Monitoring the Migrations of Wild Snake River Spring/Summer Chinook Salmon Juveniles, 2009-2010

Stephen Achord, Benjamin P. Sandford, Eric E. Hockersmith, Matthew G. Nesbit, Nathan D. Dumdei, Jesse J. Lamb, Kenneth W. McIntyre, Neil N. Paasch, Steven G. Smith, and Richard W. Zabel

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Fish Ecology Division
Northwest Fisheries Science Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
2725 Montlake Boulevard East
Seattle, Washington 98112-2097

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EXECUTIVE SUMMARY

This report provides results from an ongoing project to monitor the migration behavior and survival of wild juvenile spring/summer Chinook salmon in the Snake River Basin. Data reported are from detections of PIT-tagged fish from late summer 2009 to mid-2010. In summer 2009, the National Marine Fisheries Service (NMFS) tagged fish in Idaho streams and the Oregon Department of Fish and Wildlife (ODFW) tagged fish in Oregon streams. Our analyses include migration behavior and estimated survival of fish at instream PIT-tag monitors and arrival timing and estimated survival to Lower Granite Dam. Principal results from tagging and interrogation during 2009-2010 are listed below:

1) In July and August 2009, we PIT tagged and released 15,347 wild Chinook salmon parr in 16 Idaho streams or sample areas.

2) Overall observed mortality from collection, handling, tagging, and after a 24-h holding period was 1.9%.

3) **Valley Creek—**Of the 2,516 Chinook salmon parr PIT tagged and released in Valley Creek in summer 2009, 463 (18.4%) were detected at two instream PIT-tag monitoring systems in lower Valley Creek from late summer 2009 to spring 2010. Of these 463 detected fish, 74.7% were detected in late summer/fall, 21.8% in winter, and 3.5% in spring. Estimated parr-to-smolt survival to Lower Granite Dam was 7.3% for the late summer/fall group, 15.7% for the winter group, and 11.5% for the spring group. Based on detections at downstream dams, the overall detection efficiency of Valley Creek upper (VC1) or lower (VC2) monitors was 37.7%. Using this efficiency rate, we estimated that 48.8% of all summer-tagged parr survived to pass the Valley Creek monitors, and their survival from the downstream monitors to Lower Granite Dam was 9.3%. Overall estimated parr-to-smolt survival to the dam for all summer-tagged parr from this stream was 5.0%.

4) **Big Creek—**Of the 1,107 Chinook salmon parr PIT tagged and released in upper Big Creek in summer 2009, 45 (4.1%) were detected at two instream PIT-tag monitoring systems in lower Big Creek from late summer 2009 to spring 2010. Of these 45 fish, 75.6% were detected in late summer/fall, 13.3% in winter, and 11.1% in spring. Estimated parr-to-smolt survival to Lower Granite Dam for each of these groups was 87.2% for the late summer/fall group, 67.5% for the winter group, and 36.8% for the spring group. Based on detections at downstream dams, the overall detection efficiency of Big Creek upper (A) or lower (B) monitors was 11.9%. Using this efficiency rate, we estimated that 34.1% of all summer-tagged parr from upper Big Creek survived to pass the monitors on lower Big Creek, and their

survival from the downstream monitors to Lower Granite Dam was 79.0%. Overall estimated parr-to-smolt survival for all summer-tagged parr from this stream (area) to the dam was 17.9%.

Of the 1,435 Chinook salmon parr PIT tagged and released in lower Big Creek in summer 2009, 196 (13.7%) were detected at the two instream PIT-tag monitoring systems in lower Big Creek from late summer 2009 to spring 2010. Of these 196 fish, 71.4% were detected in late summer/fall, 25.5% in winter, and 3.1% in spring. Estimated parr-to-smolt survival to Lower Granite Dam for each of these groups was 27.8% for the late summer/fall group and 57.8% for the winter group. No fish from the spring group were detected at the dam. Based on detections at downstream dams, the overall detection efficiency of Big Creek upper (A) or lower (B) monitors was 15.6%. Using this efficiency rate, we estimated that 87.8% of all summer-tagged parr survived to the lower Big Creek monitors and that their estimated survival from that point to Lower Granite Dam was 34.6%. Overall estimated parr-to-smolt survival for all summer-tagged parr from this stream (area) at the dam was 25.5%.

Increasing the number of fish tagged and/or the number of antennas should provide better precision for these survival estimates in the future. Development and maintenance of the instream PIT-tag monitoring systems for both Valley and Big Creeks was turned over to the Integrated Status and Effectiveness Monitoring Program (ISEMP) project in 2010.

5) **Secesh River—**Of the 903 Chinook salmon parr PIT tagged and released in the Secesh River and Lake Creek in summer 2009, 146 (16.2%) were detected at the instream PIT-tag monitoring system in the lower Secesh River (near Zena Creek) from late summer 2009 to spring 2010. Only 6 of these fish were subsequently detected at Lower Granite Dam; therefore, no survival estimates were calculated.

6) **South Fork of the Salmon River—**Of the 1,001 Chinook salmon parr PIT tagged and released in upper South Fork of the Salmon River in summer 2009, 251 (25.1%) were detected at the instream PIT-tag monitoring system in the South Fork Salmon River near Krassel Creek from late summer 2009 to spring 2010. Estimated survival from release to the monitors near Krassel Creek was 47.7%. Of fish detected on these monitors, 62.2% were detected in late summer/fall, 21.9% in winter, and 15.9% in spring. Estimated parr-to-smolt survival to Lower Granite Dam for each of these groups was 45.1% for the late summer/fall group, 53.8% for the winter group, and 61.3% for the spring group. Estimated survival to Lower Granite Dam for all summer-tagged parr detected at the Krassel Creek monitoring site was 49.8%. Overall estimated parr-to-smolt survival for all summer-tagged parr from this stream at the dam was 21.5%.

Only 10 fish were detected from the Secesh and South Fork Salmon Rivers and Lake Creek at the lower South Fork Salmon River instream PIT-tag monitoring site at Guard Station Road Bridge. These three monitoring sites were developed by the Integrated Status and Effectiveness Monitoring Program.

7) At Little Goose Dam in 2010, length and/or weight were measured for 468 recaptured fish from 16 Idaho stream populations. Fish had grown an average of 46.1 mm in length and 8.9 g in weight over an average of 286 days. Their mean condition factor declined from 1.29 at release (parr) to 0.98 at recapture (smolt).

8) Mean length at release was significantly greater for fish detected than for fish not detected the following spring and summer ($P < 0.0001$).

9) Fish that arrived at Lower Granite Dam in April and May were significantly larger (FL) at release than fish arriving after May ($P < 0.03$), although only 44 fish migrated after May.

10) In 2010, peak detections at Lower Granite Dam of parr tagged during the summer in 2009 (from the 16 stream populations in Idaho and 4 streams in Oregon) occurred during low flows of 59.1 kcfs on 30 April. Respective dates of the 10th, 50th, and 90th passage percentiles were 26 April, 9 May, and 29 May.

11) In 2009-2010, estimated parr-to-smolt survival to Lower Granite Dam for Idaho and Oregon streams combined averaged 15.5% (range 5.0-32.4% depending on stream of origin). For fish from Idaho streams, average estimated parr-to-smolt survival was 16.8%.

In 2010, we observed low flows throughout the spring migration season, with the highest flows later in the season (June) accompanied by weather that was cooler and wetter than normal in the Snake River basin. Clearly, complex interrelationships of several factors drive the annual migrational timing of these stocks.

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INTRODUCTION

This report provides information on wild Chinook salmon parr that we PIT tagged in Idaho in 2009 and subsequently monitored, along with PIT tagged fish from Oregon. We report estimated survival and timing of these Chinook salmon juveniles to Lower Granite Dam as well as interrogation data at several other sites throughout the Snake and Columbia River system. This research continues studies that began under Bonneville Power Administration (BPA) funding in 1991. Results from previous study years were reported by Achord et al. (1994-1995a,b; 1996a; 1997-1998; 2000-2001a,b; 2002-2010). The goals of this ongoing study are to:

1) Characterize the migration timing and estimate parr-to-smolt survival of different populations of wild Snake River spring/summer Chinook salmon at Lower Granite Dam
2) Determine whether consistent migration patterns are apparent
3) Determine which environmental factors influence these patterns
4) Characterize the migrational behavior and estimate survival of different wild juvenile fish populations as they migrate from their natal rearing areas

This study provides critical information for recovery planning, and ultimately recovery for these wild fish populations, which are listed as threatened under the U.S. Endangered Species Act.

During 2009-2010, we collected water temperature, dissolved oxygen, specific conductance, turbidity, water depth, and pH data at six monitoring stations, in the Salmon River Basin, Idaho, for the Baseline Environmental Monitoring Program. In addition, we measured hourly water temperature and depth parameters in 10 additional streams. These environmental data can be compared with parr/smolt migration, survival, and timing data to discern patterns or characteristic relationships that may exist and that may help in recovery planning for threatened populations.

METHODS

Fish Collection and Tagging

The Oregon Department of Fish and Wildlife (ODFW) PIT tagged wild Chinook salmon parr in the Grande Ronde and Imnaha River drainages in northeast Oregon in 2009. All tagging, detection, and timing information for fish from these streams in 2009-2010 will be reported by ODFW. However, with ODFW's concurrence, we report here the timing and overall estimated survival to Lower Granite Dam of fish tagged in summer from these Oregon streams.

National Marine Fisheries Service (NMFS) personnel tagged fish in Idaho streams during 2009 (Figure 1). Fish were collected and tagged using safe handling methods developed for this study; these methods are detailed in Matthews et al. (1990; 1997) and in previous reports from this study (Achord et al. 1994; 1995a; b; 2003; 2004; 2010).

Instream PIT-Tag Monitors

Until recently, opportunities to monitor the migration of PIT-tagged wild juvenile fish were limited to instream or inriver traps, the juvenile fish bypass systems at dams, and a PIT-tag detection trawl system operated in the upper Columbia River estuary. In an effort to detect fish closer to their natal rearing sites, we began development of instream PIT-tag monitoring systems. We placed the first instream detection systems at two sites in Valley Creek during 2002, and development and improvement of these systems has continued since then. More recent development of these systems is discussed below; further detail can be found in Achord et al. (2004; 2005; 2009; 2010). Briefly, both systems were set up to automatically interrogate, store, and transmit data to the Columbia River PIT-Tag Information System (PTAGIS), a regional shared database operated by the Pacific States Marine Fisheries Commission (PSMFC 1996).

In summer 2007, NMFS transitioned from using the 12-mm TX1411ST PIT tag to the new 12-mm TX1411SST tag. The main reason for this change was the extended detection range (maximum about 43 cm) of the SST tag compared to the ST tag (maximum range about 20 cm). From 1 August 2007 through the first week of September 2007, a single instream antenna was operated at each Valley Creek site. Starting the second week of September 2007, multiplex transceivers were installed, allowing two antennas to operate at each Valley Creek site.

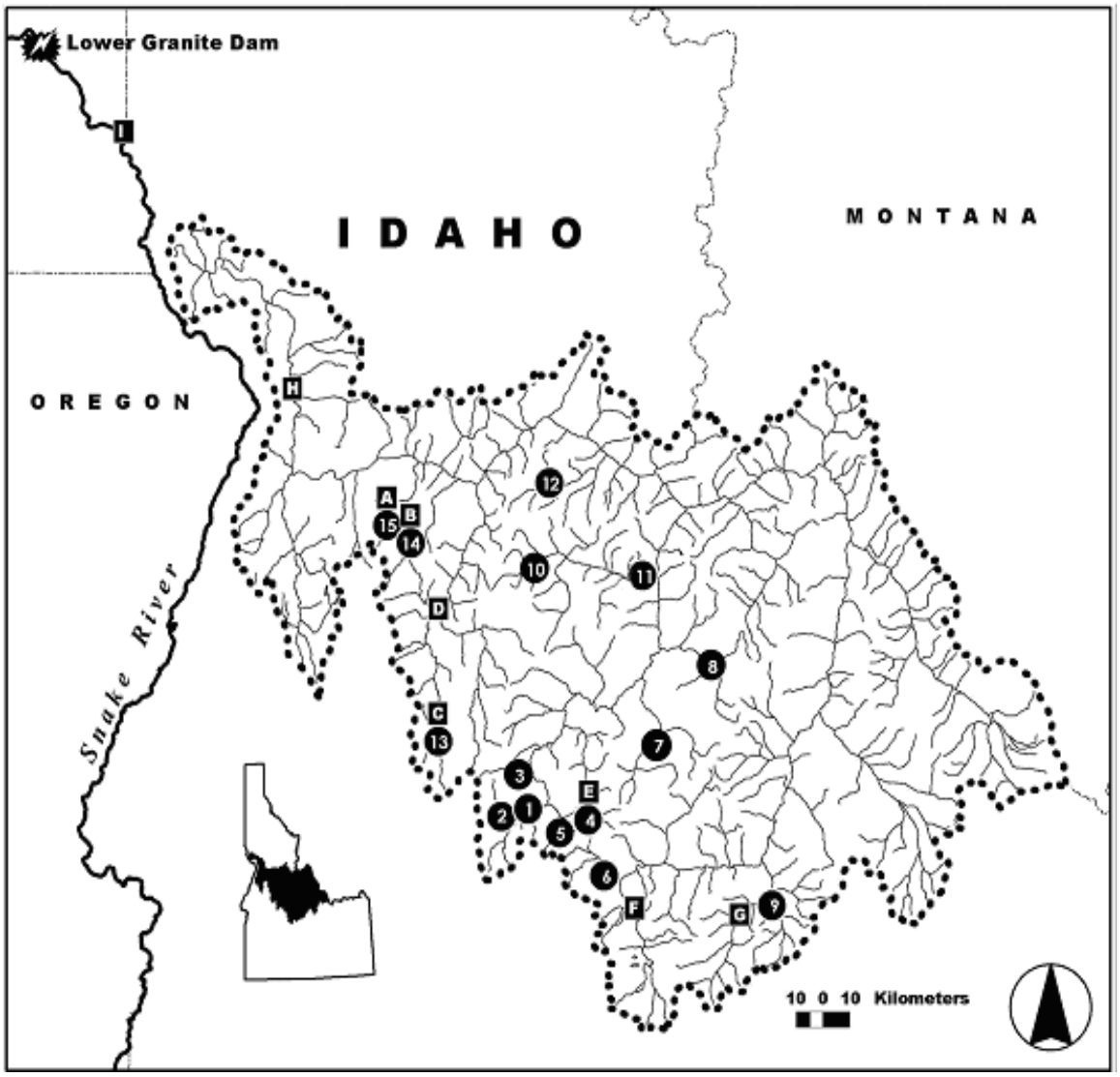

Figure 1. Wild spring/summer Chinook salmon parr were PIT tagged during 2009 in the following streams or sample areas:

1-Bear Valley Creek
2-Elk Creek
3-Sulphur Creek
4-Marsh Creek
5-Cape Horn Creek
6-Valley Creek
7-Loon Creek
8-Camas Creek
9-Herd Creek
10-Big Creek (upper)
11-Big Creek (lower) and Trap
12-Chamberlain and WF Chamberlain Cr
13-South Fork Salmon River
14-Secesh River
15-Lake Creek

Juvenile migrant fish traps shown above are as follows:

A-Lake Creek Trap
B-Secesh River Trap
C-South Fork Salmon River Trap
D-Lower Secesh River Trap
E-Marsh Creek Trap
F-Sawtooth Trap
G-East Fork Salmon River Trap
H-Salmon River Trap
I-Snake River Trap

These antennas were constructed of 12.7-mm polyethylene (60-cm base × 3-m long × 17-cm high) and placed end-to-end (with a gap in-between). One of the antennas at the upstream Valley Creek site failed after about 2 months of operation and was not replaced until mid-2008. In addition, as development of this system continued throughout 2007-2008; the monitoring systems operated intermittently.

In summer 2008, four specially designed rectangular antennas were staked to the substrate with duck-billed anchors at the upper Valley Creek monitoring site (VC1). The new antennas were constructed from 10.2-cm (4 inch) diameter schedule-80 PVC pipe. Each antenna was rectangular (3 m long × 0.8 m wide) with two supporting cross-members. Two of these antennas were also installed at the lower Valley Creek monitoring site (VC2) for a total of three antennas (two new antennas placed end-to-end and one 60-cm-wide antenna placed 2 m below them). Both monitoring systems operated throughout the 2008-2009 and 2009-2010 monitoring periods with few problems.

With the development of PVC-pipe antennas and the new anchoring systems, we decided to install three of these rectangular antennas at Big Creek. Upper (A) and lower (B) monitoring systems were installed at lower Big Creek in summer 2008, and remained in place through spring. An additional antenna was installed at the lower monitoring site. The three PVC-pipe antennas installed at this site were washed out during high flows in mid-May 2009, and the remaining antenna flooded at this site about the same time. However, the duck-billed anchors held, and we discovered that stronger straps were needed for attaching antennas to the stakes. All three lost antennas were recovered intact. Despite these problems, both systems operated well through mid-spring 2009. These systems also operated well from late summer 2009 to late spring 2010, when the cables became dislodged from antennas at both sites.

In 2009-2010, we began monitoring summer-tagged wild fish at three monitoring sites in the South Fork of the Salmon River drainage developed by the Integrated Status and Effectiveness Monitoring Program (ISEMP project 2003-017-00). These sites were in the lower Secesh River near Zena Creek Ranch (rkm 5), in the lower South Fork Salmon River at Guard Station Road Bridge (rkm 30), and in the South Fork Salmon River near Krassel Creek (rkm 65). These three sites monitored tagged fish from the Secesh and South Fork Salmon Rivers and Lake Creek.

Detection data from wild PIT-tagged Chinook salmon juveniles were collected from five instream detection system sites: Valley Creek, Big Creek, South Fork Salmon River (Krassel), lower South Fork Salmon River (Guard Station Road Bridge), and lower Secesh River from late July 2009 through June 2010.

Juvenile Migrant Traps

Some fish PIT tagged as parr in natal rearing areas were subsequently collected at migrant traps (Figure 1). During fall 2009 and spring 2010, juvenile migrant fish traps were operated at Knox Bridge on the South Fork of the Salmon River, South Fork Salmon River below the mouth of the Secesh River, on Lake Creek, on the Secesh River near Chinook Campground and near the stream mouth, on Marsh Creek, in lower Big Creek at Taylor Ranch, and near the Sawtooth Hatchery on the upper Salmon River.

Also during spring 2010, juvenile migrant fish traps were operated in Idaho on the lower Salmon River near Whitebird and on the Snake River at Lewiston. Traps were operated by the Nez Perce Tribe and the Idaho Department of Fish and Game (IDFG). Generally, fish at these traps were anesthetized, scanned for PIT tags, and then measured for length and weight. Some of these fish were also PIT tagged at the traps. Upon recovery from the anesthetic, all fish were released back to the streams or rivers.

Recaptures at Dams

Since 2001, we have recaptured our study fish at Little Goose Dam to collect information on growth during the parr-to-smolt stage. Recapture is accomplished by programming the PIT-tag separation-by-code (SbyC) system to divert wild tagged fish from the population passing Little Goose Dam (Downing et al. 2001).

In 2010, we continued this effort, and the SbyC system was programmed to separate up to a maximum of 100 wild fish from each stream. All recaptured fish were handled using water-to-water transfers and other best handling practices. After handling, all tagged and untagged fish were returned to the river via the bypass system.

In addition to length (mm) and weight (g) measurements on these wild smolts at Little Goose Dam, a Fulton-type condition factor (CF) was calculated as:

$$CF = \frac{\text{weight (g)}}{\text{length (mm)}^3} \times 10^5$$

Condition factor was calculated for these fish both at release (using release data associated with the PIT tag code) and recapture.

Interrogation Systems at Snake and Lower Columbia River Dams

During spring and summer 2010, wild Chinook salmon smolts that had been PIT-tagged as parr in 2009 began volitional migration downstream. Of the eight dams encountered by these smolts on the lower Snake and Columbia Rivers, seven were equipped with smolt collection and/or PIT-tag interrogation systems. These were Lower Granite, Little Goose, Lower Monumental, and Ice Harbor Dam on the Snake River, and McNary, John Day, and Bonneville Dam on the Columbia River.

At these seven dams, all smolts guided from turbine intakes into juvenile bypass systems were electronically monitored for PIT tags by interrogation systems similar to those described by Prentice et al. (1990). Dates and times to the nearest second were automatically recorded as PIT-tagged fish passed each detector. Detection data were transferred to PTAGIS, a regional database, at designated intervals each day. Tagged fish were also monitored using a surface pair-trawl fitted with a PIT-tag detection antenna and operated in the upper Columbia River estuary ~150 km downstream from Bonneville Dam (Ledgerwood et al. 2004).

Data Analyses

Probability Estimates of Detection and Survival

For the PIT-tagged release groups from each stream population, we estimated survival probabilities from release as parr to arrival at Lower Granite Dam as smolts as well as detection probabilities at the dam. For streams with instream monitors, this migration corridor was divided into two smaller segments: 1) a stream segment, which spanned from the point of release to the lower instream monitor, and 2) a river segment, which spanned from the lower instream monitor to the dam.

Stream segment—For estimates of parr-to-smolt survival in each stream segment, we constructed a detection history for each fish that included detection or non-detection at 1) one or both of the upper and lower instream monitors and/or 2) any downstream dam. This produced four possible detection histories. Counts of fish with each detection history were fitted to a multinomial model, with cell probabilities parameterized as functions of detection and survival probability. The model was the Cormack-Jolly-Seber (CJS) single-release model with multiple recapture (Cormack 1964; Jolly 1965; Seber 1965). The CJS model is used extensively for estimates of survival of PIT-tagged fish in the Columbia River basin.

Because there were two monitor sites at the Valley Creek and Lower Big Creek locations, it would have been possible to use information from just those sites to estimate detection and survival probabilities using a method similar to that described by Connolly et al. (2008). However, evidence from past detection data showed that detection at an upper instream monitor was not independent of detection at a lower monitor, violating a critical assumption required by the CJS model. An additional untestable assumption of 100% survival between the upper and lower instream monitors would have allowed us to model the dependency between these detection probabilities; however, sample size in many cases was not sufficient to obtain useful estimates from this model. Therefore, we chose the CJS method described above.

***River segment*—**For the river segment, we estimated survival from release to Lower Granite Dam for all streams. For streams with instream monitors, we also estimated survival from the lower instream monitor to Lower Granite Dam Through the use of auxiliary data (see below), we estimated separate probabilities of survival for each stream overall or each of the three periods when fish were detected by instream monitors: late summer and fall (August-October), winter (November-February), and spring (March-June). For instream monitor estimates, we first grouped detected fish by seasonal period of instream detection. Then, for each cohort (overall release or instream seasonal groups), we compiled a temporal distribution of detections at Lower Granite Dam (i.e., a daily count at the dam of the number of fish from each seasonal period detected at the dam on each day).

Each daily count at the dam was then divided by the estimated probability of detection at Lower Granite Dam on that day (see below) to derive an estimate of the total number of fish from each cohort that passed Lower Granite Dam on that day. Daily passage estimates were then summed to give an estimate of the total number of fish from each cohort that survived to Lower Granite Dam. For each stream, this total was divided by the total number of fish released in that stream to derive an estimate of survival to Lower Granite Dam. For streams with monitors, the total that were detected at the upper and lower instream monitors during each seasonal period and survived to Lower Granite was also divided by the total number detected at the monitors during each seasonal period to derive estimates of survival to Lower Granite Dam by season. For streams with monitors, we also estimated an overall parr-to-smolt survival rate to Lower Granite Dam by calculating the weighted average of the three seasonal survival estimates, where each season was weighted according to the proportion of total detections that occurred during that season.

Daily detection probabilities at Lower Granite Dam were estimated as shown in the steps below using auxiliary data with the method of Schaefer (1951) modified by Sandford and Smith (2002). The auxiliary data were for all wild Chinook salmon tagged and released in the Snake River Basin upstream from the dam. For each day of the migration season, we estimated numbers of all wild Chinook salmon PIT-tagged and released upstream from Lower Granite Dam that passed the dam detected or undetected. Thus a series of daily probabilities of detection was developed as follows:

1) Fish detected on day *i* at Little Goose Dam that had previously been detected at Lower Granite Dam were tabulated according to day of passage at Lower Granite Dam.
2) Fish detected on day *i* at Little Goose Dam that had *not* previously been detected at Lower Granite Dam were assigned to an estimated day of passage at Lower Granite Dam, assuming that their passage distribution at Lower Granite Dam was proportionate to that of detected fish.
3) This process was repeated for all days with detections at Little Goose Dam.
4) Detected and non-detected fish passing Lower Granite Dam on day *i* were summed.
5) Detection probability on day *i* was estimated by dividing the number of fish detected at Lower Granite Dam on day *i* by the sum of detected and (estimated) non-detected fish passing that day.

We modified the method slightly (see Sandford and Smith 2002) for estimates in the tails of the passage distribution where the above process was not applicable (e.g., for days when no detections occurred at Little Goose Dam).

Bootstrap methods were used to derive standard errors for the estimated probability of survival for each stream from both release and instream monitors to Lower Granite Dam (Achord et al. 2007b). Auxiliary data were used to derive bootstrap distributions of daily detection probability estimates. Lower Granite Dam detection data for each release or instream monitor group were used for bootstrap distributions of passage at Lower Granite Dam.

Migration Timing

For each stream, we monitored within-season migration timing at Lower Granite Dam based on daily detection numbers at the dam of all wild PIT-tagged Chinook smolts. Streams where wild parr were tagged for this study varied in temperature, elevation, mean flow, and population size. Therefore, to compare arrival timing at Lower Granite Dam between streams, we used an approach analogous to analysis of variance with multiple comparisons.

First, detections at Lower Granite Dam were expanded (i.e., weighted) by dividing daily detection totals by the daily detection probability estimates obtained above. Next, migration timing statistics (i.e., passage dates of the 10th, median, and 90th percentiles of the tagged population from each stream) were calculated based on these expanded detections. The bootstrap method of Efron and Tibshirani (1993) was used to calculate estimates of standard errors (SEs) for each migration timing statistic. Then, a "representative" estimate of variance for each statistic was calculated as the median of the SEs for fish from all 18 stream populations. This method assumed that the timing of passage percentiles had similar distributions among streams. The Student-Newman-Keuls (SNK) multiple comparison method was used to compare each statistic between streams ($\alpha = 0.05$; Petersen 1985).

We also examined arrival timing at Lower Granite Dam of individual populations over a period of years to determine similarities or differences between years and between populations. Comparisons of the 10th, 50th, and 90th percentile passage dates were made among 19 streams or sample areas using a two-factor analysis of variance (ANOVA). Year was considered a random factor and stream a fixed factor. Residuals were visually examined to assess normality. Treatment means were compared using Fisher's least significant difference procedure (Peterson 1985), with $\alpha = 0.05$.

Environmental Information

In 2009-2010, we also collected hourly measurements of water temperature (°C), dissolved oxygen (ppm), specific conductance (µS/cm), turbidity (ntu), water depth (ft), and pH from the following six locations: Marsh Creek, Valley Creek, Sawtooth Hatchery in the upper Salmon River, South Fork of the Salmon River (Knox Bridge), Secesh River, and Big Creek (lower) at Taylor Ranch. All environmental monitoring systems except the system at Valley Creek were close to juvenile migrant fish traps. The water quality monitor at Valley Creek was located near our instream PIT-tag monitoring system (VC2). In 2009-2010, we also collected hourly water temperatures and depths in Bear Valley/Elk Creek and in Sulphur, Chamberlain, West Fork Chamberlain, upper Big, Cape Horn, Herd, Loon, Camas, and Lake Creeks.

RESULTS

Fish Collection and Tagging

From 21 July to 22 August 2009, we collected 20,202 wild Chinook salmon parr from 16 Idaho stream populations (Figure 1). These populations were sampled over a distance of about 44.5 stream km and an area of approximately 422,433 m^2 (Table 1; Appendix Table 1). Of the fish collected, 15,347 were PIT tagged and released back into the streams along with the remaining untagged live fish. Collected fish were rejected for tagging if they had been previously tagged, were too small or injured, had matured precociously, or if sufficient numbers of fish had already been tagged. Numbers of tagged fish released per stream or sample area ranged from 142 in Lake Creek to 2,516 in Valley Creek (Table 1; Appendix Tables 1-2a).

In 2009, the mean fork length of all Chinook salmon parr collected was 62.3 mm and the mean weight was 3.5 g. The mean fork length of Chinook salmon parr that were tagged and released was 64.6 mm, and the mean weight was 3.8 g (Table 1; Appendix Table 1). Collection areas within streams were further delineated by recording Global Positioning System coordinates using Universal Transverse Mercator grid (Appendix Table 2b).

Other than Chinook salmon parr, sculpin was the most abundant fish observed during collection operations (Table 2). However, records of non-target fish do not represent their total abundances in the collection areas, as we targeted Chinook salmon for collection, not other coincident species.

Mortality associated with collection and tagging procedures was low (Table 3; Appendix Table 3). Overall, collection mortality was 1.8%, tagging and 24-h delayed mortality was 0.05%, and observed mortality was 1.9%. In addition, three lost tags (0.02%) were observed during field work in 2009.

Table 1. Summary of collection, PIT tagging, and release of wild Chinook salmon parr with average fork lengths and weights (includes recaptured tagged fish), approximate distances, and estimated areas sampled in streams of Idaho during July and August 2009.

	Collection			Tagging and release			Collection area to stream mouth (km)	Est. area sampled (m^2)
Tagging location	N	Mean length	Mean weight	N	Mean length	Mean weight		
Bear Valley Creek	1,184	62.4	3.3	1,028	62.7	3.3	9-9.4 & 13.4-14	21,835
Elk Creek	1,121	64.2	3.6	1,004	64.3	3.4	0-5	28,358
Marsh Creek	1,313	62.0	4.0	1,002	64.3	3.7	11.5-15.5	28,420
Cape Horn Creek	1,228	57.0	3.6	676	60.5	3.1	0-4.5	30,241
Sulphur Creek	1,046	69.8	5.1	1,006	69.4	4.9	5-9	37,489
Valley Creek	3,662	60.4	2.8	2,516	63.0	3.1	5, 8, & 12	49,382
Loon Creek	816	63.6	3.7	741	64.4	3.8	29-32	22,198
Camas Creek	600	64.0	3.9	532	65.1	4.1	20-22	16,698
Big Creek (upper)	1,701	59.3	3.2	1,107	62.2	3.1	57-60	37,670
Big Creek (lower)	1,588	67.4	4.0	1,435	67.9	4.0	8-13.5	47,617
Herd Creek	1,074	67.5	5.6	1,039	67.5	5.6	1-3	15,927
West Fork Chamberlain Cr	1,248	59.2	2.8	795	64.3	3.3	1-2	1,950
Chamberlain Cr	631	62.8	3.4	562	63.9	3.7	25-26	13,731
South Fork Salmon River	1,113	67.2	4.0	1,001	67.3	4.0	117-119	24,358
Secesh River	1,464	57.2	2.7	761	64.9	3.6	25-29	36,324
Lake Creek	413	53.4	3.1	142	62.6	3.5	1-1.8	10,235
Total/mean	20,202	62.3	3.5	15,347	64.6	3.8	44.5	422,433

Table 2. Summary of species other than Chinook salmon parr observed during collection operations in Idaho in July and August 2009. Numbers of steelhead in parentheses were PIT tagged for the Idaho Department of Fish and Game.

	Incidental catch totals by stream									
Streams	Steelhead (tagged)	Unidentified fry	Brook trout	Cutthroat trout	Bull Trout	Sculpin	Dace	Sucker	Whitefish	Shiner
Bear Valley Creek	49 (0)	378	235	0	0	563	29	204	5	0
Elk Creek	62 (0)	355	631	0	2	726	14	346	95	0
Marsh Creek	72 (0)	353	180	0	1	699	0	0	48	0
Cape Horn Creek	101 (0)	98	77	0	3	1,262	0	0	2	0
Sulphur Creek	262 (0)	76	0	0	0	2,820	0	15	43	0
Valley Creek	316 (0)	1,075	257	0	4	1,293	252	63	126	3
Loon Creek	199 (0)	726	0	4	0	258	0	0	66	0
Camas Creek	124 (0)	168	0	0	2	0	0	0	16	0
Big Creek (upper)	267 (76)	471	417	0	10	2,045	0	0	0	0
Big Creek (lower)	204 (99)	1,189	0	31	1	864	390	108	48	0
Herd Creek	120 (0)	157	0	0	0	294	0	0	15	0
WF Chamberlain Cr	1 (0)	16	0	0	1	11	0	0	16	0
Chamberlain Cr	54 (0)	112	0	0	4	223	0	0	13	0
SF Salmon R	184 (92)	499	10	0	7	34	21	0	6	0
Secesh River	112 (58)	419	18	0	25	1,238	115	5	0	0
Lake Creek	11 (0)	95	33	0	20	656	0	0	0	0
Totals	2,138 (325)	6,187	1,858	35	80	12,986	821	741	499	3

Table 3. Tagging mortality rates for wild Chinook salmon parr collected and PIT tagged in Idaho in July and August 2009. There were three lost tags for the study.

	Mortality (%)		
Tagging location	Collection	Tagging and 24-h	Overall
Bear Valley Creek	2.4	0.0	2.4
Elk Creek	1.2	0	1.2
Marsh Creek	1.5	0	1.5
Cape Horn Creek	1.1	0	1.1
Sulphur Creek	1.7	0	1.7
Valley Creek	1.4	0	1.4
Loon Creek	2.3	0.3	2.6
Camas Creek	2.3	0	2.3
Big Creek (upper)	2.9	0.1	2.9
Big Creek (lower)	5.1	0.1	5.2
Herd Creek	1.9	0	1.9
West Fork Chamberlain Creek	0	0	0.0
Chamberlain Creek	0.3	0.3	0.6
South Fork Salmon River	1.0	0	1.0
Secesh River	1.3	0.3	1.4
Lake Creek	2.2	0	2.2
Mean	1.8	0.05	1.9

Detections at Instream PIT-Tag Monitors

Valley Creek

From 31 July to 3 August 2009, 2,516 wild Chinook salmon parr were collected, PIT tagged, and released in natal rearing areas 3-10 km above the upper instream monitor in lower Valley Creek (VC1; Table 1). Between 31 July 2009 and 30 June 2010, the 7 instream antennas comprising the two Valley Creek sites detected 463 of these fish at least once (Figure 2). Median downstream travel time between the upstream and downstream Valley Creek monitors was approximately 13.2 h (range 20 min-228 d) for the 75 fish detected at both sites. Of the 463 detections, 346 (74.7%) occurred during late summer/fall (Aug-Oct); 101 (21.8%) in winter (Nov-Feb); and 16 (3.5%) in spring (Mar-Jun; Figure 2).

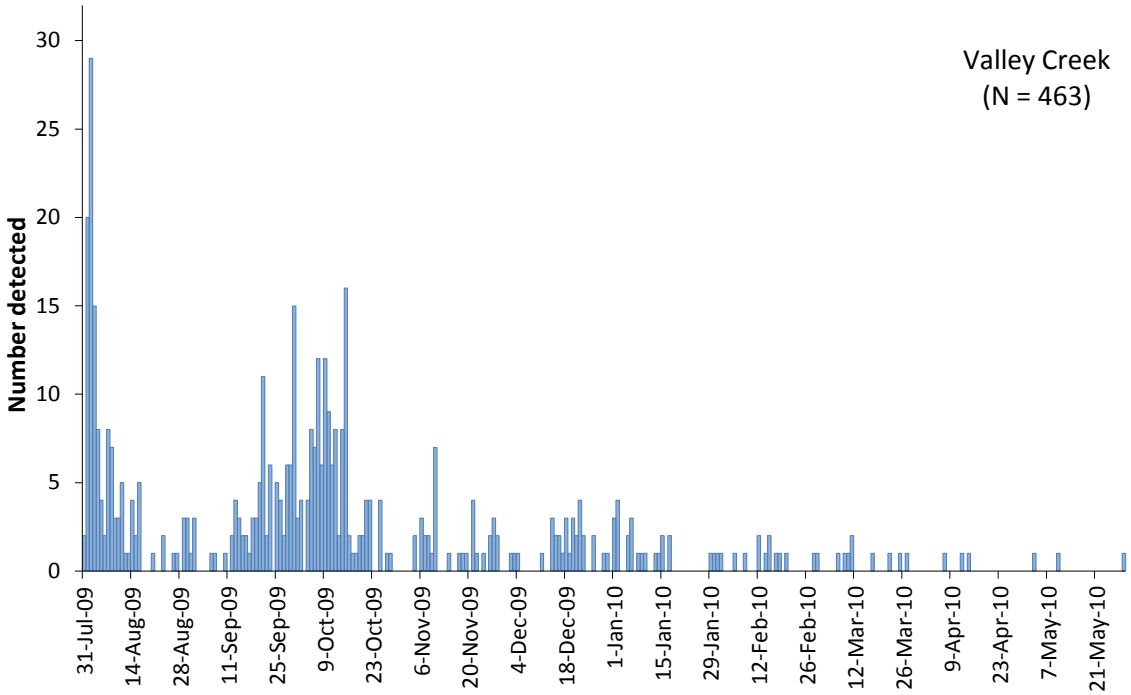

Figure 2. Detections of 463 wild spring/summer Chinook salmon parr, pre-smolts, and smolts at the upper and lower instream monitoring sites in lower Valley Creek from July 2009 through June 2010. A total of 2,516 Chinook salmon parr were PIT tagged and released in areas 3-10 km above these sites during 31 July-3 August 2009.

Based on detections at downstream dams, the overall efficiency of Valley Creek monitors in detecting these fish was 37.7%. Based on this efficiency, an estimated 48.8% (SE 5.9%; 95% CI 37-60.6%) of all summer-tagged parr survived to migrate past the Valley Creek monitors. Their survival from the Valley Creek monitors to Lower Granite Dam was 9.3% (SE 2.7%; 95% CI 4.6-15.2%). For fish detected from July 2009 to June 2010, we found a slight but significant relationship between timing of detection in lower Valley Creek and fork length at tagging ($P < 0.001$; Figure 3).

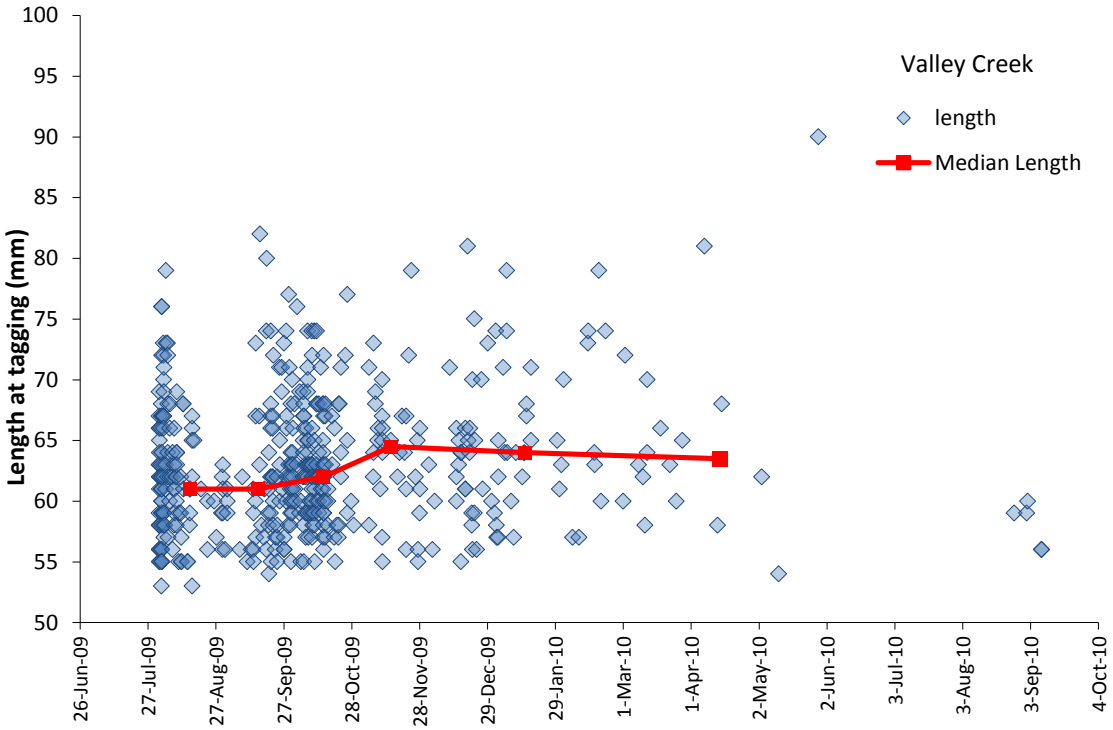

Figure 3. Fork length and median FL of 463 summer-tagged parr from migration year 2009 that were detected at both the upper and lower instream monitoring sites in lower Valley Creek, July 2009-June 2010. An additional 5 fish from migration year 2010 were detected in late summer 2010.

Lower Big Creek

From 12 to 14 August 2009, 1,435 wild Chinook salmon parr from lower Big Creek were collected, PIT tagged, and released in natal rearing areas 0-3 km above the instream PIT-tag monitors in lower Big Creek at Taylor Ranch (Table 1). Between 12 August 2009 and 30 June 2010, 196 of these fish were detected at least once on the upper and lower Taylor Ranch monitors combined (TAY-a, TAY-b; Figure 4). Of these 196 detections, 140 (71.4%) occurred in late summer/fall (Aug-Oct); 50 (25.5%) in winter (Nov-Feb); and 6 (3.1%) in spring (Mar-Jun; Figure 4).

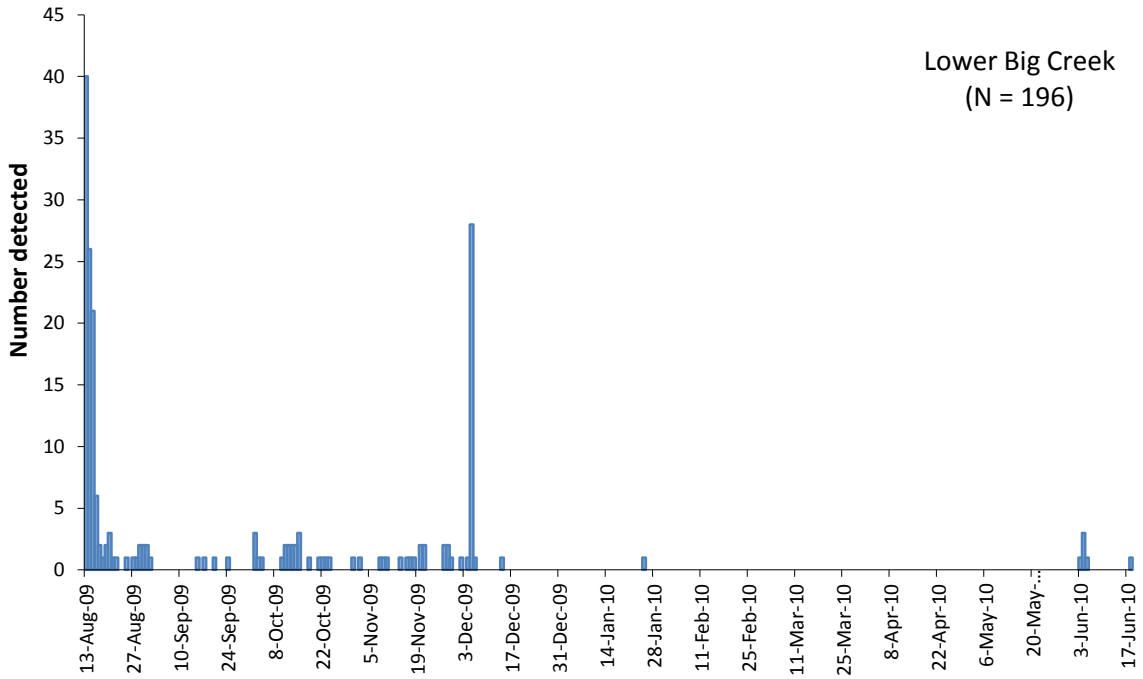

Figure 4. Detections of 196 PIT-tagged wild spring/summer Chinook salmon parr, pre-smolts, and smolts from lower Big Creek at the upper (TAY-a) and lower (TAY-b) instream PIT-tag monitoring antennas at Taylor Ranch in lower Big Creek from August 2009 through June 2010. A total of 1,435 Chinook salmon parr were PIT tagged and released in areas 0-3 km upstream from these antennas from 12 to 14 August 2009.

Based on detections at downstream dams, the overall detection efficiency of the upstream and downstream monitors at lower Big Creek was 15.6%. Using this detection efficiency rate, we estimated that 87.8% (SE 12.4%, 95% CI 63-112.6%) of all summer-tagged parr from this stream (area) survived to migrate past the monitors at lower Big Creek, and their survival from these monitors to Lower Granite Dam was 34.6% (SE 8.6%; 95% CI 19.7-53.4%). Detection data collected from August 2009 to June 2010 indicated no relationship between fork length at tagging and timing of detection in lower Big Creek (P = 0.283; Figure 5).

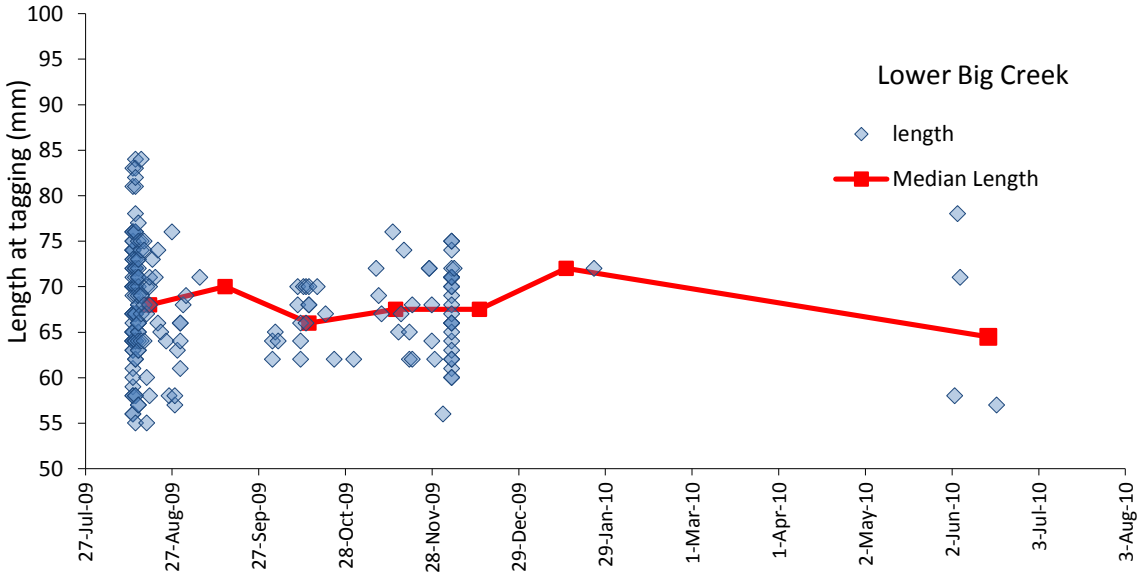

Figure 5. Length at tagging (FL) and median fork length of 196 parr from lower Big Creek. These fish were tagged summer 2009 and detected on the upper and lower instream PIT-tag monitoring antennas at Taylor Ranch, August 2009-June 2010.

Upper Big Creek

From 6 to 7 August 2009, 1,107 wild Chinook salmon parr from upper Big Creek were collected, PIT tagged, and released in natal rearing areas from 49 to 52 km above the Taylor Ranch instream monitors in lower Big Creek (Table 1). Between August 2009 and June 2010, the 7 instream antennas at upper and lower had 45 unique detections of these fish (Figure 6). Of these 45 detections, 34 (75.6%) occurred in late summer/fall; 6 (13.3%) occurred in winter; and 5 (11.1%) occurred in spring (Figure 6).

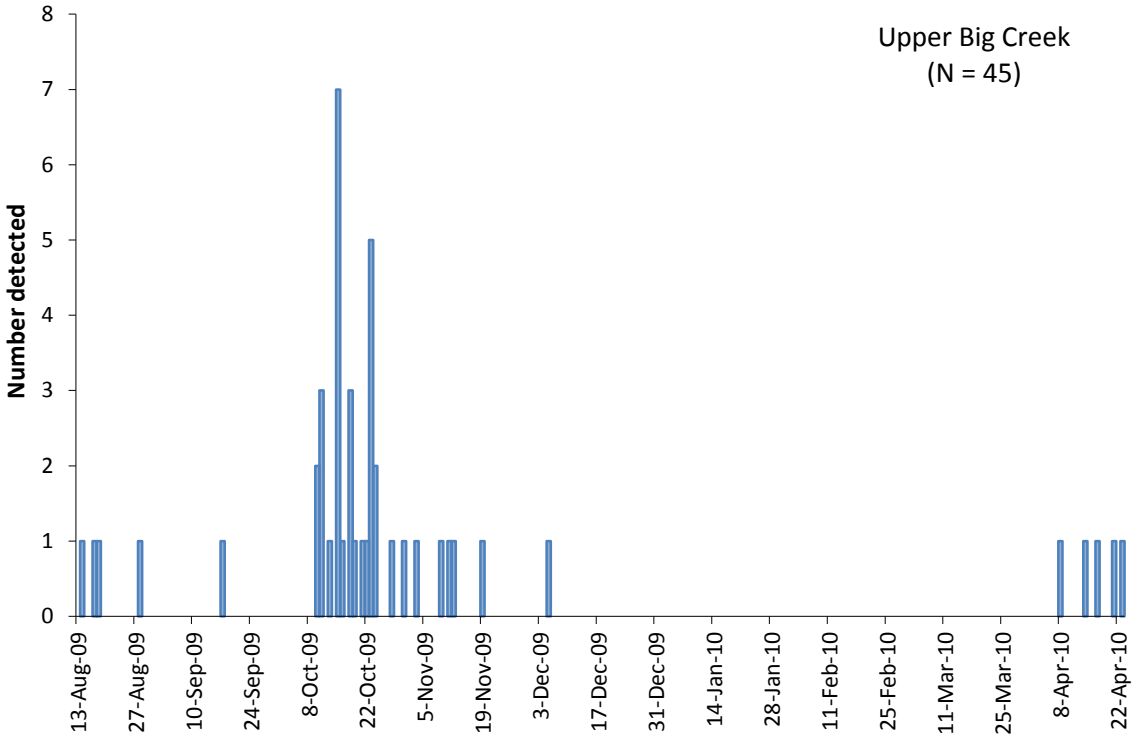

Figure 6. Detections of 45 parr, pre-smolts, and smolts from upper Big Creek at the upper (TAY-a) and lower (TAY-b) instream PIT-tag monitoring antennas in lower Big Creek, August 2009-June 2010. A total of 1,107 wild spring/summer Chinook salmon parr were PIT tagged and released in areas 49-52 km upstream from these antennas during 6-7 August 2009.

Based on detections at downstream dams, the overall efficiency of the upper or lower instream monitors at Taylor Ranch in lower Big Creek in detecting these fish was 11.9%. Based on this efficiency, an estimated 34.1% (SE 6.9%, 95% CI 20.3-48%) of all summer-tagged parr survived to migrate past the downstream monitors, and their survival from the downstream monitors to Lower Granite Dam was 79.0% (SE 26.2%, 95% CI 35.6-100%). Detection data collected from August 2009 to June 2010 indicated no relationship between fork length at tagging in upper and lower Big Creek (P = 0.283; Figures 5 and 7) and timing of detection on the upper and lower monitors (TAY-a and TAY-b, respectively) at Taylor Ranch.

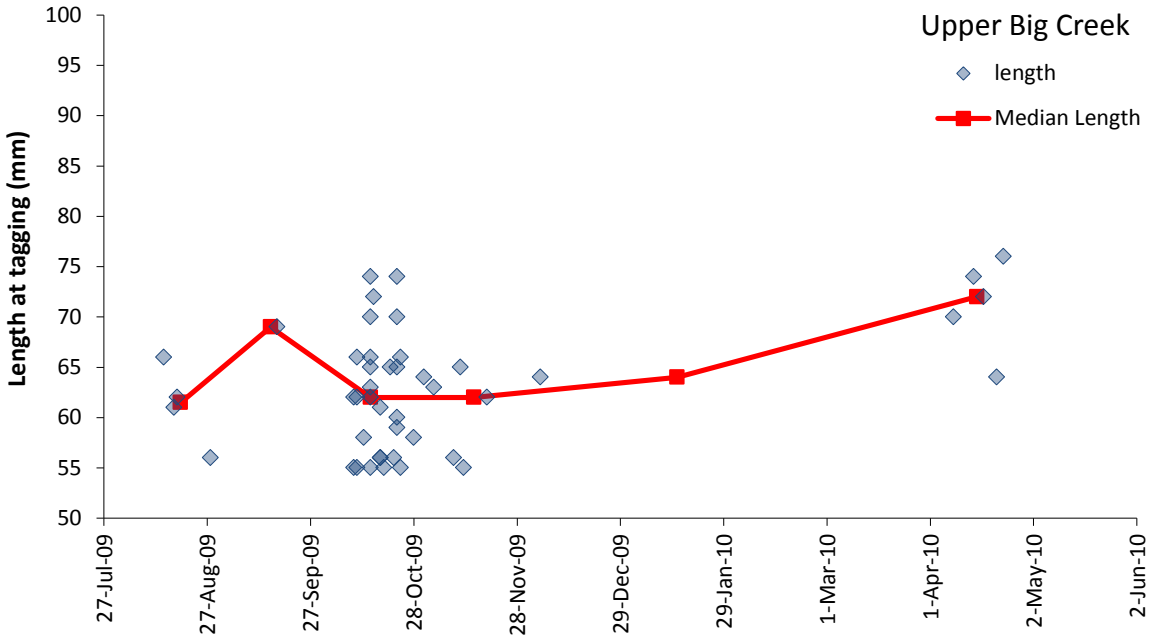

Figure 7. Length at tagging (FL) and median fork length of 45 summer-tagged parr from upper Big Creek that were detected at Taylor Ranch upper and lower instream PIT-tag monitoring antennas, August 2009-June 2010.

South Fork Salmon River

From 17 to 18 August 2009, 1,001 wild Chinook salmon parr from the South Fork Salmon River were collected, PIT tagged, and released in natal rearing areas. These fish were released 52-53 km above the instream monitor near Krassel Creek (rkm 65) and 87-88 km above the monitor in the lower South Fork Salmon River at Guard Station Road Bridge (rkm 30; Table 1). From August 2009 to June 2010, 251 of these fish were detected at the SF Salmon River monitor near Krassel Creek (Figure 8), but only 5 were detected at the site near Guard Station Road Bridge. Of the 251 detections near Krassel Creek, 156 (62.2%) occurred in late summer/fall, 55 (21.9%) occurred in winter, and 40 (15.9%) occurred in spring (Figure 8). An estimated 47.7% (SE 3.5%, 95% CI 40.7-54.7%) of all summer-tagged parr from this stream survived to migrate passed these monitors, and their survival to Lower Granite Dam was 49.8% (SE 9.5%, 95% CI 32.2-68.9).

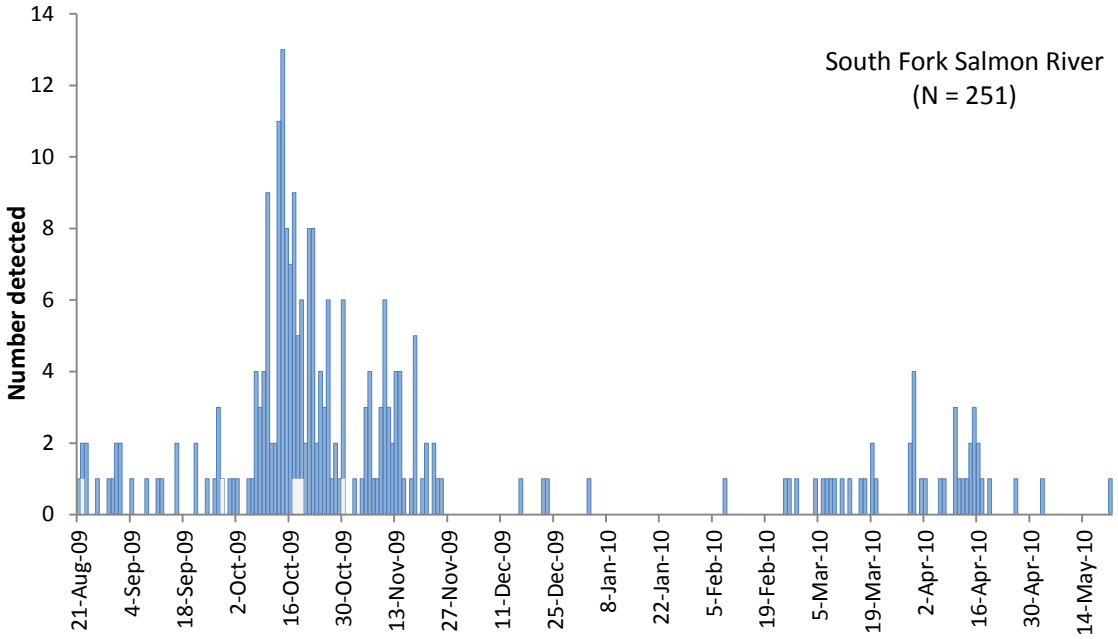

Figure 8. Detections of 251 PIT-tagged wild spring/summer Chinook salmon parr, pre-smolts, and smolts at the Krassel Creek instream PIT-tag monitoring site in the South Fork of the Salmon River from August 2009 through June 2010. A total of 1,001 Chinook salmon parr were PIT tagged and released in areas from 52 to 53 kilometers above these antennas from 17 to 18 August 2009.

Secesh River and Lake Creek

From 20 to 22 August 2009, 903 wild Chinook salmon parr from the Secesh River and Lake Creek were collected, PIT tagged, and released in or near their natal rearing areas. Release sites were 21-42 km above the instream PIT-tag monitors near Zena Creek Ranch, and ~55-76 km above the South Fork Salmon River monitoring site at Guard Station Road Bridge (Table 1). From August 2009 to June 2010, 146 of these fish were detected at the lower Secesh River site near Zena Creek Ranch (Figure 9), but only 5 were detected at the lower South Fork Salmon River near Guard Station Road Bridge. Of the 146 detections from the Zena Creek site, only 6 fish were detected at Lower Granite Dam; therefore, we did not estimate downstream survival or detection efficiencies for these fish.

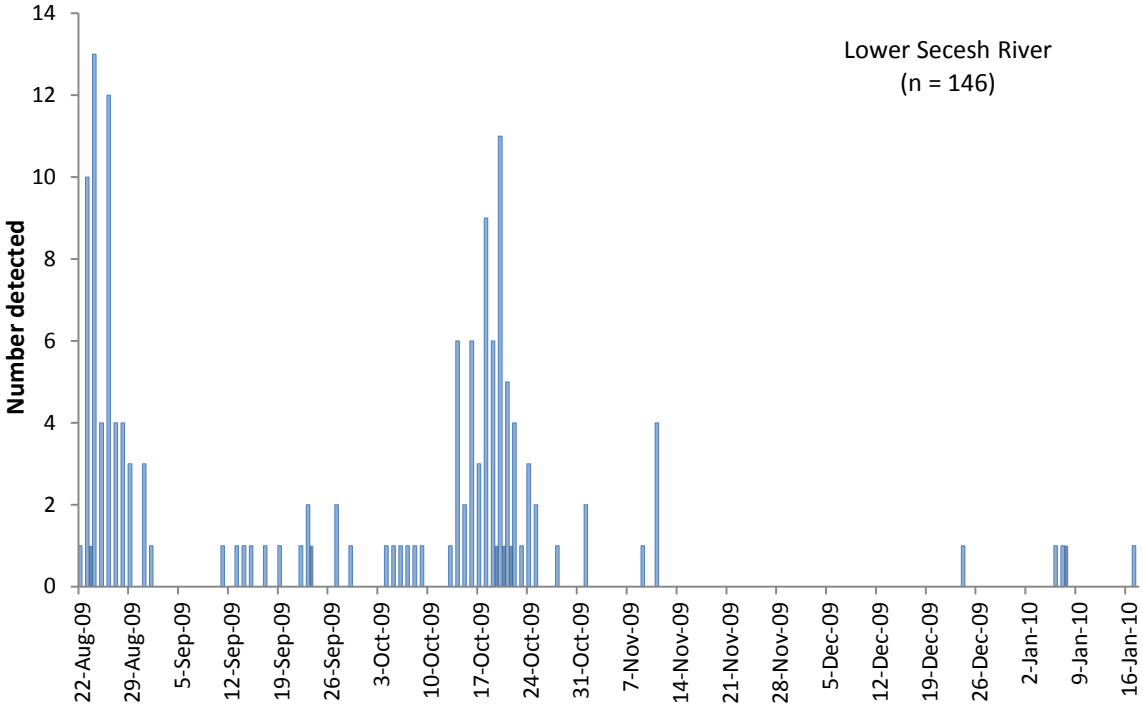

Figure 9. Detections of 146 PIT-tagged wild spring/summer Chinook salmon parr, pre-smolts, and smolts on the instream monitors near Zena Creek Ranch on the lower Secesh River, August 2009-June 2010. Two additional fish were detected on 15 April and 12 August 2010 (not shown). A total of 903 PIT-tagged Chinook salmon parr were released in the Secesh River or Lake Creek, ~21-42 km upstream from these antennas, during 20-22 August 2009.

Recaptures at Traps and Dams

A total of 741 wild fish PIT-tagged in summer 2009 were recaptured at traps above Lower Granite Dam from summer-fall 2009 to spring 2010, and 468 were recaptured in the separation-by-code system at the Little Goose Dam juvenile fish facility (Table 4). Overall parr-to-smolt growth measured at Little Goose Dam indicated a mean growth rate of 0.16 mm/d and mean weight gain of 0.031 g/d.

Table 4. Length, weight, and condition of wild spring/summer Chinook salmon PIT-tagged in Idaho during summer 2009 and recaptured either in the separation-by-code system at Little Goose Dam (2010) or at traps during summer-fall 2009 and spring-summer 2010. Condition factor and weight gain could be calculated only for fish that had been weighed at tagging. No fish were recaptured at dams other than Little Goose.

	Recaptured fish						Weight and condition factor (CF)				
		Days to recapture		Length gain (mm)				Weight gain (g)		Mean CF	
	n	range	mean	n	range	mean	n	range	mean	release	recapture
Wild spring/summer Chinook salmon recaptured at Little Goose Dam											
Bear Valley Creek	19	287-329	310	19	27-68	45.6	19	5-21	10.5	1.13	1.03
Elk Creek	26	284-320	302	26	32-70	49.2	23	1-18	10.6	1.11	0.99
Sulphur Creek	33	279-314	293	33	22-67	39.6	18	1-15	7.6	1.31	0.99
Marsh Creek	39	279-317	297	39	28-62	46.6	3	1-3	2.3	1.19	0.98
Valley Creek	37	276-331	297	37	34-67	47.6	18	1-19	9.1	1.05	0.97
Loon Creek	50	269-303	285	50	32-71	47.9	37	1-22	9.6	1.26	0.97
Camas Creek	27	266-309	285	27	30-56	44.0	9	1-12	6.8	1.35	0.99
Big Creek (upper)	37	277-325	295	37	30-62	47.9	23	1-14	10.6	1.12	1.02
Big Creek (lower)	43	262-292	270	43	33-58	46.0	20	1-15	8.0	1.11	0.93
South Fork Salmon R.	38	258-297	272	38	24-73	45.7	9	1-14	9.3	1.11	0.97
West Fork Chamberlain Cr	11	258-298	273	11	41-67	50.1	2	13-15	14.0	1.10	0.92
Chamberlain Creek	23	256-293	267	23	28-60	44.8	11	1-14	7.0	1.20	0.98
Secesh River	21	255-293	270	21	23-63	44.4	7	6-14	8.9	1.18	0.94
Lake Creek	5	255-296	276	5	26-62	36.0	5	3-13	6.6	1.31	1.03
Herd Creek	31	264-300	283	31	25-70	45.0	3	3-7	5.3	1.53	0.94
Cape Horn Creek	28	278-327	296	28	31-71	50.0	10	6-19	11.5	1.14	1.03
Totals or averages	468	255-331	286	468	22-73	46.1	217	1-22	8.9	1.29	0.98
Wild spring/summer Chinook salmon recaptured at traps											
Big Creek (Taylor)											
Upper Big Creek											
Fall	83	0-87	9	83	-4-23	1.5	40	-1-3	0.1	1.06	1.02
Spring	1	224-224	224	1	22	22.0	0	---	---	---	0.90

Table 4. Continued.

	Recaptured fish						Weight and condition factor (CF)				
		Days to recapture		Length gain (mm)				Weight gain (g)		Mean CF	
	n	range	mean	n	range	mean	n	range	mean	release	recapture
Wild spring/summer Chinook salmon recaptured at traps (continued)											
Lower Big Creek											
Fall	63	0-96	58	63	-4-19	7.3	41	-1-3	0.7	1.07	0.96
Spring	8	244-292	264	8	15-32	24.3	7	3-6	4.3	1.04	1.04
SF Salmon River (Knox)											
Fall	161	1-69	35	160	-3-21	27.0	27	-1-3	0.6	1.11	0.95
Spring-summer	13	231-243	238	13	12-32	19.5	2	2-4	3.0	1.10	0.98
Lake Creek (fall)	13	1-25	12	13	-1-7	2.3	13	-1-1	-0.3	1.11	0.88
SF Salmon River (lower)											
Fall	29	5-85	61	28	0-21	10.2	5	-1-3	1.4	1.06	0.92
Spring-summer	13	203-243	226	13	13-24	17.6	0	---	---	---	0.98
Secesh River traps											
Upper trap											
Fall	47	2-79	29	47	-2-148	7.2	20	-1-1	0.0	1.10	0.91
Spring-summer	3	257-281	266	3	8-26	15.3	1	4	4.0	0.97	1.04
Lower trap (fall)	9	2-55	32	9	-1-9	3.6	9	-1-1	-0.3	1.23	0.93
Marsh Creek											
Fall	276	1-98	38	275	-3-23	7.5	0	---	---	1.07	---
Spring-summer	2	272-375	324	2	28-58	43.0	0	---	---	---	---
Salmon River (spring)	19	230-277	250	19	21-52	33.8	0	---	---	1.23	---
Snake River (spring)	1	367	367	1	65	65.0	0	---	---	---	1.41
Totals	741	---	---	738	---	---	165	---	---	---	---

Detection at Dams

Parr-to-Smolt Survival Estimates

For fish from all Idaho streams combined, we estimated an average annual parr-to-smolt survival probability of 16.8% (SE 0.7%; Table 5; Appendix Tables 5-20). This estimate was based on expanded detections at Lower Granite Dam from 20 April to 8 July 2010 (2,579 fish).[†] An additional 1,078 first-time detections (not expanded) were recorded at Little Goose, Lower Monumental, Ice Harbor, McNary, John Day, and Bonneville Dam, and in the PIT-tag detection trawl in the upper Columbia River estuary (Appendix Tables 5-19 and 21-26). By comparing all first-time detections at interrogation dams and the trawl (1,768) to the expanded number of detections at Lower Granite Dam (2,579), we estimated that 31.5% of the wild fish from Idaho passed through the dams undetected.

Table 5. Summary of observed and expanded detections of PIT-tagged wild spring/summer Chinook salmon smolts from Idaho at Lower Granite Dam in 2010. Expanded numbers are parr-to-smolt survival estimates and standard errors (%). See Table 1 for numbers released.

	Lower Granite Dam			
	Observed detections		Mean annual parr-to-smolt survival	
Stream	N	Percent	N	Percent (SE %)
Bear Valley Creek	30	2.9	109	10.6 (2)
Elk Creek	27	2.7	108	10.8 (2)
Marsh Creek	54	5.4	188	18.7 (3)
Cape Horn Creek	43	6.4	137	20.3 (3)
Sulphur Creek	60	6.0	206	20.5 (3)
Valley Creek	37	1.5	126	5.0 (1)
Loon Creek	70	9.4	240	32.4 (4)
Camas Creek	43	8.1	155	29.2 (5)
Herd Creek	46	4.4	171	16.5 (2)
Big Creek (upper)	56	5.1	198	17.9 (3)
Big Creek (lower)	90	6.3	366	25.5 (3)
W Fork Chamberlain/Chamberlain Cr	49	3.6	197	14.5 (2)
S Fork Salmon River	53	5.3	216	21.5 (3)
Secesh River	28	3.7	147	19.3 (5)
Lake Creek	4	2.8	14	9.9 (5)
Totals or averages	690	4.5	2,579	16.8 (0.7)

[†] Due to rounding, the expanded detection numbers at Lower Granite Dam in Table 5 may vary slightly from those in Appendix Tables 5-20.

Valley Creek—For Chinook salmon juveniles detected at the Valley Creek instream PIT-tag monitors, we estimated an overall survival rate to Lower Granite Dam of 9.3% in 2010 (SE 2.7%; 95% CI 4.6-15.2%). Estimated overall parr-to-smolt survival for fish from this stream was 5.0% (SE 0.9%; 3.4-7.1%; Table 5). Estimated survival to Lower Granite Dam in 2009-2010 was 7.3% (SE 2.9%; 2.2-14%) for fish leaving Valley Creek in late summer/fall, 15.7% (SE 6.8%; 3.4-29.9%) for fish leaving in winter, and 11.5% (SE 10.9%; 6.3-35%; only 1 fish detected) for fish leaving in spring.

Big Creek—For Chinook salmon juveniles PIT tagged in lower Big Creek and detected at the Big Creek instream PIT-tag monitors, overall survival to Lower Granite Dam was estimated at 34.6% (SE 8.6%; 95% CI 19.7-53.4%). Overall parr-to-smolt estimated survival for fish from this stream (area) was 25.5% (SE 2.8%; 20.3-31.2%; Table 5). During 2009-2010, estimated survival was 27.8% (SE 9.4%; 11.7-47.5%) for lower Big Creek fish detected in late summer/fall, 57.8% (SE 20.8%; 20.8-100%) for fish detected in winter, and 0% for fish detected in spring.

For Chinook salmon juveniles PIT tagged in upper Big Creek and detected on the lower Big Creek instream monitors, overall survival to Lower Granite Dam was estimated at 79.0% (SE 26.2%; 35.6-100%). Overall parr-to-smolt survival for fish from upper Big Creek was estimated at 17.9% (SE 2.6%; 13.4-23.7%; Table 5). For upper Big Creek fish detected at the Big Creek monitors, estimated survival to Lower Granite Dam in 2009-2010 was 87.2% (SE 33.2%; 33.4-100%) for upper Big Creek fish detected in late summer/fall, 67.5% (SE 53.9%; 16.7-100%) for fish detected in winter, and 36.8% (SE 33.7%; 20-100%) for fish detected in spring.

South Fork Salmon River—In 2010, we estimated a 49.8% (SE 9.5%; 95% CI 32.2-68.9%) overall survival rate to Lower Granite Dam for Chinook salmon juveniles previously detected at the South Fork Salmon River instream PIT-tag monitors near Krassel Creek. For fish detected at this monitoring site, estimated survival rates to the dam in 2009-2010 were 45.1% (SE 11%; 25.3-67.9%) for fish detected in late summer/fall, 53.8% (SE 21.3%; 17.1-98.4%) for fish detected in winter, and 61.3% (SE 25.3%; 17.2-100%) for fish detected in spring. The overall parr-to-smolt estimated survival rate for fish from this stream was 21.5% (SE 3.1%; 16.3-28.1%; Table 5).

Relationship between Length and Detection

For fish from all Idaho streams combined, average fork length at release was 64.6 mm (Table 1; Appendix Table 1). Among these fish, the average fork length at release of fish detected the following spring at dams was significantly longer than that of fish not detected at the dams (65.9 vs. 64.5 mm; $P < 0.01$). Also, fish that were larger at release tended to pass Lower Granite Dam earlier than their smaller cohorts (Figure 10).

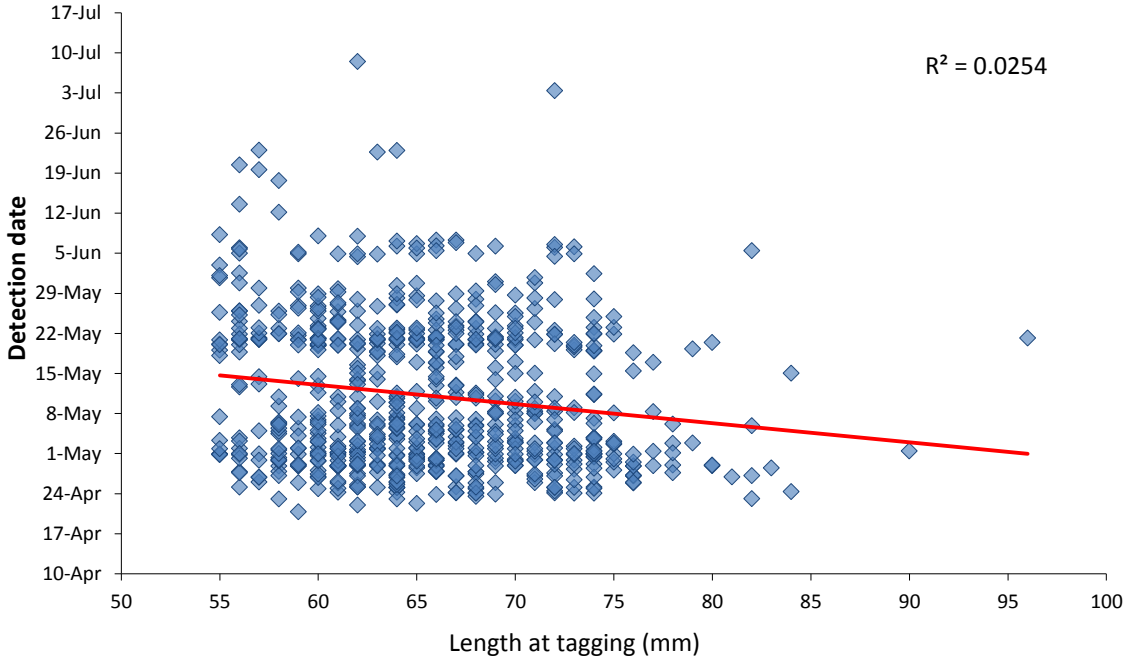

Figure 10. The relationship between fork length of parr at tagging (in 2009) to detection date at Lower Granite Dam in 2010.

All Idaho fish were grouped in 5-mm length bins, and their length distributions were compared using a series of chi-square tests. The length distributions of all fish were compared to those of fish detected at the dams in spring. The expected number of detected fish from each length bin was based on the proportion released fish in each bin and was compared to the observed number. For the two smallest length bins (60-64 mm and 59 mm or less), significantly less detected fish were observed than expected ($P < 0.001$ and $P = 0.005$; Figure 11). For the 65-69 mm bin, observed and expected numbers were not significantly different ($P = 0.095$), but for the 70-74 and 75-79 mm bins, significantly more detected fish were observed than expected ($P < 0.001$ and $P = 0.011$). For the largest bin, (80-84 mm), expected and observed detections were similar ($P = 0.895$).

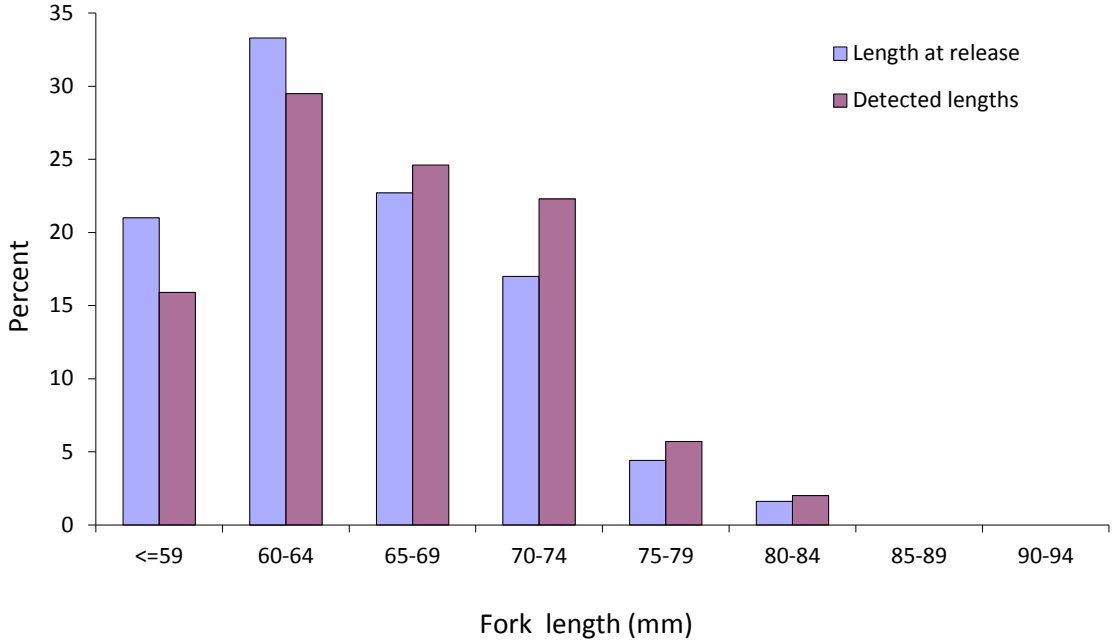

Figure 11. Percent by fork length increments (mm), of PIT-tagged wild spring/summer Chinook salmon parr released in Idaho streams in 2009 (n = 15,323) and percent of fish detected for these length increments at dams in spring and summer 2010 (n = 1,765).

In 2010, we found a significant difference in fork length at time of release between fish that passed Lower Granite Dam in April and May and fish that passed after May ($P < 0.03$). Fish migrating through the dam in April and May were on average 2.2 mm larger at release than fish migrating after May. However, only 44 fish migrated through the dam after May. These data suggest that fish size may have influenced migration timing or overwintering location.

Migration Timing

Lower Granite Dam

Passage timing at Lower Granite Dam varied for fish from 18 Idaho and Oregon stream populations (Figure 12). Comparisons among these 18 populations (Appendix Table 4a-4b, Figure 12) showed that fish from the Secesh River had a significantly earlier passage timing of the 10th percentile than fish from all the other streams (P <0.05). The 10th percentile passage date of fish from upper Big Creek was significantly later than that of fish from all other streams except Valley, Herd, Catherine, and Cape Horn Creeks (P <0.05). Standard errors of these estimates ranged from 0.1 to 8.4 d (median 0.83 d). Overall, the 10th percentile passage dates for fish from 18 stream populations ranged from 20 April to 1 May (Appendix Tables 4a-4b).

In comparisons of the 50th percentile passage date at the dam, fish from Big Creek (lower) and Secesh Rivers were significantly earlier than fish from all other streams except Chamberlain/W. F. Chamberlain and Elk Creeks (P <0.05). Fish from Catherine Creek were significantly later at the dam than fish from all other streams (P <0.05). Standard errors of these estimates ranged 0.5-4.7 d (median 1.54 d). The 50th percentile passage date for fish from all 18 stream populations ranged from 28 April to 4 June (Appendix Tables 4a-4b).

In terms of the 90th percentile passage date at the dam, fish from lower Big Creek were significantly earlier than fish from all other streams (P <0.05). Fish from Catherine Creek were significantly later at the dam than fish from all other stream populations (P <0.05). Standard errors of these estimates ranged from 0.5 to 3.7 d (median 1.74 d). The 90th percentile passage date for fish from all streams combined ranged from 6 May to 19 June (Appendix Tables 4a-4b).

For the number of days encompassing the middle 80th percentile passage (10th to 90th percentile), lower Big Creek fish had a significantly more condensed distribution (12 d) than fish from all other streams (25-51 d; P <0.05; Appendix Tables 4a-4b). Fish from Catherine Creek displayed significantly more protracted timing at the dam than fish from all other stream populations except the Secesh and upper Imnaha Rivers (51 d vs. 12-43 d; P <0.05). Standard errors of these estimates ranged 1.3-8.4 d (median 2.04 d).

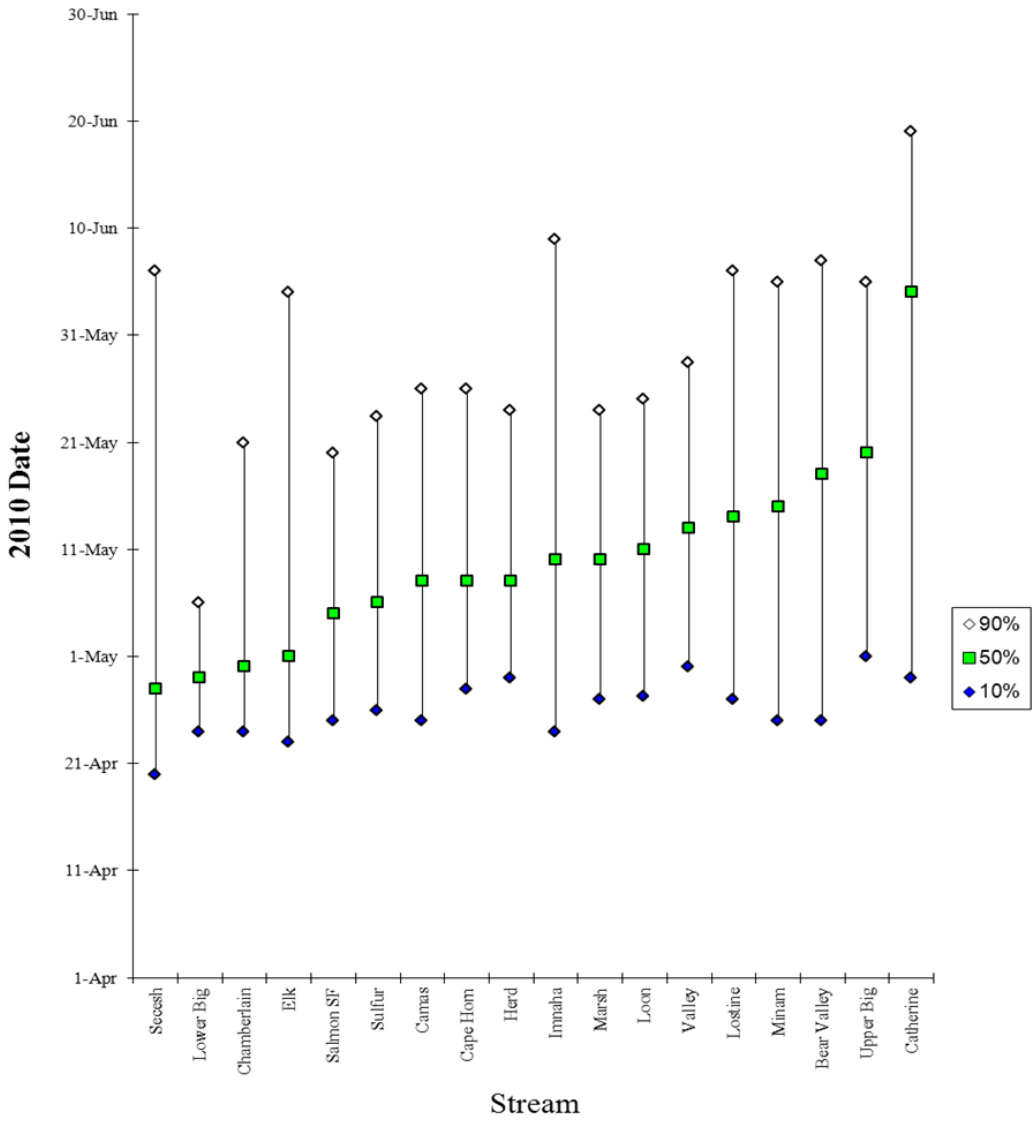

Figure 12. Estimated passage distribution timing at Lower Granite Dam in 2010 for wild spring/summer Chinook salmon smolts from streams of Idaho and Oregon. Big Creek is divided into lower and upper portions and Chamberlain and West Fork Chamberlain Creeks were combined for these analyses. See Appendix Tables 5-20 for daily estimated passage numbers of fish from Idaho streams.

Detection data at Lower Granite Dam for fish from streams with 8 or more years of data has shown clear variation among the 19 stream populations in arrival timing of the 10th, 50th, and 90th percentiles of these populations (Table 6). Secesh River fish had significantly earlier passage timing of the 10th population percentile at Lower Granite Dam than fish from all other streams except Lake Creek, and Lostine, Minam, and upper Imnaha Rivers (P <0.05). Also, upper Big Creek fish had significantly later migration timing at the dam than all the other streams except Catherine Creek (P <0.05).

Secesh River fish had significantly earlier arrival timing at Lower Granite Dam of the 50th population percentile than fish from all the other streams except lower Big and Herd Creeks (P <0.05). Fish from upper Big Creek had significantly later timing of the 50th percentile at the dam than fish from all other streams except Catherine Creek (P <0.05). Among 90th percentile passage times at the dam, lower Big Creek fish had significantly earlier timing than fish from all other streams except Herd Creek (P <0.05). Fish from upper Big Creek had significantly later passage timing of the 90th percentile at the dam than fish from all other streams except Bear Valley, Cape Horn, Lake, Valley, and Catherine Creeks, and the South Fork of the Salmon River (P <0.05).

Table 6. The 95% confidence interval (CI) and mean passage dates (10th, 50th, and 90th percentiles), with standard errors (SE) in days, at Lower Granite Dam for wild spring/summer Chinook salmon smolts from streams in Idaho and Oregon over all data years.

	Percentile passage dates at Lower Granite Dam (95% CI, mean, SE)			
Stream	10th (SE)	50th (SE)	90th (SE)	Data years
Secesh River	12-17 April, 14 April (1)	24-29 April, 26 April (1)	23 May-5 June, 30 May (3)	21
South Fork Salmon River	17-24 April, 20 April (2)	7-12 May, 10 May (1)	31 May-10 June, 5 June (2)	19
Catherine Creek	23-29 April, 26 April (1)	11-20 May, 15 May (2)	28 May-9 June, 3 June (3)	20
Imnaha River (upper)	14-19 April, 17 April (1)	29 April-5 May, 2 May (1)	18-27 May, 22 May (2)	18
Bear Valley Creek	18-25 April, 22 April (2)	5-11 May, 8 May (1)	25 May-3 June, 30 May (2)	19
Big Creek (upper)	25 April-4 May, 30 April (2)	13-23 May, 18 May (2)	28 May-14 June, 5 June (4)	16
Elk Creek	17-24 April, 21 April (2)	2-8 May, 5 May (2)	23 May-2 June, 28 May (2)	18
Valley Creek	22-29 April, 25 April (2)	9-17 May, 13 May (2)	30 May-10 June, 4 June (3)	19
Marsh Creek	18-23 April, 21 April (1)	1-8 May, 5 May (2)	19-27 May, 23 May (2)	16
Lake Creek	13-20 April, 16 April (2)	27 April-4 May, 30 April (2)	23 May-07 June, 31 May (3)	17
Lostine River	13-20 April, 17 April (2)	1-7 May, 4 May (1)	18-26 May, 22 May (2)	19
Sulphur Creek	17-27 April, 22 April (2)	1-15 May, 8 May (3)	21 May-2 June, 27 May (3)	12
Cape Horn Creek	20-29 April, 25 April (2)	6-16 May, 11 May (2)	24 May-6 June, 30 May (3)	13
Big Creek (lower)	17-22 April, 20 April (1)	26 April-1 May, 29 April (1)	8-15 May, 11 May (2)	14
E. Fork Salmon River	15-24 April, 19 April (2)	25 April-7 May, 1 May (2)	13-23 May, 18 May (2)	7
Loon Creek	22 April-1 May, 27 April (2)	4-13 May, 9 May (2)	16-26 May , 21 May (2)	12
Herd Creek	17-25 April, 21 April (2)	27 April-4 May, 1 May (2)	11-19 May, 15 May (2)	12
Grand Ronde River (upper)	23 April-10 May, 1 May (3)	13 May-4 June, 24 May (4)	21 May-3 July, 12 June (8)	5
Imnaha River (lower)	5-20 April, 12 April (2)	14 April-5 May, 25 April (3)	2-15 May, 9 May (2)	4
Chamb/WF Chamberlain Cr	17-24 April, 20 April (2)	28 April-8 May, 3 May (2)	15 May-8 June, 27 May (6)	12
Camas Creek	23-30 April, 26 April (2)	7-16 May, 11 May (2)	21-29 May, 25 May (2)	12
Minam River	14-21 April, 18 April (2)	2-9 May, 6 May (2)	19-26 May, 23 May (2)	12

Comparison with River Flows

We grouped first-time detections (expanded) at Lower Granite Dam of all Idaho and Oregon streams combined and compared their collective timing with river flows during the same periods (Figure 13 and Appendix Table 20). Overall, passage at the dam during 2010 occurred between late-April and early-July, with the middle 80th percentile passage occurring from 26 April to 29 May (Table 7). The peak passage date occurred during low flows of 59.1 kcfs on 30 April (Appendix Table 20).

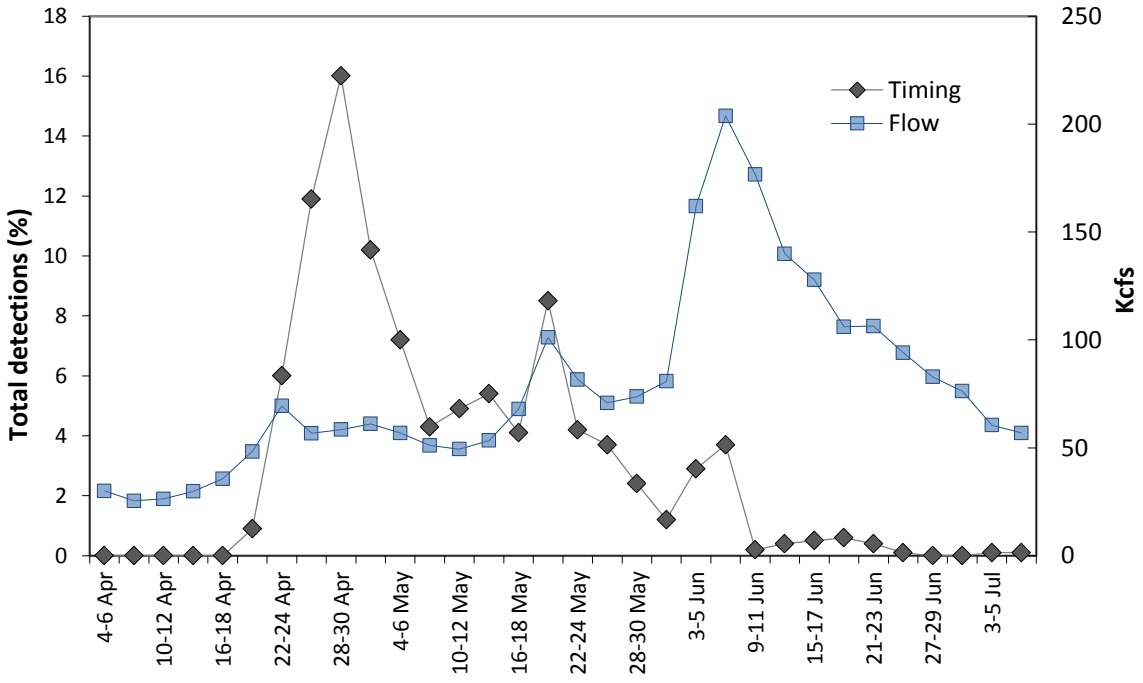

Figure 13. Overall migration timing of PIT-tagged wild spring/summer Chinook salmon smolts with associated river flows at Lower Granite Dam, 2010. Daily detections from Idaho and Oregon streams were pooled in 3-day intervals and expanded based on daily detection probability. River flows at the dam were averaged daily over the same periods.

Table 7. Annual spring passage dates at Lower Granite Dam from 1989 to 2010 for combined populations of wild spring/summer Chinook salmon smolts PIT tagged the previous summers as parr in Idaho and Oregon streams. No fish were tagged in the middle fork Salmon River during 1989 and 1996-1997. Years from 1996 to 1998 had much higher proportions of Oregon fish.

	Percentile passage dates at Lower Granite Dam			
Year	10th	50th	90th	Range
1989	23 April	14 May	13 June	04 April-22 July
1990	19 April	07 May	07 June	05 April-18 July
1991	01 May	18 May	12 June	13 April-20 July
1992	15 April	02 May	27 May	05 April-27 July
1993	26 April	14 May	31 May	14 April-10 August
1994	22 April	08 May	01 June	13 April-04 Sept.
1995	17 April	09 May	04 June	08 April-22 Sept.
1996	15 April	27 April	19 May	09 April-15 July
1997	12 April	24 April	18 May	31 March-22 Sept.
1998	11 April	02 May	23 May	31 March-07 Aug.
1999	20 April	03 May	28 May	27 March-08 July
2000	17 April	07 May	30 May	10 April-20 July
2001	26 April	09 May	27 May	06 April-07 July
2002	16 April	03 May	30 May	28 March-05 July
2003	18 April	11 May	29 May	31 March-04 July
2004	16 April	03 May	26 May	01 April-16 July
2005	25 April	07 May	24 May	04 April–20 June
2006	18 April	02 May	22 May	03 April–18 June
2007	15 April	30 April	14 May	05 April-18 June
2008	30 April	11 May	23 May	10 April-02 July
2009	23 April	02 May	20 May	02 April-25 June
2010	26 April	09 May	29 May	20 April–08 July

Environmental Information

Environmental water quality factors varied by month and between locations (Appendix Tables 27-42), as did the percentage of fish collected and/or detected at adjacent traps or instream PIT-tag monitors (Appendix Figures 1-6). In 2007, Northwest Fisheries Science Center personnel completed the Water Quality Baseline Environmental Monitoring website for storage and dissemination of water quality data collected during this study since 1993 (NWFSC 2007). This website also has links to weather, climate, and stream flow data in the Salmon River basin.

DISCUSSION

Mortality rates associated with collection and tagging in 2009 were comparable to those in earlier years (Achord et al. 1992; 1994-1998; 2000-2010). Detections from the instream PIT-tag monitoring systems in Valley Creek enabled us to estimate survival and migration timing for wild Chinook salmon juveniles leaving this stream. We now have survival estimates and timing information from late summer to the following spring from 2003 to 2010. In 2008, monitoring systems were improved with the addition of multiplex transceivers and a total of 7 antennas. These improvements resulted in more accurate survival estimates in 2008-2009, with 23.5% of the tagged fish being detected at the monitors. In 2009-2010, 18.4% of the tagged fish were detected at these monitors.

Although we were able to estimate survival from detections at the Big Creek monitors in 2008-2009 and 2009-2010, we only detected 9.2 and 9.5%, of the tagged fish, respectively. These low detection rates were responsible for the extreme variability in estimates of survival to Lower Granite Dam over both years (range 0-106%). More precise survival estimates may be obtained in the future by increasing the number of fish tagged, improving detection efficiency/effectiveness, and/or adding more antennas. Continued development and maintenance at these instream monitoring sites will be conducted by the Integrated Status and Effectiveness Monitoring Project (ISEMP).

Survival models appropriate for the data collected from instream PIT-tag monitoring sites need to be developed. This need increases with additional years of data collected from the instream sites currently in place, as well as expected data from new sites planned for the Salmon River drainage and throughout the Columbia River Basin.

At Little Goose Dam, mean growth measured from the parr-to-smolt stage was 0.16 mm/d for 2009-2010 overall. This was comparable to the overall rate measured in previous years of 0.13-0.16 mm/d (Achord et al. 2002; 2003; 2004; 2005; 2006; 2007; 2008; 2009; 2010). The overall mean weight gain was 0.031 g/d in 2009-2010, and was also comparable to the previous years.

Annual parr-to-smolt survival estimates for the combined Idaho and Oregon populations over the last 18 years have ranged from 8.2 to 24.4%, with an average annual survival rate of 16.4% (Figure 14). The lowest parr-to-smolt survival rates were estimated in 2004 and 2005 (8.2 and 8.4%, respectively).

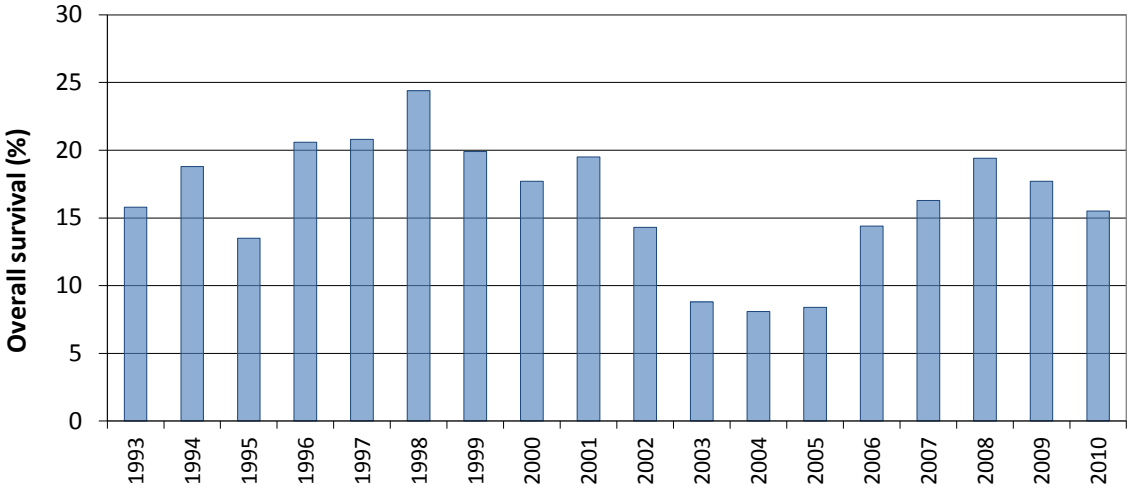

Figure 14. The overall estimated parr-to-smolt survival rates for wild spring/summer Chinook salmon from Idaho and Oregon streams to Lower Granite Dam from 1993 to 2010. Overall average standard error = 0.7% (yearly range 0.2-1.8%).

These low estimates may have resulted from stream conditions with much higher parr density (Figure 15). Returns of wild adults to the Snake River basin from 2001 to 2003 were more than an order of magnitude greater than returns from 1994 to 1996, when we measured the highest rates of parr-to-smolt survival (20.6 to 24.4%).

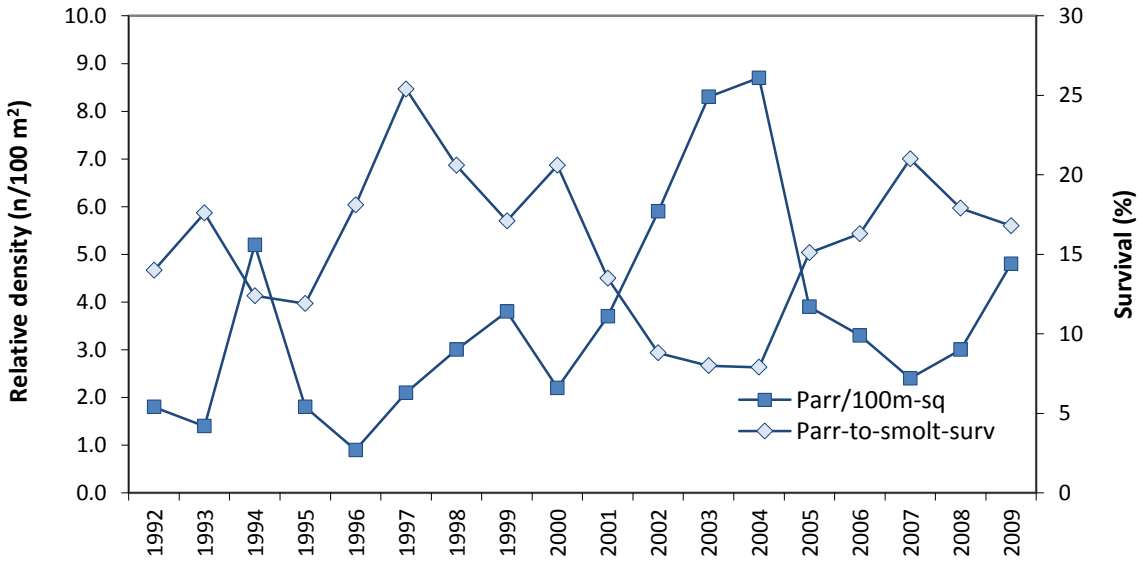

Figure 15. Annual average relative Chinook salmon parr densities (per 100 m^2) in areas sampled in all Idaho streams from 1992 to 2009 plotted against subsequent annual smolt survival estimate to Lower Granite Dam the following year.

In 2010, fish that were larger at tagging tended to arrive at Lower Granite Dam earlier than fish that were smaller at tagging. In addition, we observed that wild fish detected at the dam early in the migration season (April and May) had been significantly larger at release than fish migrating after May. Over the two decades of this wild fish study, we have consistently observed this relationship between length at tagging and migration timing at Lower Granite Dam.

In contrast, detections on the instream monitors at Valley Creek over the last 6 years have indicated no biologically meaningful relationship between length at tagging and migration timing (Achord et. al. 2006; 2007; 2008; 2009; 2010; and Figure 3). Likewise, detections on the instream monitors at lower Big Creek in 2008-2009 and in 2009-2010 have shown no meaningful relationship between size and timing (Achord et. al. 2010; Figures 5 and 7). These data show that for most years, the initiation of movement from natal rearing streams to larger rivers by parr, pre-smolts, and smolts was not related to parr size at tagging. However, larger fish probably initiate smoltification earlier than smaller tagged fish in spring, thus arriving at Lower Granite Dam earlier.

In spring 2010, we observed that for populations from the combined streams overall, the 50th and 90th passage percentiles occurred in early and late May, respectively at Lower Granite Dam.

In 2010, low flows occurred throughout the migration period until late May. Thereafter, until early summer, cooler- and wetter-than-normal weather conditions prevailed, with much higher-than-normal flows in the Snake River basin. As we have reported previously, Chinook salmon smolt passage timing at Lower Granite Dam for individual wild populations has been highly variable and usually protracted, with timing patterns for some populations ranging from early to late spring. Complex yearly interrelationships between flow and annual climatic conditions are primary factors contributing to passage timing. However, water temperatures in streams above the dam, turbidity, physiological development, variability in stock behavior, fish size, and other yet unknown factors may all contribute substantially to wild smolt passage timing.

As additional instream PIT-tag monitors, traps, and environmental monitors are installed in study streams, we can more accurately examine the relationships between environmental conditions within the streams and the movements of fry, parr, and smolts out of their natal rearing areas. Mapped over time, this information, along with weather and climate data, may provide tools for the prediction of movement in different wild fish stocks. Such tools are vital to recovery planning for threatened or (ESA) endangered species of Pacific salmon.

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APPENDIX

Data Tables and Figures

Appendix Table 1. Summary of numbers collected, tagged, released, and minimum, maximum, and mean lengths and weights of wild Chinook salmon parr, collected and PIT tagged in various Idaho streams, 2009. The length-weight data includes recaptured tagged fish.

	Collection							Tagging and Release			
	Number of fish			Length		Weight		Length		Weight	
	Collected	Tagged	Released	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Bear Valley Creek	1,184	1,028	1,028	46-123	62.4	1.2-30.7	3.3	54-82	62.7	1.2-7.5	3.3
Elk Creek	1,121	1,004	1,004	47-137	64.2	1.0-39.6	3.6	55-87	64.3	1.7-7.1	3.4
West Fork Chamberlain Cr	1,248	796	795	40-136	59.2	1.0-7.2	2.8	53-136	64.3	1.7-7.2	3.3
Valley Creek	3,662	2,516	2,516	38-140	60.4	0.5-17.7	2.8	51-109	63.0	1.4-17.7	3.1
Camas Creek	600	533	532	45-79	64.0	1.3-7.1	3.9	54-79	65.1	1.9-7.1	4.1
Chamberlain Creek	631	564	562	41-129	62.8	0.9-31.9	3.4	54-81	63.9	1.9-8.3	3.7
Big Creek (upper)	1,701	1,108	1,107	40-130	59.3	0.9-29.5	3.2	52-119	62.2	1.6-21.1	3.1
Big Creek (lower)	1,588	1,436	1,435	46-91	67.4	1.9-7.8	4.0	55-91	67.9	1.9-7.8	4.0
Loon Creek	816	743	741	44-81	63.6	1.4-6.8	3.7	55-81	64.4	2.0-6.8	3.8
Marsh Creek	1,313	1,002	1,002	39-117	62.0	2.0-20.9	4.0	53-117	64.3	2.0-6.8	3.7
Sulphur Creek	1,046	1,006	1,006	52-129	69.8	1.5-32.2	5.1	55-112	69.4	1.8-19.9	4.9
Lake Creek	413	142	142	39-84	53.4	0.9-9.8	3.1	53-84	62.6	1.8-7.7	3.5
South Fork Salmon River	1,113	1,001	1,001	53-97	67.2	1.8-8.8	4.0	55-97	67.3	1.8-8.8	4.0
Secesh River	1,464	763	761	40-107	57.2	0.6-11.2	2.7	52-136	64.9	0.8-21.1	3.6
Cape Horn Creek	1,228	676	676	36-125	57.0	0.6-28.2	3.6	55-109	60.5	1.7-12.3	3.1
Herd Creek	1,074	1,040	1,039	53-94	67.3	2.9-10.7	5.6	53-94	67.5	2.9-10.7	5.6
Total or mean	20,202	15,358	15,347	36-140	62.3	0.5-39.6	3.5	51-136	64.6	0.8-21.1	3.8

Appendix Table 2a. Summary of tagging dates and temperatures (°C), release dates, times, and temperatures, methods of capture, distance (in kilometers) from the mouth of the stream to the release point, number released (in 2009), and number/percent of first-time detections (unadjusted) for each tag group at seven downstream dams and the PIT-tag trawl at the mouth of the Columbia River during 2010.

	Tagging			Capture	Release					Detection	
	Date	Time	(°C)	method	Date	Time	(°C)	rkm	N	N	(%)
Bear Valley Creek											
SA09202.BV1	7/21/09	---	12.7	SHOCK	7/22/09	07:00	11.0	10	110	7	6.4
SA09202.BV2	7/21/09	---	11.5	SHOCK	7/21/09	09:20	16.0	10	461	35	7.6
SA09203.BV1	7/22/09	---	12.0	SHOCK	7/22/09	09:35	15.0	13	457	43	9.4
Elk Creek											
SA09204.EC1	7/23/09	---	12.0	BSEINE	7/24/09	05:30	12.0	01	105	7	6.7
SA09204.EC2	7/23/09	---	12.0	BSEINE	7/23/09	10:35	14.0	01	473	49	10.4
SA09204.EC3	7/23/09	---	13.0	SHOCK	7/23/09	10:35	14.0	02	174	27	15.5
SA09205.EC1	7/24/09	---	12.0	SHOCK	7/24/09	10:55	15.0	05	252	37	14.7
Marsh Creek											
SA09208.MC1	7/27/09	---	09.0	SHOCK	7/28/09	05:15	09.0	12	96	18	18.7
SA09208.MC2	7/27/09	---	11.0	SHOCK	7/27/09	12:00	16.0	12	472	56	11.9
SA09209.MC1	7/28/09	---	09.0	BSEINE	7/28/09	09:30	13.0	14	48	6	12.5
SA09209.MC2	7/28/09	---	10.0	SHOCK	7/28/09	10:45	14.0	15	386	59	15.3
Sulphur Creek											
SA09209.SU1	7/28/09	---	10.0	SHOCK	7/29/09	05:00	10.0	05	110	16	14.5
SA09209.SU2	7/28/09	---	11.0	SHOCK	7/28/09	10:00	13.0	06	268	39	14.5
SA09210.SU1	7/29/09	---	09.6	SHOCK	7/29/09	10:00	13.0	08	628	92	14.6
Cape Horn Creek											
SA09210.CH1	7/29/09	---	07.0	SHOCK	7/30/09	05:00	06.0	01	100	14	14.0
SA09210.CH2	7/29/09	---	07.0	SHOCK	7/29/09	12:00	11.0	02	271	35	12.9
SA09211.CH1	7/30/09	---	06.0	SHOCK	7/30/09	09:45	09.0	05	305	42	13.8

Appendix Table 2a. Continued.

	Tagging			Capture	Release					Detection	
	Date	Time	(°C)	method	Date	Time	(°C)	rkm	N	N	(%)
Valley Creek											
SA09212.VC1	7/31/09	---	09.5	SHOCK	8/01/09	05:15	09.0	05	104	7	6.7
SA09212.VC2	7/31/09	---	10.0	SHOCK	7/31/09	10:45	15.0	05	693	31	4.5
SA09213.VC1	8/01/09	---	11.0	SHOCK	8/01/09	10:00	16.0	08	724	31	4.3
SA09213.VC2	8/01/09	---	13.0	SHOCK	8/01/09	10:00	16.0	08	355	16	4.7
SA09215.VC1	8/03/09	---	10.0	SHOCK	8/03/09	10:10	13.0	12	640	21	3.3
Big Creek (upper)											
SA09218.BC1	8/06/09	---	09.0	SHOCK	8/07/09	05:15	09.0	57	115	16	13.9
SA09218.BC2	8/06/09	---	10.0	SHOCK	8/06/09	12:50	12.0	58	299	26	8.7
SA09219.BC1	8/07/09	---	09.0	SHOCK	8/07/09	07:30	10.0	60	40	5	12.5
SA09219.BC2	8/07/09	---	10.0	SHOCK	8/07/09	12:45	11.0	60	653	79	12.1
Big Creek (lower)											
SA09224.LB1	8/12/09	---	13.0	SHOCK	8/13/09	06:30	13.0	10	389	71	18.2
SA09225.LB1	8/13/09	---	13.0	SHOCK	8/13/09	10:45	14.0	11	493	89	18.0
SA09226.LB1	8/14/09	---	12.0	SHOCK	8/14/09	10:15	12.0	11	553	65	11.7
Loon Creek											
SA09218.LN1	8/06/09	---	10.5	SHOCK	8/07/09	05:15	09.0	30	104	19	18.3
SA09218.LN2	8/06/09	---	11.0	SHOCK	8/06/09	09:30	12.0	31	135	29	21.5
SA09219.LN1	8/07/09	---	09.0	SHOCK	8/07/09	09:30	10.0	32	502	99	19.7
Camas Creek											
SA09221.CA1	8/09/09	---	09.0	SHOCK	8/10/09	05:00	08.0	22	104	15	14.4
SA09221.CA2	8/09/09	---	09.2	SHOCK	8/09/09	11:00	13.0	23	275	42	15.3
SA09222.CA1	8/10/09	---	08.0	SHOCK	8/10/09	08:45	09.0	24	153	28	18.3
Herd Creek											
SA09223.HC1	8/11/09	---	09.0	SHOCK	8/12/09	05:15	08.0	02	127	9	7.1
SA09223.HC2	8/11/09	---	11.5	SHOCK	8/11/09	11:00	12.5	03	486	54	11.1
SA09224.HC1	8/12/09	---	09.1	SHOCK	8/12/09	09:00	10.5	03	426	53	12.4

Appendix Table 2a. Continued.

	Tagging			Capture	Release					Detection	
	Date	Time	(°C)	method	Date	Time	(°C)	rkm	N	N	(%)
South Fork Salmon River											
SA09229.SF1	8/17/09	---	07.0	SHOCK	8/18/09	07:30	08.0	117	139	21	15.1
SA09229.SF2	8/17/09	---	07.0	SHOCK	8/17/09	12:00	13.0	117	547	89	16.3
SA09230.SF1	8/18/09	---	08.0	SHOCK	8/18/09	09:40	10.0	118	315	36	11.4
West Fork Chamberlain Creek											
SA09230.WC1	8/18/09	---	07.2	SHOCK	8/18/09	11:10	11.6	01	795	75	9.4
Chamberlain Creek											
SA09231.CB1	8/19/09	---	08.7	SHOCK	8/20/09	05:00	08.5	25	96	12	12.5
SA09231.CB2	8/19/09	---	09.4	SHOCK	8/19/09	10:15	13.5	25	466	57	12.2
Secesh River											
SA09232.SE1	8/20/09	---	10.0	SHOCK	8/21/09	05:30	11.0	26	105	11	10.5
SA09232.SE2	8/20/09	---	11.0	SHOCK	8/20/09	12:30	14.0	26	307	25	8.1
SA09233.SE1	8/21/09	---	11.2	SHOCK	8/21/09	10:30	14.0	27	349	42	12.0
Lake Creek											
SA09234.LC1	8/22/09	---	10.0	SHOCK	8/22/09	08:15	10.0	02	142	13	9.1

Appendix Table 2b. Universal Transverse Mercator (UTM) grid coordinates of Global Positioning System that identified sampling areas at the beginning and end of daily sampling for each collection crew in 2009.

Streams and dates	Section covered	UTM Start		UTM End	
		northing	easting	northing	easting
Bear Valley Creek					
7/21/2009	right bank	4920580	11T633117	4920761	11T632905
7/21/2009	left bank	4920950	11T633171	4920732	11T632852
7/22/2009	left bank	4919103	11T630244	4918942	11T629831
7/22/2009	right bank	4919098	11T630197	4919038	11T629671
Elk Creek					
7/23/2009	entire stream	4918798	11T629518	4918816	11T628454
7/23/2009	right bank	4918810	11T629464	4918764	11T628873
7/23/2009	left bank	4918810	11T629464	4918687	11T628785
7/24/2009	both sides	4919447	11T627388	4919447	11T626271
7/24/2009	both sides	4918764	11T628873	4919272	11T628262
Marsh Creek					
7/27/2009	right bank	4917109	11T646305	4916349	11T646994
7/27/2009	left bank	4917116	11T646294	4916112	11T647121
7/28/2009	entire stream	4916111	11T647143	4915902	11T647187
7/28/2009	left bank	4915902	11T647187	4915427	11T647684
7/28/2009	right bank	4915902	11T647187	4915519	11T647533
Sulphur Creek					
7/28/2009	left bank	4932542	11T630439	4932551	11T630405
7/28/2009	right bank	4932542	11T630439	4932551	11T630405
7/29/2009	right bank	4932551	11T630405	4932401	11T629155
7/29/2009	left bank	4932551	11T630405	4932402	11T629315
Cape Horn Creek					
7/29/2009	left bank	4917249	11T645716	4916237	11T645243
7/29/2009	right bank	4917245	11T645716	4916237	11T642543
7/30/2009	right bank	4916142	11T645120	4915696	11T644580
7/30/2009	left bank	4916142	11T645120	4915725	11T644618
Valley Creek					
7/31/2009	right bank	4899448	11T661311	4899696	11T660870
7/31/2009	left bank	4899454	11T661237	4899442	11T661143
7/31/2009	both sides	4899698	11T660732	4899842	11T660510
8/1/2009	both sides	4901888	11T659290	4902024	11T659251
8/1/2009	left bank	4900596	11T659708	4900759	11T659784
8/1/2009	both sides	4900562	11T659784	4900759	11T659557
8/3/2009	both sides	4904128	11T658912	4904340	11T658853
8/3/2009	right bank	4903769	11T659026	4904241	11T658968
8/3/2009	left bank	4903799	11T659028	4904546	11T658779
Upper Big Creek					
8/6/2009	left bank	4997268	11T632315	4996652	11T631558
8/6/2009	right bank	4997268	11T632315	4996652	11T631558
8/7/2009	left bank	4996652	11T631558	4995564	11T631329
8/7/2009	right bank	4996652	11T631558	4995564	11T631329

Appendix Table 2b. Continued.

Streams and dates	Section covered	UTM Start		UTM End	
		northing	easting	northing	easting
Lower Big Creek					
8/12/2009	right bank	4996497	11T670264	4996756	11T669161
8/12/2009	left bank	4996454	11T670250	4996738	11T669144
8/13/2009	right bank	4996750	11T669161	4996800	11T668395
8/13/2009	left bank	4996750	11T669161	4996836	11T668235
8/14/2009	left bank	4996768	11T668072	4996869	11T667120
8/14/2009	right bank	4996843	11T668248	4996869	11T667120
Loon Creek					
8/6/2009	right bank	4941374	11T674313	4941500	11T674246
8/6/2009	left bank	4941374	11T674313	4941300	11T674246
8/7/2009	right bank	4941500	11T674246	4940395	11T673379
8/7/2009	left bank	4941500	11T674246	4940395	11T673379
Camas Creek					
8/9/2009	left bank	4968496	11T696365	4967665	11T697023
8/9/2009	right bank	4968496	11T696365	4967256	11T697212
8/10/2009	left bank	4967665	11T697023	4967395	11T697187
8/10/2009	right bank	4967256	11T697212	4966769	11T697641
Herd Creek					
8/11/2009	left bank	4892117	11T716229	4891694	11T716714
8/11/2009	right bank	4892117	11T716229	4891694	11T716714
8/12/2009	left bank	4891694	11T716714	4891437	11T716822
8/12/2009	right bank	4891694	11T716714	4891430	11T716851
South Fork Salmon River					
8/17/2009	left bank	4944116	11T603590	4943394	11T603616
8/17/2009	right bank	4944116	11T603590	4943471	11T603611
8/18/2009	left bank	4943417	11T603619	4943116	11T603504
8/18/2009	right bank	4943417	11T603619	4943116	11T603504
West Fork Chamberlain Creek					
8/18/2009	entire stream	5027451	11T642008	5027662	11T641664
Chamberlain Creek					
8/19/2009	right bank	5026320	11T642257	5025879	11T641751
8/19/2009	left bank	5026320	11T642257	5026033	11T641932
Secesh River					
8/20/2009	left bank	5005767	11T592917	5007197	11T593508
8/20/2009	right bank	5005748	11T592960	5007219	11T593490
8/21/2009	left bank	5007192	11T593508	5007192	11T593641
8/21/2009	right bank	5007206	11T593478	5008074	11T593656
Lake Creek					
8/22/2009	right bank	5012377	11T586069	5012871	11T585863
8/22/2009	left bank	5012327	11T586069	5012785	11T585842

Appendix Table 3. Summary of mortality and rejection rates during PIT tagging of wild Chinook salmon parr collected from Idaho streams during July and August 2009. Number rejected includes; fish too small to tag, precocious males, injured fish, fish collected for genetic evaluation, previously tagged fish, and in some cases extra collected fish. The portion of rejects that were precocious males is shown in parentheses. There were also three lost tags, one from Camas Creek, one from Herd Creek and one from West Fork Chamberlain Creek.

					Observed mortality			
					Collection	Delayed	Total	
Stream	Number collected	Number tagged	Number rejected	Rejected (%)	and handling	post-tagging	N	(%)
Bear Valley Creek	1,184	1,028	156 (6)	13.2	28	0	28	2.4
Elk Creek	1,121	1,004	117 (14)	10.4	14	0	14	1.2
Marsh Creek	1,313	1,002	311 (5)	23.7	20	0	20	1.5
Cape Horn Creek	1,228	676	552 (40)	45.0	14	0	14	1.1
Sulphur Creek	1,046	1,006	40 (10)	3.8	18	0	18	1.7
Valley Creek	3,662	2,516	1,146 (28)	31.3	51	0	51	1.4
Loon Creek	816	743	75	9.2	19	2	21	2.6
Camas Creek	600	533	68	11.3	14	0	14	2.3
Herd Creek	1,074	1,040	35	3.3	20	0	20	1.9
Big Creek (upper)	1,701	1,108	594 (28)	34.9	49	1	50	2.9
Big Creek (lower)	1,588	1,436	153	9.6	81	1	82	5.2
W F Chamberlain Cr	1,248	796	453	36.3	0	0	0	0.0
Chamberlain Cr	631	564	69 (1)	10.9	2	2	4	0.6
S. F. Salmon R	1,113	1,001	112	10.1	11	0	11	1.0
Secesh River	1,464	763	703 (5)	48.0	19	2	21	1.4
Lake Creek	413	142	271 (2)	65.6	9	0	9	2.2
Total/average	20,202	15,358	4,855 (139)	24.0	369	8	377	1.9

Appendix Table 4a. Accumulated and 2010 passage dates at Lower Granite Dam for PIT-tagged wild spring/summer Chinook salmon smolts from streams in Idaho. Dashes indicate years for which no parr were tagged the previous summer. Asterisks indicate numbers detected were insufficient to estimate migration timing.

	Percentile passage dates at Lower Granite Dam			
Year	10th	50th	90th	Range
Bear Valley Creek				
1990	19 April	05 May	31 May	11 April-18 July
1991	03 May	20 May	12 June	18 April-23 June
1992	15 April	02 May	24 May	07 April-28 June
1993	29 April	16 May	22 June	22 April-27 July
1994	22 April	06 May	29 May	16 April-15 July
1995	28 April	18 May	12 June	13 April-20 July
1996-1997	---	---	---	---
1998	25 April	06 May	23 May	31 March-25 June
1999	23 April	03 May	07 June	20 April-21 June
2000	18 April	07 May	02 June	14 April-02 July
2001	08 May	16 May	28 May	26 April-17 June
2002	16 April	04 May	31 May	12 April-26 June
2003	14 April	05 May	28 May	12 April-14 June
2004	15 April	07 May	28 May	13 April-05 July
2005	20 April	05 May	23 May	20 April-10 June
2006	13 April	01 May	19 May	11 April-20 May
2007	18 April	03 May	13 May	08 April-24 May
2008	30 April	14 May	27 May	24 April-10 June
2009	22 April	01 May	27 May	18 April-16 June
2010	25 April	18 May	07 June	25 April-12 June
Elk Creek				
1990	---	---	---	---
1991	03 May	20 May	16 June	25 April-24 June
1992	11 April	30 April	28 May	05 April-17 July
1993	02 May	16 May	11 June	21 April-26 June
1994	23 April	04 May	21 May	18 April-09 July
1995	18 April	11 May	05 June	10 April-09 July
1996-1997	---	---	---	---
1998	07 April	02 May	15 May	04 April-21 June
1999	21 April	03 May	27 May	01 April-08 July
2000	15 April	28 April	19 May	13 April-28 May
2001	30 April	11 May	27 May	30 April-27 May
2002	16 April	29 April	02 June	13 April-05 July
2003	20 April	06 May	29 May	31 March-30 May
2004	18 April	08 May	04 July	14 April-12 July
2005	27 April	11 May	29 May	18 April-12 June
2006	15 April	27 April	26 May	06 April-11 June
2007	16 April	02 May	14 May	14 April-31 May
2008	02 May	11 May	23 May	25 April-16 June
2009	25 April	30 April	18 May	19 April-07 June
2010	23 April	01 May	04 June	22 April-19 June

Appendix Table 4a. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
Sulphur Creek				
1990	18 April	30 April	31 May	11 April-27 June
1991	---	---	---	---
1992	16 April	03 May	23 May	10 April-01 June
1993	28 April	16 May	12 June	24 April-28 June
1994	---	---	---	---
1995	02 May	23 May	09 June	11 April-09 July
1996-1999	---	---	---	---
2000	15 April	07 May	24 May	12 April-30 May
2001-2002	---	---	---	---
2003	02 May	25 May	08 May	22 April-24 June
2004	10 April	25 April	11 May	02 April-24 May
2005	01 May	07 May	22 May	22 April-05 June
2006	11 April	28 April	17 May	11 April- 17 May
2007	---	---	---	---
2008	03 May	12 May	02 June	27 April-04 June
2009	22 April	29 April	18 May	02 April-21 May
2010	26 April	06 May	23 May	25 April-06 June
Cape Horn Creek				
1990	---	---	---	---
1991	24 April	16 May	28 May	19 April-06 June
1992	12 April	28 April	30 May	10 April-01 June
1993	08 May	19 May	26 June	05 May-01 July
1994	---	---	---	---
1995	29 April	14 May	19 June	14 April-28 July
1996-1998	---	---	---	---
1999	29 April	22 May	29 May	25 April-12 June
2000	01 May	24 May	01 June	20 April-09 July
2001-2002	---	---	---	---
2003	21 April	17 May	01 June	15 April-18 June
2004	15 April	04 May	24 May	14 April-28 May
2005	29 April	09 May	24 May	11 April-29 May
2006	23 April	30 April	14 June	22 April-14 June
2007	13 April	06 May	19 May	09 April-20 May
2008	03 May	18 May	23 May	25 April-03 June
2009	---	---	---	---
2010	28 April	08 May	26 May	27 April-20 June
Camas Creek				
1993	03 May	16 May	27 May	24 April-24 June
1994	30 April	15 May	26 May	24 April-11 July
1995	27 April	12 May	05 June	17 April-11 June
1996-1999	---	---	---	---
2000	26 April	25 May	02 June	13 April-24 June
2001-2002	---	---	---	---
2003	02 May	24 May	30 May	26 April-06 June
2004	18 April	08 May	24 May	16 April-04 June
2005	29 April	07 May	28 May	12 April-19 June
2006	20 April	30 April	17 May	20 April-03 June
2007	23 April	06 May	16 May	19 April-19 May
2008	05 May	14 May	21 May	27 April-31 May
2009	25 April	08 May	22 May	25 April-05 June
2010	25 April	08 May	26 May	24 April-07 June

Appendix Table 4a. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
Marsh Creek				
1990	17 April	29 April	31 May	09 April-01 July
1991	26 April	20 May	09 June	17 April-18 June
1992	17 April	07 May	02 June	10 April-13 July
1993	29 April	15 May	27 May	24 April-10 August
1994	23 April	04 May	18 May	16 April-08 August
1995	17 April	09 May	24 May	11 April-08 July
1996-1998	---	---	---	---
1999	21 April	01 May	25 May	11 April-13 June
2000	21 April	28 April	27 May	14 April-16 June
2001	---	---	---	---
2002	18 April	04 May	23 May	14 April-26 May
2003	14 April	05 May	29 May	03 April-09 June
2004	16 April	28 April	10 May	03 April-30 May
2005	27 April	06 May	18 May	22 April-04 June
2006	12 April	30 April	18 May	11 April-03 June
2007	---	---	---	---
2008	29 April	07 May	18 May	24 April-20 May
2009	23 April	30 April	18 May	20 April-22 May
2010	27 April	10 May	24 May	24 April-06 June
Valley Creek				
1989	24 April	14 May	12 June	09 April-17 June
1990	16 April	08 May	05 June	12 April-29 June
1991	11 May	20 May	20 June	21 April-13 July
1992	15 April	30 April	27 May	13 April-04 June
1993	30 April	16 May	02 June	24 April-06 June
1994	24 April	04 May	03 June	22 April-09 June
1995	04 May	02 June	08 July	22 April-18 July
1996-1998	---	---	---	---
1999	24 April	13 May	12 June	19 April-01 July
2000	20 April	12 May	29 May	13 April-14 July
2001	10 May	19 May	01 June	28 April-03 July
2002	24 April	20 May	03 June	19 April-19 June
2003	14 April	17 May	28 May	01 April-31 May
2004	25 April	11 May	26 May	04 April-16 June
2005	27 April	15 May	08 June	23 April-20 June
2006	30 April	24 May	15 June	16 April-17 June
2007	20 April	03 May	20 May	13 April-24 May
2008	28 April	11 May	26 May	21 April-06 June
2009	24 April	04 May	04 June	10 April-18 June
2010	30 April	13 May	28 May	27 April-22 June
Loon Creek				
1993	05 May	12 May	17 May	03 May-5 June
1994	29 April	10 May	24 May	22 April-07 June
1995	23 April	11 May	28 May	13 April-07 June
1996-1998	---	---	---	---

Appendix Table 4a. Continued.

	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
Loon Creek (Continued)				
1999	30 April	18 May	27 May	22 April-16 June
2000	22 April	08 May	24 May	14 April-01 June
2001-2002	---	---	---	---
2003	30 April	17 May	28 May	21 April-30 May
2004	23 April	05 May	15 May	15 April-26 May
2005	04 May	10 May	24 May	20 April-03 June
2006	20 April	02 May	19 May	10 April- 21 May
2007	---	---	---	---
2008	07 May	17 May	26 May	28 April-29 May
2009	24 April	30 April	19 May	16 April-21 May
2010	27 April	11 May	25 May	23 April-04 June
Herd Creek				
1992	14 April	20 April	10 May	13 April-18 May
1993	26 April	30 April	18 May	26 April-31 May
1994	***	***	***	***
1995	18 April	03 May	14 May	11 April-28 May
1996-1998	---	---	---	---
1999	20 April	29 April	10 May	30 March-20 May
2000	16 April	25 April	18 May	14 April-19 May
2001	30 April	04 May	14 May	28 April-07 June
2002	***	***	***	***
2003	16 April	03 May	26 May	06 April-29 May
2004	16 April	30 April	10 May	12 April-21 June
2005	27 April	07 May	22 May	20 April-13 June
2006	16 April	25 April	06 May	10 April-16 May
2007	***	***	***	***
2008	29 April	10 May	19 May	24 April-23 May
2009	---	---	---	---
2010	29 April	08 May	24 May	25 April-06 June
South Fork Salmon River				
1989	25 April	13 May	14 June	16 April-20 June
1990	---	---	---	---
1991	20 April	16 May	10 June	17 April-13 July
1992	14 April	29 April	27 May	07 April-27 July
1993	29 April	16 May	02 June	26 April-28 June
1994	27 April	15 May	28 June	22 April-09 July
1995	20 April	10 May	10 June	13 April-13 July
1996	19 April	15 May	09 June	19 April-03 July
1997	13 April	28 April	12 June	07 April-15 June
1998	25 April	12 May	15 June	02 April-07 August
1999	31 March	04 May	01 June	27 March-11 June
2000	20 April	18 May	31 May	12 April-20 July
2001	29 April	14 May	01 June	26 April-07 July
2002	15 April	03 May	24 May	11 April-09 June
2003	19 April	16 May	03 June	19 April-12 June

Appendix Table 4a. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
South Fork Salmon River (continued)				
2004	16 April	10 May	02 June	08 April-19 June
2005	28 April	12 May	30 May	22 April-19 June
2006	28 April	11 May	16 June	27 April-18 June
2007-2008	---	---	---	---
2009	24 April	03 May	26 May	02 April-30 May
2010	25 April	05 May	20 May	23 April-05 June
Big Creek (upper)				
1990	27 April	30 May	22 June	17 April-18 July
1991	18 May	10 June	26 June	26 April-01 July
1992	22 April	08 May	03 June	15 April-26 June
1993	08 May	18 May	26 May	26 April-15 June
1994	03 May	19 May	19 July	25 April-30 August
1995	05 May	23 May	09 June	02 May-26 June
1996-1998	---	---	---	---
1999	28 April	14 May	03 June	25 April-19 June
2000	30 April	27 May	14 June	15 April-29 June
2001- 2002	---	---	---	---
2003	06 May	25 May	01 June	01 May-21 June
2004	18 April	12 May	05 June	15 April-17 June
2005	27 April	07 May	23 May	20 April-07 June
2006	26 April	08 May	25 May	19 April-10 June
2007	19 April	06 May	20 May	15 April-18 June
2008	06 May	20 May	23 May	25 April-05 June
2009	26 April	19 May	28 May	22 April-07 June
2010	01 May	20 May	05 June	25 April-13 June
Big Creek (lower)/Rush Creek[a]				
1993	24 April	29 April	13 May	21 April-16 May
1994	23 April	29 April	11 May	21 April-15 June
1995	19 April	01 May	14 May	11 April-05 June
1996-1998	---	---	---	---
1999	19 April	28 April	23 May	04 April-30 May
2000	19 April	30 April	13 May	16 April-26 May
2001	---	---	---	---
2002	15 April	25 April	07 May	12 April-22 May
2003	14 April	26 April	18 May	12 April-25 May
2004	15 April	23 April	04 May	06 April-15 May
2005	22 April	02 May	09 May	06 April-15 May
2006	11 April	22 April	03 May	10 April-22 May
2007	18 April	27 April	06 May	06 April-12 May
2008	29 April	12 May	20 May	23 April-20 May
2009	24 April	28 April	07 May	03 April-21 May
2010	24 April	29 April	06 May	22 April-05 June

Appendix Table 4a. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
Chamberlain Creek/West Fork Chamberlain Creek[b]				
1992	15 April	26 April	03 June	12 April-24 June
1993	28 April	15 May	23 June	23 April-22 July
1994	24 April	01 May	05 July	24 April-04 September
1995	16 April	09 May	20 June	12 April-22 September
1996-2001	---	---	---	---
2002	26 April	04 May	20 May	18 April-29 May
2003	23 April	20 May	26 May	21 April-26 May
2004	11 April	24 April	10 May	07 April-23 June
2005	26 April	03 May	13 May	20 April-30 May
2006	15 April	01 May	08 May	14 April-19 May
2007	17 April	02 May	11 May	17 April-24 May
2008	---	---	---	---
2009	24 April	29 April	18 May	13 April-25 June
2010	24 April	30 April	21 May	23 April-08 July
Secesh River				
1989	20 April	27 April	09 June	09 April-19 July
1990	14 April	22 April	07 June	10 April-13 July
1991	20 April	27 April	14 June	13 April-20 July
1992	13 April	29 April	04 June	05 April-03 July
1993	26 April	16 May	16 June	22 April-15 July
1994	22 April	26 April	11 July	21 April-07 August
1995	14 April	01 May	24 May	10 April-10 July
1996	14 April	25 April	29 May	12 April-15 July
1997	10 April	18 April	04 May	04 April-11 July
1998	08 April	24 April	28 May	03 April-06 July
1999	03 April	23 April	25 May	29 March-21 June
2000	13 April	23 April	04 June	12 April-11 July
2001	16 April	28 April	13 May	06 April-13 June
2002	13 April	21 April	17 May	11 April-01 July
2003	18 April	30 April	01 June	03 April-04 July
2004	04 April	27 April	28 May	01 April-13 June
2005	23 April	03 May	26 May	04 April-19 June
2006	13 April	24 April	23 May	08 April-08 June
2007	09 April	22 April	16 May	05 April-23 May
2008	---	---	---	---
2009	19 April	28 April	17 May	11 April-02 June
2010	20 April	28 April	06 June	20 April-22 June
Lake Creek				
1989	23 April	02 May	16 June	12 April-01 July
1990	---	---	---	---
1991	---	---	---	---
1992	---	---	---	---
1993	23 April	09 May	22 June	22 April-25 June

Appendix Table 4a. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
Lake Creek (continued)				
1994	21 April	28 April	19 May	20 April-24 June
1995	17 April	10 May	10 June	14 April-20 July
1996	15 April	21 April	19 May	15 April-02 June
1997	11 April	25 April	02 July	07 April-22 September
1998	04 April	25 April	26 May	02 April-16 July
1999	20 April	26 April	27 May	08 April-20 June
2000	13 April	04 May	04 June	13 April-18 July
2001	---	---	---	---
2002	16 April	29 April	03 June	13 April-03 June
2003	06 April	06 May	04 June	06 April-20 June
2004	14 April	25 April	28 May	09 April-16 June
2005	20 April	28 April	29 May	19 April-19 June
2006	17 April	28 April	19 May	17 April-19 May
2007	08 April	27 April	03 May	08 April-14 May
2008	30 April	07 May	23 May	25 April-24 May
2009	23 April	03 May	30 May	04 April-20 June
2010	***	***	***	***

[a] No fish were tagged in Rush Creek from 2005 to 2010.

[b] No fish were tagged in Chamberlain Creek in 1992, 2002, and 2006.

Appendix Table 4b. Accumulated and 2010 passage dates at Lower Granite Dam for PIT-tagged wild spring/summer Chinook salmon smolts from streams in Oregon. Dashes indicate years for which no parr were tagged the previous summer. Asterisks indicate numbers detected were insufficient to estimate migration timing.

	Percentile passage dates at Lower Granite Dam			
Year	10th	50th	90th	Range
Catherine Creek				
1991	01 May	14 May	08 June	17 April-23 June
1992	16 April	01 May	21 May	09 April-29 June
1993	06 May	18 May	05 June	29 April-26 June
1994	25 April	11 May	20 May	13 April-26 July
1995	01 May	19 May	09 June	26 April-02 July
1996[a]	19 April	13 May	29 May	14 April-14 June
1997	08 May	14 May	01 June	24 April-10 June
1998	28 April	21 May	28 May	24 April-04 June
1999	26 April	25 May	15 June	26 April-26 June
2000	30 April	08 May	23 May	12 April-06 June
2001	29 April	17 May	17 June	28 April-03 July
2002	24 April	10 May	18 June	15 April-01 July
2003	26 April	10 May	09 June	14 April-09 June
2004	22 April	15 May	11 June	15 April-25 June
2005	20 April	12 May	23 May	14 April-02 June
2006	28 April	16 May	30 May	26 April-06 June
2007	19 April	29 April	17 May	19 April-19 May
2008	06 May	07 June	02 July	30 April-02 July
2009	24 April	13 May	21 May	12 April-13 June
2010	29 April	04 June	19 June	24 April-21 June
Grande Ronde River (upper)				
1989	12 May	06 June	19 June	27 April-22 July
1990	---	---	---	---
1991	---	---	---	---
1992	---	---	---	---
1993	05 May	16 May	25 May	23 April-20 June
1994	28 April	23 May	07 July	23 April-29 August
1995	27 April	29 May	12 June	12 April-01 July
1996[b]	26 April	17 May	29 May	19 April-06 June
1997-2010	---	---	---	---
Imnaha River (lower)				
1989	11 April	30 April	11 May	04 April-05 June
1990	10 April	18 April	09 May	05 April-27 May
1991	20 April	01 May	13 May	14 April-15 May
1992	10 April	21 April	03 May	06 April-21 May
1993-2010	---	---	---	---
Imnaha River (upper)				
1993	24 April	14 May	28 May	15 April-23 June
1994	24 April	08 May	09 June	20 April-11 August
1995	13 April	02 May	03 June	10 April-07 July
1996	16 April	26 April	18 May	14 April-12 June
1997	11 April	19 April	11 May	03 April-02 June
1998	11 April	28 April	13 May	03 April-24 May
1999	22 April	08 May	26 May	17 April-03 June

Appendix Table 4b. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
Imnaha River (upper) (continued)				
2000	14 April	02 May	24 May	12 April-16 June
2001	21 April	30 April	16 May	08 April-28 May
2002	16 April	04 May	17 May	15 April-31 May
2003	22 April	08 May	26 May	17 April-31 May
2004	19 April	04 May	22 May	18 April-8 June
2005	19 April	03 May	27 May	05 April-11 June
2006	12 April	29 April	15 May	03 April-04 June
2007	13 April	25 April	13 May	05 April-24 May
2008	17 April	06 May	22 May	14 April-01 June
2009	13 April	05 May	20 May	04 April-09 June
2010	24 April	10 May	09 June	23 April-24 June
Lostine River				
1990	***	***	***	***
1991	29 April	14 May	26 May	20 April-09 July
1992	16 April	30 April	11 May	12 April-02 June
1993	23 April	03 May	17 May	17 April-01 June
1994	22 April	30 April	16 May	19 April-07 June
1995	12 April	02 May	17 May	08 April-09 June
1996	23 April	15 May	07 June	17 April-19 June
1997	17 April	28 April	16 May	09 April-21 May
1998	---	---	---	---
1999	30 March	09 May	27 May	29 March-29 May
2000	13 April	08 May	25 May	13 April-03 June
2001	25 April	09 May	22 May	10 April-12 June
2002	11 April	21 April	13 May	28 March-29 May
2003	13 April	08 May	26 May	11 April-03 June
2004	15 April	04 May	05 June	14 April-15 June
2005	16 April	29 April	26 May	05 April-18 June
2006	14 April	26 April	16 May	05 April-09 June
2007	14 April	03 May	15 May	05 April-21 May
2008	22 April	11 May	29 May	10 April-14 June
2009	13 April	28 April	15 May	02 April-21 May
2010	27 April	14 May	06 June	24 April-17 June
Minam River				
1999	08 April	28 April	25 May	31 March-02 June
2000	15 April	03 May	22 May	10 April-29 May
2001	25 April	07 May	23 May	08 April-12 June
2002	17 April	03 May	20 May	16 April-31 May
2003	17 April	13 May	29 May	13 April-01 June
2004	15 April	28 April	28 May	08 April-31 May
2005	19 April	08 May	21 May	08 April-08 June
2006	13 April	08 May	20 May	11 April-06 June
2007	11 April	27 April	12 May	04 April-22 May
2008	23 April	08 May	21 May	17 April-11 June
2009	24 April	13 May	22 May	11 April-06 June
2010	25 April	15 May	05 June	23 April-16 June

a Includes fish tagged from summer 1995 through spring 1996.

b All fish tagged at traps in fall or spring for this migration year.

Appendix Table 5. Detections during 2010 of PIT-tagged smolts by date at four Snake River dams and three Columbia River dams for 1,028 wild Chinook salmon from Bear Valley Creek released 21-22 July 2009. Release sites were 629-632 km above Lower Granite Dam. Plus 1 detected at the trawl on 24 May 2010.

			Bear Valley Creek					
	Lower Granite		First detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
25 Apr	2	12						
26 Apr								
27 Apr			1					
28 Apr	1	4	1					
29 Apr			2					
30 Apr					1			
01 May	3	10	1		1	1		
02 May			1					
03 May	1	3						
04 May	3	10	1					
05 May	2	7						
06 May								
07 May	1	3				2		
08 May								
09 May			1			1		
10 May						2		
11 May	1	4				2		
12 May			1			1		
13 May								1
14 May					1			
15 May								
16 May						1	1	
17 May								
18 May	2	7		1		2		1
19 May	2	6	1			2		
20 May	1	2		1		1		
21 May						1		
22 May								
23 May	1	2	1					
24 May	2	6				1		
25 May							1	1
26 May	2	6	1			1		
27 May								1
28 May								
29 May						1		
01 Jun								
03 Jun				1				
04 Jun	2	7						
05 Jun								
06 Jun	1	6	1					
07 Jun	2	11	3	1				
08 Jun			1					
11 Jun			1	1				
12 Jun	1	3						
13 Jun							1	
20 Jun			1					
Totals	30	109	20	5	3	19	3	4

Appendix Table 6. Detections at Snake and Columbia River dams during 2010 of the 1,004 wild PIT-tagged Chinook salmon smolts released 23-24 July 2009 from Elk Creek. Release sites were 634-639 km above Lower Granite Dam (1 fish was detected in the estuary trawl on 15 May).

	Elk Creek							
	Lower Granite		First detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
20 Apr								
21 Apr								
22 Apr	1	8						
23 Apr	1	6						
25 Apr	1	6						
26 Apr	2	10						
27 Apr								
28 Apr	2	8	3					
29 Apr			4					
30 Apr	4	15	3					
01 May	1	3	4			1		
02 May	1	3	1					
03 May			5			3		
04 May					1	1		
05 May								
06 May	1	4				3		1
07 May	1	3	1			3		
08 May	1	3				2	1	
09 May			2			3		
10 May						2		
11 May								
12 May								
13 May						1		1
14 May						1		
15 May								1
16 May						1		1
17 May	1	5	1					
18 May	1	4				3		
19 May						4		
20 May				1		2		
21 May	1	2	1	1	1	1		
22 May	2	4	1					1
23 May			1					
24 May								1
25 May	1	3		1		1		
26 May								
27 May								
28 May								
29 May			2					
30 May	1	4		1				1
31 May								
01 Jun	1	5						1

Appendix Table 6. Continued.

	Elk Creek							
	Lower Granite		First detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
03 Jun								
04 Jun	1	4		1		1		
05 Jun			2					
06 Jun	1	6	2			1		
07 Jun			3					
09 Jun				1				
11 Jun				1				
12 Jun				1			1	
19 Jun	1	3						
04 Jul								1
08 Jul						1		
Totals	27	108	36	8	2	35	2	9

Appendix Table 7. Detections at Snake and Columbia River dams during 2010 of the 1,002 wild PIT-tagged Chinook salmon smolts released 27-28 July 2009 from Marsh Creek. Release sites were 632-635 km above Lower Granite Dam.

	Marsh Creek							
	Lower Granite		First detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
21 Apr								
22 Apr								
23 Apr								
24 Apr	1	6						
25 Apr	1	6						
26 Apr	1	5						
27Apr	1	5						
28 Apr	1	4	1					
29 Apr	5	21	5					
30 Apr	3	12	2					
01 May	4	13	1					
02 May	1	3	2					
03 May	1	3				1		
04 May								
05 May	1	4						
06 May	1	4	1			1		
07 May	1	3					1	
08 May	1	3	1		1			1
09 May			1			2		
10 May	3	12	2			1		
11 May	1	4				3	1	
12 May						1		
13 May	1	6	1					1
14 May	1	6						
15 May						1		
16 May				1				
17 May	1	5		1		1		
18 May	2	7	1	1	1	1		1
19 May	2	6	3	2		3		
20 May	5	11	3			1		1
21 May	4	7	1			1		
22 May	3	7	3	1				
23 May	2	5	1			2		
24 May	1	3	1			1		
25 May	2	6						
26 May	1	3						
27 May			2		1			
28 May	1	3	1					
29 May			2					
30 May								
31 May			1					
03 Jun					1		1	
04 Jun						1	1	
06 Jun	1	6	1					
08 Jun			1	2	2			
09 Jun				2				
10 Jun							1	
13 Jun								1
Totals	54	188	38	10	6	21	5	5

Appendix Table 8. Detections during 2010 of PIT-tagged smolts by date at four Snake River dams and three Columbia River dams for 676 wild Chinook salmon from Cape Horn Creek released 29-30 July 2009. Release sites were 630-635 km above Lower Granite Dam.

	Cape Horn Creek							
	Lower Granite		First detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
27 Apr	2	9						
28 Apr	3	11						
29 Apr			2					
30 Apr	1	4	1					
01 May	2	7						
02 May	3	9	1					
03 May	2	7	2					
04 May	2	6						
05 May	1	4	1					
06 May	1	4						
07 May	2	6	1					
08 May	1	3	1			1		
09 May	1	3				3		
10 May	2	8						
12 May	1	5						
16 May						1		
17 May						2		1
18 May			1	1		1		
19 May	2	6				1		
20 May	5	11	2					
21 May	1	2		1				
22 May	2	4				1		
23 May						1		
24 May	2	6				1		
25 May	2	6			2			1
26 May	1	3					1	
27 May	1	3	4		1			
28 May	1	3						
01 Jun								
02 Jun					1			
03 Jun			1					
04 Jun			1					
05 Jun			1	1				
06 Jun					1			
07 Jun				1		1		
09 Jun							1	
10 Jun				1				
13 Jun							1	
17 Jun	1	3						
20 Jun	1	3						
Totals	43	137	19	5	5	13	3	2

Appendix Table 9. Detections during 2010 of PIT-tagged smolts by date at four Snake River dams and three Columbia River dams for 1,006 wild Chinook salmon from Sulphur Creek released 28-29 August 2009. Fish were released 604-607 km above Lower Granite Dam.

	Sulphur Creek							
	Lower Granite		First detections					
	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
22 Apr								
23 Apr								
24 Apr								
25 Apr	2	12						
26 Apr	2	10						
27 Apr								
28 Apr	4	15	1					
29 Apr	2	8	6					
30 Apr	5	19	1					
01 May	2	7	2					
02 May	3	9	1			2		
03 May	1	3	1			2		
04 May	4	13				1		
05 May	1	4				1		
06 May	2	8				3		
07 May	1	3	1			1		
08 May	3	9				1		
09 May								
10 May			3			1		
11 May	2	9			1	3		
12 May			1					
13 May								
14 May	1	6				1		
15 May	1	6						
16 May	1	6	1	1		1	1	2
17 May			1					
18 May	1	4			2	6	1	
19 May	3	9		1		4		
20 May	3	6	5	1		2	1	2
21 May	6	11	1			2		
22 May	3	7				2		
23 May	1	2					1	1
24 May	3	8			1	1		
25 May						2		
26 May								
27 May	1	3						
28 May				1				
29 May			1			1		
30 May								
31 May						1		1
01 Jun						1		
02 Jun								
03 Jun						1		
04 Jun	1	4	1					
06 Jun	1	6						
08 Jun				2				
11 Jun								
18 Jun								
Totals	60	206	27	6	4	40	4	6

Appendix Table 10. Detections during 2010 of PIT-tagged smolts by date at four Snake River dams and three Columbia River dams for 2,516 wild Chinook salmon from Valley Creek released 31 July-03 August 2009. Release sites were 743-750 km above Lower Granite Dam. Plus 4 were first-detected at the trawl on 15, 22, and 24 May and 10 June.

	Valley Creek							
	Lower Granite		First detections					
Detection Date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
21 Apr								
22 Apr								
23 Apr								
24 Apr								
25 Apr								
26 Apr								
27 Apr	1	5						
28 Apr			1					
29 Apr	1	4	2					
30 Apr	3	12	2					
01 May	2	7	1	1	1			
02 May	2	6						
03 May	1	3						
04 May								
05 May	1	4			1			
06 May	1	4						
07 May			1					
08 May	2	6	1					
09 May	2	7	1					
10 May	1	4	1					1
11 May						3		
12 May								
13 May	1	6						
14 May	1	6	2			1		
15 May	1	6						
16 May								
17 May	1	5				1	1	
18 May						2		
19 May			2	1		3		1
20 May	1	2						
21 May	4	7				1		
22 May	2	4	1				1	
23 May	1	2						
24 May								
25 May	1	3						
26 May			1			1		
27 May	1	3	1					
28 May	2	7	2					
29 May	1	3	1					
30 May			1	1				

Appendix Table 10. Continued.

	Valley Creek							
	Lower Granite		First detections					
Detection Date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
01 Jun	1	5						
02 Jun			1			1		
03 Jun			1					
04 Jun			2					
05 Jun								
06 Jun								1
07 Jun			2	1	1		1	
08 Jun			2				1	1
09 Jun				1				
10 Jun								
11 Jun				1				
12 Jun			1					
13 Jun						1		1
16 Jun								
18 Jun								
22 Jun	1	5						
23 Jun				1				
24 Jun			1					
25 Jun			1					
26 Jun								
Totals	37	126	32	7	3	14	4	5

Appendix Table 11. Detections during 2010 of PIT-tagged smolts by date at four Snake River dams and three Columbia River dams for 532 wild Chinook salmon from Camas Creek released 09-10 August 2009. Release sites were 524-526 km above Lower Granite Dam.

	Camas Creek							
	Lower Granite		First detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
24 Apr	2	12						
25 Apr	1	6						
27 Apr								
28 Apr								
29 Apr								
30 Apr	5	19	3					
01 May	3	10	1					
02 May	1	3						
03 May	2	7						
04 May	2	6						
05 May						1		
06 May	1	4						
07 May	3	9						
08 May	1	3				1	1	
09 May	1	3						
10 May	1	4	1			1		
11 May								
12 May	2	10	1			1		
13 May			1					
14 May			1					1
15 May								
16 May	2	11	2					
17 May			1					
18 May	1	4	2	1		1		
19 May	1	3	1			2		1
20 May	3	6						1
21 May	2	4	1	2		2		
22 May	2	4						
23 May					1			1
24 May								
25 May	2	6						
26 May	2	6						
27 May					1	1		
29 May				1				
30 May	1	4		1				1
31 May							1	
03 Jun					1			
05 Jun	1	5						
07 Jun	1	6						
08 Jun			1	1				
09 Jun			1					
Totals	43	155	17	6	3	10	2	5

Appendix Table 12. Detections during 2010 of PIT-tagged smolts by date at four Snake River dams and three Columbia River dams for 1,039 wild Chinook salmon from Herd Creek released 11-12 August 2009. Fish were released 699-701 km above Lower Granite Dam. Plus 1 first-detection on 25 May at the trawl.

	Herd Creek							
	Lower Granite		First detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
25 Apr	1	6						
26 Apr								
27 Apr	2	9		1				
29 Apr	2	8						
30 Apr	3	12			1			
01 May	2	7	1					
02 May			1					
03 May	3	10						
04 May	1	3						
05 May	5	18	1					
06 May	2	8	1					
07 May	1	3				1		
08 May	1	3	1	1		1		
09 May								
10 May	2	8						
11 May	1	4	1			1		
12 May	1	5		1		2	1	
13 May	1	6	1					1
14 May						1		
15 May	2	13			1			
16 May	1	6						
17 May				1		2		
18 May	1	4	3	2		2		
19 May	2	6		2		5		
20 May	2	4		2		1	1	1
21 May	2	4				3	1	
22 May			1			1		
23 May	2	5	1		1	1		
24 May	2	6	1			2		2
25 May			1				1	
26 May			1	1				
27 May	1	3				1	1	
28 May	1	3						
29 May	1	3						
31 May			1					
02 Jun					1			
03 Jun								
04 Jun			1					
06 Jun	1	6		1				
10 Jun				1	2			
Totals	46	171	17	13	6	24	5	4

Appendix Table 13. Detections during 2010 of PIT-tagged smolts by date at four Snake River dams and three Columbia River dams for 741 wild Chinook salmon from Loon Creek released 06-07 August 2009. Release sites were 550-552 km above Lower Granite Dam. Plus 1 first-detection at the trawl on 29 May.

	Loon Creek							
	Lower Granite		First detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
23 Apr	1	6						
27 Apr	4	19						
28 Apr	2	8						
29 Apr	2	8						
30 Apr	3	12						
01 May	2	7	2					
02 May	4	12	2					
03 May	3	10	3					
04 May	3	10						
05 May	1	4						
06 May	2	8				1		
07 May			1					
08 May	3	9	1					
09 May			1					
10 May	2	8						
11 May	3	13	1		1	1		
12 May	1	5				1		
13 May	1	6	1					
15 May	2	13	2					1
16 May			1	1		2		
17 May	1	5	1					
18 May	1	4				1		
19 May	3	9	2			3		2
20 May	6	13	3			5		1
21 May	6	11	2					
22 May	3	7	1	1		2		
23 May	2	5	1			1		
24 May	1	3				1	1	1
25 May	2	6	1					1
26 May	1	3	1	1		2		1
27 May	1	3	1		1	1		1
28 May			4			1		
29 May	1	3						
30 May			1					
31 May	1	5	1			1		
02 Jun	1	5				1		
03 Jun				1				
04 Jun	1	4						
08 Jun				1				
11 Jun							1	
14 Jun							1	
Totals	70	240	34	5	2	24	3	8

Appendix Table 14. Detections during 2010 of PIT-tagged smolts by date at four Snake River dams and three Columbia River dams for 1,107 wild Chinook salmon from Big Creek (upper) released 06-07 August 2009. Release sites were 535-538 km above Lower Granite Dam. Plus 1 first-detection at the trawl on 14 May.

	Big Creek (upper)							
	Lower Granite		First detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
25 Apr	1	6						
27 Apr	1	5						
29 Apr	1	4						
30 Apr	1	4	1					
01 May	2	7						
02 May			1					
04 May	1	3						
05 May	1	4						
06 May	3	11						
07 May	1	3						
08 May	2	6			1			
09 May	2	7				1		
10 May			2					
11 May	1	4						
12 May			1			2		
13 May	3	17						
14 May			1			2		
15 May			2					1
16 May			1	1		1		
17 May								1
18 May	1	4		2		2		
19 May	3	9	1		1	4		1
20 May	6	13	1			3		1
21 May	1	2				1	1	
22 May	3	7				1	1	
23 May			1					
24 May			3			3		
25 May	1	3						
26 May	2	6	1					
27 May	1	3						
28 May	2	7	2					
29 May	3	10						
30 May	2	8		1				1
31 May	1	5						
02 Jun			1					
03 Jun			1					
04 Jun	4	15					1	
05 Jun	3	14						
06 Jun			1					
07 Jun	2	11	3					
08 Jun			1		1			
09 Jun			1		1			
10 Jun				1				
11 Jun			1	1				
13 Jun	1	3						
16 Jun			1			1		1
25 Jun			1					
Totals	56	198	29	6	4	21	3	6

Appendix Table 15. Detections during 2010 of PIT-tagged smolts by date at four Snake River dams and three Columbia River dams for 1,435 wild Chinook salmon from Big Creek (lower) released 12-14 August 2009. Release sites were 489-491 km above Lower Granite Dam. Plus 1 first-detection at the trawl on 12 May.

	Big Creek (lower)							
	Lower Granite		First detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
22 Apr	1	8						
24 Apr	6	35	1					
25 Apr	5	29	1					
26 Apr	3	14						
27 Apr	10	47	1					
28 Apr	13	49	2					
29 Apr	10	42	10					
30 Apr	7	27	7	1				
01 May	8	26	10	1	2	1		
02 May	5	15	1			1		
03 May	6	20	7			3		
04 May	1	3	3		1	3		
05 May	1	4	2		2	3		
06 May	3	11			1	5		
07 May			2			4		
08 May					2	1		
09 May			1		1			
10 May	1	4	1					1
11 May						2	1	
12 May								1
13 May	1	6	2	1		2		3
14 May			1			2		1
15 May			1		1	1		
16 May					2		1	
17 May								2
18 May			2			3	1	1
19 May	1	3	1	1		2		1
20 May	5	11	1			1		3
21 May						1		1
22 May						1		1
23 May			1					
24 May				1				
25 May							1	
26 May	1	3	1					1
27 May			1					1
28 May	1	3						
05 Jun	1	5						
Totals	90	366	60	5	12	36	4	17

Appendix Table 16. Detections during 2010 of PIT-tagged smolts by date at four Snake River dams and three Columbia River dams for 1,357 wild Chinook salmon from West Fork Chamberlain/Chamberlain Creeks released 18-19 August 2009. Release sites were 437-438 km above Lower Granite Dam.

	West Fork Chamberlain/Chamberlain Creeks							
	Lower Granite		First detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
23 Apr	2	11						
24 Apr	3	18						
25 Apr	3	18	1					
27 Apr	3	14						
28 Apr	5	19	1	1				
29 Apr	4	17	6					
30 Apr	5	19	8					
01 May	6	20	6		3			
02 May			2					
03 May	1	3	2			4		
04 May			2					
05 May	1	4				2		
06 May	1	4				3		
07 May	3	9	1			5		
08 May						1		
09 May					2	1		
10 May	1	4	2		1	1		
11 May				1		1		
12 May						1		
13 May			1			1		1
14 May					1			
15 May	1	6						
16 May						1		
17 May			1					
18 May	1	4	1	1		3		
19 May	1	3		1	1	1		
20 May	1	2	1			1		1
21 May	3	6		1		2	1	
22 May			1				1	
23 May	1	2						
24 May			1					2
25 May					1	1		
26 May			1					1
27 May			1					1
29 May			1					
01 Jun	1	5						
03 Jun					1			
06 Jun	1	6	1					
07 Jun			1					
10 Jun			1					
08 Jul	1	4						
Totals	49	197	43	5	10	29	2	6

Appendix Table 17. Detections during 2010 of PIT-tagged smolts by date at four Snake River dams and three Columbia River dams for 1,001 wild Chinook salmon from South Fork Salmon River released 17-18 August 2009. Release sites were 467-468 km above Lower Granite Dam.

	South Fork Salmon River								
	Lower Granite		First detections						
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville	
23 Apr	1	6							
24 Apr	1	6							
25 Apr	5	29							
26 Apr	2	10							
27 Apr	3	14							
28 Apr	3	11	1						
29 Apr	2	8	5						
30 Apr			2	1					
01 May	3	10	5		2				
02 May	1	3	1						
03 May	3	10	2			3			
04 May						1			
05 May	4	14	1			1			
06 May	5	19				4			
07 May	1	3							
08 May	1	3				3			
09 May			1						
10 May	2	8	2						
11May	1	4	1			3		2	
12 May								1	
13 May			1						
14 May	2	12							
15 May	1	6						1	
16 May	1	6	2			3			
17 May			1			1			
18 May	1	4	1	1		2			
19 May	2	6	1		1	2		2	
20 May	1	2		2		1			
21 May	1	2			1	1		1	
22 May			1			1	1		
23 May	1	2				2			
24 May						3	1		
25 May	1	3				2			
27 May	3	9	1				1		
28 May						1			
29 May						1			
01 Jun			1			1			
02 Jun			1						
03 Jun					1				
04 Jun			1	1					
05 Jun	1	5	1						
08 Jun			1	1					
09 Jun						1			
10 Jun			1						
Totals	53	216	35	6	5	37	3	7	

Appendix Table 18. Detections during 2010 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 761 wild Chinook salmon from Secesh River released 20-21 August 2009. Release sites were 429-431 km above Lower Granite Dam.

	Secesh River							
	Lower Granite		First detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
20 Apr	1	28						
23 Apr	1	6						
24 Apr	2	12						
25 Apr	1	6						
26 Apr	2	10						
27 Apr	2	9						
28 Apr	1	4				1		
29 Apr	4	17	3					
30 Apr	2	8	3					
01 May			3		2			
02 May			3			1		
03 May	2	7	4			3		
04 May			1			4		
05 May								
06 May	1	4				1		
07 May								1
08 May			1			1		1
09 May						1		
11 May					1			
13 May					1			
15 May	1	6						
18 May			1					
19 May						2		
20 May			2					
21 May	2	4						
23 May						1		
24May			1			1		
25 May						1		
30 May	1	4						
31 May	1	5				1		
06 Jun	2	12						
07 Jun			1					
08 Jun	1	5	1	1				
09 Jun			1					
22 Jun	1	2						
Totals	28	147	25	1	4	18	0	2

Appendix Table 19. Detections during 2010 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 142 wild Chinook salmon from Lake Creek released 22 August 2009. Release site was 451 km above Lower Granite Dam. Plus 1 first-detection at the trawl on 10 May.

	Lake Creek							
	Lower Granite		First detections					
Detection date	First detection	Expanded	Little Goose	Lower Monumental	Ice Harbor	McNary	John Day	Bonneville
28 Apr			1					
29 Apr			1					
30 Apr	1	4						
01 May						1		
03 May								
04 May			1					
05 May			1					
06 May						1		
07 May								
08 May								
09 May								
11 May								
12 May								
13 May								
14 May								
16 May								
17 May								
18 May								
19 May								
20 May								
21 May								
22 May	1	2						
23 May								
24 May								
25 May								
26 May								
27 May								
28 May								
30 May								1
31 May								
01 Jun								
03 Jun								
04 Jun								
05 Jun	1	5						
12 Jun			1					
14 Jun								
17 Jun								
03 Jul	1	4						
Totals	4	14	5	0	0	2	0	1

Appendix Table 20. Daily and expanded detections (with estimated detection efficiencies) of PIT-tagged wild spring/summer Chinook salmon smolts from Idaho and Oregon at Lower Granite Dam during 2010, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam.

				Detection at Lower Granite Dam			
				Idaho only		Idaho and Oregon	
Date	Average flow (kcfs)	Average spill (kcfs)	Water temperature (°C)	N	Expanded	N	Expanded (detection efficiency)
01 Apr	33.7	0.0	8.3	0	0	0	0
02 Apr	39.4	0.0	8.4	0	0	0	0
03 Apr	36.2	20.0	8.4	0	0	0	0
04 Apr	31.8	18.8	8.4	0	0	0	
05 Apr	27.7	15.2	8.3	0	0	0	0
06 Apr	30.4	17.8	7.9	0	0	0	0
07 Apr	25.2	12.7	7.7	0	0	0	0
08 Apr	24.9	12.3	7.7	0	0	0	0
09 Apr	26.1	13.5	7.5	0	0	0	0
10 Apr	30.1	17.5	7.7	0	0	0	0
11 Apr	24.3	11.7	7.8	0	0	0	0
12 Apr	24.6	11.8	8.1	0	0	0	0
13 Apr	29.2	16.5	8.4	0	0	0	0
14 Apr	28.0	15.4	8.6	0	0	0	0
15 Apr	32.1	19.3	8.8	0	0	0	0
16 Apr	34.5	20.3	9.4	0	0	0	0
17 Apr	33.2	20.3	9.5	0	0	0	0
18 Apr	39.4	20.5	9.9	0	0	0	0
19 Apr	45.2	20.4	10.6	0	0	0	0
20 Apr	48.4	20.5	11.0	1	28	1	28 (0.036)
21 Apr	51.4	20.2	11.4	0	0	0	0
22 Apr	62.6	20.3	12.2	2	16	2	16 (0.128)
23 Apr	76.2	20.4	12.1	6	34	9	52 (0.174)
24 Apr	69.3	20.5	11.4	15	88	19	112 (0.170)
25 Apr	61.6	20.5	10.4	23	135	24	141 (0.170)
26 Apr	55.4	20.5	10.0	12	58	12	58 (0.207)
27 Apr	53.0	20.6	10.1	29	137	33	156 (0.211)
28 Apr	55.8	20.4	10.0	35	132	39	147 (0.266)
29 Apr	60.3	20.3	9.9	33	138	38	159 (0.239)
30 Apr	59.1	20.4	10.1	43	165	45	173 (0.260)
01 May	65.7	20.5	10.0	40	132	43	142 (0.302)
02 May	58.9	20.6	9.7	21	64	23	70 (0.329)
03 May	58.8	20.4	9.3	26	85	28	92 (0.306)
04 May	62.5	20.5	9.0	17	55	18	58 (0.309)
05 May	55.3	20.3	9.2	19	67	19	67 (0.284)
06 May	52.8	20.6	9.4	24	91	24	91 (0.265)
07 May	52.5	20.6	9.3	15	45	18	54 (0.331)
08 May	51.1	20.5	9.2	16	48	16	48 (0.334)
09 May	49.8	20.6	9.1	6	21	8	27 (0.292)
10 May	50.2	20.5	9.3	15	61	17	69 (0.245)

Appendix Table 20. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Water temperature (°C)	Detection at Lower Granite Dam: Idaho only N	Idaho only Expanded	Idaho and Oregon N	Idaho and Oregon Expanded (detection efficiency)
11 May	50.5	20.5	9.7	10	43	11	48 (0.230)
12 May	47.6	20.5	10.4	5	26	6	31 (0.193)
13 May	51.4	20.4	11.2	8	44	8	44 (0.180)
14 May	52.5	20.3	11.9	5	30	8	48 (0.168)
15 May	56.4	20.7	12.2	9	57	11	69 (0.159)
16 May	60.5	20.5	12.6	5	28	7	39 (0.178)
17 May	65.8	20.6	12.9	4	22	6	33 (0.182)
18 May	77.4	19.0	13.2	12	43	14	50 (0.282)
19 May	93.5	19.0	13.3	22	68	27	84 (0.323)
20 May	106.0	20.6	12.9	39	83	48	102 (0.472)
21 May	103.8	20.6	11.7	33	61	37	68 (0.543)
22 May	89.7	20.7	11.1	21	46	26	57 (0.458)
23 May	80.9	20.6	10.6	11	26	15	35 (0.427)
24 May	74.1	20.6	10.3	11	31	12	34 (0.355)
25 May	73.3	20.6	10.6	12	37	14	43 (0.327)
26 May	69.1	20.5	10.9	10	30	10	30 (0.329)
27 May	70.0	20.6	11.4	9	28	12	38 (0.320)
28 May	71.5	20.6	11.5	8	27	9	30 (0.301)
29 May	73.8	20.8	11.7	6	21	6	21 (0.291)
30 May	75.9	20.7	12.0	5	20	5	20 (0.247)
31 May	73.8	20.7	12.3	3	14	3	14 (0.212)
01 Jun	78.8	20.7	12.4	3	16	3	16 (0.192)
02 Jun	89.7	20.8	12.6	1	5	1	5 (0.197)
03 Jun	128.6	41.4	12.5	0	0	0	0
04 Jun	160.9	69.4	12.2	9	33	13	47 (0.274)
05 Jun	196.5	104.9	11.5	7	32	9	41 (0.222)
06 Jun	207.2	115.6	11.3	8	48	11	65 (0.168)
07 Jun	200.1	108.9	11.6	5	28	6	34 (0.179)
08 Jun	204.0	112.1	12.0	1	5	2	11 (0.187)
09 Jun	181.5	90.5	12.2	0	0	1	5 (0.194)
10 Jun	180.2	89.1	12.3	0	0	0	0
11 Jun	168.0	77.9	12.3	0	0	0	0
12 Jun	151.1	61.8	12.3	1	3	2	5 (0.392)
13 Jun	137.6	48.8	12.6	1	3	2	6 (0.341)
14 Jun	131.0	40.9	13.2	0	0	0	0
15 Jun	130.0	39.9	13.8	0	0	0	0
16 Jun	131.0	41.3	13.9	0	0	1	3 (0.354)
17 Jun	122.3	32.6	13.6	1	3	4	13 (0.308)
18 Jun	113.4	30.2	13.1	0	0	1	3 (0.361)
19 Jun	104.2	20.6	12.5	1	3	3	8 (0.354)
20 Jun	100.6	20.2	12.8	1	3	2	6 (0.337)
21 Jun	107.8	21.8	13.3	0	0	1	3 (0.391)
22 Jun	112.8	24.9	13.5	3	7	4	9 (0.438)

Appendix Table 20. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Water temperature (°C)	Detection at Lower Granite Dam: Idaho only N	Idaho only Expanded	Idaho and Oregon N	Idaho and Oregon Expanded (detection efficiency)
23 Jun	98.6	18.7	13.4	0	0	0	0
24 Jun	93.7	22.1	13.7	0	0	1	4 (0.263)
25 Jun	98.3	19.3	14.5	0	0	0	0
26 Jun	90.3	30.0	15.4	0	0	0	0
27 Jun	85.9	20.5	15.8	0	0	0	0
28 Jun	81.4	19.1	15.8	0	0	0	0
29 Jun	81.5	19.5	16.0	0	0	0	0
30 Jun	79.6	21.5	16.5	0	0	0	0
01 Jul	76.9	21.2	17.1	0	0	0	0
02 Jul	72.2	19.0	17.3	0	0	0	0
03 Jul	62.8	18.8	17.2	1	4	1	4 (0.282)
04 Jul	60.4	18.8	16.9	0	0	0	0
05 Jul	58.2	18.7	16.9	0	0	0	0
06 Jul	56.9	18.7	16.8	0	0	0	0
07 Jul	56.3	18.6	16.8	0	0	0	0
08 Jul	57.4	18.7	16.9	1	4	1	4 (0.267)
09 Jul	51.9	18.7	17.0	0	0	0	0
10 Jul	55.1	18.7	17.2	0	0	0	0

Appendix Table 21. First-time detections of PIT-tagged wild spring/summer Chinook salmon smolts from Idaho during 2010, with associated flows, spill levels, and temperatures at Little Goose Dam.

	Little Goose Dam			
Date	Average flow (kcfs)	Average spill (kcfs)	Water temperature (°C)	Numbers detected
24 Apr	66.8	20.1	11.5	1
25 Apr	60.3	18.1	11.9	2
26 Apr	53.2	15.9	12.2	0
27 Apr	51.6	15.4	12.4	2
28 Apr	55.2	16.6	12.0	12
29 Apr	58.1	17.3	11.3	46
30 Apr	58.9	17.6	10.7	33
01 May	65.3	19.5	10.3	37
02 May	54.9	16.6	10.2	17
03 May	59.9	18.0	10.2	26
04 May	59.9	18.0	10.2	8
05 May	53.6	16.0	10.3	6
06 May	51.7	15.4	10.1	2
07 May	50.6	15.1	9.7	8
08 May	51.5	15.4	9.8	6
09 May	46.3	13.9	9.7	8
10 May	48.8	14.6	10.0	14
11 May	49.4	14.8	10.1	3
12 May	46.0	13.8	10.3	4
13 May	49.4	14.8	10.5	8
14 May	51.1	15.3	11.0	5
15 May	55.9	16.6	11.5	5
16 May	57.4	17.2	12.1	7
17 May	64.6	19.4	12.7	6
18 May	76.3	22.8	13.2	12
19 May	90.1	27.0	13.1	12
20 May	100.4	30.1	13.3	18
21 May	102.4	30.6	13.4	6
22 May	86.1	26.0	13.3	9
23 May	78.6	23.6	12.7	7
24 May	72.2	21.5	12.4	7
25 May	71.8	21.4	11.7	2
26 May	68.4	20.5	11.6	7
27 May	68.6	20.4	11.3	11
28 May	70.0	20.9	11.0	9
29 May	71.6	21.5	11.0	7
30 May	75.4	22.6	11.4	2
31 May	72.7	21.7	11.9	3
01 Jun	77.0	23.0	12.3	1
02 Jun	86.6	25.9	12.5	3
03 Jun	122.5	35.4	12.9	3
04 Jun	148.6	39.2	13.0	6
05 Jun	187.0	78.9	12.9	4
06 Jun	198.6	88.9	12.1	6
07 Jun	192.9	83.8	11.7	13
08 Jun	195.3	86.5	11.7	8
09 Jun	174.9	63.8	12.2	3
10 Jun	173.6	62.1	12.4	3
11 Jun	162.3	51.0	12.6	2
12 Jun	147.0	42.0	12.7	2
16 Jun	129.1	31.1	13.6	1
20 Jun	100.1	30.0	13.9	1
24 Jun	94.9	28.4	14.3	1
25 Jun	98.3	29.5	14.6	2

Appendix Table 22. Daily first-time detections of PIT-tagged wild spring/summer Chinook salmon smolts from Idaho during 2010, with associated flows, spill levels, and temperatures at Lower Monumental Dam.

	Lower Monumental Dam			
Date	Average flow (kcfs)	Average spill (kcfs)	Water temperature (°C)	Numbers detected
27 Apr	52.7	25.3	11.7	1
28 Apr	53.7	23.9	12.0	1
30 Apr	60.2	31.1	12.1	2
01 May	65.3	35.9	11.7	2
08 May	51.8	37.2	10.4	1
11 May	48.2	31.4	10.2	1
12 May	47.2	33.4	10.2	1
13 May	49.1	30.1	10.3	1
16 May	57.3	21.4	10.9	4
17 May	62.9	15.7	11.2	2
18 May	76.5	14.4	11.9	10
19 May	89.0	17.1	12.4	8
20 May	101.3	20.5	12.7	7
21 May	105.4	26.8	13.2	5
22 May	85.1	25.6	13.3	2
23 May	79.9	25.0	13.4	0
24 May	72.9	25.7	13.3	1
25 May	72.1	26.0	13.0	1
26 May	66.8	25.7	12.5	2
27 May	67.9	25.8	12.2	0
28 May	70.3	26.1	11.9	1
29 May	70.3	26.9	11.5	1
30 May	74.9	25.9	11.3	4
03 Jun	123.8	31.3	12.5	2
04 Jun	157.2	41.4	13.0	2
05 Jun	197.3	81.3	13.1	1
06 Jun	212.8	97.0	12.8	1
07 Jun	205.0	90.3	12.1	3
08 Jun	207.5	92.1	11.8	8
09 Jun	183.2	68.4	12.1	4
10 Jun	179.6	64.7	12.3	3
11 Jun	167.6	54.3	12.5	4
12 Jun	150.7	37.2	12.7	1
23 Jun	96.6	17.0	13.7	1

Appendix Table 23. Daily first-time detections of PIT-tagged wild spring/summer Chinook salmon smolts from Idaho at Ice Harbor Dam during 2010, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam.

	Ice Harbor Dam			
Date	Average flow (kcfs)	Average spill (kcfs)	Water temperature (°C)	Numbers detected
30 Apr	62.3	26.7	11.8	2
01 May	66.3	19.8	12.0	11
04 May	61.4	24.3	11.7	2
05 May	56.2	16.8	11.2	3
06 May	54.5	38.4	10.9	1
08 May	54.7	20.5	10.7	4
09 May	45.2	13.5	10.8	3
10 May	51.1	15.3	11.0	1
11 May	48.2	14.4	11.0	3
14 May	52.8	21.7	11.2	2
15 May	57.2	17.0	11.2	2
16 May	59.0	42.5	11.5	2
18 May	79.4	55.5	12.0	3
19 May	90.4	62.0	12.1	3
21 May	108.3	66.5	12.7	2
23 May	80.5	24.2	13.4	2
24 May	73.4	22.0	13.4	1
25 May	72.8	21.8	13.6	3
27 May	68.2	20.5	13.7	4
02 Jun	90.2	26.8	12.2	2
03 Jun	124.3	55.2	12.3	4
06 Jun	216.4	135.8	13.5	1
07 Jun	204.9	123.7	13.1	1
08 Jun	210.4	127.7	12.5	3
09 Jun	187.6	105.0	12.3	1
10 Jun	182.8	99.4	12.4	2
13 Jun	139.8	61.2	13.3	1

Appendix Table 24. Daily first-time detections of PIT-tagged wild spring/summer Chinook salmon smolts from Idaho at McNary Dam during 2010, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam.

	McNary Dam			
Date	Average flow (kcfs)	Average spill (kcfs)	Water temperature (°C)	Numbers detected
28 Apr	165.8	66.6	10.9	1
01 May	182.8	73.8	10.3	4
02 May	154.5	61.9	10.3	4
03 May	180.0	71.9	10.5	19
04 May	174.4	70.3	10.6	10
05 May	189.8	76.1	10.7	8
06 May	153.2	61.6	10.7	22
07 May	190.2	76.3	10.7	16
08 May	159.0	63.8	10.5	12
09 May	175.1	70.3	10.8	12
10 May	180.8	72.6	10.8	8
11 May	164.2	65.9	11.0	19
12 May	187.9	75.7	11.2	9
13 May	208.6	84.1	11.2	4
14 May	182.8	73.6	11.5	8
15 May	172.9	69.5	11.7	2
16 May	174.2	70.0	11.8	11
17 May	202.4	81.3	12.3	7
18 May	209.4	84.4	12.4	29
19 May	228.7	92.4	12.7	38
20 May	234.5	94.2	12.6	18
21 May	267.8	107.2	12.6	16
22 May	240.8	96.8	12.4	9
23 May	209.8	84.4	12.4	8
24 May	237.4	95.6	12.4	15
25 May	219.0	88.3	12.9	7
26 May	218.4	87.6	13.0	3
27 May	211.1	84.4	13.0	3
28 May	186.1	74.7	13.0	2
29 May	175.1	70.3	12.8	3
30 May	217.5	87.5	12.7	0
31 May	194.5	78.2	12.9	3
01 Jun	202.8	81.3	13.0	2
02 Jun	233.2	93.7	13.1	2
03 Jun	275.0	116.4	13.1	1
04 Jun	305.4	141.3	12.8	2
06 Jun	320.6	156.3	13.7	1
07 Jun	321.6	157.7	14.0	1
09 Jun	364.1	200.0	13.8	1
13 Jun	319.3	161.4	14.1	1
16 Jun	350.8	179.7	14.3	1
08 Jul	208.7	104.8	17.7	1

Appendix Table 25. Daily first-time detections of PIT-tagged wild spring/summer Chinook salmon smolts from Idaho at John Day Dam during 2010, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam.

	John Day Dam			
Date	Average flow (kcfs)	Average spill (kcfs)	Water temperature (°C)	Numbers detected
07 May	194.3	77.6	11.1	1
08 May	163.6	52.7	11.2	2
11 May	153.9	46.1	11.5	2
12 May	198.8	75.9	11.7	1
16 May	182.0	58.5	12.6	3
17 May	204.1	61.4	12.9	1
18 May	197.8	75.6	12.9	2
20 May	221.3	88.4	13.1	2
21 May	276.1	109.9	13.1	3
22 May	242.9	79.2	12.9	4
23 May	215.8	64.8	12.9	1
24 May	248.7	74.7	13.0	2
25 May	225.6	67.6	13.1	3
26 May	209.4	62.8	13.0	1
27 May	218.7	65.6	13.0	2
31 May	197.2	59.3	13.6	1
03 Jun	298.2	110.5	13.9	1
04 Jun	310.6	121.8	14.0	2
07 Jun	352.5	112.4	14.1	1
08 Jun	361.6	116.1	14.2	1
09 Jun	385.2	124.8	14.4	1
10 Jun	389.4	125.0	14.7	1
11 Jun	408.4	125.0	14.8	1
12 Jun	400.9	124.2	14.7	1
13 Jun	328.2	98.8	14.5	2
14 Jun	317.6	95.1	14.5	1

Appendix Table 26. Daily first-time detections of PIT-tagged wild spring/summer Chinook salmon smolts from Idaho at Bonneville Dam during 2010, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam. Table also includes first-time detections at the PIT-tag trawl (TWX) near the mouth of the Columbia River.

	Bonneville Dam			
Date	Average flow (kcfs)	Average spill (kcfs)	Water temperature (°C)	Numbers detected
06 May	170.3	99.1	11.2	1
07 May	198.0	94.2	11.3	1
08 May	170.6	89.1	11.4	2
10 May	183.9	77.3	11.7	2
11 May	159.8	74.4	11.7	2
12 May	195.5	81.3	11.8	2
13 May	209.1	89.5	12.0	8
14 May	199.5	89.4	12.5	2
15 May	173.2	87.0	12.9	4
16 May	184.9	84.4	13.2	3
17 May	210.9	80.6	13.2	4
18 May	214.7	74.6	13.1	3
19 May	245.6	80.0	13.2	8
20 May	219.8	90.8	13.2	11
21 May	270.8	99.2	13.1	2
22 May	244.7	99.5	13.0	2
23 May	219.2	99.4	12.9	2
24 May	239.5	99.5	12.8	6
25 May	235.4	99.4	13.0	3
26 May	202.1	99.3	13.2	3
27 May	217.3	99.4	13.3	4
30 May	218.6	99.6	13.2	4
31 May	212.5	99.6	13.6	1
01 Jun	213.3	99.6	13.9	1
06 Jun	343.1	124.9	14.4	1
08 Jun	363.7	153.1	14.5	1
13 Jun	343.8	145.1	15.3	2
16 Jun	346.6	151.7	14.5	1
04 Jul	202.3	94.6	16.8	1
	Estuary pair trawl (TWX)			
10 May to 10 Jun				11

Appendix Table 27. Monthly environmental data collected from Marsh Creek (rkm 179.8 from the mouth of the Middle Fork Salmon River) from August 2009 through July 2010.

	Marsh Creek											
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Temperature (°C)												
Min.	5.2	3.2	0.0	-0.1	-0.1	-0.1	-0.1	-0.1	-0.1	0.0	2.4	6.1
Max.	18.6	15.9	8.6	6.1	2.5	3.7	5.4	7.8	9.9	11.7	15.3	18.6
Ave.	11.3	9.2	3.9	1.2	0.1	0.9	1.3	2.3	2.8	4.6	7.8	12.1
Dissolved oxygen (ppm)												
Min.	4.7	4.8	5.8	11.0	11.7	8.7	---	---	9.0	8.9	8.7	8.4
Max.	8.1	9.8	13.7	15.3	15.3	14.3	---	---	13.3	12.0	11.9	11.0
Ave.	6.4	7.0	9.0	13.2	13.1	11.2	---	---	11.1	10.7	10.1	9.4
Specific conductance (µS/cm)												
Min.	50.0	55.0	50.0	56.0	48.0	51.0	55.0	58.0	36.0	28.0	28.0	34.0
Max.	58.0	59.0	72.0	71.0	62.0	62.0	66.0	67.0	74.0	46.0	45.0	58.0
Ave.	55.0	57.1	60.1	62.7	58.3	58.7	60.2	62.8	55.1	39.4	36.8	48.9
Turbidity (ntu)												
Min.	---	---	---	---	---	---	---	---	---	---	---	---
Max.	---	---	---	---	---	---	---	---	---	---	---	---
Ave.	---	---	---	---	---	---	---	---	---	---	---	---
Depth (ft)												
Min.	0.9	0.7	0.5	0.5	0.4	0.0	0.5	0.2	0.3	1.3	2.2	1.0
Max.	1.5	1.4	1.6	1.5	2.4	2.0	1.2	1.3	2.0	2.6	4.4	2.2
Ave.	1.2	1.1	1.0	1.0	1.3	0.9	0.8	0.8	1.2	1.9	2.8	1.7
pH												
Min.	7.4	7.5	7.4	7.6	7.4	7.7	7.8	7.9	6.9	6.8	6.6	7.2
Max.	8.7	8.9	8.8	8.6	8.6	8.8	8.9	8.6	8.4	8.6	8.0	8.3
Ave.	7.8	7.9	7.8	7.9	7.7	8.0	8.2	8.1	7.6	7.3	7.2	7.6

Appendix Table 28. Monthly environmental data collected from the Salmon River near Sawtooth Hatchery (rkm 618) from August 2009 through July 2010.

	Salmon River											
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Temperature (°C)												
Min.	7.8	6.2	2.3	---	---	---	---	---	0.0	1.8	5.6	9.1
Max.	20.1	17.7	10.4	---	---	---	---	---	11.4	13.8	17.0	19.4
Ave.	13.4	11.6	6.5	---	---	---	---	---	5.6	7.0	9.9	14.1
Dissolved oxygen (ppm)												
Min.	1.1	8.2	9.9	---	---	---	---	---	5.9	5.7	5.2	4.4
Max.	11.3	13.8	14.3	---	---	---	---	---	8.9	8.9	7.8	7.8
Ave.	9.1	10.0	11.5	---	---	---	---	---	7.0	7.1	6.6	6.1
Specific conductance (µS/cm)												
Min.	125.0	149.0	147.0	---	---	---	---	---	103.0	79.0	52.0	61.0
Max.	158.0	158.0	158.0	---	---	---	---	---	147.0	120.0	100.0	120.0
Ave.	145.0	155.7	153.2	---	---	---	---	---	125.3	103.6	65.1	88.1
Turbidity (ntu)												
Min.	---	---	---	---	---	---	---	---	---	---	---	---
Max.	---	---	---	---	---	---	---	---	---	---	---	---
Ave.	---	---	---	---	---	---	---	---	---	---	---	---
Depth (ft)												
Min.	1.1	1.0	0.9	---	---	---	---	---	0.9	1.3	1.9	1.4
Max.	1.9	1.7	1.9	---	---	---	---	---	2.0	2.2	3.7	2.7
Ave.	1.4	1.4	1.4	---	---	---	---	---	1.5	1.7	2.8	2.1
pH												
Min.	7.6	7.7	7.8	---	---	---	---	---	7.8	---	---	7.9
Max.	8.8	9.0	9.1	---	---	---	---	---	8.6	---	---	8.6
Ave.	8.1	8.1	8.2	---	---	---	---	---	8.1	---	---	8.3

Appendix Table 29. Monthly environmental data collected from Valley Creek (rkm 609.4 from the mouth of the Salmon River; 0.4 km from the mouth of Valley Creek) from August 2009 through July 2010.

	Valley Creek											
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Temperature (°C)												
Min.	7.5	4.9	0.1	0.0	0.0	0.0	---	---	0.1	0.2	4.6	8.4
Max.	23.1	18.9	10.4	7.3	0.6	0.5	---	---	10.6	13.6	17.2	22.0
Ave.	14.5	12.0	4.7	1.2	0.2	0.2	---	---	4.1	6.5	10.0	14.6
Dissolved oxygen (ppm)												
Min.	4.6	5.4	7.1	10.2	11.1	12.0	---	---	10.8	10.4	9.8	6.7
Max.	7.0	8.3	12.2	12.8	12.9	13.5	---	---	15.3	14.4	13.6	13.0
Ave.	5.8	6.7	9.1	12.0	12.2	12.6	---	---	12.5	12.3	11.4	10.5
Specific conductance (µS/cm)												
Min.	59.0	68.0	60.0	68.0	75.0	77.0	---	---	32.0	37.0	32.0	40.0
Max.	72.0	75.0	81.0	85.0	97.0	87.0	---	---	79.0	56.0	42.0	60.0
Ave.	66.1	72.0	69.4	74.9	84.6	80.4	---	---	56.2	44.0	38.8	50.6
Turbidity (ntu)												
Min.	-1.5	-1.4	-1.1	---	---	---	---	---	---	---	---	---
Max.	25.1	323.4	136.2	---	---	---	---	---	---	---	---	---
Ave.	0.7	8.5	1.4	---	---	---	---	---	---	---	---	---
Depth (ft)												
Min.	1.1	0.9	0.7	0.7	0.5	1.2	---	---	0.9	1.4	2.2	1.3
Max.	1.7	1.5	1.8	1.6	1.6	1.6	---	---	2.6	2.6	4.5	2.5
Ave.	1.4	1.2	1.2	1.2	1.1	1.4	---	---	1.7	1.9	2.9	1.9
pH												
Min.	7.3	7.5	7.3	7.6	7.3	7.4	---	---	7.2	7.3	7.0	7.3
Max.	8.2	8.2	8.1	8.1	8.0	7.8	---	---	8.1	8.1	7.9	8.4
Ave.	7.7	7.8	7.7	7.8	7.5	7.5	---	---	7.6	7.7	7.4	7.9

Appendix Table 30. Monthly environmental data collected from the South Fork Salmon River (rkm 112 from its confluence with the main Salmon River) from August 2009 through July 2010.

South Fork Salmon River												
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Temperature (°C)												
Min.	7.9	5.3	0.0	-0.1	0.0	-0.1	-0.1	0.0	-0.1	-0.1	3.4	7.4
Max.	20.0	17.2	8.1	4.8	0.5	1.9	4.3	6.0	7.4	9.4	15.0	19.2
Ave.	13.7	11.6	3.8	0.9	0.0	0.5	0.8	1.9	2.9	4.5	7.6	13.5
Dissolved oxygen (ppm)												
Min.	8.5	9.4	12.4	---	---	---	---	---	11.0	11.4	9.7	7.6
Max.	11.7	14.2	15.3	---	---	---	---	---	14.4	15.3	14.5	13.4
Ave.	9.9	11.3	14.1	---	---	---	---	---	12.6	13.2	12.3	10.0
Specific conductance (µS/cm)												
Min.	47.0	50.0	41.0	36.0	47.0	40.0	42.0	46.0	37.0	33.0	28.0	32.0
Max.	53.0	58.0	58.0	53.0	61.0	58.0	67.0	63.0	65.0	45.0	36.0	47.0
Ave.	49.6	54.5	49.8	45.9	53.3	51.6	55.8	56.5	49.3	39.5	30.5	40.4
Turbidity (ntu)												
Min.	---	---	---	---	---	---	---	---	---	---	---	---
Max.	---	---	---	---	---	---	---	---	---	---	---	---
Ave.	---	---	---	---	---	---	---	---	---	---	---	---
Depth (ft)												
Min.	1.1	0.8	0.7	0.7	0.6	0.1	0.7	0.7	0.6	1.3	1.1	0.5
Max.	1.5	1.6	2.2	1.9	3.3	3.1	2.3	1.4	2.2	3.0	5.3	1.2
Ave.	1.3	1.3	1.2	1.2	2.0	1.2	1.0	1.1	1.4	1.9	2.3	0.8
pH												
Min.	7.8	7.8	7.6	7.5	7.5	7.7	7.7	7.7	7.0	6.9	6.7	7.2
Max.	8.8	9.2	9.0	8.5	8.3	8.3	8.4	8.8	9.0	8.5	8.5	8.7
Ave.	8.1	8.2	7.9	7.8	7.7	7.8	7.9	8.0	7.5	7.3	7.2	7.6

Appendix Table 31. Monthly environmental data collected from the Secesh River (rkm 27 from its confluence with the South Fork Salmon River) from August 2009 through July 2010.

	Secesh River											
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Temperature (°C)												
Min.	6.5	4.1	-0.1	0.0	0.0	0.1	0.1	0.1	---	---	---	---
Max.	19.5	16.1	7.2	4.3	0.1	0.1	0.1	0.1	---	---	---	---
Ave.	12.6	10.3	2.6	0.4	0.1	0.1	0.1	0.1	---	---	---	---
Dissolved oxygen (ppm)												
Min.	---	9.2	4.0	---	---	---	---	---	---	---	---	---
Max.	---	15.3	15.3	---	---	---	---	---	---	---	---	---
Ave.	---	11.2	8.4	---	---	---	---	---	---	---	---	---
Specific conductance (µS/cm)												
Min.	31.0	33.0	28.0	28.0	28.0	30.0	31.0	31.0	---	---	---	---
Max.	40.0	40.0	38.0	34.0	37.0	31.0	33.0	33.0	---	---	---	---
Ave.	35.2	35.4	33.3	30.1	32.8	30.4	31.5	31.7	---	---	---	---
Turbidity (ntu)												
Min.	---	---	---	---	---	---	---	---	---	---	---	---
Max.	---	---	---	---	---	---	---	---	---	---	---	---
Ave.	---	---	---	---	---	---	---	---	---	---	---	---
Depth (ft)												
Min.	0.8	0.4	0.3	0.7	1.1	1.2	1.9	1.8	---	---	---	---
Max.	1.6	1.2	1.7	2.1	2.9	3.1	3.3	3.7	---	---	---	---
Ave.	1.0	0.8	0.9	1.3	2.1	2.5	2.7	2.8	---	---	---	---
pH												
Min.	6.8	7.3	6.9	6.9	6.6	6.8	6.9	7.0	---	---	---	---
Max.	8.8	9.1	8.7	7.4	7.1	7.0	7.2	7.4	---	---	---	---
Ave.	7.6	7.8	7.4	7.1	6.8	6.9	7.0	7.1	---	---	---	---

Appendix Table 32. Monthly environmental data collected from Big Creek near Taylor Ranch (rkm 10 from its confluence with the Middle Fork Salmon River) from August 2009 through July 2010.

	Big Creek											
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Temperature (°C)												
Min.	8.8	6.7	0.0	0.0	0.0	0.0	0.0	0.1	---	---	---	---
Max.	20.2	17.9	9.2	5.4	0.6	0.7	1.2	6.7	---	---	---	---
Ave.	14.7	12.7	5.2	1.2	0.1	0.3	0.4	2.3	---	---	---	---
Dissolved oxygen (ppm)												
Min.	9.4	10.3	7.9	9.3	9.5	8.3	---	---	---	---	---	---
Max.	15.3	15.3	15.3	13.3	13.9	9.9	---	---	---	---	---	---
Ave.	11.4	12.5	11.9	11.4	11.5	9.1	---	---	---	---	---	---
Specific conductance (µS/cm)												
Min.	101.0	108.0	96.0	95.0	64.0	75.0	83.0	80.0	---	---	---	---
Max.	118.0	129.0	123.0	118.0	142.0	109.0	123.0	97.0	---	---	---	---
Ave.	109.8	118.5	110.2	102.2	94.3	90.6	97.8	85.2	---	---	---	---
Turbidity (ntu)												
Min.	-1.1	-1.4	-1.5	---	---	---	---	---	---	---	---	---
Max.	488.6	2.5	5.5	---	---	---	---	---	---	---	---	---
Ave.	7.5	-0.6	-0.8	---	---	---	---	---	---	---	---	---
Depth (ft)												
Min.	2.5	2.5	2.4	2.3	2.2	1.7	2.3	2.2	---	---	---	---
Max.	3.4	3.4	3.4	3.3	5.3	4.3	3.3	3.1	---	---	---	---
Ave.	3.0	3.0	2.9	2.9	3.4	2.9	2.6	2.6	---	---	---	---
pH												
Min.	7.7	7.7	7.8	8.0	7.3	7.3	7.3	7.3	---	---	---	---
Max.	9.0	9.2	9.1	8.8	8.8	8.5	7.6	8.2	---	---	---	---
Ave.	8.2	8.2	8.2	8.2	8.0	7.6	7.4	7.7	---	---	---	---

Appendix Table 33. Monthly environmental data collected from Bear Valley/Elk Creek (14 rkm from the confluence of Bear Valley Creek with the Middle Fork Salmon River; 50 m below the mouth of Elk Creek) from August 2009 through July 2010.

Bear Valley Creek/Elk Creek												
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Temperature (°C)												
Min.	8.7	5.3	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.3	4.9	9.5
Max.	20.5	17.0	8.1	4.8	0.2	0.3	0.4	1.3	6.4	9.5	15.8	18.8
Ave.	14.0	11.7	4.0	0.7	0.0	0.0	0.0	0.2	1.9	4.5	9.6	14.2
Depth (ft)												
Min.	3.1	2.8	2.7	2.8	3.0	2.5	2.8	2.5	2.6	3.3	3.8	3.2
Max.	3.5	3.5	4.2	4.0	4.1	4.3	3.6	3.9	4.1	5.5	6.9	3.8
Ave.	3.3	3.2	3.2	3.3	3.6	3.5	3.1	3.1	3.3	4.1	4.8	3.6

Appendix Table 34. Monthly environmental data collected from Sulphur Creek (rkm 10 from its confluence with the Middle Fork Salmon River) from August 2009 through July 2010.

Sulphur Creek												
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Temperature (°C)												
Min.	6.1	3.4	0.1	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	3.1	6.6
Max.	17.2	14.4	7.2	4.4	1.6	2.8	3.3	5.0	6.7	8.9	14.6	16.4
Ave.	11.0	9.2	3.8	1.2	0.2	0.8	0.9	1.5	2.1	3.5	7.2	11.3
Depth (ft)												
Min.	1.0	0.7	0.6	0.7	0.5	0.1	0.6	0.6	0.6	1.5	1.8	1.1
Max.	1.5	1.4	2.0	1.5	1.3	1.4	1.2	1.4	2.6	3.4	5.0	1.9
Ave.	1.2	1.1	1.1	1.1	1.0	0.9	0.9	1.0	1.5	2.3	2.8	1.4

Appendix Table 35. Monthly environmental data collected from upper Big Creek (rkm 60 from its confluence with the Middle Fork Salmon River) from August 2009 through July 2010.

Upper Big Creek												
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Temperature (°C)												
Min.	6.3	5.1	1.5	0.2	0.0	0.0	0.0	0.0	0.0	0.7	2.8	5.1
Max.	15.2	14.3	8.7	6.0	2.8	2.8	3.7	6.4	7.8	9.0	10.9	14.5
Ave.	10.2	9.0	4.7	2.2	0.6	1.2	1.4	2.4	2.9	3.9	5.5	9.3
Depth (ft)												
Min.	1.8	1.5	1.3	1.4	1.4	0.9	1.5	1.4	1.4	1.8	2.7	2.0
Max.	2.2	2.3	2.2	2.2	2.7	2.6	2.2	2.2	2.6	3.3	5.6	3.1
Ave.	2.0	1.9	1.8	1.9	1.9	1.8	1.8	1.8	2.0	2.3	3.4	2.4

Appendix Table 36. Monthly environmental data collected from Chamberlain Creek (rkm 25 from its confluence with the main Salmon River) from August 2009 through July 2010.

Chamberlain Creek												
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Temperature (°C)												
Min.	6.0	3.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	3.0	7.2
Max.	18.9	16.0	7.9	4.6	0.1	1.2	2.4	4.9	7.6	8.1	14.2	17.3
Ave.	12.2	10.0	3.2	0.6	0.0	0.3	0.4	1.4	2.3	3.8	7.5	12.3
Depth (ft)												
Min.	0.8	0.5	0.3	0.5	0.7	0.0	0.4	0.3	0.3	1.0	1.6	1.0
Max.	1.3	1.3	1.3	1.4	2.2	1.9	1.6	1.2	1.8	2.7	4.1	1.7
Ave.	1.1	0.9	0.9	1.0	1.4	0.8	0.8	0.8	1.0	1.6	2.4	1.4

Appendix Table 37. Monthly environmental data collected from West Fork Chamberlain Creek (rkm 25 from the confluence of Chamberlain Creek with the main Salmon River; 1 rkm from the mouth of West Fork Chamberlain Creek) from August 2009 through July 2010.

West Fork Chamberlain Creek												
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Temperature (°C)												
Min.	5.5	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8	5.8
Max.	16.3	14.0	6.8	3.7	0.4	1.5	2.1	3.7	6.7	8.5	15.4	16.9
Ave.	10.8	8.9	2.7	0.5	0.1	0.6	0.5	1.1	1.7	3.3	7.4	11.1
Depth (ft)												
Min.	1.2	0.8	0.7	0.7	0.8	0.2	0.8	0.7	0.6	1.4	1.7	1.3
Max.	2.1	1.6	1.7	1.6	1.6	1.7	1.5	1.6	2.4	3.1	4.0	2.0
Ave.	1.6	1.3	1.2	1.3	1.2	1.1	1.1	1.2	1.4	2.1	2.7	1.6

Appendix Table 38. Monthly environmental data collected from Lake Creek (rkm 46 from the confluence of the Secesh River with the South Fork Salmon River; 1 rkm above the mouth of Lake Creek) from August 2009 through July 2010.

Lake Creek												
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Temperature (°C)												
Min.	5.7	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	5.9
Max.	17.1	14.1	6.6	3.1	0.0	0.2	0.9	1.6	5.4	8.4	13.4	17.3
Ave.	11.2	8.9	2.3	0.3	0.0	0.0	0.1	0.2	1.0	2.8	6.2	11.2
Depth (ft)												
Min.	1.0	0.6	0.5	0.7	1.2	0.1	0.7	0.4	0.5	1.0	2.1	1.2
Max.	2.0	1.4	1.7	2.0	2.5	2.1	2.5	2.9	1.8	2.5	4.2	2.4
Ave.	1.3	1.1	1.1	1.3	1.9	1.3	1.2	1.0	1.2	1.7	2.8	1.7

Appendix Table 39. Monthly environmental data collected from Cape Horn Creek (rkm 180 from the mouth of the Middle Fork Salmon River; 150 m above the Marsh Creek monitoring site) from August 2009 through July 2010.

Cape Horn Creek												
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Temperature (°C)												
Min.	4.5	2.6	0.0	-0.1	-2.0	-0.2	-0.1	-0.1	0.0	0.0	2.1	4.6
Max.	16.8	15.1	8.0	5.4	0.0	1.3	3.1	5.3	9.0	11.0	13.3	16.8
Ave.	9.7	8.2	3.0	0.5	-0.3	0.0	0.3	1.2	2.3	3.6	6.0	9.8
Depth (ft)												
Min.	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.2
Max.	1.2	0.6	0.6	1.3	0.8	1.3	0.5	0.8	0.5	0.8	2.2	0.8
Ave.	0.5	0.3	0.2	0.4	0.4	0.2	0.1	0.2	0.2	0.4	1.1	0.5

Appendix Table 40. Monthly environmental data collected from Herd Creek (rkm 15 from the confluence of the Salmon River and East Fork Salmon River; 1 rkm above the mouth of Herd Creek) from August 2009 through July 2010.

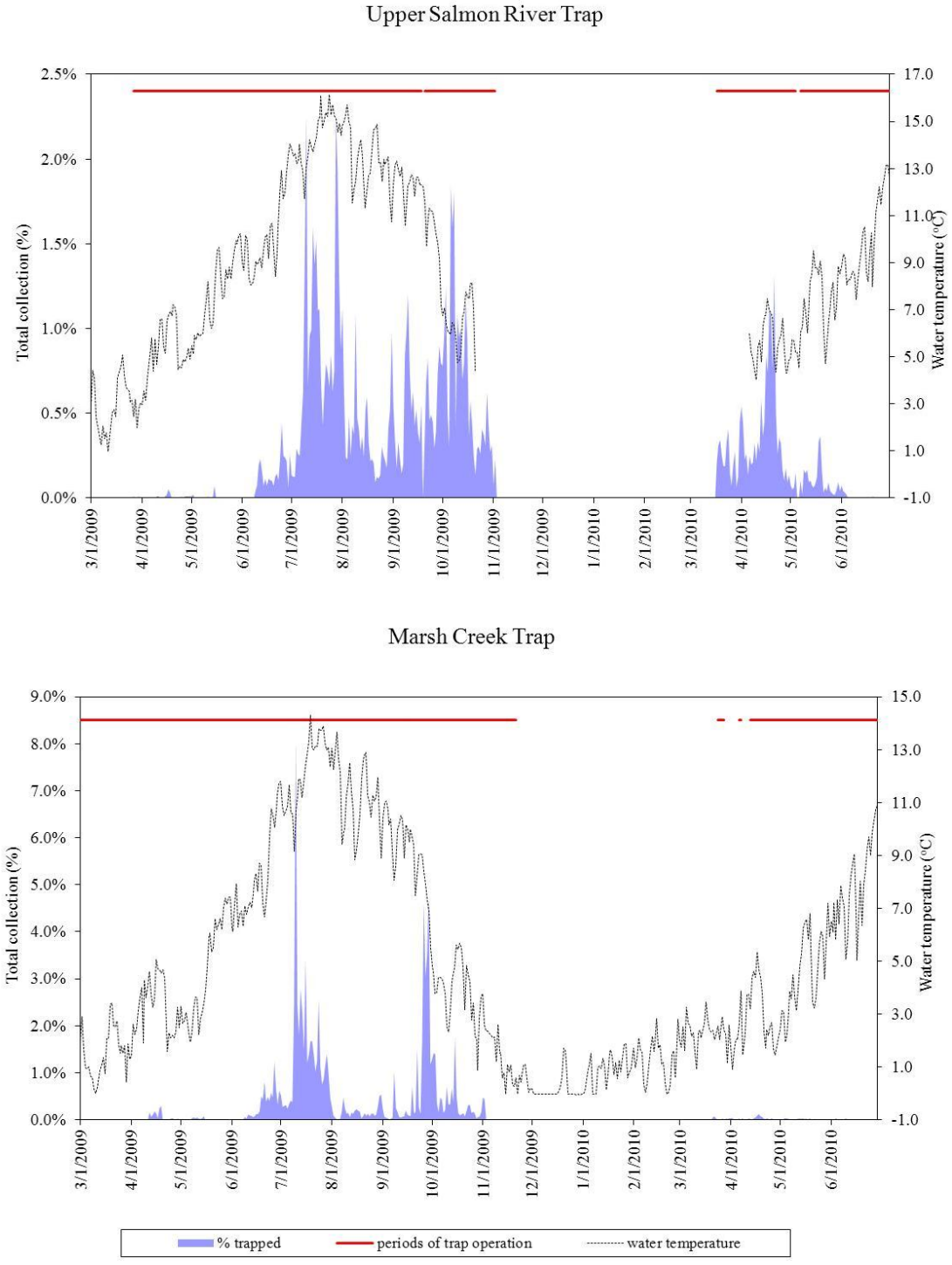
Herd Creek												
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Temperature (°C)												
Min.	6.8	5.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	3.4	6.2
Max.	17.1	15.5	10.2	6.9	1.9	3.5	5.9	9.0	13.0	13.9	13.3	17.4
Ave.	11.5	10.4	5.2	1.6	0.2	0.8	1.2	3.0	5.3	6.6	8.3	11.2
Depth (ft)												
Min.	1.5	1.1	1.1	1.1	0.9	0.4	1.0	0.8	0.9	1.0	1.7	1.5
Max.	2.2	1.9	2.0	2.0	2.3	2.1	1.9	1.8	1.8	1.9	2.6	2.3
Ave.	1.8	1.6	1.5	1.6	1.4	1.4	1.3	1.4	1.4	1.5	2.2	1.9

Appendix Table 41. Monthly environmental data collected from Camas Creek (rkm 23 from its confluence with the Middle Fork Salmon River) from August 2009 through July 2010.

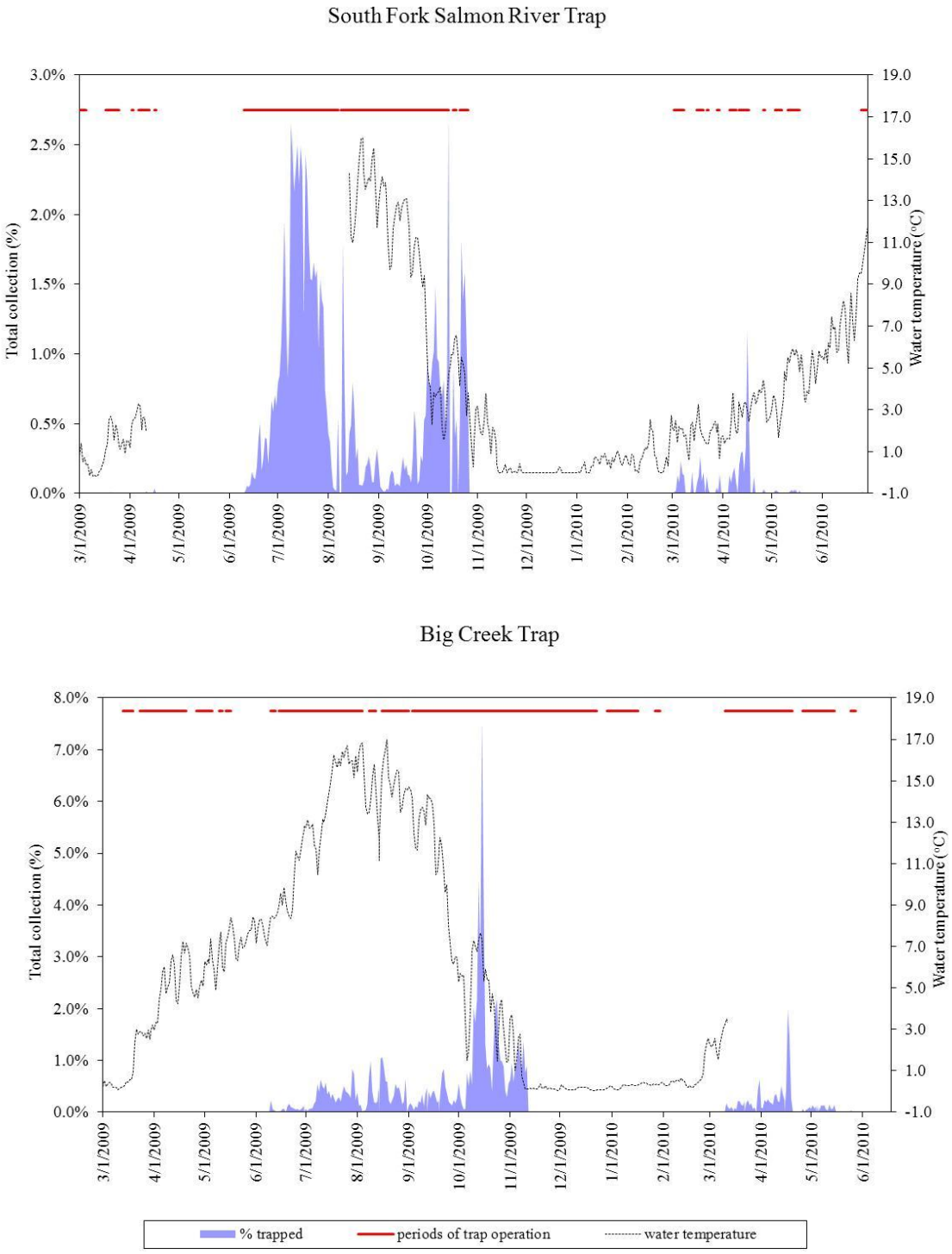
Camas Creek												
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Temperature (°C)												
Min.	6.7	4.9	0.1	0.0	-2.0	-1.9	0.0	-0.1	0.0	0.2	4.1	6.8
Max.	18.0	15.7	8.6	4.3	0.2	0.9	1.7	5.2	10.3	12.7	13.9	18.0
Ave.	12.6	10.7	4.2	0.7	-0.7	-0.4	0.4	1.4	3.7	5.6	8.1	12.1
Depth (ft)												
Min.	0.7	0.3	0.2	0.2	0.3	0.3	0.2	0.0	0.1	0.9	2.2	1.2
Max.	1.6	1.2	1.1	1.2	1.2	0.8	1.0	1.0	1.8	2.6	4.3	2.5
Ave.	1.1	0.9	0.7	0.7	0.6	0.5	0.5	0.6	0.9	1.6	3.1	1.7

Appendix Table 42. Monthly environmental data collected from Loon Creek (rkm 31 from its confluence with the Middle Fork Salmon River) from August 2009 through July 2010.

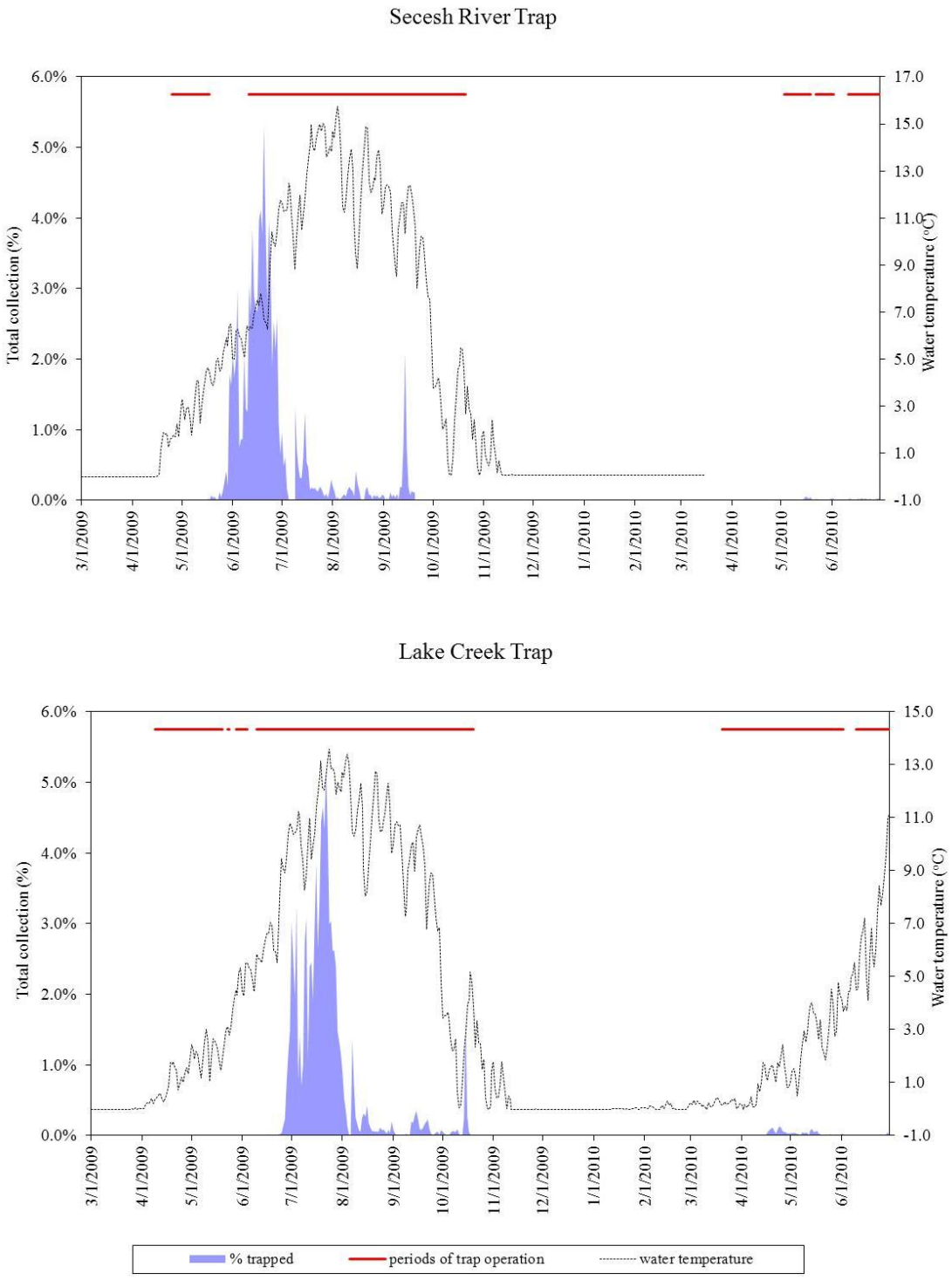
Loon Creek												
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Temperature (°C)												
Min.	6.6	5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	3.2	5.6
Max.	17.5	15.2	8.9	5.7	0.2	2.3	3.5	7.3	10.6	11.6	11.8	16.3
Ave.	11.3	9.9	4.3	1.0	0.0	0.3	0.7	2.1	3.9	5.0	6.5	10.3
Depth (ft)												
Min.	1.5	1.5	1.3	1.3	1.5	0.5	1.1	1.1	1.0	1.7	2.7	2.5
Max.	2.4	2.3	2.3	2.3	3.0	3.5	2.7	2.1	2.5	3.0	5.0	3.4
Ave.	2.0	1.9	1.8	1.8	2.3	1.8	1.7	1.6	1.8	2.3	3.6	2.9



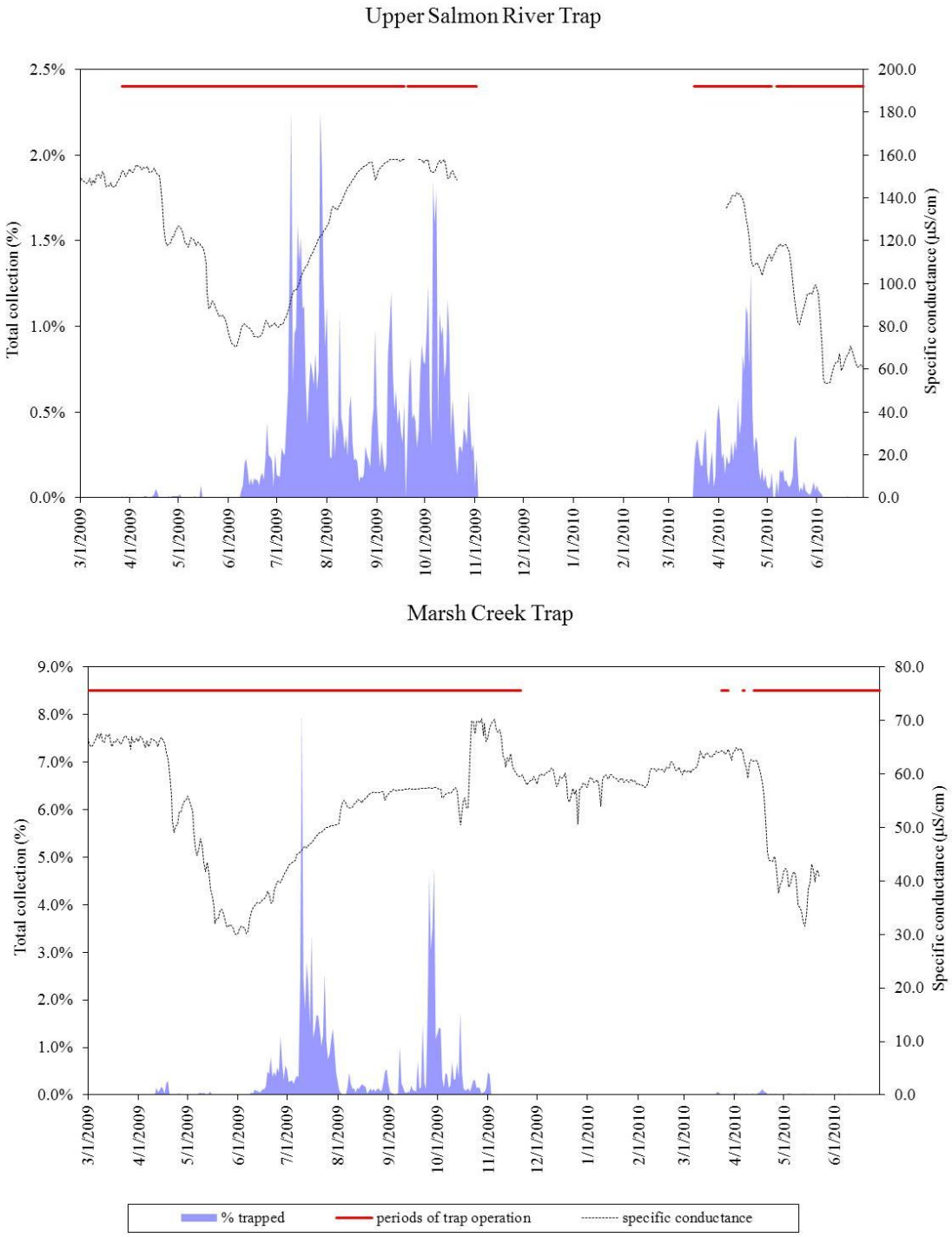
Appendix Figure 1. Daily passage of wild Chinook salmon fry, parr, and smolts at six migrant traps, expressed as percentages of total collected, and plotted against average daily water temperatures collected near traps. Periods of trap operation are also shown.



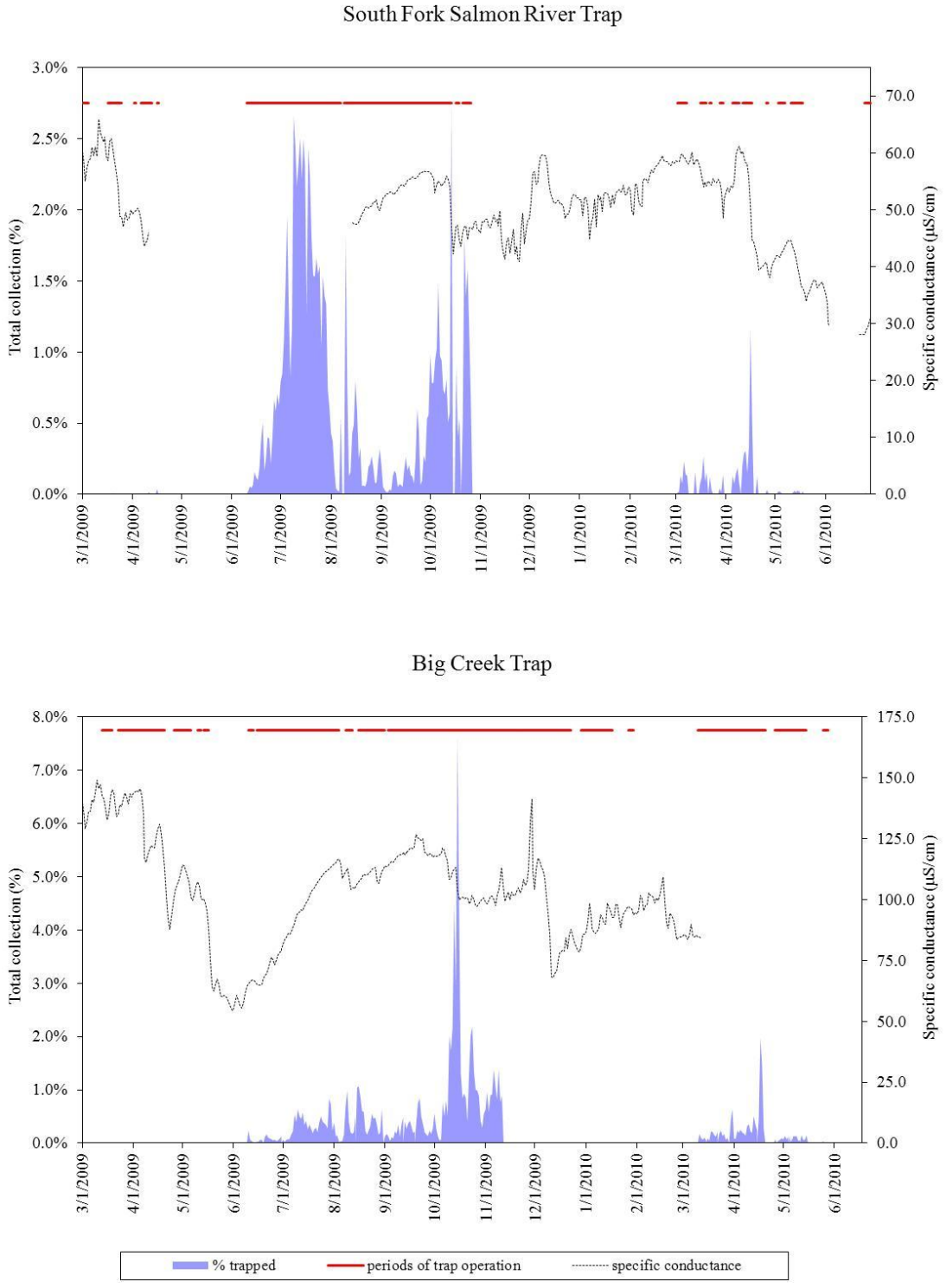
Appendix Figure 1. Continued.



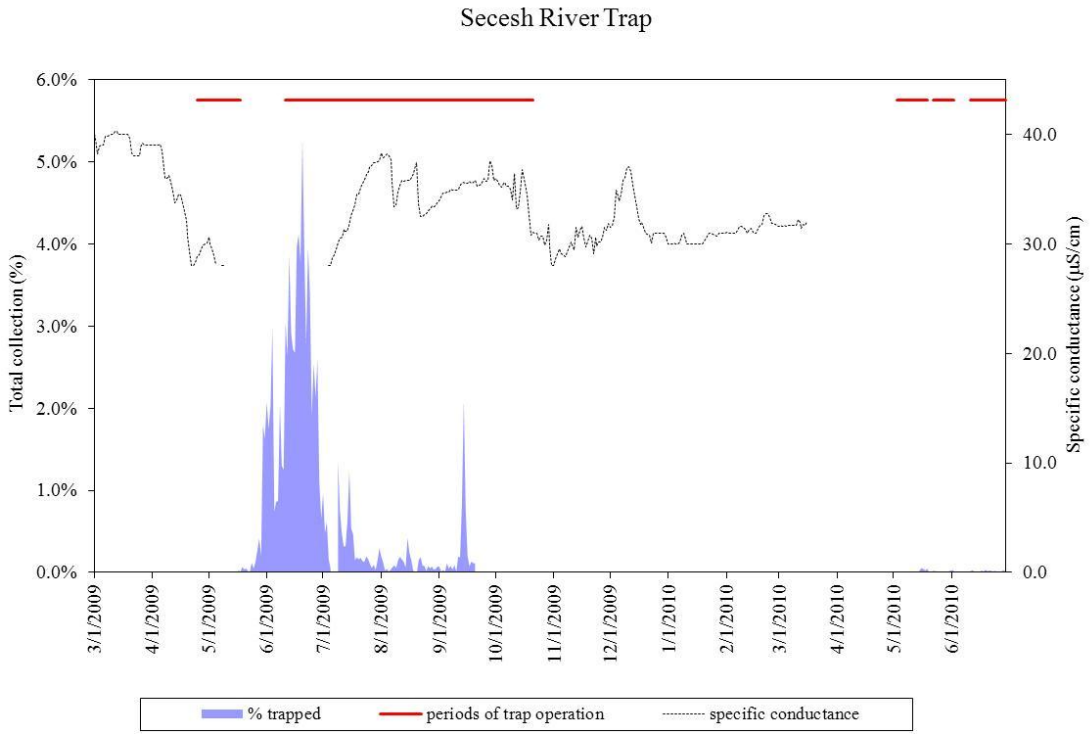
Appendix Figure 1. Continued.



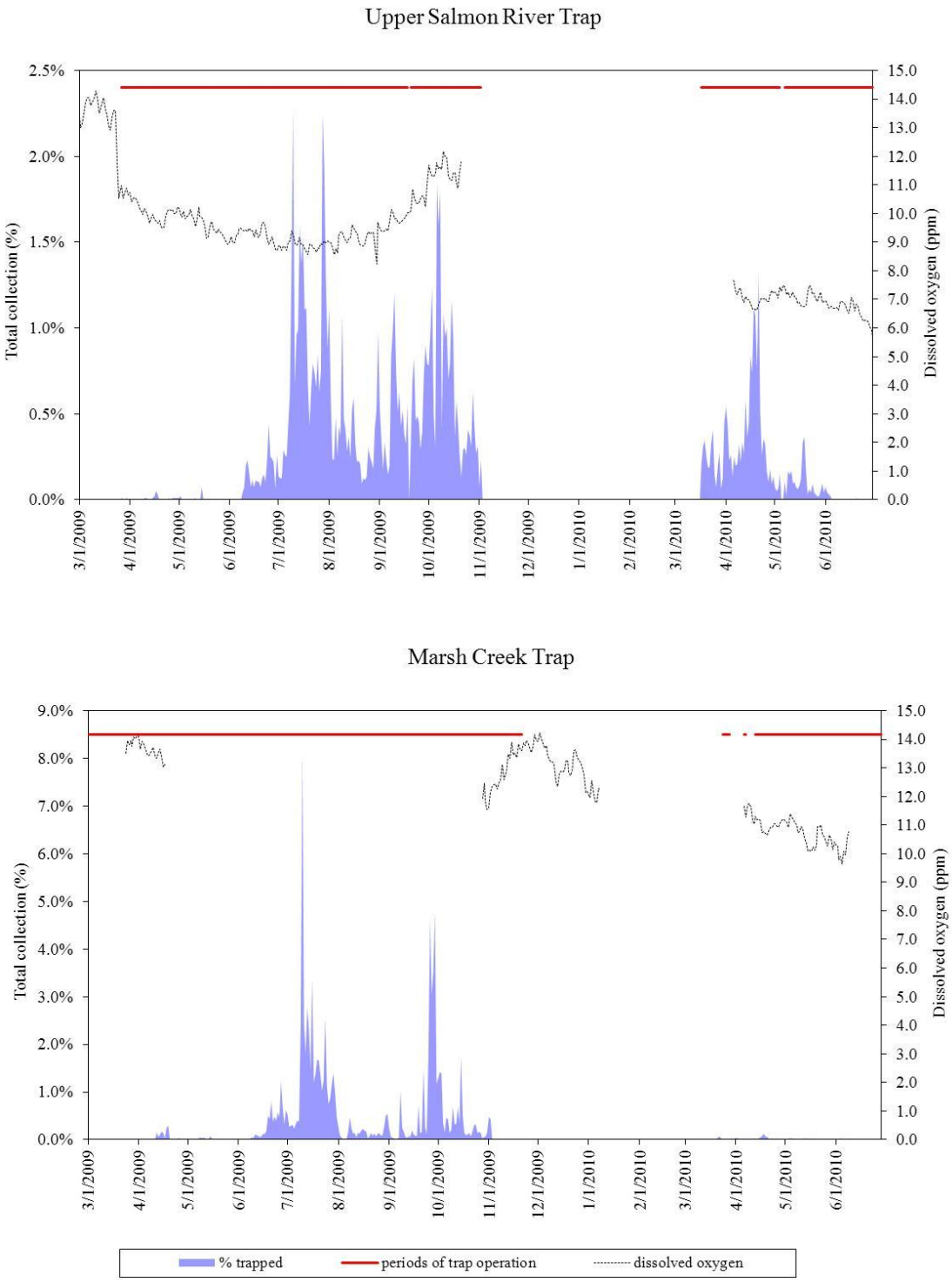
Appendix Figure 2. Daily passage of wild Chinook salmon fry, parr, and smolts at five migrant traps, expressed as percentages of total collected, and plotted against average daily specific conductance collected near traps. Periods of trap operation are also shown.



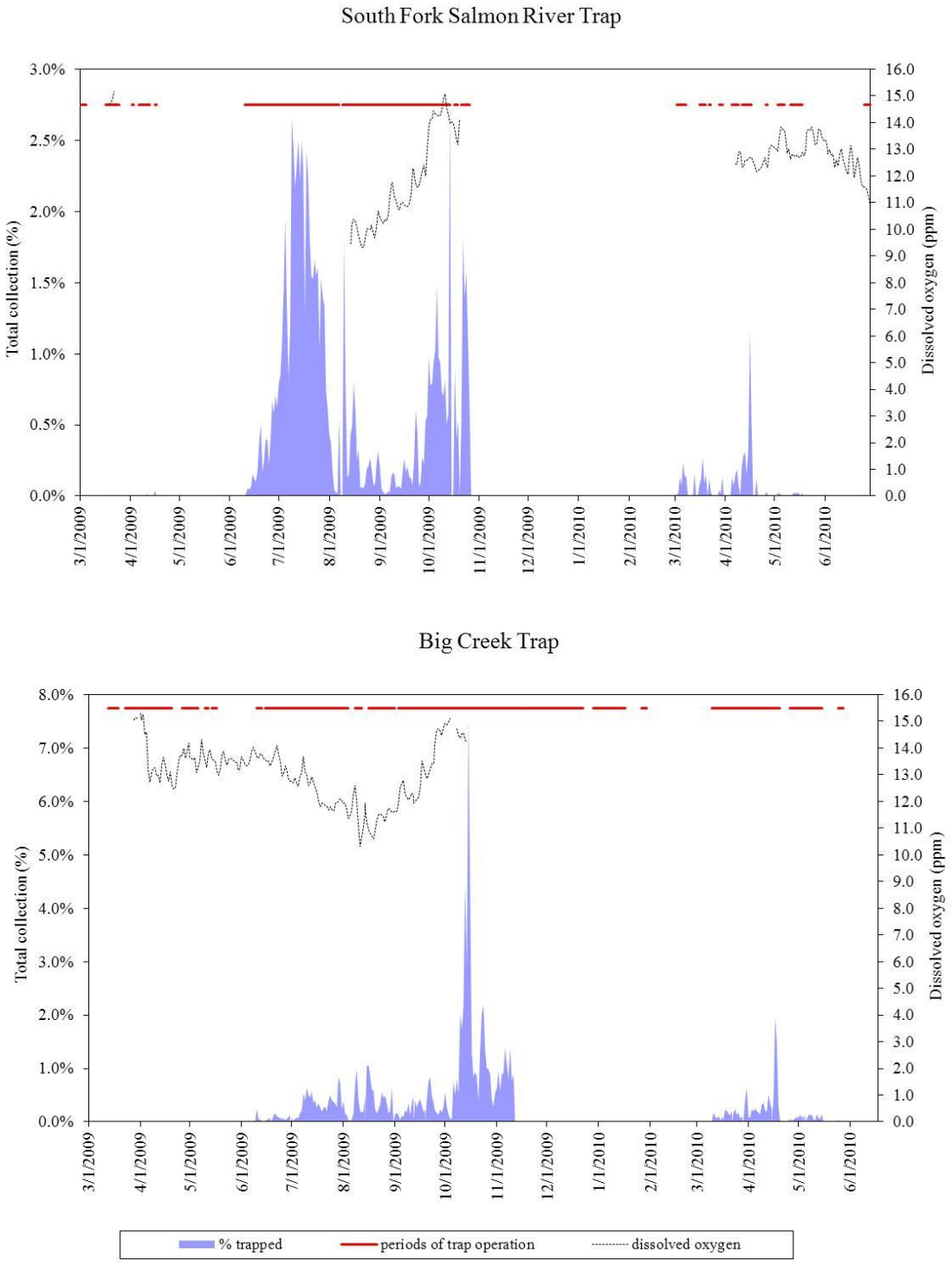
Appendix Figure 2. Continued.



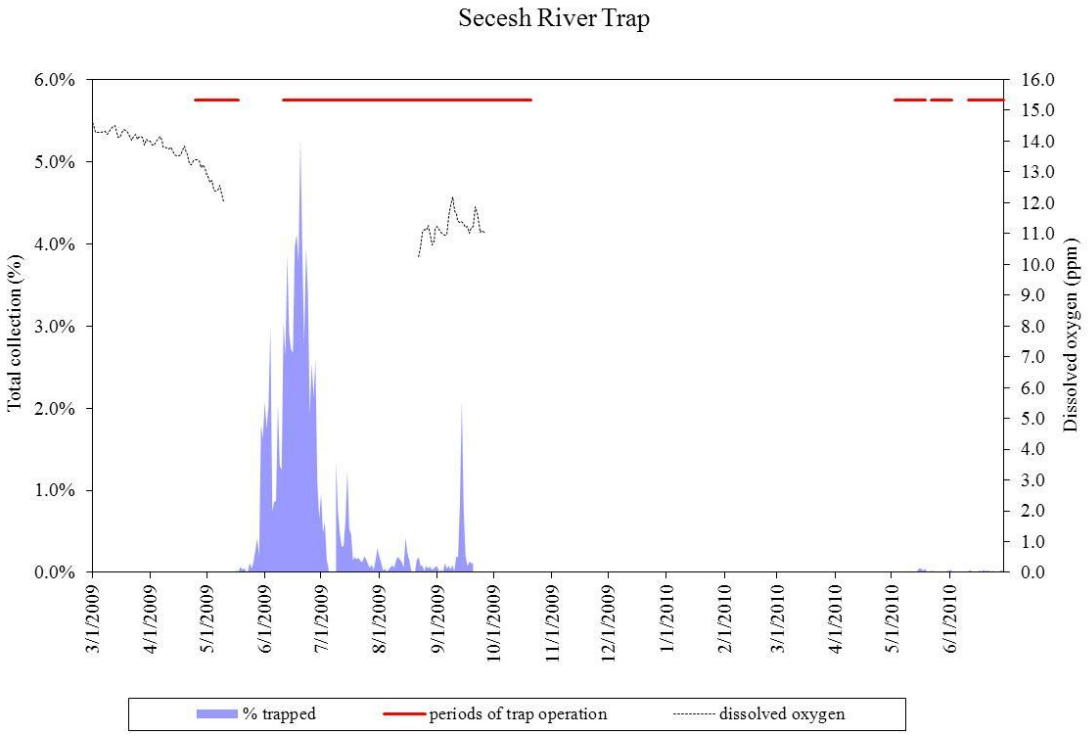
Appendix Figure 2. Continued.



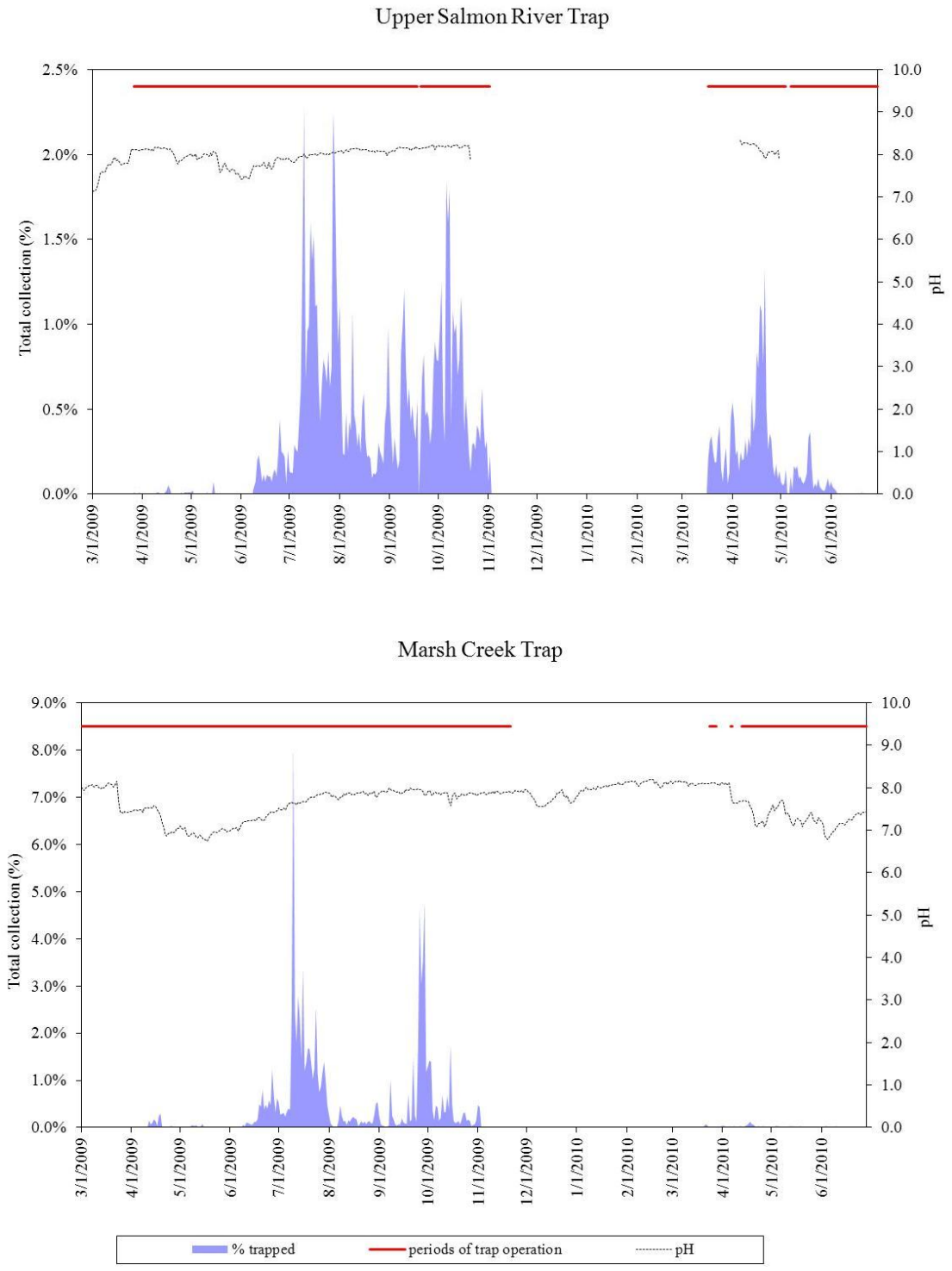
Appendix Figure 3. Daily passage of wild Chinook salmon fry, parr, and smolts at five migrant traps, expressed as percentages of total collected, and plotted against average daily dissolved oxygen collected near traps. Periods of trap operation are also shown.



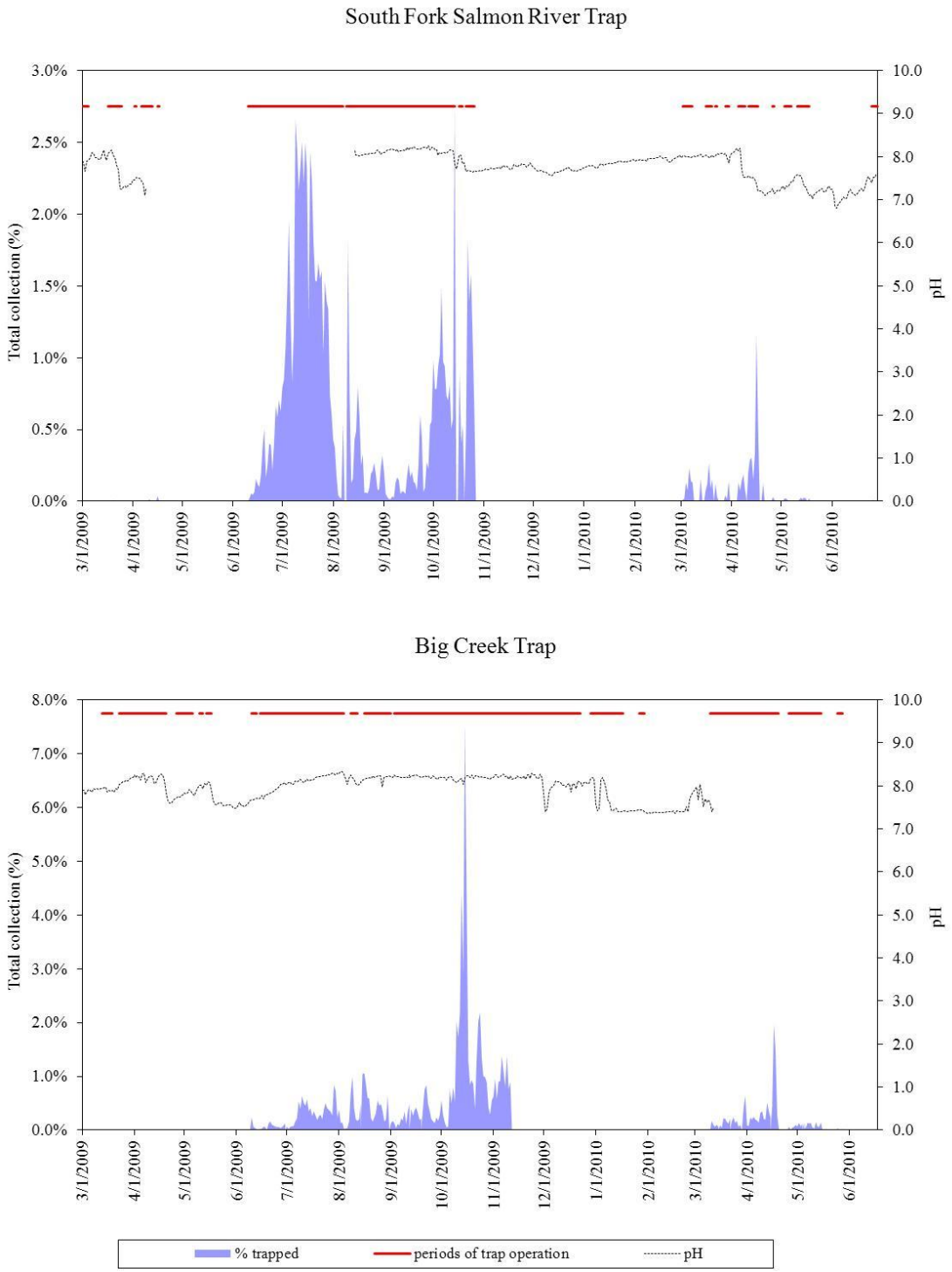
Appendix Figure 3. Continued.



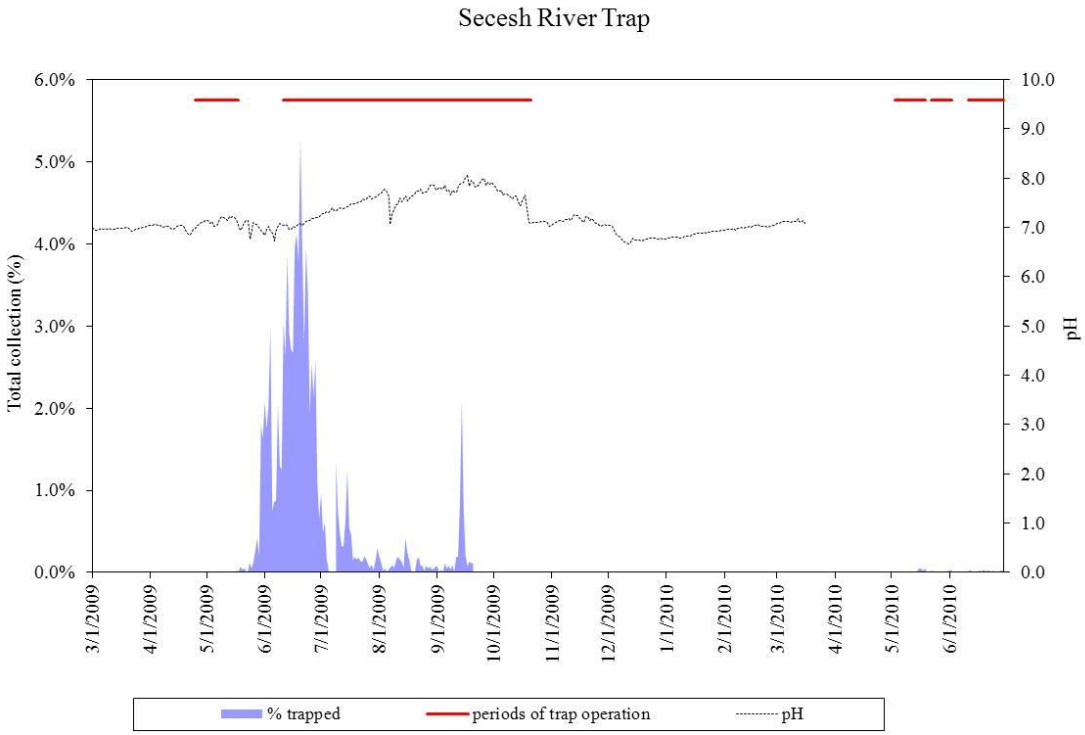
Appendix Figure 3. Continued.



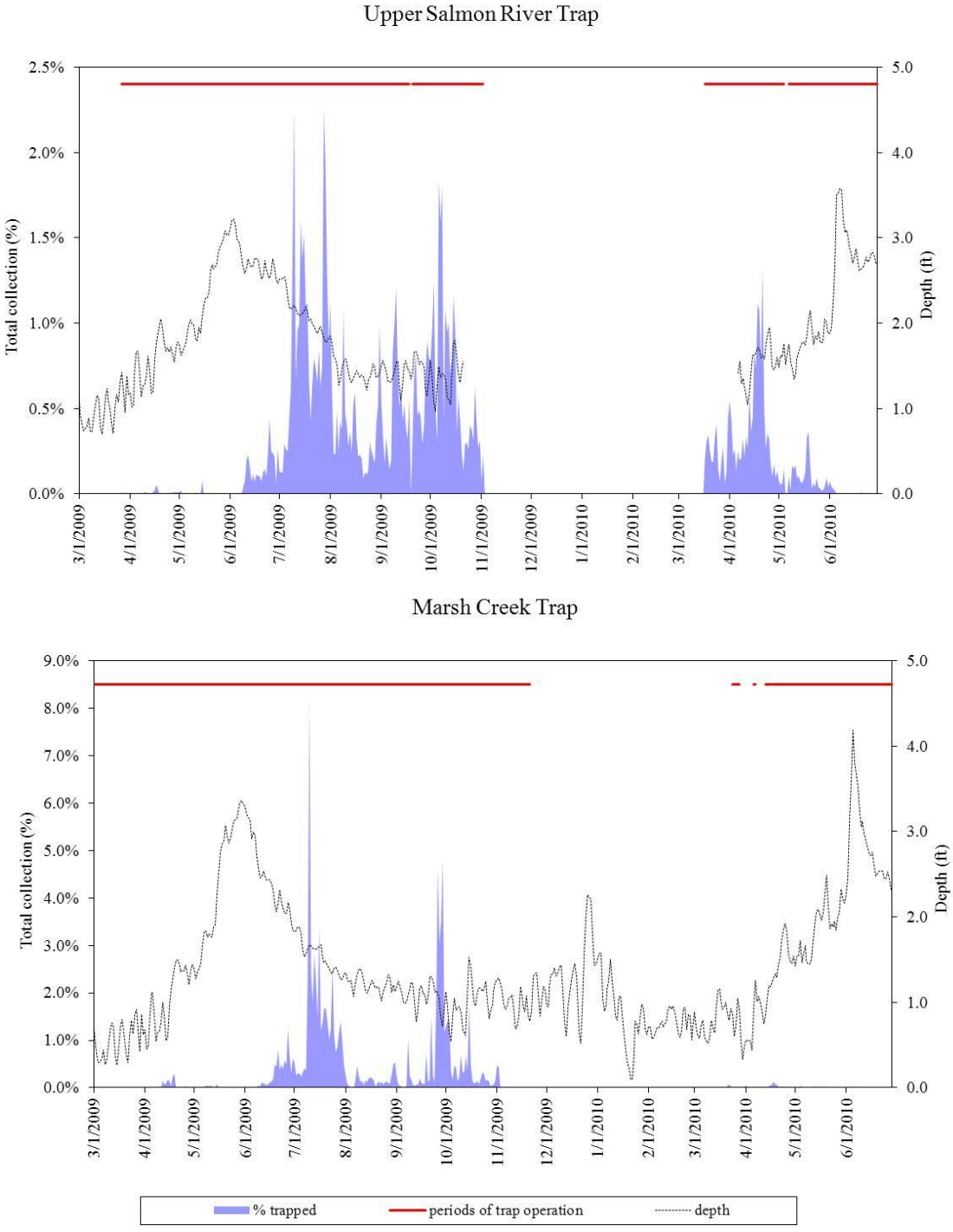
Appendix Figure 4. Daily passage of wild Chinook salmon fry, parr, and smolts at five migrant traps, expressed as percentages of total collected, and plotted against average daily pH collected near traps. Periods of trap operation are also shown.



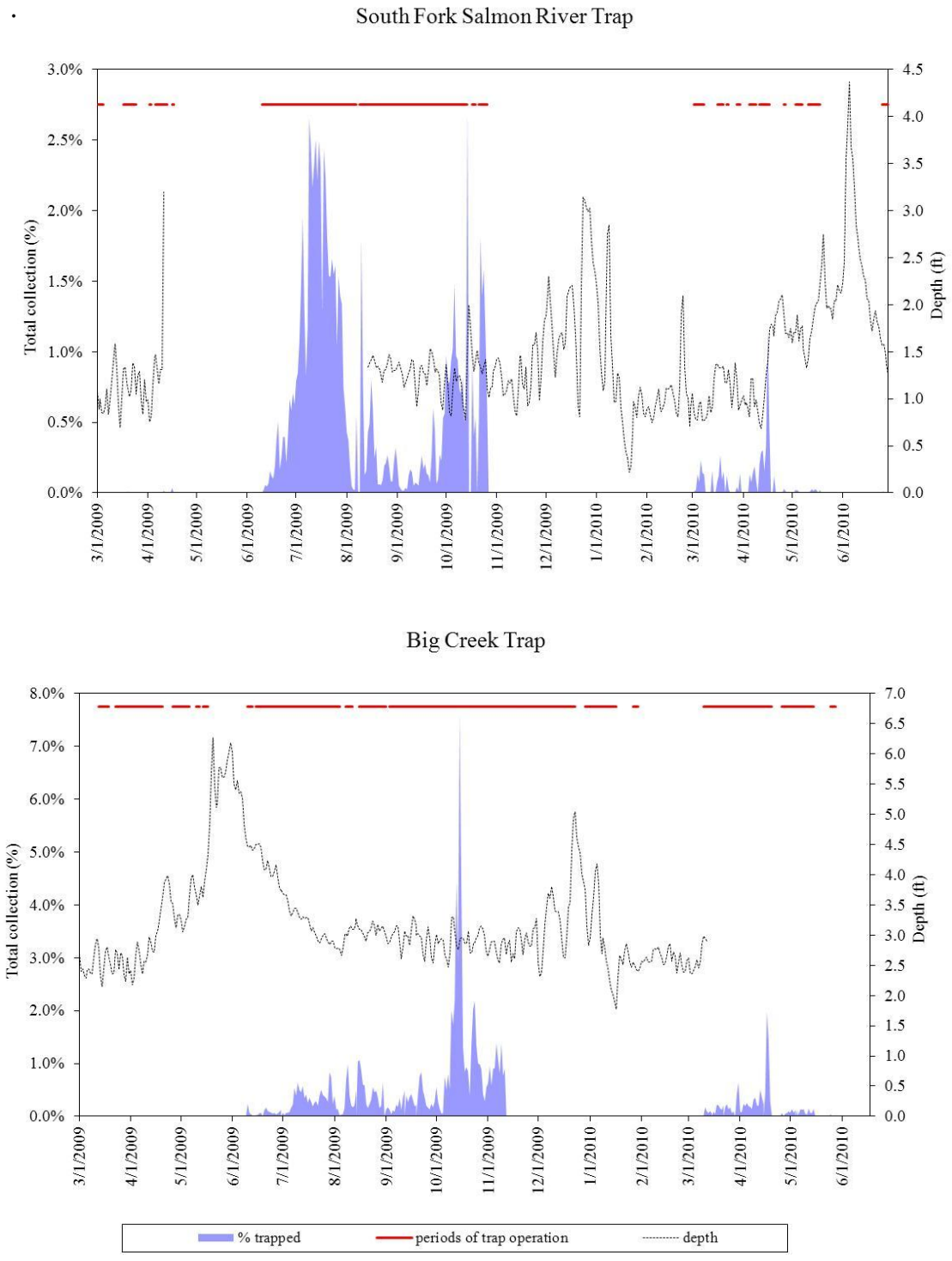
Appendix Figure 4. Continued.



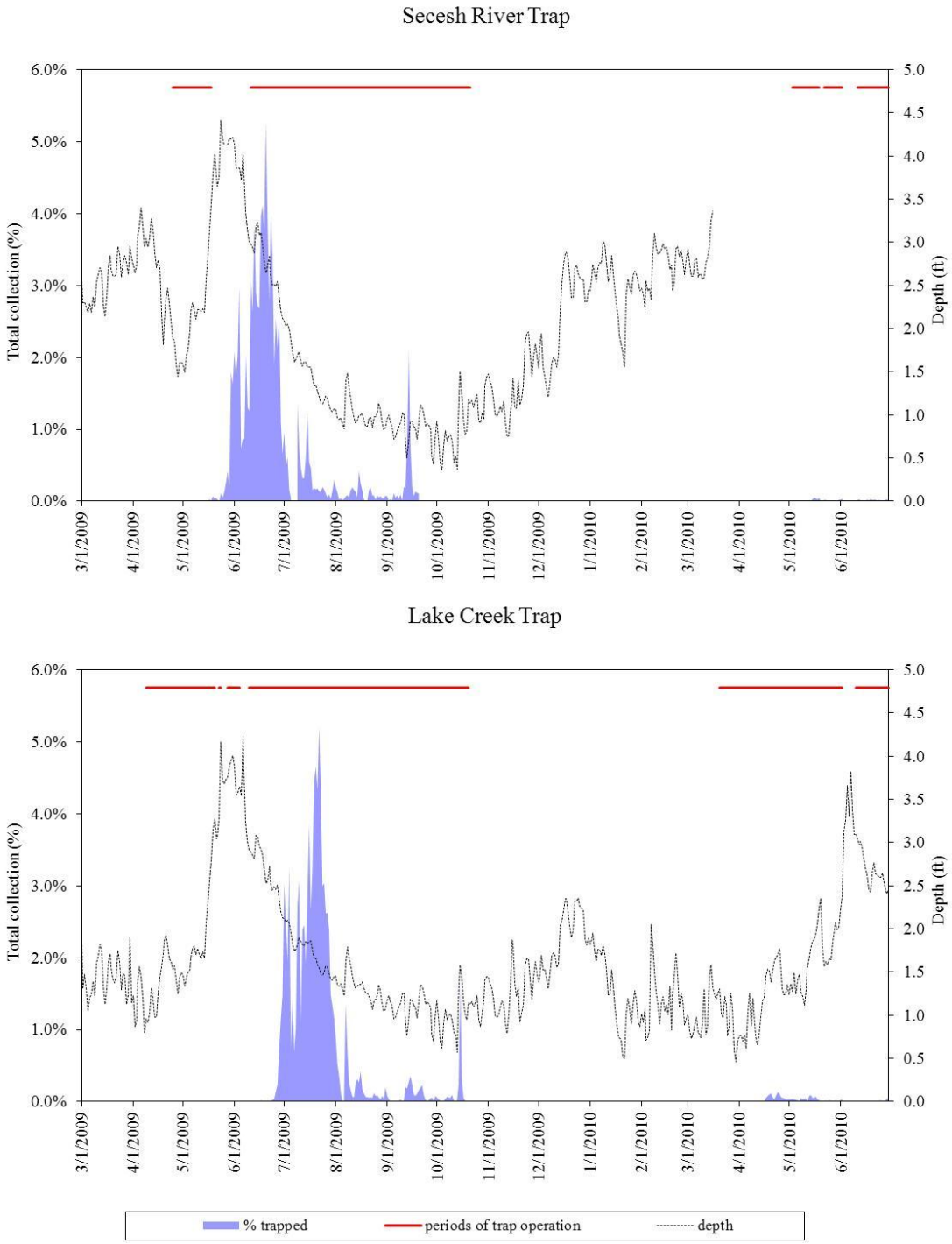
Appendix Figure 4. Continued.



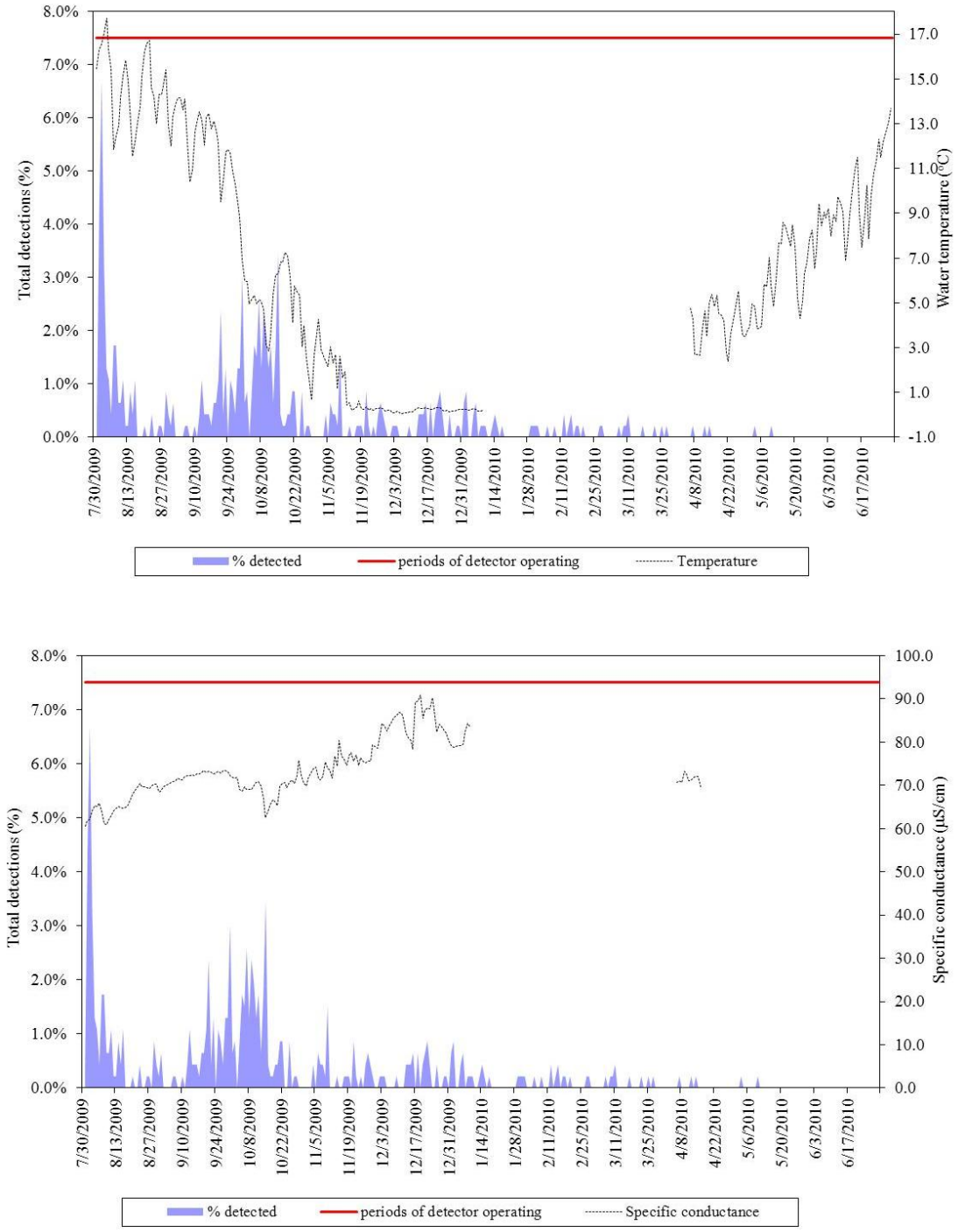
Appendix Figure 5. Daily passage of wild Chinook salmon fry, parr, and smolts at six migrant traps, expressed as percentages of total collected, and plotted against average daily depth collected near traps. Periods of trap operation are also shown.



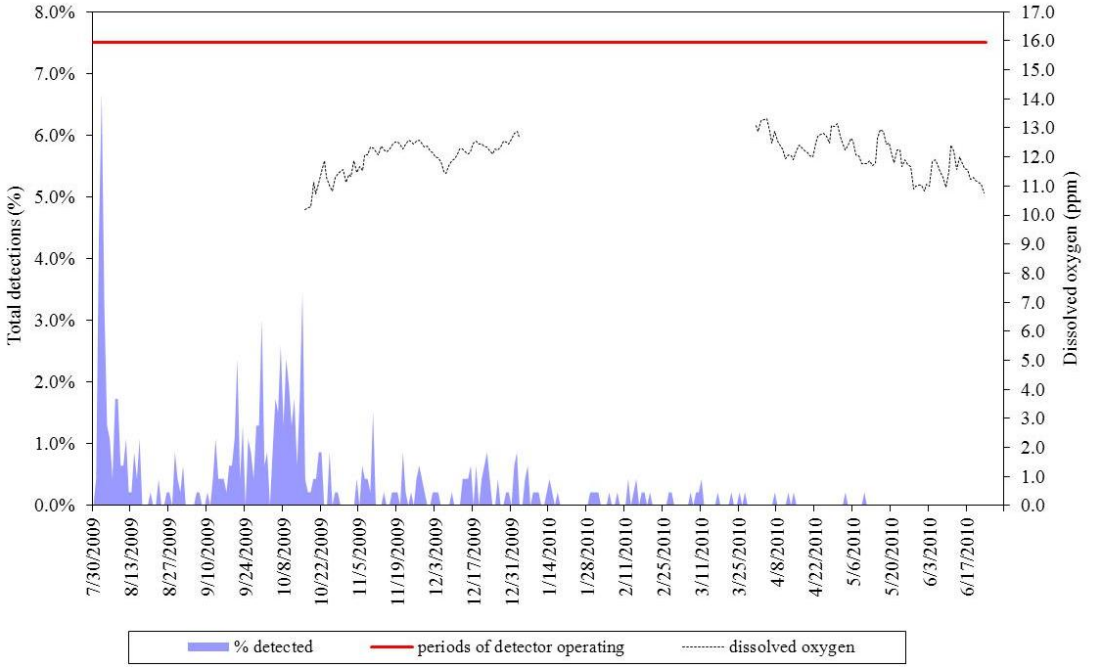
Appendix Figure 5. Continued.

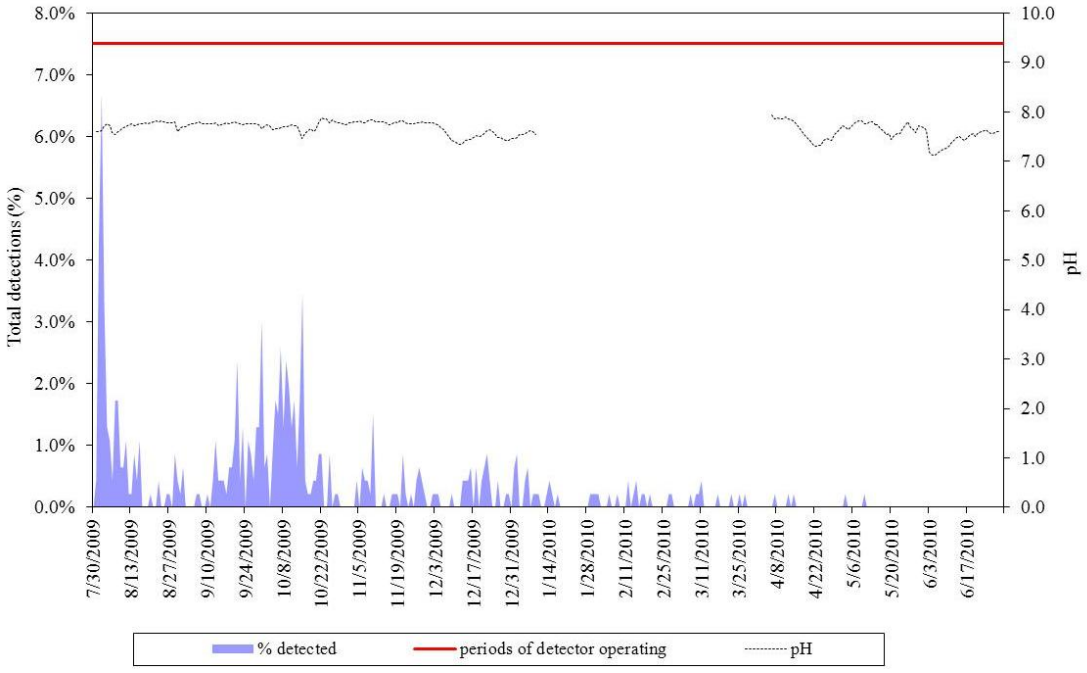


Appendix Figure 5. Continued.

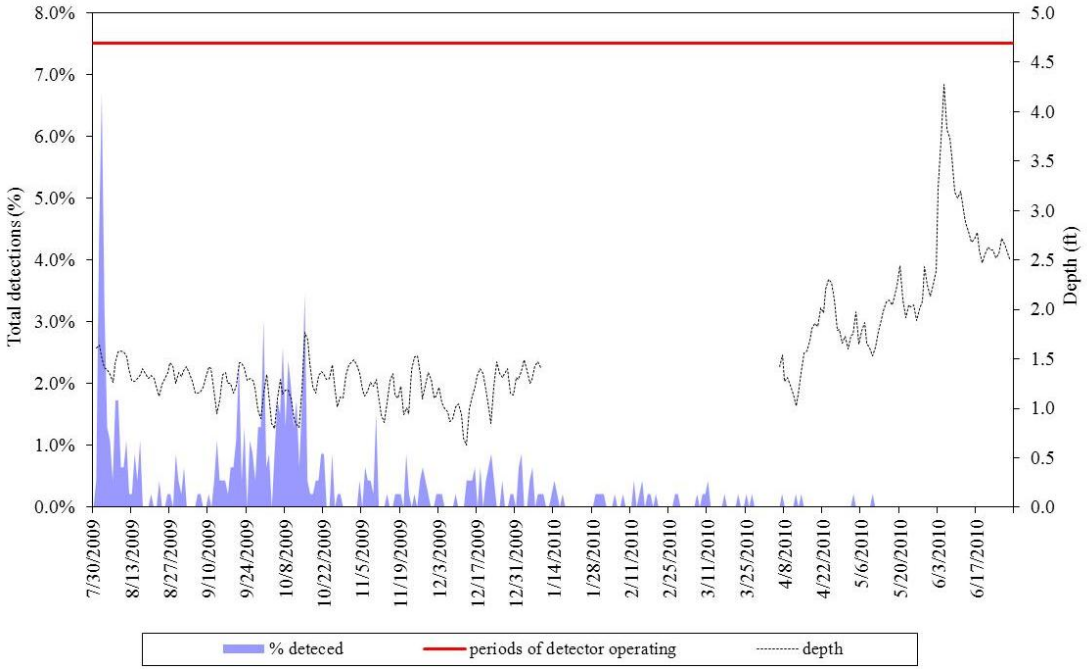


Appendix Figure 6. Combined daily PIT-tag detections of wild Chinook salmon parr at instream PIT-tag detectors in Valley Creek, expressed as percentages of total detected, and plotted against average daily aquatic conditions collected near the detectors. Periods of operation for the detectors are also shown.





Appendix Figure 6. Continued.



Appendix Figure 6. Continued.