Monitoring the Migrations of Wild Snake River Spring/Summer Chinook Salmon Juveniles, 2005-2006

Stephen Achord, Benjamin P. Sandford, Eric E. Hockersmith, Kenneth W. McIntyre,
Neil N. Paasch, and John G. Williams

Report of research by

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

for

Division of Fish and Wildlife
Bonneville Power Administration
U.S. Department of Energy
P.O. Box 3621
Portland, Oregon 97208-3621
Project 1991-028-00
Contract No. 00021961

February 2007

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 detections in 2006 of fish tagged in Idaho streams during summer 2005 by the National Marine Fisheries Service (NMFS) and fish tagged in Oregon streams during 2005 by the Oregon Department of Fish and Wildlife (ODFW). Our analyses include arrival timing and estimated survival to Lower Granite Dam. Principal results from tagging and interrogation during 2005-2006 are listed below:

1) In July and August 2005, we PIT tagged and released 12,826 wild Chinook salmon parr in 15 Idaho streams or sample areas.

2) Overall observed mortality from collection, handling, tagging, and after a 24-h holding period was 1.4%.

3) Of the 2,218 Chinook salmon parr PIT tagged and released in Valley Creek in summer 2005, 182 (8.2%) were detected at two instream PIT-tag monitoring systems in lower Valley Creek from late summer 2005 to the following spring 2006. Of these, 45.6% were detected in late summer/fall, 36.8% in winter, and 17.6% in spring. Estimated parr-to-smolt survival to Lower Granite Dam was 7.7% for the late-summer/fall group, 44.3% for the winter group, and 18.1% for the spring group. Based on detections at downstream dams, the overall efficiency of the lower Valley Creek monitor (VC2) for detecting these fish was 11.2%. Based on this VC2 efficiency, we estimated that 58.4% of all summer-tagged parr survived to move out of Valley Creek, and their estimated survival from that point to Lower Granite Dam was 20.6%. Overall estimated parr-to-smolt survival for all summer-tagged parr from this stream at the dam was 13.1%. Development and improvement of the instream PIT-tag monitoring systems continued throughout 2005 and 2006.

4) At Little Goose Dam in 2006, length and weight was taken for 557 recaptured fish from 15 Idaho stream populations. On average, these fish grew 35.1 mm in length and gained 8.2 g in weight over an average of 266 d. Their mean condition factor declined from 1.27 at release (parr) to 1.07 at recapture (smolt).

5) Fish that were larger at release were detected at a significantly higher rate the following spring and summer than their smaller cohorts ($P < 0.0001$).

6) Fish that migrated through Lower Granite Dam in April and May were significantly larger at release than fish that migrated after May (P <0.0001).

7) In 2006, peak detections at Lower Granite Dam of parr tagged during summer 2005 (from the 15 stream populations in Idaho and 4 streams in Oregon) occurred during high (and increasing) flows of 139.5 kcfs on 30 April. For fish from these 19 streams combined, passage of the 10th, 50th, and 90th percentiles occurred on 18 April, 2 May, and 22 May, respectively.

8) In 2005-2006, estimated parr-to-smolt survival to Lower Granite Dam for Idaho and Oregon streams combined averaged 14.4% (range 6.8-37.1% depending on stream of origin). For fish from Idaho streams, estimated parr-to-smolt survival averaged 15.1%. This survival rate was almost double that of the previous year (2004-2005) for Idaho streams (7.9%). Density dependent factors appear to be responsible for the increased survival because relative parr densities declined by over half from 2004 (8.7 parr/100 m^2 sampled) to 2005 (3.9 parr/100 m^2 sampled).

In 2006, the 50th and 90th percentile passage dates for wild fish at Lower Granite Dam occurred in early and late May, respectively. In 2006, we observed high flows throughout the spring migration season. Clearly, complex interrelationships of several factors drive the annual migrational timing of the stocks.

CONTENTS

INTRODUCTION

This report provides information on PIT-tagging of wild Chinook salmon parr in Idaho in 2005 and the subsequent monitoring of these fish and similarly tagged fish from Oregon. We report here the estimated survival and timing to Lower Granite Dam of these Chinook salmon juveniles, as well as interrogation data from 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; 2003; 2004; 2005; 2006). The goals of this ongoing study are to:

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

This study provides critical information for recovery planning, and ultimately recovery for these ESA-listed wild fish stocks.

During 2005-2006, we recorded water temperature, dissolved oxygen, specific conductance, turbidity, water depth, and pH from six monitoring stations in the Salmon River Basin, Idaho. We included weather/climate data from 3 stations and stream flow data from 2 stations in the basin. These data are collected for a Baseline Environmental Monitoring Program, which provides environmental data for comparison with parr/smolt migration, survival, and timing data. Such comparisons will help to discern whether patterns or characteristic relationships exist that may help in recovery planning for threatened stocks.

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 2005. All tagging, detection, and timing information for fish from these streams in 2005-2006 will be reported by ODFW. However, with ODFW concurrence, we report here the timing and overall estimated survival to Lower Granite Dam of summer-tagged fish from these Oregon streams.

National Marine Fisheries personnel tagged fish in Idaho streams during 2005 using the safe handling methods developed for wild fish studies. These handling methods are detailed in Matthews et al. (1986, 1990) and in previous reports from this study (Achord et al. 1994; 1995a,b; 2003; 2004).

Interrogation at Instream PIT-Tag Monitors

Until recently, opportunities to monitor migrating PIT-tagged wild juvenile fish were limited to a few instream or inriver traps (these traps required operators and were not continuous passive monitoring sites), the juvenile fish bypass systems at dams, and the PIT-tag trawl at the mouth of the Columbia River. In an effort to detect fish closer to tagging sites, in 2002, we began development of instream PIT-tag monitoring systems in Valley Creek. We placed detector systems at two sites located 1.6 km apart. Development of the monitoring systems continued from 2003 to 2006, and details about the equipment evaluated are described in Achord et al. (2004; 2005). Both systems were set up to automatically interrogate, store, and transmit data to the PIT Tag Information System (PTAGIS), operated by the Pacific States Marine Fisheries Commission in Portland, Oregon (PSMFC 1996). Detection data are transferred to PTAGIS in a manner similar to that of the interrogation systems at Snake and Columbia River dams. Detection data collected at these sites from August 2005 through July 2006 are reported here.

Juvenile Migrant Traps

Some fish PIT tagged as parr in natal rearing areas were subsequently collected at migrant traps (Figure 1). During fall 2005 and spring 2006, juvenile migrant fish traps were operated at Knox Bridge on the South Fork of the Salmon River, on Lake Creek, near Chinook Campground on the Secesh River, on Marsh Creek, and near the Sawtooth Hatchery on the upper Salmon River. Also during spring 2006, juvenile migrant fish traps were operated on the lower Salmon River near Whitebird, Idaho, and on the Snake River at Lewiston, Idaho. Traps were operated by the Nez Perce Tribe and the Idaho Department of Fish and Game.

Generally, fish at these traps were anesthetized, scanned for PIT tags, and then measured for length and weight. Upon recovery from the anesthetic, all fish were released back to the streams or rivers.

Recaptures at Dams

While collecting and PIT tagging fish at the dams for various studies, NMFS and other personnel occasionally encounter wild fish that are already PIT tagged. In such cases, biological data are usually collected from these fish. To increase sample sizes for parr-to-smolt growth information on previously PIT-tagged wild fish, in 2006 we continued efforts begun in 2001 to utilize the PIT-tag separation-by-code system (Downing et al. 2001) at Little Goose Dam. The system was programmed to separate up to a maximum of 100 wild fish from each stream so that we could take length and weight measurements from a sample of fish. All fish that were separated at the dam were handled using water-to-water transfers and other best handling practices. After handling, all tagged and untagged fish were returned to the bypass system for release below the dam.

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

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

Condition factors were calculated for these fish both at release and recapture.

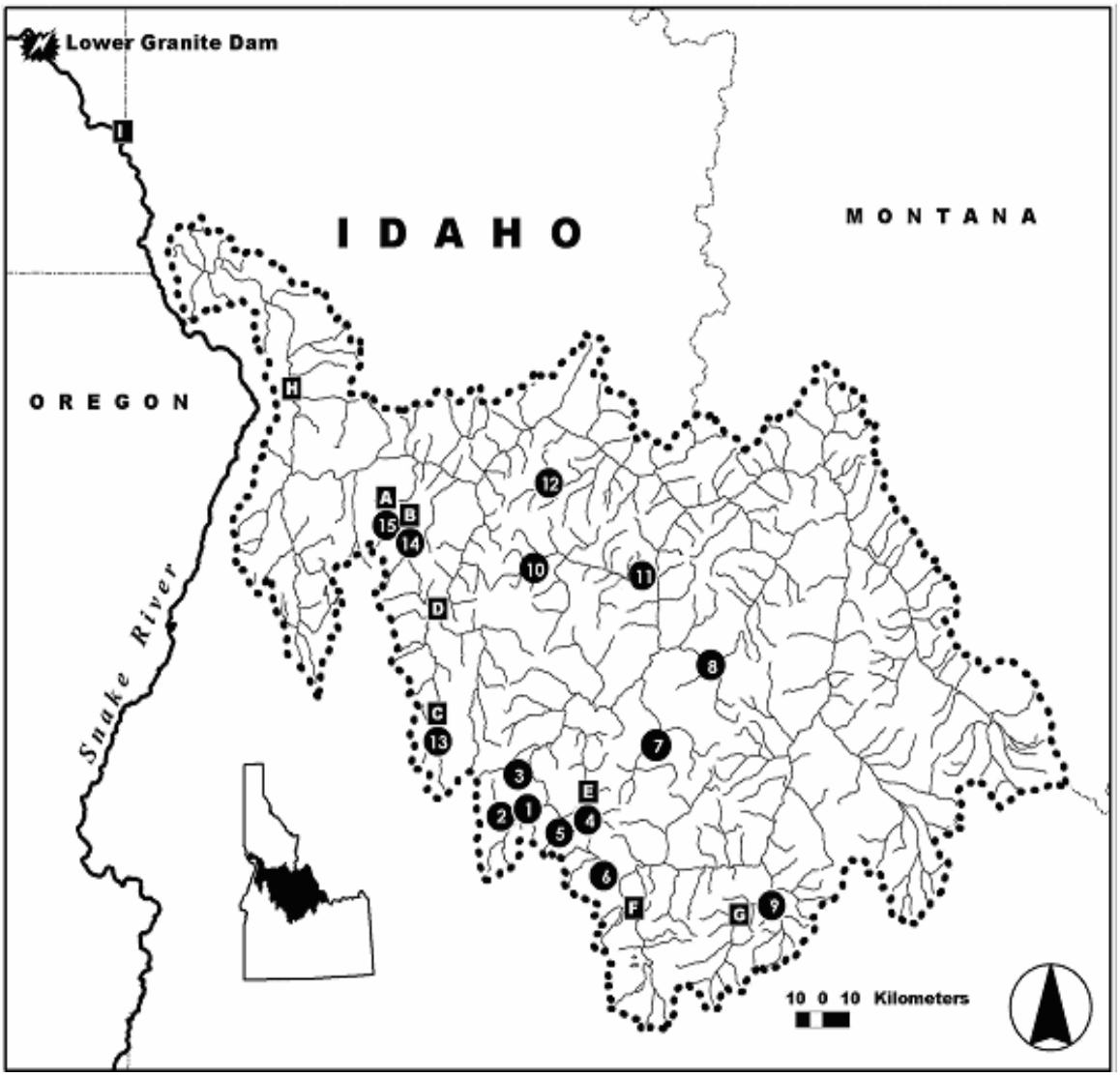


Figure 1. Wild spring/summer Chinook salmon parr were PIT tagged during 2005 in the following stream or sample areas:

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

Juvenile migrant fish traps shown above are as follows:

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

Interrogation at Lower Snake and Columbia River Dams

During spring and summer 2006, surviving Chinook salmon PIT tagged as parr in 2005 for this study migrated volitionally downstream through hydroelectric dams on the Snake and Columbia Rivers. Of the eight lower Snake River and Columbia River dams the smolts passed, the following seven were equipped with smolt collection and/or PIT-tag interrogation systems: Lower Granite, Little Goose, Lower Monumental, and Ice Harbor Dams on the Snake River, and McNary, John Day, and Bonneville Dams on the Columbia River.

At these seven dams, all smolts guided from turbine intakes into juvenile bypass systems were electronically monitored for PIT tags. The PIT-tag interrogation systems were the same (or similar) as those described by Prentice et al. (1990). Dates and times to the nearest second were automatically recorded on a computer as PIT-tagged fish passed each detector. Detection data were transferred once daily to PTAGIS (PSMFC 1996).

Tagged fish were also monitored by a surface pair-trawl detector operated in the upper estuary of the Columbia River (approximately 150 km downstream from Bonneville Dam). For details of its operation, see Ledgerwood et al. (2004).

Migration Timing

We monitored within-season migration timing at Lower Granite Dam based on daily detection numbers (of all wild PIT-tagged Chinook salmon smolts) expanded relative to estimated daily detection probabilities. Detection probabilities were calculated using the methods of Sandford and Smith (2002) to estimate the number of PIT-tagged wild spring/summer Chinook salmon smolts that passed the dam each day. These daily totals were then summed to obtain a yearly survival estimate, which we compared to survival estimates from previous years.

Migration timing at Lower Granite Dam was calculated by totaling the (expanded) number of detections in 3-d intervals and dividing by total detections during the season. This method was applied to detection data for fish from combined streams.

There was no straightforward way of comparing Lower Granite Dam arrival statistics (10th, median, and 90th percentiles) between streams to find statistically significant differences. We used an approach analogous to analysis of variance with multiple comparisons. Bootstrap methods were used to calculate estimates of the

standard error for each statistic (Efron and Tibshirani 1993). A "representative" estimate of variance for each statistic was then calculated as the median of the standard errors for fish from all 19 stream populations. This method assumed that the timing of passage percentiles had similar distributions among streams. The Student-Newmann-Keuls (SNK) multiple comparison method was used to make comparisons between streams for each statistic ($\alpha = 0.05$; Petersen 1985).

We also examined the migration timing at Lower Granite Dam of individual populations over a period of years to determine similarities or differences between years and between populations. We chose populations with 8 or more years of timing data for these analyses. Comparisons of the 10th, 50th, and 90th percentile passage dates were made among 18 streams or sample areas using a two-factor analysis of variance. "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). Statistical significance was set at $\alpha = 0.05$.

Environmental Information

In 2005-2006, we collected hourly measurements of water temperature, dissolved oxygen, specific conductance, turbidity, water depth, and pH from the following locations: 1) Marsh Creek, 2) Valley Creek, 3) Sawtooth Hatchery in the upper Salmon River, 4) South Fork of the Salmon River (Knox Bridge), and 5) Big Creek (lower) at Taylor Ranch. All monitoring systems except the system at Valley Creek and Big 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) and the monitor in Big Creek (lower) was located near our proposed instream PIT-tag monitoring sites for 2006. Also, we collected weather/climate data from three weather stations and stream flow data from two stations in the Salmon River basin.

RESULTS

Fish Collection and Tagging

From 26 July to 31 August 2005, we collected 15,547 wild Chinook salmon parr in 15 Idaho stream populations (Figure 1) over a distance of about 40 stream kilometers and an area of approximately 394,579 m^2 (Table 1; Appendix Table 1). Of these fish, 12,826 were PIT tagged and released back into streams along with the remaining untagged live fish. Some fish were not tagged because of small size, injury, precocious maturation, or excess numbers collected. In addition, some fish were previously tagged and others were collected for genetic and marine-derived nutrient samples. Numbers of tagged fish released per stream or sample area ranged from 238 in Cape Horn Creek to 2,218 in Valley Creek (Table 1 and Appendix Tables 1 and 2a).

Fork lengths of all collected Chinook salmon parr ranged from 38 to 139 mm (mean 66.8 mm) and weights ranged from 0.7 to 40.1 g (mean 4.2 g). The fork lengths of tagged and released Chinook salmon parr ranged from 52 to 131 mm (mean 66.9 mm) (only 4 fish smaller than 55 mm were inadvertently tagged) and weights ranged from 1.2 to 19.2 g (mean 4.0 g; Appendix Table 1). In 2005, collection areas within the streams were further delineated by recording Global Positioning System (GPS) coordinates using Universal Transverse Mercator (UTM) grid (Appendix Table 2b).

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

Mortality associated with collection and tagging procedures was low (Table 3; Appendix Table 3). Overall collection mortality was 1.3% and overall tagging and 24-h delayed mortality was 0.2%. Overall observed mortality was 1.4%.

Table 1. Summary of collection, PIT tagging, and release of wild Chinook salmon parr with average fork lengths and weights, approximate distances, and estimated areas sampled in streams of Idaho during July and August 2005.

Tagging location	Number of fish		Average length (mm)		Average weight (g)		Collection area to mouth of stream (km)	Est. area sampled in streams (m^2)
	Collected	Tagged and released	Collected	Tagged	Collected	Tagged		
Bear Valley Cr	1,211	1,000	63.7	63.4	3.5	3.5	9-12 ; 13-15	37,060
Elk Creek	1,098	1,002	68.3	67.1	4.4	3.9	0-2	14,919
Marsh Creek	877	777	70.8	70.8	4.8	4.8	11-14	26,609
Sulphur Creek	331	274	74.2	68.4	6.7	4.4	5-9	23,708
Cape Horn Cr	279	238	65.5	64.5	4.8	3.9	0-2	12,258
Valley Creek	2,712	2,218	63.7	64.9	3.4	3.2	4-5; 6-8; 17-19	66,362
Loon Creek	516	489	66.4	66.9	4.1	4.1	33-35; 36-37	18,392
Camas Creek	538	500	65.0	65.5	3.7	3.8	22-25	21,368
Herd Creek	621	509	81.2	80.1	7.3	7.4	1-3.5	21,721
Big Cr (upper)	1,917	1,688	64.6	65.1	4.0	3.8	54-57	49,098
Big Cr (lower)	841	817	73.4	73.4	---	---	8-10	35,301
W.F. Chamb. Cr	1,018	798	62.6	64.3	3.5	3.8	1-1.5	1,150
S.F. Salmon R.	1,784	1,009	58.2	62.3	2.7	2.9	117-118; 121	25,376
Secesh River	1,248	1,092	63.1	64.0	3.3	3.4	25-28	30,491
Lake Creek	556	415	61.1	62.7	3.1	3.1	1-1.5	10,766
Totals/averages	15,547	12,826	66.8	66.9	4.2	4.0	40	394,579

Table 2. Summary of species other than Chinook salmon parr observed during collection operations in Idaho in July and August 2005. Numbers of steelhead in parentheses were PIT tagged for the Idaho Department of Fish and Game.

Streams	Steelhead	Tagged Steelhead	Un-identified fry	Brook trout	Cutthroat trout	Bull Trout
Bear Valley Creek	198	(160)	550	325	0	3
Elk Creek	71	(71)	82	315	0	0
Marsh Creek	92	(74)	464	575	0	0
Sulphur Creek	330	(229)	528	0	6	3
Cape Horn Creek	16	(16)	21	37	0	1
Valley Creek	264	(230)	1,944	530	0	5
Loon Creek	252	(213)	705	0	0	1
Camas Creek	211	(191)	1,917	0	1	5
Herd Creek	363	(249)	130	0	0	2
Big Creek (upper)	203	(130)	823	435	0	4
Big Creek (lower)	211	(187)	1,334	0	7	0
W.F. Chamberlain Cr	84	(60)	90	0	0	3
S. Fork Salmon R	299	(218)	450	14	0	3
Secesh River	163	(137)	279	4	0	6
Lake Creek	52	(31)	21	8	0	11
Totals	2,809	(2,196)	9,338	2,243	14	47

	Sculpin	Dace	Sucker	Whitefish	Shiner
Bear Valley Creek	243	39	180	75	0
Elk Creek	79	18	92	914	0
Marsh Creek	799	0	0	7	0
Sulphur Creek	1,871	0	9	205	0
Cape Horn Creek	302	0	0	1	0
Valley Creek	1,944	256	149	494	69
Loon Creek	342	0	1	6	0
Camas Creek	0	0	0	77	0
Herd Creek	378	0	0	3	0
Big Creek (upper)	6,292	1	0	0	0
Big Creek (lower)	276	263	35	6	0
W.F. Chamberlain Cr	24	0	0	82	0
S. Fork Salmon R	279	8	0	19	0
Secesh River	534	19	0	0	0
Lake Creek	509	0	0	2	0
Totals	13,872	604	466	1,891	69

Table 3. Mortality percentages for wild Chinook salmon parr collected and PIT-tagged in Idaho in July and August 2005.

	Mortality (%)		
Tagging location	Collection	Tagging and 24-h post tagging	Overall
Bear Valley Creek	0.6	0.1	0.7
Elk Creek	0.5	0.2	0.7
Marsh Creek	1.6	0.0	1.6
Sulphur Creek	0.0	0.7	0.6
Cape Horn Creek	0.4	0.0	0.4
Valley Creek	1.8	0.3	2.1
Loon Creek	1.2	0.0	1.2
Camas Creek	1.7	0.2	1.9
Herd Creek	2.9	0.0	2.9
Big Creek (upper)	1.3	0.1	1.3
Big Creek (lower)	2.7	0.0	2.7
W Fork Chamberlain Creek	0.7	0.4	1.0
S Fork Salmon River	0.4	0.1	0.5
Secesh River	1.9	0.2	2.1
Lake Creek	0.2	0.5	0.5
Totals or averages	1.3	0.2	1.4

Detections at Instream PIT-Tag Monitors

From 4 to 6 August 2005, 2,218 wild Chinook salmon parr were collected, PIT tagged, and released in natal rearing areas from 3 to 16 km above the upstream PIT-tag instream monitor (VC1) in lower Valley Creek (Table 1). Between 4 August 2005 and 30 June 2006, the two instream detectors (VC1 and VC2) had 182 unique detections of these summer-tagged Chinook salmon juveniles (Figure 2). Median downstream travel time for the 14 fish detected at both monitoring sites was 2 h and 13 min (range 22 min-110.4 d). Of the 182 detections at instream monitors, 83 (45.6%) ocurred in late summer/fall (August-October); 67 (36.8%) occurred in winter (November, December, January, February); and 32 (17.6%) occurred in spring (March-June; Figure 2). Based on detections at downstream dams, the overall efficiency of VC2 for detecting these fish was 11.0%. Based on this VC2 efficiency, we estimated that 58.4% of all summer-tagged parr survived to migrate out of this stream and that their survival from that point to Lower Granite Dam was 20.6%.

The fork lengths and median fork lengths (at tagging) of the 182 detected fish in lower Valley Creek from August 2005 to June 2006, showed no apparent trend related to migration timing throughout this period (Figure 3).

Recaptures at Traps and Dams

A total of 399 wild fish PIT-tagged in summer 2005 were recaptured at traps above Lower Granite Dam from summer/fall 2005 to spring 2006, and 559 were recaptured in the separation-by-code system at the Little Goose Dam juvenile fish facility (Table 4). Depending on the time between tagging and recapture, fish had variable increases in weight and length.

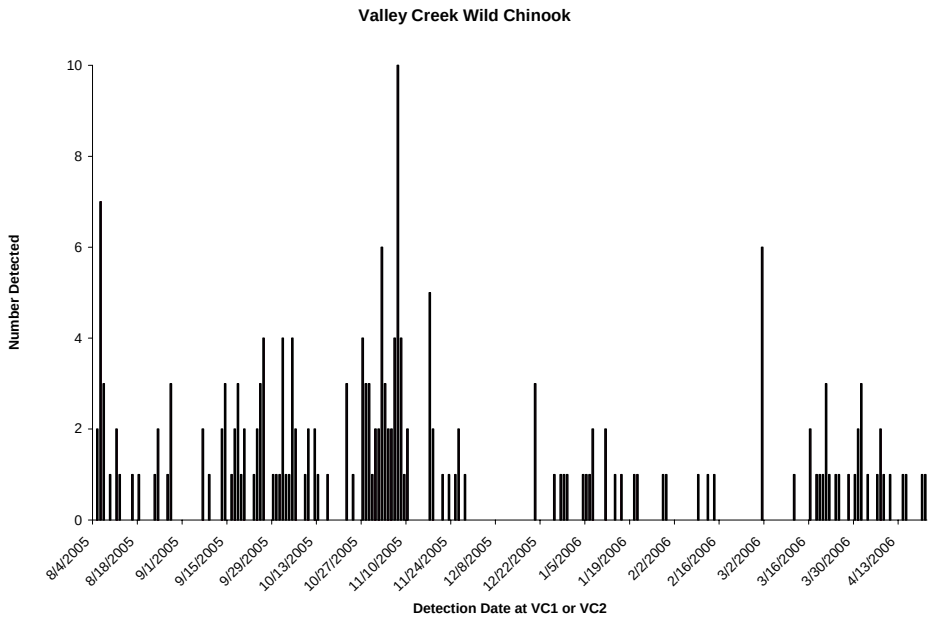


Figure 2. Detections of 182 PIT-tagged wild spring/summer Chinook salmon parr, pre-smolts, and smolts at the upper (VC1) and lower (VC2) instream PIT-tag monitoring systems in lower Valley Creek from August 2005 through June 2006. A total of 2,218 Chinook salmon parr were PIT tagged and released in areas from 3 to 16 kilometers above these antennas from 4 to 6 August 2005.

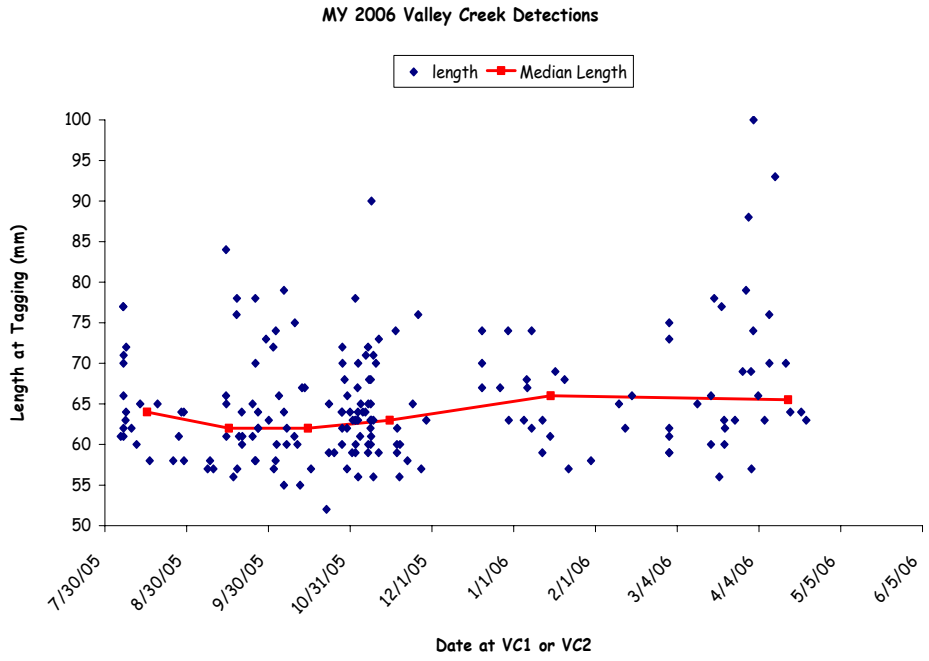


Figure 3. The fork lengths and median fork lengths of 182 summer-tagged parr detected at the upper and lower instream PIT-tag monitoring systems in lower Valley Creek from August 2005 through June 2006.

Table 4. Recapture information on PIT-tagged wild spring/summer Chinook salmon from Idaho that were tagged in summer 2005 and recaptured by the separation-by-code system in the juvenile fish bypass system at Little Goose Dam in 2006 and at traps and dams in summer and fall 2005 and spring 2006.

	Number	Length gain (mm)			Weight gain (g)			Condition factor		Recapture interval (d)	
Location	recaptured	n	range	mean	n	range	mean	release	recapture	range	mean
Streams											
Bear Valley Creek	33	33	23-58	41.3	14	5.5-17.6	9.4	1.23	1.08	264-305	282
Elk Creek	63	62	15-61	38.5	41	4.5-16.4	9.1	1.25	1.07	259-301	280
Sulphur Creek	17	17	20-51	34.4	11	5.4-15.6	8.7	1.33	1.11	261-293	275
Marsh Creek	36	36	13-50	28.6	11	3.6-11.5	6.4	1.31	1.09	256-296	271
Cape Horn Creek	15	15	24-46	35.5	8	4.3-10.1	6.9	1.31	1.10	257-292	275
Valley Creek	49	49	13-53	37.7	14	5.5-14.8	9.8	1.19	1.11	258-297	282
Loon Creek	41	41	19-63	39.3	19	4.2-13.5	8.9	1.33	1.09	258-289	273
Camas Creek	16	16	26-51	35.8	11	2.6-10.7	7.6	1.23	1.05	249-288	265
Herd Creek	45	45	16-43	27.6	10	2.5-9.7	6.5	1.22	1.02	247-287	263
Big Creek (upper)	56	56	10-47	31.9	14	3.7-10.5	7.0	1.30	1.13	244-284	269
S Fork Salmon River	34	34	12-51	34.6	9	3.7-12.3	6.3	1.29	1.11	232-277	258
Big Creek (lower)	62	62	20-50	32.6	--	--	--	--	1.00	237-253	246
W Fork Chamberlain Cr	37	37	23-56	37.4	1	7.7-7.7	7.7	1.16	1.04	240-273	253
Secesh River	45	44	16-57	37.7	13	4.1-11.9	8.6	1.23	1.04	227-271	246
Lake Creek	10	10	22-45	37.6	9	4.1-9.9	8.0	1.32	1.09	235-262	247
Totals or averages	559	557	10-63	35.1	185	2.5-17.6	8.2	1.27	1.07	227-305	266

Table 4. Continued.

Location	Number recaptured	Length gain (mm) n	Length gain (mm) range	Length gain (mm) mean	Weight gain (g) n	Weight gain (g) range	Weight gain (g) mean	Condition factor release	Condition factor recapture	Recapture interval (d) range	Recapture interval (d) mean
Traps											
S Fork Salmon River											
Knox-fall	157	156	-4-11	1.7	22	-1-0.5	-0.2	1.21	1.07	1-70	24
Knox-spring	6	6	9-20	12.7	2	-0.3-2.1	0.9	1.28	0.95	226-238	231
Lower-fall	--	--	--	--	--	--	--	--	--	--	--
Lake Creek											
fall	95	95	-10-8	0.8	66	-2.5-0.8	-0.2	1.25	1.11	1-63	18
spring	2	2	30-42	36.0	1	7.2-7.2	7.2	1.08	1.28	313-343	328
Secesh River											
fall	144	82	-3-8	2.0	39	-1.1-0.8	-0.2	1.25	1.08	2-64	24
spring	2	2	25-34	29.5	2	4.9.-9.4	7.2	1.17	1.26	352-353	352
Marsh Creek											
fall	66	66	-3-21	7.5	--	--	--	1.40	1.073	1-94	41
spring	2	2	19-22	20.5	1	3.5-3.5	3.5	1.38	1.29	246-262	254
Salmon R (spring only)	15	15	16-44	29.3	--	--	--	1.27	--	218-259	240
Snake R (spring only)	7	7	22-49	36.3	--	--	--	1.20	--	232-291	265
Totals	399	336			66						
Collector Dams											
Lower Granite	0	0	---	---	0	---	---	---	---	---	---
McNary	2	0	---	---	0	---	---	---	---	318-325	322
Totals	2	0			0						

Detections at Dams

Based on expanded detections (1,940 fish)[1] at Lower Granite Dam from 6 April to 18 June 2006, estimated survival from parr to smolt for Idaho fish averaged 15.1% (SE 0.7%, range 7.3-37.1%, SE 2.0–5.0%; Table 5; Appendix Tables 5-20). An additional 913 first-time detections (unadjusted) were recorded at Little Goose, Lower Monumental, McNary, John Day, and Bonneville Dams (Appendix Tables 5-19 and 21-25). No first-time detections occurred at Ice Harbor Dam or the PIT-tag trawl near the mouth of the Columbia River. By comparing all first-time detections at interrogation dams (1,521) to the expanded number of detections at Lower Granite Dam (1,940), we estimated that 21.6% of the wild fish from Idaho passed through the dams undetected.

For parr tagged in Idaho, average fork length at release was 66.9 mm (Table 1; Appendix Table 1). However, among fish from this group that were detected the following spring at the dams, average fork length at release was significantly higher (68.1 mm; $P < 0.01$). Also, larger fish (at release) tended to pass Lower Granite Dam earlier than smaller fish (Figure 4). The release-length distribution of detected fish was also significantly different from that of released fish in all length categories ($P < 0.03$; Figure 5).

In 2006, we again found a significant difference in fork lengths at time of release for fish that migrated through Lower Granite Dam in April and May compared to fish that migrated after May ($P < 0.0001$). Fish migrating through the dam in April and May were on average 5.5 mm larger when released than fish migrating after May. These data suggest that fish size influences migration timing or overwintering location.

In 2006, we estimated a 20.6% overall survival rate to Lower Granite Dam for Chinook salmon juveniles previously detected at the Valley Creek instream PIT-tag monitors. The overall parr-to-smolt estimated survival rate for fish from this stream was 13.1% (Table 5). Estimated survival rates for the various groups of fish leaving this stream in 2005-2006 were 7.7% for fish leaving the stream in late summer/fall, 44.3% for fish leaving the stream in winter, and 18.1% for fish leaving the stream in spring.

---

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

Table 5. Summary of observed and expanded detections of PIT-tagged wild spring/summer Chinook salmon smolts from Idaho at Lower Granite Dam in 2006. Table includes expanded numbers used for parr-to-smolt survival estimates and also includes standard error percentages (SE%). See Table 1 for numbers released.

	Lower Granite Dam Detections			
	Observed		Expanded	
Stream	N	%	N	% (SE)
Bear Valley Creek	30	3.0	98	9.8 (2.0)
Elk Creek	60	6.0	209	20.9 (3.0)
Marsh Creek	41	5.3	129	16.6 (3.0)
Cape Horn Creek	15	6.3	45	19.1 (5.0)
Sulphur Creek	13	4.7	41	14.9 (4.0)
Valley Creek	86	3.9	291	13.1 (2.0)
Loon Creek	62	12.7	181	37.1 (5.0)
Camas Creek	23	4.6	70	14.1 (3.0)
Herd Creek	43	8.4	137	27.0 (4.0)
Big Creek (upper)	79	4.7	251	14.9 (2.0)
Big Creek (lower)	53	6.5	176	21.5 (3.0)
West Fork Chamberlain Creek	41	5.1	117	14.7 (2.0)
South Fork Salmon River	25	2.5	73	7.3 (2.0)
Secesh River	27	2.5	90	8.3 (2.0)
Lake Creek	10	2.4	32	7.7 (3.0)
Totals or averages	608	4.7	1,940	15.1 (0.7)

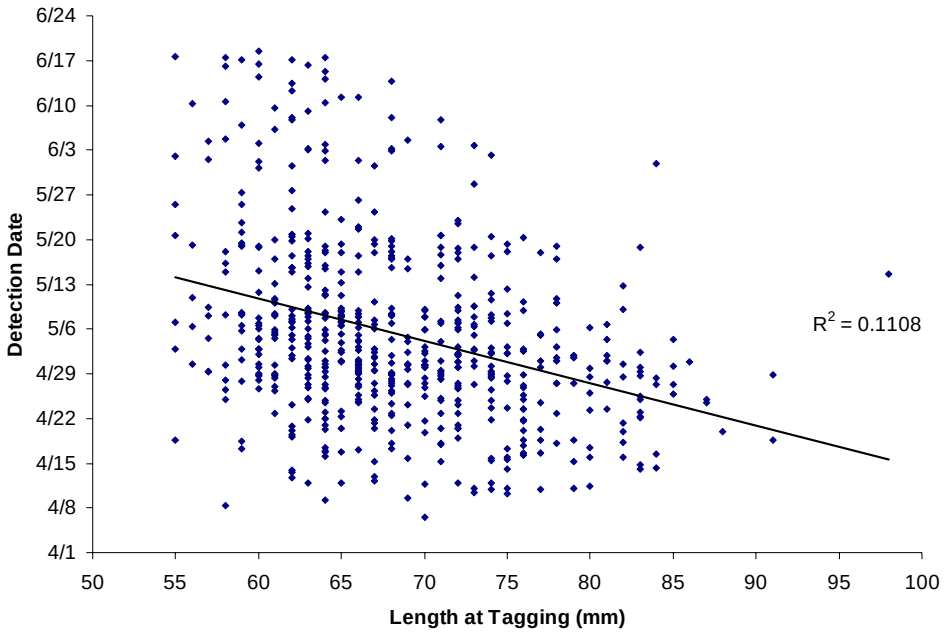


Figure 4. The relationship between fork length of parr at tagging (in 2005) to detection date at Lower Granite Dam in 2006.

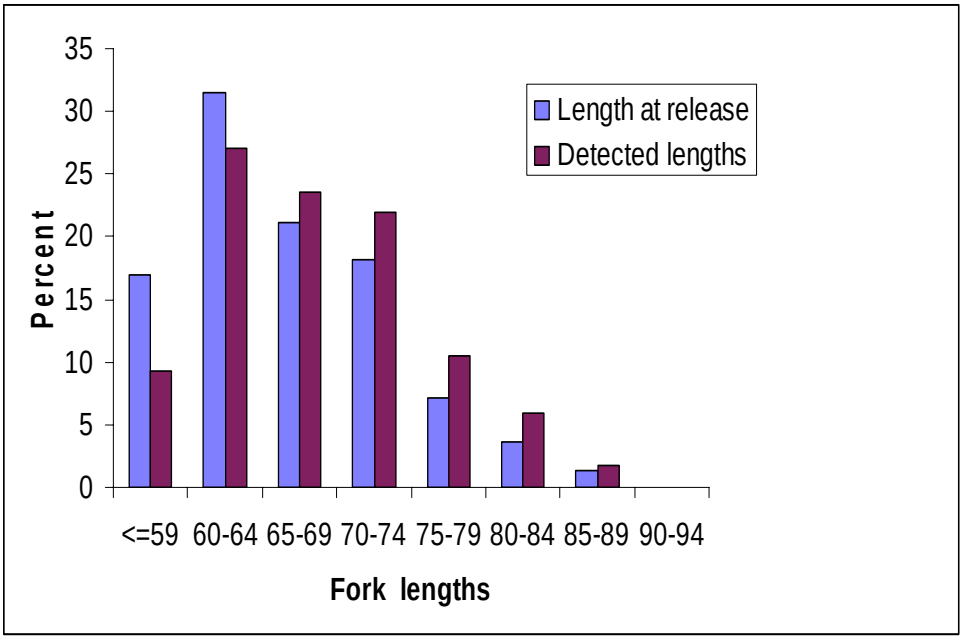


Figure 5. Percent by fork length increments (mm), of PIT-tagged wild spring/summer Chinook salmon parr released in Idaho streams in 2005 (n = 12,806) and percent of fish detected for these length increments at dams in spring and summer 2006 (n = 1,564).

Migration Timing

Lower Granite Dam

Passage timing at Lower Granite Dam varied for fish from the 19 Idaho and Oregon stream populations (Figure 6). In comparisons among all 19 Idaho and Oregon stream populations (Appendix Table 4a-4b, Figure 6), fish from Big (lower), Sulphur, Marsh, and Bear Valley Creeks and the upper Imnaha, Minam, and Secesh Rivers had a significantly earlier timing of the 10th percentile passage than fish from all other streams except the Lostine River and West Fork Chamberlain, Elk, Herd, and Lake Creeks (P <0.05).

The 10th percentile passage date of fish from Catherine Creek, South Fork Salmon River, and Valley Creek was significantly later than that of fish from all other streams except Big Creek (upper) (P <0.05). The standard errors on these passage estimates ranged from 0.2 to 2.9 d (median 1.5 d). Overall, the 10th percentile passage dates for fish from all 19 stream populations ranged from 11 to 30 April (Appendix Tables 4a-4b).

In comparisons of the 50th percentile passage date at the dam, fish from Big Creek (lower) were significantly earlier than fish from all other streams except Elk and Herd Creeks and the Lostine and Secesh Rivers (P <0.05). Fish from Valley Creek were significantly later at the dam than fish from all other streams, and fish from Catherine Creek were significantly later than those from all other streams except Valley Creek (P <0.05). Standard errors of these passage estimates ranged from 0.8 to 4.8 d (median 1.3 d). The overall 50th percentile passage dates for fish from all 19 stream populations ranged from 22 April to 24 May (Appendix Tables 4a-4b).

In terms of the 90th percentile passage date at the dam, fish from Big Creek (lower) were significantly earlier than fish from all other streams except Herd and West Fork Chamberlain Creeks (P <0.05). Fish from Valley Creek and South Fork Salmon River were significantly later than fish from all other streams (P <0.05). The standard errors on these passage estimates ranged from 0.5 to 13.0 d (median 2.8 d). The overall 90th percentile passage dates for fish from all streams ranged from 3 May to 16 June (Appendix Tables 4a-4b).

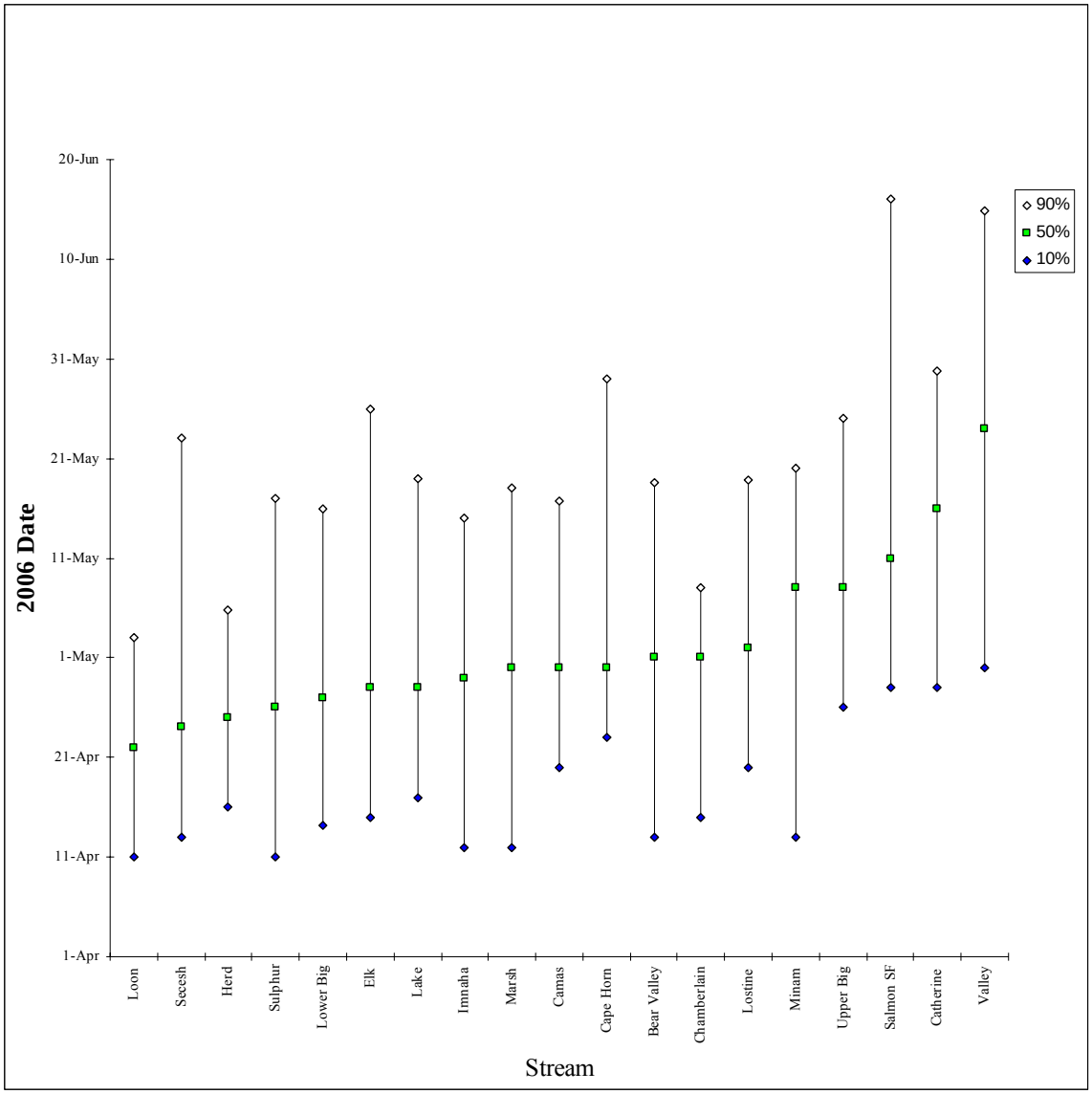


Figure 6. Estimated passage distributions at Lower Granite Dam for wild spring/summer Chinook salmon smolts from streams of Idaho and Oregon in 2006. Big Creek is divided into lower and upper portions for these analyses. See Appendix Tables 5-19 for daily estimated passage numbers from Idaho streams at the dam.

For the number of days encompassing the middle 80th percentile passage (10th to 90th percentile), Herd Creek fish had a significantly more condensed distribution (20 d) than fish from all other streams except Big (lower), West Fork Chamberlain, Camas, Loon, Big (upper), Catherine, and Lake Creeks and the Lostine and Imnaha (upper) Rivers (22-33 d; $P > 0.05$; Appendix Tables 4a-4b). Timing of the middle 80th percentile passage for fish from the other 9 streams ranged from 36 d for Bear Valley Creek fish to 49 d for South Fork Salmon River fish (Appendix Tables 4a-4b). Standard errors for these passage estimates range from 0.8 to 12.9 d (median 3.3 d).

Migration timing at Lower Granite Dam based on streams with 8 or more years of data indicated that passage dates of the 10th, 50th, and 90th percentiles vary between streams (Table 6). Secesh River and Lake Creek fish had a significantly earlier timing of the 10th percentile passage date at Lower Granite Dam than fish from all other streams except Big (lower) Creek and the Lostine and Imnaha (upper) Rivers ($P < 0.05$). Also, Big Creek (upper) fish had significantly later migration timing at the dam than all the other streams ($P < 0.05$).

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

Table 6. The 95% confidence interval (CI) and mean passage dates for the 10th, 50th, and 90th percentiles of the populations, 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 periods at Lower Granite Dam			Data
Stream	95% CI	10th (SE)	50th (SE)	90th (SE)	years
Secesh River	Lo CI	11 April	23 April	23 May	
	Up CI	17 April	29 April	07 June	
	Mean	14 April (1)	26 April (1)	31 May (4)	18
South Fork Salmon R	Lo CI	16 April	07 May	02 June	
	Up CI	24 April	13 May	11 June	
	Mean	20 April (2)	10 May (1)	06 June (2)	17
Catherine Creek	Lo CI	23 April	11 May	28 May	
	Up CI	29 April	17 May	07 June	
	Mean	26 April (2)	14 May (1)	02 June (2)	16
Imnaha River (upper)	Lo CI	14 April	28 April	17 May	
	Up CI	20 April	05 May	27 May	
	Mean	17 April (1)	02 May (2)	22 May (2)	14
Bear Valley Creek	Lo CI	17 April	04 May	26 May	
	Up CI	26 April	11 May	05 June	
	Mean	21 April (2)	08 May (2)	31 May (2)	15
Big Creek (upper)	Lo CI	25 April	12 May	29 May	
	Up CI	05 May	25 May	19 June	
	Mean	30 April (2)	19 May (3)	09 June (5)	12
Elk Creek	Lo CI	16 April	02 May	25 May	
	Up CI	24 April	10 May	04 June	
	Mean	20 April (2)	06 May (2)	30 May (2)	14
Valley Creek	Lo CI	21 April	10 May	31 May	
	Up CI	30 April	19 May	13 June	
	Mean	25 April (2)	14 May (2)	06 June (3)	15
Marsh Creek	Lo CI	16 April	01 May	20 May	
	Up CI	22 April	09 May	29 May	
	Mean	19 April (1)	05 May (2)	24 May (2)	13
Lake Creek	Lo CI	12 April	26 April	26 May	
	Up CI	19 April	04 May	10 June	
	Mean	15 April (2)	30 April (2)	02 June (4)	14
Lostine River	Lo CI	12 April	30 April	17 May	
	Up CI	20 April	07 May	26 May	
	Mean	16 April (2)	04 May (2)	22 May (2)	15

Table 6. Continued.

Stream	95% CI	Percentile passage periods at Lower Granite Dam 10th (SE)	50th (SE)	90th (SE)	Data years
Cape Horn Creek	Lo CI	19 April	05 May	24 May	
	Up CI	30 April	18 May	10 June	
	Mean	25 April (2)	12 May (3)	01 June (4)	10
Big (lower)/Rush Creeks	Lo CI	16 April	26 April	08 May	
	Up CI	21 April	29 April	16 May	
	Mean	18 April (1)	28 April (1)	12 May (2)	10
E. F. Salmon River	Lo CI	15 April	25 April	13 May	
	Up CI	24 April	07 May	23 May	
	Mean	19 April (2)	01 May (2)	18 May (2)	7
Loon Creek	Lo CI	20 April	03 May	14 May	
	Up CI	01 May	14 May	27 May	
	Mean	26 April (2)	09 May (3)	20 May (3)	9
Herd Creek	Lo CI	16 April	25 April	10 May	
	Up CI	24 April	03 May	18 May	
	Mean	20 April (2)	29 April (2)	14 May (2)	10
Grand Ronde River (upper)	Lo CI	23 April	13 May	21 May	
	Up CI	10 May	04 June	03 July	
	Mean	01 May (3)	24 May (4)	12 June (8)	5
Imnaha River (lower)	Lo CI	05 April	14 April	02 May	
	Up CI	20 April	05 May	15 May	
	Mean	12 April (2)	25 April (3)	09 May (2)	4
Chamb./W.F.Chamberlain Creeks	Lo CI	15 April	28 April	14 May	
	Up CI	25 April	10 May	16 June	
	Mean	20 April (2)	04 May (3)	31 May (7)	9
Camas Creek	Lo CI	22 April	05 May	22 May	
	Up CI	01 May	19 May	01 June	
	Mean	26 April (2)	12 May (3)	27 May (2)	8
Minam River	Lo CI	12 April	28 April	18 May	
	Up CI	24 April	12 May	29 May	
	Mean	18 April (2)	05 May (3)	24 May (2)	5

Comparison with 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 7 and Appendix Table 20). Overall, passage at the dam during 2006 occurred between early April and late June, with the middle 80th percentile passage occurring from 18 April to 22 May (Table 7). The peak passage date was 30 April, which coincided with high (and increasing) flows of 139.5 kcfs (Appendix Table 20).

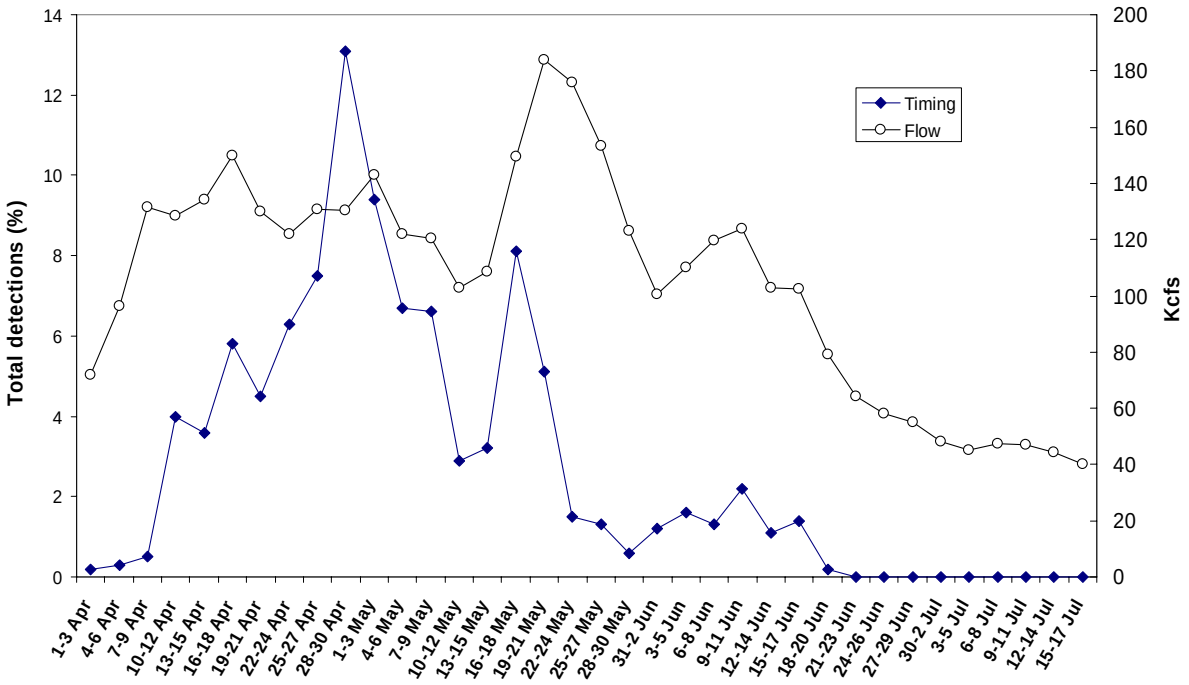


Figure 7. Overall migration timing of PIT-tagged wild spring/summer Chinook salmon smolts with associated river flows at Lower Granite Dam, 2006. Daily detections from Idaho and Oregon streams were pooled in 3-d intervals and expanded based on daily detection probability. River flows at the dam were averaged daily over the same periods.

Table 7. Accumulated and 2006 passage dates at Lower Granite Dam for combined populations of wild spring/summer Chinook salmon smolts PIT tagged as summer parr in Idaho and Oregon streams.

	Passage periods at Lower Granite Dam			
Year	10th	50th	90th	Range
1989[a]	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[a,b]	15 April	27 April	19 May	09 April-15 July
1997[a,b]	12 April	24 April	18 May	31 March-22 Sept.
1998[b]	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**

a. No fish were tagged from the Middle Fork of the Salmon River drainage for this migration year.
b. This migration year represented by a much higher proportion of fish from Oregon streams than other years.

Environmental Information

Environmental factors varied by month and between locations (Appendix Tables 26-29), as did the percentage of fish collected and/or detected at adjacent traps (Appendix Figures 1-7). In spring 2006, three water-quality sondes were lost, and another was lost and later recovered during very high flows in natal rearing areas. Therefore, all water quality data in 2005-2006 were lost from the Secesh River monitoring site, and data from Marsh Creek and the Salmon River (upper) near Sawtooth Hatchery were limited to mostly fall and winter data. The limited data collected in late summer and fall 2005 in Big Creek (lower) will not be presented in this report. Weather/climate and stream-flow data varied by month and between locations (Appendix Table 30).

DISCUSSION

Mortality rates associated with collection and tagging in 2005 were comparable to those in earlier years (Achord et al. 1992; 1994; 1995a,b; 1996a,b; 1997; 1998; 2000, 2001a,b; 2002; 2003; 2004; 2005; 2006).

The instream monitoring systems in Valley Creek enabled us to calculate survival estimates and migration timing for PIT-tagged wild Chinook salmon juveniles leaving this stream during 2003-2004, 2004-2005, and 2005-2006. However, during these years, only 8-14% of the tagged juvenile Chinook salmon were detected at instream monitors. In order to increase the precision of survival estimates, we will need to increase either the antenna size or number or the tagging sample size.

It is important to note that detections from instream monitors indicate a higher-than-expected proportion of wild juvenile Chinook salmon are moving out of Valley Creek during winter. This has very important implications for intensive fish monitoring studies throughout Idaho that use rotary screw traps because these traps are inoperable during winter in most areas. Perhaps a combination of rotary screw traps and instream PIT-tag monitoring may be appropriate for some locations or studies.

Overall mean growth in length from the parr to smolt stage, as measured at Little Goose Dam in 2006 (0.13 mm/d), was less than that observed in all previous years (2001-2005) (0.14-0.16 mm/d) (Achord et al. 2002; 2003; 2004; 2005; 2006). The overall mean weight gain in 2006 was less than that measured in all other years except 2004 (0.031 g/d for both years).

Higher flows and cooler water temperatures in 2006 contributed to only slightly earlier timing for wild fish in the lower Snake River compared to the last several years. However, due to state permitting issues at Little Goose Dam, most wild fish measurements were taken in April and early May, with very few taken in late season compared to previous years. Consequently, the respective minimum, mean, and maximum number of days between parr-to-smolt measurements was earlier on average by 9, 12, and 21 d in 2006 compared to the previous 5 years. Achord et al. (2007) found that smaller tagged fish have higher parr-to-smolt growth rates and later timing to the lower Snake River. Therefore, a combination of these conditions in 2006 may have contributed to the lower observed growth rates.

To assess possible differences that may relate to subsequent smolt-to-adult return rates. We examined length differences between known wild fish populations measured at

Little Goose Dam and untagged wild fish (≤124 mm) PIT tagged at Lower Granite Dam for transportation studies. Over a 6-year period (2001 to 2006), we found slight differences between groups in yearly mean length, but overall average mean lengths were identical for both groups of fish (108.7 mm).

Annual parr-to-smolt survival estimates for fish from Oregon and Idaho streams combined have ranged from 8.1 to 24.4% over the last 14 years, with an average annual survival rate of 16.1%. We measured the lowest parr-to-smolt survival estimates in 2004 and 2005 at 8.1 and 8.4%, respectively. These low estimates may have resulted from conditions with much higher parr density (see Figure 8 for Idaho streams). Wild adult returns to the Snake River basin from 2001 to 2003 were more than one order of magnitude greater than returns from 1994 to 1996, when we measured the highest subsequent parr-to-smolt survival (20.6 to 24.4%).

In 2006, as observed in previous years, fish that were larger at tagging tended to migrate earlier than smaller fish at Lower Granite Dam. In addition, we again observed that wild fish detected at the dam in April and May had been significantly larger at release than fish migrating after May. This suggests that size is an important factor related to either the initiation of smoltification or to other life-history dynamics that affect the migration timing of wild fish.

In spring 2006, the overall 50th and 90th percentile passage dates for wild fish at Lower Granite Dam occurred in early and late May, respectively. We experienced the highest flows throughout the spring in 2006 since 1999. As noted in our previous reports, wild 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 environmental monitors, instream PIT-tag monitors, and traps continue to be installed in study streams, we can more accurately monitor fry, parr, and smolt movements out of rearing areas and examine the relationships between these movements and environmental conditions within the streams. 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.

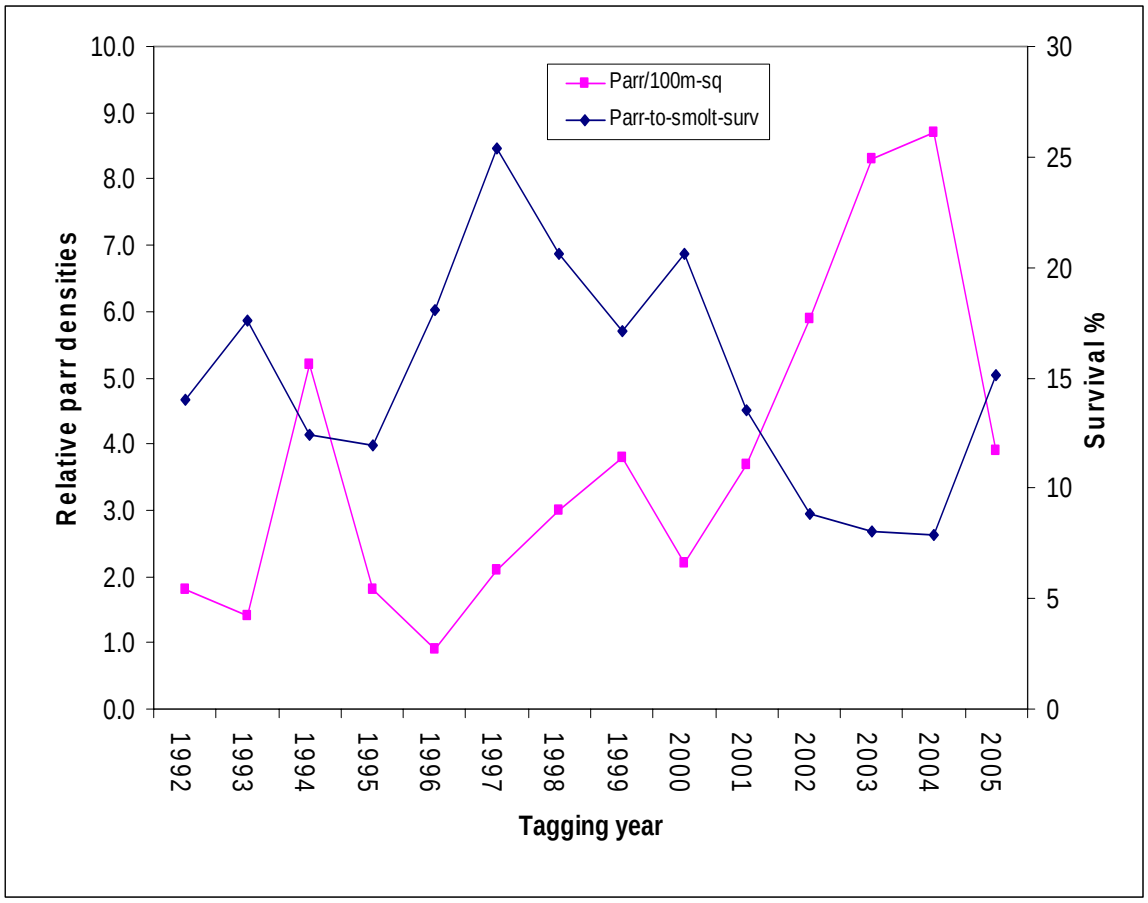


Figure 8. The relationships between relative Chinook salmon parr densities (numbers of fish per 100 m^2) to subsequent overall parr-to-smolt survival estimated the following years from 1993 to 2006 at Lower Granite Dam. Populations were from all Idaho streams combined and were tagged each summer from 1992 to 2005.

ACKNOWLEDGMENTS

We thank Bonneville Power Administration for funding this project and Richard Nelson, William D. Muir, John W. Ferguson, Jacob M. Hodge, Lanesa Hodge, Mark Hall, Josh Hall, John Hodge, Dan Lyman, Jeff Hall, Darren Ogden, Shane Collier, Dave Marvin, and Richard D. Ledgerwood for their excellent assistance in collecting and PIT tagging fish for this study. Also, thanks to personnel from the Idaho Department of Fish and Game and the Nez Perce Tribe for providing data from trapping operations in natal rearing areas. Special thanks to William R. Wassard for the successful maintenance of the instream PIT-tag monitoring systems in lower Valley Creek.

REFERENCES

Achord, S., G. A. Axel, E. E. Hockersmith, B. P. Sandford, M. B. Eppard, and G. M. Matthews. 2001a. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 1999. Report to Bonneville Power Administration, Project 91-028, Contract 99-AI-19164. 87 p. (Available on the Internet at www.efw.bpa.gov/searchpublications/).

Achord, S., G. A. Axel, E. E. Hockersmith, B. P. Sandford, M. B. Eppard, and G. M. Matthews. 2001b. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 2000. Report to Bonneville Power Administration, Project 91-028, Contract 99-AI-19164. 104 p. (Available on the Internet at www.efw.bpa.gov/searchpublications/).

Achord, S., G. A. Axel, E. E. Hockersmith, B. P. Sandford, M. B. Eppard, and G. M. Matthews. 2002. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 2001. Report to Bonneville Power Administration, Project 91-028, Contract 00005619. 74 p. (Available on the Internet at www.efw.bpa.gov/searchpublications/).

Achord, S., M. B. Eppard, E. E. Hockersmith, B. P. Sandford, G. A. Axel, and G. M. Matthews. 2000. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 1998. Report to Bonneville Power Administration, Project 9102800, Contract DE-AI79-91BP18800. 82 p. (Available on the Internet at www.efw.bpa.gov/searchpublications/).

Achord, S., M. B. Eppard, E. E. Hockersmith, B. P. Sandford, and G. M. Matthews. 1997. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 1996. Report to Bonneville Power Administration, Project 91-028, Contract DE-AI79-91BP18800. 74 p. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Achord, S., M. B. Eppard, E. E. Hockersmith, B. P. Sandford, and G. M. Matthews. 1998. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 1997. Report to Bonneville Power Administration, Project 91028, Contract DE-AI79-91BP18800. 78 p. (Available on the Internet at www.efw.bpa.gov/searchpublications/).

Achord, S., M. B. Eppard, B. P. Sandford, and G. M. Matthews. 1996a. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 1995. Report to Bonneville Power Administration, Project 91-028, Contract DE-AI79-91BP18800. 179 p. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Achord, S., J. R. Harmon, D. M. Marsh, B. P. Sandford, K. W. McIntyre, K. L. Thomas, N. N. Paasch, and G. M. Matthews. 1992. Research related to transportation of juvenile salmonids on the Columbia and Snake Rivers, 1991. Report to U.S. Army Corps of Engineers, Contract DACW68-84-H0034. 57 p. plus appendix. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Achord, S., E. E. Hockersmith, B. P. Sandford, R. A. McNatt, B. E. Feist, and G. M. Matthews. 2003. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 2002. Report to Bonneville Power Administration, Project 199102800, Contract 00005619. 94 p. (Available on the Internet at www.efw.bpa.gov/searchpublications/).

Achord, S., J. M. Hodge, B. P. Sandford, E. E. Hockersmith, K. W. McIntyre, N. N. Paasch, and J. G. Williams. 2005. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 2004. Report to Bonneville Power Administration, Project 199102800, Contract 00005619. 94 p. (Available on the Internet at www.efw.bpa.gov/searchpublications/).

Achord, S., D. J. Kamikawa, B. P. Sandford, and G. M. Matthews. 1995a. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 1993. Report to Bonneville Power Administration, Project 91-028, Contract DE-AI79-91BP18800. 88 p. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Achord, S., D. J. Kamikawa, B. P. Sandford, and G. M. Matthews. 1995b. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 1994. Report to Bonneville Power Administration, Project 91-028, Contract DE-AI79-91BP18800. 100 p. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Achord, S., G. M. Matthews, O. W. Johnson, and D. M. Marsh. 1996b. Use of Passive Integrated Transponder (PIT) tags to monitor migration timing of Snake River Chinook salmon smolts. North American Journal of Fisheries Management 16:302-313.

Achord, S., G. M. Matthews, D. M. Marsh, B. P. Sandford, and D. J. Kamikawa. 1994. Monitoring the migrations of wild Snake River spring and summer Chinook salmon smolts, 1992. Report to Bonneville Power Administration, Project 91-028, Contract DE-AI79-91BP18800. 73 p. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98112-2097.)

Achord, S., R. A. McNatt, E. E. Hockersmith, B. P. Sandford, K. W. McIntyre, N. N. Paasch, J. G. Williams, and G. M. Matthews. 2004. Monitoring the migrations of wild Snake River spring/summer Chinook salmon smolts, 2003. Report to Bonneville Power Administration, Project 199102800, Contract 00005619. 98 p. (Available on the Internet at www.efw.bpa.gov/searchpublications/).

Achord, S., B. P. Sandford, E. E. Hockersmith, J. M. Hodge, K. W. McIntyre, N. N. Paasch, L. G. Crozier, and J. G. Williams. 2006. Monitoring the migrations of wild Snake River spring/summer Chinook salmon juveniles, 2004-2005. Report to Bonneville Power Administration, Project 199102800, Contract 00021961. 100 p. (Available on the Internet at www.efw.bpa.gov/searchpublications/).

Achord, S., R. W. Zabel, and B. P. Sandford. 2007. Migration timing, growth, and estimated parr-to-smolt survival rates of wild Snake River spring/summer Chinook salmon from the Salmon River basin, Idaho, to the lower Snake River. Transactions of the American Fisheries Society 136:142-154.

Downing, S. L., E. F. Prentice, E. P. Nunnallee, and B. F. Jonasson. 2001. Development and evaluation of passive integrated transponder tag technology, annual report: 1999 to 2000. Report of the National Marine Fisheries Service to the Bonneville Power Administration, Portland, Oregon. Available at www.efw.bpa.gov/searchpublications.

Efron, B., and R. J. Tibshirani. 1993. An introduction to the bootstrap. Chapman and Hall, Norwell, MA, 436 p.

Ledgerwood, R. D., B. A. Ryan, E. M. Dawley, E. P. Nunnallee, and J. W. Ferguson. 2004. A Surface Trawl to Detect Migrating Juvenile Salmonids Tagged with Passive Integrated Transponder tags. North American Journal of Fisheries Management 24:440-451.

Matthews, G. M., J. R. Harmon, S. Achord, O. W. Johnson, and L. A. Kubin. 1990. Evaluation of transportation of juvenile salmonids and related research on the Snake and Columbia Rivers, 1989. Report to U.S. Army Corp of Engineers, Contract DACW68-84-H0034. 59 p. plus Appendix. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle WA 98112-2097.)

Matthews, G. M., D. L. Park, S. Achord, and T. E. Ruehle. 1986. Static seawater challenge test to measure relative stress levels in spring Chinook salmon smolts. Transactions of the American Fisheries Society 115(2):236-244.

PSMFC (Pacific States Marine Fisheries Commission). 1996. The Columbia Basin PIT Tag Information System (PTAGIS). PSMFC, Portland, Oregon. Online database available through the internet at http://www.psmfc.org.pittag/ (accessed October 2004).

Petersen, R. G. 1985. Design and analysis of experiments. Marcel Dekker, New York, 429 p.

Prentice, E. F., T. A. Flagg, and C. S. McCutcheon. 1990. PIT-tag monitoring systems for hydroelectric dams and fish hatcheries. Am. Fish. Soc. Symp. 7:323-334.

Sandford, B. P., and S. G. Smith. 2002. Estimation of smolt-to-adult return percentages for Snake River Basin anadromous salmonids, 1990-1997. J. Agric. Biol. Environ. Stat. 7(2):243-263.

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, 2005.

				Collection				Tagging and release			
	Number of fish			length (mm)		weight (g)		length (mm)		weight (g)	
	collected	tagged	released	range	mean	range	mean	range	mean	range	mean
Bear Valley Cr	1,211	1,001	1,000	47-128	63.7	1.1-30.9	3.5	53-103	63.4	1.2-15.6	3.5
Elk Creek	1,098	1,004	1,002	48-139	68.3	1.4-40.1	4.4	54-94	67.1	2.0-7.4	3.9
Marsh Creek	877	777	777	49-114	70.8	2.2-11.3	4.8	56-97	70.8	2.2-11.3	4.8
Sulphur Creek	331	276	274	49-127	74.2	2.0-28.0	6.7	55-98	68.4	2.0-12.0	4.4
Cape Horn Cr	279	238	238	50-115	65.5	1.7-23.8	4.8	55-99	64.5	1.7-12.4	3.9
Valley Creek	2,712	2,225	2,218	38-131	63.7	0.7-21.1	3.4	52-131	64.9	1.6-8.5	3.2
Loon Creek	516	489	489	50-84	66.4	1.7-8.9	4.1	54-84	66.9	1.7-8.9	4.1
Camas Creek	538	501	500	50-117	65.0	1.3-21.5	3.7	55-86	65.5	1.9-7.5	3.8
Herd Creek	621	509	509	53-126	81.2	1.0-27.1	7.3	62-114	80.1	3.9-19.2	7.4
Big Cr (lower)	841	817	817	56-89	73.4	-------	----	56-89	73.4	-------	----
W Fork Chamb. Cr	1,018	801	798	42-85	62.6	1.1-6.7	3.5	55-85	64.3	1.8-6.7	3.8
S Fork Salmon R	1,784	1,010	1,009	41-98	58.2	0.9-11.7	2.7	55-97	62.3	1.5-8.8	2.9
Secesh River	1,248	1,094	1,092	43-96	63.1	1.0-6.5	3.3	55-94	64.0	1.9-6.5	3.4
Lake Creek	556	417	415	43-96	61.1	1.1-12.4	3.1	55-96	62.7	1.6-12.4	3.1
Total or mean	15,547	12,848	12,826	47-111	66.8	1.3-19.8	4.2	55-98	66.9	1.9-10.6	4.0

Appendix Table 2a. Summary of tagging dates, start tagging times (PST) 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 2005), and number/percent of first-time detections (unadjusted) for each tag group at six downstream dams and the PIT-tag trawl at the mouth of the Columbia River during 2006.

	Capture				Release					Detection	
	Date	Time	Temp (°C)	Capture method	Date	Time	Temp (°C)	km	n	n	(%)
Bear Valley Creek											
SA05207.BV1	7/26/05	06:31	12.0	SHOCK	7/27/05	04:00	10.0	09	121	6	5.0
SA05207.BV2	7/26/05	08:15	12.0	SHOCK	7/26/05	11:30	14.5	10	209	19	9.1
SA05208.BV1	7/27/05	05:43	11.0	SHOCK	7/27/05	11:00	14.5	13	670	67	10.0
Elk Creek											
SA05209.EC1	7/28/05	05:21	12.0	BSEINE	7/29/05	06:15	12.0	01	102	14	13.7
SA05209.EC2	7/28/05	05:59	12.0	BSEINE	7/28/05	09:00	12.0	01	584	91	15.6
SA05209.EC3	7/28/05	09:09	12.0	SHOCK	7/28/05	10:15	13.5	02	168	18	10.7
SA05210.EC1	7/29/05	07:09	11.5	SHOCK	7/29/05	08:45	12.5	02	148	19	12.8
Marsh Creek											
SA05213.MC1	8/01/05	06:32	09.0	SHOCK	8/02/05	06:00	09.0	11	116	22	19.0
SA05213.MC2	8/01/05	08:05	09.5	SHOCK	8/01/05	11:00	14.0	12	253	36	14.2
SA05214.MC1	8/02/05	06:53	09.0	SHOCK	8/02/05	10:30	13.0	14	408	31	7.6
Cape Horn Creek											
SA05215.CH1	8/03/05	07:18	06.0	SHOCK	8/04/05	06:30	05.5	03	95	12	12.6
SA05215.CH2	8/03/05	08:28	06.0	SHOCK	8/03/05	11:00	11.0	03	143	21	14.7
Sulphur Creek											
SA05214.SU1	8/02/05	07:19	11.0	BSEINE	8/03/05	07:00	11.0	05	117	16	13.7
SA05214.SU2	8/02/05	11:02	14.0	SHOCK	8/02/05	11:30	14.0	06	20	3	15.0
SA05215.SU1	8/03/05	08:03	10.5	SHOCK	8/03/05	11:30	14.0	08	137	14	10.2

Appendix Table 2a. Continued.

	Capture				Release					Detection	
	Date	Time	Temp (°C)	Capture method	Date	Time	Temp (°C)	km	n	n	(%)
Valley Creek											
SA05216.VC1	8/04/05	07:29	10.0	SHOCK	8/05/05	05:30	09.5	05	200	7	3.5
SA05216.VC2	8/04/05	09:30	12.5	SHOCK	8/04/05	11:30	17.0	05	140	16	11.4
SA05217.VC1	8/05/05	06:43	11.0	BSEINE	8/05/05	11:30	19.0	08	35	0	0.0
SA05217.VC2	8/05/05	07:16	11.0	SHOCK	8/05/05	11:30	19.0	08	707	32	4.5
SA05217.VC3	8/05/05	10:11	16.0	SHOCK	8/05/05	11:30	19.0	08	385	21	5.5
SA05218.VC1	8/06/05	06:39	10.0	SHOCK	8/06/05	12:30	16.0	18	405	79	19.5
SA05218.VC2	8/06/05	08:36	12.0	SHOCK	8/07/05	07:25	11.5	18	346	69	19.9
Loon Creek											
SA05220.LN1	8/08/05	08:03	11.0	SHOCK	8/09/05	04:30	09.0	34	96	20	20.8
SA05220.LN2	8/08/05	09:19	11.0	SHOCK	8/08/05	12:00	15.0	35	271	71	26.2
SA05221.LN1	8/09/05	05:51	10.0	SHOCK	8/09/05	07:15	10.0	36	122	28	22.9
Camas Creek											
SA05220.CA1	8/08/05	08:04	12.5	SHOCK	8/09/05	05:00	11.0	22	103	14	13.6
SA05220.CA2	8/08/05	09:23	13.0	SHOCK	8/08/05	11:30	17.0	23	295	28	9.5
SA05221.CA1	8/09/05	07:16	11.0	SHOCK	8/09/05	10:30	12.0	24	102	11	10.8
Herd Creek											
SA05222.HC1	8/10/05	06:45	10.0	SHOCK	8/11/05	08:00	11.0	02	103	21	20.4
SA05222.HC2	8/10/05	07:38	10.0	SHOCK	8/10/05	10:45	12.0	03	406	79	19.5
Big Creek (upper)											
SA05227.BC1	8/15/05	07:34	08.0	SHOCK	8/16/05	07:00	08.0	54	167	20	12.0
SA05227.BC2	8/15/05	08:57	09.0	SHOCK	8/15/05	12:45	14.5	55	570	91	16.0
SA05227.BC3	8/15/05	10:21	10.5	SHOCK	8/15/05	12:45	14.5	55	414	59	14.2
SA05228.BC1	8/16/05	05:56	08.0	SHOCK	8/16/05	11:00	11.0	57	537	39	7.3

Appendix Table 2a. Continued.

	Capture				Release					Detection	
	Date	Time	Temp (°C)	Capture method	Date	Time	Temp (°C)	km	n	n	(%)
Big Creek (lower)											
SA05234.LB1	8/22/05	07:25	14.5	SHOCK	8/23/05	08:30	13.5	10	94	9	9.6
SA05234.LB2	8/22/05	08:27	15.0	SHOCK	8/23/05	08:30	13.5	10	223	29	13.0
SA05234.LB3	8/22/05	10:12	15.0	SHOCK	8/23/05	08:30	13.5	10	156	32	20.5
SA05235.LB1	8/23/05	06:14	13.0	SHOCK	8/23/05	09:45	14.0	11	344	54	15.7
West Fork Chamberlain Creek											
SA05234.WC1	8/22/05	08:13	10.5	BSEINE	8/23/05	06:30	09.0	02	158	22	13.9
SA05234.WC2	8/22/05	09:05	11.5	BSEINE	8/22/05	12:45	14.5	02	640	80	12.5
South Fork Salmon River											
SA05237.SF1	8/25/05	07:02	08.0	SHOCK	8/26/05	04:30	07.0	118	101	7	6.9
SA05237.SF2	8/25/05	08:27	08.5	SHOCK	8/25/05	10:30	12.5	117	550	60	10.9
SA05238.SF1	8/26/05	07:00	06.5	SHOCK	8/26/05	09:15	09.0	121	358	13	3.6
Secesh River											
SA05241.SE1	8/29/05	07:11	08.0	SHOCK	8/30/05	05:15	09.0	26	93	12	12.9
SA05241.SE2	8/29/05	08:34	09.0	SHOCK	8/29/05	11:00	10.0	27	461	45	9.8
SA05242.SE1	8/30/05	06:27	09.0	SHOCK	8/30/05	09:00	09.5	27	538	34	6.3
Lake Creek											
SA05243.LC1	8/31/05	06:26	05.5	SHOCK	9/01/05	06:45	04.5	02	108	4	3.7
SA05243.LC2	8/31/05	07:38	05.0	SHOCK	8/31/05	09:00	06.0	02	307	26	8.5

Appendix Table 2b. Universal Transverse Mercator grid coordinates of Global Positioning System that identified sampling areas at the beginning and end of daily collections in streams for each collection crew in 2005. Hand-held Garmin GPS III-plus units were used.

Stream and date	Section covered	UTM start		UTM end	
		northing	easting	northing	easting
Bear Valley Creek					
7-26-05	Right bank	4920628	11T0633094	4920648	11T0631887
7-26-05	Left bank	4970522	11T0633080	4920657	11T0631888
7-27-05	Right bank	4919119	11T0630282	4918828	11T0629520
7-27-05	Left bank	4919093	11T0630248	4918294	11T0629881
Elk Creek					
7-28-05	Entire stream	4918767	11T0629565	4918811	11T0629471
7-28-05	Right bank	4918613	11T0629386	4918639	11T0629067
7-28-05	Left bank	4918728	11T0629440	4918585	11T0629023
7-29-05	Right bank	4918617	11T0629053	4918678	11T0628897
7-29-05	Left bank	4918613	11T0629020	4918624	11T0628821
Marsh Creek					
8-01-05	Right bank	4917152	11T0646181	4915877	11T0647240
8-01-05	Left bank	4917152	11T0646181	4915877	11T0647240
8-02-05	Left bank	4915822	11T0649222	4915380	11T0647715
8-02-05	Right bank	4915822	11T0647222	4915380	11T0647715
Sulphur Creek					
8-02-05	Entire stream	4932911	11T0630752	4932471	11T0630142
8-02-05	Left bank	4932559	11T0630379	4932529	11T0630155
8-02-05	Right bank	4932559	11T0630380	4932530	11T0630156
8-03-05	Right bank	4933260	11T0631510	4933147	11T0631097
8-03-05	Left bank	4933261	11T0631512	4933057	11T0630962
Cape Horn Creek					
8-03-05	Left bank	4917423	11T0645796	4916277	11T0645365
8-03-05	Right bank	4917423	11T0645796	4916277	11T0645365
Valley Creek					
8-04-05	Left bank	4899454	11T0661374	4899860	11T0660452
8-04-05	Right bank	4899455	11T0661375	4899861	11T0660453
8-05-05	Left bank	4900374	11T0659821	4900778	11T0659555
8-05-05	Right bank	4900374	11T0659822	4900779	11T0659556
8-05-05	Entire stream	4901928	11T0659265	4902232	11T0659329
8-05-05	Entire stream	4901929	11T0659269	4902126	11T0659330
8-06-05	Entire stream	4906315	11T0657673	4906580	11T0657413
8-06-05	Entire stream	4906315	11T0657673	4906580	11T0657413
8-06-05	Right bank	4906488	11T0657400	4906860	11T0656419
8-06-05	Left bank	4906488	11T0657400	4906860	11T0656419
Camas Creek					
8-08-05	Right bank	4968278	11T0696409	4967201	11T0697352
8-08-05	Left bank	4968278	11T0696409	4967201	11T0697452

Appendix Table 2b. Continued.

Stream and date	Section covered	UTM start northing	UTM start easting	UTM end northing	UTM end easting
Camas Creek (continued)					
8-09-05	Left bank	4967187	11T0697349	4966990	11T0697564
8-09-05	Right bank	4967188	11T0697350	4966991	11T0697565
Loon Creek					
8-08-05	Right bank	4942164	11T0674892	4941054	11T0674044
8-08-05	Left bank	4942164	11T0674892	4941054	11T0674044
8-09-05	Right bank-sc	4940532	11T0673589	4940389	11T0673383
8-09-05	Right bank-sc	4940532	11T0673589	4940389	11T0673383
Herd Creek					
8-10-05	Entire stream	4891675	11T0719533	4891396	11T0716976
8-10-05	Left bank	4891432	11T0716954	4891200	11T0717177
8-10-05	Left bank	4892104	11T0716228	4891699	11T0716704
8-10-05	Right bank	4891432	11T0716954	4891200	11T0717177
8-10-05	Right bank	4892104	11T0716228	4891699	11T0716704
Big Creek (upper)					
8-15-05	Right bank	4996672	11T0631569	4996570	11T0631136
8-15-05	Left bank	4996670	11T0631571	4996570	11T0631136
8-15-05	Entire stream	4996570	11T0631136	4995297	11T0631286
8-16-05	Left bank	4995431	11T0631279	4994631	11T0631140
8-16-05	Right bank	4995431	11T0631279	4994631	11T0631140
8-16-05	Entire stream	4995431	11T0631279	4994631	11T0631140
Big Creek (lower)					
8-22-05	Right bank	4996504	11T0670258	4996624	11T0669573
8-22-05	Left bank	4996504	11T0670258	4996624	11T0669573
8-23-05	Left bank	4996623	11T0669567	4996744	11T0669114
8-23-05	Right bank	4996624	11T0669567	4996745	11T0669115
West Fork Chamberlain Creek					
8-22-05	Entire stream	----------	----------	----------	----------
South Fork Salmon River					
8-25-05	Left bank	4943990	11T0603512	4943378	11T0603633
8-25-05	Right bank	4943990	11T0603512	4943378	11T0603633
8-26-05	Right bank	4940381	11T0604702	4940351	11T0604734
8-26-05	Left bank	4940381	11T0604703	4940352	11T0604735
8-26-05	Left bank	4939995	11T0604779	4939977	11T0604748
Secesh River					
8-29-05	Left bank	5005734	11T0592856	5007211	11T0593374
8-29-05	Right bank	5005735	11T0592857	5007205	11T0593923
8-30-05	Right bank	5007407	11T0593423	5007977	11T0593634
8-30-05	Left bank	5007407	11T0593423	5007977	11T0593634
Lake Creek					
8-31-05	Left bank	5012371	11T0586075	5012775	11T0585890
8-31-05	Right bank	5012372	11T0586076	5012776	11T0585891

Appendix Table 3. Summary of observed total mortality for PIT-tagged wild Chinook salmon parr collected from Idaho streams during July and August 2005. 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 are precocious males are in parentheses.

					Observed mortality			
				Percent	Collec-		Total	
Stream	Number collected	Number Tagged	Number Rejected	Rejected (%)	tion and handling	Tagging delayed	Number	%
Elk Creek	1,098	1,004	92 (31)	8.4	6	2	8	0.7
Marsh Creek	877	777	100 (05)	11.4	14	0	14	1.6
Sulphur Creek	331	276	53 (52)	16.0	0	2	2	0.6
Cape Horn Creek	279	238	41 (12)	14.7	1	0	1	0.4
Valley Creek	2,712	2,225	480 (78)	17.7	49	7	56	2.1
Loon Creek	516	489	27 (00)	5.2	6	0	6	1.2
Camas Creek	538	501	36 (01)	6.7	9	1	10	1.9
Herd Creek	621	509	112 (23)	18.0	18	0	18	2.9
Big Creek (upper)	1,917	1,689	227 (36)	11.8	24	1	25	1.3
Big Creek (lower)	841	817	24 (00)	2.9	23	0	23	2.7
W. ForkChamb. Cr	1,018	801	214 (00)	21.0	7	3	10	1.0
S.F. Salmon River	1,784	1,010	773 (03)	43.3	8	1	9	0.5
Secesh River	1,248	1,094	152 (01)	12.2	24	2	26	2.1
Lake Creek	556	417	137 (01)	24.6	1	2	3	0.5
Total or Percent	15,547	12,848	2,677	17.2	197	22	219	1.4

Appendix Table 4a. Accumulated and 2006 passage dates at Lower Granite Dam for PIT-tagged wild spring/summer Chinook salmon smolts from streams in Idaho.

	Percentile passage dates at Lower Granite Dam			
Year	10th	50th	90th	Range
Bear Valley Creek				
1990[a]	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[a] 1997[a]	---	---	---	---
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**
Elk Creek				
1990[a]	---	---	---	---
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[a] 1997[a]	---	---	---	---
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**
Sulphur Creek				
1990	18 April	30 April	31 May	11 April-27 June
1991[a]	---	---	---	---
1992	16 April	03 May	23 May	10 April-01 June
1993	28 April	16 May	12 June	24 April-28 June
1994[a]	---	---	---	---
1995	02 May	23 May	09 June	11 April-09 July
1996[a] -1999[a]	---	---	---	---
2000	15 April	07 May	24 May	12 April-30 May
2001[a] 2002[a]	---	---	---	---
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**

Appendix Table 4a. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
Cape Horn Creek				
1990a	---	---	---	---
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
1994a	---	---	---	---
1995	29 April	14 May	19 June	14 April-28 July
1996a-1998a	---	---	---	---
1999	29 April	22 May	29 May	25 April-12 June
2000	01 May	24 May	01 June	20 April-09 July
2001a-2002a	---	---	---	---
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**
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
1996a	---	---	---	---
1997a	---	---	---	---
1998a	---	---	---	---
1999a	---	---	---	---
2000	26 April	25 May	02 June	13 April-24 June
2001a 2002a	---	---	---	---
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**
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
1996a	---	---	---	---
1997a	---	---	---	---
1998a	---	---	---	---
1999	21 April	01 May	25 May	11 April-13 June
2000	21 April	28 April	27 May	14 April-16 June
2001a	---	---	---	---
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**

Appendix Table 4a. Continued.

	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
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[a]1997[a]1998[a]	---	---	---	---
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**
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[a]	---	---	---	---
1997[a]	---	---	---	---
1998[a]	---	---	---	---
1999	30 April	18 May	27 May	22 April-16 June
2000	22 April	08 May	24 May	14 April-01 June
2001[a] 2002[a]	---	---	---	---
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**
East Fork Salmon River				
1989	22 April	03 May	18 May	07 April-08 June
1990[a]	---	---	---	---
1991	22 April	09 May	26 May	16 April-20 June
1992	13 April	21 April	16 May	10 April-03 June
1993	25 April	06 May	18 May	22 April-01 June
1994	22 April	28 April	17 May	20 April-25 May
1995	14 April	28 April	10 May	11 April-27 May
1996[a]	---	---	---	---
1997[a]	---	---	---	---
1998[a]	---	---	---	---
1999[a]	---	---	---	---
2000	21 April	07 May	25 May	15 April-27 May
2001[a]	---	---	---	---
2002[a]	---	---	---	---
2003[a]	---	---	---	---
2004[a] -**2006[a]**	---	---	---	---

Appendix Table 4a. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
Herd Creek				
1992	14 April	20 April	10 May	13 April-18 May
1993	26 April	30 April	18 May	26 April-31 May
1994b	---	---	---	---
1995	18 April	03 May	14 May	11 April-28 May
1996a1997a 1998a	---	---	---	---
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
2002b	---	---	---	---
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**
South Fork Salmon River				
1989	25 April	13 May	14 June	16 April-20 June
1990a	---	---	---	---
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
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**
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
1996a 1997a1998a	---	---	---	---
1999	28 April	14 May	03 June	25 April-19 June
2000	30 April	27 May	14 June	15 April-29 June
2001a	---	---	---	---
2002a	---	---	---	---
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**

Appendix Table 4a. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
Big Creek (lower)/ Rush Creek				
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[a]	---	---	---	---
1997[a]	---	---	---	---
1998[a]	---	---	---	---
1999	19 April	28 April	23 May	04 April-30 May
2000	19 April	30 April	13 May	16 April-26 May
2001[a]	---	---	---	---
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[d]	22 April	02 May	09 May	06 April-15 May
2006[d]	**11 April**	**22 April**	**03 May**	**10 April-22 May**
West Fork Chamberlain Creek				
1992[c]	15 April	26 April	03 June	12 April-24 June
1993	28 April	15 May	23 June	23 April-22 July
1994[c]	24 April	01 May	05 July	24 April-04 September
1995[c]	16 April	09 May	20 June	12 April-22 September
1996[a]-1997[a]	---	---	---	---
1998[a]	---	---	---	---
1999[a]	---	---	---	---
2000[a]	---	---	---	---
2001[a]	---	---	---	---
2002	26 April	04 May	20 May	18 April-29 May
2003[c]	23 April	20 May	26 May	21 April-26 May
2004[c]	11 April	24 April	10 May	07 April-23 June
2005[c]	26 April	03 May	13 May	20 April-30 May
2006	**15 April**	**01 May**	**08 May**	**14 April-19 May**
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**

Appendix Table 4a. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
Lake Creek				
1989	23 April	02 May	16 June	12 April-01 July
1990[a]	---	---	---	---
1991[a]	---	---	---	---
1992[a]	---	---	---	---
1993	23 April	09 May	22 June	22 April-25 June
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[a]	---	---	---	---
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**

a. No parr were tagged the summer prior to this migration year.
b. Insufficient numbers detected to estimate timing.
c. Includes fish from Chamberlain Creek.
d. No fish were tagged in Rush Creek for this migration year.

Appendix Table 4b. Accumulated and 2006 passage dates at Lower Granite Dam for PIT-tagged wild spring/summer Chinook salmon smolts from streams in Oregon.

	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**
Grande Ronde River (upper)				
1989	12 May	06 June	19 June	27 April-22 July
1990[b]	---	---	---	---
1991[b]	---	---	---	---
1992[b]	---	---	---	---
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 [c]	26 April	17 May	29 May	19 April-06 June
1997[b]	---	---	---	---
1998[b]	---	---	---	---
1999[b]	---	---	---	---
2000[b]	---	---	---	---
2001[b]	---	---	---	---
2002[b]	---	---	---	---
2003[b]	---	---	---	---
2004[b]-**2006[b]**	---	---	---	---
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[b] 1994[b] 1995[b]	---	---	---	---
1996[b]-1999[b]	---	---	---	---
2000[b]	---	---	---	---
2001[b] 2002[b]2003[b]	---	---	---	---
2004[b] **-2006[b]**	---	---	---	---

Appendix Table 4b. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
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
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**
Lostine River				
1990[d]	---	---	---	---
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[b]	---	---	---	---
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**
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**

a. Includes fish tagged from summer 1995 through spring 1996.
b. No parr were tagged the summer prior to this migration year.
c. All fish tagged at traps in fall or spring for this migration year.
d. Insufficient numbers detected to estimate timing.

Appendix Table 5. Detections during 2006 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 999 wild Chinook salmon from Bear Valley Creek released 26-27 July 2005. Release sites were 629-635 km above Lower Granite Dam.

	Bear Valley Creek						
Detection	Lower Granite		First Detections				
date	1st detection	Expanded	Little Goose	LMO	McNary	John Day	Bonneville
11 Apr	1	4					
12 Apr	1	4					
13 Apr	1	5					
16 Apr	1	4					
18 Apr	1	4	1	1			
21 Apr	1	4					
22 Apr	1	3	1				
23 Apr			1				
24 Apr			1				
25 Apr			1				
26 Apr	1	3		1			
27 Apr	1	3	1				
28 Apr	2	5				1	
29 Apr	2	5	2				
30 Apr	1	3	3				
01 May	1	3	2		1		
02 May			5	1			
03 May	1	3	1				
04 May	2	5	1			1	
05 May	1	2		2			
06 May			1	1			
07 May	2	4	1	1			
08 May	1	2					
09 May						1	
10 May			1		1	1	
11 May			1				
12 May			1				
13 May			1		1		
14 May							
15 May	2	6					
16 May	1	3	2		2		
17 May							
18 May	3	12	1	1			
20 May	2	9					
21 May			1				
22 May			2	1			
23 May				1			
25 May			2	1			
26 May			1	1			
29 May				1			
01 Jun			1				
12 Jun			1				
15 Jun			1				
25 Jun			1				
4 Jul				1			
Totals	30	98	39	13	6	4	0

Appendix Table 6. Detections during 2006 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 1,002 wild Chinook salmon from Elk Creek released 28-29 July 2005. Release sites were 634-636 km above Lower Granite Dam.

	Elk Creek						
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
06 Apr	1	4					
09 Apr	1	4					
10 Apr			1				
11 Apr	1	4					
12 Apr	1	4					
15 Apr	4	17					
16 Apr	1	4		1			
18-Apr	2	8					
20-Apr	3	11		1			
21-Apr	2	7	1				
22-Apr	2	7	1	1			
23-Apr			2				
24-Apr	3	10	1	2			
25-Apr	1	3	4	1			
26-Apr	2	6	2				
27-Apr	5	15	1		1		
28-Apr	2	5	2	1			
29-Apr	2	5	3	1			
30-Apr	2	6	4	1			
01-May	2	6	3				
02-May	2	6	2				
03-May	1	3	3	1			
04-May	1	3	4				
05-May			3				1
06-May				1			
07-May	3	6	3	1			
08-May			4	1			
11-May							1
15-May	2	6	1				
16-May	2	7	1				
17-May	2	8	1				
18-May	3	12		2			
19-May				1			
20-May	1	4	2				
21-May	1	5	4				
22-May			2	1			
23-May			2				
24-May				1			
26-May	1	4					
27-May	1	4					1
31-May	1	2					

Appendix Table 6. Continued.

	Elk Creek (continued)						
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
01-Jun							
02-Jun							
03-Jun							
04 Jun							1
05-Jun							
06-Jun	1	4					
08 Jun			1				
09-Jun							
10-Jun							
11-Jun	1	9					
12-Jun							
13-Jun							
14-Jun							
19-Jun							
24 Jun			1				
26-Jun							
30-Jun							
Totals	60	209	59	18	1	0	4

Appendix Table 7. Detections during 2006 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 777 wild Chinook salmon from Marsh Creek released 01-02 August 2005. Release sites were 630-633 km above Lower Granite Dam.

	Marsh Creek						
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
10-Apr			1				
11-Apr	2	9					
12-Apr	1	4					
15-Apr	1	4					
17-Apr	1	4	5	1			
18 Apr	1	4	1				
19-Apr			1				
20-Apr	1	4					
21-Apr			2		1		
22-Apr	1	3					
23-Apr	3	10					
24-Apr	1	3					
25-Apr			2		1		
26-Apr	1	3	3				
27-Apr	1	3	2				
28-Apr	1	2		2			
29-Apr	1	3	1				
30-Apr	3	10	1				
01-May	2	6		1			
02-May	3	9	2				
03-May			2				
04-May	3	8	2				
05-May	1	2		1			
06-May	2	4					
07-May	2	4	3	1			
08-May	1	2					
09-May	1	2					
10-May	2	5					
12-May				2			
16-May			1				
17-May	1	4					
18-May	1	4	1				
19-May	1	4					
20-May	1	4	3				
22-May						1	
23-May				1			
25-May							
26-May					1		
03-Jun	1	3					
04-Jun							
05-Jun			1				
06-Jun			1				
Totals	41	129	35	9	3	1	0

Appendix Table 8. Detections during 2006 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 238 wild Chinook salmon from Cape Horn Creek released 03 August 2005. Release sites were 629-631 km above Lower Granite Dam.

	Cape Horn Creek						
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
11-Apr							
14-Apr			1				
15-Apr							
17-Apr							
18-Apr							
20-Apr			1				
22-Apr	1	3					
23-Apr	1	3			1		
24-Apr							
25-Apr							
26-Apr	1	3					
27-Apr							
28-Apr	1	2					
29-Apr	2	5	1				
30-Apr	3	10	1				
01-May			1				
02-May			1				
03-May			1				
04-May			1				
05-May							
06-May			1				
07-May			1	1			
08-May	3	7					
09-May							
10-May				1			
11-May							
12-May							
13-May							
14-May							
15-May	2	6					
19-May			1				
20-May			1				
22-May			1				
23-May							
24-May					1		
25-May							
26-May					1		
28-May							
29-May							
14-Jun	1	5					
Totals	15	45	13	2	3	0	0

Appendix Table 9. Detections during 2006 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 274 wild Chinook salmon from Sulphur Creek released 02-03 August 2005. Fish were released 604-608 km above Lower Granite Dam.

	Sulphur Creek						
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
02-Apr							
11-Apr	1	4					
15-Apr							
16-Apr	1	4					
17-Apr							
19-Apr							
20-Apr			1				
22-Apr			1				
23-Apr	1	3					
24-Apr			1				
25-Apr	1	3	1				
26-Apr	2	6					
27-Apr							
28-Apr			1				
29-Apr			2				
30-Apr			1				
01-May	1	3		1			
02-May			2				
03-May	1	3					
04-May							
05-May							
06-May	2	4					
07-May							
08-May							
09-May							
10-May	1	2					
11-May							
12-May				1			
14-May	1	3					
15-May						1	
17-May	1	4					
19-May			2	1			
20-May			1				
21-May							
22-May			1				
23-May							
24-May							
25-May							
26-May							
05-Jun							
07-Jun				1			
09-Jun			1				
Totals	13	41	15	4	0	1	0

Appendix Table 10. Detections during 2006 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 2,218 wild Chinook salmon from Valley Creek released 04-06 August 2005. Release sites were 743-758 km above Lower Granite Dam.

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

Appendix Table 10. Continued.

	Valley Creek						
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
01-Jun	2	5					
02-Jun	3	8				1	
03-Jun	4	13	1				
04-Jun	2	7	3	2		1	
05-Jun			2	1			
06-Jun	1	4	7	1			
07-Jun	2	7					
08-Jun	1	3	2				
09-Jun	2	7	1				
10-Jun	2	15	2				
11-Jun	1	9	2	1			
12-Jun	1	6	1	1	1		1
13-Jun	2	9	3				
14-Jun	1	5	4				
15-Jun	1	8	1	1		2	
16-Jun	2	7	1		2		
17-Jun	5	14	1			1	
18-Jun			3		1		
19-Jun					2		
20-Jun			1		2		
21-Jun							1
22-Jun						1	1
27-Jun					3		
01-Jul			1			1	
02-Jul			1		2		
05-Jul					1		
Totals	86	291	88	18	19	10	3

Appendix Table 11. Detections during 2006 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 489 wild Chinook salmon from Loon Creek released 08-09 August 2005. Release sites were 555-559 km above Lower Granite Dam.

	Loon Creek						
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
10-Apr	1	4					
15-Apr	1	4					
18-Apr	1	4					
19-Apr	1	4					
20-Apr	2	7					
21-Apr			1				
22-Apr							
23-Apr	1	3		1			
25-Apr	1	3					
26-Apr	1	3	2				
27-Apr	1	3					
28-Apr	5	12					
29-Apr	5	13	1				
30-Apr	4	13	2	1			
01-May	3	9					
02-May	3	9	7				
03-May	2	6	2				
04-May	1	3	1				
05-May	2	5		1			
06-May	2	4	1	1			
07-May	4	8	1	2			
08-May	8	17	4	1		1	
09-May	2	5	2				
10-May			3	1			
11-May	2	5	1				
12-May			1				
13-May			1				1
14-May	1	3	1				
15-May			1		1		
16-May							
17-May	1	4	1			1	
18-May	3	12	2				
19-May	3	13	2				
20-May			5	1			
21-May	1	5					
22-May				1			
23-May			1				
24-May							
25-May							
26-May							
28-May							
29-May							
Totals	62	181	43	10	1	2	1

Appendix Table 12. Detections during 2006 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 500 wild Chinook salmon from Camas Creek released 08-09 August 2005. Release sites were 526-529 km above Lower Granite Dam.

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

Appendix Table 12. Continued.

	Camas Creek						
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
27-May							
28-May							
29-May							
30-May							
31-May							
01-Jun							
02-Jun							
03-Jun	1	3					
04-Jun							
05-Jun							
06-Jun							
07-Jun							
08-Jun							
10-Jun							
14-Jun							
19-Jun							
28-Jun							
Totals	23	70	22	6	2	0	0

Appendix Table 13. Detections during 2006 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 509 wild Chinook salmon from Herd Creek released 10 August 2005. Fish were released 699-701 km above Lower Granite Dam.

	Herd Creek						
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
10-Apr	1	4					
11-Apr	1	4					
13-Apr			1				
15-Apr	1	4					
16-Apr	1	4					
17-Apr	2	8					
18-Apr	3	12					
19-Apr	1	4		1			
20-Apr	2	7	2				
21-Apr	1	4	1				
22-Apr	1	3	2	1			
23-Apr			1				
24-Apr	2	7	1				
25-Apr	3	10	2	1			
26-Apr			2	3			
27-Apr	2	6					
28-Apr	5	12	2	1			
29-Apr	2	5	1	1			
30-Apr	4	13	1				
01-May	2	6	4				
02-May	2	6	5	5	1		
03-May			2	1		1	
04-May	1	3	2				
05-May	1	2	2	1			
06-May			1				
07-May			1				
08-May				1			
09-May	1	2					
10-May	1	2					
11-May							
12-May	2	6					
13-May							
14-May					1		
16-May	1	3					
17-May			1				
18-May						1	
19-May						1	
20-May							
21-May							
22-May							
23-May			1				
24-May						1	
Totals	43	137	35	16	2	4	0

Appendix Table 14. Detections during 2006 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 1,688 wild Chinook salmon from Big Creek (upper) released 15-16 August 2005. Release sites were 530-533 km above Lower Granite Dam.

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

Appendix Table 14. Continued.

	Big Creek (upper) continued						
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
06-Jun			1				
07-Jun			1				
08-Jun							
10-Jun	1	8					
14-Jun			1		1		
15-Jun						1	
18-Jun			1			1	
26-Jun					2		
05-Jul			2				
Totals	79	251	85	24	10	10	1

Appendix Table 15. Detections during 2006 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 817 wild Chinook salmon from Big Creek (lower) released 22-23 August 2005. Release sites were 487-489 km above Lower Granite Dam.

	Big Creek (lower)						
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
06-Apr							
07-Apr							
10-Apr	4	16					
11-Apr	1	4					
14-Apr	3	12					
15-Apr	1	4					
16-Apr	2	8	3				
17-Apr	2	8	3				
18-Apr	2	8	3				
19-Apr			2	1			
20-Apr	2	7	4	1			
21-Apr	3	11	1	1			
22-Apr	3	10	1	2			
23-Apr	1	3	1				
24-Apr	1	3	2	2		1	
25-Apr	1	3	2				
26-Apr	2	6	2				
27-Apr	3	9	6				
28-Apr	4	10	4				
29-Apr	2	5	2	1			
30-Apr	5	16	2				
01-May	1	3		2			
02-May	3	9	4	1			
03-May	1	3	1		1		
04-May			3	3	1		
05-May	1	2	1				
06-May			1	1	1		
07-May	1	2	1				
08-May	2	4				1	
09-May	1	2					
10-May							
11-May							
12-May							
13-May			1				
14-May							
15-May			1				
22-May	1	5					
28-May							
Totals	53	176	51	15	3	2	0

Appendix Table 16. Detections during 2006 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 798 wild Chinook salmon from West Fork Chamberlain Creek released 22 August 2005. Release sites were 437-438 km above Lower Granite Dam.

	West Fork Chamberlain Creek						
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
17-Apr							
18-Apr	1	4					
19-Apr	1	4	2				
20-Apr							
21-Apr			1				
22-Apr							
23-Apr							
24-Apr	2	7		1			
25-Apr	1	3	1				
26-Apr	2	6	2	1			
27-Apr	2	6	2	1			
28-Apr	4	10	3	1			
29-Apr			2				
30-Apr	2	6	5				
01-May	2	6	3				
02-May	4	12	2	2			
03-May			2	2			
04-May	2	5	4				
05-May	2	5	2				
06-May	3	7					
07-May	4	8	2	2			
08-May	3	7	5				
09-May				1			
10-May	1	2			1		
11-May							
13-May			1				
14-May						1	
15-May	1	3		1			
16-May							
17-May			1				
18-May			1				
19-May	1	4				1	
20-May			1	1			
22-May			1				
23-May							
25-May							
26-May							
29-May							
08-Jun					1		
28-Jun					1		
Totals	41	117	43	13	3	2	0

Appendix Table 17. Detections during 2006 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 1,009 wild Chinook salmon from South Fork Salmon River released 25-26 August 2005. Release sites were 467-471 km above Lower Granite Dam.

	South Fork Salmon River						
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
13-Apr			1				
16-Apr			1				
18-Apr			1				
19-Apr			1				
20-Apr				1			
22-Apr							
23-Apr					1		
24-Apr				1			
25-Apr			1				
26-Apr			1				
27-Apr	2	6	2				
28-Apr	1	2	2				
29-Apr	1	3	1				
30-Apr	2	6	1				
01-May							
02-May			2				
03-May			1	1			
04-May	1	3	2	1			
05-May	1	2	2	1	1		
06-May	2	4					
07-May	2	4	1				
08-May				1			
09-May	1	2	2				
10-May	1	2					
11-May	1	3					
12-May							
13-May	1	3					
14-May	1	3					
15-May	1	3					
16-May	1	3	1				
18-May	2	8		1			
19-May	1	4	3				
20-May							
21-May			2	1			
22-May			2				
23-May			2	1			
24-May					1		
25-May			2				
26-May			2				
27-May							
28-May			1				
29 May			1	2			
30-May							

Appendix Table 17. Continued.

	South Fork Salmon River						
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
02-Jun	1	3					
03-Jun							
06-Jun							
08-Jun							
09-Jun							
10-Jun			1				
11-Jun							
12-Jun							
13-Jun							
14-Jun			1				
16-Jun	1	4					
17-Jun							
18-Jun	1	4					
19-Jun							
24-Jun			1				
30-Jun							
01-Jul							
Totals	25	73	41	11	3	0	0

Appendix Table 18. Detections during 2006 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 1,092 wild Chinook salmon from Secesh River released 29-30 August 2005. Release sites were 429-432 km above Lower Granite Dam.

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

Appendix Table 18. Continued.

	Secesh River						
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
23-May	1	6	2				
24-May			2				1
25-May				1			
26-May			1				
28-May				1			
29-May							
31-May			1				
01-Jun	1	2					
04-Jun							
08-Jun	1	3					
10-Jun							
11-Jun							
18-Jun				1			
19-Jun							
Totals	27	90	42	15	4	2	1

Appendix Table 19. Detections during 2006 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 415 wild Chinook salmon from Lake Creek released 31 August 2005. Release sites were 451-452 km above Lower Granite Dam.

	Lake Creek						
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
15-Apr							
17-Apr	1	4					
18-Apr			1				
19-Apr							
20-Apr							
21-Apr	1	4					
22-Apr							
24-Apr							
25-Apr	1	3					
26-Apr	1	3					
27-Apr							
28-Apr	1	2	1				
29-Apr	1	3					
30-Apr	1	3	2	1			
01-May			1	1			
02-May							
03-May			1				
04-May							
05-May			1				
06-May	1	2		1			
07-May							
08-May			1	1			
09-May			1				
10-May							
11-May							
12-May							
13-May	1	3					
14-May							
15-May			1				
16-May							
17-May			1				
19-May	1	4					
20-May							
22-May							
23-May				1			
26-May							
28-May							
29-May							
04-Jun						1	
10-Jun			1				
17-Jun			1				
18-Jun			1				
Totals	10	32	14	5	0	1	0

Appendix Table 20. Daily and expanded detections (with estimated detection efficiencies in parenthesis) of PIT-tagged wild spring/summer Chinook salmon smolts from Idaho and Oregon at Lower Granite Dam during 2006, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam.

				Idaho only		Idaho and Oregon	
Date	Average flow (kcfs)	Average spill (kcfs)	water temperature	Numbers detected	Expanded numbers detected	Numbers Detected	Expanded numbers detected
01 Apr	69.4	0.0	7.2	0	0	0	0
02 Apr	73.6	0.0	7.3	0	0	0	0
03 Apr	72.6	20.8	7.6	0	0	1	4 (0.272)
04 Apr	73.8	24.0	7.3	0	0	0	0
05 Apr	95.6	37.0	7.2	0	0	1	4 (0.242)
06 Apr	119.2	35.1	8.0	1	4	1	4 (0.261)
07 Apr	137.2	54.6	8.1	0	0	0	0
08 Apr	128.3	42.6	8.1	1	4	1	4 (0.269)
09 Apr	129.1	42.9	8.3	2	7	2	7 (0.273)
10 Apr	129.4	46.8	8.6	6	25	6	25 (0.243)
11 Apr	126.9	41.1	8.9	7	30	10	43 (0.235)
12 Apr	128.6	45.6	8.8	3	13	6	26 (0.232)
13 Apr	126.9	42.8	8.9	2	9	4	18 (0.222)
14 Apr	132.6	46.5	----	4	16	5	21 (0.243)
15 Apr	143.7	57.6	----	10	41	11	46 (0.241)
16 Apr	151.5	65.6	----	8	33	13	53 (0.245)
17 Apr	151.7	66.1	8.6	8	32	9	36 (0.249)
18 Apr	146.2	60.5	8.6	11	44	12	48 (0.252)
19 Apr	138.1	53.3	8.7	4	15	5	19 (0.269)
20 Apr	134.3	48.9	8.9	14	49	14	49 (0.285)
21 Apr	117.5	31.8	9.3	10	35	11	39 (0.282)
22 Apr	114.8	29.3	9.9	10	34	12	41 (0.294)
23 Apr	119.3	33.7	10.0	10	33	13	43 (0.299)
24 Apr	131.5	45.8	9.9	17	56	20	66 (0.305)
25 Apr	134.1	49.3	9.8	11	35	12	38 (0.312)
26 Apr	132.9	49.1	9.8	18	56	21	66 (0.320)
27 Apr	125.0	39.2	9.8	22	65	25	74 (0.340)
28 Apr	124.7	39.2	10.2	31	75	35	85 (0.411)
29 Apr	127.1	42.2	10.9	25	65	31	81 (0.384)
30 Apr	139.5	56.0	11.3	39	124	46	146 (0.314)
01 May	153.1	67.0	11.2	19	58	26	79 (0.330)
02 May	142.0	56.4	10.8	28	81	34	99 (0.344)
03 May	133.7	50.1	10.6	12	35	16	46 (0.347)
04 May	129.1	47.6	10.6	17	46	23	63 (0.367)
05 May	117.4	35.9	10.7	16	38	19	45 (0.423)
06 May	119.9	38.4	11.2	20	45	23	51 (0.447)
07 May	121.0	39.6	11.8	27	56	29	60 (0.486)
08 May	124.4	40.5	12.0	25	54	32	70 (0.460)
09 May	116.3	31.8	11.5	10	24	11	26 (0.416)
10 May	107.6	24.7	11.2	9	22	12	29 (0.416)

.

Appendix Table 20. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature	Idaho only		Idaho and Oregon	
				Numbers detected	Expanded numbers detected	Numbers Detected	Expanded numbers detected
11 May	99.8	20.3	11.3	6	15	9	23 (0.393)
12 May	101.4	20.3	11.4	4	12	6	17 (0.345)
13 May	100.1	20.4	11.6	4	12	4	12 (0.331)
14 May	105.4	24.9	12.0	6	18	8	24 (0.329)
15 May	120.4	40.4	12.5	9	29	12	39 (0.311)
16 May	131.6	52.5	13.0	9	30	11	37 (0.298)
17 May	151.5	66.7	13.0	10	39	16	62 (0.259)
18 May	165.7	80.7	12.6	17	66	24	94 (0.256)
19 May	175.0	90.6	12.2	9	40	11	49 (0.226)
20 May	183.8	102.3	11.9	11	49	13	58 (0.224)
21 May	193.4	110.2	11.7	3	15	3	15 (0.199)
22 May	177.8	95.0	11.6	3	15	3	15 (0.206)
23 May	178.3	94.7	11.7	1	6	1	6 (0.164)
24 May	171.6	90.2	12.2	3	15	3	15 (0.202)
25 May	161.9	76.4	12.3	2	10	4	20 (0.205)
26 May	157.2	71.5	12.4	1	4	1	4 (0.260)
27 May	141.5	59.6	12.5	2	8	2	8 (0.245)
28 May	129.0	54.4	12.6	1	4	2	8 (0.247)
29 May	124.1	44.4	12.3	0	0	1	4 (0.270)
30 May	116.0	41.2	12.1	0	0	1	3 (0.328)
31 May	104.1	20.6	12.2	4	10	4	10 (0.407)
01 Jun	98.4	22.0	12.8	4	9	4	9 (0.434)
02 Jun	99.4	20.2	13.4	4	10	4	10 (0.398)
03 Jun	100.8	23.9	13.8	6	20	6	20 (0.304)
04 Jun	114.2	36.3	14.2	4	14	5	17 (0.293)
05 Jun	115.5	43.9	14.4	0	0	0	0
06 Jun	118.7	44.3	14.2	2	8	4	16 (0.245)
07 Jun	117.2	47.4	14.2	2	7	2	7 (0.300)
08 Jun	123.6	48.0	14.7	2	7	2	7 (0.295)
09 Jun	127.4	50.0	14.6	2	7	3	10 (0.289)
10 Jun	125.7	59.1	14.1	3	23	3	23 (0.130)
11 Jun	118.4	68.3	14.0	2	19	2	19 (0.108)
12 Jun	106.2	37.6	14.5	1	6	1	6 (0.181)
13 Jun	101.9	29.5	14.6	2	9	2	9 (0.217)
14 Jun	100.8	42.9	14.7	2	11	2	11 (0.184)
15 Jun	112.8	36.2	14.5	1	8	1	8 (0.126)
16 Jun	100.2	25.9	14.6	3	11	3	11 (0.276)
17 Jun	94.1	20.2	14.7	5	14	5	14 (0.354)
18 Jun	87.8	20.2	14.9	1	4	1	4 (0.253)
19 Jun	79.7	20.3	15.3	0	0	0	0
20 Jun	69.4	20.3	15.8	0	0	0	0
21 Jun	67.5	20.2	16.3	0	0	0	0
22 Jun	64.5	20.0	16.6	0	0	0	0

Appendix Table 21. Daily first-time detections of PIT-tagged wild spring/summer Chinook salmon smolts from Idaho at Little Goose Dam during 2006, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam.

Date	Average flow (kcfs)	Average spill (kcfs)	Water temperature (°C)	Number detected
10 Apr	127.2	38.2	8.4	3
11 Apr	125.2	41.7	8.5	2
13 Apr	124.7	35.7	9.0	2
14 Apr	130.7	30.8	---	1
16 Apr	151.9	41.4	---	5
17 Apr	149.2	40.4	9.2	9
18 Apr	145.1	35.7	9.0	9
19 Apr	136.5	28.7	8.8	13
20 Apr	136.5	27.5	8.9	11
21 Apr	113.4	27.0	9.2	7
22 Apr	114.6	27.6	9.3	8
23 Apr	114.6	27.5	9.7	6
24 Apr	128.5	27.6	10.2	8
25 Apr	132.2	27.6	10.5	18
26 Apr	130.3	27.5	10.5	17
27 Apr	124.3	27.6	10.4	14
28 Apr	123.4	27.6	10.3	21
29 Apr	124.7	27.5	10.3	18
30 Apr	135.9	30.9	10.7	28
01 May	152.3	41.4	11.2	20
02 May	142.2	33.1	11.4	46
03 May	130.7	23.9	11.2	25
04 May	125.5	23.9	11.1	27
05 May	115.0	23.2	11.0	15
06 May	116.2	22.1	11.0	12
07 May	118.5	22.0	11.0	20
08 May	121.9	25.1	11.2	28
09 May	113.3	30.2	11.7	11
10 May	107.1	31.4	12.0	8
11 May	97.1	29.3	12.1	6
12 May	100.9	30.3	12.0	5
13 May	96.2	28.2	11.8	4
14 May	102.6	29.4	11.9	1
15 May	117.9	29.4	12.1	6

Appendix Table 21. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Water temperature (°C)	Number detected
16 May	129.0	38.2	12.6	6
17 May	149.7	40.3	13.2	5
18 May	168.9	56.2	13.6	7
19 May	169.6	57.5	13.4	14
20 May	187.6	77.6	12.9	22
21 May	194.8	85.3	12.4	14
22 May	174.1	64.0	12.0	14
23 May	176.7	65.3	12.0	18
24 May	170.9	58.6	12.1	3
25 May	160.4	48.0	12.3	8
26 May	156.2	43.8	12.5	7
27 May	139.0	42.5	12.6	2
28 May	124.9	54.4	12.7	4
29 May	120.8	42.8	12.8	3
30 May	113.1	40.1	12.9	2
31 May	102.7	25.8	12.8	2
01 Jun	96.2	25.0	12.9	1
03 Jun	95.5	20.2	13.2	2
04 Jun	111.6	23.5	13.8	4
05 Jun	115.1	26.4	14.2	3
06 Jun	115.0	41.8	14.8	9
07 Jun	116.7	39.2	15.2	1
08 Jun	122.5	34.8	15.1	3
09 Jun	124.4	45.6	14.7	2
10 Jun	124.6	62.2	15.0	4
11 Jun	114.5	74.3	15.1	2
12 Jun	105.4	34.7	14.9	2
13 Jun	100.7	22.8	14.6	3
14 Jun	98.1	39.0	14.7	6
15 Jun	112.3	34.5	14.7	2
16 Jun	98.6	31.2	14.9	1
17 Jun	93.2	20.3	15.1	2
18 Jun	89.6	23.4	15.1	5
20 Jun	68.3	21.0	15.6	1
24 Jun	60.7	18.2	17.2	2
25 Jun	57.4	17.3	17.6	1
01 Jul	44.1	13.2	19.6	1
02 Jul	44.3	13.2	19.9	1
05 Jul	47.5	15.6	20.7	2

Appendix Table 22. Daily first-time detections of PIT-tagged wild spring/summer Chinook salmon smolts from Idaho at Lower Monumental Dam during 2006, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam.

Date	Average flow (kcfs)	Average spill (kcfs)	Water temperature (°C)	Number detected
10 Apr	131.5	40.0	7.8	0
11 Apr	127.4	38.0	7.8	0
13 Apr	126.1	27.9	8.9	0
14 Apr	132.4	26.6	8.9	0
16 Apr	155.4	41.1	----	1
17 Apr	153.5	39.3	9.4	1
18 Apr	146.3	33.3	9.4	1
19 Apr	139.8	29.8	9.4	2
20 Apr	138.3	24.8	9.4	4
21 Apr	116.4	24.9	9.4	1
22 Apr	118.0	25.0	9.4	6
23 Apr	117.0	22.0	9.4	2
24 Apr	131.8	19.3	9.4	7
25 Apr	134.5	21.3	9.4	3
26 Apr	130.6	23.4	9.4	6
27 Apr	125.2	21.5	10.6	3
28 Apr	125.2	23.4	10.6	5
29 Apr	124.1	22.2	11.1	6
30 Apr	138.2	28.1	11.1	3
01 May	154.8	39.0	11.1	5
02 May	146.4	32.6	11.1	10
03 May	131.4	22.8	11.7	8
04 May	127.4	23.0	11.7	6
05 May	118.1	22.1	11.7	8
06 May	118.2	21.0	11.7	5
07 May	122.5	20.6	---	8
08 May	122.5	22.3	11.7	6
09 May	115.0	25.1	11.7	4
10 May	108.9	27.7	11.7	3
11 May	97.6	26.0	12.2	0
12 May	102.5	23.4	12.2	5
13 May	96.9	22.6	12.2	0
14 May	105.5	21.5	12.2	0
15 May	118.2	20.2	12.2	1

Appendix Table 22. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Water temperature (°C)	Number detected
16 May	130.0	25.1	12.2	1
17 May	149.7	38.2	13.0	0
18 May	169.4	54.6	13.6	6
19 May	176.9	60.8	14.4	3
20 May	193.3	76.5	13.9	5
21 May	200.9	86.1	13.3	8
22 May	180.6	66.4	13.3	6
23 May	180.8	68.9	13.3	6
24 May	173.7	60.6	12.8	2
25 May	166.0	52.3	12.8	4
26 May	158.5	44.3	12.8	1
27 May	142.0	43.2	12.8	2
28 May	128.5	33.7	12.8	2
29 May	124.1	31.5	12.8	3
30 May	116.3	36.8	12.8	1
31 May	104.6	19.6	13.3	0
01 Jun	98.9	19.9	13.3	0
03 Jun	98.7	19.9	13.3	0
04 Jun	113.0	19.5	13.3	2
05 Jun	116.2	22.0	14.4	1
06 Jun	115.7	38.4	15.0	1
07 Jun	116.9	40.1	15.6	1
08 Jun	122.8	21.9	15.6	0
09 Jun	126.3	37.7	---	0
10 Jun	125.2	45.8	---	0
11 Jun	119.4	76.4	---	1
12 Jun	105.4	33.6	---	1
13 Jun	101.2	19.1	---	0
14 Jun	99.3	29.2	---	0
15 Jun	114.6	37.2	15.6	1
16 Jun	101.1	17.6	---	0
17 Jun	91.9	16.8	---	0
18 Jun	91.1	18.8	---	1

Appendix Table 23. Daily first-time detections of PIT-tagged wild spring/summer Chinook salmon smolts from Idaho at McNary Dam during 2006, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam.

Date	Average flow (kcfs)	Average spill (kcfs)	Water temperature (°C)	Number detected
21 Apr	305.1	130.6	8.5	1
23 Apr	318.7	145.3	8.8	2
25 Apr	315.7	151.6	9.3	1
27 Apr	326.0	150.3	9.9	1
01 May	357.2	182.4	10.8	1
02 May	358.7	181.2	10.7	2
03 May	354.4	180.7	10.7	2
04 May	346.2	170.7	10.8	1
05 May	298.4	120.3	11.1	1
06 May	303.2	125.7	11.5	2
08 May	307.5	131.4	11.2	1
10 May	308.5	139.7	11.4	2
13 May	294.1	144.4	11.7	1
14 May	271.1	121.5	12.2	2
15 May	274.3	108.5	12.6	1
16 May	281.2	109.6	13.0	4
17 May	292.4	118.6	13.4	2
19 May	376.4	199.4	13.8	1
20 May	382.3	205.9	14.1	1
22 May	361.7	187.0	14.2	1
23 May	368.8	195.2	13.6	1
24 May	383.7	207.0	13.3	2
25 May	366.1	189.1	13.1	3
26 May	378.1	201.1	12.7	2
27 May	399.3	225.4	12.5	2
08 Jun	362.7	187.5	14.9	1
12 Jun	348.1	188.2	15.5	1
14 Jun	349.3	182.6	15.1	1
16 Jun	351.1	177.3	15.3	2
18 Jun	330.7	155.2	15.4	1
19 Jun	301.2	126.2	15.5	2
20 Jun	322.9	162.9	15.8	2
26 Jun	263.5	116.1	17.0	2
27 Jun	258.4	103.4	17.2	3
28 Jun	249.0	105.8	17.6	1
02 Jul	191.4	103.9	18.0	2
05 Jul	182.9	73.7	19.2	1
24 Jul	186.0	80.6	20.9	1

Appendix Table 24. Daily first-time detections of PIT-tagged wild spring/summer Chinook salmon smolts from Idaho at John Day Dam during 2006, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam.

Date	Average flow (kcfs)	Average spill (kcfs)	Water temperature (°C)	Number detected
24 Apr	335.1	172.8	9.3	1
28 Apr	299.1	108.9	10.2	1
03 May	354.7	162.4	11.5	1
04 May	347.9	129.7	11.5	1
08 May	314.9	118.6	11.5	2
09 May	282.9	99.0	11.7	1
10 May	298.0	109.4	12.0	3
14 May	255.1	100.1	12.3	1
15 May	264.6	84.8	12.5	1
16 May	266.4	79.8	12.7	1
17 May	303.5	107.4	13.0	1
18 May	345.8	133.1	13.5	1
19 May	364.4	140.6	14.0	2
22 May	369.7	152.7	14.7	1
23 May	368.6	160.5	14,8	1
24 May	390.0	177.0	14.8	2
26 May	369.4	147.1	14.4	3
27 May	389.1	194.9	14.0	1
28 May	379.4	158.9	13.6	3
29 May	398.1	170.8	13.3	1
02 Jun	302.2	95.5	13.8	1
04 Jun	325.8	120.8	14.5	2
15 Jun	365.5	144.2	16.0	3
17 Jun	332.0	114.8	15.9	1
18 Jun	326.9	116.3	16.0	1
22 Jun	259.0	108.2	16.3	1
01 Jul	187.3	55.8	18.3	1

Appendix Table 25. Daily first-time detections of PIT-tagged wild spring/summer Chinook salmon smolts from Idaho at Bonneville Dam during 2006, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam.

Date	Average flow (kcfs)	Average spill (kcfs)	Water temperature (°C)	Number detected
05 May	316.0	99.4	11.8	1
11 May	296.7	90.5	12.2	1
13 May	302.7	84.4	12.4	1
16 May	276.1	79.6	13.2	1
24 May	389.6	167.0	14.9	1
27 May	391.5	163.3	14.5	1
04 Jun	335.0	109.5	14.4	1
12 Jun	345.7	136.7	16.1	1
21 Jun	288.8	101.8	16.3	1
22 Jun	269.2	101.5	16.6	1

Appendix Table 26. Monthly environmental data collected from Marsh Creek (RKm 179.5 from the mouth of the Middle Fork Salmon River) from August 2005 through July 2006.

	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Min	9.9	5.3	2.5	0.0	0.0	0.0	0.0	0.1	---	---	---	---
Max	13.9	10.6	6.5	4.3	1.6	1.8	1.9	4.3	---	---	---	---
Mean	12.1	8.2	4.9	1.0	0.2	0.5	0.4	1.9	---	---	---	---
						Dissolved oxygen (ppm)						
Min	8.3	9.6	10.7	11.5	11.8	12.2	11.9	11.0	---	---	---	---
Max	9.7	11.0	12.3	13.2	12.9	13.2	13.2	12.3	---	---	---	---
Mean	9.0	10.3	11.4	12.7	12.4	12.7	12.6	11.8	---	---	---	---
						Specific conductance (µS/cm)						
Min	66.8	68.5	68.2	68.6	60.8	61.3	59.4	60.4	---	---	---	---
Max	70.2	70.1	72.5	75.9	72.5	66.2	65.7	77.5	---	---	---	---
Mean	68.6	69.3	70.0	72.1	67.3	63.6	62.9	69.1	---	---	---	---
						Turbidity (ntu)						
Min	0	0	0	0	0	0	0	0	---	---	---	---
Max	0.6	35.7	3.0	1.1	1.9	1.1	2.2	2.7	---	---	---	---
Mean	0.0	2.4	0.3	0.2	0.4	0.2	0.2	0.4	---	---	---	---
						Depth (ft)						
Min	0.7	0.5	0.5	0.5	0.1	0.3	0.3	0.1	---	---	---	---
Max	1.1	1.0	1.0	1.2	2.4	1.2	1.7	0.8	---	---	---	---
Mean	0.9	0.8	0.8	0.9	1.6	0.7	1.0	0.4	---	---	---	---
						pH						
Min	7.8	7.8	7.7	7.5	7.2	7.4	7.4	7.5	---	---	---	---
Max	8.0	7.9	7.9	7.8	7.5	7.7	7.7	7.8	---	---	---	---
Mean	7.9	7.9	7.8	7.6	7.3	7.5	7.5	7.7	---	---	---	---

Appendix Table 27. Monthly environmental data collected from the Salmon River near Sawtooth Hatchery (RKm 627.9) from August 2005 through July 2006.

	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Min	12.3	9.4	4.3	0.2	0.0	0.1	0.0	0.8	4.0	5.5	9.0	12.7
Max	15.4	12.9	9.9	6.4	3.5	3.0	3.5	6.1	7.2	10.4	14.4	16.3
Mean	14.1	10.9	7.4	2.6	1.0	1.2	1.3	3.2	5.7	7.8	11.8	14.8
						Dissolved oxygen (ppm)						
Min	9.8	10.0	6.9	---	---	---	---	---	---	9.6	9.2	8.7
Max	12.0	12.1	10.6	---	---	---	---	---	---	11.3	10.1	9.2
Mean	11.0	11.2	9.0	---	---	---	---	---	---	10.6	9.6	9.0
						Specific conductance (µS/cm)						
Min	199.4	220.8	206.6	190.8	128.1	126.4	137.4	140.8	95.5	58.8	63.3	73.3
Max	223.8	233.5	236.8	216.3	197.0	142.4	152.5	154.0	149.9	95.9	90.2	116.3
Mean	212.5	225.4	217.8	201.8	151.7	135.6	144.2	148.8	123.5	81.0	72.1	90.4
						Turbidity (ntu)						
Min	0.0	0.0	0.0	0.0	0.0	---	---	---	0.0	2.1	7.8	4.6
Max	1.2	0.2	1.3	2.5	9.1	---	---	---	23.3	148.9	192.4	133.9
Mean	0.0	0.0	0.2	0.4	2.5	---	---	---	4.2	18.8	65.2	47.0
						Depth (ft)						
Min	1.2	1.1	1.1	0.8	0.8	1.4	1.3	1.1	1.3	2.1	2.0	1.2
Max	1.7	1.7	1.7	1.6	2.8	2.3	2.2	1.9	2.7	3.7	3.4	2.0
Mean	1.5	1.4	1.5	1.2	1.8	1.7	1.7	1.5	1.9	2.9	2.5	1.5
						pH						
Min	8.2	8.4	8.4	8.4	8.1	8.2	8.2	8.3	7.8	7.3	7.4	7.7
Max	8.4	8.5	8.6	8.5	8.5	8.3	8.4	8.4	8.4	8.0	7.8	8.1
Mean	8.3	8.5	8.5	8.4	8.2	8.3	8.3	8.4	8.1	7.7	7.7	7.9

Appendix Table 28. Monthly environmental data collected from Valley Creek (RKm 609.4 from the mouth of the Salmon River) from August 2005 through July 2006.

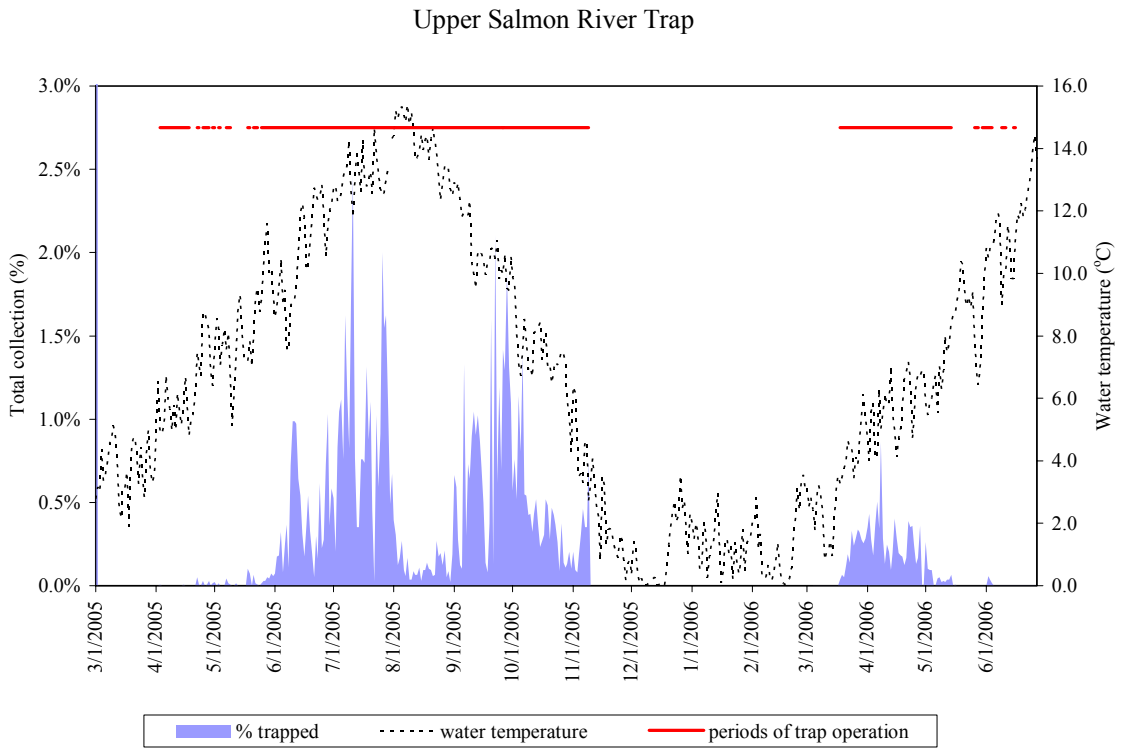
	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Min	---	---	---	---	0.2	0.3	0.3	0.6	2.3	4.9	8.9	13.0
Max	---	---	---	---	0.7	0.7	1.0	5.4	6.2	11.2	14.6	18.6
Mean	---	---	---	---	0.4	0.5	0.6	2.0	4.0	8.0	11.5	16.0
						Dissolved oxygen (ppm)						
Min	---	---	---	---	6.2	6.7	7.3	7.3	7.4	13.7	13.1	---
Max	---	---	---	---	8.9	7.4	7.8	8.0	16.7	16.8	16.1	---
Mean	---	---	---	---	6.6	7.1	7.6	7.7	13.1	15.6	14.8	---
						Specific conductance (µS/cm)						
Min	---	---	---	---	66.4	68.9	77.0	78.8	37.3	29.3	24.5	25.3
Max	---	---	---	---	78.9	82.3	82.7	87.4	85.1	45.4	30.8	45.2
Mean	---	---	---	---	73.9	75.7	80.2	83.8	61.0	37.5	26.1	34.3
						Turbidity (ntu)						
Min	---	---	---	---	0.0	0.0	0.0	0.0	0.2	1.1	0.0	0.0
Max	---	---	---	---	1.7	1.3	1.0	25.8	29.7	17.9	4.1	5.0
Mean	---	---	---	---	0.4	0.2	0.1	1.3	8.5	5.4	0.7	0.3
						Depth (ft)						
Min	---	---	---	---	0.8	0.9	0.8	0.5	0.8	2.6	2.7	1.5
Max	---	---	---	---	1.7	1.7	1.7	1.3	3.1	3.9	3.4	2.6
Mean	---	---	---	---	1.4	1.3	1.2	0.9	1.9	3.1	3.0	2.1
						pH						
Min	---	---	---	---	7.5	7.8	7.8	8.0	7.2	7.0	7.0	6.6
Max	---	---	---	---	7.9	8.0	8.2	8.3	8.1	7.6	7.5	7.6
Mean	---	---	---	---	7.6	7.9	8.0	8.2	7.5	7.3	7.3	7.1

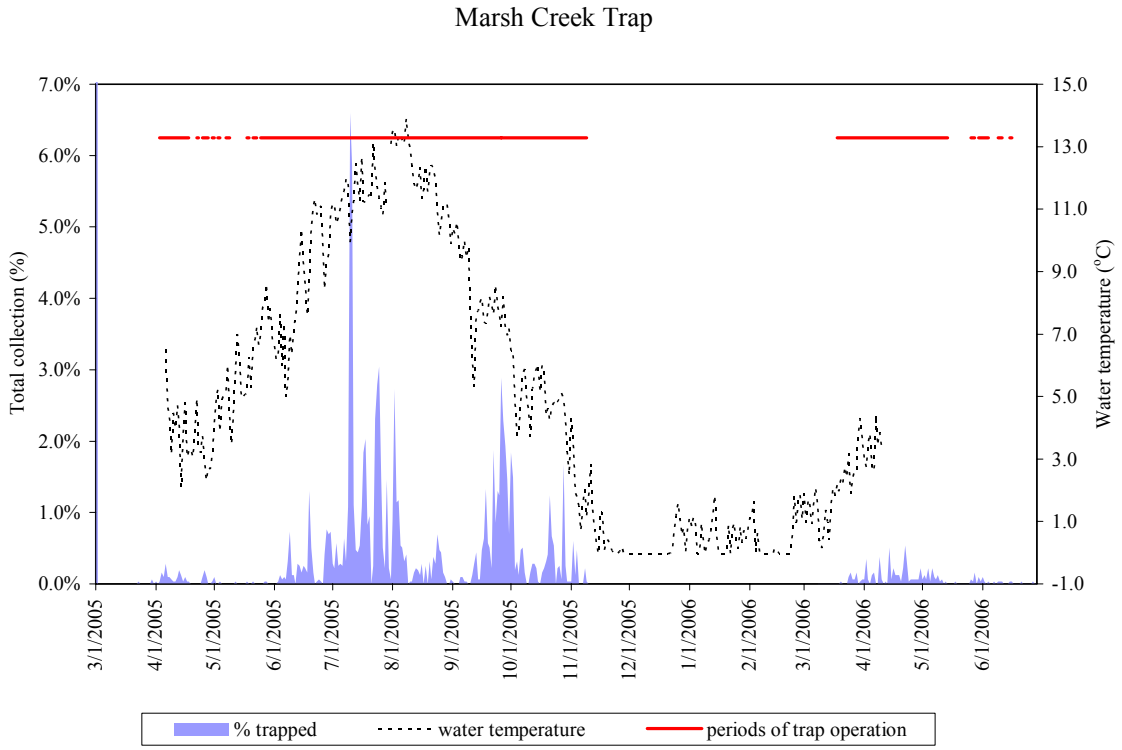
Appendix Table 29. Monthly environmental data collected from South Fork Salmon River (112 km from its confluence with the Salmon River) from August 2005 through July 2006.

	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Min	11.6	6.8	2.5	0.0	0.0	0.0	0.0	0.0	1.7	3.3	5.8	12.2
Max	17.0	12.5	8.2	4.1	0.5	0.8	0.7	3.0	4.1	5.7	12.0	17.9
Mean	14.4	9.6	5.3	0.7	0.1	0.3	0.1	1.0	2.9	4.5	7.9	14.7
						Dissolved oxygen (ppm)						
Min	---	---	---	10.5	10.8	10.9	11.6	11.3	11.0	9.7	7.5	6.9
Max	---	---	---	11.3	11.2	11.8	12.1	12.1	12.0	11.1	9.5	9.1
Mean	---	---	---	11.0	11.0	11.4	11.8	11.8	11.6	10.3	8.6	8.3
						Specific conductance (µS/cm)						
Min	---	---	---	36.2	31.7	34.2	38.2	35.7	24.0	17.0	19.0	28.6
Max	---	---	---	51.3	53.3	43.5	47.0	43.0	40.2	26.0	27.8	38.5
Mean	---	---	---	45.6	44.9	40.4	44.6	40.4	32.8	22.0	21.9	33.9
						Turbidity (ntu)						
Min	0.0	---	---	0.0	0.0	0.0	0.0	0.0	0.2	3.0	0.3	0.0
Max	38.3	---	---	0.1	0.1	1.1	0.6	1.4	26.0	44.4	7.8	0.6
Mean	1.3	---	---	0.0	0.0	0.1	0.0	0.2	9.5	11.6	2.5	0.1
						Depth (ft)						
Min	0.4	0.2	0.3	0.4	0.2	0.2	0.3	0.2	0.6	2.4	1.7	1.0
Max	0.9	0.8	0.9	1.7	2.3	2.0	2.1	1.0	3.0	4.1	2.9	1.6
Mean	0.7	0.6	0.6	0.9	1.4	0.9	1.2	0.6	1.8	3.0	2.3	1.3
						pH						
Min	7.8	7.9	7.8	7.7	7.4	7.6	7.7	7.7	7.1	6.9	7.1	7.1
Max	8.1	8.2	8.0	8.0	7.8	7.8	7.9	7.9	7.7	7.3	7.5	7.6
Mean	8.0	8.0	7.9	7.8	7.7	7.8	7.8	7.8	7.3	7.2	7.3	7.4

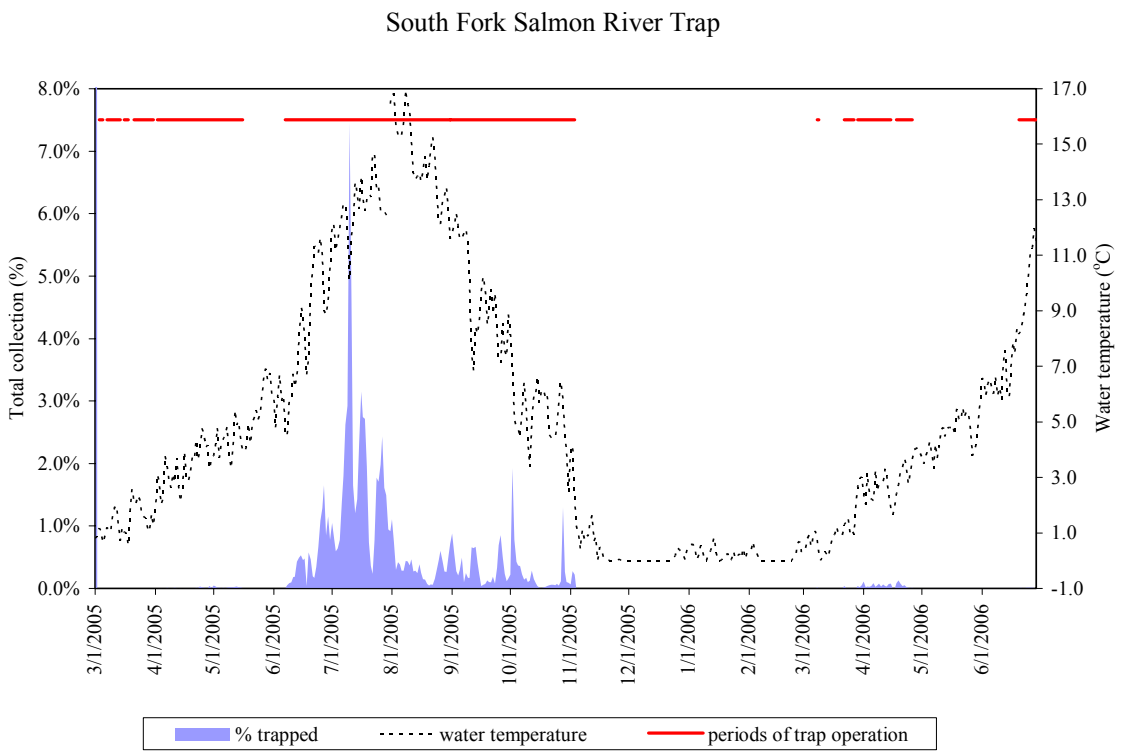
Appendix Table 30. The monthly weather data at three weather stations in the Salmon River drainage. Table also includes stream flow at two sites from August 2005 through July 2006.

	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Air temperature (°C), precipitation (cm) and snowfall (cm) at Stanley, Idaho												
Min	0.5	-4.8	-5.7	-12.5	-18.3	-14.5	-21.6	-13.4	-5.5	-3.0	1.7	4.3
Max	26.2	20.6	14.4	1.3	-5.3	-2.5	2.3	3.5	10.2	17.4	21.7	27.2
Mean	13.3	8.2	4.5	-5.6	-11.8	-8.5	-12.0	-4.9	2.4	7.2	12.2	15.7
Precip.	0.0	0.0	0.0	6.3	3.1	4.4	0.8	0.5	0.6	0.0	2.4	1.6
Snow	0.0	0.0	0.0	44.5	33.0	18.5	20.3	0.5	10.2	0.0	0.0	0.0
Air temperature (°C), precipitation (cm) and snowfall (cm) at Taylor Ranch, Idaho												
Min	9.5	4.2	1.4	-5.0	-11.0	-5.9	-9.7	-4.0	1.3	3.9	9.1	11.7
Max	32.1	23.7	14.9	2.6	-3.7	1.9	1.9	7.8	12.9	21.9	27.5	32.0
Mean	20.3	13.9	8.2	-1.2	-7.4	-2.0	-3.9	1..9	8.0	12.9	18.3	21.8
Precip.	0.8	3.5	4.5	5.9	3.6	2.5	1.8	1.7	3.3	1.4	2.6	1.5
Snow	0.0	0.0	0.0	25.9	18.8	16.0	19.8	11.4	0.0	0.0	0.0	0.0
Air temperature (°C), precipitation (cm) and snowfall (cm) at Middle Fork Lodge, Idaho												
Min	7.4	1.4	-0.7	-6.7	-12.3	-8.2	-11.9	-6.0	0.8	2.0	6.9	9.1
Max	30.5	23.9	16.4	4.3	-1.7	2.4	2.4	6.9	13.9	20.8	26.1	31.2
Mean	18.7	12.7	7.9	-1.2	-7.0	-2.9	-4.8	0.5	6.6	12.0	16.5	20.1
Precip.	.7	2.8	1.7	7.5	6.4	6.9	1.9	3.2	3.4	2.0	3.0	0.4
Snow	0.0	0.0	0.0	0.0	40.1	29.0	64.3	11.2	10.6	0.0	0.0	0.0
Stream flow (m^3/s)												
Valley Creek												
	---	---	---	---	---	---	---	---	---	---	---	---
Salmon River at Shoup												
	36.2	34.3	29.7	26.0	24.1	21.6	22.2	27.3	51.2	202.8	150.3	56.4

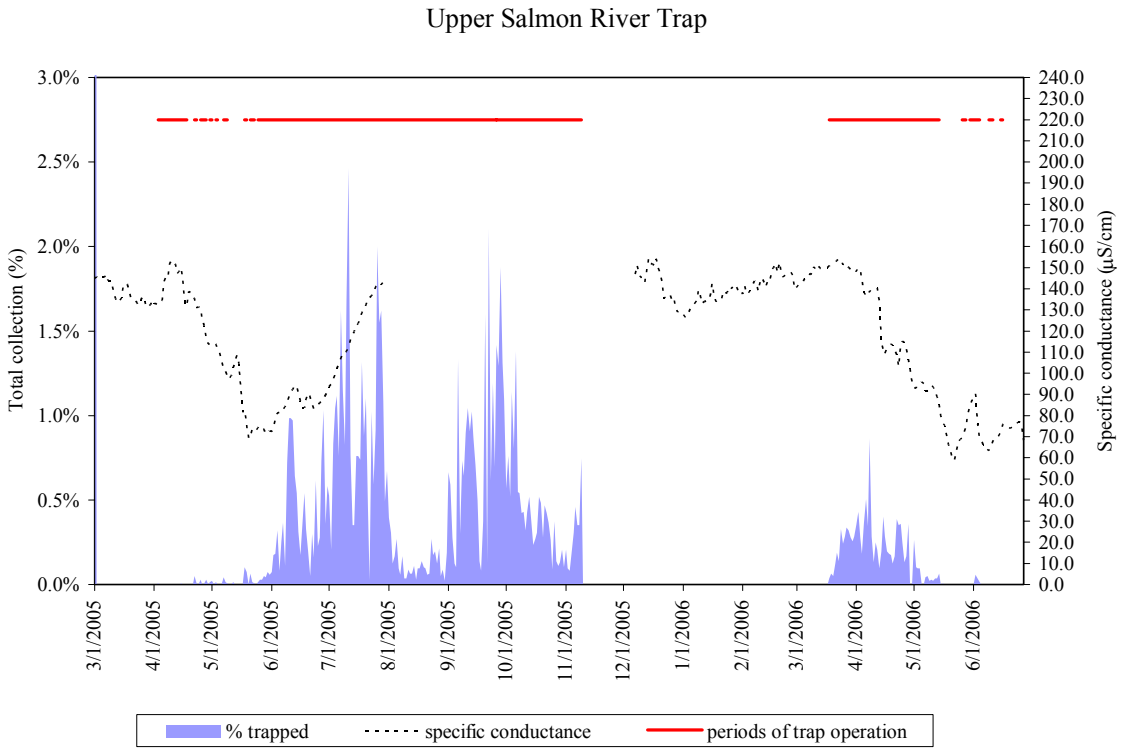


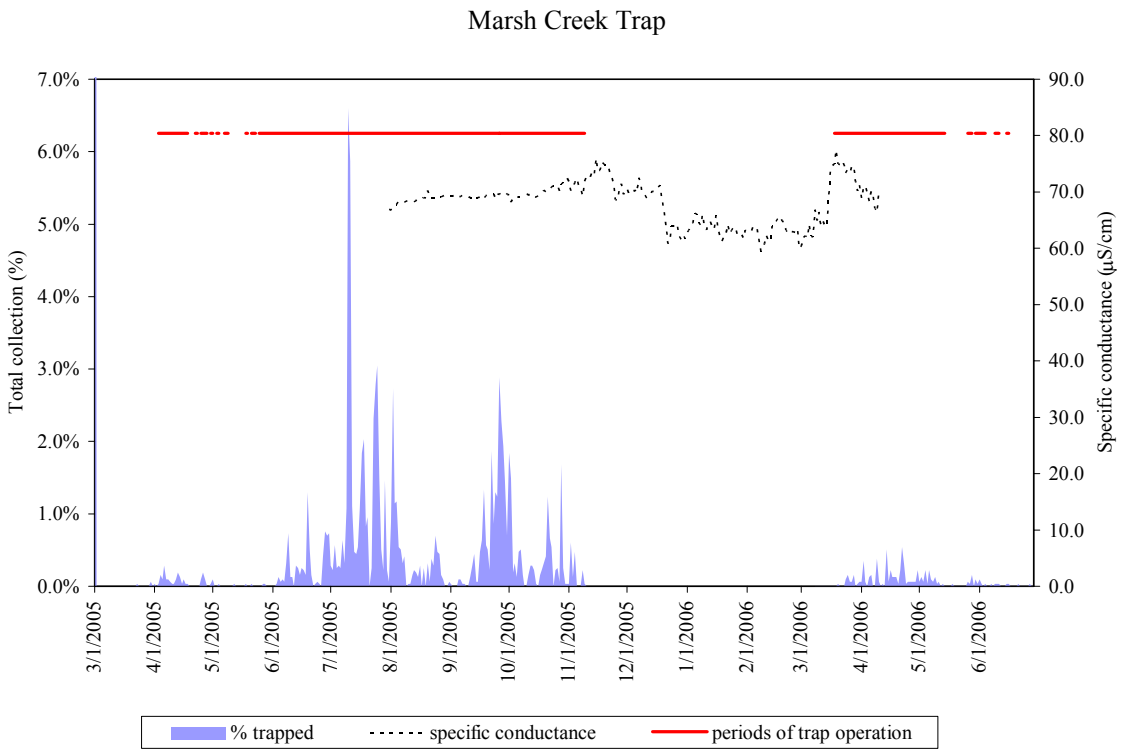


Appendix Figure 1. Daily passage of wild chinook salmon fry, parr, and smolts at three migrant traps, expressed as percentages of total collected, and plotted against average daily water temperatures collected near traps. Periods of trap operation are also shown.

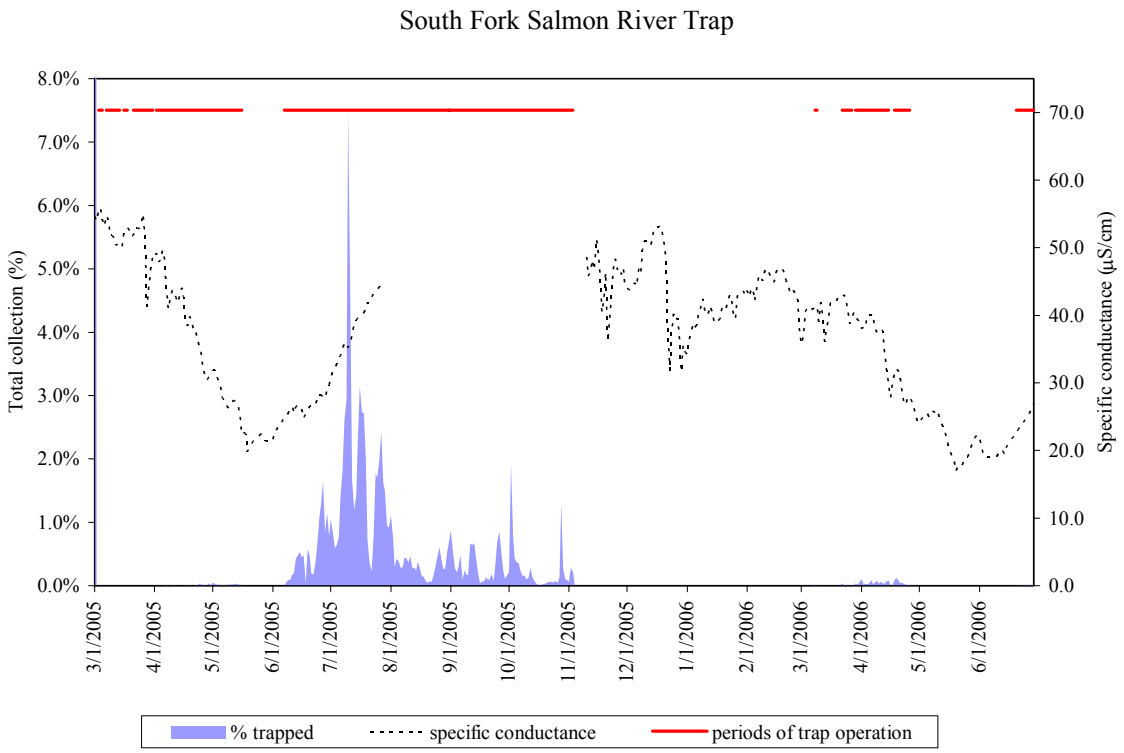


Appendix Figure 1. Continued.

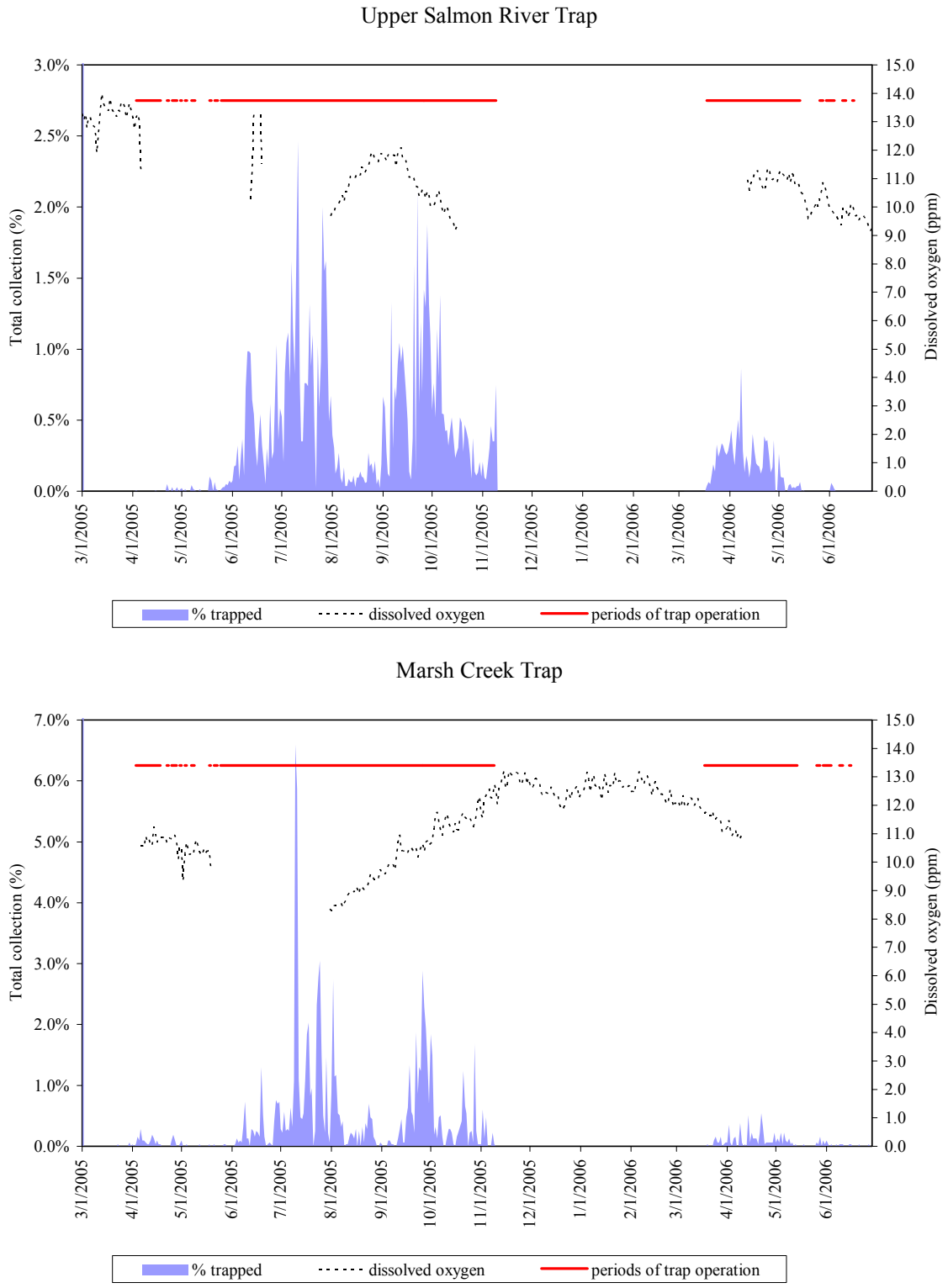




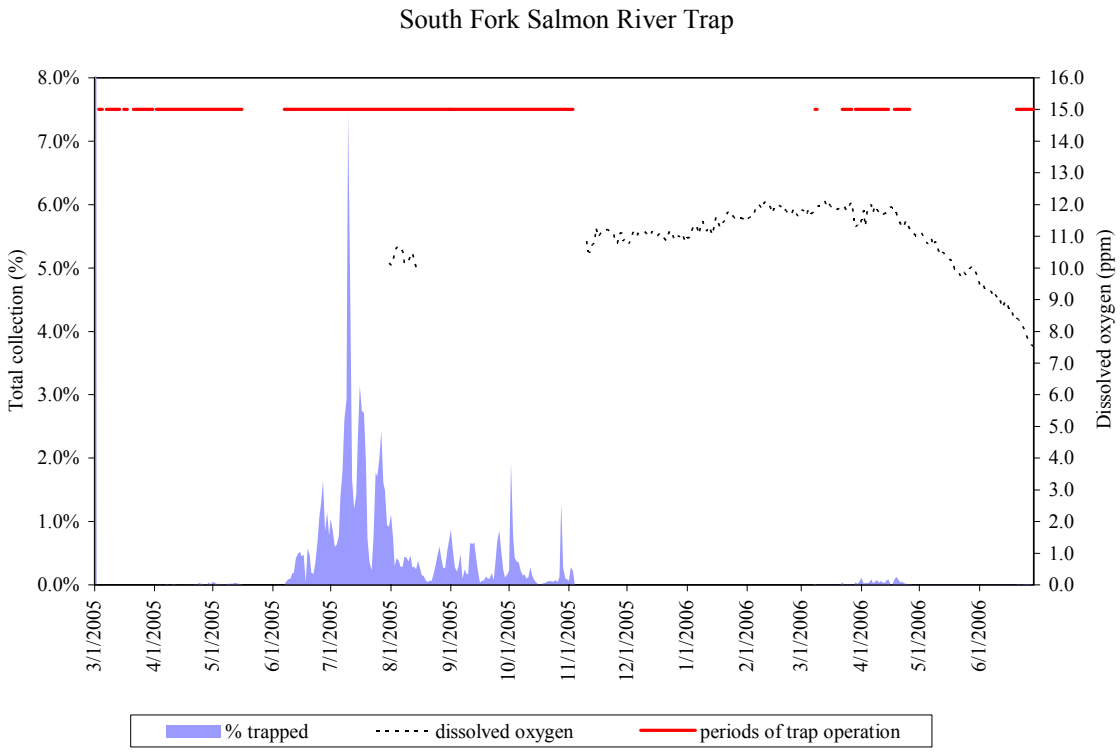
Appendix Figure 2. Daily passage of wild chinook salmon fry, parr, and smolts at three migrant traps, expressed as percentages of total collected, and plotted against average daily specific conductance collected near traps. Periods of trap operation are also shown.



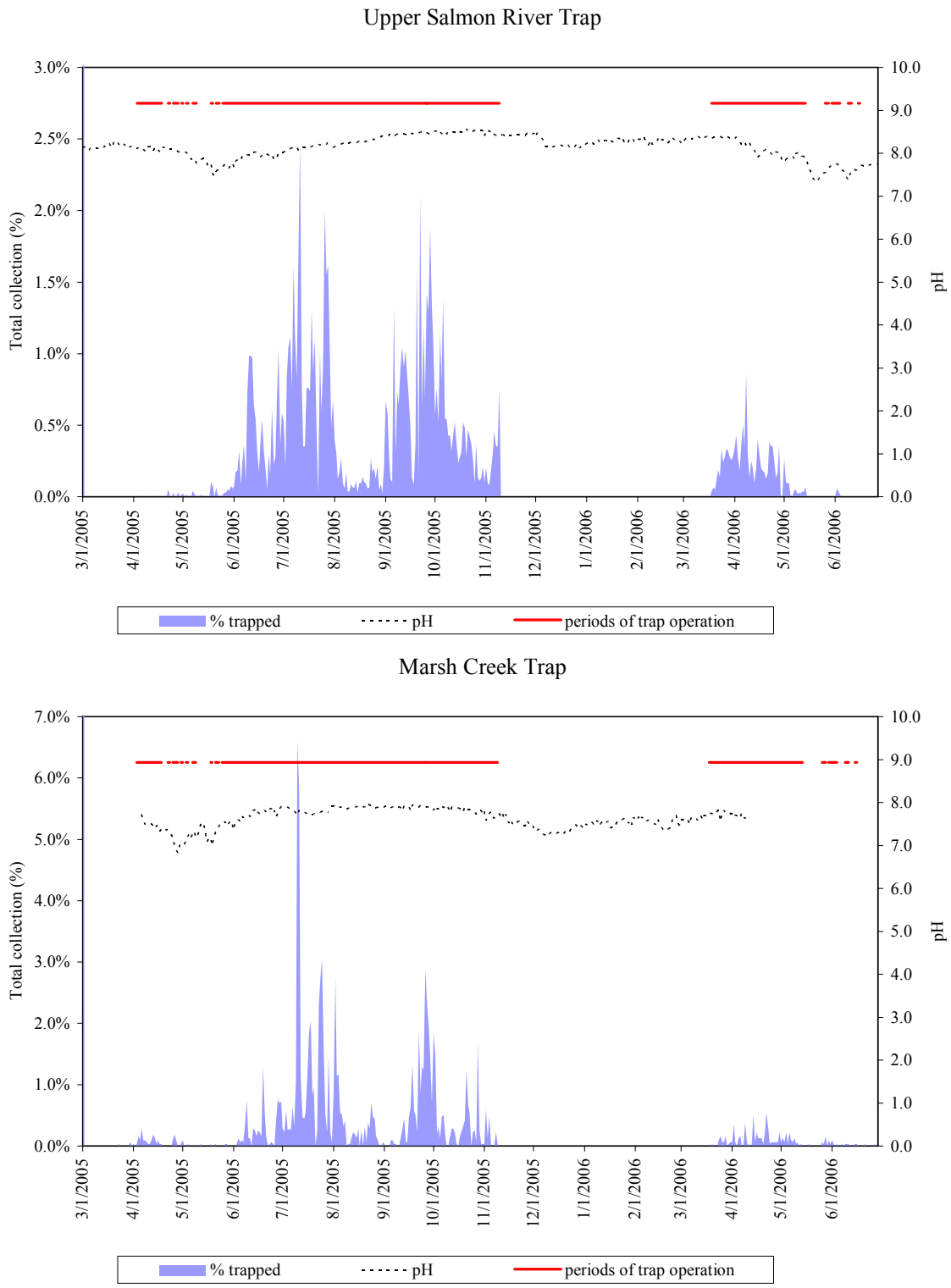
Appendix Figure 2. Continued.



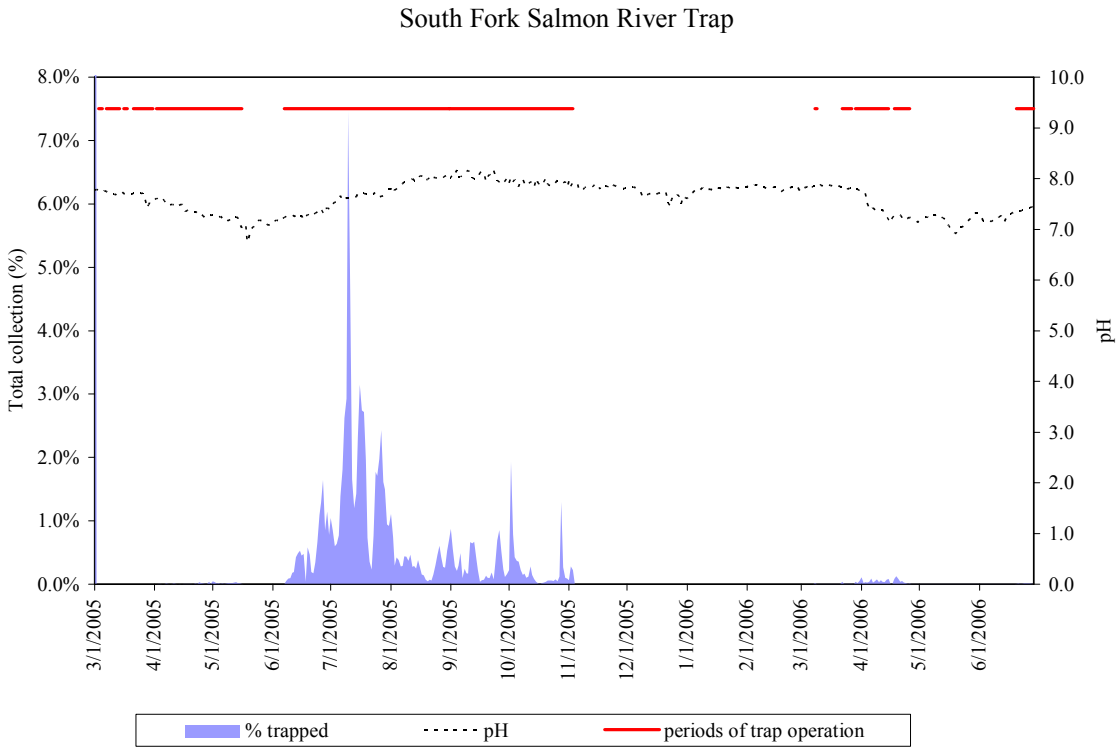
Appendix Figure 3. Daily passage of wild chinook salmon fry, parr, and smolts at three migrant traps, expressed as percentages of total collected, and plotted against average daily dissolved oxygen collected near traps. Periods of trap operation are also shown.



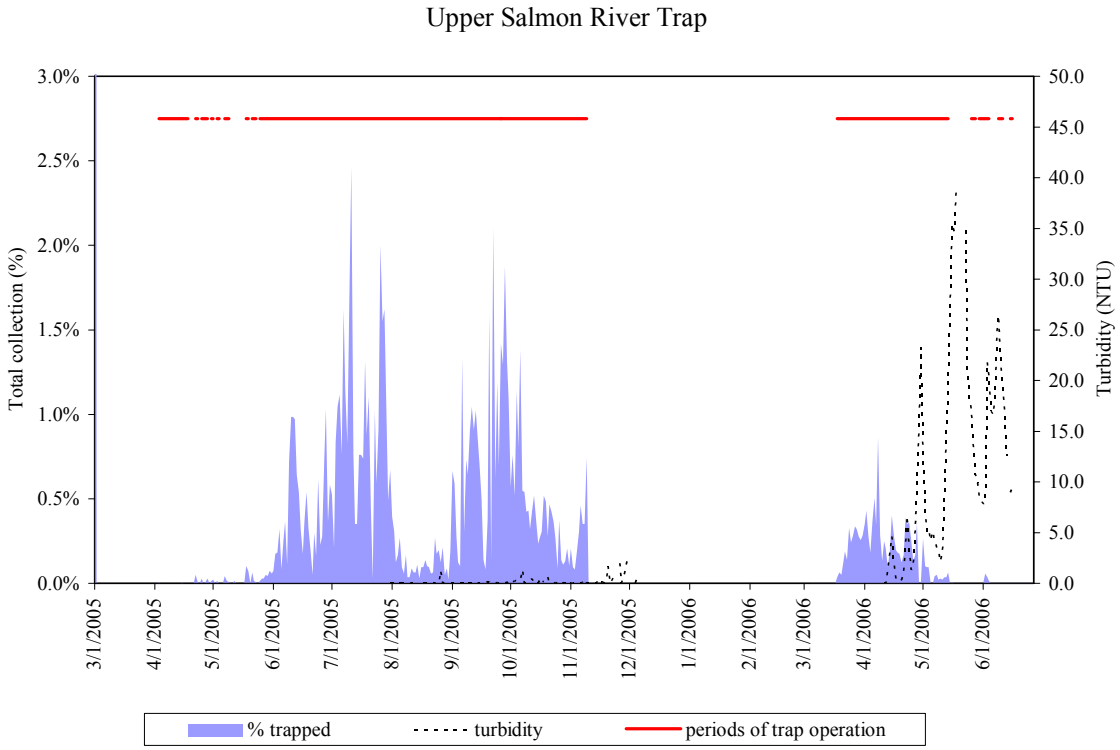
Appendix Figure 3. Continued.

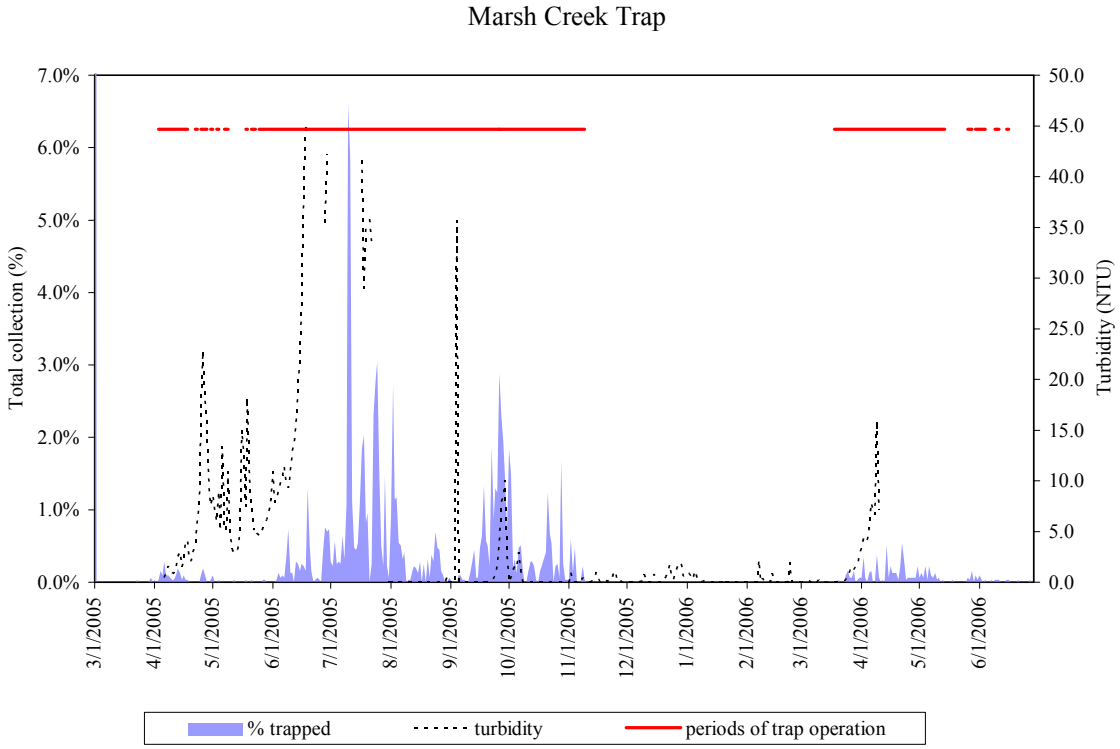


Appendix Figure 4. Daily passage of wild chinook salmon fry, parr, and smolts at three migrant traps, expressed as percentages of total collected, and plotted against average daily pH collected near traps. Periods of trap operation are also shown.

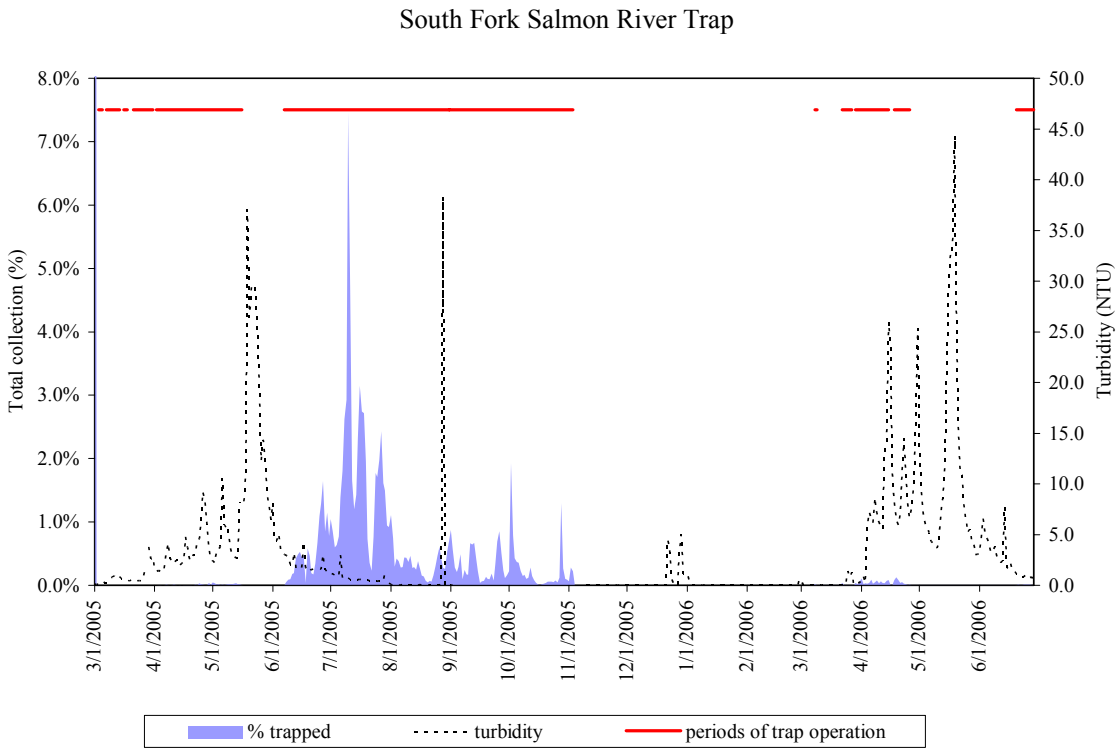


Appendix Figure 4. Continued.

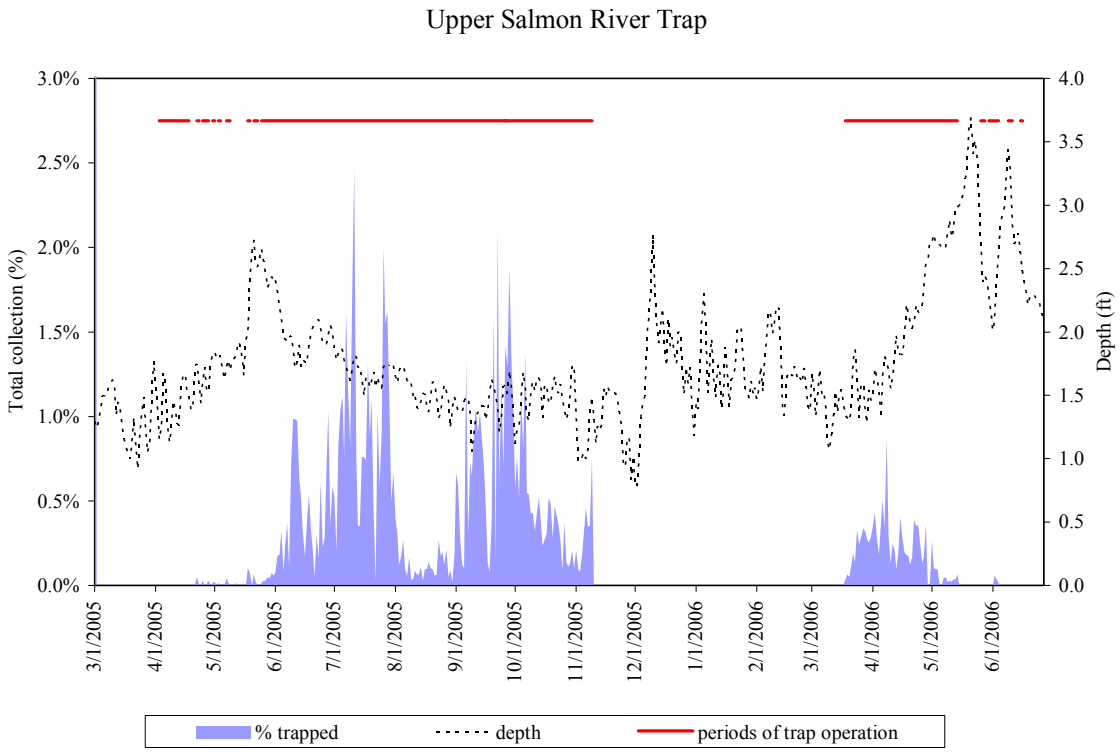


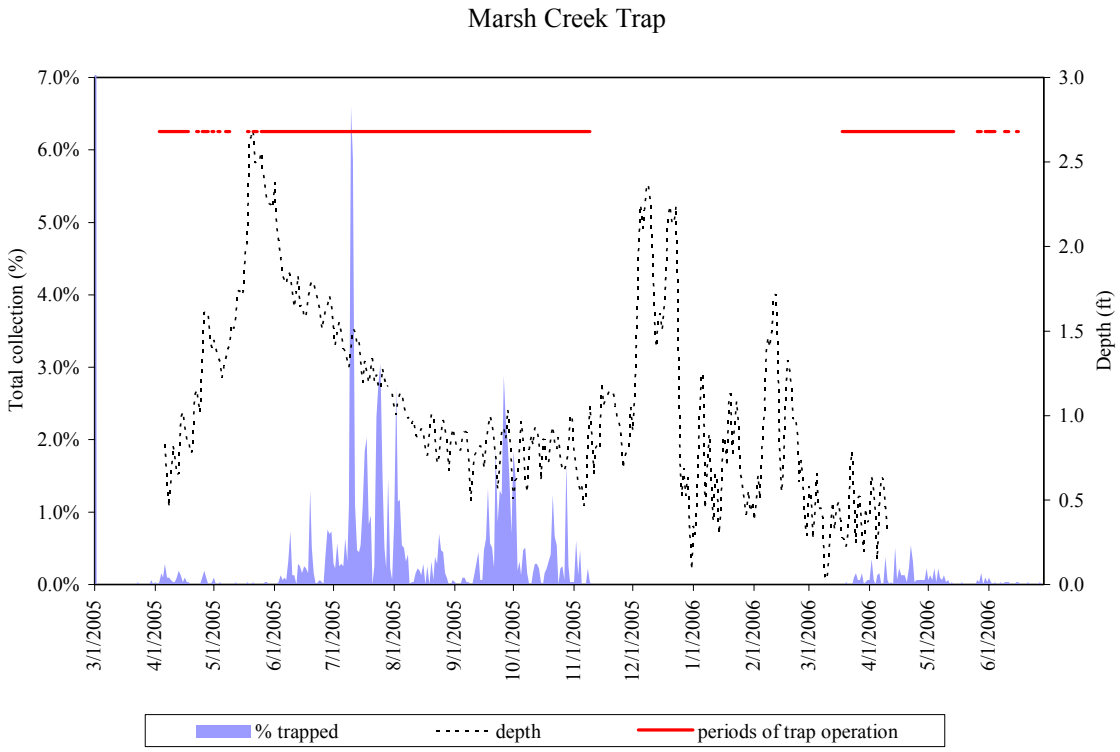


Appendix Figure 5. Daily passage of wild chinook salmon fry, parr, and smolts at three migrant traps, expressed as percentages of total collected, and plotted against average daily turbidity collected near traps. Periods of trap operation are also shown.

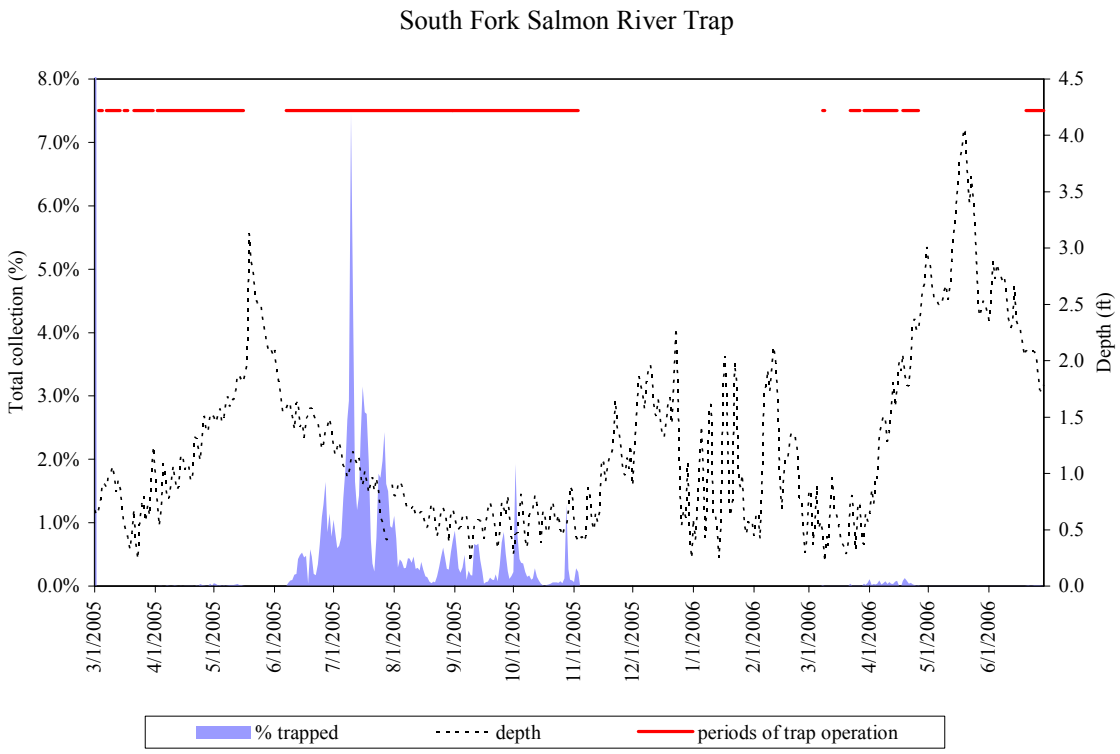


Appendix Figure 5. Continued.

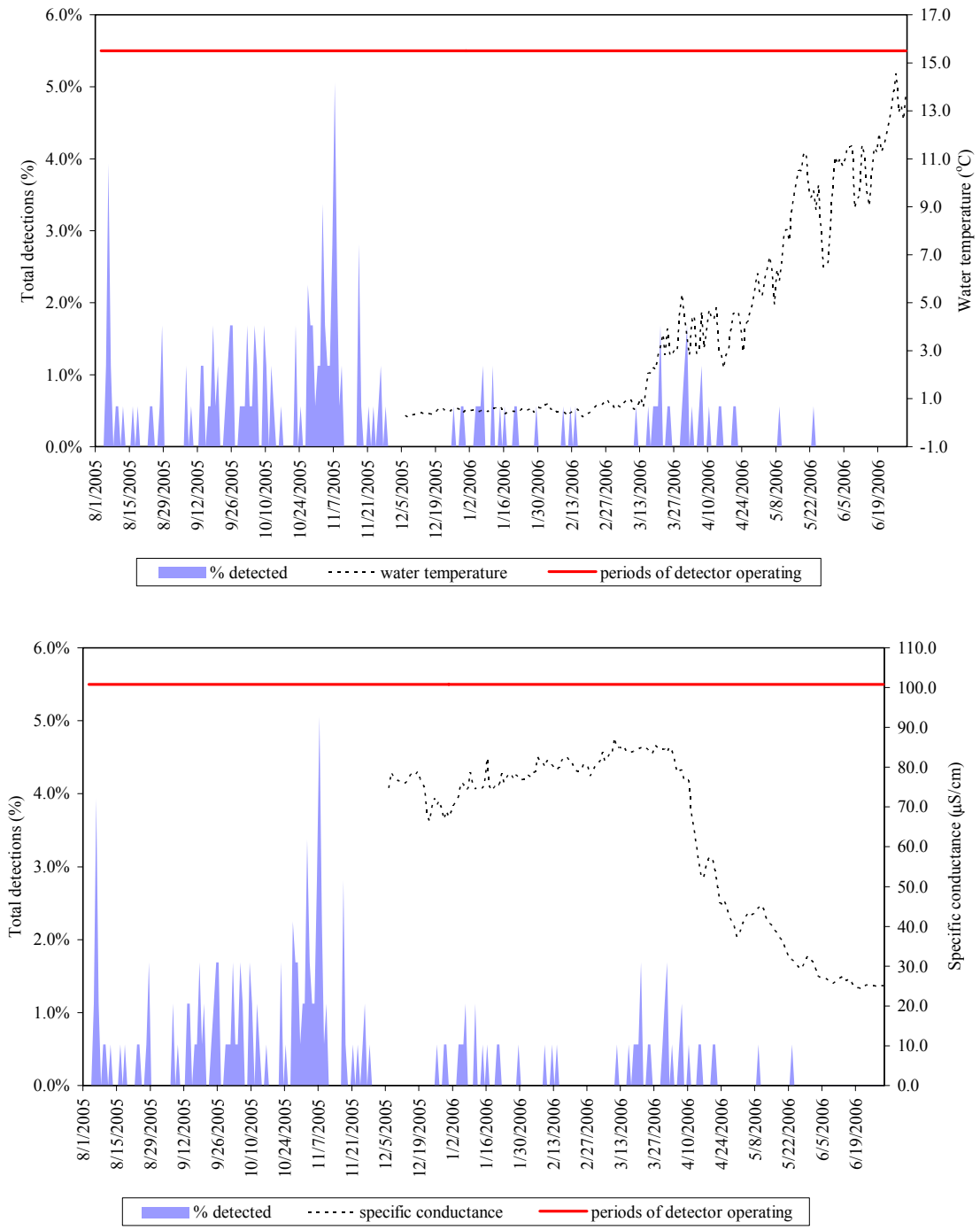




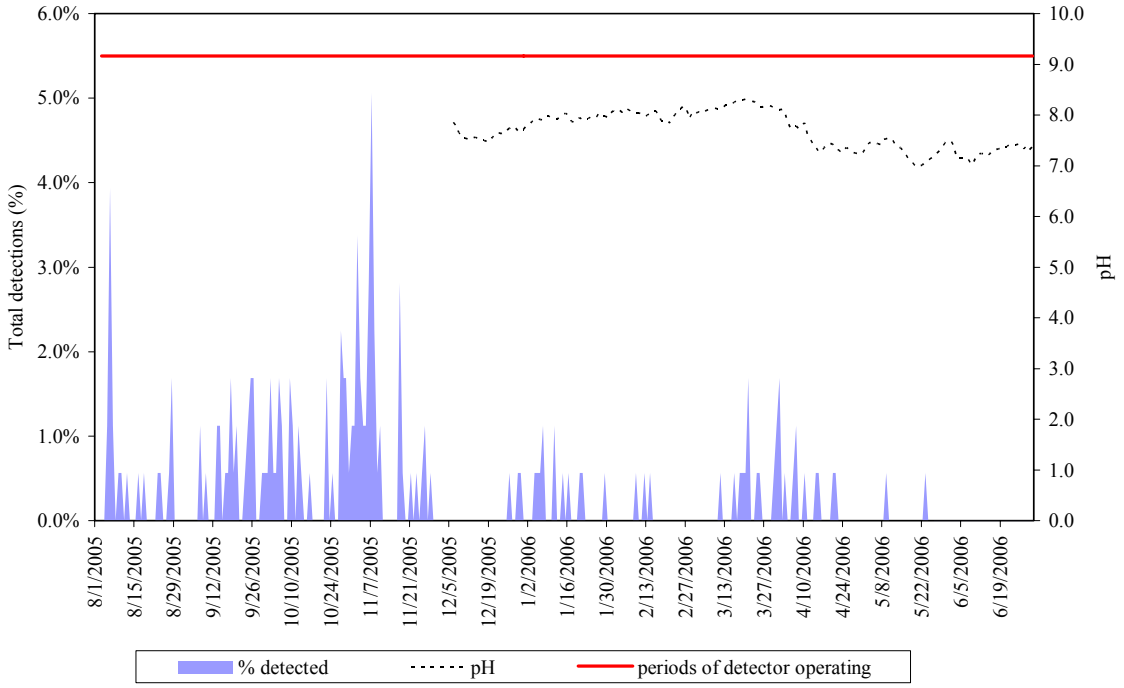
Appendix Figure 6. Daily passage of wild chinook salmon fry, parr, and smolts at three migrant traps, expressed as percentages of total collected, and plotted against average daily depth collected near traps. Periods of trap operation are also shown.

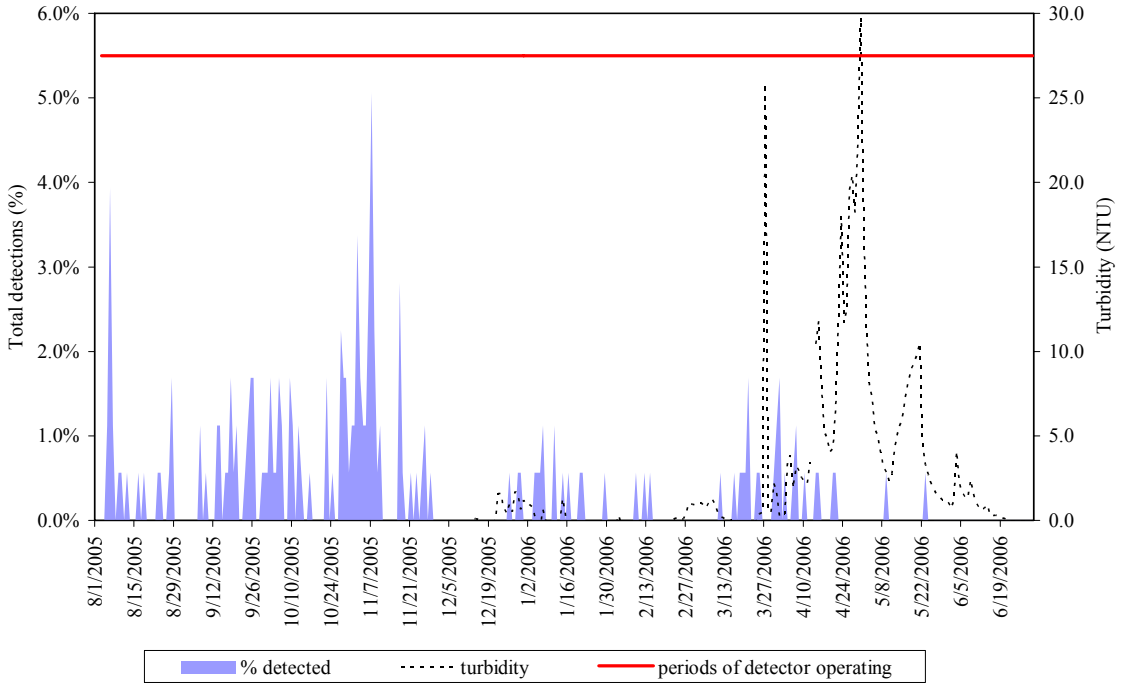


Appendix Figure 6. Continued.

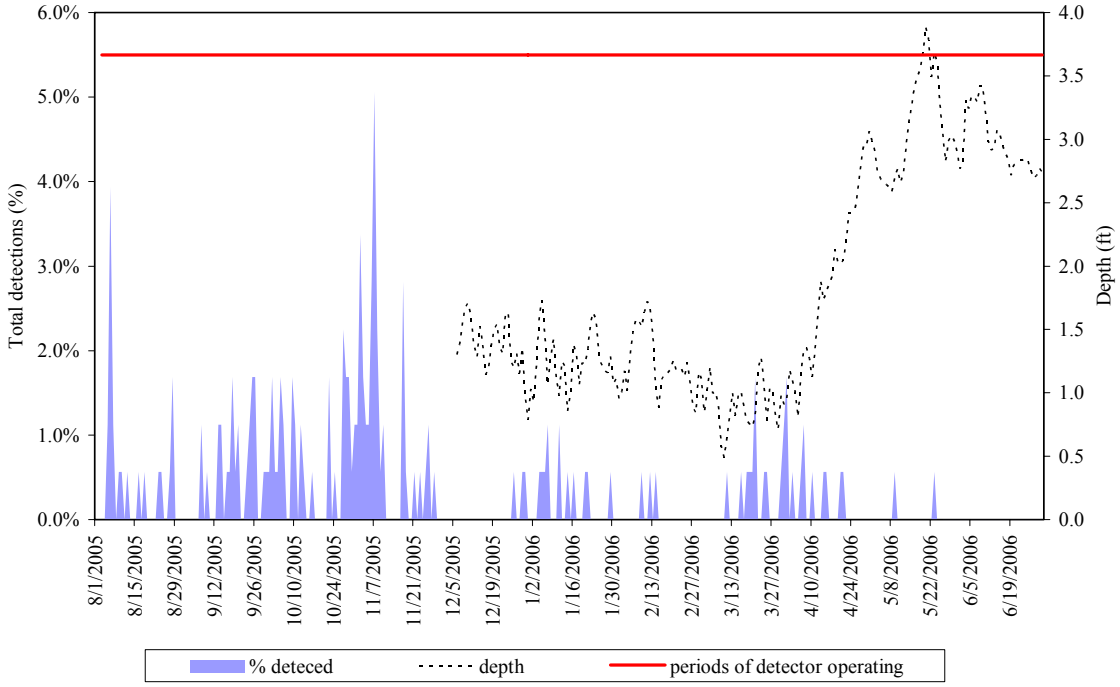


Appendix Figure 7. Combined daily PIT-tag detections of wild chinook salmon parr at instream PIT-tag detectors in Valley Creek, expressed as percentages of total collected, and plotted against average daily aquatic conditions collected near the detectors. Periods of operation for the detectors are also shown.





Appendix Figure 7. Continued.



Appendix Figure 7. Continued.