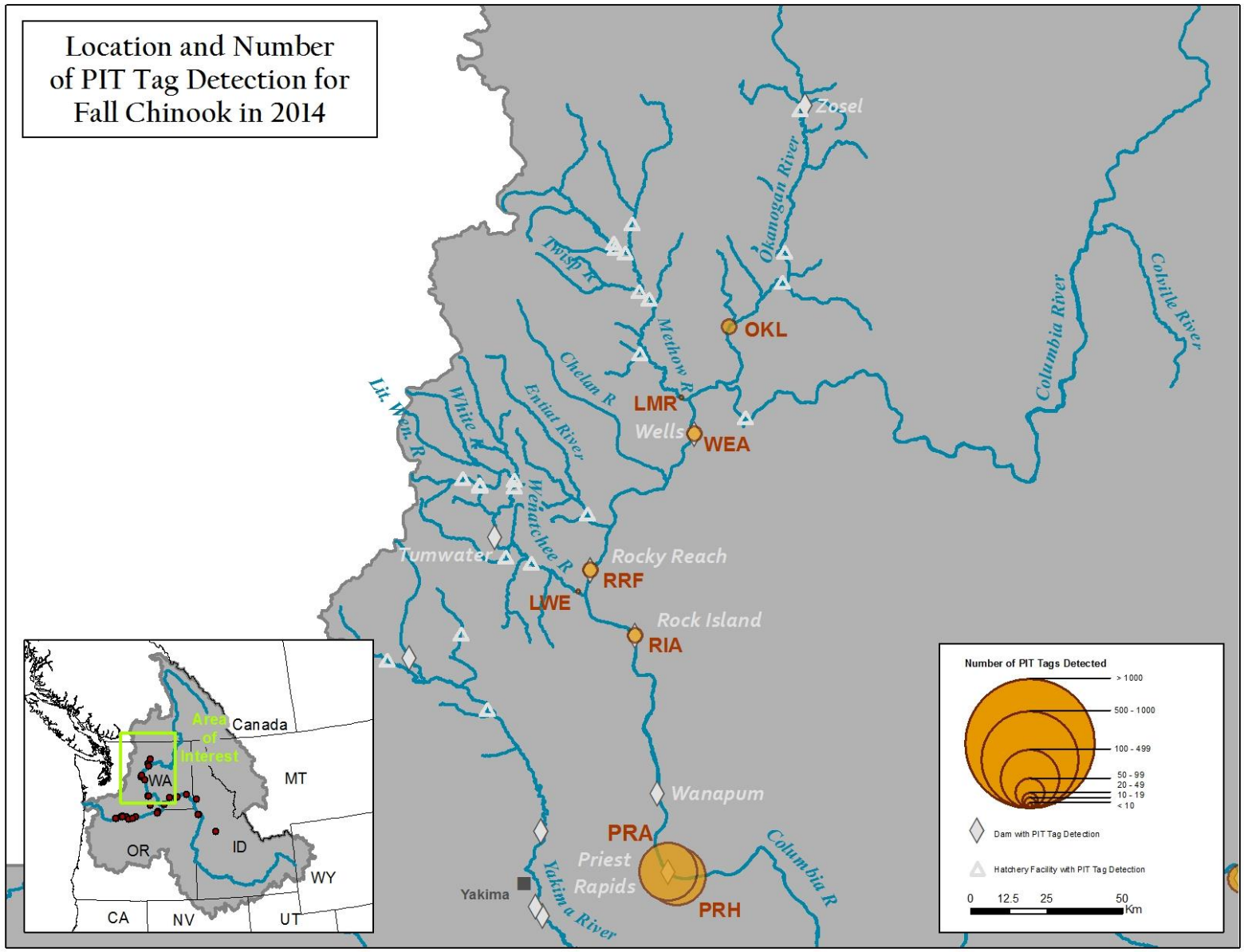

Figure A13. Map of Upper Columbia River detection sites and number of fall Chinook salmon detected. Table A4 in the Appendix lists the PTAGIS sites' full name and the three-letter codes on this map. Fall Chinook is defined as fish passing Bonneville Dam from August 1 to end of year.

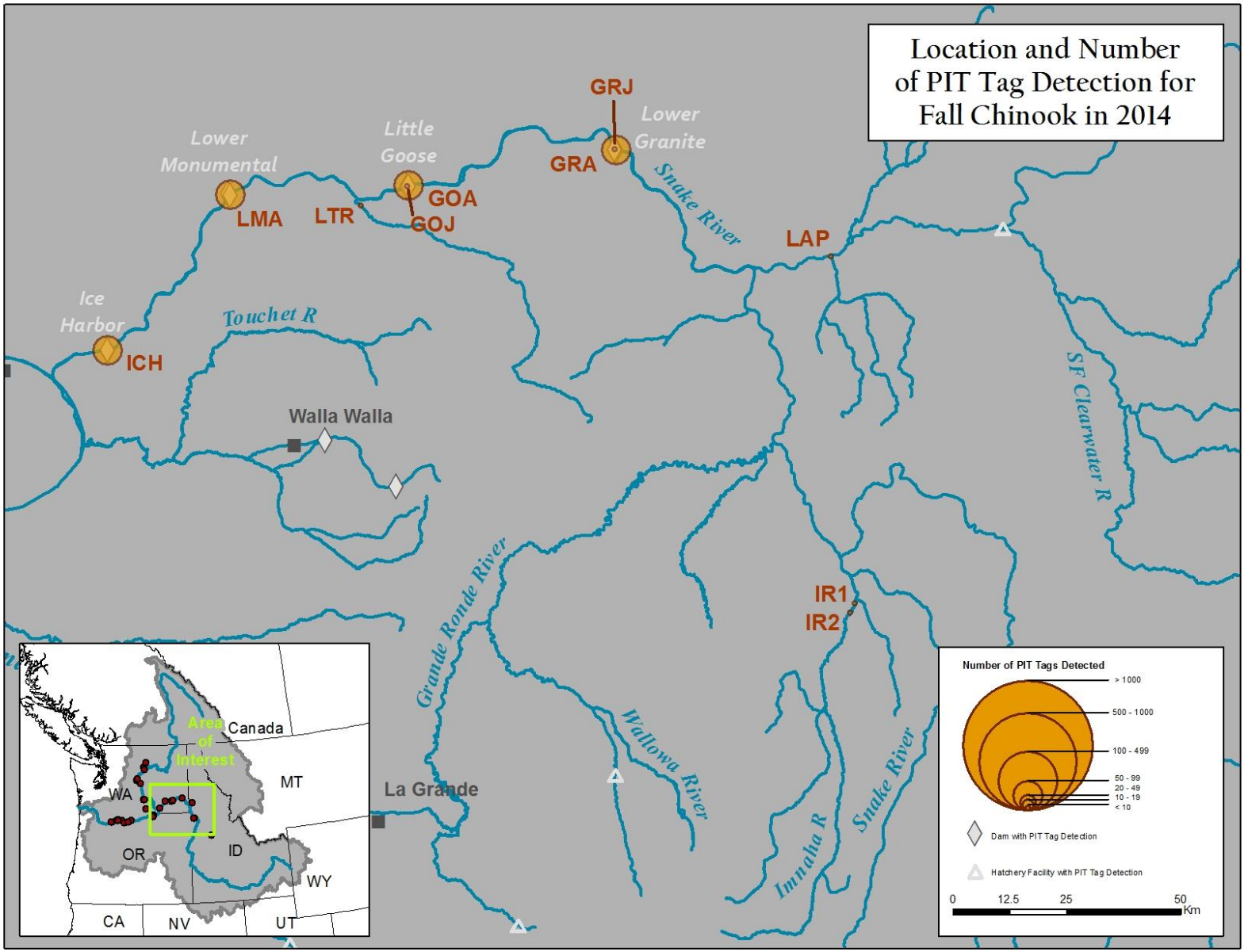

Figure A14. Map of Lower Snake River detection sites and number of fall Chinook salmon detected. Table A4 in the Appendix lists the PTAGIS sites' full name and the three-letter codes on this map. Fall Chinook is defined as fish passing Bonneville Dam from August 1 to end of year.

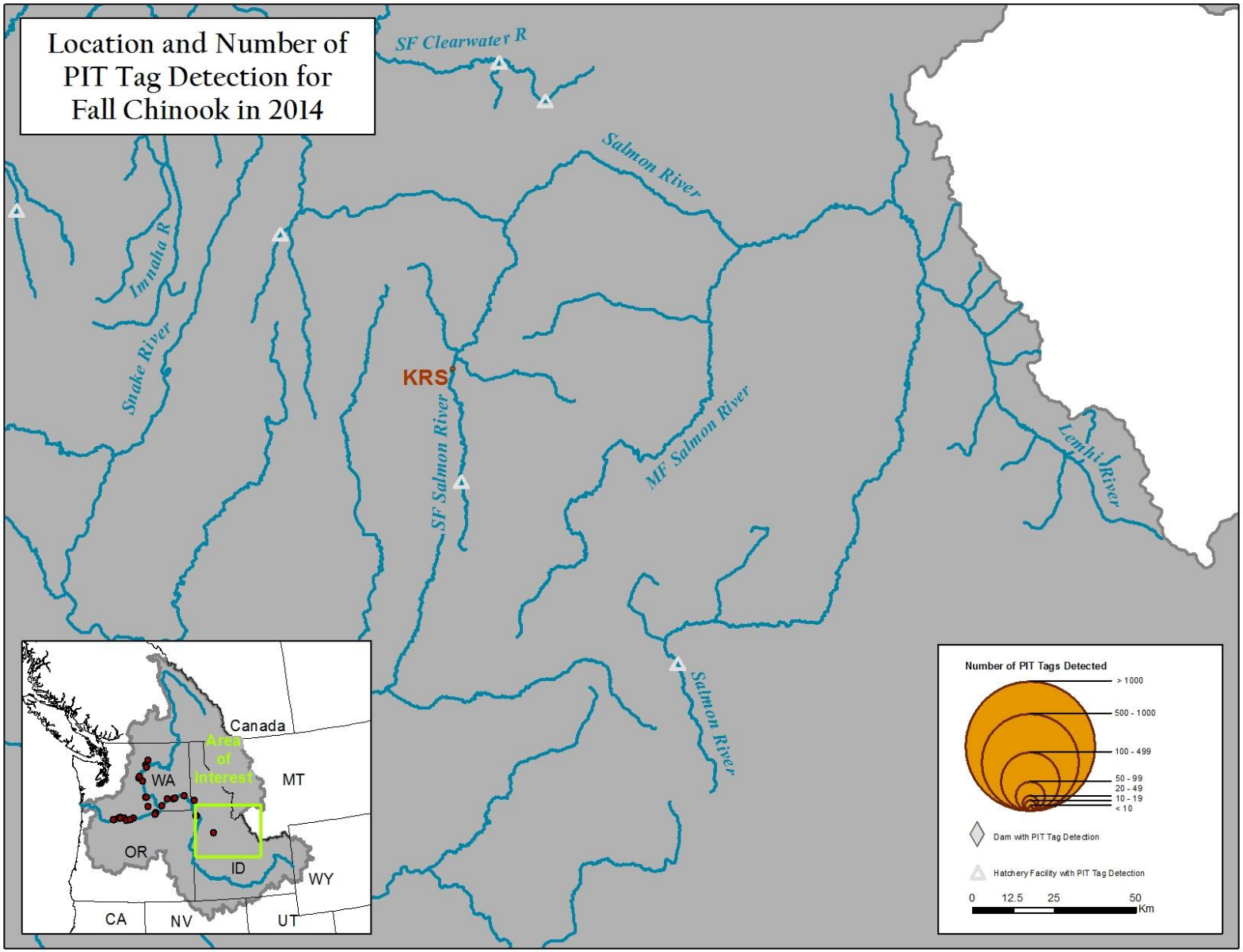

Figure A15. Map of Salmon River detection sites and number of fall Chinook salmon detected. Table A4 in the Appendix lists the PTAGIS sites' full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from August 1 to end of year.

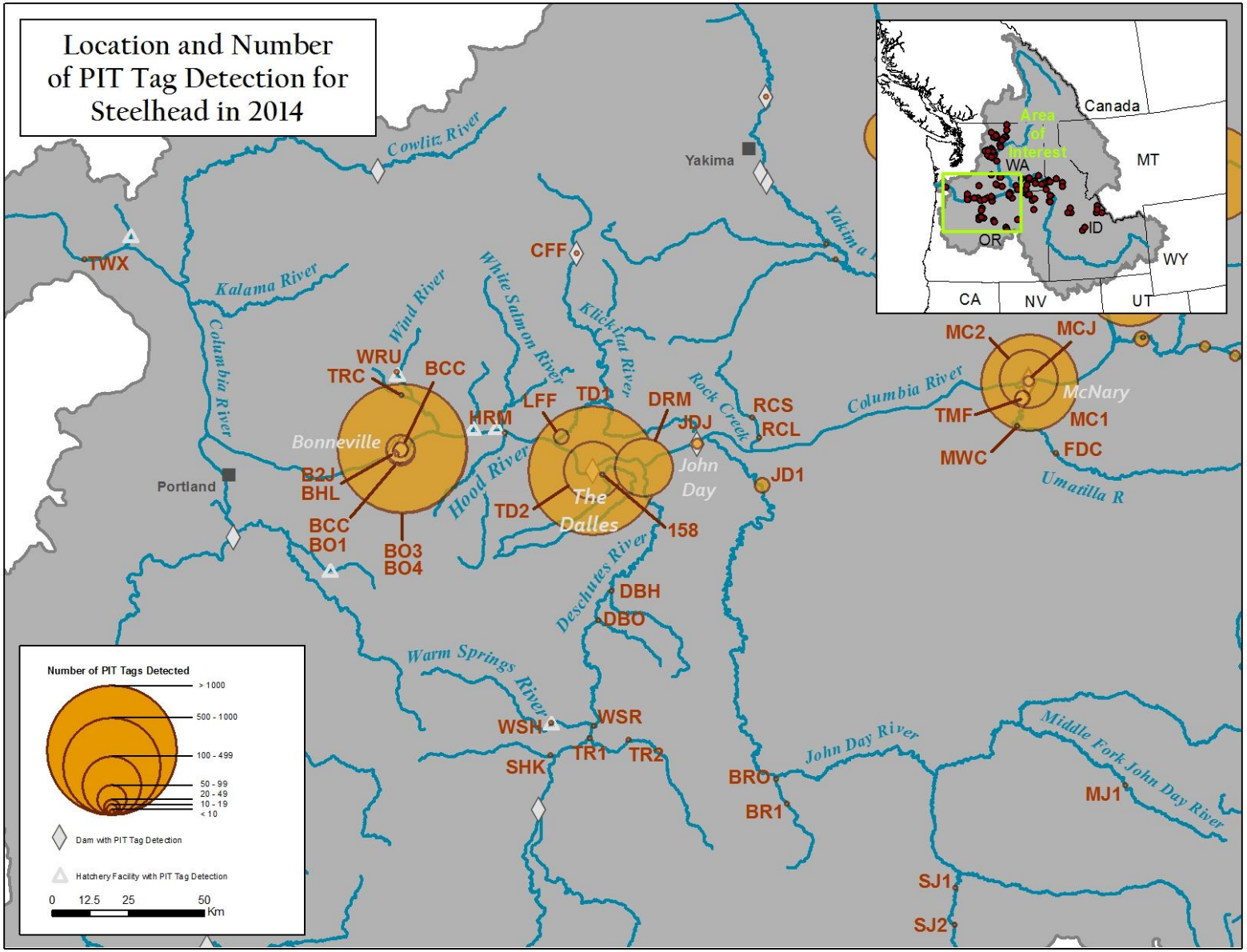

Figure A16. Map of Lower Columbia River detection sites and number of steelhead detected. Table A4 in the Appendix lists the PTAGIS sites' full name and the three-letter codes on this map.

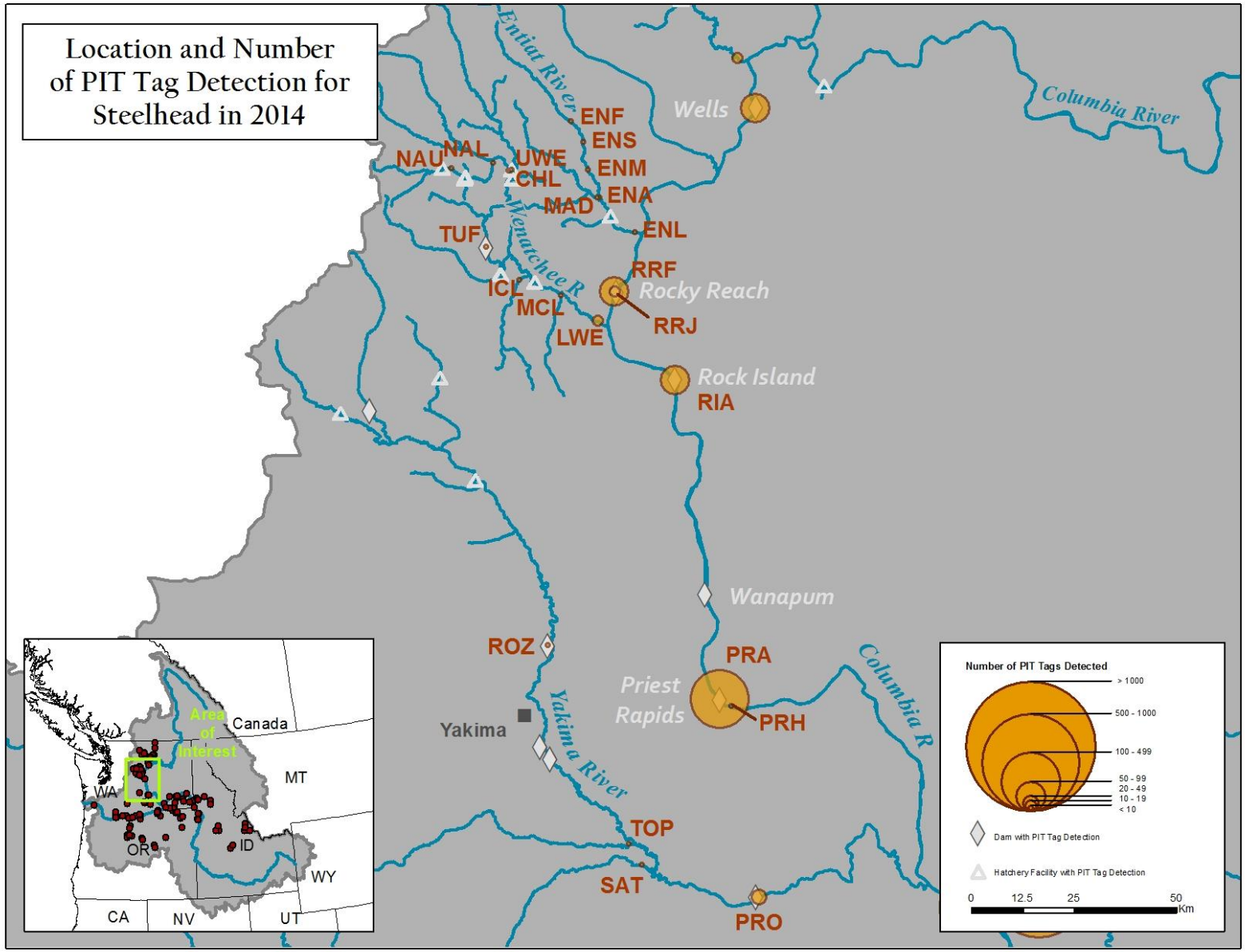

Figure A17. Map of Upper Columbia River (between the Snake River and Wells Dam) detection sites and number of steelhead detected. Table A4 in the Appendix lists the PTAGIS sites' full name and the three-letter codes on this map.

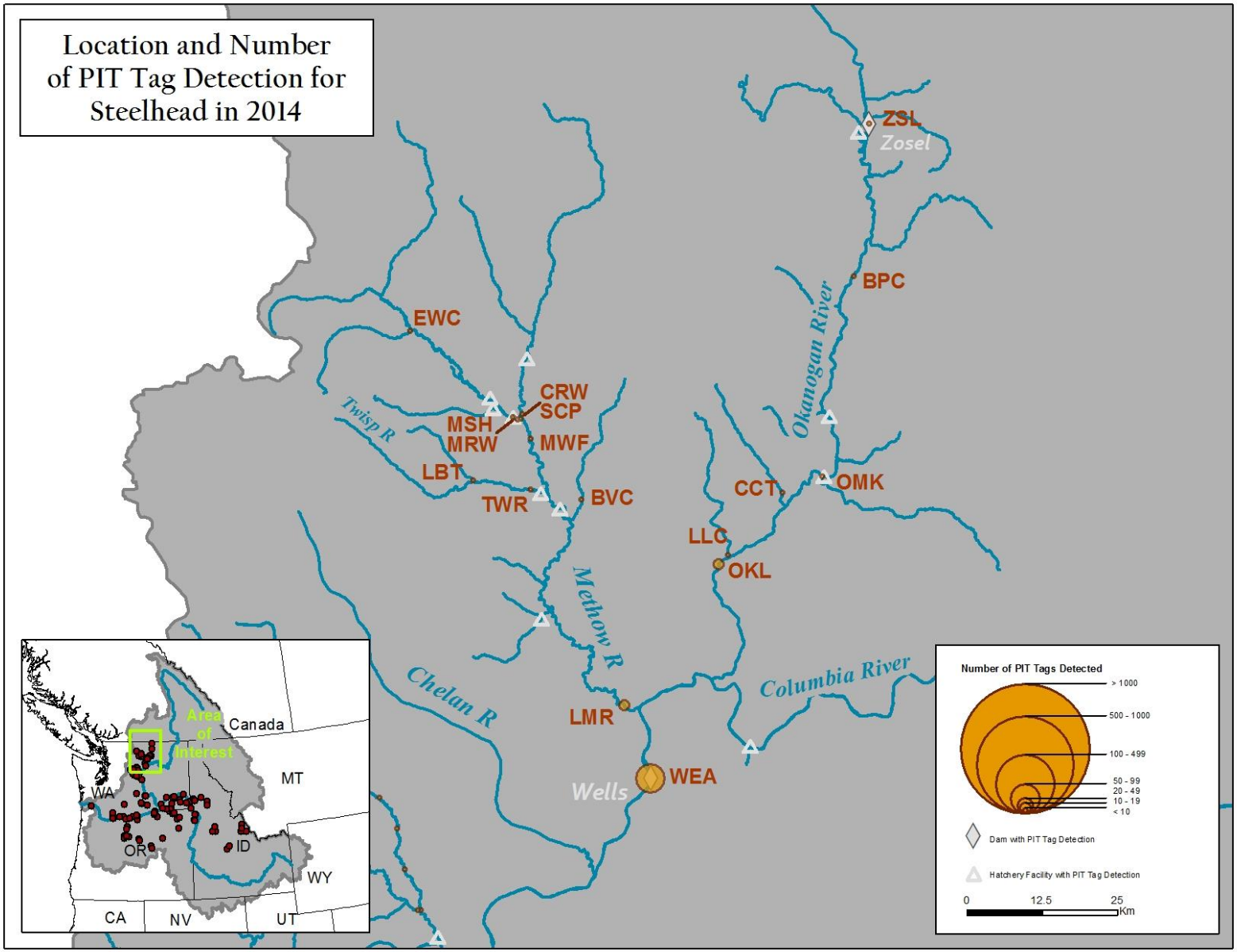

Figure A18. Map of Upper Columbia River (Wells Dam and above) detection sites and number of steelhead detected. Table A4 in the Appendix lists the PTAGIS sites' full name and the three-letter codes on this map.

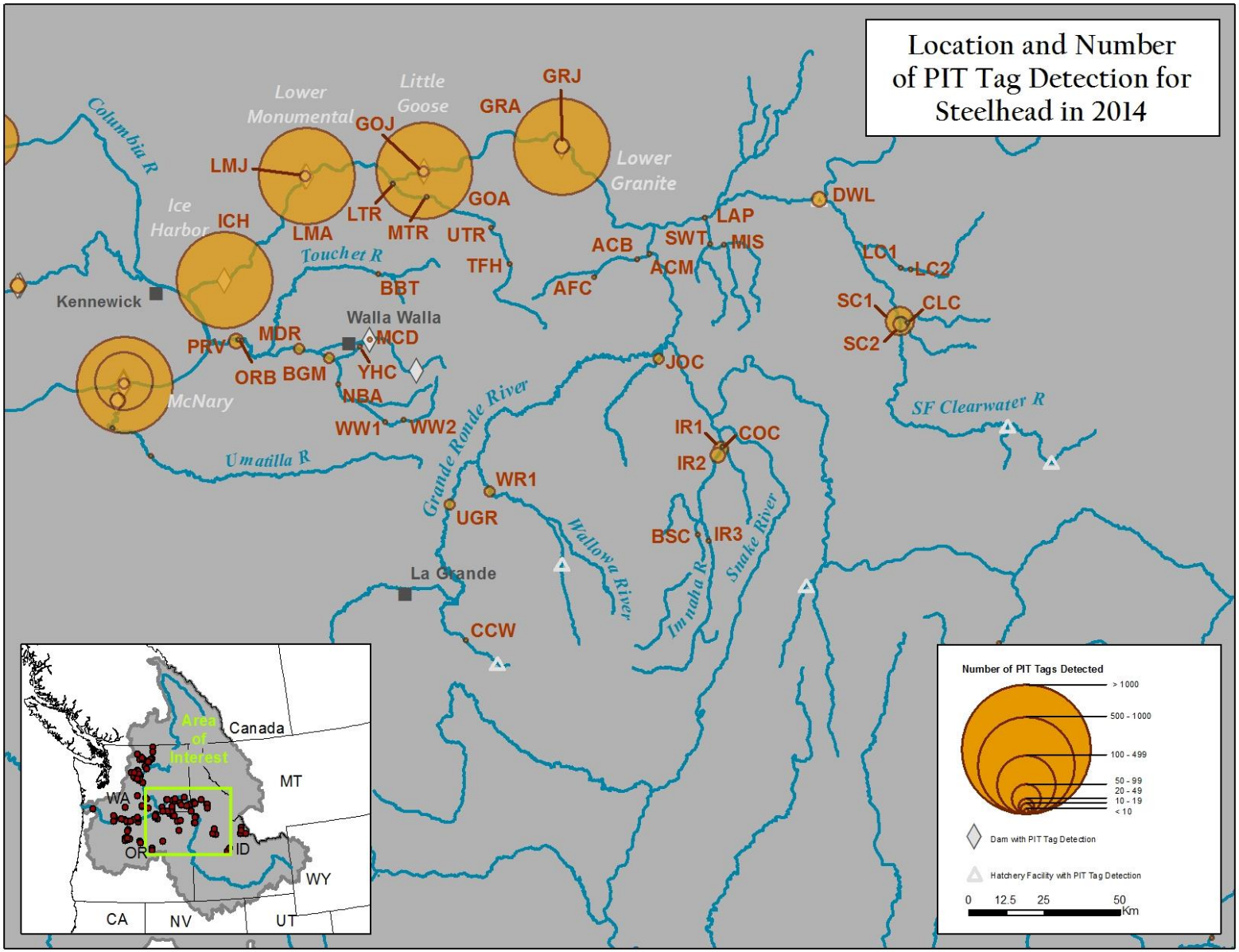

Figure A19. Map of Lower Snake River detection sites and number of steelhead detected. Table A4 in the Appendix lists the PTAGIS sites' full name and the three-letter codes on this map.

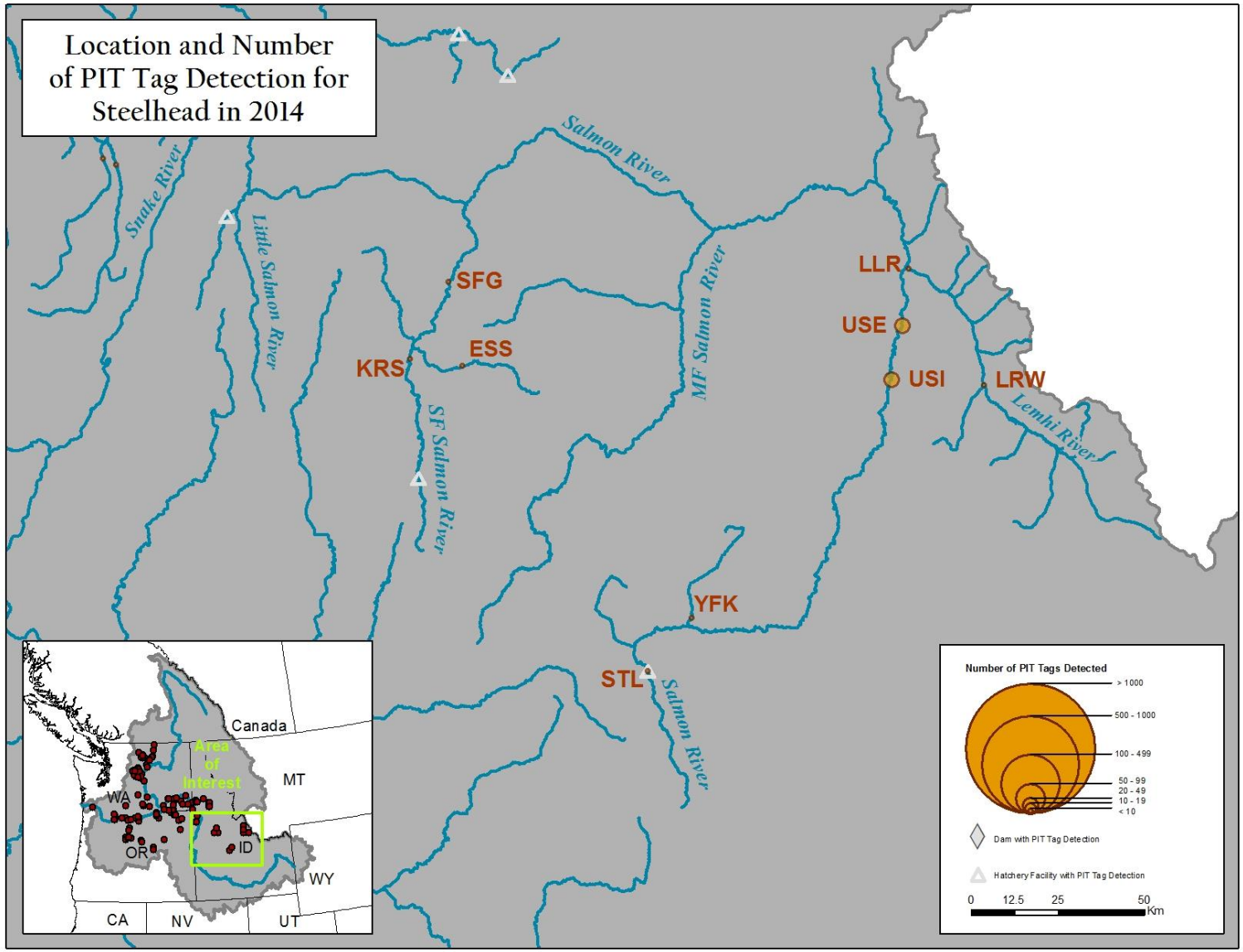

Figure A20. Map of Salmon River detection sites and number of steelhead detected. Table A4 in the Appendix lists the PTAGIS sites' full name and the three-letter codes on this map.