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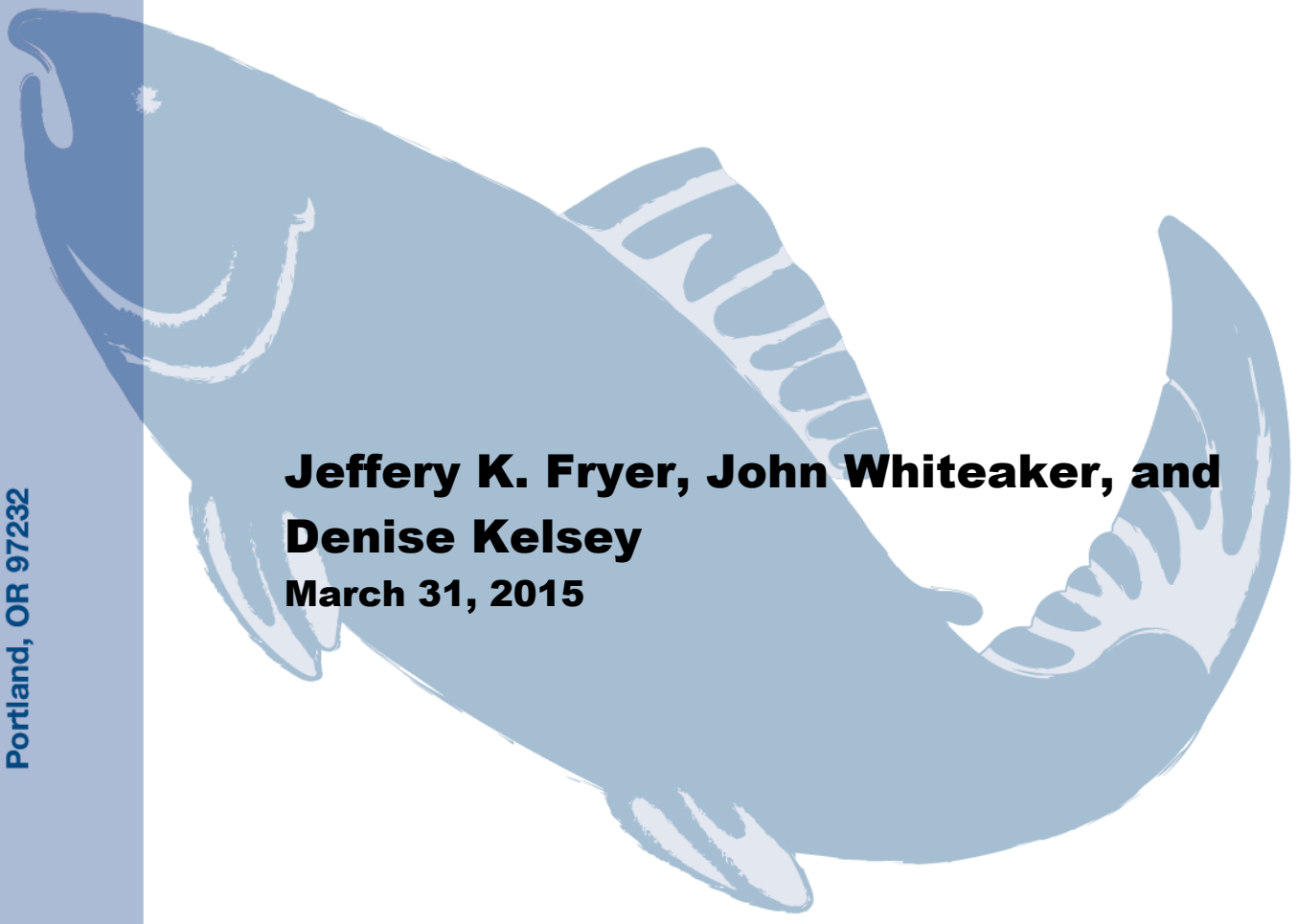
TECHNICAL REPORT 15-02

Upstream Migration Timing of Columbia Basin Chinook and Sockeye Salmon and Steelhead in 2013



Jeffery K. Fryer, John Whiteaker, and Denise Kelsey

March 31, 2015

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Columbia River Inter-Tribal Fish Commission Technical Report for BPA Project 2008-518-00, Contract 64561 Report Date Range (01/13-12/13)

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ABSTRACT

In 2013 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 1008 spring Chinook, 937 summer Chinook, 1461 fall Chinook, and 772 Sockeye salmon, and 1276 steelhead.

Chinook migration rates between mainstem dams ranged between 18.5 and 46.0 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 -35.0% to +10.7% at mainstem dams.

Steelhead median rates between mainstem dams ranged from 14.7 km to 31.1 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 in early October at 60.0% of the total steelhead run, with the estimated weekly number of B-run steelhead peaking the week of September 15, 2013 at 2259 fish. A total of 92 PIT tagged steelhead tracked in 2013 were detected moving downstream (mostly in juvenile bypasses) after March 31, 2014 presumably in an attempt to return to the ocean after spawning.

The estimated stock composition of Sockeye Salmon passing Bonneville Dam based on where PIT tagged Sockeye were last detected was 70.0% Okanogan, 28.0% Wenatchee, 1.0% Entiat, 0.5% Yakima, and 0.6% Deschutes. No Sockeye were PIT tagged that were last detected in the Snake River. The mean migration rate between Bonneville and Rock Island Dam was 37.1 km per

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

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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 23 through October 14, 2013, 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 and above 22C sampling is halted.

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.

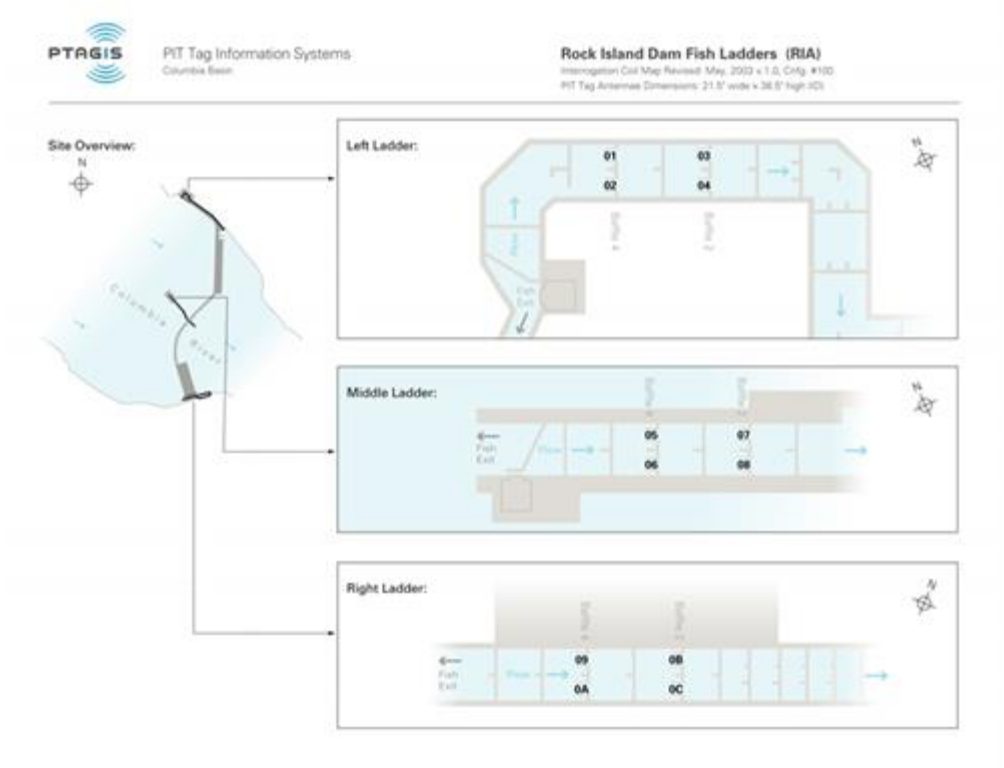

Figure 1. Example PIT tag detection configuration at Rock Island Dam showing two adjoining antennas at two weirs in each fish ladder. (Figure from www.ptagis.org.)

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 997 spring Chinook, 918 summer Chinook, and 1435 fall Chinook Salmon were PIT tagged in 2013 (Tables 1-3) between April 22 and October 14, 2013. Sampling restrictions due to water temperatures exceeding 21.1C reduced the number of days of sampling during Statistical weeks 31-38 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 Chinook missing PIT tag antennas after tagging), the numbers of Chinook tracked upstream consisted of 1008 spring Chinook, 937 summer Chinook, and 1461 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 2013.

Dates	Week	Sampled	Tagged	Previously Tagged	Not Detected After Release	Total Tracked	Days Temperature Restrictions in Effect	
							Reduced hours	No sampling
4/23-26	17	109	109	0	0	109	0	0
4/29-5/3	18	184	180	4	0	184	0	0
5/6-5/8	19	146	138	6	0	144	0	0
5/13-5/16	20	245	239	6	0	245	0	0
5/20-24	21	213	203	10	0	213	0	0
5/28-5/31	22	114	108	5	0	113	0	0
Total	**23**	**1011**	**977**	**31**	**0**	**1008**	**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 middle of the run (when temperature restrictions reduced sampling) and over-sampled at the end of the run (Figure 4).

Table 2. Number of PIT tagged summer Chinook Salmon tracked at Bonneville Dam by date and statistical week in 2013.

Dates	Week	Sampled	Tagged	Previously Tagged	Not Detected After Release	Total Tracked	Days Temperature Restrictions in Effect	
							Reduced hours	No sampling
6/3-6/7	23	190	184	5	1	188	0	0
6/10-6/14	24	185	173	11	2	182	0	0
6/19-6/21	25	67	64	3	0	67	0	0
6/24-6/27	26	89	87	2	0	89	0	0
7/1-7/3	27	106	106	0	0	106	0	0
7/8-7/12	28	150	149	1	0	150	0	0
7/15-19	29	89	88	1	1	88	**0**	**0**
7/22-26	30	49	49	0	0	49	2	0
7/30-7/31	31	18	18	0	0	18	1	0
Total		**943**	**918**	**23**	**4**	**937**	**3**	**0**

Table 3. Number of PIT tagged fall Chinook Salmon tracked at Bonneville Dam by date and statistical week in 2013.

Dates	Week	Sampled	Tagged	Previously Tagged	Not Detected After Release	Total Tracked	Days Temperature Restrictions in Effect	
							Reduced hours	No sampling
8/2	31	5	5	0	0	5	1	0
8/6,9	32	22	22	0	0	22	2	2
8/13-16	33	84	83	1	2	82	4	1
8/22,23	34	61	61	0	0	61	2	3
8/27-30	35	121	113	6	0	119	4	0
9/5-6	36	114	112	0	0	112	2	2
9/10-9/12	37	212	207	3	2	208	2	3
9/17-9/20	38	188	183	4	0	187	3	1
9/23,25-27	39	255	252	3	1	254	0	0
9/30,10/1,3,4	40	206	201	4	0	205	0	0
10/7-11	41	179	170	9	1	178	0	0
10/14	42	28	26	2	0	28	0	0
Total		**1475**	**1435**	**32**	**6**	**1461**	**20**	**12**

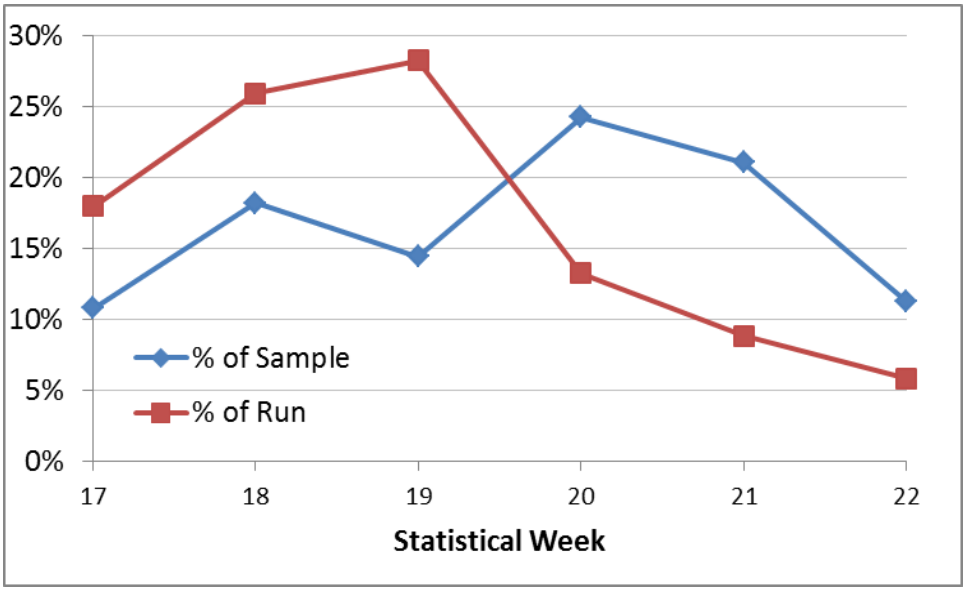

Figure 2. The weekly spring Chinook sample and run as a percentage of the total sample and run size at Bonneville Dam in 2013.

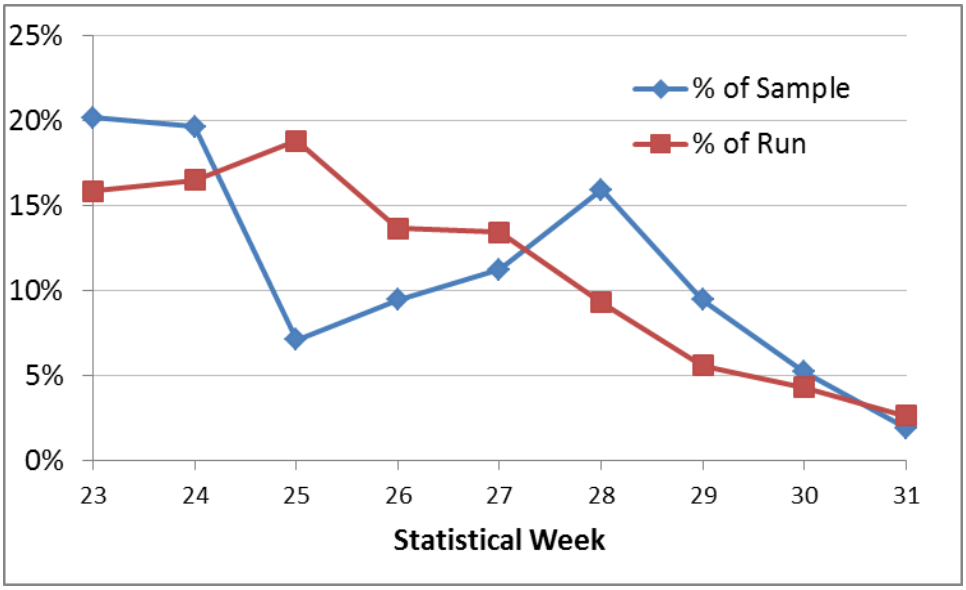

Figure 3. The weekly summer Chinook sample and run as a percentage of the total sample and run size at Bonneville Dam in 2013.

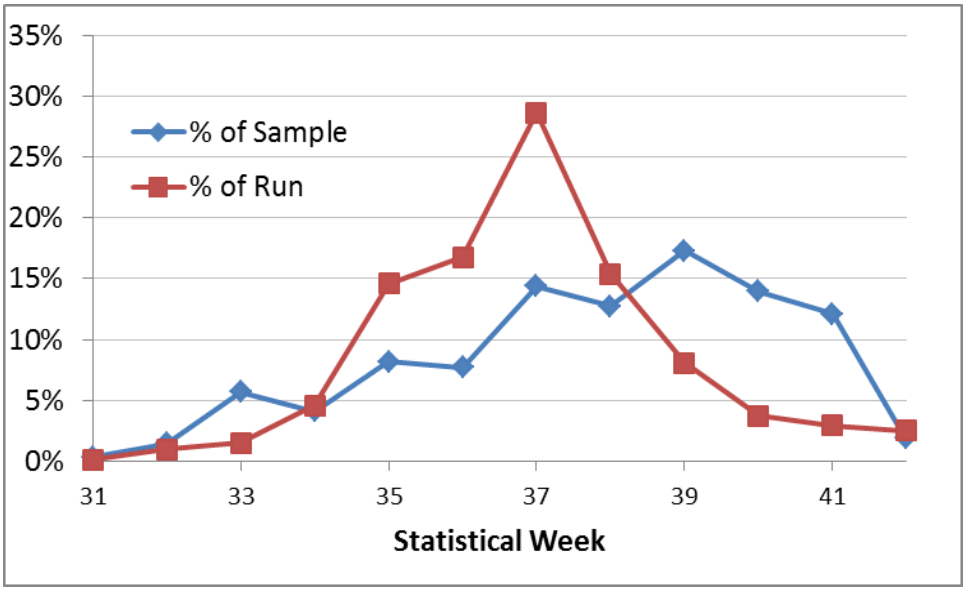

Figure 4. The weekly fall Chinook sample and run as a percentage of the total sample and run size at Bonneville Dam in 2013.

Detection Numbers

The tracking of 1008 spring Chinook generated 58,305 weir detections, which were grouped into 5,923 site detections at 104 sites. The 937 summer Chinook generated 48,764 weir detections, grouped into 6,020 site detections at 70 sites, and the 1,461 fall Chinook generated 49,043 weir detections grouped into 5,539 site detections at 39 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 2014).

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 21 spring Chinook, 18 summer Chinook, and 8 fall Chinook and all were correctly aged using scale patterns. Only the total age was compared as it is not possible to separate freshwater and saltwater age using PIT tag data.

In 2013, 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 97.8% 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 2013. 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	250	6		2	97.7%
Age 4		184	4	47	97.9%
Age 5			21		100.0%
Total	**250**	**190**	**25**	**49**	**97.8%**

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, nine Chinook Salmon greater than 36 cm in length were sampled which were estimated to spend no winters in saltwater. Eight of the minijacks were aged as Age 1.0 and one as Age 2.0. 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 the Deschutes River mouth, Priest Rapids Hatchery, and Wells Dam, while one each were last detected at Lower Granite Dam, The Dalles Dam, and the Hood River mouth.

We also sampled and PIT tagged a total of 22 tule Chinook Salmon for another project[a]. Of these fish, 7 were last observed passing upstream through the Bonneville Dam Washington Shore ladder, 12 at Spring Creek National Fish

[a] Tule Chinook are a lower river run of Chinook that return from the ocean ready to spawn, with a dark coloration, hooked snouts, and well developed breeding teeth. Upriver bright Chinook, which this project has focused on, retain their bright sides and firm flesh as they migrate upstream and are favored by commercial and sort fishers.

Hatchery, and 1 each at the Bonneville Dam Oregon Shore ladder, and the Hood and Deschutes river mouth in stream arrays.

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, with another peak early in the fall 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 2013.

Dam	Spring Chinook	Summer Chinook	Fall Chinook
Bonneville	100.0%	100.0%	100.0%
The Dalles	82.6%	90.6%	65.5%
McNary	70.1%	81.0%	48.5%
Priest Rapids	14.3%	58.3%	14.9%
Rock Island	14.2%	56.8%	5.9%
Rocky Reach	7.4%	47.9%	5.2%
Wells	6.7%	40.8%	2.8%
Ice Harbor	47.2%	18.2%	8.8%
Lower Granite	45.3%	17.5%	8.2%

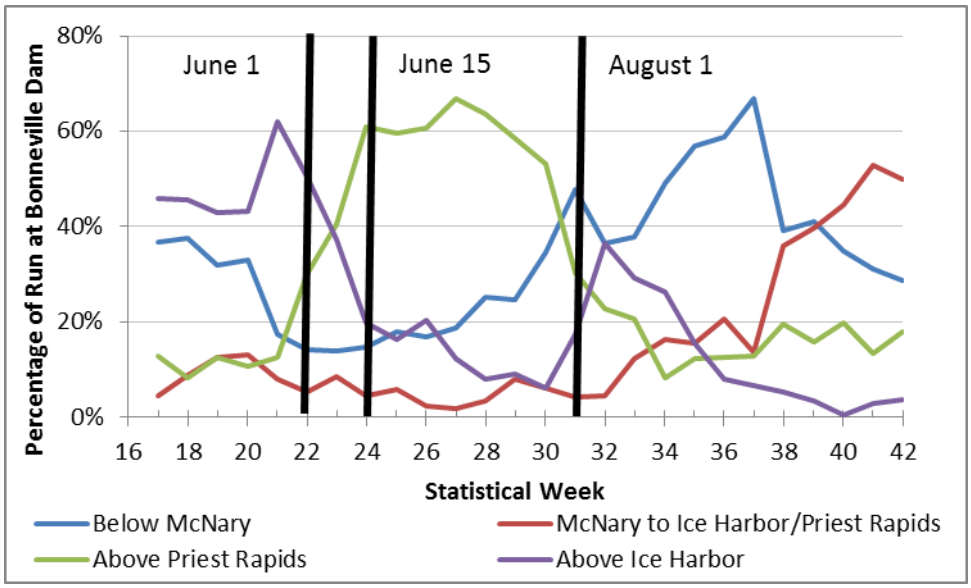

Figure 5. Distribution of final detection areas of the Columbia Basin by statistical week for Chinook Salmon PIT tagged at Bonneville Dam in 2013

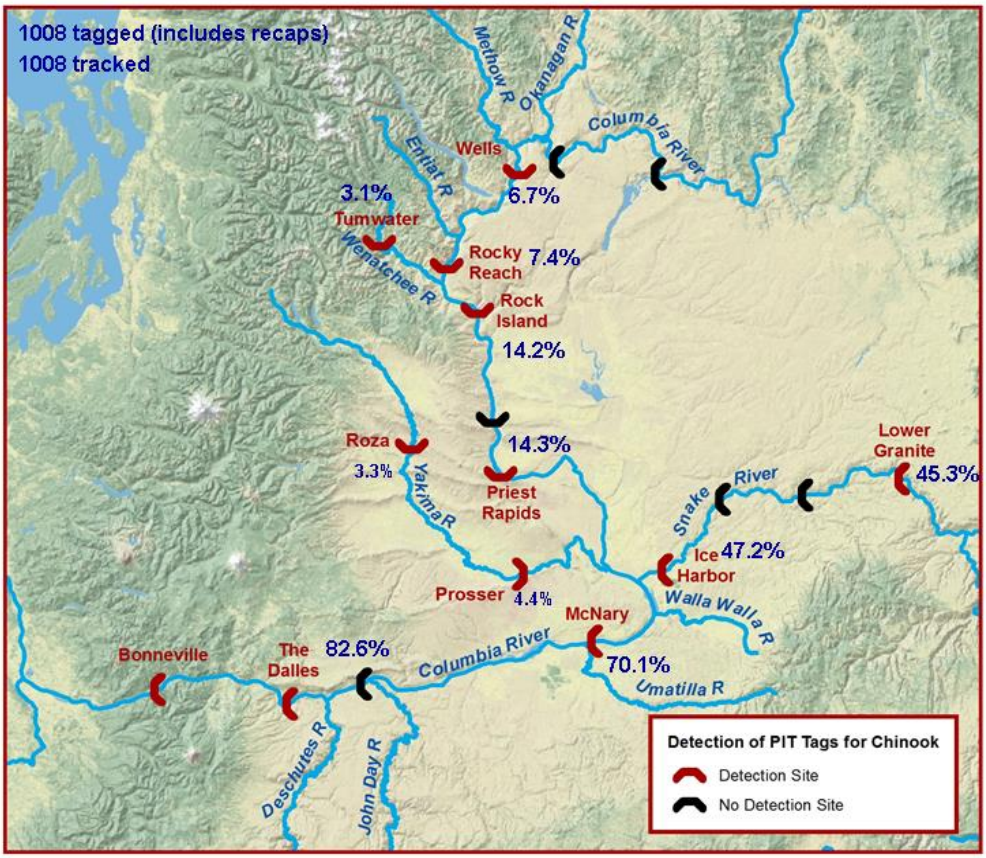

Figure 6. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of spring Chinook Salmon PIT tagged at Bonneville Dam, and the percentage of the run estimated to pass upstream dams in 2013.

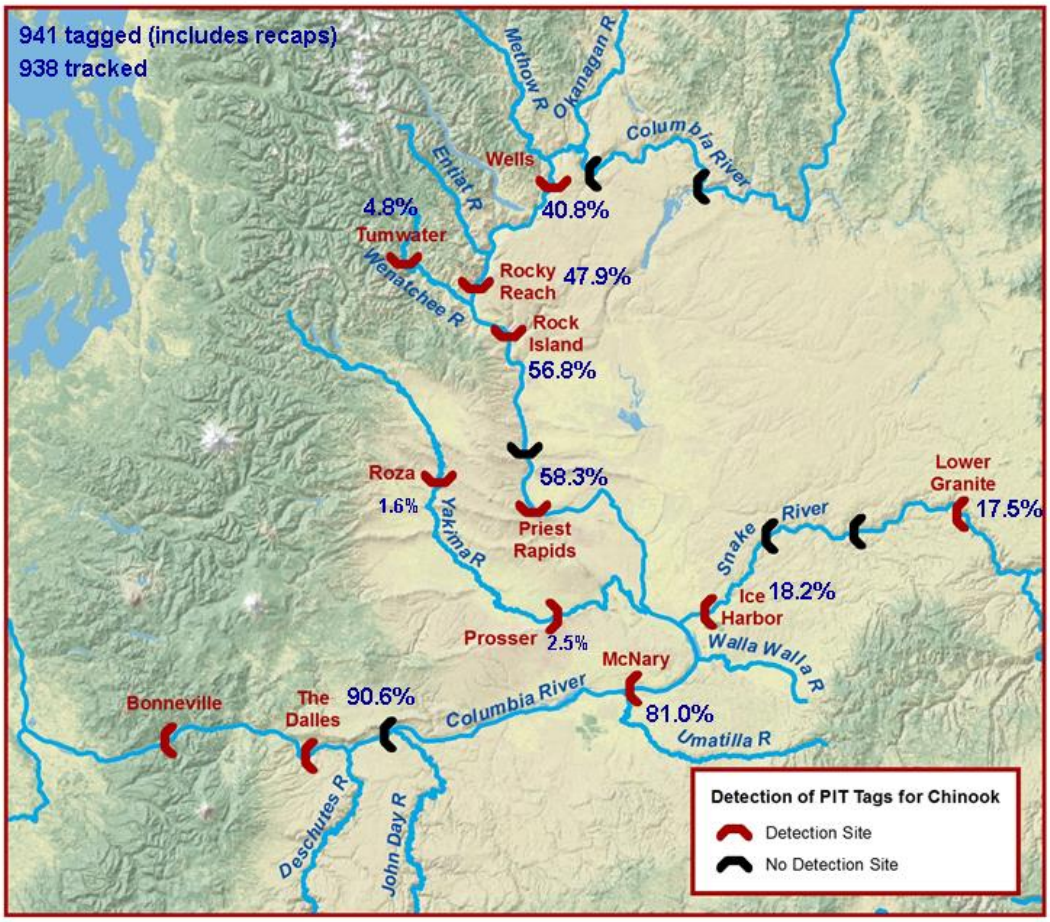

Figure 7. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of summer Chinook Salmon PIT tagged at Bonneville Dam, and the percentage of the run estimated to pass upstream dams in 2013.

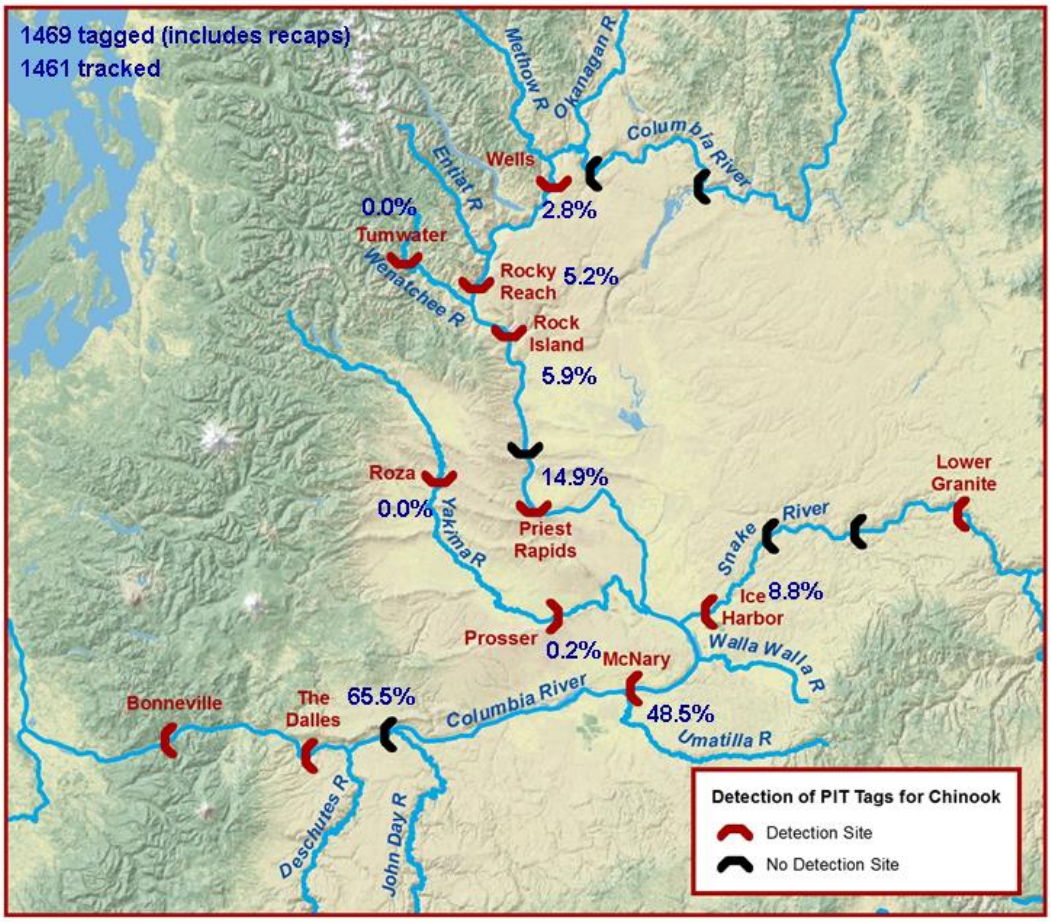

Figure 8. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of fall Chinook Salmon PIT tagged at Bonneville Dam, and the percentage of the run estimated to pass upstream dams in 2013.

The percentage of PIT tagged Chinook Salmon documented passing a dam without detection was 2.2% or less for all dams except Rock Island Dam (Table 6). 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, 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 generally within 15% of visual counts (Table 7). The greatest differences are with fall Chinook where PIT tag estimates ranged from 44.6% under the visual count at Priest Rapids Dam to 55.1% over

the visual count at Wells Dam.

Table 6. Percentage of Chinook Salmon detected upstream that missed detection at mainstem dams in 2013.

Dam	Spring	Summer	Fall
Bonneville	0.5%	0.4%	1.1%
The Dalles	0.9%	0.5%	1.0%
McNary	0.7%	0.9%	0.7%
Priest Rapids	1.4%	0.4%	0.0%
Rock Island	6.2%	4.1%	12.3%
Rocky Reach	0.0%	0.7%	0.0%
Wells	0.0%	0.0%	NA
Ice Harbor	0.5%	0.4%	2.2%
Lower Granite	0.0%	0.0%	NA
Weighted mean (by sample size)	**0.8%**	**0.7%**	**1.3%**

Table 7. Chinook Salmon escapement by run at Columbia Basin mainstem dams upstream of Bonneville Dam in 2013. Estimates are from both PIT tag recoveries and dam counts 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	101513	96674	-4.8%	106389	105518	-0.8%
McNary	74455	82196	10.4%	90549	94285	4.1%
Priest Rapids	15023	16588	10.4%	74257	68411	-7.9%
Rock Island	16445	15725	-4.4%	72372	64109	-11.4%
Rocky Reach	8942	8682	-2.9%	63729	55783	-12.5%
Wells	10113	7906	-21.8%	53715	47865	-10.9%
Ice Harbor	56628	55016	-2.8%	18233	21182	16.2%
Lower Granite	54971	53492	-2.7%	15995	20489	28.1%
	Fall Chinook Salmon			**All Chinook Salmon**		
The Dalles	690522	684775	-0.8%	898424	886967	-1.3%
McNary	509358	508935	-0.1%	674362	685416	1.6%
Priest Rapids	282446	156588	-44.6%	371726	241587	-35.0%
Rock Island	69436	56808	-18.2%	158253	136643	-13.7%
Rocky Reach	56519	54594	-3.4%	129190	119058	-7.8%
Wells	18934	29362	55.1%	82762	85133	2.9%
Ice Harbor	77313	92302	19.4%	152174	168500	10.7%
Lower Granite	78960	86844	10.0%	149926	160824	7.3%

Between 11.4% and 16.8% 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, 17% or greater of summer Chinook reaching Ice Harbor and Lower Granite dams would be identified as spring Chinook based on passage date for those 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 2013.

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	0.5%	0.0%	0.0%	0.4%	0.1%
June 8	August 9	McNary	4.3%	0.0%	1.6%	0.8%	0.1%
June 13	August 14	Priest Rapids	16.8%	0.0%	0.4%	0.6%	0.4%
June 17	August 18	Rock Island	16.3%	0.0%	0.8%	0.6%	2.8%
June 19	August 20	Rocky Reach	14.5%	0.0%	1.1%	0.7%	1.4%
June 28	August 29	Wells	11.4%	0.0%	5.2%	0.8%	19.5%
June 11	August 12	Ice Harbor	3.8%	0.0%	33.7%	3.7%	0.0%
June 17	August 18	Lower Granite	4.1%	0.0%	17.0%	0.0%	0.0%

Tributary escapement estimates for five sites, each with more than 30 detections, are found in Table 9 alongside estimates using visual or trap counts at three of the sites. Chinook passing the Wenatchee, Yakima, and Imnaha sites were primarily spring or summer Chinook while those passing Lyle Falls were primarily fall Chinook (Figure 9).

Table 9. Estimated 2013Chinook Salmon escapement, as estimated using PIT tag detections, to Tumwater, Prosser, and Roza dams, the Imnaha River and Lyle Falls.

Location and River	Number of Tag Detections	Escapement Estimate from Trap or Visual Counts	Estimated Escapement Using PIT Tags	Difference (%) Between Estimates
Tumwater Dam, Wenatchee River	85	9,550	9,360	-2.0%
Prosser Dam, Yakima River	80	18,593	10,673	-42.6%
Roza Dam, Yakima River	56	6,102	5,737	-6.0%
Imnaha PIT Tag Antennas	30	NA	4,306	NA
Lyle Falls	41	NA	22,369	NA

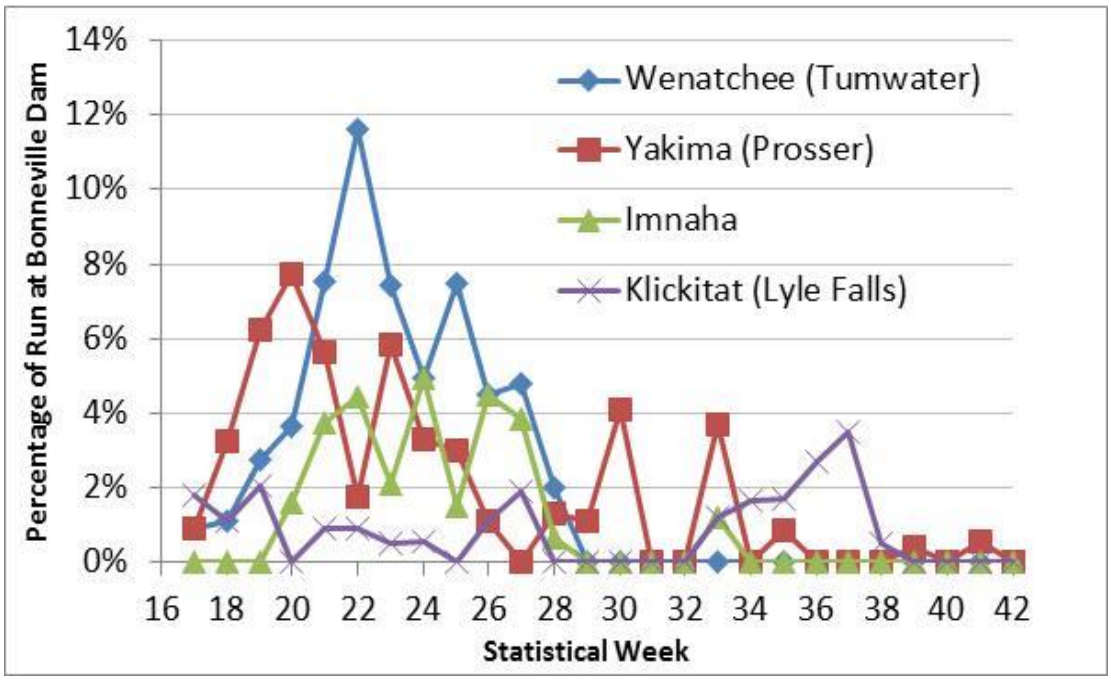

Figure 9. Percentage of Chinook Salmon by statistical week tagged at Bonneville Dam in 2013 destined for the Yakima, Wenatchee, Klickitat (at Lyle Falls) and Imnaha subbasins based on upstream PIT tag detections at Prosser, Tumwater , and Lyle Falls fishways, and the Imnaha weir.

Migration Rates and Passage Time

Chinook migration rates between mainstem dams ranged between 18.5 and 46.0 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) Wells, Bonneville, McNary, and Lower Granite dams (Table 11). At Wells, Bonneville, and McNary 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 and Bonneville dams may also be inflated, because at both sites, fish may take time to recover from sampling before moving upstream again (many fish are trapped and sampled at Lower Granite Dam for other projects, while this project samples fish at Bonneville Dam). New antennas a Wells Dam, operative for the first time in 2013, were located downstream of fish traps on each ladder while the existing antennas are located upstream of those traps. Therefore, Wells Dam passage

times also incorporate delays caused by fish trapping.

Table 10. Chinook Salmon travel rates between Columbia Basin dams estimated using PIT tag data in 2013.

		Median Migration Rate (km/day)		
Between Mainstem Dams	**Distance (km)**	**Spring Chinook**	**Summer Chinook**	**Fall Chinook**
Bonneville-The Dalles	74	37.7	36.8	35.1
The Dalles-McNary	157	46.0	45.5	40.6
Bonneville – McNary	231	40.7	40.3	37.6
McNary - Priest Rapids	167	28.1	34.9	19.9
Priest Rapids - Rock Island	89	29.6	31.3	23.6
Rock Island - Rocky Reach	33	28.4	29.4	18.5
Rocky Reach – Wells	65	29.3	31.1	32.2
Bonneville - Rock Island	487	30.4	34.8	25.5
Bonneville – Wells	585	29.5	32.4	21.6
McNary - Ice Harbor	67	38.5	44.7	35.3
Ice Harbor - Lower Granite	156	37.8	39.2	25.3
To and Between Tributary Sites				
Rock Island - Tumwater	73	3.7	4.1	--
McNary - Prosser	141	29.6	19.3	10.5
Prosser - Roza	133	13.0	20.2	--
Lower Granite - South Fork Salmon (SFG)	375	25.6	36.4	--

At the three tributary dams in Table 11, spring Chinook Salmon passing Tumwater Dam had the highest median passage time at 75.5 minutes. At no dam were more than 8.1% of Chinook Salmon detected spending more than 12 hours passing.

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 2013.

	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	70.8	79.8	73.9	8.1%	3.4%	4.6%
The Dalles	0.1	0.1	0.1	5.3%	1.9%	1.7%
McNary	102.1	74.5	87.6	7.5%	3.4%	3.4%
Priest Rapids	4.3	5.1	5.9	0.4%	1.1%	4.0%
Rock Island	8.2	28.9	46.3	0.9%	5.9%	1.0%
Rocky Reach	10.3	1.6	7.4	0.8%	1.9%	0.3%
Wells	139.7	111.3	100.4	2.0%	5.1%	0.3%
Ice Harbor	3.5	1.9	1.6	2.7%	0.7%	0.1%
Lower Granite	80.4	67.0	47.6	5.7%	2.3%	1.0%
Tumwater	75.5	6.6	NA	1.6%	0.0%	0.0%
Prosser	9.7	8.5	2.6	0.3%	0.1%	0.1%
Roza	1.8	1.7	NA	0.7%	0.1%	0.0%

Upstream Age and Length-at-Age Composition

Age 1.2 was the predominant age class for both spring and summer Chinook passing at all dams with PIT tag detection (Table 12, Figures 10 and 11). Age 0.2 was the most abundant age class for fall Chinook passing all dams except Wells Dam where Age 0.1 was most abundant (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 2013.

			Brood Year and Age Class							
Run, Site, Number		**2011**	**2010**		**2009**		**2008**		**2007**	
Spring	**Age-able**	**0.1**	**0.2**	**1.1**	**0.3**	**1.2**	**0.4**	**1.3**	**0.5**	**1.4**
Bonneville	843	0.0%	0.3%	35.0%	0.4%	53.2%	0.2%	10.6%	0.0%	0.3%
The Dalles	759	0.0%	0.3%	36.4%	0.5%	51.2%	0.2%	11.1%	0.0%	0.3%
McNary	658	0.0%	0.4%	37.0%	0.6%	50.4%	0.1%	11.2%	0.0%	0.3%
Priest Rapids	132	0.0%	0.1%	5.9%	0.1%	9.2%	0.1%	2.4%	0.0%	0.2%
Rock Island	131	0.0%	0.3%	32.4%	0.7%	51.6%	0.3%	13.6%	0.0%	1.0%
Rocky Reach	64	0.0%	1.1%	35.5%	1.5%	48.3%	0.0%	12.2%	0.0%	1.5%
Wells	58	0.0%	1.1%	37.8%	1.6%	49.2%	0.0%	9.2%	0.0%	1.1%
Ice Harbor	453	0.0%	0.0%	39.2%	0.2%	50.2%	0.1%	10.3%	0.0%	0.1%
Lower Granite	435	0.0%	0.0%	39.7%	0.2%	50.3%	0.1%	9.7%	0.0%	0.0%
Summer										
Bonneville	827	0.5%	11.8%	26.5%	15.7%	24.0%	0.7%	20.5%	0.0%	0.4%
The Dalles	743	0.5%	12.3%	27.2%	14.5%	23.9%	0.7%	20.4%	0.0%	0.4%
McNary	664	0.4%	12.3%	28.3%	14.8%	23.5%	0.8%	19.4%	0.0%	0.4%
Priest Rapids	474	0.3%	14.9%	12.1%	18.3%	25.6%	1.2%	27.1%	0.0%	0.6%
Rock Island	462	0.3%	15.2%	11.3%	18.6%	25.5%	1.3%	27.3%	0.0%	0.6%
Rocky Reach	388	0.3%	15.7%	11.2%	16.8%	26.3%	0.6%	29.0%	0.0%	0.1%
Wells	335	0.3%	17.0%	11.7%	18.0%	26.2%	0.5%	26.0%	0.0%	0.1%
Ice Harbor	154	1.0%	8.9%	79.0%	2.0%	8.2%	0.0%	0.5%	0.0%	0.5%
Lower Granite	148	1.0%	8.5%	80.3%	0.9%	8.3%	0.0%	0.5%	0.0%	0.5%
Fall										
Bonneville	1358	4.6%	48.4%	1.7%	41.7%	0.7%	2.5%	0.2%	0.1%	0.1%
The Dalles	969	6.2%	53.3%	1.9%	36.3%	0.7%	1.4%	0.1%	0.1%	0.0%
McNary	763	6.3%	55.1%	1.9%	34.8%	0.6%	1.1%	0.1%	0.1%	0.0%
Priest Rapids	217	9.0%	52.3%	0.1%	38.5%	0.2%	0.0%	0.0%	0.0%	0.0%
Rock Island	73	8.6%	56.7%	0.1%	34.4%	0.1%	0.0%	0.0%	0.0%	0.0%
Rocky Reach	64	11.4%	58.7%	0.1%	29.7%	0.1%	0.0%	0.0%	0.0%	0.0%
Wells	36	17.4%	32.2%	0.2%	50.0%	0.2%	0.0%	0.0%	0.0%	0.0%
Ice Harbor	101	13.8%	62.7%	4.3%	18.4%	0.9%	0.0%	0.0%	0.0%	0.0%
Lower Granite	97	13.8%	64.0%	2.6%	19.0%	0.6%	0.0%	0.0%	0.0%	0.0%

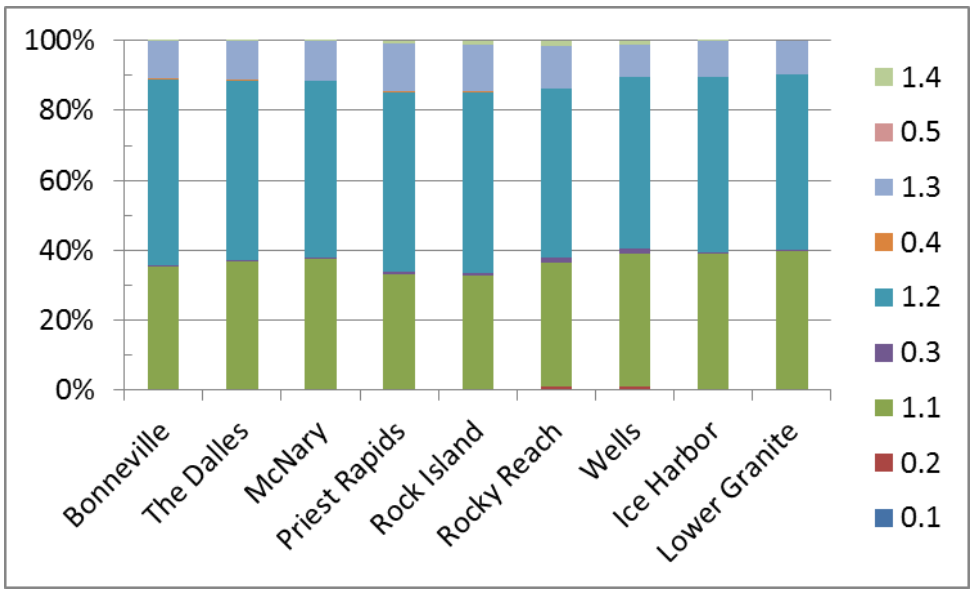

Figure 10. Spring Chinook age composition at Columbia and Snake river dams estimated using PIT tagged Chinook tracked by this project. Spring Chinook are defined as passing Bonneville Dam between April 1 and May 31, 2013.

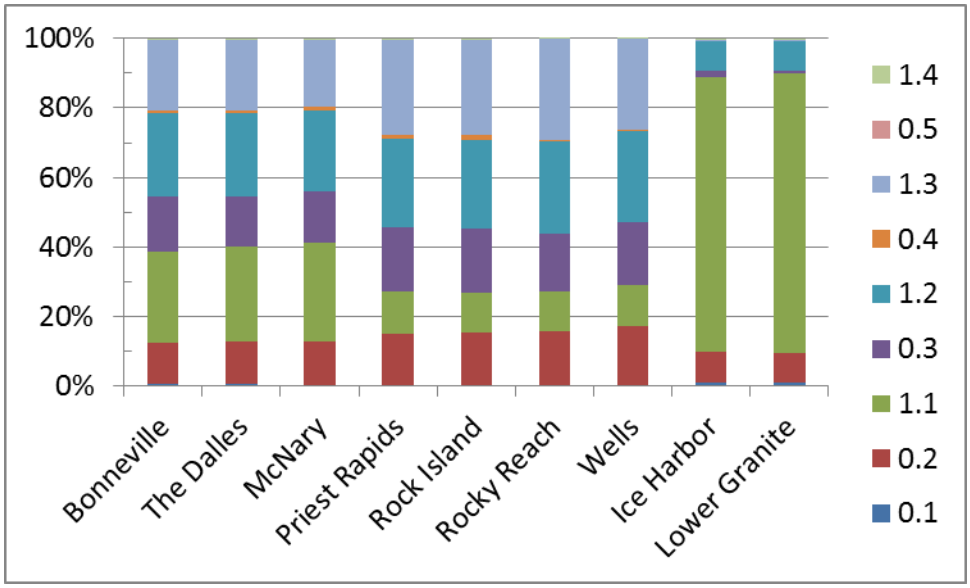

Figure 11. Summer Chinook age composition at Columbia and Snake river dams estimated using PIT tagged Chinook tracked by this project. Summer Chinook are defined as passing Bonneville Dam between June 1 and July 31, 2013.

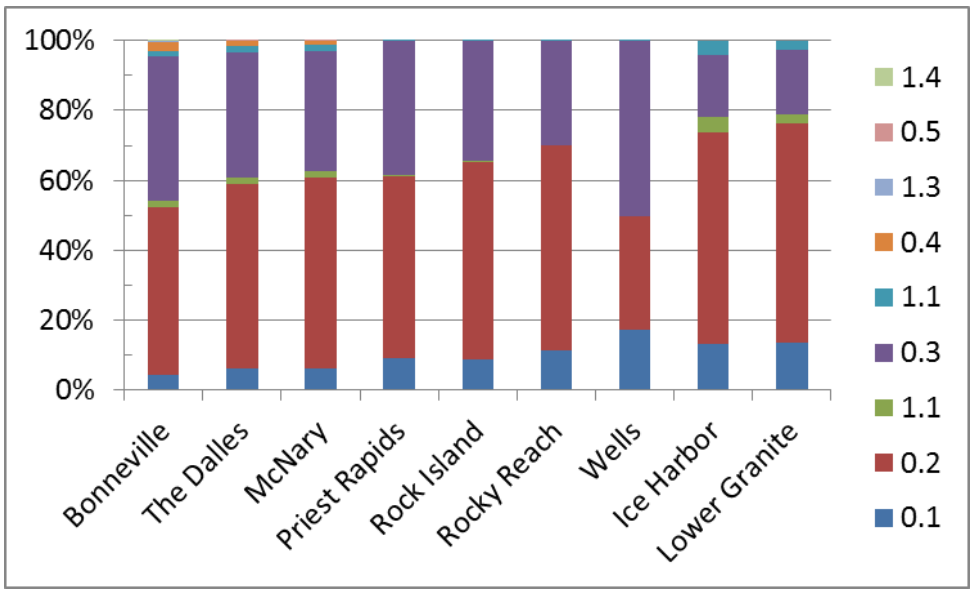

Figure 12. Fall Chinook age composition at Columbia and Snake river dams estimated using PIT tagged Chinook tracked by this project. Fall Chinook are defined as passing Bonneville Dam on or after August 1, 2013.

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 between on or before May 31, at Columbia and Snake River dams in 2013.

Dam	Statistic	Brood Year and Age Class						
		2010		2009		2008		2007
		0.2	1.1	0.3	1.2	0.4	1.3	1.4
Bonneville	μ	65.3	51.1	78.7	70.8	88.0	84.7	93.8
	s	2.9	3.8	3.2	4.6	3.9	5.4	6.4
	n	3	337	6	401	3	87	6
The Dalles		65.3	51.0	78.7	70.6	88.0	84.8	93.1
		2.9	3.7	3.2	4.7	3.9	5.5	7.0
		3	314	6	347	3	81	5
McNary	μ	65.3	51.0	78.7	70.6	89.0	85.2	93.1
	s	2.9	3.7	3.2	4.7	4.9	5.3	7.0
	n	3	272	6	297	2	73	5
Priest Rapids	μ	67.0	72.2	78.2	84.4	92.5	93.0	64.8
	s	--	4.6	2.4	5.8	--	8.0	15.0
	n	1	61	3	21	1	4	5
Rock Island	μ	67.0	72.2	78.2	84.4	92.5	93.0	64.8
	s	--	4.6	2.4	5.8	--	8.0	15.0
	n	1	61	3	21	1	4	24
Rocky Reach	μ	67.0	70.9	79.5	84.3		86.3	58.5
	s	--	4.7	0.7	5.7		1.1	13.6
	n	1	30	2	6		2	12
Wells	μ	67.0	71.0	79.5	82.3		87.0	58.5
	s	--	4.9	0.7	3.6		--	13.6

	n	1	28	2	4		1	12
Ice Harbor	μ		50.8	81.0	70.5	85.5	85.5	93.5
	s		3.6	4.2	4.4	--	5.3	--
	n		199	2	203	1	47	1
Lower Granite	μ		50.7	81.0	70.6	85.5	85.6	-
	s		3.6	4.2	4.4	--	5.4	-
	n		192	2	197	1	43	0

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 2013.

Dam	Statistic	Brood Year and Age Class							
		2011	2010		2009		2008		2007
		0.1	0.2	1.1	0.3	1.2	0.4	1.3	1.4
Bonneville	μ	43.4	62.7	53.6	80.2	71.2	86.3	83.7	90.6
	s	3.7	4.6	4.5	5.9	6.6	3.3	5.7	5.7
	n	6	105	209	140	189	5	169	4
The Dalles	μ	42.8	62.5	53.5	80.2	71.1	86.3	83.8	90.6
	s	3.8	4.7	4.5	6.1	6.6	3.3	5.5	5.7
	n	5	96	194	117	170	5	152	4
McNary	μ	43.5	62.5	53.4	80.2	71.0	86.3	83.5	90.6
	s	4.0	4.6	4.5	6.2	6.6	3.3	5.4	5.7
	n	4	85	179	105	152	5	130	4
Priest Rapids	μ	44.5	62.6	53.1	79.8	70.9	86.3	83.5	92.0
	s	5.7	4.7	5.6	5.9	7.1	3.3	5.5	6.1
	n	2	76	55	93	117	5	123	3
Rock Island	μ	44.5	62.6	53.3	79.9	70.8	86.3	83.5	92.0
	s	5.7	4.8	5.6	6.0	7.2	3.3	5.6	6.1
	n	2	75	53	91	113	5	120	3
Rocky Reach	μ	44.5	63.2	52.5	79.5	70.5	86.0	83.5	85.5
	s	5.7	4.2	5.7	6.1	7.2	4.0	4.8	--
	n	2	67	43	72	102	3	98	1
Wells	μ	44.5	63.1	52.8	79.2	71.0	86.0	83.8	85.5
	s	5.7	4.2	5.8	6.2	7.3	5.7	4.8	--
	n	2	64	39	66	85	2	76	1
Ice Harbor	μ	45.0	63.3	53.7	72.0	71.2		87.5	86.5
	s	--	1.4	3.9	4.9	4.2		0.0	--
	n	1	6	115	2	27		2	1
Lower Granite	μ	45.0	63.7	53.7	68.5	71.2		87.5	86.5
	s	--	1.2	3.9	--	4.2		0.0	--
	n	1	5	111	1	27		2	1

Table 15. Fall Chinook Salmon length-at-age composition, as estimated by PIT tag detections of fish aged using scale pattern analysis that passed Bonneville after July 31st, for fall Chinook Salmon at Columbia and Snake River dams in 2013.

Dam	Statistic	Brood Year and Age Class								
		2011	2010		2009		2008		2007	
		0.1	0.2	1.1	0.3	1.2	0.4	1.3	0.5	1.4
Bonneville	μ	45.4	64.7	55.7	76.2	72.3	86.0	77.0	86.0	86.0
	s	4.0	5.0	4.6	5.7	3.9	6.2	11.5	6.6	--
	n	51	713	18	518	15	34	4	3	1
The Dalles	μ	45.1	64.4	54.9	75.6	72.4	84.6	76.0	82.5	
	s	3.1	4.9	4.6	6.0	4.2	5.4	13.8	3.5	
	n	43	538	14	338	12	18	3	2	
McNary	μ	45.3	64.5	55.5	75.2	71.2	85.1	76.0	82.5	
	s	2.9	4.9	4.5	5.9	3.6	5.6	13.8	3.5	
	n	31	442	11	251	9	13	3	2	
Priest Rapids	μ	46.5	65.5	61.5	74.6	71.5				
	s	2.7	4.8	--	5.9	0.7				
	n	11	128	1	75	2				
Rock Island	μ	45.5	64.6	61.5	74.6	71.0				
	s	2.6	5.7	--	7.1	--				
	n	4	38	1	29	1				
Rocky Reach	μ	45.5	64.7	61.5	75.0	71.0				
	s	2.6	5.9	--	7.4	--				
	n	4	33	1	25	1				
Wells	μ	47.5	63.6	61.5	74.6	71.0				
	s	2.1	7.0	--	6.1	--				
	n	2	20	1	12	1				
Ice Harbor	μ	44.1	63.6	55.4	74.0	72.8				
	s	3.4	5.4	2.1	6.9	2.9				
	n	10	62	5	20	4				
Lower Granite	μ	44.3	63.6	54.5	74.0	73.3				
	s	3.6	5.4	0.9	6.9	3.2				
	n	9	62	3	20	3				

Fallback

Estimated fallback-reascension rates based on Chinook Salmon reascending fish ladders ranged from 0% to 55.2% (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 2013 as estimated by PIT tags[b].

Dam	Spring Chinook (%)	Summer Chinook (%)	Fall Chinook (%)
Bonneville	5.2%	0.9%	0.7%
The Dalles	8.4%	2.6%	2.9%
McNary	9.6%	0.1%	2.8%
Priest Rapids	2.6%	1.7%	55.2%
Rock Island	7.5%	5.7%	25.4%
Rocky Reach	14.5%	9.2%	4.1%
Wells	21.4%	17.1%	2.4%
Ice Harbor	6.3%	4.1%	1.8%
Lower Granite	5.7%	5.5%	3.8%
Tumwater	5.0%	5.0%	--
Prosser	6.5%	0.0%	16.7%
Roza	5.0%	0.0%	--
Weighted Mean-All Sites	7.7%	4.0%	2.4%
Weights-Columbia and Snake Dams Only	7.3%	4.1%	2.3%

A total of 157 tagged Chinook Salmon had more than one fallback event at the dams shown in Table 16 with one spring Chinook (3D9.1C2DE948F4) tagged at Bonneville Dam on May 7, 2013 falling back over Bonneville Dam eight times and The Dalles Dam four times before last being detected at the upper most antenna in the Bonneville Dam Oregon Shore ladder on June 29, 2013.

Fall Chinook at Priest Rapids Dam had the highest fallback rate with 58 fall Chinook generating 128 fallback events out of 232 fall Chinook detected passing the site. A total of 52 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. Seven fall Chinook reascended between two and four times at Priest Rapids Dam.

Night Passage

Night passage (2000-0400 Pacific Standard Time) of tagged Chinook Salmon was less than 1% at Bonneville, but increased further upstream (Table 17) and for most of the runs was greater than 10% for Prosser, Roza and Tumwater dams. The Bonneville Dam estimate of night passage is likely biased

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

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 17. Estimated Chinook Salmon night passage (2000-0400) in 2013 at Columbia Basin dams as estimated by PIT tag detections.

Site	Spring Chinook (%)	Summer Chinook (%)	Fall Chinook (%)
Bonneville	0.2%	0.5%	0.0%
The Dalles	1.8%	2.6%	1.5%
McNary	0.9%	1.8%	1.1%
Priest Rapids	3.9%	0.7%	2.6%
Rock Island	3.4%	2.6%	8.5%
Rocky Reach	3.9%	2.3%	2.7%
Wells	2.9%	2.8%	7.3%
Ice Harbor	1.4%	1.8%	0.9%
Lower Granite	2.9%	4.3%	1.0%
Prosser	11.1%	0.0%	--
Roza	4.3%	12.0%	16.7%
Tumwater	22.5%	25.0%	--

RESULTS-STEELHEAD

Sample Size

A total of 1253 steelhead were PIT tagged in 2013 (Table 18). 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 1276 (Table 18).

Table 18. Number of steelhead PIT tagged at Bonneville Dam and tracked past Bonneville by date and statistical week in 2013.

Dates	Week	Sampled	PIT Tagged	Previously Tagged	Not Detected After Release	Total Tracked	Days Temperature Restrictions in Effect	
							Reduced hours	No sampling
4/23-26	17	8	8	0	0	8	0	0
4/29-5/3	18	5	5	0	0	5	0	0
5/6-5/8	19	8	8	0	0	8	0	0
5/13-5/16	20	8	7	1	0	8	0	0
5/20-24	21	16	16	0	0	16	0	0
5/28-5/31	22	11	11	0	0	11	0	0
6/3,5,7	23	7	7	0	0	7	0	0
6/10,12	24	5	5	0	0	5	0	0
6/19-6/21	25	7	7	0	0	7	0	0
6/24-6/27	26	8	8	0	0	8	0	0
7/1-7/3	27	7	7	0	0	7	0	0
7/8-7/12	28	49	48	1	0	49	0	0
7/15-7/19	29	176	171	4	1	174	0	0
7/22,23,25,26	30	177	172	5	0	177	2	0
7/30,7/31,8/2	31	104	103	1	1	103	1	0
8/6,8/9	32	89	89	0	0	89	2	2
8/13-8/16	33	159	155	4	0	159	4	1
8/22-8/23	34	58	57	1	0	58	2	3
8/27-8/30	35	107	102	5	0	107	4	0
9/5-9/6	36	28	28	0	0	28	2	2
9/10-9/12	37	14	14	0	0	14	2	3
9/17-9/20	38	56	55	0	0	55	3	1
9/23,25,26,27	39	61	59	2	0	61	0	0
9/30,10/1,10/3,10/4	40	53	53	0	0	53	0	0
10/8-10/11	41	49	48	1	0	49	0	0
10/14	42	10	10	0	0	10	0	0
Total		**1280**	**1253**	**25**	**2**	**1276**	**22**	**12**

Distribution of Sample

As has often been the case with our steelhead sampling program, we undersampled the peak of the run. During the peak steelhead passage week, Statistical Week 32 (Figure 13), we sampled only 89 steelhead (Table 18) in which 21.7% of the run passed. Water temperatures at Bonneville Dam exceeded 21.1C in Week 32, resulting in sampling being restricted to two days with limited hours both days.

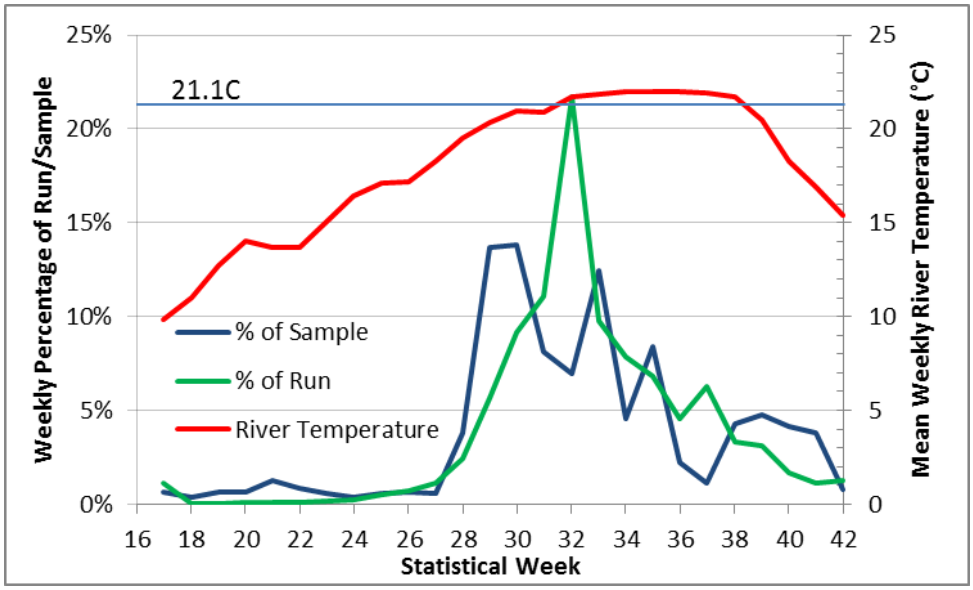

Figure 13. The weekly steelhead sample and run as a percentage of the total sample and run size at Bonneville Dam in 2013.

Detection Numbers

The 1276 steelhead tracked in 2013 generated 62,538 weir detections and 6656 site detections at 120 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 28 out of 30 steelhead, that had been previously PIT tagged, were correctly aged (93.3%). Only the total age could be compared for it was not possible to separately validate freshwater and ocean age.

In 2013 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 267 out of 281 steelhead samples (Table 19).

Table 19. Comparison of age estimates using genetics and scale pattern analysis for Chinook Salmon sampled at Bonneville Dam in 2013. 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	207	2	0	99.0%
2	11	60	1	83.3%
Total				**95.0%**

Mainstem Dam Recoveries, Mortality, and Escapement Estimates

Data on tag detections was last downloaded from www.ptagis.org on November 1, 2014. An estimated 49.6% of the steelhead run was last detected upstream of Ice Harbor Dam while only 6.5% of the run was last detected upstream of Priest Rapids Dam (Figure 14). The proportion of steelhead bound for the Snake River steadily increased as the run progressed (Figures 15 and 16).

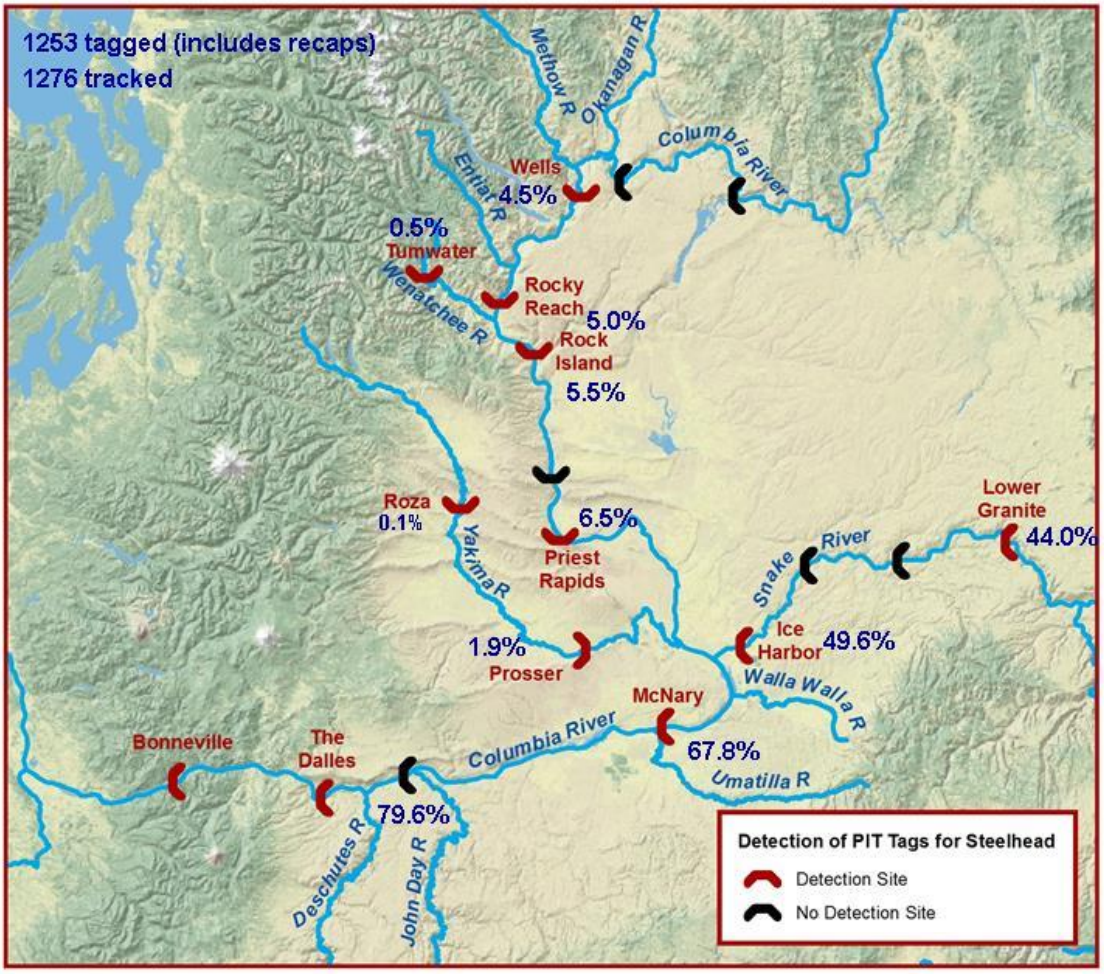

Figure 14. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of steelhead PIT tagged at Bonneville Dam, and the percentage of the run estimated to pass upstream dams in 2013.

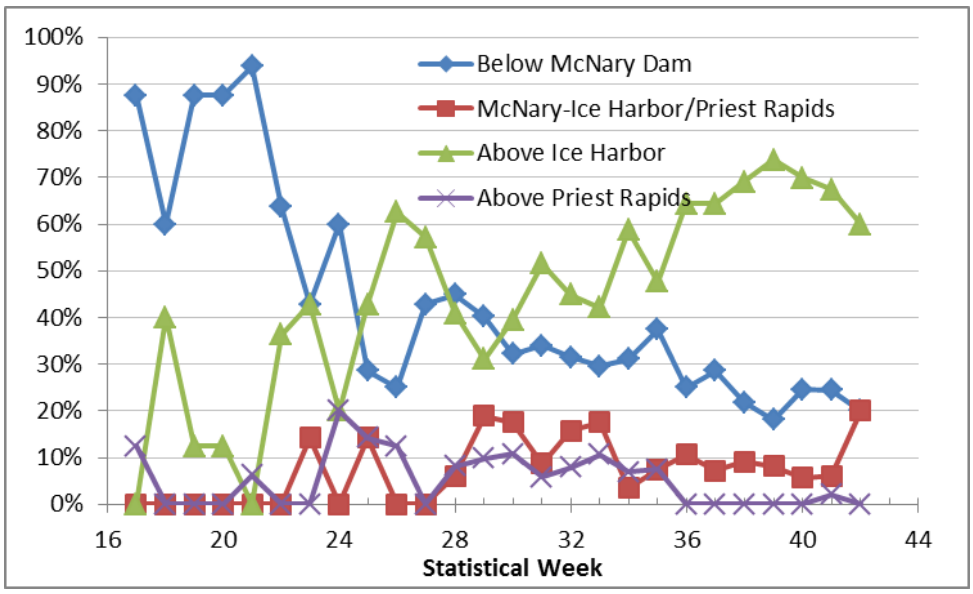

Figure 15. Distribution of final upstream detection site by statistical week for steelhead PIT tagged at Bonneville Dam in 2013 estimated as a percentage of the weekly sample.[c]

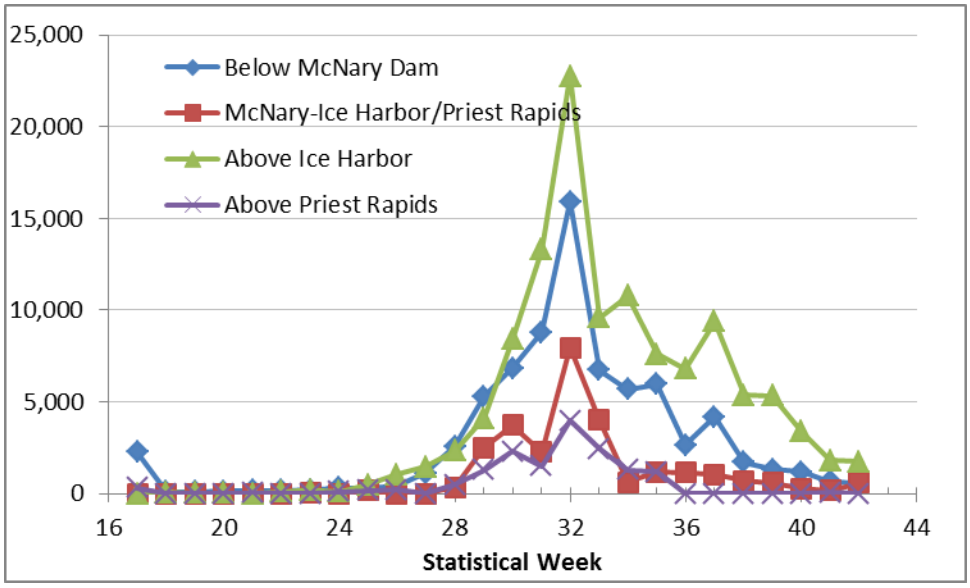

Figure 16. Distribution of final detection site by statistical week for steelhead PIT tagged at Bonneville Dam in 2013 estimated in numbers of fish passing Bonneville Dam by week.

In 2013, a PIT tag site was installed just upstream of the mouth of the Deschutes River (DRM). A total of 178 of the 1276 steelhead tracked by this

[c] 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.

study were detected at this site. However, of 15 steelhead PIT tagged by this study and captured upstream of the DRM site in the trap at Sherars Falls, only 6 were detected at DRM. The DRM detection rate of 40% suggests the possibility that the number of steelhead entering the Deschutes may be much higher than the PIT tag detection data would suggest. Most steelhead detected at DRM were last detected in the Snake River (Figure 17).

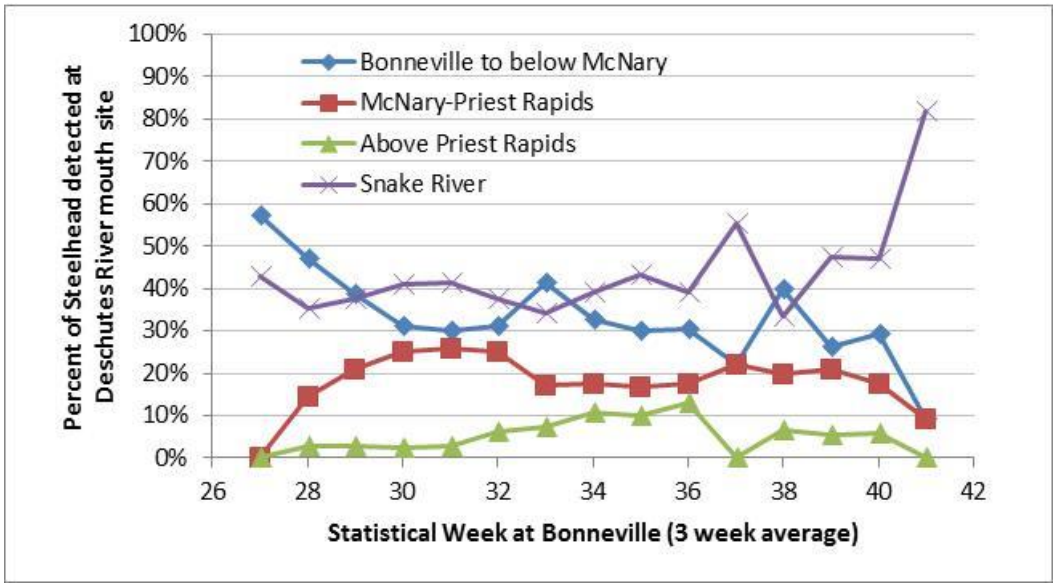

Figure 17. Distribution of final detection site by statistical week for steelhead PIT tagged at Bonneville Dam which were detected at the Deschutes River Mouth detection antenna. Data is averaged over three week intervals.

As with Chinook Salmon, the percentage of PIT tagged steelhead passing a dam without detection was under 2% (Table 20) with the exception of Rock Island Dam, which has known detection issues due to antenna size and electrical noise (Fryer et al. 2012).

Table 20. Percentages of steelhead passing a dam undetected that were subsequently detected at an upstream dam in 2013.

Dam	Percent Undetected
Bonneville	0.4%
The Dalles	0.5%
McNary	0.6%
Priest Rapids	0.0%
Rock Island	4.2%
Rocky Reach	1.7%
Wells	0.0%
Ice Harbor	1.0%
Lower Granite	0.0%
Mean (weighted by number passing each dam)	**0.6%**

Migration Rates and Passage Time

The fastest median migration rate between dams, as measured in kilometers per day, was between The Dalles and McNary dams (31.1 km/day), while the slowest was 14.7 km/day between Bonneville and McNary dams (Table 21).

Table 21. Steelhead migration rate between Columbia Basin dams as estimated by PIT tag detections in 2013.

Steelhead		
Dam Pair	**Distance (km)**	**Median Migration Rate (km/day)**
Bonneville-The Dalles	74	20.0
The Dalles-McNary	157	31.1
Bonneville - McNary	231	14.7
McNary - Priest Rapids	167	26.8
Priest Rapids - Rock Island	89	20.9
Rock Island - Rocky Reach	33	18.2
Rocky Reach - Wells	65	30.1
Rock Island - Tumwater	73	4.5
Bonneville – Rock Island	487	21.3
Bonneville - Wells	585	19.0
McNary - Ice Harbor	67	27.2
Ice Harbor - Lower Granite	156	20.1

Median steelhead passage times (Table 22) at the mainstem dams, as measured from first to last detection within the ladders, were generally less than that 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 22. 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 2013.

Dam	Median Passage Time (minutes)	Percentage with more than 12 hours between first detection and last detection at a dam
Bonneville	60.4	6.3%
The Dalles	0.1	3.6%
McNary	82.9	7.9%
Priest Rapids	5.4	7.1%
Rock Island	3.2	7.5%
Rocky Reach	1.5	4.9%
Wells	82.0	3.7%
Ice Harbor	3.6	9.4%
Lower Granite	70.7	12.5%
Tumwater	11.2	42.9%

Upstream Age and Length-at-Age Composition

Age 1.1 steelhead had the highest abundance among all age classes in 2013 (Table 23, Figure 18). Length-at-age composition data is found in Table 24.

Table 23. Age composition estimates for steelhead at upstream Columbia and Snake River dams (%) in 2013. These were estimated from scale patterns of steelhead sampled at Bonneville Dam.

	Brood Year And Age Class												
	2010	2009		2008			2007			Unknown			Repeat Spawners
Site	1.1	1.2	2.1	1.3	2.2	3.1	2.3	3.2	4.1	r	r.1	r.2	
Bonneville	32.6%	15.5%	17.1%	0.1%	6.9%	1.8%	0.0%	0.5%	0.3%	0.8%	16.7%	6.1%	1.5%
The Dalles	31.6%	14.1%	18.5%	0.0%	6.8%	1.7%	0.0%	0.6%	0.4%	0.8%	18.0%	5.9%	1.6%
McNary	32.9%	14.7%	17.2%	0.0%	6.5%	1.5%	0.0%	0.5%	0.4%	0.9%	18.7%	5.2%	1.4%
Priest Rapids	25.0%	14.8%	18.2%	0.0%	11.4%	2.3%	0.0%	0.0%	0.0%	1.1%	18.2%	8.0%	0.0%
Rock Island	21.9%	16.4%	0.0%	0.0%	13.7%	0.0%	0.0%	0.0%	0.0%	1.4%	17.8%	9.6%	0.0%
Rocky Reach	23.4%	17.2%	18.8%	0.0%	9.4%	0.0%	0.0%	0.0%	0.0%	1.6%	20.3%	7.8%	0.0%
Wells	26.3%	17.5%	19.3%	0.0%	7.0%	0.0%	0.0%	0.0%	0.0%	1.8%	19.3%	7.0%	0.0%
Ice Harbor	38.4%	15.2%	10.8%	0.0%	4.4%	1.0%	0.0%	0.2%	0.6%	1.1%	19.3%	4.2%	0.5%
Lower Granite	36.9%	17.6%	11.7%	0.0%	4.8%	1.2%	0.0%	0.2%	0.8%	1.0%	20.7%	4.6%	0.5%

Table 24. Steelhead length-at-age composition, as estimated by PIT tag detections of fish aged from scales at Bonneville Dam in 2013.

		Brood Year and Age Class											
Dam	Statistic	2010	2009		2008			2007			Unknown		
		1.1	1.2	2.1	1.3	2.2	3.1	2.3	3.2	4.1	r.1	r.2	r.3
Bonneville	μ	56.9	72.1	56.3	81.9	68.7	56.1	86.8	68.0	59.0	56.4	70.0	79.3
	s	3.5	6.9	2.7	5.1	5.2	3.0	0.4	3.0	0.0	3.3	5.9	4.0
	n	363	230	224	5	91	25	2	4	2	204	91	6
McNary	μ	57.0	72.1	56.2		68.8	56.5	86.5	67.3	59.0	56.2	70.5	85.0
	s	3.6	7.0	2.7		5.6	2.8	--	3.3	0.0	3.3	6.2	--
	n	294	162	197		71	19	1	3	2	167	63	1
Priest Rapids	μ	57.0	72.0	56.3		69.2	56.1	86.5	65.8	59.0	56.3	71.1	85.0
	s	3.7	6.9	2.7		5.8	2.9	--	2.5	0.0	3.4	6.6	--
	n	258	141	152		59	12	1	2	2	143	51	1
Rock Island	μ	57.0	68.7	56.8		70.1	57.0				56.2	69.3	
	s	3.1	1.6	3.0		3.6	2.8				3.7	3.4	
	n	22	13	16		10	2				16	7	
Rocky Reach	μ	56.8	68.8	56.9		70.1					56.6	69.3	
	s	2.8	1.6	3.3		3.6					3.5	3.8	
	n	16	12	13		10					13	7	
Wells	μ	56.8	68.7	56.3		69.1					56.6	69.2	
	s	2.9	1.6	2.6		2.0					3.5	4.3	
	n	15	11	12		6					13	5	
Ice Harbor	μ	56.8	68.8	56.6		70.0					56.0	69.3	
	s	2.9	1.6	2.4		1.1					3.3	7.3	
	n	15	10	11		4					11	4	
Lower Granite	μ	56.9	72.6	56.8		70.2	53.1	86.5	67.5	59.0	56.1	71.9	85.0
	s	3.6	7.1	2.9		7.5	0.9	--	--	0.0	3.4	7.5	--
	n	220	123	68		28	4	1	1	2	107	34	1

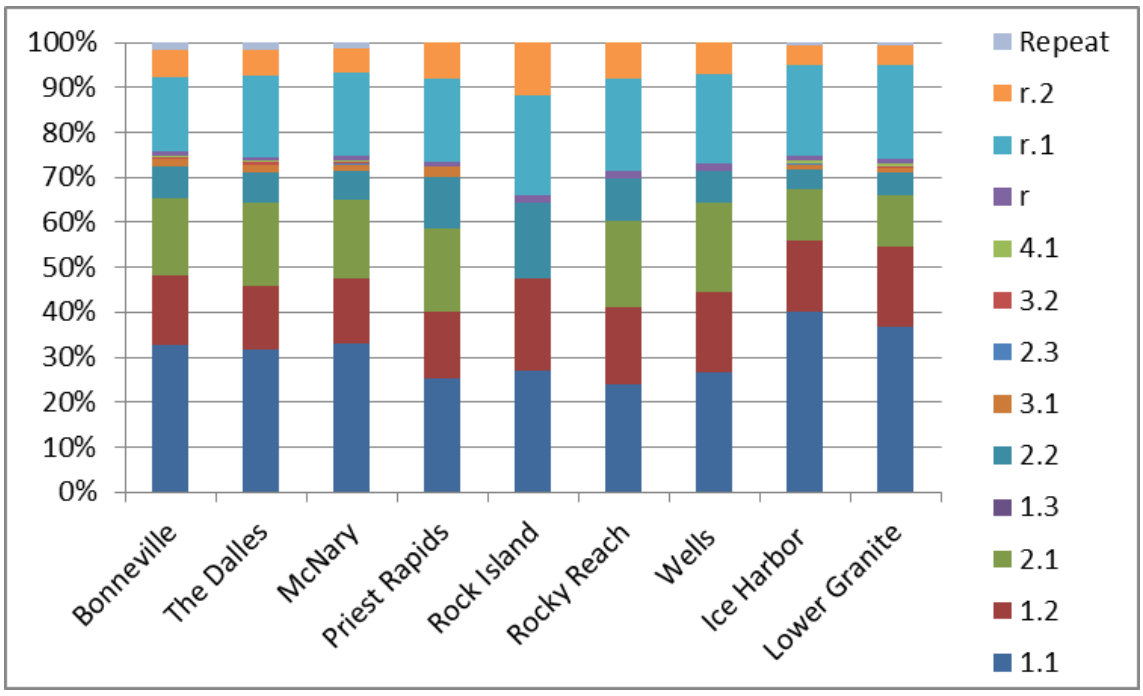

Figure 18. Steelhead age composition at Columbia and Snake river dams estimated from upstream detections of steelhead aged using scales at Bonneville Dam in 2013. RS are repeat spawners. The "r" in age r.X means that the freshwater zone of the scale was regenerated and the age therefore not possible to determine.

Fallback

Estimated minimum fallback rates based on steelhead either reascending fish ladders or steelhead subsequently detected downstream ranged from 1.5% to 19.3% (Table 25). 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 19.3% at Priest Rapids Dam.

Table 25. Estimated minimum steelhead fallback at Columbia Basin dams in 2013 as estimated by PIT tag[d] detections.

Dam	Percent Fallback%
Bonneville	1.5%
The Dalles	3.8%
McNary	8.3%
Priest Rapids	19.3%
Rock Island	8.6%
Rocky Reach	11.1%
Wells	7.4%
Ice Harbor	8.8%
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 was under 9% at all mainstem dams except Rock Island at 17.1% (Table 26). No steelhead were last detected at Priest Rapids Dam between 2000 and 0400. The Bonneville Dam estimate of night passage is likely biased low due to the tagging hours, which generally occurred between about 0700 and 1400 PST. Given the median Bonneville Dam passage time of 60.4 minutes (Table 22), steelhead would be expected to pass during daytime hours.

Table 26. Estimated steelhead night passage (2000-0400) at Columbia Basin dams in 2013.

Site	Steelhead (%)
Bonneville	1.8%
The Dalles	4.4%
McNary	5.2%
Priest Rapids	0.0%
Rock Island	17.1%
Rocky Reach	4.8%
Wells	8.9%
Ice Harbor	7.7%
Lower Granite	4.4%

B-Run Analyses

A total of 87 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 were at their highest point when sampling ended in Statistical Week 43 at 60.0% 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 38 at 2260 fish. Overall, we estimated that 4.5% of the run at Bonneville was B-Run. Among steelhead detected above McNary Dam and in tributaries between Bonneville and McNary dams (thereby eliminating most of the steelhead that may have been captured in the Zone 6 fishery), steelhead with fork lengths 78.0 cm and greater were almost entirely destined for the Snake River (Figure 20).

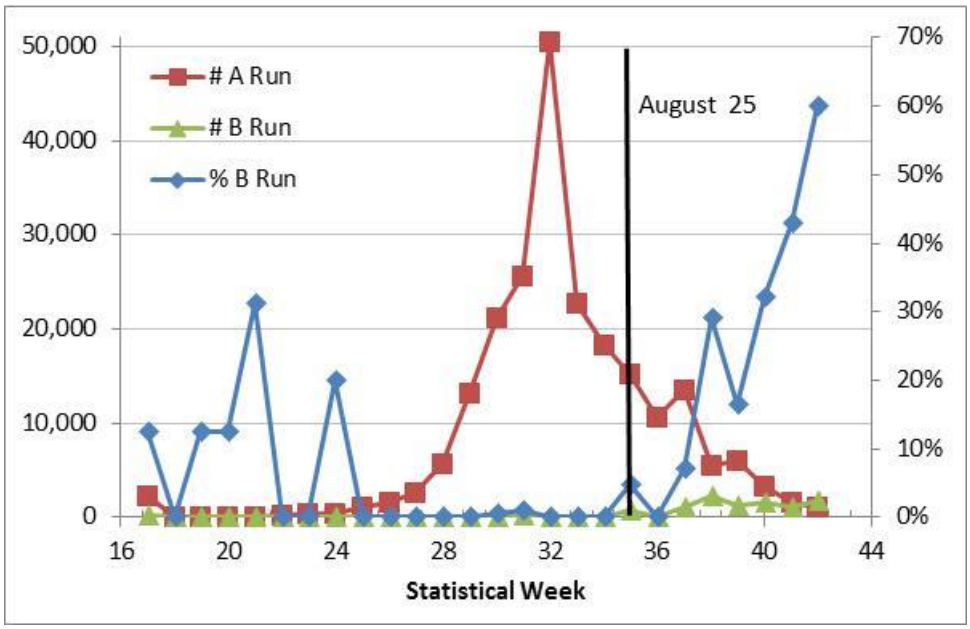

Figure 19. Percentage of B-run steelhead and estimated A- and B-run escapement at Bonneville Dam by statistical week in 2013. August 25 is noted as it is considered the date that separates A- and B-run steelhead.

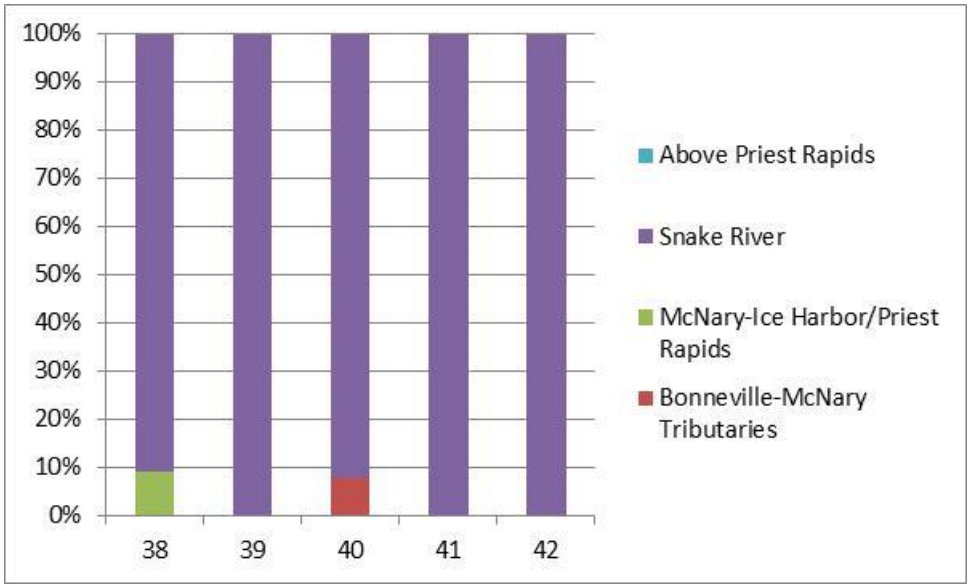

Figure 20. Final detection site for B-run steelhead (≥78 cm fork length) by Statistical Week they were sampled at Bonneville Dam in 2013. Weeks with fewer than three B-run steelhead sampled are omitted.

Kelt Analyses

A total of 92 steelhead PIT tagged and tracked in 2013 were detected moving in the Columbia Basin after March 31, 2014, going downstream

presumably in an attempt to return to the ocean after spawning (kelts), or 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 27). An additional 16 were detected moving back upstream during summer and fall months of 2014 presumably to spawn again (repeat spawners) (Appendix Table A6).

Most kelts that are detected moving out of the system are detected in the juvenile bypasses of the other major dams such as Bonneville (42), John Day (8), McNary (4), Ice Harbor (1), Lower Monumental (8), Little Goose (9), Lower Granite (4), and Rocky Reach (1).

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 2013, 71 of the steelhead identified as kelts or repeat spawners were detected entering and/or leaving major rivers of the Columbia and Snake Basins, and 35 of these fish were detected in upper regions and creeks of the tributaries, presumably to spawn (Table A6 and Figure A1 - map of all detection locations).

We have also updated information of several kelts/repeat spawners from past annual reports (2012 and 2011) with data from 2013/2014 movements (Table A7 and A8). 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 2013/2014, steelhead tagged in 2010 were not detected moving in the system.

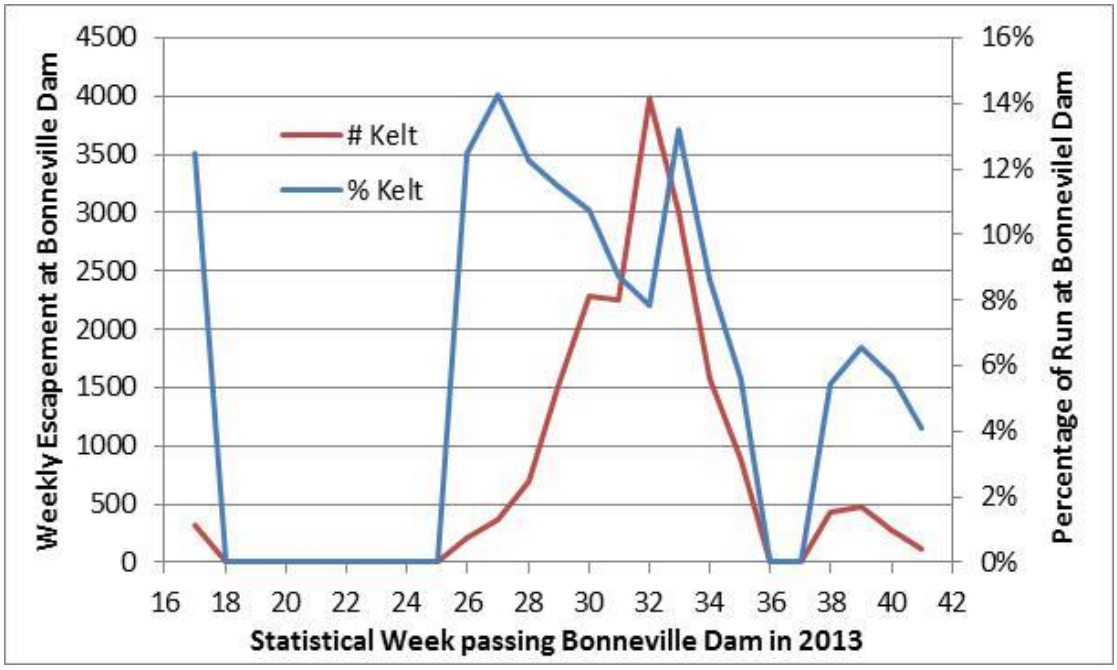

Figure 21. Percentage and number of steelhead by statistical week as sampled at Bonneville Dam in 2013 which ultimately displayed kelt behavior by March 31, 2014 or upstream after June 1, 2014. being detected moving downstream through Columbia Basin dams after

Table 27. PIT tagged steelhead tracked from Bonneville Dam in 2009-2013 last detected moving downstream after March 31 of the year after sampling, listed by last downstream detection site.

Last site	2013	2012	2011	2010	2009
Bonneville Corner Collector	34	26	10	23	61
Bonneville Juvenile Bypass	4	5	1	4	7
Bonneville Dam Bradford Island Ladders heading downstream	3	2	0	0	0
Estuary Trawl	2	2	0	0	1
Ice Harbor Juvenile Bypass		0	1	6	0
John Day Juvenile Bypass	8	6	3	11	3
Little Goose Juvenile Bypass	9	5	11	13	6
Lower Granite Juvenile Bypass	4	3	4	10	3
Lower Monumental Juvenile Bypass	7	1	12	9	4
Lower Washington Shore McNary Dam ladder, likely moving downstream.	0	0	0	2	1
McNary Dam Juvenile Bypass	4	4	3	2	4
Rocky Reach Juvenile Bypass	2	0	4	6	7
Migrating downstream in tributaries	5	4	0	0	0
Trapped by CRITFC kelt program					
Snake Basin	7	NA	NA	NA	NA
Yakima Basin	6	NA	NA	NA	NA
Total	**92**	**58**	**49**	**86**	**97**
Percent of steelhead tracked last moving downstream	**7.2%**	**4.0%**	**3.1%**	**5.2%**	**4.8%**
Additional steelhead detected migrating upstream in subsequent migration year	**16**	**5**	**5**	**9**	**NA**
Minimum number of kelt	**108**	**63**	**54**	**95**	**NA**

RESULTS-SOCKEYE[e]

Sample Size

In 2013 a total of 799 Sockeye Salmon were sampled by this project at the Bonneville Dam Adult Fish Facility between June 5 and August 9, 2013 (Table 28). Of these, seven were not tagged or the tags were unreadable, and two died prior to release. One Sockeye was previously tagged and added to the 789 Sockeye tagged and released. Of the 790 Sockeye Salmon tracked, 18 were not detected after release. These fish may have shed their tags, had defective tags, or died. It was also possible that 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 near the fish counting window that detect very close to 100% of passing PIT tagged fish (Appendix Table A3). 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 2006-2013 indicates that PIT tagged Sockeye Salmon are missed, although the percentage is normally low (Table 29).

Table 28. Number of Sockeye Salmon sampled and PIT tagged at Bonneville Dam and tracked upstream by date and statistical week in 2013.

Sampling Dates	Statistical Week	Sampled (n)	Tagged	Previously Tagged	Detected after tagging and tracked
6/5-6/7	23	16	16	0	16
6/10-6/14	24	148	148	0	146
6/19-6/21	25	140	139	0	138
6/24-6/27	26	232	228	0	224
7/1-7/3	27	85	82	0	77
7/8-7/12	28	117	116	1	114
7/15-7/18	29	47	47	0	44
7/22,23,26;8/2,9	30-32	14	13	0	13
Total		**799**	**789**	**1**	**772**

[e] The information presented in this section of the report is a summary of Fryer et al. 2011.

Table 29. Number and percentage of PIT tagged fish not detected at dam detection sites as estimated from upstream detections in 2013 along with comparison data for 2006-2012.

Dam	2013 N	2013 %	2012	2011	2010	2009	2008	2007	2006
Bonneville	3	0.4%	1.8%	0.5%	0.7%	0.6%	0.4%	2.1%	0.2%
The Dalles	10	1.6%	NA	NA	NA	NA	NA	NA	NA
McNary	13	2.1%	12.1%	1.6%	3.8%	5.0%	10.1%	6.5%	3.1%
Priest Rapids	0	0.0%	0.4%	0.2%	0.6%	0.3%	0.3%	0.8%	0.0%
Rock Island	25	4.4%	5.4%	4.4%	6.2%	2.6%	6.9%	6.8%	1.3%
Rocky Reach	0	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%	--	--	--	--
Ice Harbor	0	NA	0.0%	NA	0.0%	20.0%	0.0%	--	--
Tumwater	0	0.0%	0.0%	0.0%	0.0%	0.0%	--	--	--

Age Analysis

The predominant age group was Age 1.2, flowed by Age 1.1 and 1.3 (Table 30). Age 1.1 Sockeye increased as the run progressed while Age 1.2 and 1.3 Sockeye decreased.

Table 30. Weekly and total age composition of Sockeye Salmon at Bonneville Dam as estimated from scale patterns in 2013.

Statistical Week	N Ageable	Age Class				
		1.1	1.2	2.1	1.3	2.2
23	16	0.0%	62.5%	0.0%	37.5%	0.0%
24	148	2.1%	67.9%	0.0%	25.0%	5.0%
25	140	0.7%	77.0%	0.0%	18.0%	4.3%
26	232	6.6%	72.1%	0.0%	12.7%	8.7%
27	85	22.2%	64.2%	1.2%	8.6%	3.7%
28	117	41.6%	40.7%	0.9%	8.0%	8.8%
29	47	70.2%	12.8%	2.1%	8.5%	6.4%
30	14	85.7%	14.3%	0.0%	0.0%	0.0%
Composite	**799**	**17.4%**	**62.7%**	**0.5%**	**13.4%**	**6.0%**
Std. Dev.		**1.3%**	**1.8%**	**0.3%**	**1.2%**	**0.9%**

Upstream Recoveries, Mortality, and Escapement Estimate

PIT tag antennas became operational at The Dalles Dam on February 7, 2013. Sockeye counts estimated by PIT tags deployed by this project were within 2.5% of visual counts at The Dalles (Table 31, Figure 22). The PIT tag estimate was 15.6% greater than the McNary count; however the McNary visual count was much lower than visual counts at both The Dalles and Priest Rapids. At McNary Dam it is possible for fish to use navigation locks to bypass fish ladders, thus avoiding both PIT tag detection and visual detection; however we only estimated 2.1% of Sockeye were missed at McNary Dam (Table 29). Our

PIT tag estimate ranged from 10.6% to 27.9% less than that of visual counts at Priest Rapids, Rock Island, Rocky Reach, and Wells dams. However, we estimate 40.1% more Sockeye than the Tumwater visual count.

Table 31. 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 2013.

Dam	Estimated Percentage Reaching Dam	Estimated Escapement Using Bonneville PIT Tagged Sockeye	Visual Dam Count	Difference Between Bonneville PIT Tag and Visual Estimate
Bonneville	100.0%	--	185,505	--
The Dalles	89.5%	166,006	161,896	2.5%
McNary	83.6%	155,158	134,202	15.6%
Priest Rapids[f]	78.6%	145,717	163,079	-10.6%
Rock Island	74.2%	137,693	159,204	-13.5%
Rocky Reach	52.4%	97,178	131,660	-26.2%
Wells	50.5%	93,746	129,993	-27.9%
Tumwater	20.9%	38,862	27,738	40.1%
Ice Harbor	0.0%	0	895	NA
Lower Granite	0.0%	0	757	NA

[f] Eleven tagged Sockeye 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 also not included in Priest Dam visual counts.

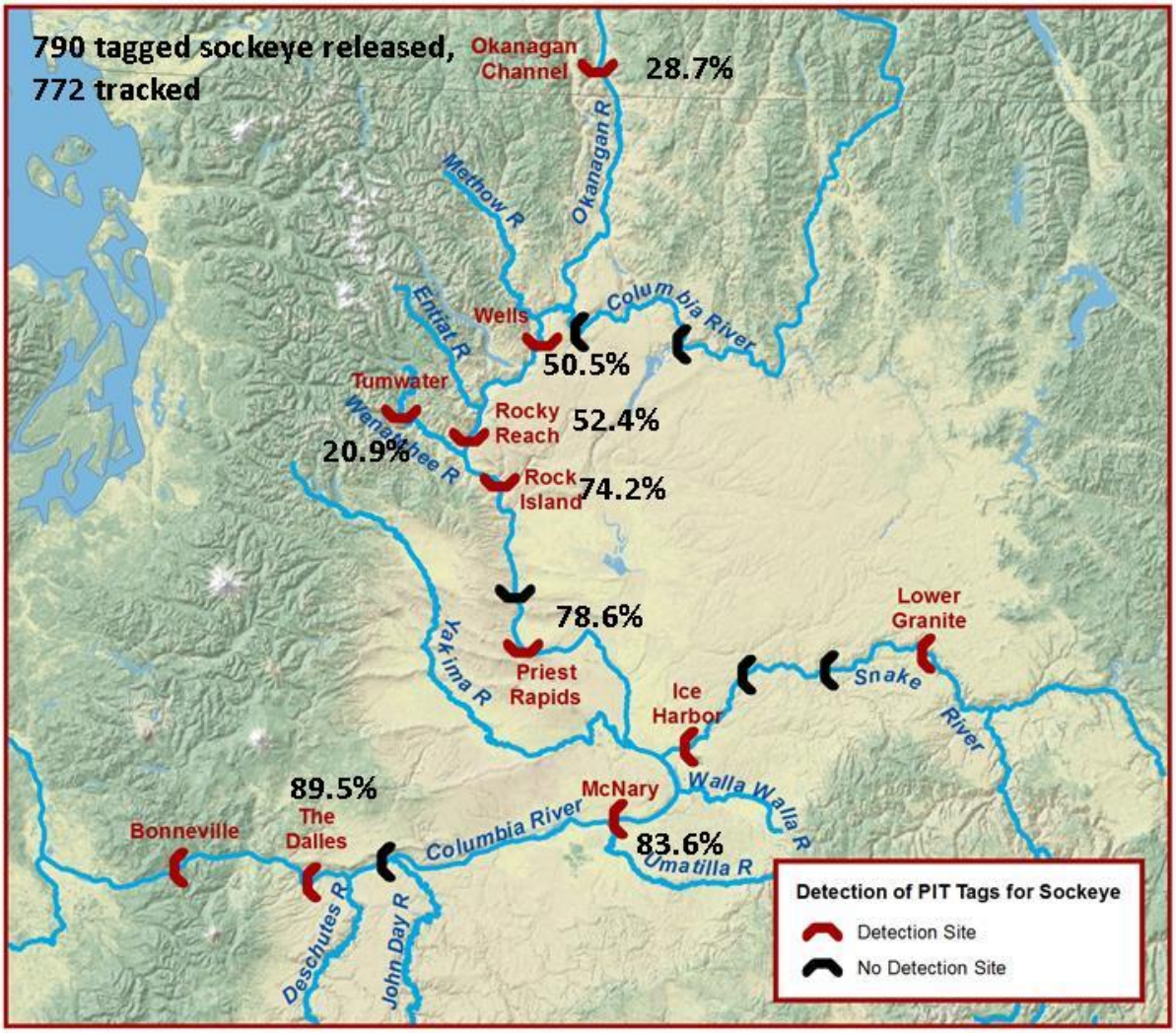

Figure 22. Map of the Columbia River Basin from Bonneville to Wells and Lower Granite dams showing the number of fish PIT tagged at Bonneville Dam, and the percentage of the run estimated to pass The Dalles, McNary, Priest Rapids, Rock Island, Rocky Reach, Wells.

As in most years of this study, and also true in 2013, survival from Bonneville to Priest Rapids and Rock Island dams showed a significant linear decrease with week tagged at Bonneville Dam (Table 32, Figure 23). The relationships for survival from Bonneville to McNary and Rock Island dams, as well as Rocky Reach to Wells dam were not significantly related to statistical week. The percentage of Age 1.2 Sockeye surviving to Rock Island Dam (79.3%) was greater than that for Age 1.3 (72.2%), Age 2.2 (74.5%) or Age 1.1 (68.0%) Sockeye Salmon (Figure 24).

Table 32. Sockeye Salmon survival through selected reaches by statistical week as estimated by PIT tag detections in 2013 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%	87.5%	87.5%	100.0%
24	93.8%	89.0%	87.6%	86.2%	96.7%
25	94.2%	92.0%	88.4%	82.6%	98.7%
26	85.3%	83.0%	79.5%	76.8%	97.1%
27	90.7%	81.3%	76.0%	69.3%	94.6%
28	86.0%	77.2%	72.8%	69.3%	93.0%
29	81.8%	65.9%	52.3%	47.7%	100.0%
30	100.0%	84.6%	38.5%	30.8%	100.0%
Composite	**89.5%**	**83.6%**	**78.6%**	**74.2%**	**96.6%**
p-value	**0.408**	**0.082**	**0.002**	**0.001**	**0.932**

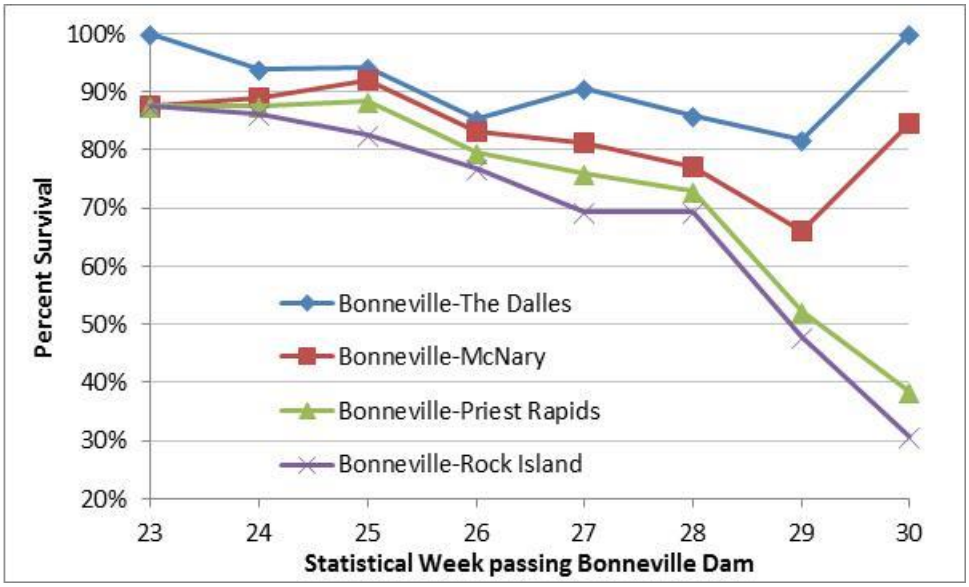

Figure 23. Survival of Sockeye Salmon PIT tagged at Bonneville Dam to The Dalles, McNary, Priest Rapids, and Rock Island dams by statistical week in 2013.

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

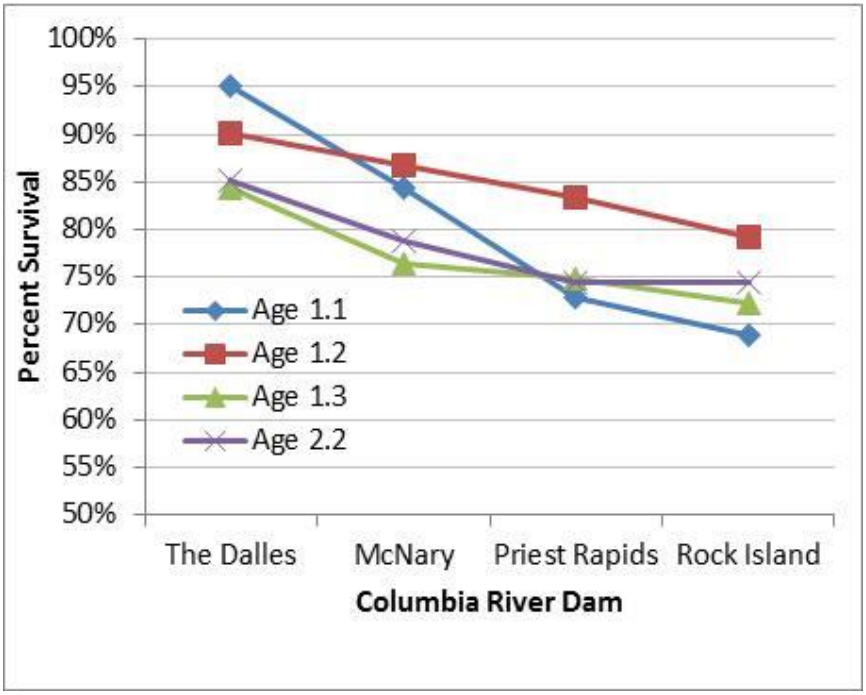

Figure 24. Survival of Sockeye Salmon PIT tagged at Bonneville Dam to The Dalles, McNary, Priest Rapids, and Rock Island dams age group in 2013.

Migration Rates and Passage Time

Adult Sockeye Salmon travel quickly upstream with a median migration rates between mainstem dams ranging between 21.7 and 52.7 km/day for Sockeye tagged at Bonneville Dam (Table 33). Returning adults tagged as smolts generally have slightly slower migration rates, with their median migration rate from Bonneville to Rock Island Dam being 1.3 km per day less than Sockeye tagged as adults (Table 33).

Sockeye Salmon tagged at Bonneville Dam later in the migration travel upstream faster than those earlier in the migration (Table 34). There is a significant (α=0.05) linear relationship between statistical week passing Bonneville Dam and migration time from Bonneville to Rock Island, Rocky Reach, Tumwater, and Wells dams as well as between McNary and Rock Island, Rock Island and Rocky Reach, and Rocky Reach and Wells dams. The median difference in travel time from Bonneville Dam to all upstream mainstem dams except Wells Dam (where only four Sockeye classified as Wenatchee stock were detected) was one day or less between the two major stocks (Table 34). Age 1.3 Sockeye Salmon generally had a slower migration upstream than Age 1.2 and 1.2 Sockeye but Age 1.3 sockeye migrated earlier when migration times were slower, likely a result of higher flows (Tables 33 and 35).

Table 33. Median Sockeye Salmon migration rates and travel time between dams as estimated by PIT tag detections in 2013.

		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	1.9	39.9	1.7	44.0
The Dalles-McNary	162	3.1	52.7	3.3	49.4
McNary-Priest Rapids	167	4.8	34.6	5.0	33.7
Priest Rapids-Rock Island	89	2.9	30.5	2.9	30.5
Rock Island-Rocky Reach	33	1.1	30.8	1.0	32.3
Rocky Reach-Wells	65	1.8	35.3	1.9	34.6
Rock Island-Tumwater	73	11.6	6.3	12.1	6.0
Bonneville-McNary	231	5.0	46.2	5.1	45.7
Bonneville-Rock Island	487	13.1	37.1	13.6	35.8
Bonneville-Tumwater	560	25.8	21.7	26.8	20.9
Bonneville-Wells	585	16.0	36.6	16.6	35.2

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 7.4 minutes or less at all dams except for Bonneville Dam, and, in the case of juvenile-tagged fish, Wells and Lower Granite dams (Table 35). 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.

Table 34. 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 2013.

Statistical Week at Bonneville Dam	BON-TDA	BON-MCN	BON-PRA	BON-RIA	BON-TUM	BON-RRH	BON-WEL	BON-OKC	WEL-OKC	RIA-TUF
23	2.2	6.0	12.3	16.8	38.3	18.8	21.9	115.1	93.1	20.3
24	2.0	5.2	13.0	17.9	34.2	19.3	21.5	108.8	86.2	15.4
25	1.9	5.1	10.7	13.7	27.0	14.8	16.7	101.9	85.8	12.2
26	1.9	5.1	9.8	12.8	24.6	13.7	15.8	96.0	81.1	10.9
27	1.7	4.8	9.0	11.8	21.0	12.5	15.0	88.5	75.5	7.6
28	1.7	4.6	8.7	10.8	19.8	11.7	13.1	86.1	72.3	8.2
29	1.7	4.8	8.1	10.7	--	11.6	13.6	80.2	67.1	--
30	1.9	5.0	10.6	12.3	--	13.3	15.9	75.9	60.1	--
P-value	**0.02**	**0.04**	**0.04**	**0.01**	**0.00**	**0.01**	**0.01**	**0.00**	**0.00**	**0.00**
Stock										
Okanagan	1.9	5.0	9.8	12.9	--	14.0	16.0	96.5	81.3	--
Wenatchee	1.9	5.1	10.2	13.9	25.8	13.9	23.7	--	--	11.6
Unknown[h]	1.8	5.1	9.9	13.0	--	--	--	--	--	--
Age										
1.1	1.7	4.8	8.7	10.9	--	12.0	13.8	85.4	72.1	--
1.2	1.9	5.0	10.1	13.2	25.3	14.7	16.6	99.2	82.6	11.8
1.3	1.9	5.1	10.9	15.2	28.1	17.6	19.6	95.2	77.4	11.6

Table 35. 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 2013.

	Adults Tagged at Bonneville Dam		Previously Tagged as Juveniles	
Dam	Median Passage (Minutes)	%>12 hours	Median Passage (Minutes)	%>12 hours
Bonneville	64.9	6.7%	54.5	9.7%
The Dalles	0.1	2.1%	0.1	10.6%
McNary	0.1	0.8%	0.2	2.5%
Priest Rapids	6.2	2.1%	6.9	2.7%
Rock Island	3.7	1.3%	4.1	1.6%
Rocky Reach	1.3	2.7%	1.4	1.3%
Wells	7.4	3.5%	49.4	7.7%
Tumwater	6.6	4.3%	7.2	3.3%
Ice Harbor	--	--	7.1	17.4%
Lower Granite	--	--	130.9	29.7%

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

Night Passage

Okanagan Sockeye Salmon stock tagged at Bonneville Dam generally passed PIT tag antennas at night (2000-0400 hours) at a higher rate than Wenatchee Sockeye Salmon stock (Table 36). As Okanagan Sockeye Salmon got closer to natal areas night migration increased, reaching 36.4% passing the Okanagan Channel PIT antenna during night hours. The Bonneville Dam estimate of night passage is likely biased low because tagging occurred between about 0800 and 1300 hours, and with a median passage time of 65 minutes from tagging to final detection at Bonneville Dam (Table 35), fish would be expected to pass the counting window prior to 2000 hours.

Table 36. Estimations for Sockeye Salmon stocks' nighttime passage (2000-0400 standard time) in 2013 at mainstem Columbia River dams as estimated by last PIT tag detection time.

Dam	Adults Tagged at Bonneville Dam				Sockeye Tagged as Juveniles
	Okanagan Stock	Wenatchee Stock	Unknown	All Adults	
Bonneville-OR shore	0.0%	0.0%	0.0%	0.0%	2.7%
Bonneville-WA shore	0.0%	0.6%	0.5%	0.3%	3.6%
The Dalles-OR shore	10.1%	5.1%	8.8%	7.7%	9.4%
The Dalles, WA shore	3.0%	10.7%	4.5%	5.6%	6.4%
McNary-OR shore	6.6%	2.2%	0.0%	4.0%	5.6%
McNary-WA shore	13.4%	4.1%	14.8%	9.7%	6.4%
Priest Rapids	5.2%	1.2%	2.6%	3.3%	2.0%
Rock Island	7.3%	1.9%	0.0%	4.5%	3.1%
Rocky Reach	12.0%	11.1%	NA	6.8%	3.8%
Wells	15.5%	0.0%	NA	8.5%	18.5%
Tumwater	NA	2.5%	NA	2.5%	3.3%
Okanagan Channel	36.4%	NA	NA	NA	15.9%

Fallback

Fallback rates for adults tagged at Bonneville Dam ranged from 1.0% at Bonneville Dam to 6.2% at McNary Dam (Table 37). Visual counts suggested that 34.1% of Sockeye pass the Oregon shore ladder (DART 2013). Fallback rates of Sockeye tagged as juveniles were generally higher than those tagged as adults, reaching a high of 54.9% at Lower Granite Dam (50 out of 91 Sockeye passing).

Table 37. Estimated fallback rates for Sockeye Salmon at dams in 2013[i].

Dam	Adults Tagged at Bonneville	Tagged as Juveniles
Bonneville	1.0%	11.0%
The Dalles	2.8%	19.2%
McNary	6.2%	7.4%
Priest Rapids	3.6%	2.7%
Rock Island	2.2%	2.4%
Rocky Reach	4.6%	11.3%
Wells	1.3%	13.8%
Tumwater	1.8%	1.7%
Zosel	5.8%	0.0%
Ice Harbor	No tagged Sockeye detected	16.5%
Lower Granite	No tagged Sockeye detected	54.9%

Stock Composition Estimates

The percentage of Wenatchee Sockeye Salmon stock was highest during the middle of the run at Bonneville Dam when compared to the beginning and end (Table 38). The overall stock composition estimate at Bonneville Dam was 28.0% Wenatchee, 70.0% Okanagan with a total of eight Sockeye were last detected in the Entiat, Yakima, and Deschutes rivers, resulting in stock composition estimates of 1.0% for the Entiat, 0.5% Yakima, and 0.6% Deschutes[j]. The percentage of the run at Bonneville Dam estimated to be of Okanogan origin of 70.0% was over 12 percentage points less than that estimated using dam counts (Table 38).

Nine Sockeye Salmon last detected in the Wenatchee River were previously detected at Rocky Reach Dam with one of these also detected at Wells Dam. There were no Sockeye detected at Tumwater Dam that were subsequently detected anywhere downstream of Tumwater Dam (including in the Columbia River upstream of the Wenatchee River).

[i] Does not include Sockeye Salmon that fell back over a dam and were not subsequently detected.
[j] It is also possible that the two Sockeye last detected in the Deschutes were harvested in the Zone 6 fishery or died by other means. The only other PIT tagged Sockeye detected in the Deschutes were two Snake River Sockeye that were also detected subsequent to the Deschutes River.

Table 38. Weekly and composite Sockeye Salmon stock composition at Bonneville Dam as estimated by PIT tags in 2013 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	% Entiat	% Yakima	% Deschutes
23 (May 30-June 8)	2,331	16	85.7%	14.3%	0.0%	0.0%	0.0%
24 (June 11-14)	16,807	146	71.8%	28.2%	0.0%	0.0%	0.0%
25 (June 18-22)	40,879	138	65.5%	34.5%	0.0%	0.0%	0.0%
26 (June 25-29)	49,628	224	59.4%	40.0%	0.0%	0.6%	0.6%
27 (June 27-July 1)	37,818	77	68.0%	28.0%	4.0%	0.0%	2.0%
28 (July 5-8)	25,433	114	86.1%	10.1%	1.3%	2.5%	0.0%
29 (July 11-14)	9,214	44	100.0%	0.0%	0.0%	0.0%	0.0%
30 (July 18-19)	3,395	13	100.0%	0.0%	0.0%	0.0%	0.0%
Composite	**185,505**	**772**	**70.0%**	**28.0%**	**1.0%**	**0.5%**	**0.6%**
Visual Fish Counts at dams (using difference between Rock Island and Rocky Reach counts to estimate proportion Wenatchee)			82.7%	17.3%			
Visual Fish Counts at dams (Tumwater count to estimate the proportion Wenatchee)			82.6%	17.4%			

A total of ten Sockeye Salmon PIT tagged[k] at Bonneville Dam were adipose clipped with one each recorded as right and left maxillary clipped and one each right and left ventral clipped (Table 39). Of these Sockeye, five were last detected in the Wenatchee Basin, two in the Okanagan Basin, four at Wells Dam, one at McNary Dam, and one at Bonneville Dam. One adipose-clipped fish was not detected after release following tagging at Bonneville Dam.

Table 39. Last detection site of clipped Sockeye Salmon tagged at Bonneville Dam in 2013.

Last Detection Site	Left Maxillary	Left Ventral	Right Maxillary	Right Ventral	Adipose
Bonneville Dam	0	0	0	0	1
McNary Dam	0	0	0	0	1
Wenatchee River	0	0	0	1	4
Wells Dam	1	0	0	0	3
OKC	0	1	1	0	0
Not Detected	0	0	0	0	1
Total	**1**	**1**	**1**	**1**	**10**

[k] Juvenile Sockeye Salmon are adipose clipped in Snake River and Lake Wenatchee hatchery programs.

DISCUSSION

This study sampled and PIT tagged over 5000 salmonids at Bonneville Dam in 2013 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 2013 marked the 8th year we have been tagging Sockeye Salmon, the 67th year we have tagged Chinook and the 5th 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 2013 the percentage of Chinook Salmon at Bonneville Dam which ultimately passed Ice Harbor Dam peaked at 62.1% of the run for the week starting May 19, declining to 12.3% for the week starting June 30, 2013 and continuing to decline for most of July. The portion of the run bound for upstream of Priest Rapids Dam over the same period increased from 12.6% to 67.0%. These results suggest, as in 2010-2012, 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.

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 16.8% of spring, 1.0% of the summer, and 0.4% 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 springs, and misclassified fall Chinook were all classified as summer Chinook at Priest Rapids Dam. This study found that 3.8% of spring, and 37.4% of the summer 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.

Escapement estimates using PIT tag data for mainstem dam passage varied from the traditional methods (i.e. visual counts) and ranged from -35.0% to +10.7% 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 -27.9% to +15.6% (Table 31). 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.

An estimated 7.2% of steelhead returning in 2013, were last detected heading downstream in spring or summer of 2014. This is higher than what has

been observed in previous years (4.0% in 2012, 3.1% in 2011, 5.2% in 2010, and 4.8% in 2009). The percentage of B-run steelhead at Bonneville Dam in 2013 comprised 4.5% of the run compared to 7.6% in 2012, 11.4% in 2011, 18.0% in 2010, and 8.0% in 2009.

The number of fish tagged in 2013 was over 1000 less than those tagged in 2012 (Table 40). This was primarily due to a decrease in Sockeye abundance and high water temperatures limiting the number of steelhead and fall Chinook which could be sampled.

Table 40. 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%

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.

DART (Columbia River Data Access in Real Time). 2013. Online at: http://www.cbr.washington.edu/dart/dart.html

Fish Passage Center (FPC). 2014 and 2012. 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, K. Hyatt. 2011. Studies into Factors Limiting the Abundance of Okanogan and Wenatchee Sockeye Salmon in 2010. U.S. Dept. of Energy Bonneville Power Administration Report Project #2008-503-00.

Fryer, J.K., H. Wright, S. Folks, K. Hyatt. 2012. Studies into Factors Limiting the Abundance of Okanogan and Wenatchee Sockeye Salmon in 2011. 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 2013. 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	70	90.0	90.0	92.9	95.7	100.0
BO4	3347	98.1	98.6	98.1	99.1	100.0
The Dalles	**N**	**1**	**2**			
TD1	2269	99.7	99.7			100.0
	N	**1**	**2**			
TD2	478	99.2	100.0			100.0
McNary	**N**	**1**	**2**			
MC1	1485	100.0	99.9			100.0
		1	**2**	**3**		
MC2	518	97.5	99.5	97.5		100.0
Priest Rapids	**N**	**1-2**	**3-4**			
East	704	99.4	99.9			100.0
		5-6	**7-8**			
West	233	94.4	99.6			100.0
Rock Island	**N**	**1-2**	**3-4**			
Left (east)	266	100.0	100.0			100.0
		5-6	**7-8**			
Middle	72	100.0	100.0			100.0
		09-0A	**0B-0C**			
Right (west)	440	95.7	85.5			99.4
Rocky Reach	**N**	**1-2**	**3-4**			
	596	99.0	100.0			100.0
Wells	**N**	**1-2**	**3-4**			
Left (east)	371	100.0	99.5			100.0
		5-6	**7-8**			
Right (west)	134	99.3	100.0			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**	
	643	99.7	99.9	99.7	99.5	100.0
Tumwater	**N**	**A1**	**A2**			
	85	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 2013. 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)	1259	98.9	99.0	98.6	99.7	100.0
BO1 (South)	28	92.9	96.4	100.0	96.4	100.0
The Dalles	**N**	**1**	**2**			
TD1 (South)	842	99.8	100.0			100.0
TD2 (North)	167	100.0	100.0			100.0
McNary	**N**	**1**	**2**	**3**		
MC1 (South)	657	99.1	99.5			100.0
MC2 (North)	160	98.1	100.0	100.0		100.0
Priest Rapids	**N**	**1-2**	**3-4**			
East	71	100.0	100.0			100.0
		5-6	**7-8**			
West	18	72.2	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	7	85.7	100.0			100.0
		09-0A	**0B-0C**			
Right (west)	29	100.0	86.2			100.0
Rocky Reach	**N**	**1-2**	**3-4**			
	63	100.0	100.0			100.0
Wells	**N**	**1-2**	**3-4**			
Left (east)	35	100.0	100.0			100.0
		5-6	**7-8**			
Right (west)	18	100.0	100.0			100.0
Ice Harbor	**N**	**438**	**437**	**436**	**435**	
South	485	99.8	87.7	99.6	88.2	100.0
North	137	100.0	95.8	95.8	98.5	100.0
Lower Granite 12.5 mm	512	100.0	100.0	100.0	100.0	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 2013.

Dam, Site, Tag Type, and Number		Antenna and Probability of Detection at Antenna				Overall Detection Probability
Bonneville	**N**	**1**	**2**	**3**	**4**	
BO1	15	100.0	93.3	93.3	100.0	100.0
BO4	755	98.9	98.8	99.6	99.1	100.0
The Dalles	**N**	**1**	**2**			
TD1 (Oregon)	574	99.7	99.5			100.0
TD2 (Washington)	108	100.0	100.0			100.0
McNary	**N**	**1**	**2**	**3**		
MC1 (Oregon)	371	97.8	97.6			100.0
MC2 (Washington)	165	92.1	100.0	92.1		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	131	100.0	100.0			100.0
Middle	110	97.3	100.0			100.0
Right	317	90.2	86.4			98.7
Rocky Reach	**N**	**Upper**	**Lower**			
Right	414	100.0	99.0			100.0
Wells	**N**	**Upper**	**Lower**			
Left	320	99.5	100.0			100.0
Right	187	100.0	100.0			100.0
Tumwater	**N**	**Upper**	**Lower**			
Left	162	99.4	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.

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.
15D	Fifteenmile Ck at Dry Cr	At the confluence of Fifteenmile and Dry Creeks. Site is on private land.
85M	Eightmile Ck at Fivemile Cr	At the confluence of Eightmile and Fivemile 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.
BMT	Big Meadow Temporary Array	This site is a temporary PIT tag detection system located at rkm 0.3 on Big Meadow Creek, Wenatchee River.
BO1	Bonneville Bradford Is Ladder	Bradford Island Adult Fishway at Bonneville Dam.
BO2	Bonneville Cascades Is Ladder	Cascades Island Adult Fishway at Bonneville Dam.
BO3	Bonneville WA Shore Ladder/AFF	Washington Shore Adult Fishway and AFF at Bonneville Dam; replaces B2A and BWL.
BO4	Bonneville WA Ladder Slots	Washington Shore Fishway Vertical Slots at Bonneville Dam.
BPC	Bonaparte Creek Instream Array	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.
BR2	Bridge Creek Gable	Located at the confluence of Gable and Bridge creeks.
BSC	Big Sheep Creek ISA at km 6	In-stream detection system located in Big Sheep Creek at river km 6 (N 45.50649, W -116.85067).
CAL	Carson NFH Adult Return Ladder	Hatchery adult spring Chinook return ladder from the Wind River to Carson NFH.
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.
CHM	Chumstick Creek	Chumstick Creek PIT Tag Detection Site, rkm 0.4, near North Road Bridge.
CHU	Upper Chiwawa River	Chiwawa River rkm 12, located above the Forest Road 62 bridge and below Alder Creek.
CHW	Chiwaukum Creek	Chiwaukum Creek PIT Tag Detection Site, rkm 0.4, near Tumwater Campground.
COC	Cow Creek ISA at stream mouth	Instream detectors on Cow Creek at river km 0.5.
CRC	Carmen Creek, Salmon R Basin	Instream array in Carmen Creek located 0.68 km upstream of the confluence with the Salmon River.
CRT	Crooked River Satellite Facility	Ladder of the Crooked River Satellite Facility. The Crooked River is a tributary to the South Fork Clearwater River. The array consists of two overflow antennas.
CRW	Chewuch River above Winthrop	Chewuch River at river km 1, above Winthrop, WA.
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.
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.
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.
FDD	Feed Diversion Dam	Feed Diversion Dam, at Umatilla River rkm 47.
GLC	Gold Creek, Methow River	Gold Creek, Methow River Basin.
GOA	Little Goose Fish Ladder	Adult Fishway at Little Goose Dam.
GOJ	Little Goose Dam Juvenile	Little Goose Dam Juvenile Fish Bypass/Transportation Facility.
GRA	Lower Granite Dam Adult	Lower Granite Dam Adult Fishway and Fish Trap.
GRJ	Lower Granite Dam Juvenile	Lower Granite Dam Juvenile Fish Bypass/Transportation Facility.
HLM	Potlatch River near Helmer	Potlatch River near Helmer.
HRM	Hood River Mouth	Mouth of the Hood River against the west side jetty just inside the bar where the Hood River meets the Columbia River.
HYC	Hayden Creek Instream Array	Lower section of Hayden Creek, in the Lemhi River Basin.
ICH	Ice Harbor Dam (Combined)	Ice Harbor Dam Adult Fishways (both) and Full Flow Bypass.

Table A5. 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).
KHS	Big Bear Cr at Kendrick HS	Mouth of Big Bear Creek (Potlach River Watershed) at Kendricks High School.
KRS	SF Salmon River at Krassel Cr	Krassel Creek at rkm 65 on the South Fork Salmon River.
LBC	Libby Creek Instream Array, Methow River	Instream detector on Libby Creek, Methow River watershed.
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.
LOP	Lostine River Acclimation Pond	Lostine River Acclimation Pond, operated by the Nez Perce Tribe.
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.
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.
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.
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.
NMC	Ninemile Creek Instream Array	Site is located on Ninemile Creek, 0.78 km upstream from the confluence with Lake Osoyoos.
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 A5. Continued.

Site Code	Site Name	Site Description
PD7	Columbia River Estuary at rkm 70	Columbia River Estuary at rkm 70.
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.
RRT	Red River Satellite Facility	Ladder of the Red River Satellite Facility. The Red River is a tributary to the South Fork Clearwater River.
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.
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.
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).
WFF	Willamette Falls Adult Fishway	Willamette Falls Adult Fishway (ODFW).
WPC	Wimpey Creek, Lemhi R. Basin	Instream array located in Wimpey Creek 70 m upstream of the confluence with the Lemhi River.
WR1	Wallowa River at river km 14	Instream array located in the Wallowa River, Oregon rkm 522.271.131.014 (N 45.633769 ° W -117.73369°).
WRU	Upper Wind River (WA) rkm 30	At rkm 30 of the Wind River, WA. The site is at the FR3065 bridge over the Wind River.
WSH	Warm Springs Hatchery	Adult Fishway at Warm Springs NFH.
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 2013 and later labeled as kelts or repeat spawners when they began migrating downstream and upstream presumably to and from the ocean in spring, summer, or fall of 2014.

Tag Year	Tag Number	Last Summer/Fall Detection After Tagging 2013	Fall 2013	Winter 2013/14	Spring 2014	Summer 2014	Fall 2014	Comments
2013	3D9.1C2E038455	Wells - August 4th	Gold Creek (Methow) - November 13th		Gold Creek (Methow) - March 17th to May 5th Rocky Reach Juvenile Bypass - May 12th Estuary - May 24th			
2013	384.3B23AD997C	Bonneville Washington Shore Ladder - August 17th	Lower Granite - November 16th		Estuary - May 7th			
2013	384.3B23AD0F67	Bonneville Washington Shore Ladder - October 26th	Ice Harbor - November 6th		Lower Granite - March 22nd	Little Goose Juvenile Bypass - June 16th Bonneville Dam Corner Collector - June 25th		
2013	384.3B23ADD53E	The Dalles East Ladder - August 16th	Lower Methow - September 29th		Lower Twisp (Methow) - May 1st Rocky Reach Juvenile Bypass - May 18th Bonneville Dam Corner Collector - May 26th			
2013	3D9.1C2E04AE85	McNary - July 30th	Lower Granite - November 7th		Bonneville Dam Corner Collector - May 26th			
2013	3D9.1C2E03A561	Bonneville Washington Shore Ladder - July 20th			Bonneville Dam Corner Collector - April 4th			
2013	384.3B23ACDB37	McNary - September 30th		McDonald Ferry (John Day) - February 21st	Bonneville Dam Corner Collector - April 10th			
2013	384.3B23AD1584	The Dalles East Ladder - September 28th	Lower Granite - October 7th			Bonneville Dam Corner Collector - June 17th		
2013	3D9.1C2E036987	McNary - July 25th	Lower Granite - October 7th		Upper Grande Ronde - March 3rd Upper Grande Ronde - April 19th Bonneville Dam Corner Collector - May 8th			
2013	384.3B23ADA022	Deschutes River Mouth - July 23rd	McNary - November 14th		Bonneville Dam Corner Collector - May 9th			
2013	384.3B23ADB9B8	Deschutes River Mouth - August 3rd	Threemile Dam (Umatilla) - October 10th	Feed Diversion Dam (Umatilla) - December 24th		Maxwell Canal (Umatilla) - June 6th Threemile Dam (Umatilla) - June 10th Bonneville Dam Corner Collector - June 14th		
2013	384.3B23ADED82	Bonneville Washington Shore Ladder - August 6th	McNary - September 26th	McNary - December 9th Ice Harbor - December 12th	Lower Monumental - March 14th Lower Granite - March24th	Bonneville Dam Corner Collector - June 12th		
2013	3D9.1C2DE9655E	Upper Wenatchee - June 22nd Lower Nason Cr (Wenatchee) - June 29th	Lower Nason Cr (Wenatchee) - September 7th		Lower Nason Cr (Wenatchee) - March 30th Bonneville Dam Corner Collector - May 12th			Steelhead was tagged on April 25th at Bonneville Dam AFF and passed Tumwater Dam (Wenatchee) on the 3rd of June going upriver.
2013	384.3B23AD906F	The Dalles East Ladder - August 31st	Lower Granite - September 17th			Bonneville Dam Corner Collector - June 28th		
2013	3D9.1C2E037969	Bonneville Washington Shore Ladder - August 23rd	McDonald Ferry (John Day) - November 2nd	Bridge Creek 0 (John Day) - February 28th	Bridge Creek 1 (John Day) - March 13th Bridge Creek 1 (John Day) - April 18th Bridge Creek 0 (John Day) - April 21st Bonneville Dam Corner Collector - May 3rd			
2013	384.3B23AFB07D	Ice Harbor - October 28th			Lower Granite - March 14th to 19th Lower Lolo Cr (Clearwater) - April 11th Upper Lolo Cr (Clearwater) - April 12th Bonneville Dam Corner Collector - May 13th			This steelhead ascended Lower Granite Dam several times before being recaptured on the 19th. It was never detected moving downriver through the Lower Granite ladders.
2013	3D9.1C2E050CE4	Lower Granite - July 28th				Bonneville Dam Corner Collector - June 12th		
2013	3D9.1C2E02C932	Bonneville Washington Shore Ladder - July 23rd	McNary - September 28th		McDonald Ferry (John Day) - March 16th	Bonneville Dam Corner Collector - June 20th		
2013	384.3B23AD56BC	McNary - October 4th		Threemile Dam (Umatilla) - January 3rd	Threemile Dam (Umatilla) - May 9th Bonneville Dam Corner Collector - May 13th			
2013	384.3B23AD9165	Bonneville Washington Shore Ladder - July 25th	Prosser Dam (Yakima) - October 13th	Lower Status Cr (Yakima) - February 14th	Bonneville Dam Corner Collector - May 6th			
2013	384.3B23AD9106	Bonneville Washington Shore Ladder - August 28th		Pierce RV Prk (Walla Walla) - December 20th	Pierce RV Prk (Walla Walla) - May 14th Bonneville Dam Corner Collector - May 19th			
2013	384.3B23AF4829	Lower Granite - October 1st			Lower Monumental Juvenile Bypass - May 16th Bonneville Dam Corner Collector - May 23rd			
2013	3D9.1C2E0354D4	Bonneville Washington Shore Ladder - July 19th	Deschutes River Mouth - October 3rd	Deschutes River Mouth - December 3rd McNary - December 14th	Bonneville Dam Corner Collector - May 14th			
2013	384.3B23AE041F	Bonneville Washington Shore Ladder - August 29th	Lower Granite - October 4th		Upper Salmon - March 24th Bonneville Dam Corner Collector - April 28th			
2013	3D9.1C2E03BC58	Deschutes River Mouth - August 26th	Lower Granite - September 19th		Upper Salmon - March 21st Little Goose Juvenile Bypass - April 16th Bonneville Dam Corner Collector - April 27th			
2013	384.3B23AE0897	Bonneville Washington Shore Ladder - July 31st	McDonald Ferry (John Day) - October 20th		Bonneville Dam Corner Collector - April 22nd			
2013	3D9.1C2E0371B6	The Dalles East Ladder - August 28th		Deschutes River Mouth - January 8th	Bonneville Dam Corner Collector - April 20th			
2013	384.3B23ADC0A3	Bonneville Washington Shore Ladder - August 29th	McNary - October 4th	Pierce RV Prk (Walla Walla) - December 24th McDonald Bridge (Walla Walla) - January 15th	Bonneville Dam Corner Collector - May 7th			
2013	384.3B23AE08B5	The Dalles East Ladder - September 30th	Prosser Dam (Yakima) - October 10th	Lower Toppenish (Yakima) - February 18th	Lower Toppenish (Yakima) - April 17th Bonneville Dam Corner Collector - May 2nd			
2013	3D9.1C2E0374E9	McNary - August 29th	Lower Granite - September 20th			Lower Granite Juvenile Bypass - June 6th Lower Monumental Juvenile Bypass - June 10th Bonneville Dam Corner Collector - June 17th		
2013	3D9.1C2E034CF7	McNary - August 2nd	McDonald Ferry (John Day) - November 15th		SF John Day 1 - April 4th SF John Day 2 - April 20th SF John Day 1 - April 21st Bonneville Dam Corner Collector - May 7th			
2013	384.3B23AD9D6C	Bonneville Washington Shore Ladder - July 26th	Lower Granite - October 9th		Lower Imnaha River - March 9th Upper Imnaha River - April 6th Lower Imnaha River - April 25th Bonneville Dam Corner Collector - May 18th			
2013	384.3B23AD1D44	Ice Harbor - August 8th Ice Harbor - August 10th	Ice Harbor - November 25th		Lower Granite - March 7th Upper Grande Ronde - March 27th Bonneville Dam Corner Collector - May 9th			Steelhead collected in CRITFC Kelt Project at Lower Granite Dam.
2013	384.3B23AD8D4F	McNary - August 6th				Bonneville Cascade Is. Ladder - August 12th		May have spent a few months in the ocean before returning.
2013	384.3B23ADD1D9	The Dalles North Ladder - August 29th	Lower Granite - September 14th		Lower Imnaha 7 - April 7th Lower Imnaha 10 - April 8th Bonneville Bradford Island - May 22nd			
2013	384.3B23ADEED1	Bonneville Washington Shore Ladder - August 13th	McNary - October 22nd		Bonneville Bradford Island - May 16th			
2013	384.3B23AD82FF	Deschutes River Mouth - August 9th	McNary - October 2nd	McDonald Ferry (John Day) - December 22nd	SF John Day - April 30th Bonneville Bradford Island - May 12th			
	384.3B23ADEBD7	Deschutes River Mouth - August 3rd	Lower Granite - September 19th		Bonneville Bradford Is. Ladder - May 12th			
2013	384.3B23ADD481	Ice Harbor - August 19th	Lower Granite - September 22nd		Bonneville Juvenile Bypass - May 24th			
2013	384.3B23ADEDAE	McNary - August 8th	McDonald Ferry (John Day) - October 20th		SF John Day 2- May 29th SF John Day 1- May 30th	John Day Juvenile Bypass - June 4th Bonneville Juvenile Bypass - June 7th		
2013	384.3B23ADEF1C	Bonneville Washington Shore Ladder - August 16th	McDonald Ferry (John Day) - October 25th		Bonneville Juvenile Bypass - May 6th			
2013	3D9.1C2E04D73B	Deschutes River Mouth - August 9th	McDonald Ferry (John Day) - October 10th		Bonneville Juvenile Bypass - May 6th			
2013	384.3B23AD1FFE	McNary - September 12th	Pierce RV Prk (Walla Walla) - September 22nd		Bonneville Juvenile Bypass - April 25th			

Table A5 (Continued).

Tag Year	Tag Number	Last Summer/Fall Detection After Tagging 2013	Fall 2013	Winter 2013/14	Spring 2014	Summer 2014	Fall 2014	Comments
2013	3D9.1C2E03B3B8	The Dalles East Ladder - July 19th	Sherars Falls Trap (Deschutes) - October 5th	Lower Trout Cr (Deschutes) - February 14th Trout/Antelope Cr (Deschutes) - February 18th	Trout/Antelope Cr (Deschutes) - March 5th Bonneville Juvenile Bypass - March 31st			
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		May have spent a some time in the ocean before returning.
2013	3D9.1C2E0349AF	The Dalles East Ladder - July 26th	McDonald Ferry (John Day) - October 5th				Bonneville Bradford Island - September 15th Deschutes River Mouth - September 19th	May have spent a few months in the ocean before returning.
2013	384.3B23ADE215	McNary - August 23rd	McDonald Ferry (John Day) - October 15th			Deschutes River Mouth - August 24th	Deschutes River Mouth - September 4th	May have spent a few months in the ocean before returning.
2013	3D9.1C2E088E57	The Dalles East Ladder - July 21st				Bonneville Washington Ladder - July 29th Deschutes River Mouth - August 1st		May have spent a few months in the ocean before returning.
2013	3D9.1C2E03C2D6	McNary - July 28th	Prosser Dam (Yakima) - September 20th	Lower Toppenish Creek (Yakima) - February 16th	Lower Toppenish Creek (Yakima) - March 26th John Day Dam Juvenile Bypass - April 20th			
2013	384.3B23ADC6CE	The Dalles North Ladder - August 12th	Prosser Dam (Yakima) - September 27th	Lower Satus Creek (Yakima) - February 15th	Lower Satus Creek (Yakima) - March 4th John Day Dam Juvenile Bypass - April 9th			
2013	3D9.1C2D84E74A	Bonneville Washington Shore Ladder - July 10th	McDonald Ferry (John Day) - October 5th	Bridge Creek (John Day) - February 25th	Bridge Creek (John Day) - March 27th John Day Dam Juvenile Bypass - April 9th			
2013	384.3B23AE0265	Lower Granite - August 16th	Lower Tucannon - September 16th		Ice Harbor - March 24th John Day Dam Juvenile Bypass - March 31st			
2013	3D9.1C2E087DD2	McNary - July 18th	McNary Juvenile Bypass - October 10th McDonald Ferry (John Day) - October 19th		John Day Dam Juvenile Bypass - April 18th			
2013	3D9.1C2E042530	Bonneville Washington Shore Ladder - July 23rd	McNary - September 11th		John Day Dam Juvenile Bypass - May 19th			
2013	384.3B23AE03CA	Bonneville Washington Shore Ladder - August 14th	McNary - September 13th		John Day Dam Juvenile Bypass - May 7th			
2013	384.3B23AD8FF1	Bonneville Washington Shore Ladder - July 30th	The Dalles East Ladder - September 14th		Threemile Dam (Umatilla) - March 9th John Day Dam Juvenile Bypass - April 19th			
2013	3D9.1C2E03A00F	McNary - July 27th	McDonald Ferry (John Day) - November138th			Bonneville Washington Ladder - August 18th	The Dalles East Ladder - September 8th McDonald Ferry (John Day) - October 8th	May have spent a few months in the ocean before returning.
2013	384.3B23AD398E	The Dalles East Ladder - September 2nd		Threemile Dam (Umatilla) - December 29th Threemile Dam (Umatilla) - January 1st	Threemile Dam (Umatilla) - May 1st			
2013	384.3B23AD05EF	McNary - July 31st			Threemile Dam (Umatilla) - March 15th Threemile Dam (Umatilla) - May 17th			
2013	384.3B23AD7B80	McNary - September 15th			Threemile Dam (Umatilla) - March 15th Threemile Dam (Umatilla) - May 7th			
2013	384.3B23ADE015	Bonneville Washington Shore Ladder - August 14th	McNary - October 16th		Threemile Dam (Umatilla) - March 14th Threemile Dam (Umatilla) - May 31st			
2013	384.3B23AD1D39	McNary - July 31st	Prosser Dam (Yakima) - November 5th	Lower Status Creek - February 14th	Lower Status Creek - March 21st McNary Juvenile Bypass - April 16th			
2013	384.3B23ADF924	The Dalles North Ladder - August 30th	Prosser Dam (Yakima) - September 10th		McNary Juvenile Bypass - May 13th			
2013	3D9.1C2E041868	Lower Granite - August 10th			McNary Juvenile Bypass - April 24th			
2013	3D9.1C2E03B6DB	Lower Granite - August 27th			McNary Juvenile Bypass - May 4th			
2013	384.3B23ADF015	The Dalles East Ladder - July 29th	McDonald Ferry (John Day) - October 2nd			The Dalles East Ladder - August 2nd	McNary - September 28th	May have spent a few months in the ocean before returning.
2013	3D9.1C2E03B4A3	The Dalles East Ladder - July 16th	Threemile Dam (Umatilla) - October 8th		Threemile Dam (Umatilla) - May 3rd			
2013	384.3B23AF1600	Lower Granite - October 19th			Lower SF Clearwater - April 18th Ice Harbor - April 28th			
2013	384.3B23AD6827	The Dalles East Ladder - September 29th	Lower Granite - November 1st		Upper Salmon River - April 4th Lower Monumental Juvenile Bypass - May 4th			
2013	384.3B23AD9A69	McNary - August 6th	Lower Granite - November 9th		Lower Granite - March 6th Lower Granite - April 20th Lower Monumental Juvenile Bypass - April 28th			This steelhead actually went down and up the Lower Granite Ladder 6 times over the span of more then a month from March 6th to April 20th.
2013	384.3B23ADB56B	Ice Harbor - August 24th	Lower Granite - September 24th		Lower Granite - March 16th Lower Monumental Juvenile Bypass - May 9th			
2013	3D9.1C2E03E737	The Dalles East Ladder - August 18th	Lower Granite - September 19th		Lower Monumental Juvenile Bypass - May 7th			
2013	384.3B23ADE3A4	The Dalles East Ladder - July 11th	Lower Granite - October 12th		Lower Monumental Juvenile Bypass - May 20th			
2013	384.3B23ADD09F	Ice Harbor - August 3rd	Lower Granite - September 25th		Catherine Creek (Grande Ronde) - April 28th Little Goose Juvenile Bypass - May 30th Lower Monumental Juvenile Bypass - May 31st			
2013	3D9.1C2E030FB3	The Dalles North Ladder - July 18th	Lower Granite - October 5th		Lower Monumental Juvenile Bypass - May 12th			Steelhead collected in CRITFC Kelt Project at Lower Granite Dam.
2013	384.3B23ADEDA0	The Dalles East Ladder - August 12th	Lower Granite - September 21st		Lower Imnaha - April 12th Lower Imnaha - May 1st and 2nd	Lower Monumental Juvenile Bypass - June 5th		Steelhead collected in CRITFC Kelt Project at Lower Granite Dam.
2013	384.3B23AEB841	Lower Granite - October 5th			Lower SF Clearwater - March 17th Little Goose Juvenile Bypass - May 19th			
2013	384.3B23ADA7BF	McNary - August 1st	Lower Granite - November 5th			Little Goose Juvenile Bypass - June 11th		Steelhead collected in CRITFC Kelt Project at Lower Granite Dam.
2013	384.3B23ADEF93	Bonneville Washington Shore Ladder - August 16th	Lower Granite - October 1st		Little Goose Juvenile Bypass - April 15th			
2013	384.3B23AE0288	The Dalles East Ladder - August 7th	Lower Granite - October 11th		Little Goose Juvenile Bypass - April 14th			
2013	384.3B23AD6022	Ice Harbor - August 28th	Lower Granite - October 5th			Little Goose Juvenile Bypass - June 18th		
2013	384.3B23AED82E	Lower Granite - October 5th			Krassel Cr/SF Salmon - March 30th Little Goose Juvenile Bypass - May 26th			
2013	3D9.1C2E03D01B	Lower Granite - July 12th			Little Goose Juvenile Bypass - May 8th			
2013	384.3B23ADD062	Deschutes River Mouth - July 30th	Lower Granite - October 27th		Little Goose Juvenile Bypass - April 16th			
2013	384.3B23AE089B	Bonneville Washington Shore Ladder - August 13th		The Dalles East Ladder - February 22nd	McNary - March 9th Ice Harbor - March 14th Lower Monumental - March 16th Little Goose Juvenile Bypass - April 6th			
2013	384.3B23ADF9E2	Bonneville Washington Shore Ladder - August 9th	Lower Granite - October 4th				Bonneville Cascades Is. Ladder - October 15th Lower Granite - October 31st	May have spent a few months in the ocean before returning.
2013	384.3B23AF3830	Deschutes River Mouth - October 8th	Bonneville Washington Ladder - November 17th The Dalles North Ladder - November 19th	Bonneville Washington Shore Ladder - December 12th Bonneville Washington Ladder - December 20th	Bonneville Washington Ladder - March 14th Lower Granite - March 29th			This steelhead ascended the Bonneville and The Dalles ladders three times over 5 months. It was never detected moving downstream through the ladders.

Table A5 (Continued).

Tag Year	Tag Number	Last Summer/Fall Detection After Tagging 2013	Fall 2013	Winter 2013/14	Spring 2014	Summer 2014	Fall 2014	Comments
2013	384.3B23ACDAD7	Bonneville Washington Shore Ladder - September 27th Bonneville Cascade Is. Ladder Bonneville Bradford Is. Ladder - October 4th	McNary - October 17th		Lower Granite - March 27th Lower Granite - March 27th Lower Granite Juvenile Bypass - May 22nd			This steelhead actually went up and down each of the three ladders listed at Bonneville several times for 8 days. It also spent time going up and down other ladders in the system and poked into the Deschutes River before going into the Snake.
2013	3D9.1C2E03B278	Bonneville Washington Shore Ladder - July 29th	Lower Granite - September 26th		Lower Granite Juvenile Bypass - April 22nd			
2013	3D9.1C2E037544	Bonneville Washington Shore Ladder - August 27th	Lower Granite - September 22nd		Lower Granite Juvenile Bypass - April 1st			
2013	384.3B23AD79E8	The Dalles East Ladder - August 2nd	Lower Granite - September 26th		Cow Creek (Imnaha) - May 12th and 29th	Lower Granite Juvenile Bypass - June 4th		
2013	384.3B23AD9B1C	The Dalles East Ladder - August 3rd	Lower Granite - October 13th					Steelhead collected in CRITFC Kelt Project at Lower Granite Dam.
2013	384.3B23ADA5A7	Bonneville Washington Shore Ladder - August 28th	Lower Granite - October 18th					Steelhead collected in CRITFC Kelt Project at Lower Granite Dam.
2013	384.3B23ADB677	Bonneville Washington Shore Ladder - August 9th	Lower Granite - September 27th					Steelhead collected in CRITFC Kelt Project at Lower Granite Dam.
2013	3D9.1C2E0425E6	Bonneville Washington Shore Ladder - August 22nd	Lower Granite - November 7th					Steelhead collected in CRITFC Kelt Project at Lower Granite Dam.
2013	384.3B23ADDE52	Bonneville Washington Shore Ladder - August 16th	Rocky Reach - October 14th	Wells - December 12th	Lower Okanagan - April 3rd Bonaparte Creek (Okanagan) - April 4th and 11th Rocky Reach Juvenile Bypass - May 17th		Bonneville Bradford Is. - September 24th Rocky Reach - October 15th	May have spent a few months in the ocean before returning.
2013	384.3B23ACFA8F	Wells - August 7th			Zosel Dam - March 14h Zosel Dam - April 17h Bonaparte Creek (Okanagan) - May 3rd Rocky Reach Juvenile Bypass - May 6th			This steelhead ascended the Zosel Dam 7 times from March 14th to April 12th, before going back down the ladder on April 17th.
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	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	May have spent a few months in the ocean before returning.
2013	384.3B23ADA011	Ice Harbor - August 30th	Lower Granite - September 17th		Lower Granite - April 5th Asotin Cr Upper (Snake) - April 8th Asotin Cr Lower (Snake) - April 22nd			Steelhead collected in CRITFC Kelt Project at Lower Granite Dam.
2013	384.3B23ADDD06	Deschutes River Mouth - August 28th	Lower Granite - October 11th		Upper Salmon - April 10th			Steelhead collected in CRITFC Kelt Project at Lower Granite Dam.
2013	3D9.1C2E039D6E	Bonneville Washington Shore Ladder - July 23rd	Prosser Dam (Yakima) - September 20th		Prosser Dam (Yakima) - May 16th			Steelhead collected in CRITFC Kelt Project at Prosser Dam.
2013	384.3B23ADC56F	The Dalles East Ladder - August 16th	Prosser Dam (Yakima) - September 12th		Prosser Dam (Yakima) - May 19th			Steelhead collected in CRITFC Kelt Project at Prosser Dam.
2013	384.3B23AD8DB1	Bonneville Washington Shore Ladder - August 15th	McNary - October 8th		Prosser Dam (Yakima) - March 4th Prosser Dam (Yakima) - May 15th			Steelhead collected in CRITFC Kelt Project at Prosser Dam.
2013	384.3B23ACECAE	Bonneville Washington Shore Ladder - July 18th	Prosser Dam (Yakima) - October 7th	Lower Satus Creek (Yakima) -- February 17th	Lower Satus Creek (Yakima) - March 3rd and April 1st Prosser Dam (Yakima) - April 4th			Steelhead collected in CRITFC Kelt Project at Prosser Dam.
2013	384.3B23AF07D9	Bonneville Washington Shore Ladder - October 7th	Lower Granite - November 1st	Lower SF Clearwater - February 26th				Steelhead collected in CRITFC Kelt Project at Lower Granite Dam.
2013	384.3B23ADD061	Bonneville Washington Shore Ladder - August 9th	Prosser Dam (Yakima) - September 23rd			Lower Naches (Yakima) - June 17th		Steelhead collected in CRITFC Kelt Project at Prosser Dam.
2013	384.3B23ADFB7C	McNary - July 25th	Lower Granite - October 21st	Lower Imnaha - February 26th	Little Sheep (Imnaha) - March 5th Big Sheep (Imnaha) - March 9th			Steelhead collected in CRITFC Kelt Project at Lower Granite Dam.

Key - - - Upstream | Downstream | Spawning

Table A6. Season by season activities of steelhead tagged in 2012 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 2012 report table is included here as behavioral detections became available in 2013/2014.

Tag Year	Tag Number	Last Summer/Fall Detection After Tagging 2012	Fall 2012	Winter 2012/13	Spring 2013	Summer 2013	Fall 2013	Winter 2013/14	Spring 2014	Summer 2014	Fall 2014	Comments
2012	3D9.1C2DE87110	Bonneville Washington Shore Ladder - August 27th	Lower Granite - September 13th								Lower Granite - September 19th	New steelhead added. May have spent over a year in the ocean.
2012	3D9.1C2DE91E18	Bonneville Washington Shore Ladder - July 11th								Bonneville Cascade Is. Ladder - June 22nd Bonneville Washington Shore Ladder - August 6th		New steelhead added. May have spent over a year in the ocean.
2012	3D9.1C2DE7FF5B	Bonneville Washington Shore Ladder - August 20th	McNary - October 1st		Threemile Dam (Umatilla) - April 8th Threemile Dam (Umatilla) - May 15th							New steelhead added.
2012	3D9.1C2DE7FED6	Bonneville Washington Shore Ladder - September 12th	Prosser Dam (Yakima) - October 29th		CHANDL - Chandler Canal Kelt Project Collection - April 23rd		Prosser Dam (Yakima) - October 25th					Steelhead reconditioned in CRITFC Kelt Project will be released October 23rd, 2013. New information added.
2012	3D9.1C2DE788F2	Lyle Falls (Klickitat) - July 14th			Bonneville Dam Corner Collector - April 28th					Lyle Falls (Klickitat) - July 11th		New info added. May have spent over a year in the ocean.
2012	384.1B79764604	Bonneville Washington Shore Ladder - July 24th	McNary - October 21st		Threemile Dam (Umatilla) - May 7th					The Dalles East Fish Ladder - August 3rd		New info added. May have spent over a year in the ocean.
2012	3D9.1C2DB72ED0	Bonneville Washington Shore Ladder - August 20th	Prosser Dam (Yakima) - October 18th									Steelhead collected as a kelt in CRITFC Kelt Project.
2012	3D9.1C2DE80DFE	McNary - August 11th	Roza Dam (Yakima) - October 28th		Roza Dam (Yakima) - March 5th							Steelhead collected as a kelt in CRITFC Kelt Project.
2012	3D9.1C2DE7712B	McNary - July 28th		Prosser Dam (Yakima) - January 10th	Lower Satus Cr (Yakima) - March 13th and 22nd Kelt Project Collection at Prosser - April 1st							Steelhead collected as a kelt in CRITFC Kelt Project.
2012	3D9.1C2DE8425E	McNary - August 3rd	Prosser Dam (Yakima) - October 30th		Chandler Canal Kelt Project Collection - April 11th							Steelhead collected as a kelt in CRITFC Kelt Project.
2012	3D9.1C2DE88103	Bonneville Washington Shore Ladder - September 5th	McNary - November 8th		Prosser Dam (Yakima) - March 29th	Chandler Canal Kelt Project Collection - June 11th						Steelhead collected as a kelt in CRITFC Kelt Project.
2012	3D9.1C2DE85DCC	Bonneville Washington Shore Ladder - August 21st	Lower Granite - September 24th									Steelhead collected as a kelt in CRITFC Kelt Project at Lower Granite Dam.
2012	3D9.1C2DE85FB4	Bonneville Washington Shore Ladder - August 21st	Lower Granite - October 30th									Steelhead collected as a kelt in CRITFC Kelt Project at Lower Granite Dam.
2012	3D9.1C2DE8CB2D	Bonneville Washington Shore Ladder - July 25th	Lower Granite - October 4th									Steelhead collected as a kelt in CRITFC Kelt Project at Lower Granite Dam.
2012	3D9.1C2DE8D6FE	Bonneville Washington Shore Ladder - August 31st	Lower Granite - October 10th		Lower Lemhi (Salmon) - April 1st							Steelhead collected as a kelt in CRITFC Kelt Project at Lower Granite Dam.

Table A7. Season by season activities of steelhead tagged in 2011 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 2011 report table is included here as behavioral detections became available in 2013/2014.

Tag Year	Tag Number	Last Summer Detection After Tagging 2011	Fall 2011	Winter 2011/12	Spring 2012	Summer 2012	Fall 2012	Winter 2012/13	Spring 2013	Summer 2013	Winter 2013/14	Spring 2014	Comments
2011	3D9.1C2DB5075D	Bonneville Washington Shore Ladder - August 9th	McNary - September 18th Ice Harbor - September 20th Lower Granite - September 26th							Bonneville Bradford Island - August 11th Deschutes River Mouth - August 28th Deschutes River Mouth - September 29th	McNary - October 2nd Ice Harbor - October 4th Lower Granite - October 9th	Upper Salmon River 1 - April 9th Upper Salmon River 1 - April 10th	New info added. May have spent 2012 in the ocean.

Key - - - Upstream | Downstream | Spawning

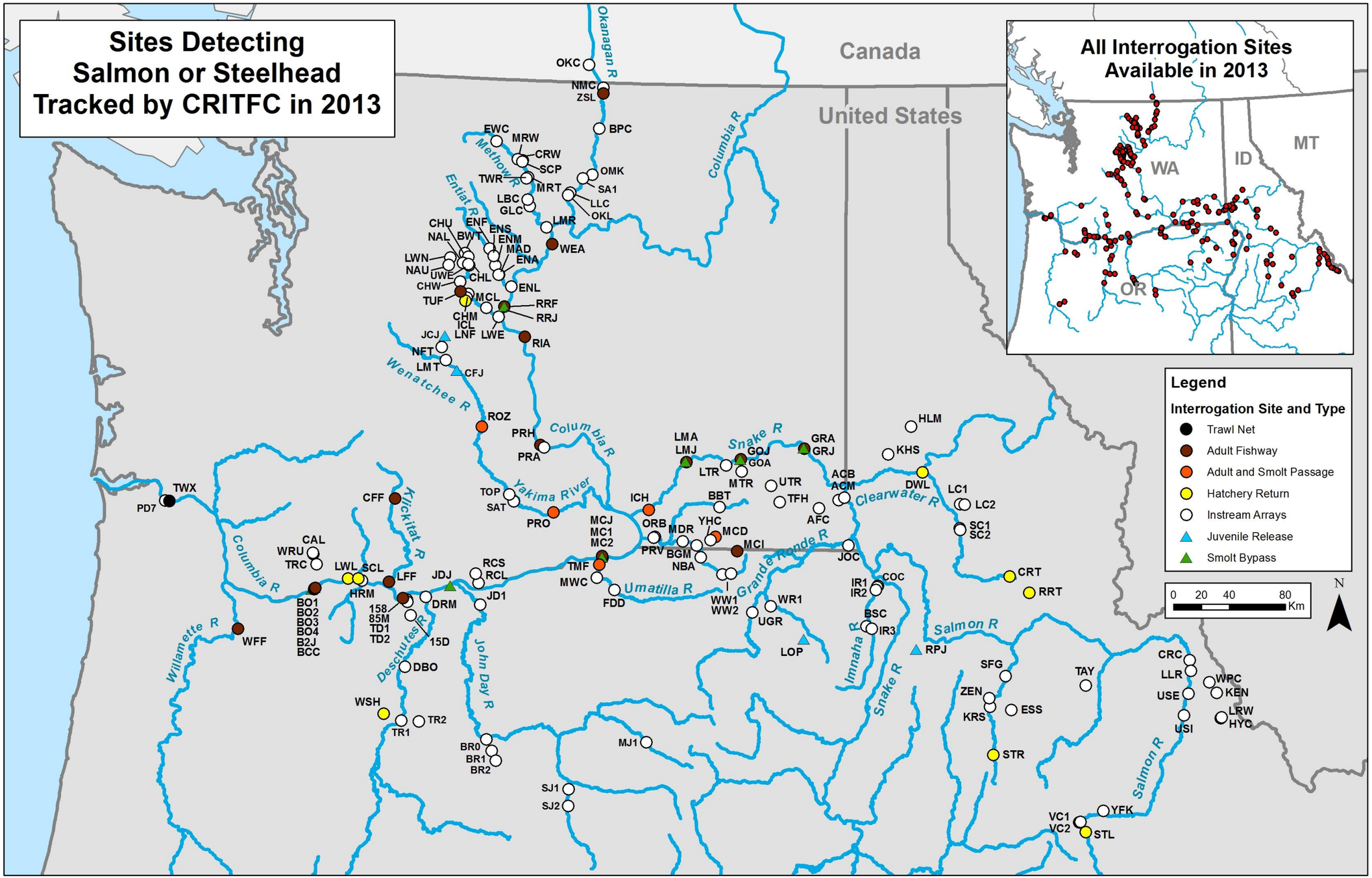

Figure A1. Map of Columbia River interrogation sites that detected Chinook and Sockeye salmon, and steelhead in 2013. Table A5 in the Appendix lists the PTAGIS sites full name and the three-letter codes on this map.

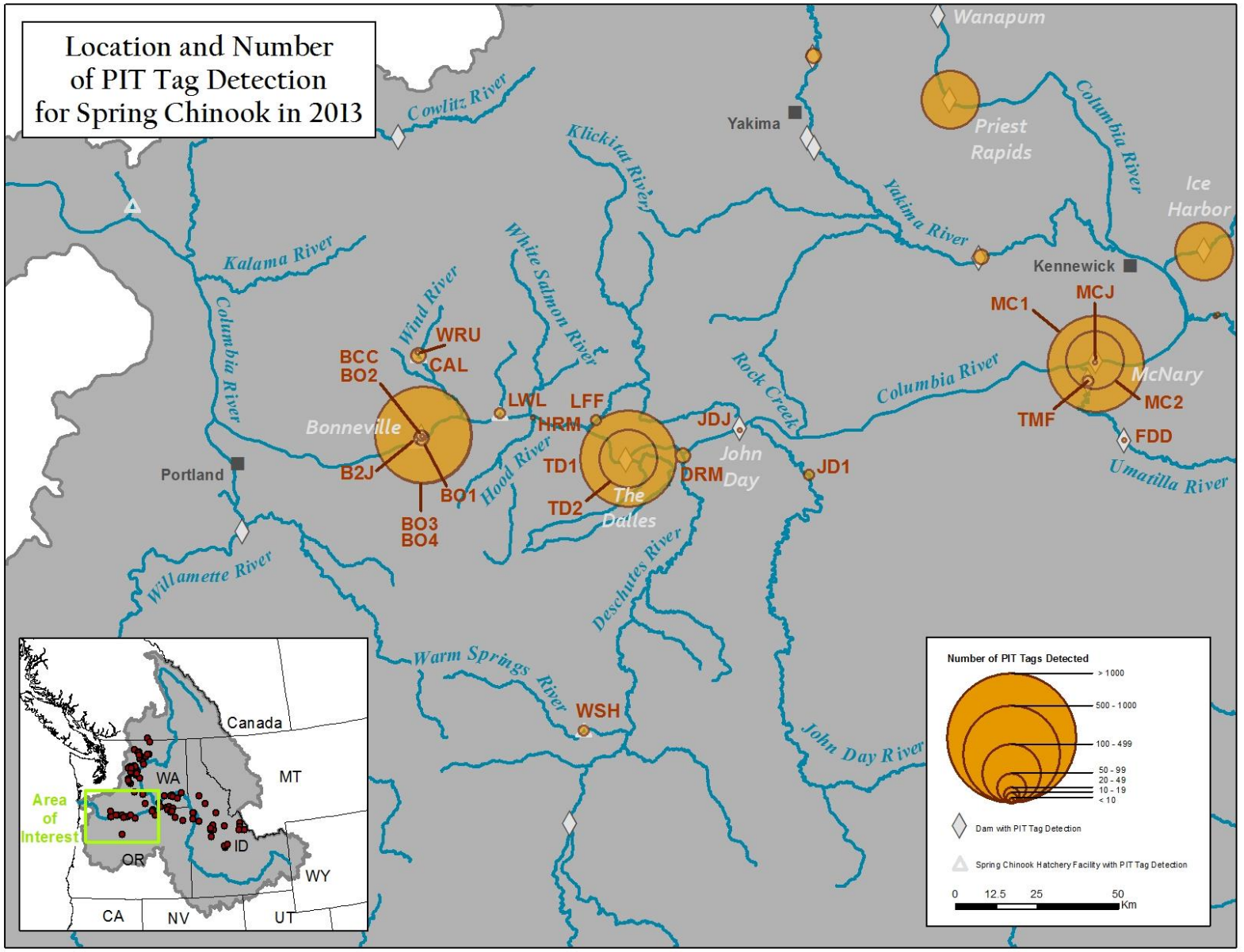

Figure A2. Map of Lower Columbia River detections sites and number of spring Chinook detected. Table A5 in the Appendix lists the PTAGIS sites full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January 1 to June 1.

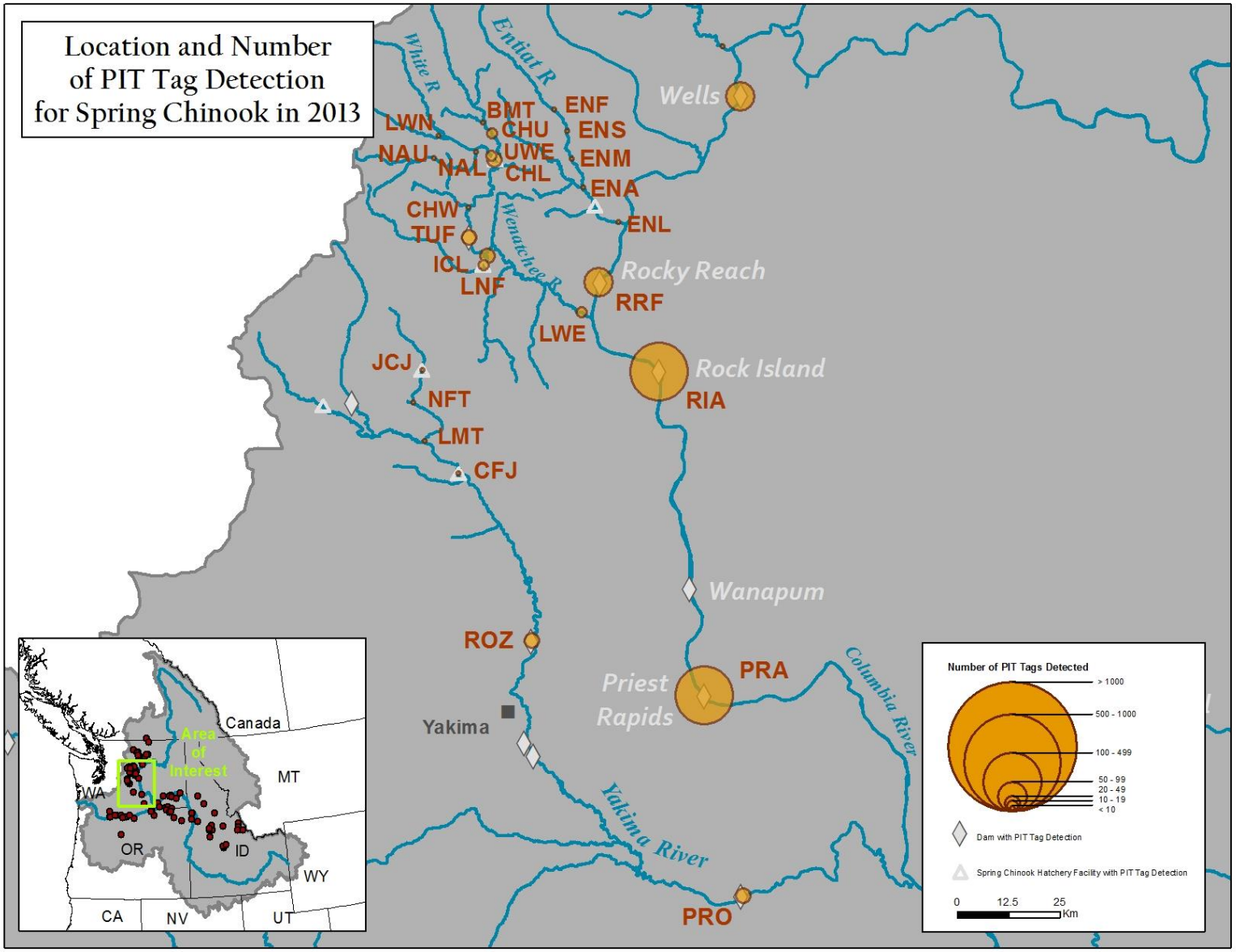

Figure A3. Map of Upper Columbia River (between the Snake River and Wells Dam) detections sites and number of spring Chinook detected. Table A5 in the Appendix lists the PTAGIS sites full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January 1 to June 1.

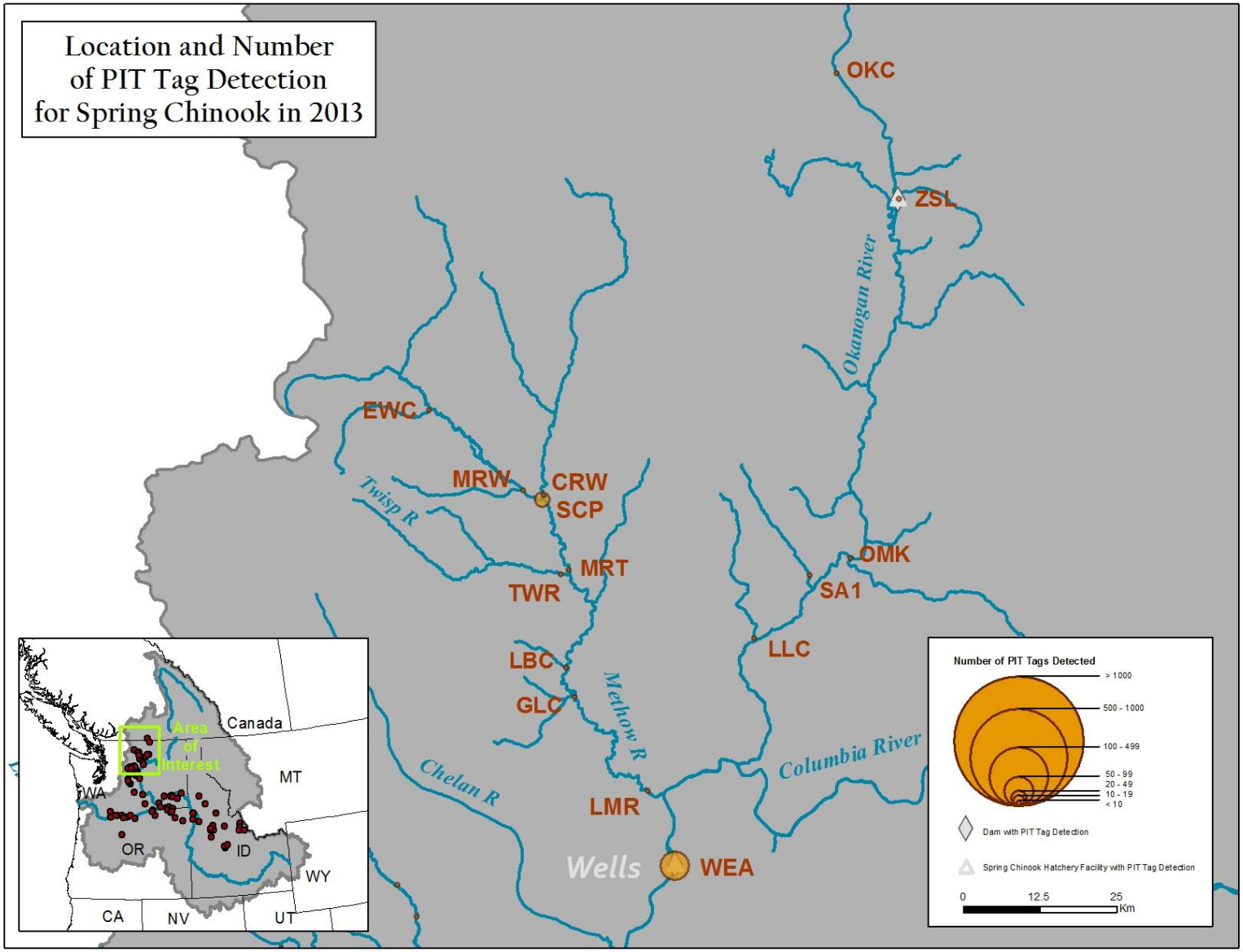

Figure A4. Map of Upper Columbia River (Wells Dam and above) detections sites and number of spring Chinook detected. Table A5 in the Appendix lists the PTAGIS sites full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January 1 to June 1.

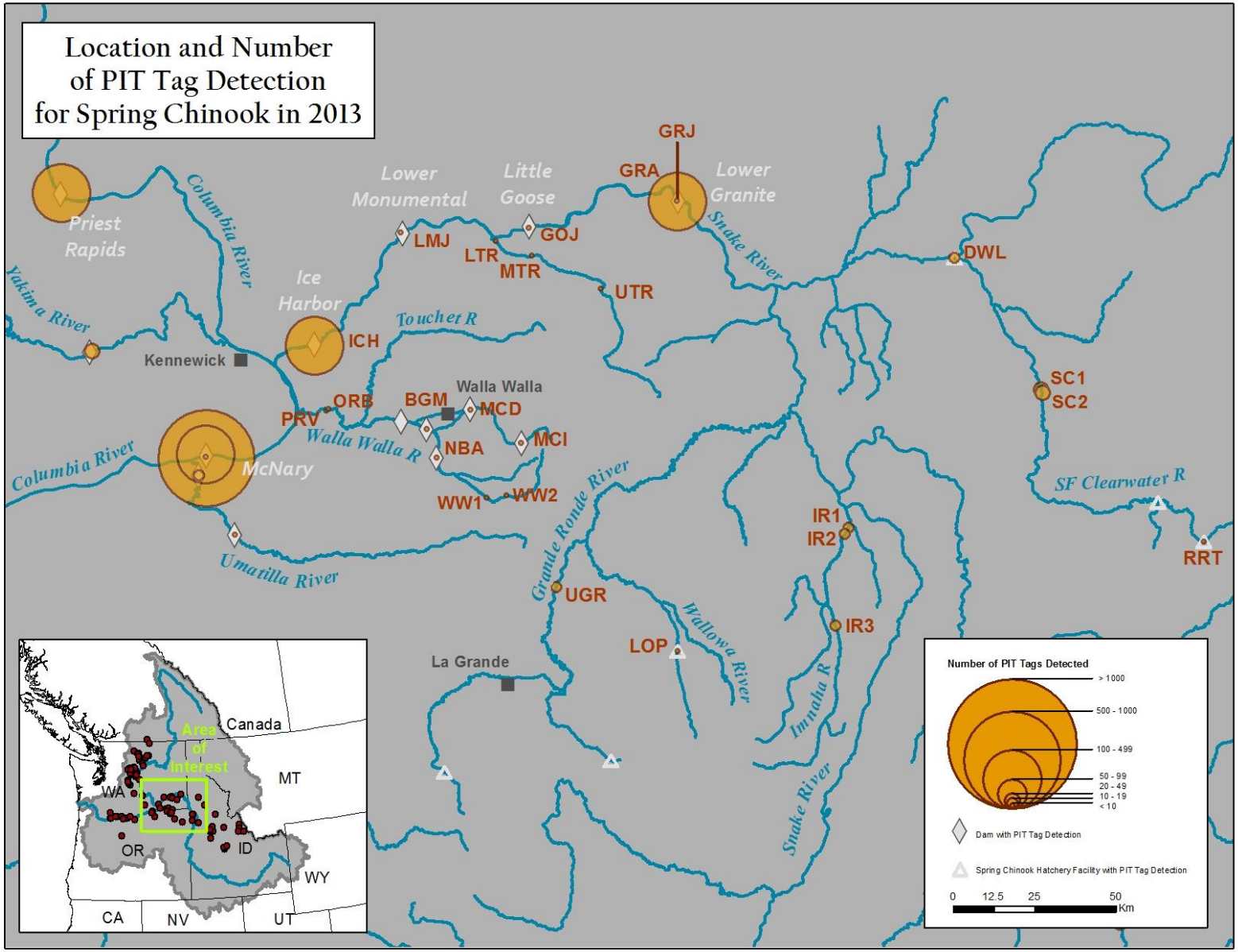

Figure A5. Map of Lower Snake River detections sites and number of spring Chinook detected. Table A5 in the Appendix lists the PTAGIS sites full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January 1 to June 1.

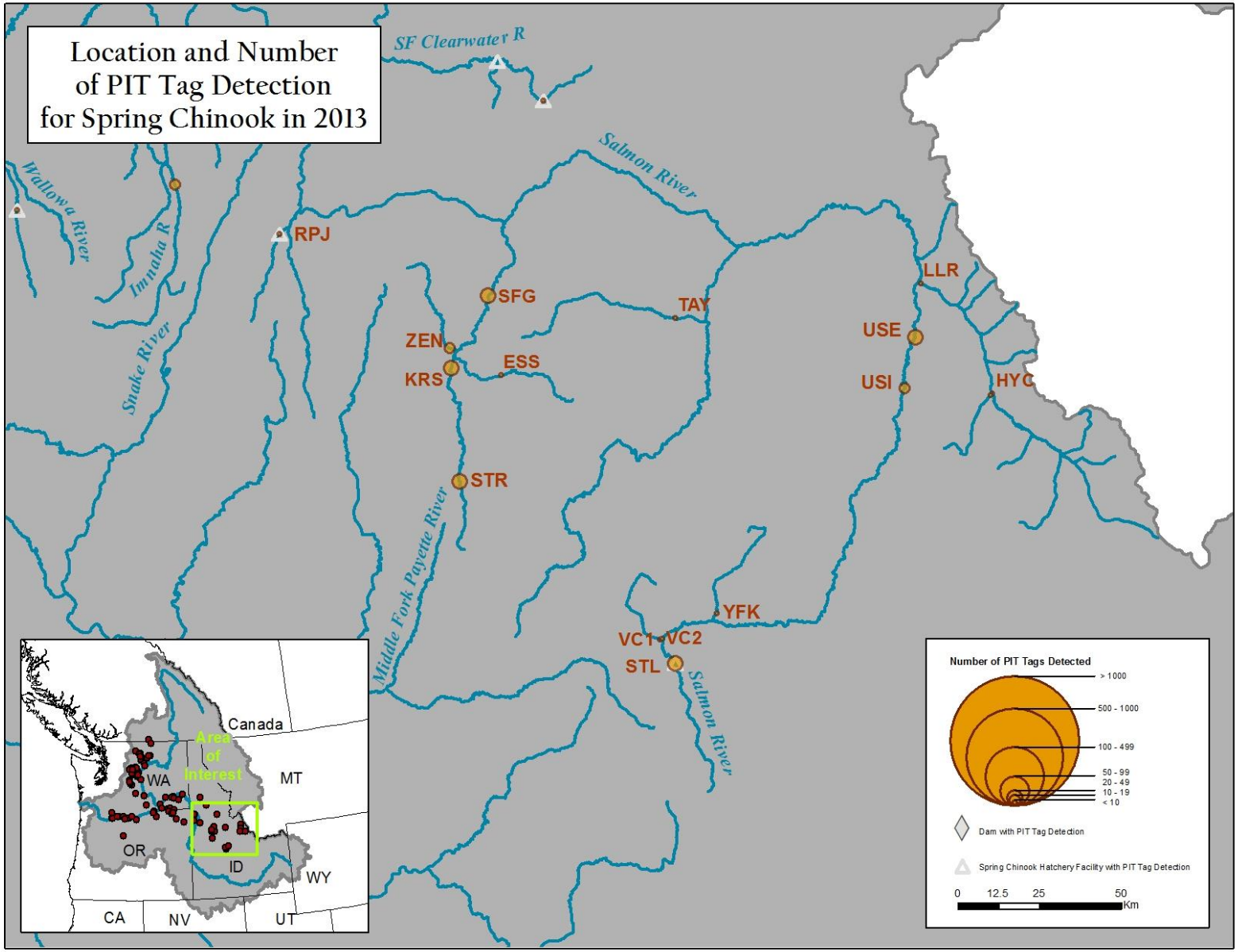

Figure A6. Map of Salmon River detections sites and number of spring Chinook detected. Table A5 in the Appendix lists the PTAGIS sites full name and the three-letter codes on this map. Spring Chinook is defined as fish passing Bonneville Dam from January 1 to June 1.

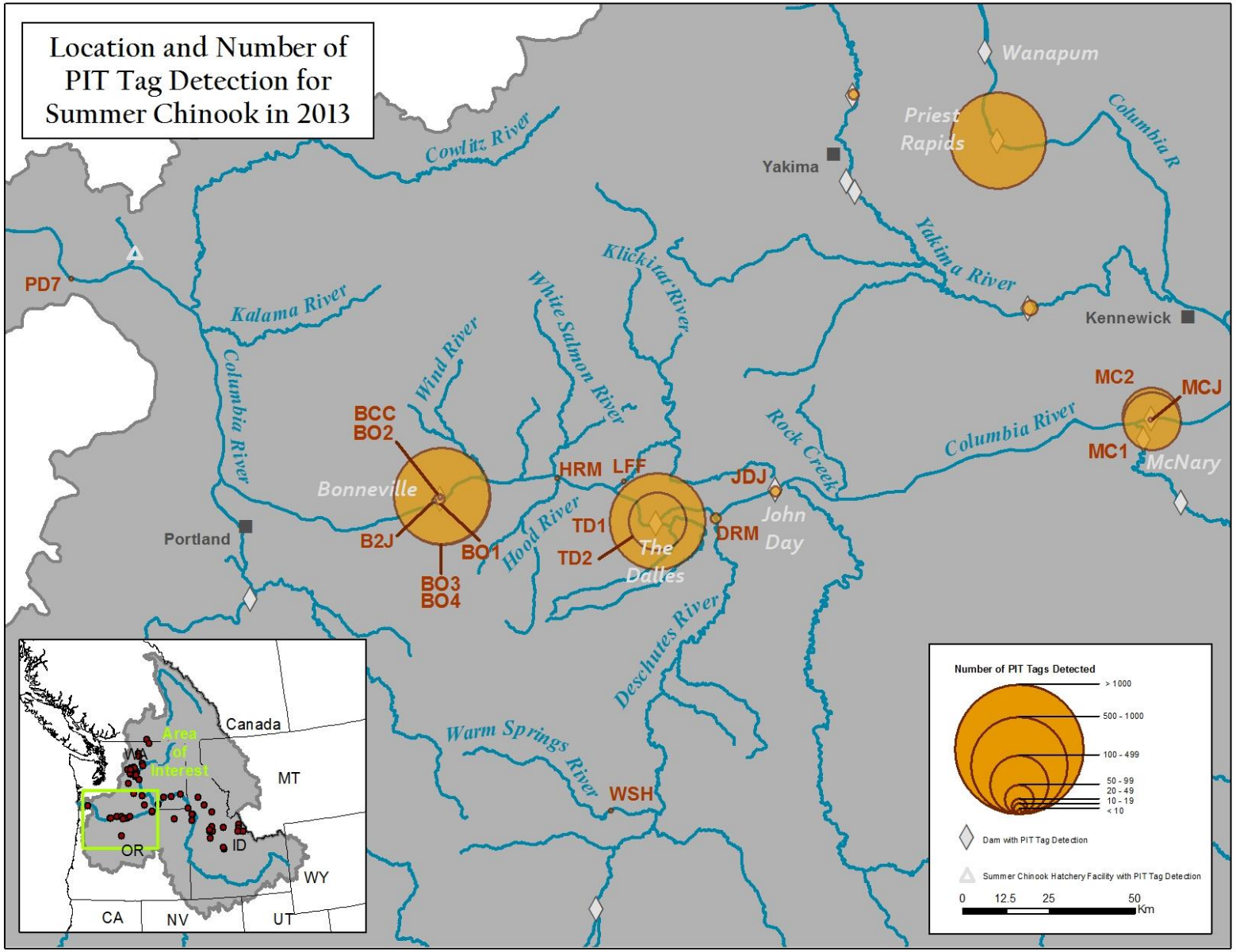

Figure A7. Map of Lower Columbia River detections sites and number of summer Chinook detected. Table A5 in the Appendix lists the PTAGIS sites full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June 1 to August 1.

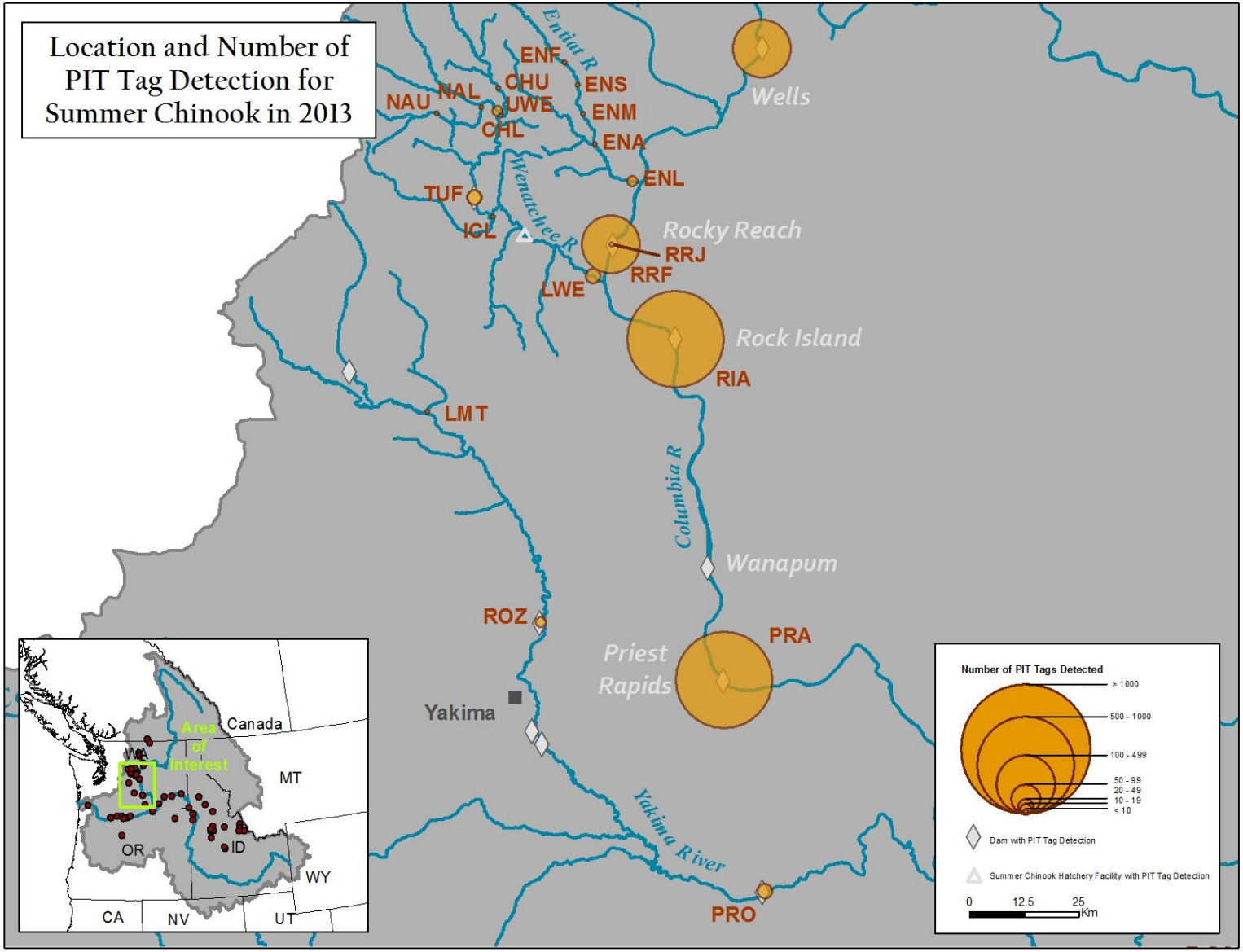

Figure A8. Map of Upper Columbia River (between the Snake River and Wells Dam) detections sites and number of summer Chinook detected. Table A5 in the Appendix lists the PTAGIS sites full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June 1 to August 1.

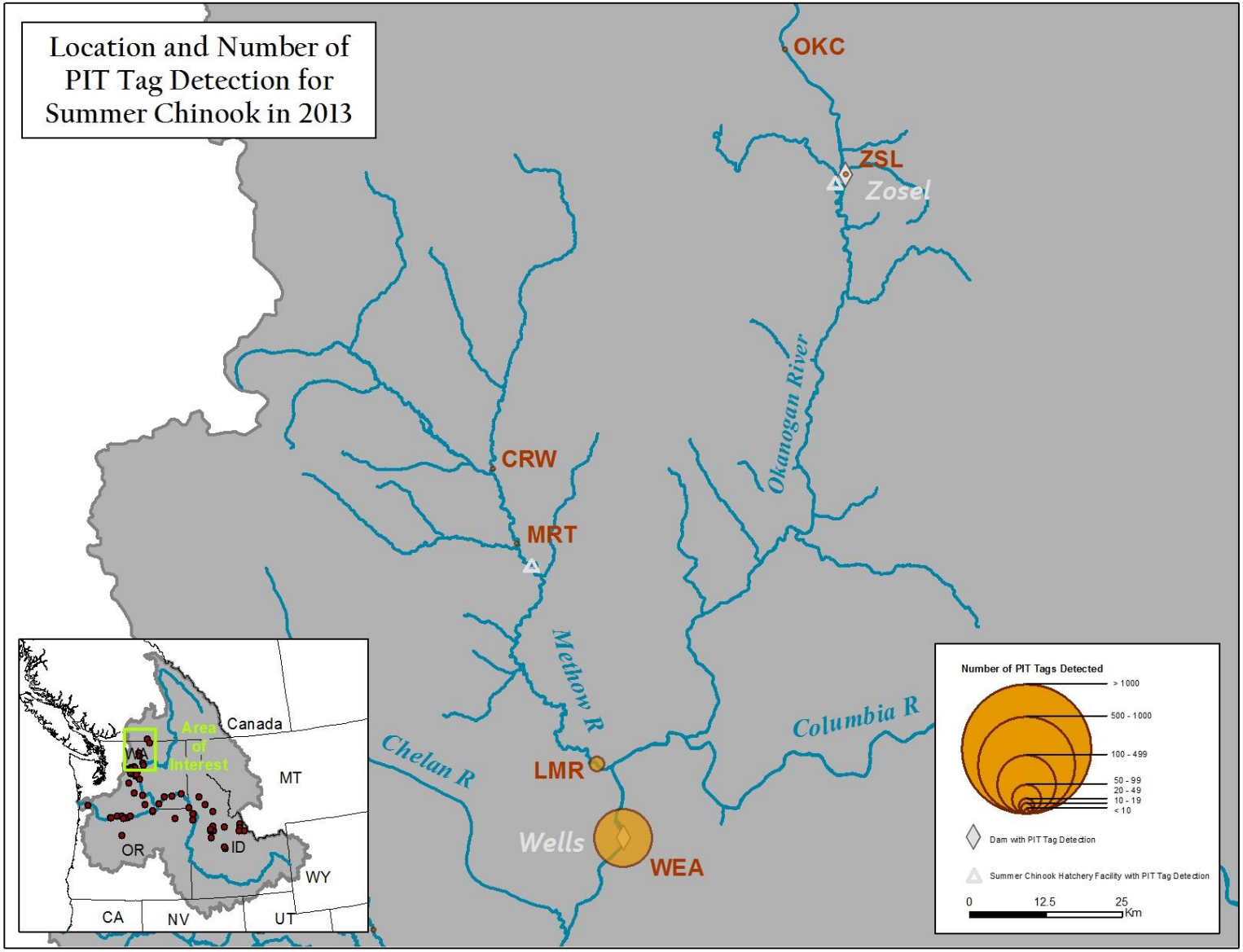

Figure A9. Map of Upper Columbia River (Wells Dam and above) detections sites and number of summer Chinook detected. Table A5 in the Appendix lists the PTAGIS sites full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June 1 to August 1.

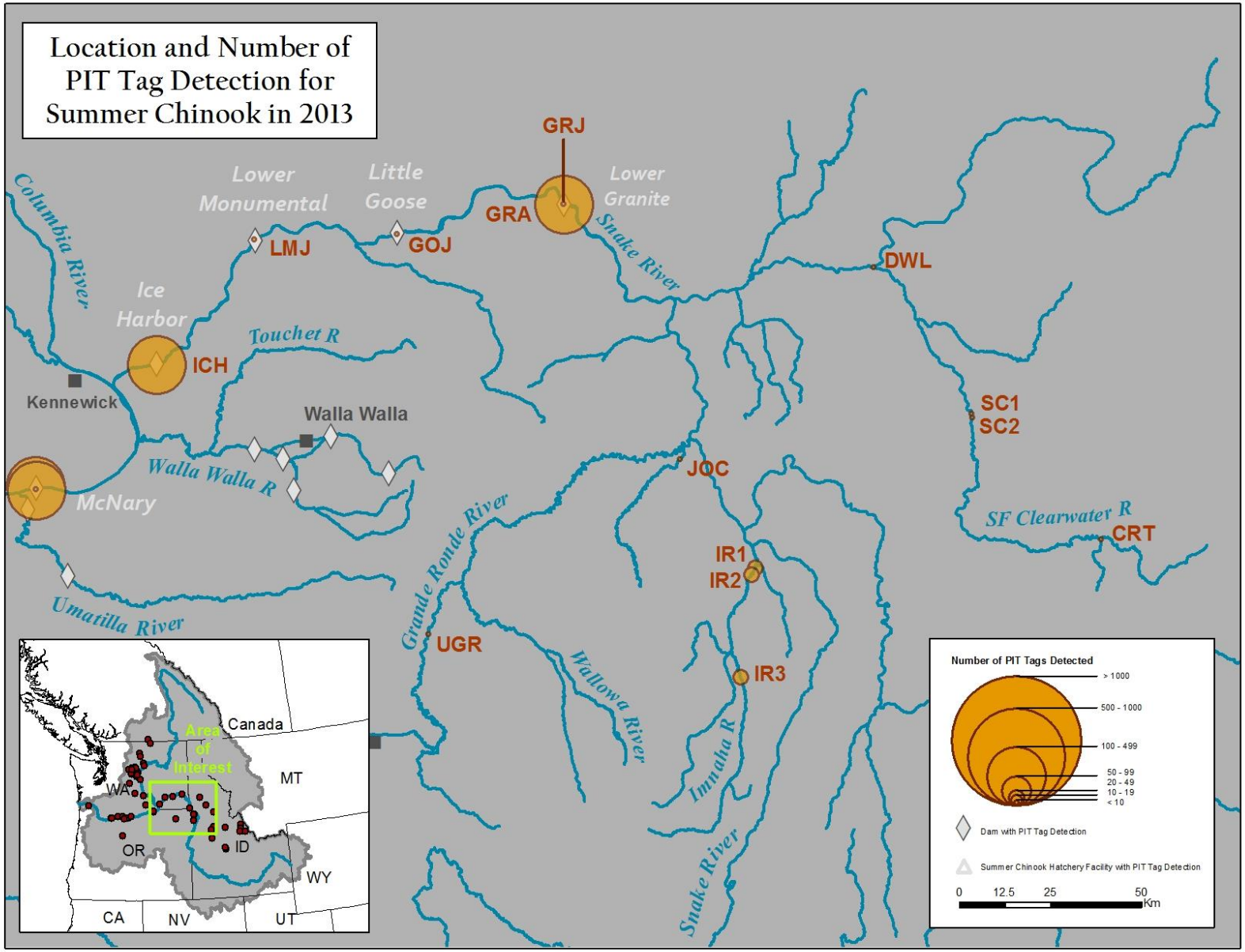

Figure A10. Map of Lower Snake River detections sites and number of summer Chinook detected. Table A5 in the Appendix lists the PTAGIS sites full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June 1 to August 1.

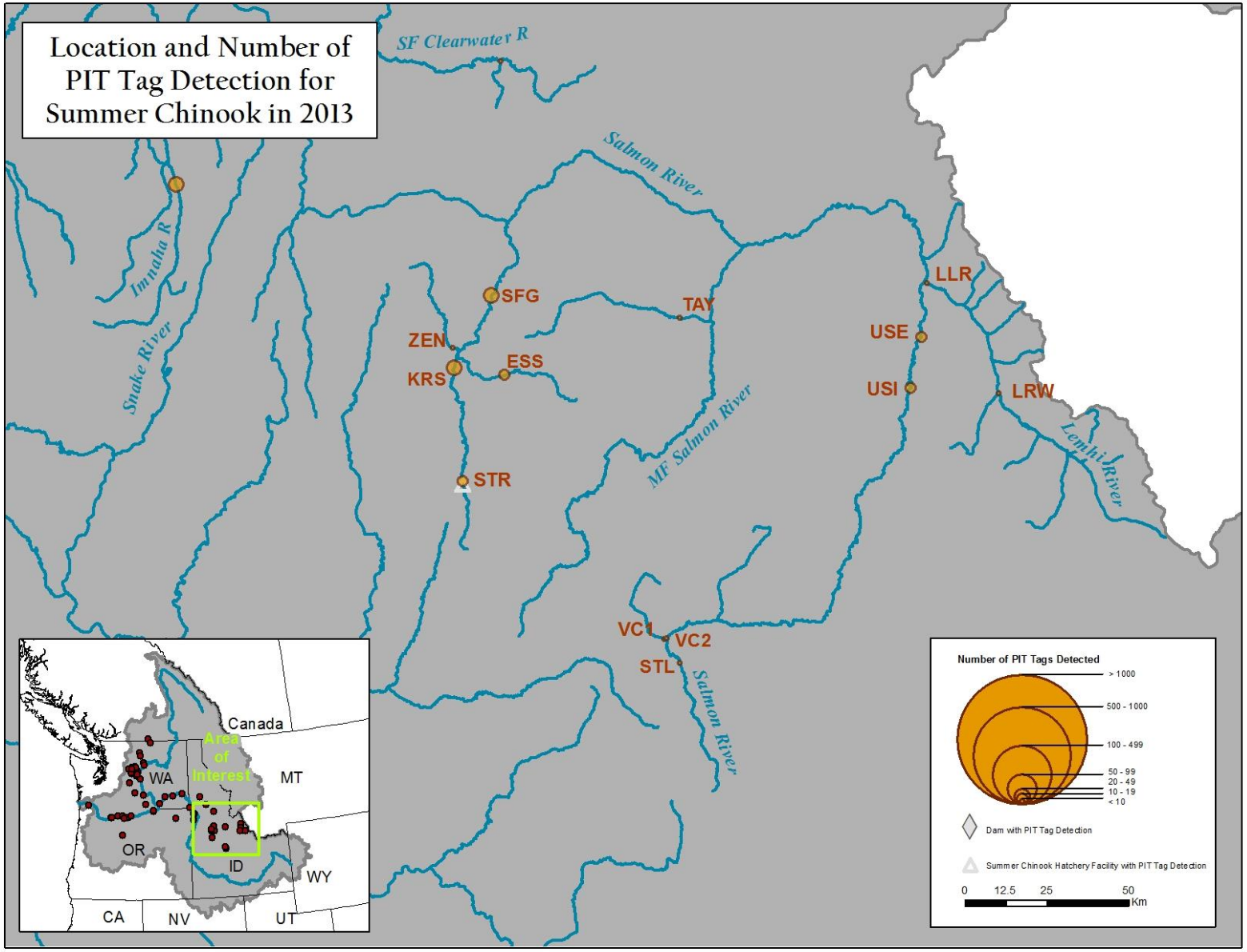

Figure A11. Map of Salmon River detections sites and number of summer Chinook detected. Table A5 in the Appendix lists the PTAGIS sites full name and the three-letter codes on this map. Summer Chinook is defined as fish passing Bonneville Dam from June 1 to August 1.

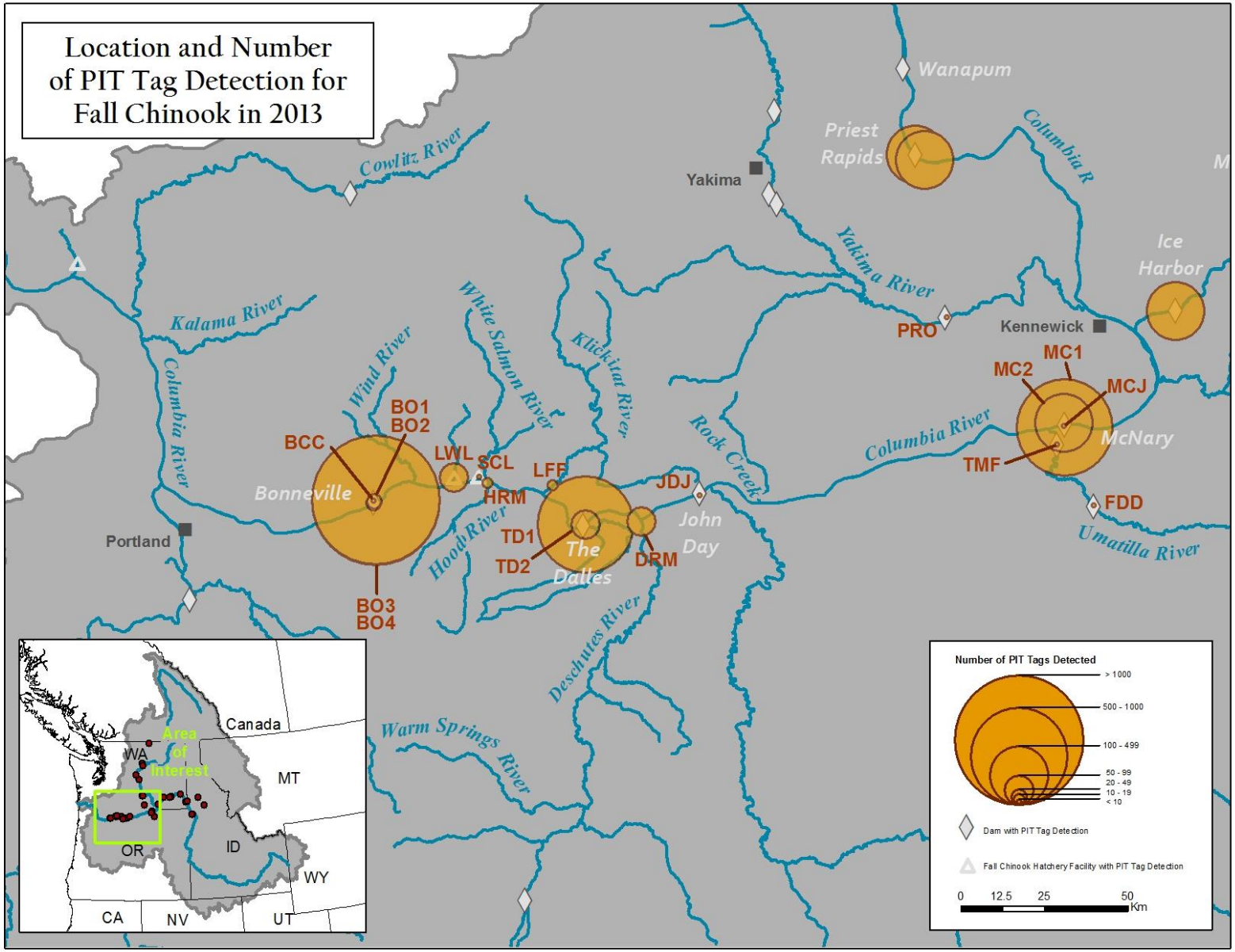

Figure A12. Map of Lower Columbia River detections sites and number of fall Chinook detected. Table A5 in the Appendix lists the PTAGIS sites full name and the three-letter codes on this map. Fall Chinook is defined as fish passing Bonneville Dam from August 1 to end of year.

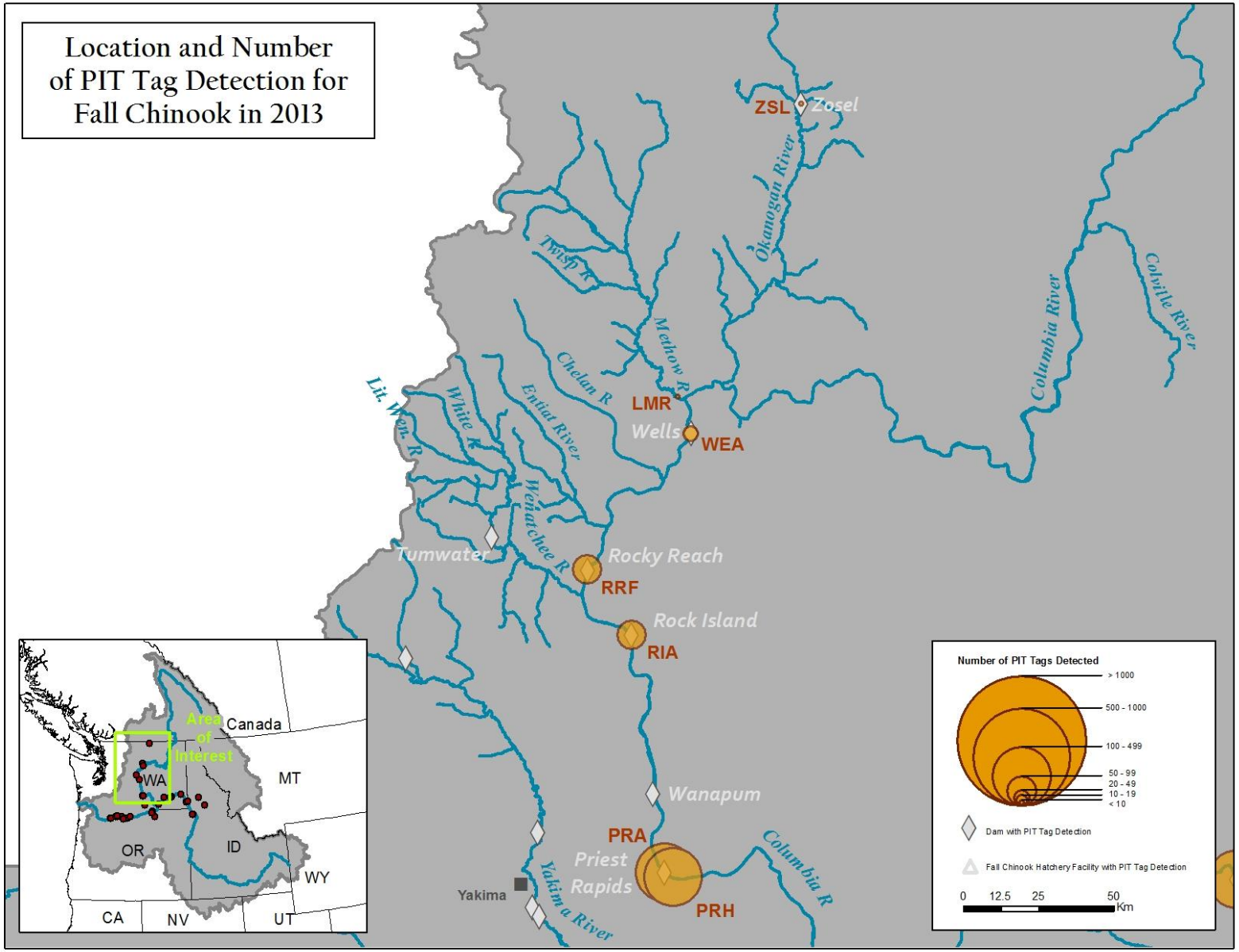

Figure A13. Map of Upper Columbia River detections sites and number of fall Chinook detected. Table A5 in the Appendix lists the PTAGIS sites full name and the three-letter codes on this map. Fall Chinook is defined as fish passing Bonneville Dam from August 1 to end of year.

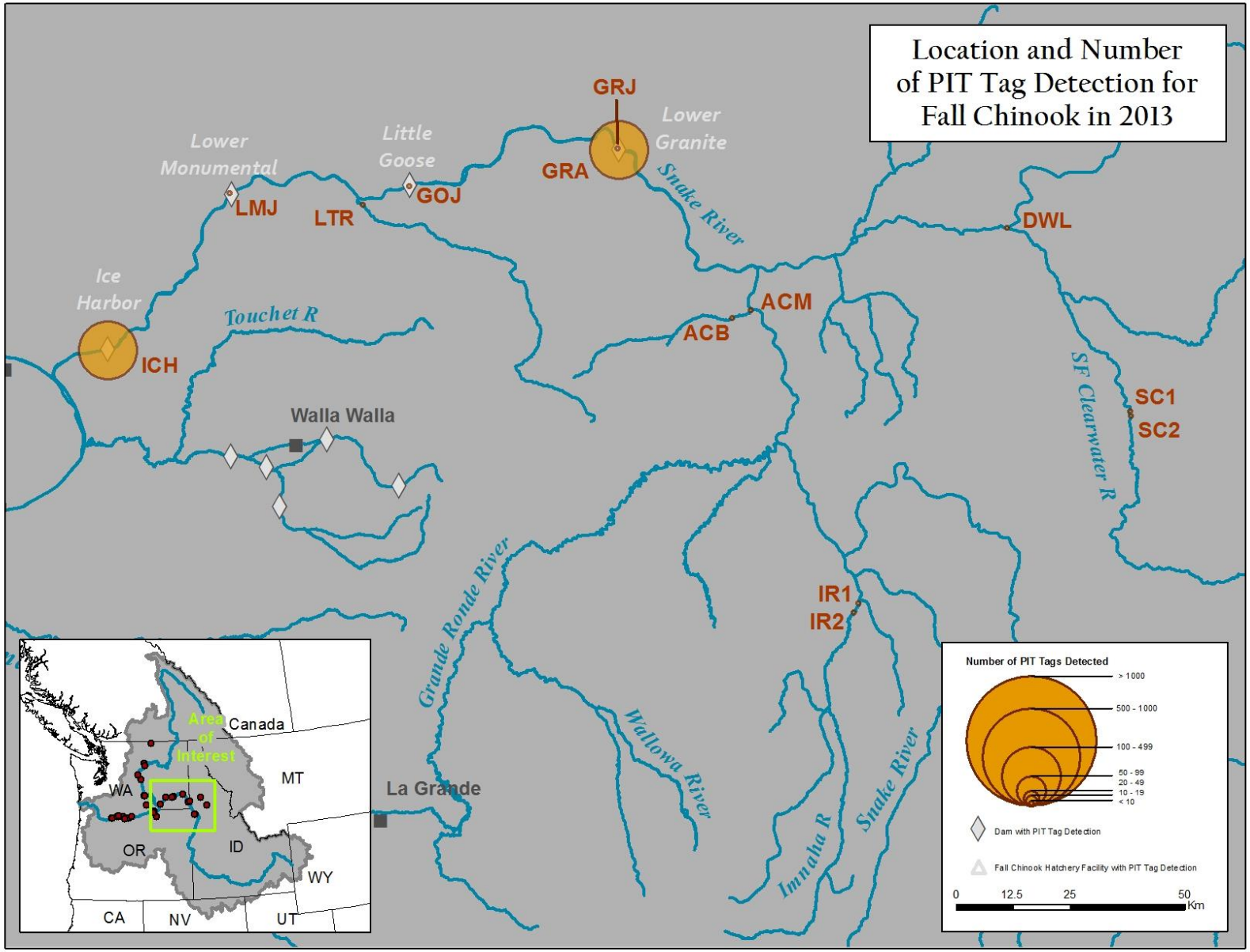

Figure A14. Map of Lower Snake River detections sites and number of fall Chinook detected. Table A5 in the Appendix lists the PTAGIS sites full name and the three-letter codes on this map. Fall Chinook is defined as fish passing Bonneville Dam from August 1 to end of year.

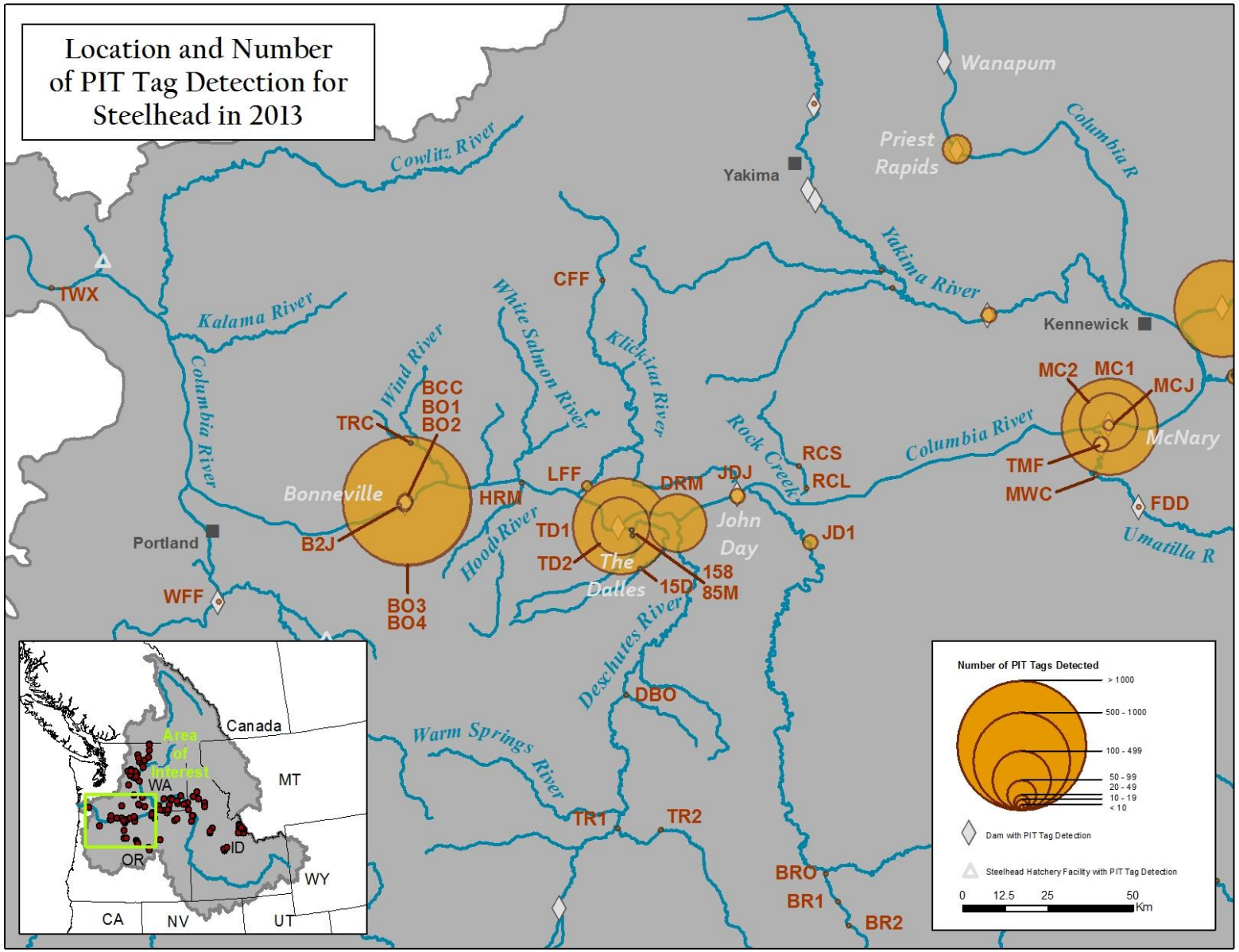

Figure A15. Map of Lower Columbia River detections sites and number of steelhead detected. Table A5 in the Appendix lists the PTAGIS sites full name and the three-letter codes on this map.

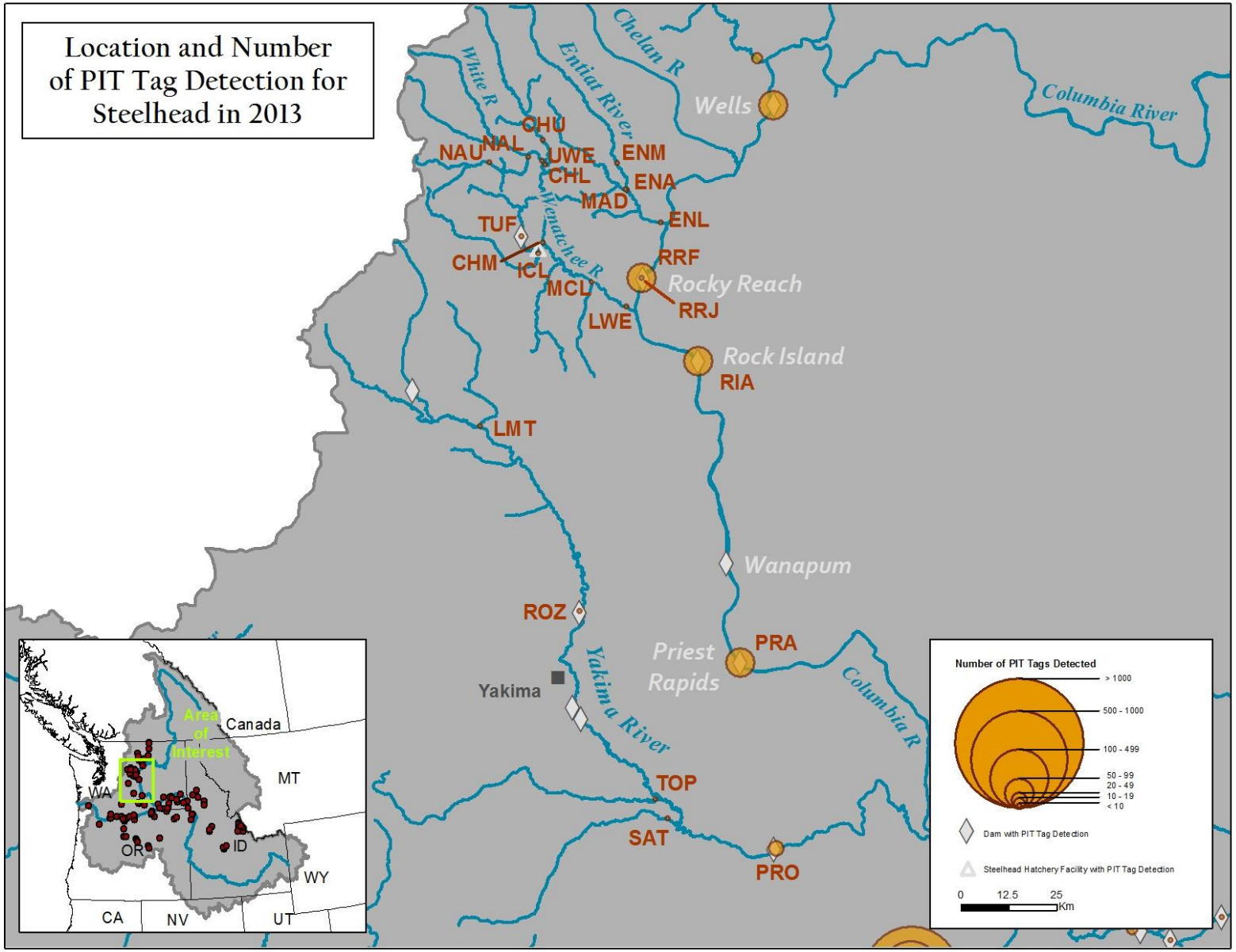

Figure A16. Map of Upper Columbia River (between the Snake River and Wells Dam) detections sites and number of steelhead detected. Table A5 in the Appendix lists the PTAGIS sites full name and the three-letter codes on this map.

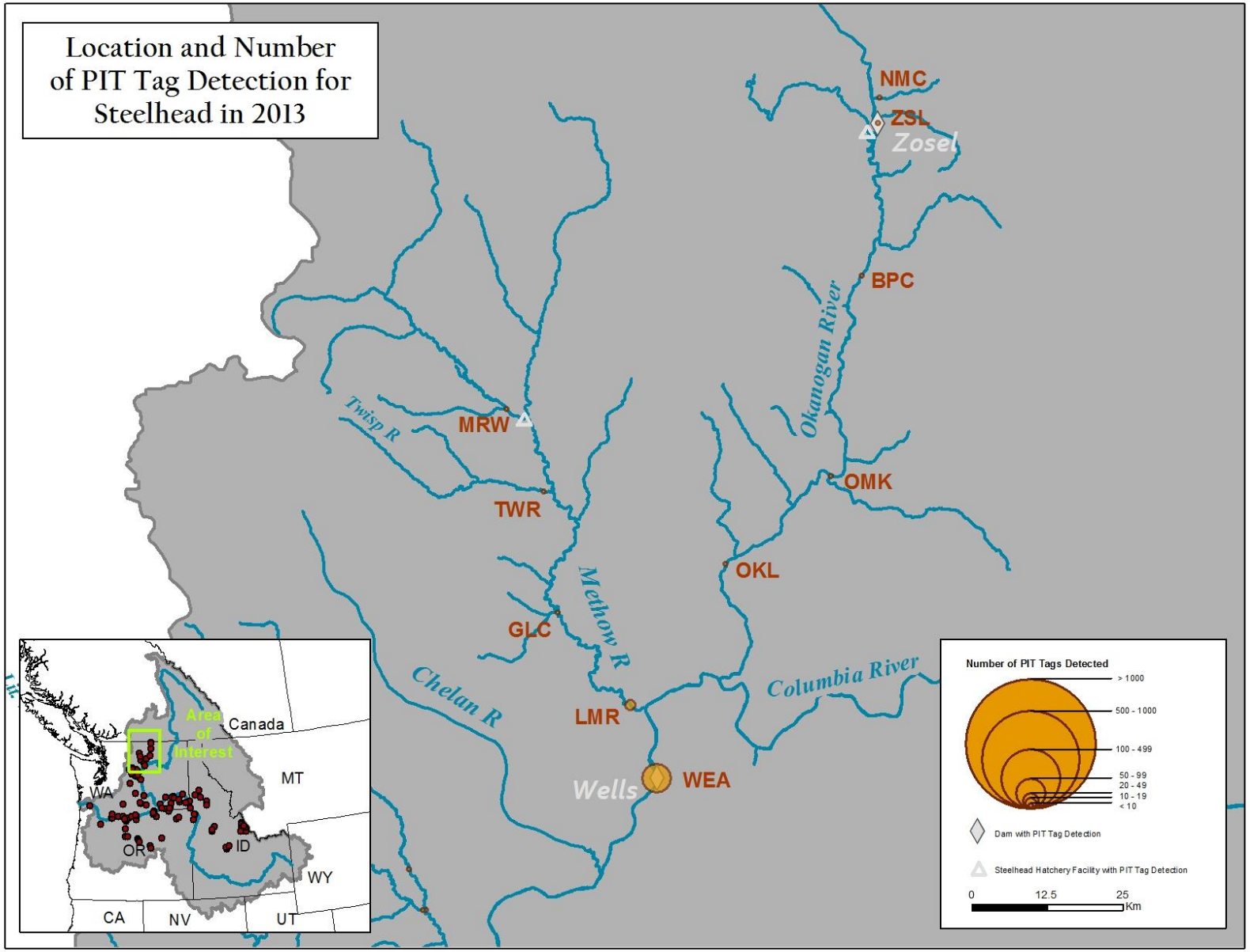

Figure A17. Map of Upper Columbia River (Wells Dam and above) detections sites and number of steelhead detected. Table A5 in the Appendix lists the PTAGIS sites full name and the three-letter codes on this map.

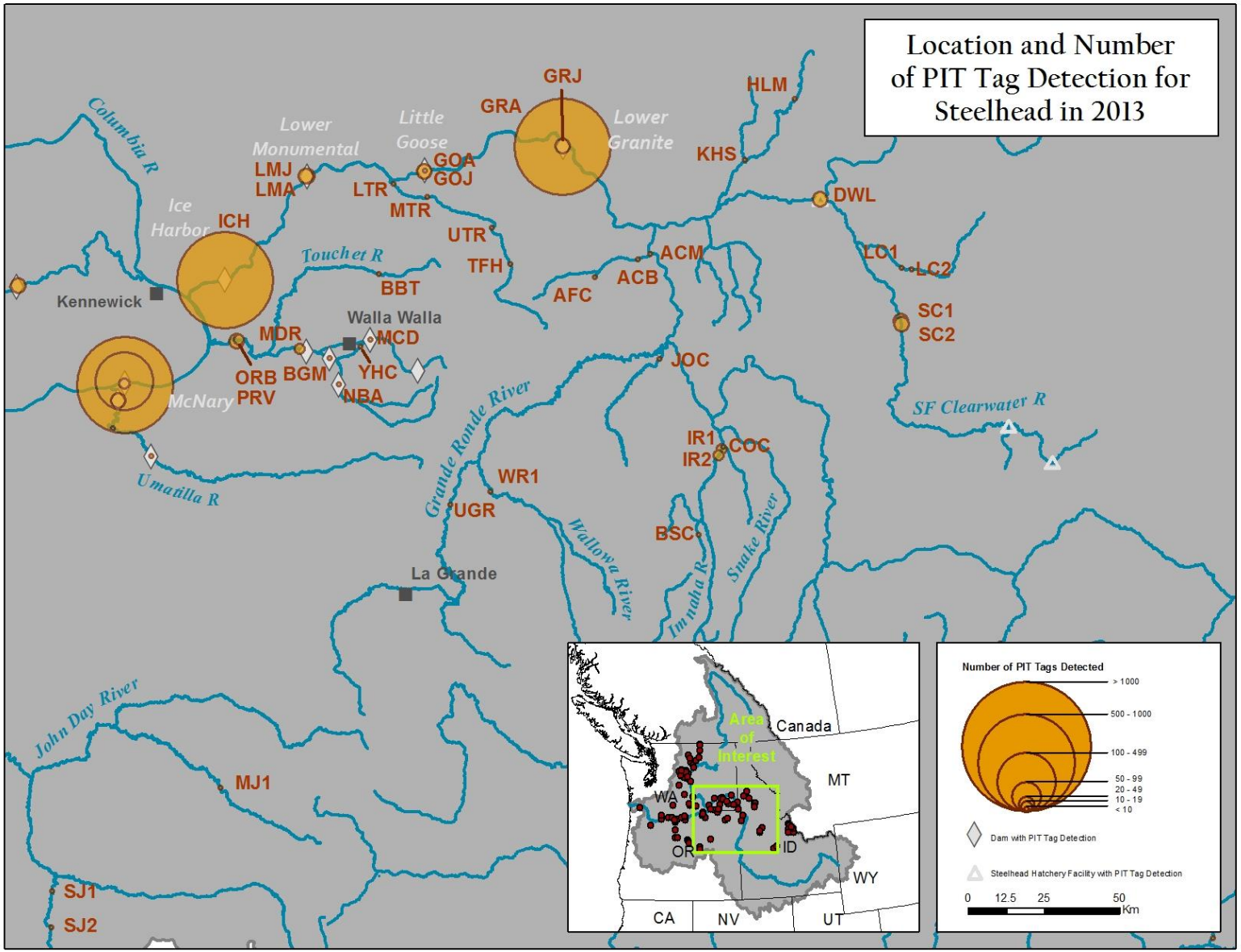

Figure A18. Map of Lower Snake River detections sites and number of steelhead detected. Table A5 in the Appendix lists the PTAGIS sites full name and the three-letter codes on this map.

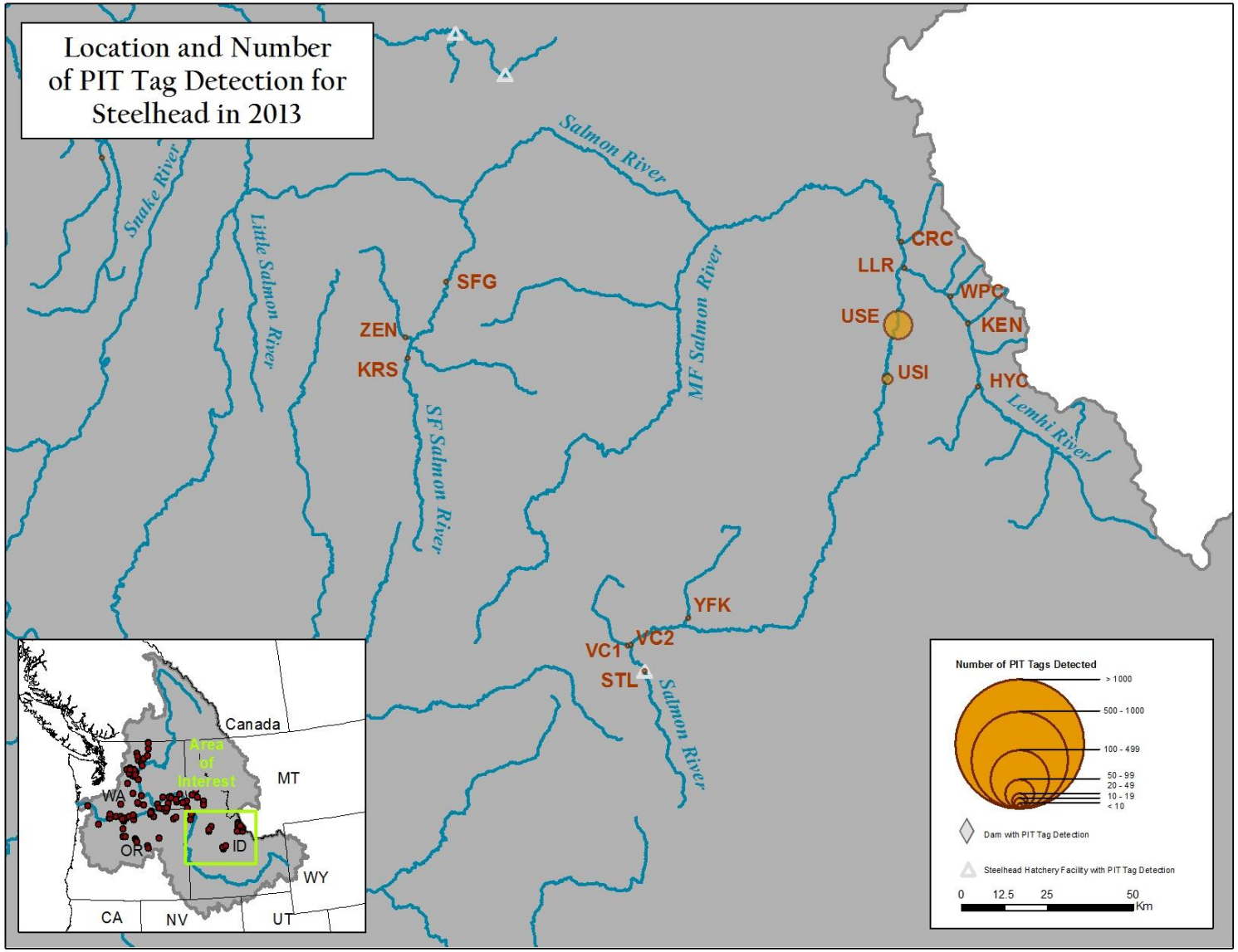

Figure A19. Map of Salmon River detections sites and number of steelhead detected. Table A5 in the Appendix lists the PTAGIS sites full name and the three-letter codes on this map.