August 2001

MONITORING THE MIGRATIONS OF WILD SNAKE RIVER SPRING SUMMER CHINOOK SALMON SMOLTS, 2000

Annual Report 2000

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Monitoring the Migrations of Wild Snake River Spring/Summer Chinook Salmon Smolts, 2000

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Report of Research by

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EXECUTIVE SUMMARY

This report details the 2000 results from an ongoing project to monitor the migration behavior of wild spring/summer chinook salmon smolts in the Snake River Basin. The report also discusses trends in the cumulative data collected for this project from Oregon and Idaho streams since 1989.

The project was initiated after 3 years of detection data from passive-integrated-transponder tags (PIT-tags) had shown distinct differences in migration patterns between wild and hatchery fish. Data showing these patterns had originated from tagging and interrogation operations begun in 1988 to evaluate a smolt transportation program conducted by the National Marine Fisheries Service (NMFS) for the U.S. Army Corps of Engineers.

In 1991, the Bonneville Power Administration began a cooperative effort with NMFS to expand tagging and interrogation of wild fish for this project. Project goals were to characterize the outmigration timing of these fish, to determine whether consistent migration patterns would emerge, and to investigate the influence of environmental factors on the timing and distribution of these migrations.

In 1992, the Oregon Department of Fish and Wildlife (ODFW) began an independent program of PIT tagging wild chinook salmon parr in the Grande Ronde and Imnaha River Basins in northeast Oregon. Since then, ODFW has reported all tagging, detection, and timing information on fish from these streams. However, with ODFW concurrence, NMFS will continue to report arrival timing of these fish at Lower Granite Dam.

We continued to tag fish from Idaho after 1992. Principal results from our tagging and interrogation during 1999-2000 are enumerated below.

1) In July and August 1999, we PIT tagged and released 10,402 wild chinook salmon parr in 15 Idaho streams.

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

3) Using the detection probability expansion method, estimated parr-to-smolt survival to Lower Granite Dam averaged 17.1% (range 11.3-35.5% depending on stream of origin).

4) Fish that were larger at release were detected at a significantly higher rate the following spring and summer than their smaller cohorts ($P < 0.001$).

5) Fish that migrated through Lower Granite Dam in April and May were significantly larger at release than fish that migrated after May ($P < 0.004$).

6) In 2000, peak detections at Lower Granite Dam of all summer-tagged wild fish (from the 15 streams in Idaho and 4 streams in Oregon) occurred during low-to-moderate flows of 82 kcfs on 11 May, with the 50th and 90th percentile passage occurring on 6 and 29 May, respectively.

Over the years, migration timing patterns have emerged for some stocks, based on detections at Lower Granite Dam. These patterns range from early to late spring, and shifts in passage distribution for these stocks appear related to annual climatic conditions.

Annual arrival timing of individual stocks at Lower Granite Dam provides the basis to determine similarities or differences in migration patterns between years or between stocks. This report details our findings on the arrival timing distributions for individual stocks in 2000 as well as arrival timing patterns for several stocks over the years at the dam.

We have observed a 2- to 3-week shift in timing of combined wild stocks passing Lower Granite Dam between relatively warm and relatively cold years. In the warm years of 1990, 1992, 1994, and 1998, the median passage date at the dam was between 29 April and 4 May, and 90% of all wild fish passed by the end of May. In the cold years of 1989, 1991, and 1993, median passage did not occur until mid-May, and the 90th percentile had not passed until mid-June (except during high flows in 1993, when the 90th percentile passed by the end of May).

In 1995, weather conditions in late winter and early spring were moderate compared to those of the previous 6 years, and we observed intermediate passage timing at the dam relative to previous study years, with the median and 90th percentile passage occurring on 9 May and 5 June, respectively. In 1996 and 1997, too few Idaho fish were detected to make meaningful comparisons of timing with other years.

In 1999, we experienced different climatic conditions than in all previous migration years. In late winter, a near-record snow pack in the Snake River Basin resulted in high flows during the early spring period (late March); however, the ensuing flows were moderated by very dry and cold conditions during mid-to-late spring and early summer. The fluctuating medium-to-high flows throughout the spring moved wild fish through Lower Granite Dam as observed in warmer years, with 50% passing by 3 May and 90% passing by 28 May.

In 2000, we had more typical temperatures and climatic conditions throughout the spring, along with slightly below-normal flows, with the highest flows occurring in April. Consequently, we observed a wild fish migration pattern similar to those seen in warm years, with 50 and 90% passage occurring in early and late May, respectively.

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INTRODUCTION

Background

In 1988, the National Marine Fisheries Service (NMFS) began a cooperative study with the U.S. Army Corps of Engineers to mark wild Snake River spring and summer chinook salmon parr with passive integrated transponder (PIT) tags for transportation research. This project continued through mid-1991, with migrating smolts monitored as they passed Lower Granite, Little Goose, and McNary Dams during spring and summer 1989-1991 (Matthews et al. 1990, 1992; Achord et al. 1992, 1996b).

Information from these 3 years of study demonstrated that the migration timing of wild stocks through Lower Granite Dam differs among stream of origin and also differs from the migration timing of hatchery-reared fish. Migrations of wild spring chinook salmon were consistently later and more protracted, and exhibited more variable timing patterns over the 3 years, than those of their hatchery-reared counterparts. In contrast, the migrations of wild summer chinook salmon during these same years were earlier, though also more protracted, than those of their hatchery counterparts.

The present study began in mid-1991, when NMFS and the Bonneville Power Administration (BPA) began a cooperative ongoing project to monitor the migrations of wild chinook salmon smolts (Achord et al.1994; 1995a,b; 1996a; 1997; 1998; 2000; 2001).

Project Goals

Prior to 1992, decisions on dam operations and use of stored water relied on recoveries of branded hatchery fish, index counts at traps and dams, and flow patterns at the dams. The advent of PIT-tag technology provided the opportunity to precisely track the smolt migrations of many wild stocks as they pass through the hydroelectric complex and other monitoring sites on their way to the ocean. With the availability of the PIT tag, a more complete approach to these decisions was undertaken starting in 1992 with the addition of PIT-tag detections of several wild spring and summer chinook salmon stocks at Lower Granite Dam.

Using data from these detections, we initiated development of a database on wild fish, addressing several goals of the Columbia River Basin Fish and Wildlife Program of the Pacific Northwest Electric Power Planning Council and Conservation Act (1980). Section 304(d) of the program states, "The monitoring program will provide information on the migrational characteristics of the various stocks of salmon and steelhead within the Columbia Basin." Further, Section 201(b) urges conservation of genetic diversity, which will be possible only if wild stocks are preserved.

In 2000, we also continued to collect environmental data for the Baseline Environmental Monitoring Program, which was developed from 1993 to 1997. The project is designed to collect data to be used in conjunction with the data on parr and smolt movements to discern patterns or characteristic relationships between these movements and the environmental factors.

The goals of this ongoing study are 1) to characterize the migration timing of different stocks of wild Snake River spring/summer chinook salmon smolts at dams on the Snake and Columbia Rivers, 2) to determine whether consistent migration patterns are apparent, and 3) to determine what environmental factors influence these patterns.

This report provides information on PIT tagging of wild chinook salmon parr in 1999 and the subsequent monitoring of these fish. Fish were monitored as they migrated through juvenile migrant traps in 1999 and 2000 as well as through interrogation systems at Lower Granite, Little Goose, Lower Monumental, McNary, John Day, and Bonneville Dams during 2000.

In addition, data from environmental monitoring in 2000 is reported here. This data consists of temperature, dissolved oxygen, specific conductance, turbidity, depth, and pH measured at five monitoring stations in the Salmon River Basin, Idaho.

METHODS

Fish Collection and Tagging

In 1992, Oregon Department of Fish and Wildlife (ODFW) began PIT tagging wild chinook salmon parr in the Grande Ronde and Imnaha River drainages in northeast Oregon. All tagging, detection, and timing information for fish from these streams in 1999-2000 will be reported by ODFW. However, with ODFW's concurrence, NMFS will continue to report the timing at Lower Granite Dam of summer-tagged fish from these Oregon streams. Collection and PIT-tagging procedures described by Matthews et al. (1990) and Achord et al. (1994; 1995a,b) were used for our field work in 1999.

Juvenile Migrant Traps

During fall 1999 and spring 2000, juvenile migrant fish traps were operated at Knox Bridge on the South Fork of the Salmon River, at the South Fork of the Salmon River below its confluence with the Secesh River, at Lake Creek, near Chinook Campground on the Secesh River, at Marsh Creek, and near the Sawtooth Hatchery on the upper Salmon River (Fig. 1). Also during spring 2000, juvenile migrant fish traps were operated on the East Fork of the Salmon River, on the lower Salmon River near Whitebird, Idaho, and on the Snake River at Lewiston, Idaho (Fig. 1). Traps were operated by the Nez Perce Tribe, Shoshone-Bannock Tribe, and the Idaho Department of Fish and Game.

Interrogation at Dams

During spring and summer 2000, surviving chinook salmon PIT tagged for this study migrated volitionally downstream through hydroelectric dams on the Snake and Columbia Rivers. Of the eight dams the smolts passed, the following six were equipped with smolt collection and/or PIT-tag interrogation systems: Lower Granite, Little Goose, and Lower Monumental Dams on the Snake River (Fig. 1), and McNary, John Day, and Bonneville Dams on the Columbia River.

At these six 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 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 the mainframe computer operated by the Pacific States Marine Fisheries Commission in Portland, Oregon.

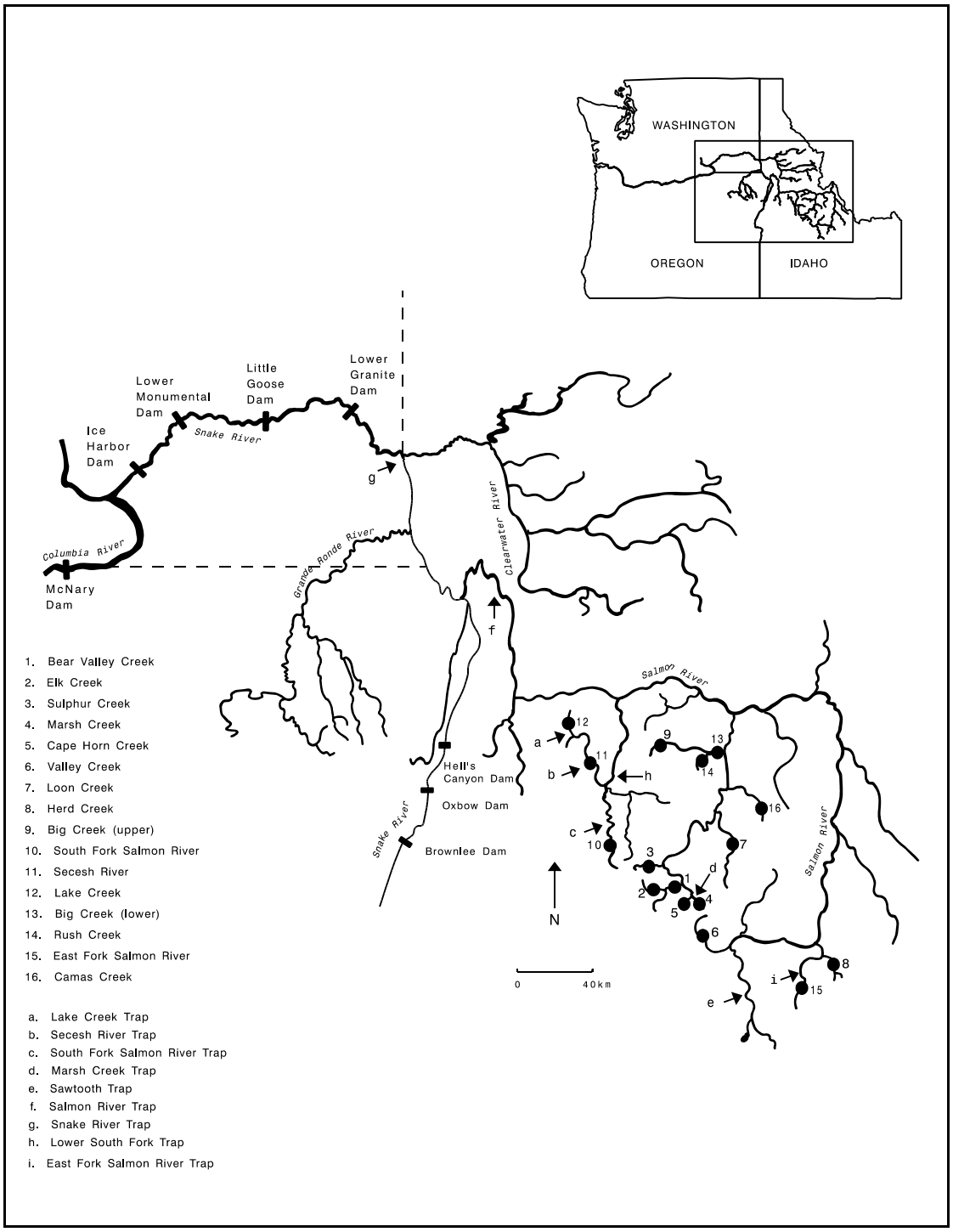


Figure 1. Locations where wild spring/summer chinook salmon parr were PIT tagged during 1999. Map includes juvenile salmonid migrant fish traps and four of six PIT-tag interrogation dams. The two interrogation dams not shown, John Day Dam and Bonneville Dam, are on the Columbia River below McNary Dam.

Migration Timing

During the years of spill from 1993 to 1997, migration timing at each interrogation dam was analyzed based on first-time detection numbers expanded relative to the proportion of daily spill (Achord et al. 1995a,b; 1996b, 1997, 1998). This produced a spill-adjusted or indexed number of PIT-tagged fish passing each dam daily for individual or combined populations. Since 1998, within-season migration timing at Lower Granite Dam has been based on daily detection numbers expanded relative to estimated daily detection probabilities. Detection probabilities were calculated using the methods of Sandford and Smith (In press) to provide an estimate of the number of PIT-tagged wild spring/summer chinook salmon smolts that passed the dam each day. At interrogation dams below Lower Granite Dam, migration timing was based simply on first-time detections (without adjustments).

Migration timing at all dams was calculated by totaling the number of detections in 3-day intervals and dividing by total detections during the season (expanded numbers were used only for detections at Lower Granite Dam). This method was applied to detection data for fish from individual and combined streams. Migration timing at Lower Granite Dam was calculated for smolts from individual streams in Idaho and Oregon, while migration timing at all interrogation dams was calculated for smolts from all Idaho streams combined at all interrogation dams except John Day and Bonneville Dams.

There was no straightforward way to compare within-season passage timing dates among stocks from different streams to discern statistically significant differences in arrival timing at Lower Granite Dam. Therefore, we used an approach analogous to analysis of variance with multiple comparisons between the 10th, 50th (median), and 90th percentile passage dates at the dam. 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 all 19 streams. The Student-Newmann-Keuls (SNK), multiple comparison method ($\alpha = 0.05$) was used to make comparisons between streams for each statistic (Petersen 1985).

Environmental Information

Environmental data was collected from monitoring systems at the following locations: 1) in Marsh Creek, 2) in Valley Creek, 3) near Sawtooth Hatchery in the upper Salmon River, 4) in the South Fork of the Salmon River by Knox Bridge, and 5) near the Chinook Campground in the Secesh River. All monitoring systems except the system at Valley Creek were adjacent to juvenile migrant fish traps.

RESULTS

Fish Collection and Tagging

From 27 July to 29 August 1999, we collected 15,052 wild chinook salmon parr in Idaho over a distance of about 41 stream kilometers (Table 1; Appendix Table 1). Of these fish, 10,402 were PIT tagged and released back into the streams; the remainder were not tagged because of size, injury, precocious maturation, or because they were collected for genetic studies. Numbers released per stream ranged from 315 in Herd Creek to 1,010 in the South Fork of the Salmon River (Appendix Table 2). Fork lengths of tagged and released wild fish ranged from 52 to 105 mm (mean 63.9 mm) and weights ranged from 1.6 to 10.9 g (mean 3.9 g).

Other than chinook salmon parr, sculpin were the most abundant species observed during collection operations (Table 2). However, the records of these observations do not represent total abundances of fish in the areas of collection.

Mortality associated with collection and tagging procedures was low, and 24-hour tag loss was zero (Table 3; Appendix Table 3). Average collection mortality was 1.9%, and average tagging and 24-hour delayed mortality was 0.1%. The average overall observed mortality was 1.9%.

Detections at Traps

A total of 442 wild fish PIT-tagged in summer 1999 were recaptured above Lower Granite Dam from fall 1999 to summer 2000 (Table 4). Two were precocious males recaptured in Bear Valley and Herd Creeks in summer 2000. The remaining 440 were recaptured from the eight juvenile salmonid migrant traps, with 402 recaptured in fall 1999 and 38 recaptured in spring and summer 2000 (Table 4).

For fish recaptured during fall 1999, average growth rates between tagging and recapture ranged from 0.09 to 0.13 mm/day. For those captured from traps during spring and summer, average growth rates between tagging and recapture ranged from 0.07 to 0.15 mm/day.

Table 1. Summary of collection, PIT-tagging, and release of wild chinook salmon with average fork lengths and weights and approximate distances covered in streams of Idaho during July and August 1999.

Tagging location	Number collected	Number released	Average length of tagged fish (mm)	Average weight of tagged fish (g)	Kilometers covered in streams
Bear Valley Creek	1,198	837	62.1	3.3	4
Elk Creek	710	660	65.0	3.6	3
Sulphur Creek	876	838	60.4	3.3	2
Marsh Creek	777	554	66.2	4.0	2
Cape Horn Creek	1,107	423	60.6	3.0	3
Valley Creek	1,562	1,009	64.3	3.6	4
Loon Creek	940	719	62.8	3.7	2
Camas Creek	972	763	61.0	3.3	2
East Fork Salmon River	818	674	65.4	4.1	2
Herd Creek	324	315	70.5	5.1	2
Big Creek (upper)	864	701	64.9	3.9	5
South Fork Salmon River	2,371	1,010	61.8	3.3	2
Secesh River	1,316	907	65.1	4.0	3
Lake Creek	787	603	64.7	3.9	1
Big Creek (lower)/Rush Creek	430	389	74.0	5.7	4
Totals or averages	15,052	10,402	63.9	3.9	41

Table 2. Summary of species other than chinook salmon parr observed during collection operations in Idaho in July and August 1999.

Streams	Steelhead	Unidentified fry	Brook trout	Cutthroat trout	Bull trout	Sculpin	Dace	Sucker	Whitefish	Shiner
Bear Valley Creek	49	93	343	0	1	1,290	24	1	8	0
Elk Creek	15	26	427	0	5	1,184	10	0	31	0
Sulphur Creek	31	125	0	2	0	1,256	5	1	4	0
Marsh Creek	4	19	171	0	2	235	2	0	6	0
Cape Horn Creek	9	12	31	0	2	292	0	0	0	0
Valley Creek	57	49	188	0	0	1,021	236	13	12	0
E. Fork Salmon River	14	0	0	0	2	262	0	1	1	0
Loon Creek	180	393	0	3	1	420	0	0	2	0
Herd Creek	22	31	0	0	0	40	0	0	2	0
Camas Creek	141	299	0	0	3	0	0	0	2	0
Big Creek (upper)	19	52	307	0	8	915	0	0	0	0
S. Fork Salmon River	53	44	18	0	1	474	6	0	26	0
Secesh River	92	199	60	0	6	487	50	0	2	0
Lake Creek	25	41	30	0	14	474	0	0	30	0
Big Creek (lower)	235	536	0	5	3	411	92	0	2	0
Rush Creek	13	23	0	0	0	28	0	0	0	0
Totals	959	1,942	1,575	10	48	8,789	425	16	128	0

Table 3. Mortality and tag loss for wild chinook salmon parr collected and PIT tagged in Idaho in July and August 1999.

Tagging location	Mortality (%)				24-hour tag loss (%)
	Collection	Tagging	24-hour	Overall	
Bear Valley Creek	0.7	0.4	0.0	0.9	0.0
Elk Creek	1.1	0.0	0.0	1.1	0.0
Sulphur Creek	1.4	0.1	0.0	1.5	0.0
Marsh Creek	1.2	0.0	0.0	1.2	0.0
Cape Horn Creek	0.5	0.5	0.0	0.7	0.0
Valley Creek	1.9	0.0	0.0	1.9	0.0
Loon Creek	3.1	0.1	0.0	3.2	0.0
Camas Creek	2.9	0.1	0.0	3.0	0.0
East Fork Salmon River	6.4	0.1	0.0	6.5	0.0
Herd Creek	2.5	0.0	0.0	2.5	0.0
Big Creek (upper)	0.8	0.0	0.0	0.8	0.0
South Fork Salmon River	0.9	0.0	0.0	0.9	0.0
Secesh River	1.2	0.0	0.0	1.2	0.0
Lake Creek	3.0	0.2	0.0	3.2	0.0
Big Creek (lower)/Rush Creek	5.6	0.0	0.0	5.6	0.0
Totals or averages	1.9	0.1	0.0	1.9	0.0

Table 4. Recapture information on PIT-tagged wild fish that were tagged in summer 1999 and recaptured at eight juvenile migrant fish traps and two streams in Idaho, from fall 1999 to summer 2000.

Recapture site	Number recaptured	Length gain (mm)		Recapture interval (days)	
		range	average	range	average
Fall 1999					
Lake Creek Trap	159	0-20	5	1-70	38
Lower S. F. Salmon River Trap	9	2-9	5	40-71	55
Marsh Creek Trap	5	0-5	3	7-65	33
Secesh River Trap	149	0-14	4	1-70	33
S. F. Salmon River Trap (Knox)	80	0-13	2	1-58	22
Total for fall 1999	402				
Spring/summer 2000					
Bear Valley Creek	1	-------	52	-------	378
Herd Creek	1	-------	64	-------	372
Lake Creek Trap	4	10-42	26	244-360	299
Marsh Creek Trap	3	15-30	21	236-245	241
East Fork Salmon River Trap	7	19-38	29	223-266	247
Salmon River Trap (Whitebird)	2	24-26	25	220-250	235
Secesh River Trap	5	32-62	49	346-370	361
S. F. Salmon River Trap (Knox)	9	6-48	18	200-403	240
Snake River Trap (Lewiston)	8	29-51	39	227-289	255
Total for spring/summer 2000	40				
Total	442				

Detections at Dams

Based on expanded detections at Lower Granite Dam from 12 April to 20 July 2000 (1,781 fish), survival from parr to smolt averaged 17.1% (range 11.3-35.5%; Table 5; Appendix Tables 4-18). An additional 848 first-time detections were recorded at the other 5 dams and by the PIT-tag detector trawl in the Columbia River estuary (Table 5; Appendix Tables 4-18) and were used for evaluations of migration timing. By comparing all first-time detections at interrogation dams (1,432) to the expanded number of detections at Lower Granite Dam (1,781), we estimated that 19.6% of the wild fish from Idaho passed through the hydropower system undetected.

For parr tagged in Idaho, average fork length at release was 63.9 mm. However, of fish from this group that were detected the following spring at the dams, average fork length at release was 65.4 mm. These length differences were significant (chi-square, $P = 0.000$). The release-length distribution of detected fish was also significantly different from that of released fish in all length categories except 75-79 mm ($P < 0.021$; Fig. 2).

We also found a significant difference in fork lengths at time of release for fish that migrated through Lower Granite Dam in April compared to fish that migrated after May ($P = 0.000$). However, no significant differences in fork length at time of release were observed between fish that migrated through the dam in May and those that passed after May ($P = 0.072$). Fish migrating through the dam in April and May were on average 3.1 mm larger when released than fish migrating after May, and this difference was significant ($P < 0.004$). These data suggest that fish size may influence migration timing or overwintering location with respect to detection at the first dam.

Table 5. Summary of first-time detections of PIT-tagged wild spring/summer chinook salmon smolts from Idaho at six dams from April to July 2000. Expanded detections at Lower Granite Dam provide estimates of parr-to-smolt survival. Four additional first-time detections were recorded by the PIT-tag detector trawl in the Columbia River estuary.

	Detections												
	Lower Granite			Little Goose		Lower Monumental		McNary		John Day		Bonneville	
		Expanded											
Stream	Detected	N	%	N	%	N	%	N	%	N	%	N	%
Bear Valley Creek	44	137	16.4	46	5.5	11	1.3	2	0.2	3	0.4	4	0.5
Elk Creek	42	123	18.6	44	6.7	8	1.2	13	2.0	0	0.0	6	0.9
Sulphur Creek	52	152	18.1	54	6.4	11	1.3	15	1.8	5	0.6	4	0.5
Marsh Creek	23	68	12.3	23	4.2	14	2.5	5	0.9	1	0.2	2	0.4
Cape Horn Creek	17	59	13.9	16	3.8	7	1.7	5	1.2	0	0.0	2	0.5
Valley Creek	51	150	14.9	29	2.9	10	1.0	5	0.5	2	0.2	2	0.2
East Fork Salmon River	35	101	15.0	33	4.9	5	0.7	4	0.6	1	0.1	1	0.1
Loon Creek	47	140	19.5	52	7.2	9	1.3	14	1.9	2	0.3	6	0.8
Herd Creek	23	66	21.0	16	5.1	5	1.6	6	1.9	0	0.0	1	0.3
Camas Creek	53	179	23.5	38	5.0	14	1.8	12	1.6	1	0.1	5	0.7
Big Creek (upper)	44	145	20.7	31	4.4	2	0.3	15	2.1	0	0.0	3	0.4
South Fork Salmon River	39	114	11.3	23	2.3	9	0.9	12	1.2	0	0.0	1	0.1
Secesh River	40	117	12.9	43	4.7	14	1.5	13	1.4	5	0.6	1	0.1
Lake Creek	30	92	15.3	26	4.3	7	1.2	7	1.2	1	0.2	1	0.2
Big Creek (lower)/Rush Creek	48	138	35.5	35	9.0	8	2.1	8	2.1	1	0.3	4	1.0
Totals or averages	588	1,781	17.1	509	4.9	134	1.3	136	1.3	22	0.2	43	0.4

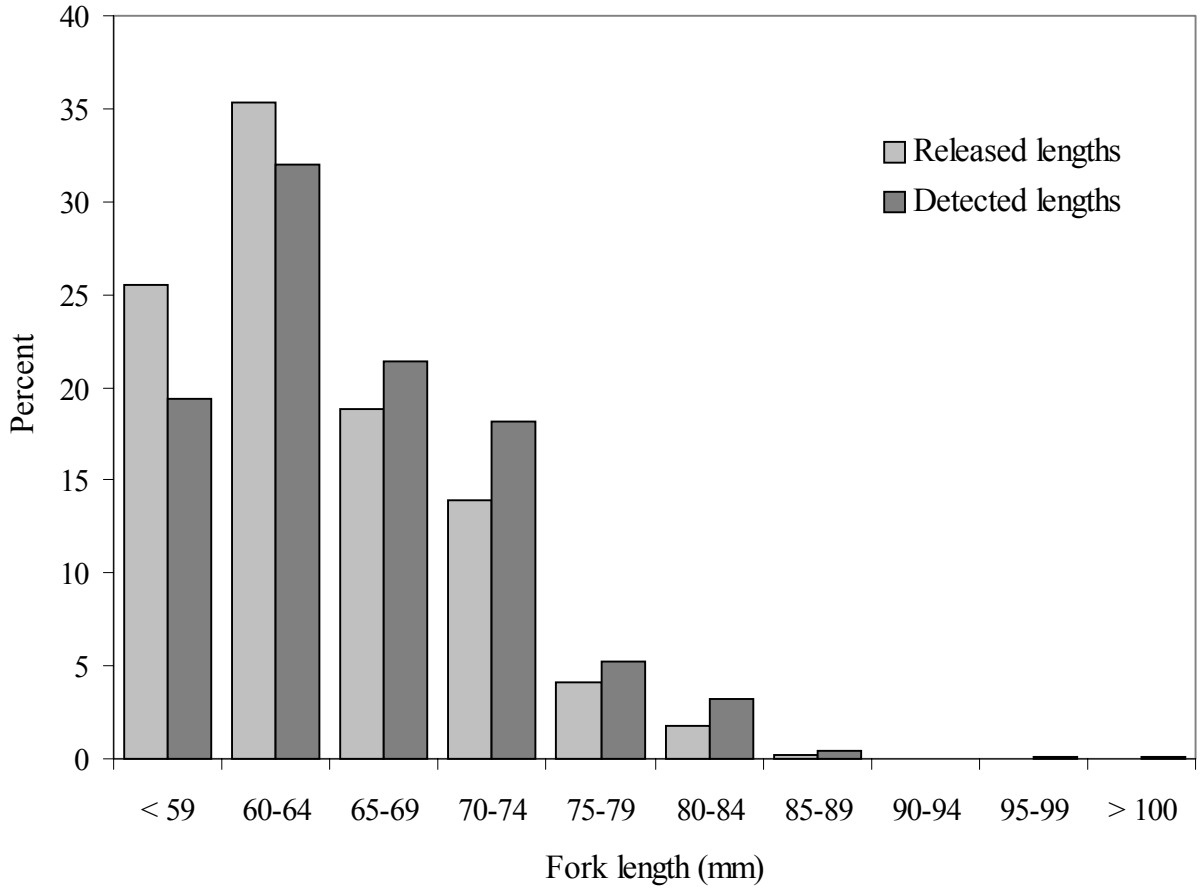


Figure 2. Percent by fork length increments, of PIT-tagged wild spring/summer chinook salmon parr released in Idaho streams in 1999 and percent of fish detected for these length increments at Lower Granite, Little Goose, Lower Monumental, McNary, John Day, and Bonneville Dams in spring and summer 2000.

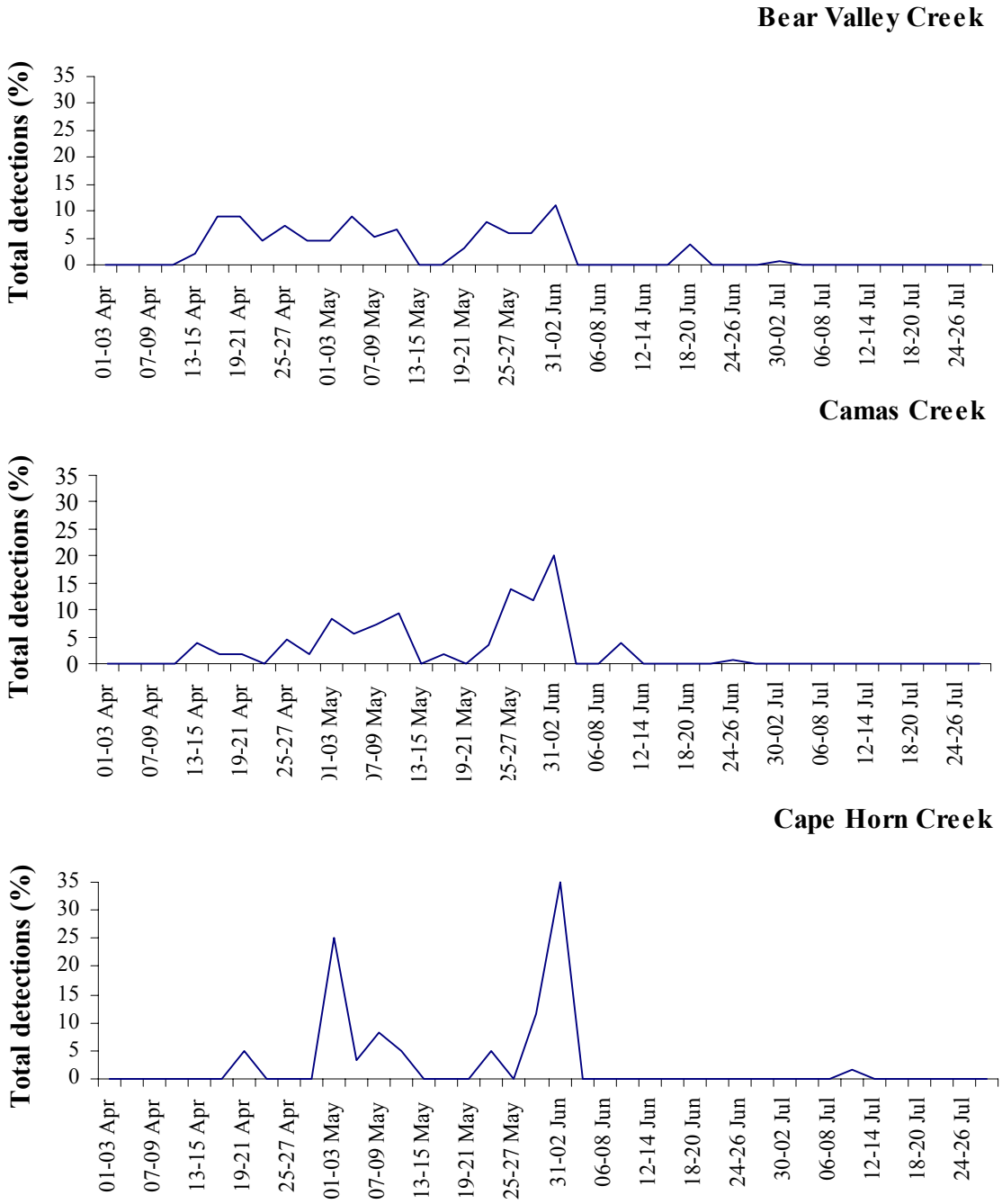


Figure 3. The migration timing (expanded by estimated detection probabilities) at Lower Granite Dam in 2000 of wild spring/summer chinook salmon smolts from individual streams in Idaho and Oregon PIT tagged during summer 1999.

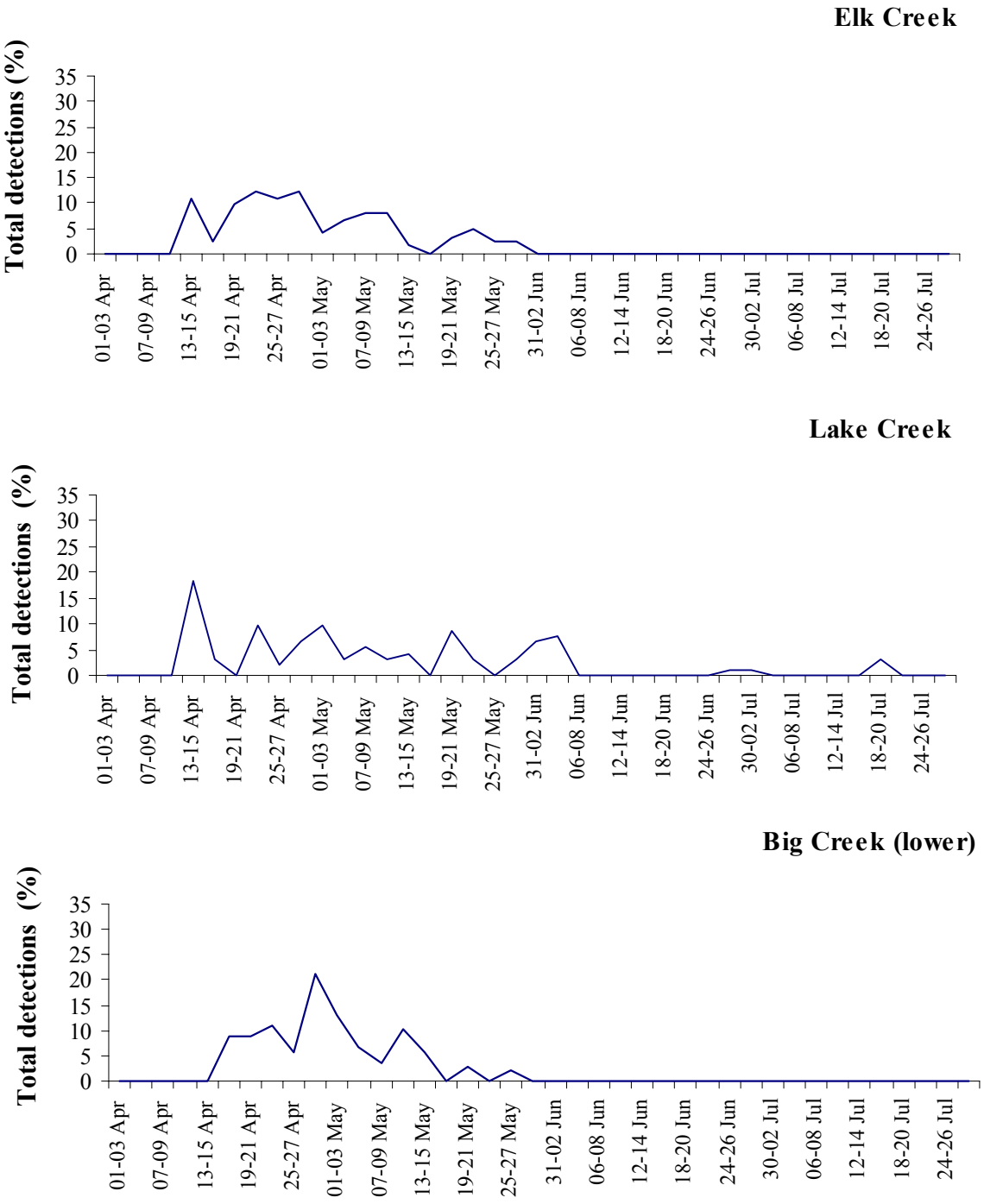
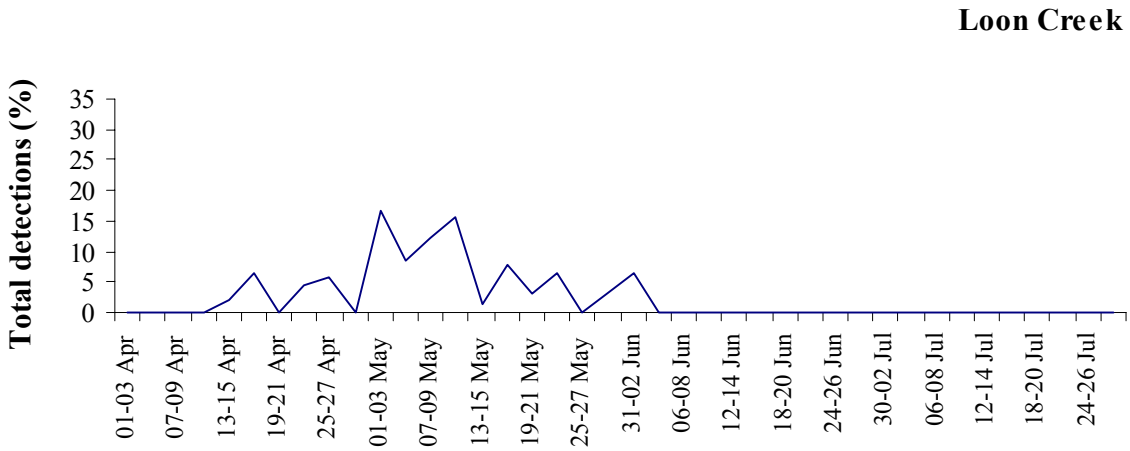
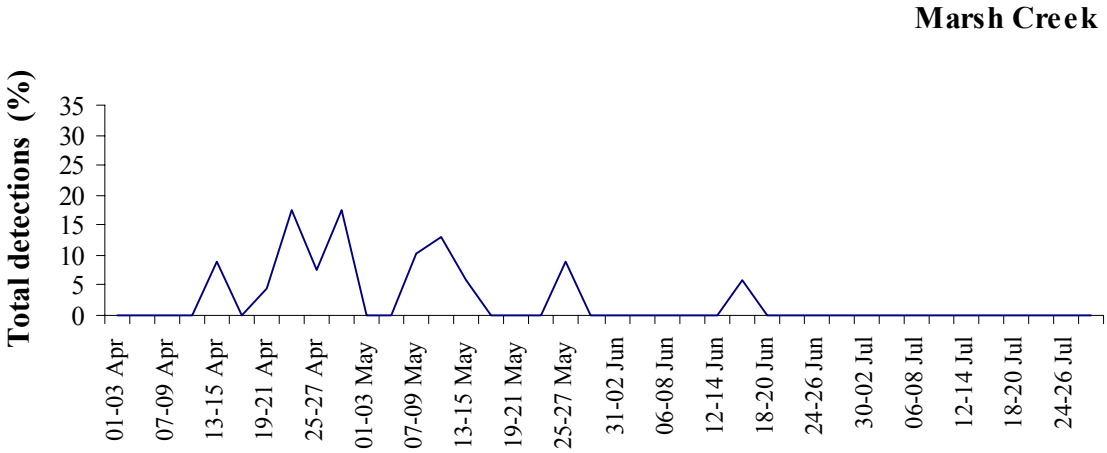


Figure 3. Continued.





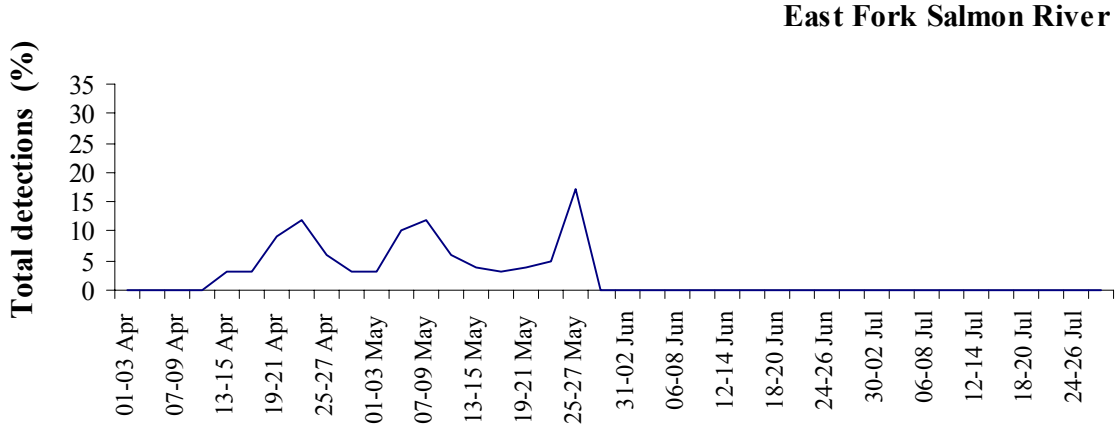


Figure 3. Continued.

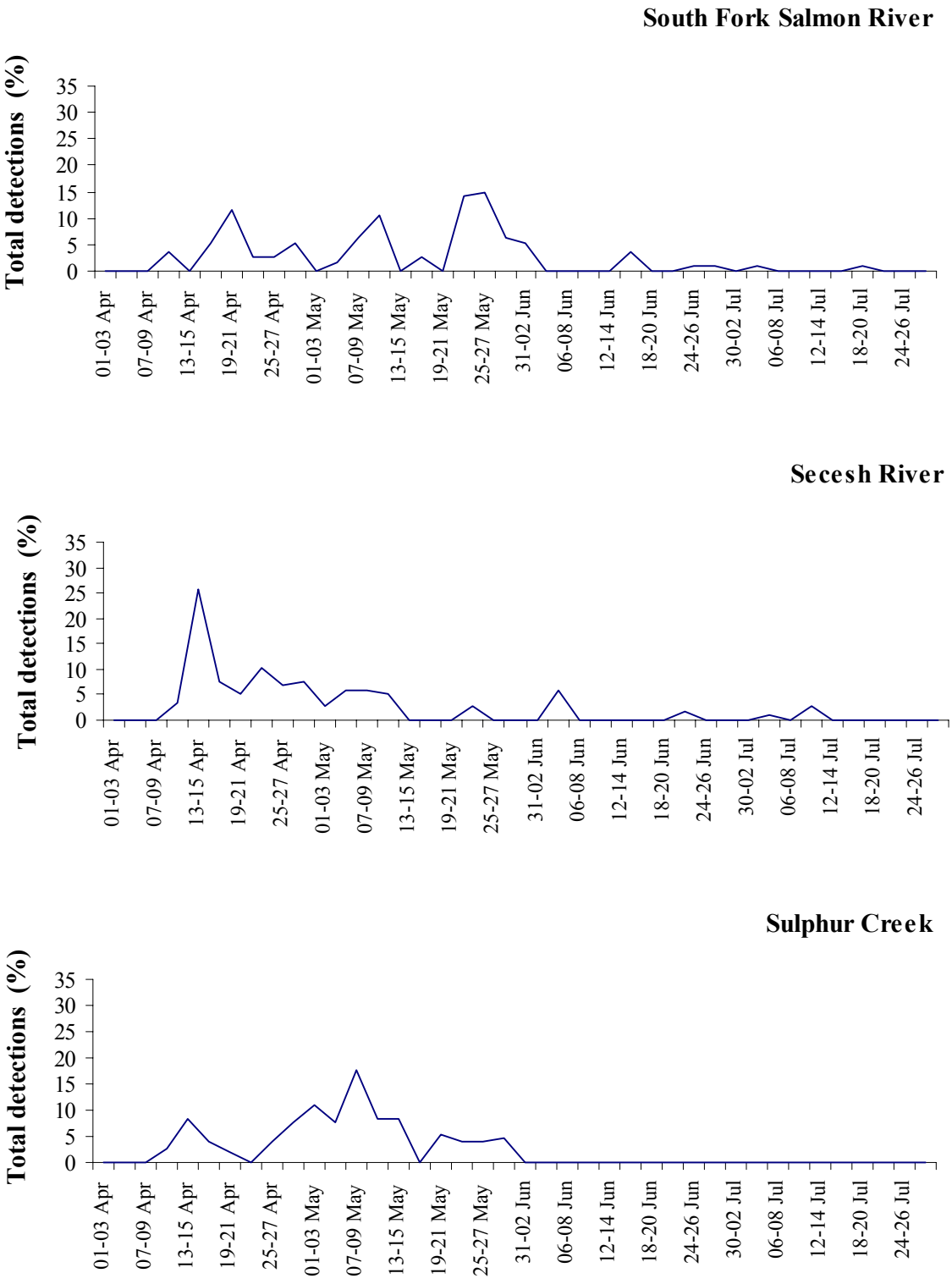


Figure 3. Continued.

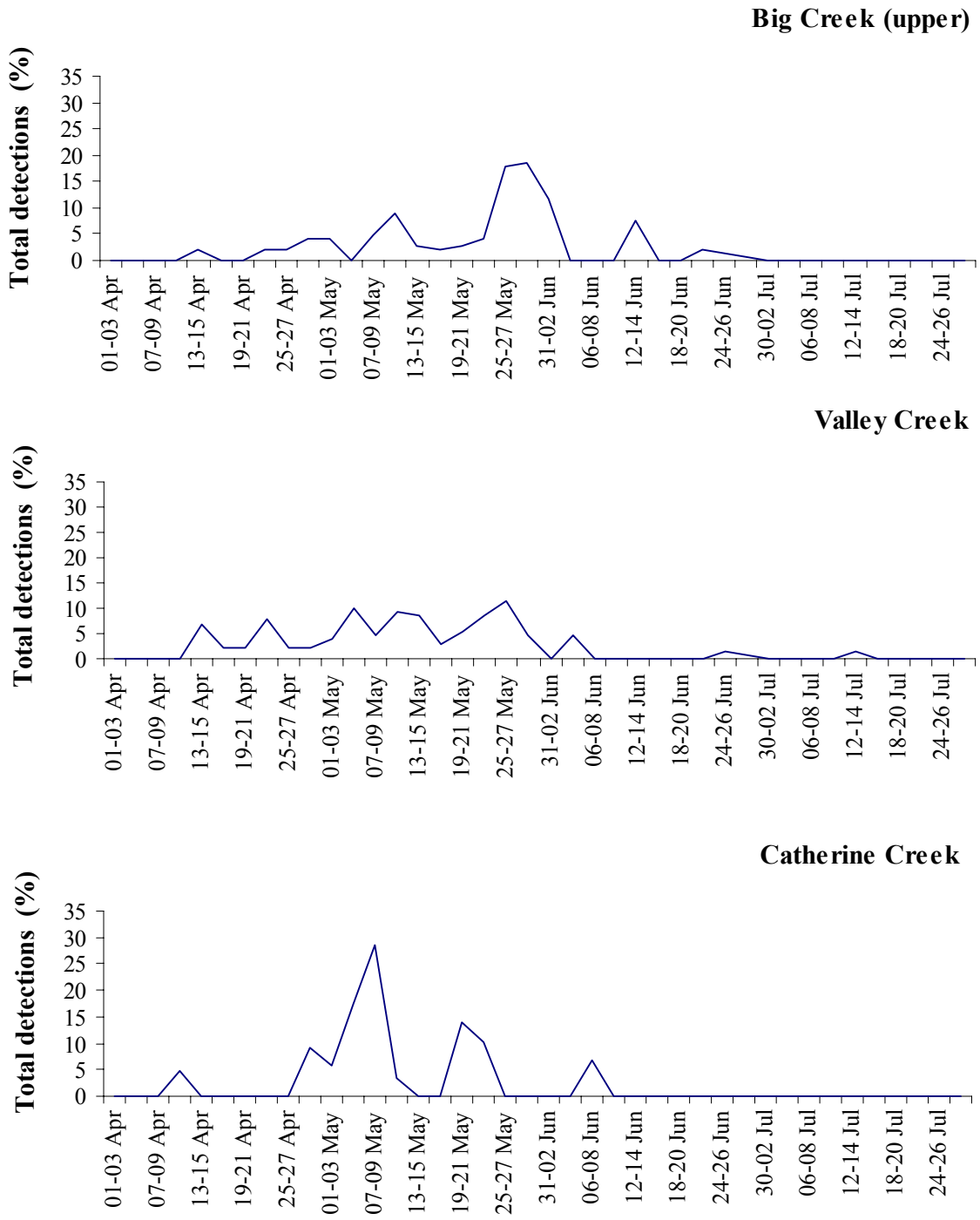


Figure 3. Continued.

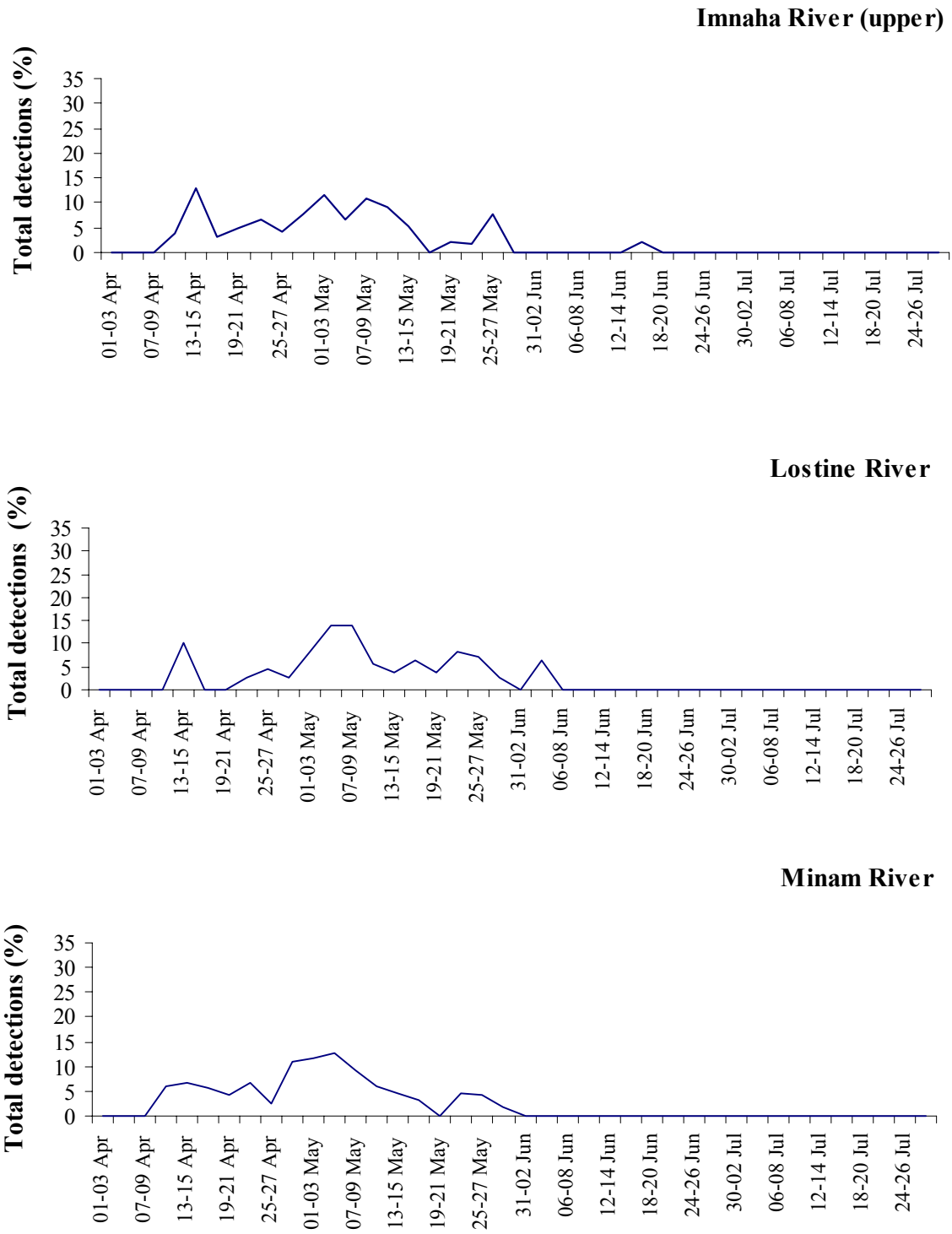


Figure 3. Continued.

Migration Timing

Lower Granite Dam

In comparisons among all 19 streams in which parr were tagged in summer 1999 (Tables 6a-6b), fish from the Secesh River, Lake Creek, and Lostine River arrived earlier at Lower Granite Dam than fish from all other streams. Fish from these 3 streams had significantly earlier timing for 10th percentile passage than fish from South Fork Salmon River, Marsh Creek, East Fork Salmon River, Loon Creek, Camas Creek, Catherine Creek, Big Creek (upper), and Cape Horn Creek ($P < 0.05$). However, the 10th percentile passage dates of fish from the remaining 8 streams were not significantly different from those of either the 3 early-arriving or the 8 later-arriving streams listed above. The overall 10th percentile passage distributions for fish from all 19 streams ranged from 13 April to 1 May (Tables 6a-6b).

Fish from the Secesh River had significantly earlier 50th percentile passage time at the dam than all other Idaho and Oregon streams except Herd Creek, Elk Creek, and Marsh Creek ($P < 0.05$). The overall 50th percentile passage distributions for fish from all 19 streams ranged from 23 April to 27 May (Tables 6a-6b).

Fish from Big (lower)/Rush Creek had a significant earlier 90th percentile passage at the dam than fish from Valley Creek, South Fork Salmon River, Cape Horn Creek, Bear Valley Creek, Camas Creek, Secesh River, Lake Creek, and Big Creek (upper) ($P < 0.05$). Fish from the other 10 streams had intermediate (non-significant) timing for the 90th percentile passage distributions ($P > 0.05$). The overall 90th percentile passage distributions for fish from all 19 streams ranged from 13 May to 14 June (Tables 6a-6b).

The middle 80th percentile passage distributions were of significantly shorter duration (23-32 days) for fish from Catherine Creek, Big (lower)/Rush Creek, Cape Horn Creek, Herd Creek, and Loon Creek than for fish from Bear Valley Creek, Big Creek (upper), Lake Creek, and Secesh River (45-53 days; $P < 0.05$) (Tables 6a-6b). The middle 80th percentile passage distributions for fish from the other 10 streams ranged from 34 to 42 days.

Downstream Interrogation Dams

Timing of smolts from individual streams in Idaho is not presented here for Little Goose, Lower Monumental, McNary, John Day, or Bonneville Dams; see Appendix Tables 4-18 for this information.

Table 6a. Accumulated and 2000 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	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**
Elk Creek				
1990[b]	----------	----------	----------	----------
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**
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]	----------	----------	----------	----------
1997[a]	----------	----------	----------	----------
1998[a]	----------	----------	----------	----------
1999	24 April	19 May	27 May	22 April-29 May
2000	**15 April**	**07 May**	**24 May**	**12 April-30 May**

Table 6a. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
Cape Horn Creek				
1990[a]	----------	----------	----------	----------
1991	24 April	16 May	28 May	19 April-06 June
1992	12 April	28 April	30 May	10 April-01 June
1993	08 May	19 May	26 June	05 May-01 July
1994[a]	----------	----------	----------	----------
1995	29 April	14 May	19 June	14 April-28 July
1996[a]	----------	----------	----------	----------
1997[a]	----------	----------	----------	----------
1998[a]	----------	----------	----------	----------
1999	29 April	22 May	29 May	25 April-12 June
2000	**01 May**	**24 May**	**01 June**	**20 April-09 July**
Camas Creek				
1993	03 May	16 May	27 May	24 April-24 June
1994	30 April	15 May	26 May	24 April-11 July
1995	27 April	12 May	05 June	17 April-11 June
1996[a]	----------	----------	----------	----------
1997[a]	----------	----------	----------	----------
1998[a]	----------	----------	----------	----------
1999[a]	----------	----------	----------	----------
2000	**26 April**	**25 May**	**02 June**	**13 April-24 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
1996[a]	----------	----------	----------	----------
1997[a]	----------	----------	----------	----------
1998[a]	----------	----------	----------	----------
1999	21 April	01 May	25 May	11 April-13 June
2000	**21 April**	**28 April**	**27 May**	**14 April-16 June**
Valley Creek				
1989	24 April	14 May	12 June	09 April-17 June
1990	16 April	08 May	05 June	12 April-29 June
1991	11 May	20 May	20 June	21 April-13 July
1992	15 April	30 April	27 May	13 April-04 June

Table 6a. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
Valley Creek (Continued)				
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**
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**
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**
Herd Creek				
1992	14 April	20 April	10 May	13 April-18 May
1993	26 April	30 April	18 May	26 April-31 May
1994[b]	----------	----------	----------	----------
1995	18 April	03 May	14 May	11 April-28 May
1996[a]	----------	----------	----------	----------

Table 6a. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
Herd Creek (Continued)				
1997[a]	----------	----------	----------	----------
1998[a]	----------	----------	----------	----------
1999	20 April	29 April	10 May	30 March-20 May
2000	**16 April**	**25 April**	**18 May**	**14 April-19 May**
South Fork Salmon River				
1989	25 April	13 May	14 June	16 April-20 June
1990[a]	----------	----------	----------	----------
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**
Big Creek (upper)				
1990	27 April	30 May	22 June	17 April-18 July
1991	18 May	10 June	26 June	26 April-01 July
1992	22 April	08 May	03 June	15 April-26 June
1993	08 May	18 May	26 May	26 April-15 June
1994	03 May	19 May	19 July	25 April-30 August
1995	05 May	23 May	09 June	02 May-26 June
1996[a]	----------	----------	----------	----------
1997[a]	----------	----------	----------	----------
1998[a]	----------	----------	----------	----------
1999	28 April	14 May	03 June	25 April-19 June
2000	**30 April**	**27 May**	**14 June**	**15 April-29 June**
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**

Table 6a. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
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]	----------	----------	----------	----------
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**
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**

[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.

Table 6b. Accumulated and 2000 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**
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]	----------	----------	----------	----------
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]	----------	----------	----------	----------
1997[b]	----------	----------	----------	----------
1998[b]	----------	----------	----------	----------
1999[b]	----------	----------	----------	----------
2000[b]	----------	----------	----------	----------

Table 6b. 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**
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-3 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**

[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.

Comparison with Flows

We combined all detections of wild fish from Idaho streams at each of four interrogation dams and compared the timing at each dam with river flows during the same periods (Fig. 4). Overall, passage occurred between early April and late July at Lower Granite Dam, with the middle 80% passage occurring from mid-April to late-May (Table 7). The peak passage date was 11 May, which coincided with low-to-moderate flows (82 kcfs) but not with peak flows at the dam (Appendix Table 19).

The middle 80% passage of wild fish at Little Goose, Lower Monumental, and McNary Dams occurred between late April and early June (Table 7). Peak passage periods for fish at Little Goose, Lower Monumental, and McNary Dams coincided with medium-to-high river flows on various dates throughout April and May (Fig. 4 and Appendix Tables 20-22). Passage distributions for fish at John Day and Bonneville Dams are presented in Table 7 and Appendix Tables 4-18; however, too few wild fish were detected at these dams to make meaningful comparisons with flow or other variables.

Environmental Information

In 2000, we collected measurements of temperature, dissolved oxygen, specific conductance, turbidity, depth, and pH from 5 environmental monitoring stations in the Salmon River Basin. We maintained a web site where this data, as well as data from previous years, are made available through the Baseline Environmental Monitoring Program (Perkins 1998).

Data collected during 1999-2000 are presented in Appendix Figures 1-6, which compare various water quality parameters to chinook salmon fry, parr, and smolt movements through adjacent traps (Fig. 1) in 1999-2000. Appendix Tables 23-27 provide a summary of environmental information collected from the five environmental monitoring sites (Marsh Creek, Valley Creek, Sawtooth Hatchery, Knox Bridge, and Secesh River) from August 1999 to July 2000.

Appendix Table 28 provides a summary of flow information at five USGS sites in the Salmon River drainage from August 1999 to July 2000.

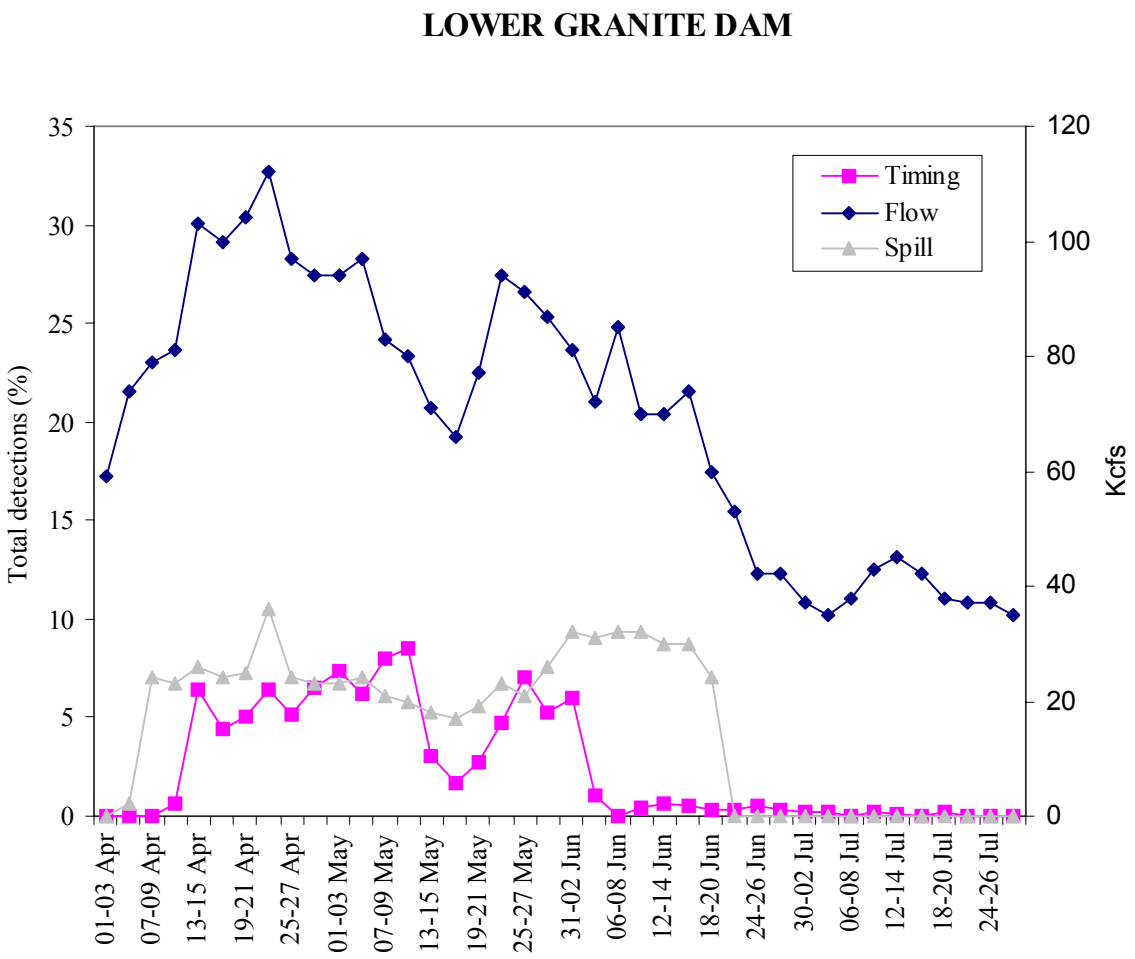


Figure 4. The overall migration timing of PIT-tagged wild spring/summer chinook salmon smolts at Lower Granite, Little Goose, Lower Monumental, and McNary Dams in 2000, with associated river flows and spill at these dams. Data represent detections from 15 Idaho streams combined by 3-day intervals and average river flows and spill at the dams over the same time periods. Detections were expanded by estimated daily detection probabilities at Lower Granite Dam only.

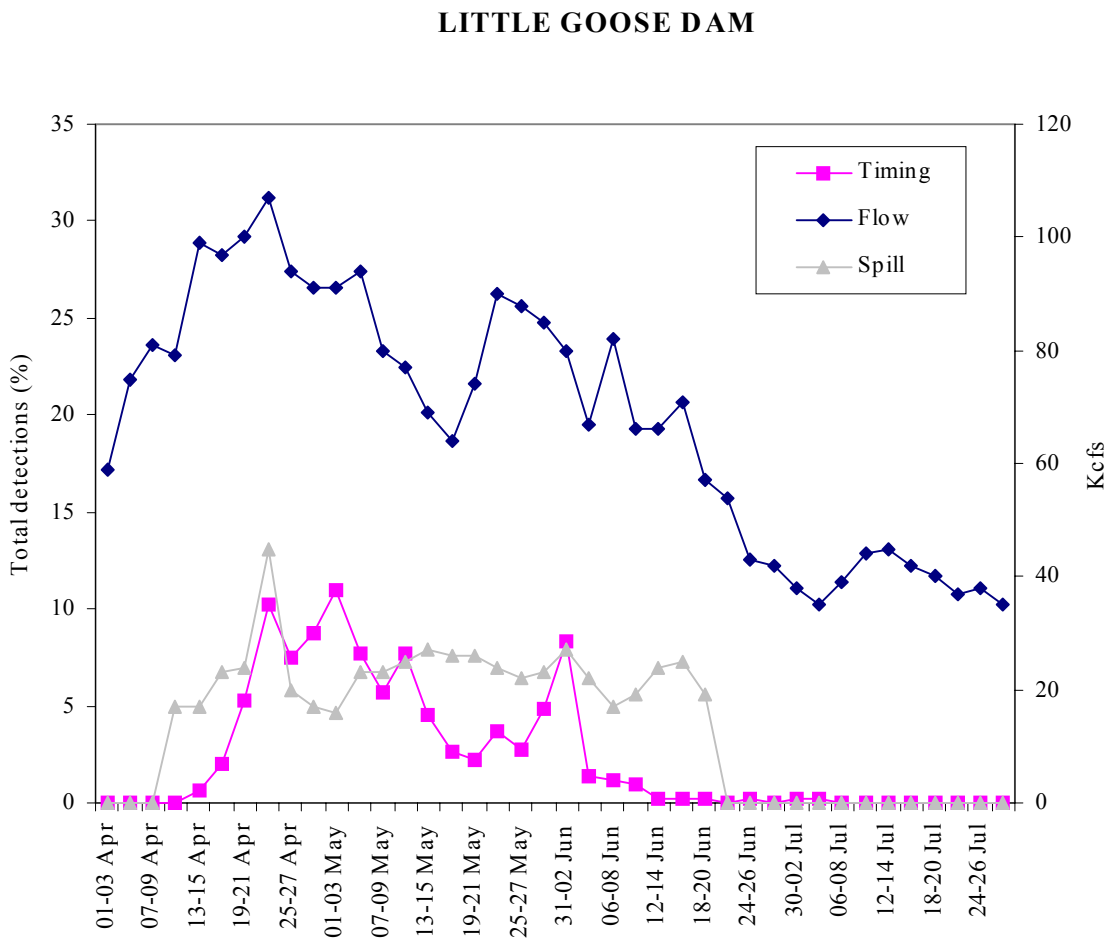


Figure 4. Continued.

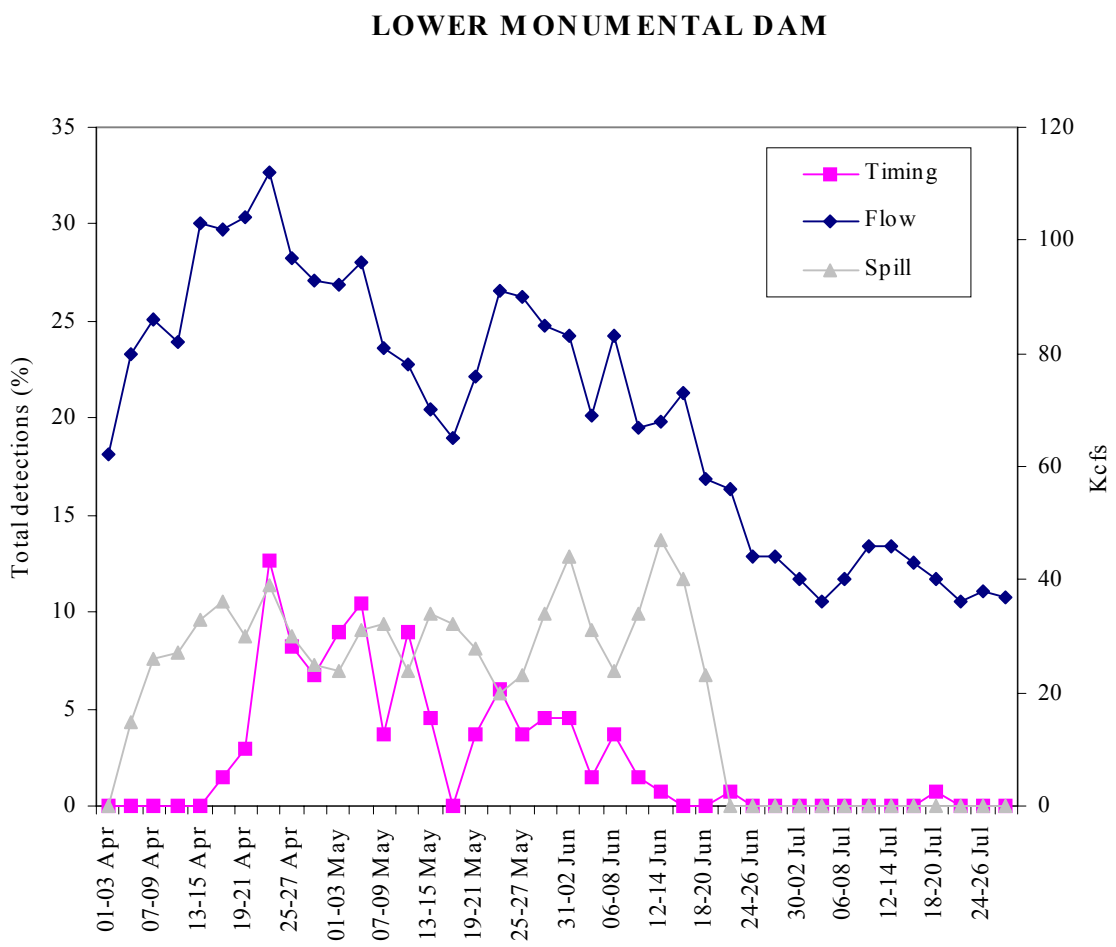


Figure 4. Continued.

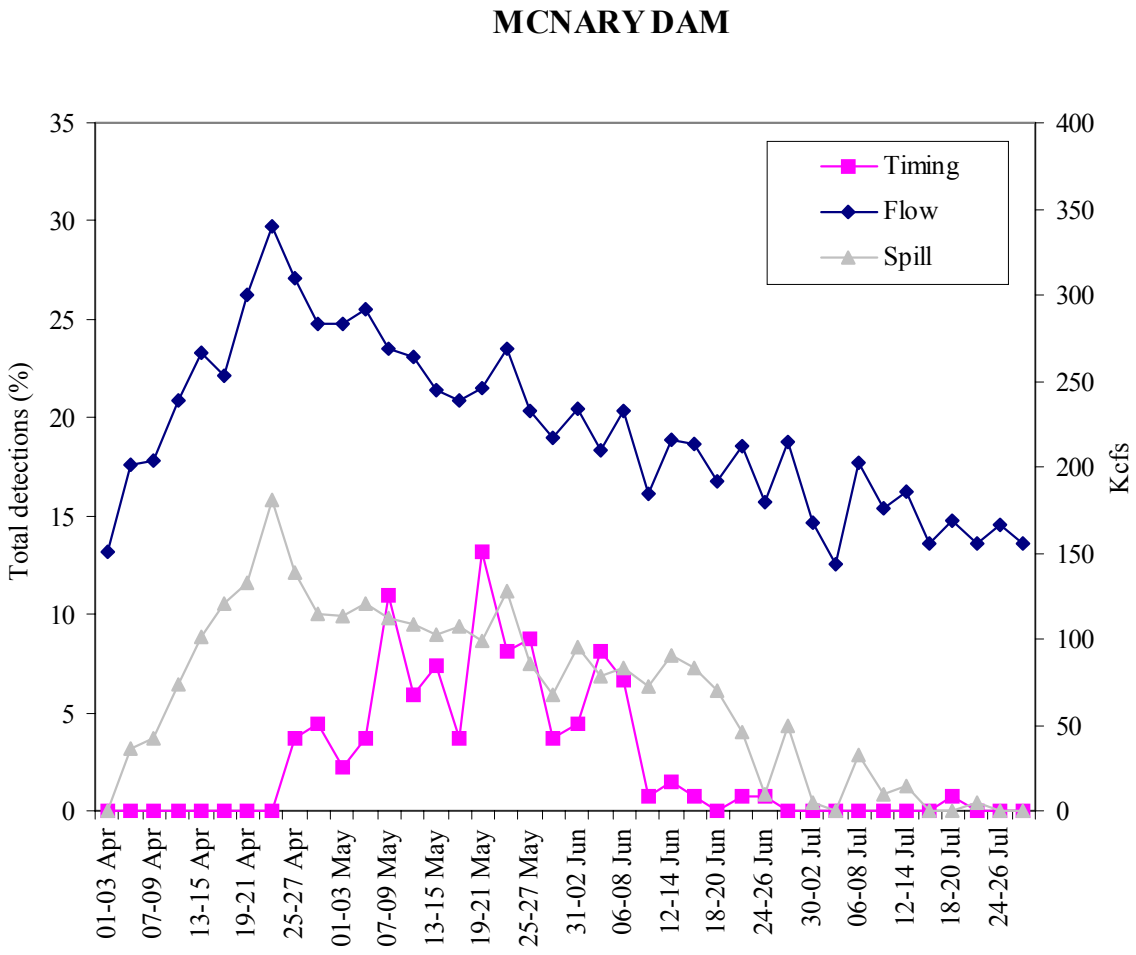


Figure 4. Continued.

Table 7. Passage dates at Lower Granite (expanded), Little Goose, Lower Monumental, McNary, John Day, and Bonneville Dams for combined populations of PIT-tagged wild spring/summer chinook salmon smolts from 15 streams in Idaho in 2000.

	Percentile passage dates at dams			
Site	10%	50%	90%	Range
Lower Granite Dam	17 April	07 May	31 May	12 April-20 July
Little Goose Dam	22 April	05 May	31 May	13 April-04 July
Lower Monumental Dam	24 April	06 May	31 May	16 April-20 July
McNary Dam	03 May	20 May	07 June	25 April-18 July
John Day Dam	01 May	09 May	04 June	28 April-07 June
Bonneville Dam	11 May	24 May	07 June	05 May-27 June

DISCUSSION

Mortality rates associated with collection and tagging in 1999 were comparable to those in earlier years (Achord et al. 1992; 1994; 1995a,b; 1996a,b; 1997; 1998; 2000, 2001).

Of the 80 wild fish tagged and released in summer 1999 at the South Fork of the Salmon River and detected in fall at the Knox Bridge trap, 12 (15.0%) were detected in spring 2000 at the dams. This detection rate was 80.7% higher than the detection rate (non adjusted) for all other fish tagged and released in summer 1999 at the South Fork Salmon River (8.3%). This detection rate was similar to that observed in 1998 and 1999 for fish trapped at Knox Bridge, when detections were 83.2 and 107.3% higher, respectively, for these fish than for all South Fork of the Salmon River fish. From 1995 to 1997, too few summer-tagged fish (15-38) were detected at the trap to provide meaningful comparisons.

We observe a similar trend emerging in fish detected at the Lake Creek trap: 34 of the 159 wild fish tagged and released in summer 1999 at Lake Creek, and subsequently detected in the fall at the trap on Lake Creek, were detected at the dams. When we compare this 21.4% detection rate to the overall detection rate at the dams for all fish tagged at Lake Creek that summer, (11.9%), we see a detection rate 79.8% higher for fish seen at the trap. Again, this higher rate was similar to that observed during the 1999 migration, when fish seen at the Lake Creek trap were detected at a rate 69.7% higher than the rate of all fish tagged in summer 1998 at Lake Creek.

Further comparisons between detection rates at Lower Granite Dam for fish seen at traps versus all fish tagged in summer from a given stream were not made due to the low numbers monitored at other traps. However, these higher detection rates at the dams for PIT-tagged fish previously detected at traps in the fall may provide important insights for the study of wild fish migration characteristics. For example, they may indicate a higher survival rate for known fall migrants and/or may indicate significant mortality in the stream from summer to fall.

The average time between tagging and recapture for fish captured at the Knox Bridge and Lake Creek traps ranged from 19 to 38 days during 1998 and 1999. Fish captured in fall of 1998 and 1999 at the Lake Creek trap were an average of 1.3 and 1.8 mm larger (respectively) at release than all fish tagged in Lake Creek the previous summer. However, in both of these years, fish from the South Fork of the Salmon River were the same average length at release as fish detected at the Knox Bridge trap on the South Fork Salmon River in the fall. This implies that at least in the South Fork Salmon River, size at tagging had little, if any, effect on mortality after release.

Length-distribution curves for data collected over the last 12 years have generally shown that wild fish released and subsequently detected at dams are slightly larger at release than fish that are released but not detected. The reason for this difference in detection rates is unknown, but it appears that larger fish survived slightly better and/or were guided slightly better into the collection systems at the dams than smaller fish.

However, we found no evidence of a relationship between detection and size in fish captured at the Marsh Creek trap in 1994 or at the Knox Bridge trap in the South Fork of the Salmon River in 1997, 1998, and 1999. If these fish were representative of wild fish from these streams, then survival within the first 3 months after tagging was not size specific.

Another consistent trend that has emerged over the years is the difference in arrival timing at the dams with respect to size at release. In 2000, we again observed that wild fish detected at the dams 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.

Relationships with Flow

In 2000, peak detections at Lower Granite Dam of wild fish from 19 Idaho and Oregon streams coincided with low-to-moderate flow of 82 kcfs on 11 May. Moderately high flows in mid-April coincided with increasing wild fish detections; however, peak flows did not coincide with peak detections later in April (Fig. 5). As observed at Lower Granite Dam from 1989 through 1999, peak detections of wild spring/summer chinook salmon smolts from Idaho and Oregon were highly variable and generally independent of river flows before about 9 May. However, in every year except 2000, peak detections of wild fish from 9 to 31 May coincided with periods of peak flow. Raymond (1979) showed that peaks in migration for the composite population of spring and summer chinook salmon smolts (mostly wild) passing Ice Harbor Dam from 1964 to 1969 preceded periods of maximum river discharge in most years. During these years, fish passage peaked between 26 April and 13 May. With respect to river flows, our observations matched those of Raymond for wild fish migrating before mid-May.

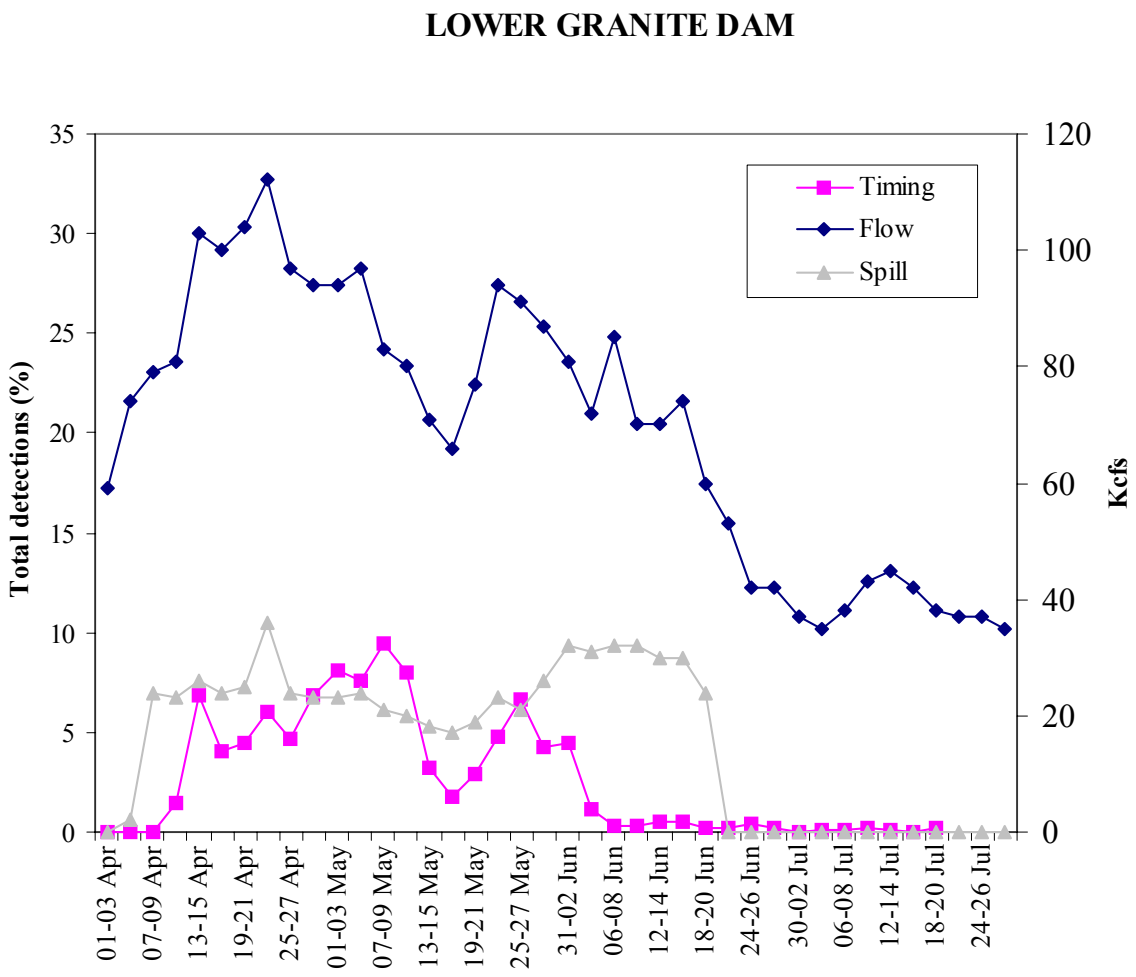


Figure 5. Overall migration timing of PIT-tagged wild spring/summer chinook salmon smolts with associated river flows and spill at Lower Granite Dam, 2000. Daily detections from 15 Idaho and 4 Oregon streams were pooled in 3-day intervals and expanded based on daily detection probability (Sandford and Smith in press). River flows and spill at the dam were averaged daily over the same periods.

Climatic Influence

Annual overall climatic variation is emerging as an important factor controlling the overall migrational timing and passage dynamics of wild spring/summer chinook salmon smolts at Lower Granite Dam. In the warm years of 1990, 1992, 1994, and 1998, the median passage date at the dam was between 29 April and 4 May, and 90% of all wild fish passed by the end of May. In the cold years of 1989, 1991, and 1993, median passage did not occur until mid-May, and the 90th percentile had not passed until mid-June (except during high flows in 1993, when the 90th percentile passed by the end of May).

Within these 7 years, we saw a consistent 2- to 3-week shift in timing of wild fish at the dam between relatively warm and relatively cold years. In 1995, intermediate weather conditions prevailed in late winter and early spring (compared to the previous 6 years), and we observed intermediate passage times of 9 May and 5 June for the 50 and 90% passage dates, respectively, for these combined wild populations.

In 1999, we experienced different climatic conditions than in all previous migration years. In late winter, a near-record snow pack in the Snake River Basin resulted in high flows early in the migration period (during late March); however, the ensuing flows were moderated by very dry and cold conditions during the remaining spring and early summer. Fluctuating, medium-to-high flows throughout the spring moved the wild fish through Lower Granite Dam as observed in warmer years, with 50% passing by 3 May and 90% passing by 28 May (Achord et al. 2001). Flow during 2000 was slightly below normal, with highest flows occurring in April, along with more seasonal temperatures and climatic conditions throughout the spring. Consequently, we observed a wild fish migration pattern similar to a warm year, with 50% passing by 6 May and 90% passing by 29 May.

The migration timing of individual wild stocks has been highly variable and usually protracted at Lower Granite Dam. However, migration-timing patterns emerging for some stocks range from early to late spring. Shifts in timing of passage distribution for these stocks have been less than 1 to 5 weeks over all years, and these shifts appear directly related to annual climatic conditions.

Cumulative Data: 1989-2000

An important objective of this study is to examine the migration timing at Lower Granite Dam of individual stocks over a period of years to determine similarities or differences between years and between stocks. We now have at least 9 years of migration-timing data for fish from 6 of the study streams, and this allowed us to construct 95% confidence intervals for the 10th, 50th, and 90th percentile passage dates at Lower Granite Dam for fish from these streams (Table 8).

Comparisons of the 10th, 50th, and 90th percentile passage dates were made among these 6 streams using a two-factor analysis of variance (ANOVA). Year was considered a random factor and stream a fixed factor. Residuals were visually examined to assess normality. Treatment means were compared using Fisher's least significant difference procedure (Peterson 1985).

Results showed that Secesh River fish had a significantly earlier timing for the 10th percentile passage than fish from Bear Valley Creek, Valley Creek, or Catherine Creek ($P < 0.05$). The 10th percentile passage of fish from Secesh River was also earlier than those of fish from the Lostine or South Fork of the Salmon River, though the difference was not significant ($P > 0.05$). Secesh River fish also had significantly earlier arrival timing at the dam for the 50th percentile passage than fish from the other 5 streams ($P < 0.05$). However, for the 90th percentile passage, Lostine River fish had significantly earlier timing at the dam than fish from the other 5 streams.

We also examined the length of time that encompassed the middle 80th percentile passage as a measure of protracted or compressed timing characteristics for stocks from individual streams and from wild fish from all streams combined. The middle 80th percentile passage at Lower Granite Dam averaged 43 days (range 34 to 51 days) for fish from all 6 streams combined. Catherine Creek and Lostine River fish had a significantly shorter passage duration (middle 80%) at the dam (34 and 35 days, respectively) than fish from the other 4 streams (42-51 days; $P < 0.05$).

In examining chinook salmon smolt passage timing at the dams over the last 12 years, it has become clear that flow is only one of several factors that influence passage timing. Other factors, such as annual climatic conditions, water temperature, turbidity, physiological development, variability in stock behavior, fish size, and other yet unknown factors may equally affect wild smolt passage timing at dams.

Table 8. The 95% confidence interval passage dates at Lower Granite Dam for wild fish from 6 streams in Idaho and Oregon that have 9 or more years of migration timing data from 1989 to 2000.

	Passage periods at Lower Granite Dam				
Stream	10%	50%	90%	95% Confidence interval	Data years
Secesh River	11 April	22 April	24 May	lower bound	
	18 April	01 May	14 June	upper bound	12
	14 April	26 April	04 June	mean	
South Fork Salmon River	13 April	05 May	03 June	lower bound	
	24 April	15 May	15 June	upper bound	11
	19 April	10 May	09 June	mean	
Catherine Creek	22 April	09 May	25 May	lower bound	
	02 May	19 May	06 June	upper bound	10
	27 April	14 May	31 May	mean	
Bear Valley Creek	19 April	03 May	27 May	lower bound	
	28 April	14 May	11 June	upper bound	9
	23 April	09 May	04 June	mean	
Valley Creek	18 April	05 May	30 May	lower bound	
	01 May	20 May	19 June	upper bound	9
	25 April	13 May	09 June	mean	
Lostine River	10 April	30 April	15 May	lower bound	
	23 April	10 May	27 May	upper bound	9
	17 April	05 May	21 May	mean	

As additional environmental monitors and traps are 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, will provide tools for the accurate prediction of movement in different wild stocks. Such tools are vital to recovery planning for threatened or (ESA) endangered species of Pacific salmon.

Action 152 of the "Reasonable and Prudent Alternatives" in the 2000 NMFS Biological Opinion encourages cooperation between government agencies by sharing water quality and biological monitoring information, project reports, and data from existing programs and from subbasin or watershed assessment products (NMFS 2001). During 2000, we encouraged a cooperative spirit in all future data exchanges with agencies and tribes during ongoing studies in spawning and rearing areas. Such cooperation will serve to facilitate planning for recovery of the wild fish stocks.

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APPENDIX

Data Tables and Figures

Appendix Table 1. Summary of tagging dates, number collected, tagged, released, and minimum, maximum, and average lengths and weights of wild chinook salmon parr, PIT tagged in various Idaho streams in 1999.

Stream	Tagging dates	Number collected	Number tagged	Number released	Length		Weight	
					Range	Average	Range	Average
Bear Valley Creek	27-28 Jul	1,198	840	837	53-98	62.1	1.7-7.0	3.3
Elk Creek	29-30 Jul	710	660	660	54-105	65.0	1.7-7.4	3.6
Sulphur Creek	01-02 Aug	876	839	838	52-85	60.4	1.6-7.3	3.3
Marsh Creek	02 Aug	777	554	554	53-84	66.2	2.0-8.7	4.0
Cape Horn Creek	03 Aug	1,107	425	423	53-89	60.6	1.6-7.4	3.0
Valley Creek	04-05 Aug	1,562	1,009	1,009	53-94	64.3	1.8-10.1	3.6
Loon Creek	06-07 Aug	940	720	719	52-89	62.8	1.7-8.1	3.7
Camas Creek	09-10 Aug	972	764	763	52-77	61.0	1.9-7.0	3.3
East Fork Salmon River	09-10 Aug	818	675	674	54-87	65.4	2.1-9.3	4.1
Herd Creek	11 Aug	324	315	315	57-90	70.5	1.8-10.1	5.1
Big Creek (upper)	16-18 Aug	864	701	701	54-87	64.9	2.0-10.9	3.9
South Fork Salmon River	19-20 Aug	2,371	1,010	1,010	52-95	61.8	1.7-9.5	3.3
Secesh River	23-24 Aug	1,316	907	907	53-90	65.1	2.0-9.8	4.0
Lake Creek	25 Aug	787	604	603	54-92	64.7	2.2-8.5	3.9
Big Creek (lower)/Rush Creek	28-29 Aug	430	389	389	58-88	74.0	2.4-8.7	5.7
Totals or averages	---	15,052	10,412	10,402	52-105	63.9	1.6-10.9	3.9

Appendix Table 2. A summary of the tagging dates, start tagging times and temperatures (°C), release dates, times, and temperatures, method of capture, distance (in kilometers) from the stream's mouth to the release point, number released (in 1999), and number/percent of first-time detections (unadjusted) for each tag group at six downstream dams and the PIT- trawl in the Columbia River estuary during 2000.

Stream	Tag group	Tagging date	Tagging time	Release date	Release time	Tagging temperature	Release temperature	Capture method	Release river km	Number released	Number detected	Percent detected
Bear Valley Crk	SA99208.BV1	27 July	05:48	28 July	07:30	11.5	11.5	Shock	11	100	13	13.0
	SA99208.BV2	27 July	07:06	27 July	13:30	11.5	15.0	Shock	12	418	46	11.0
	SA99209.BV1	28 July	06:14	28 July	10:30	11.5	12.5	Shock	13	204	30	14.7
	SA99209.BV2	28 July	07:56	29 July	06:45	12.5	13.0	Shock	15	115	21	18.3
Elk Creek	SA99210.EC1	29 July	06:11	30 July	06:45	13.0	12.5	Seine	1	170	28	16.5
	SA99210.EC2	29 July	07:12	29 July	11:00	13.0	13.0	Seine	1	127	22	17.3
	SA99210.EC3	29 July	08:04	29 July	14:00	14.0	16.0	Shock	1	85	15	17.6
	SA99211.EC1	30 July	06:45	30 July	10:45	12.0	13.0	Shock	2	35	6	17.1
	SA99211.EC2	30 July	07:02	30 July	11:40	12.0	15.0	Shock	2	243	42	17.3
Sulphur Creek	SA99213.SU1	01 Aug	10:45	02 Aug	05:45	7.0	5.0	Shock	5	101	10	9.9
	SA99214.SU1	02 Aug	06:02	02 Aug	11:10	5.0	8.5	Shock	6	207	41	19.8
	SA99214.SU2	02 Aug	09:04	02 Aug	13:25	6.0	11.0	Shock	7	530	91	17.2
Marsh Creek	SA99214.MC1	02 Aug	07:07	03 Aug	06:30	8.0	7.0	Shock	11	97	8	8.2
	SA99214.MC2	02 Aug	08:24	02 Aug	13:00	9.0	13.5	Shock	12	457	60	13.1
Cape Horn Crk	SA99215.CH1	03 Aug	06:00	04 Aug	06:45	7.5	7.0	Shock	1	110	11	10.0
	SA99215.CH2	03 Aug	07:30	03 Aug	12:30	8.0	9.0	Shock	3	313	36	11.5

Appendix Table 2. Continued.

Stream	Tag group	Tagging date	Tagging time	Release date	Release time	Tagging temperature	Release temperature	Capture method	Release river km	Number released	Number detected	Percent detected
Valley Creek	SA99216.VC1	04 Aug	05:51	05 Aug	08:30	10.0	12.0	Shock	4	123	12	9.8
	SA99216.VC2	04 Aug	06:52	04 Aug	12:45	11.0	15.0	Shock	5	586	63	10.7
	SA99217.VC1	05 Aug	05:39	05 Aug	11:45	11.0	13.0	Shock	18	300	24	8.0
Loon Creek	SA99218.LN1	06 Aug	07:34	07 Aug	07:14	9.5	9.0	Shock	33	120	29	24.2
	SA99218.LN2	06 Aug	09:00	06 Aug	12:45	10.0	12.0	Shock	33	226	46	20.4
	SA99219.LN1	07 Aug	05:55	07 Aug	12:04	9.0	11.5	Shock	35	373	57	15.3
Camas Creek	SA99221.CA1	09 Aug	08:02	10 Aug	07:30	8.0	9.5	Shock	22	111	13	11.7
	SA99221.CA2	09 Aug	09:22	10 Aug	07:45	9.0	9.0	Shock	22	209	28	13.4
	SA99222.CA1	10 Aug	04:57	10 Aug	09:20	9.5	10.0	Shock	21	198	40	20.2
	SA99222.CA3	10 Aug	06:36	10 Aug	11:45	9.0	12.5	Shock	22	245	42	17.1
E. F. Salmon River	SA99221.EF1	09 Aug	07:35	10 Aug	07:30	9.0	8.5	Shock	30	104	8	7.7
	SA99221.EF2	09 Aug	09:28	10 Aug	07:30	11.5	8.5	Shock	31	195	26	13.3
	SA99222.EF1	10 Aug	06:29	10 Aug	11:00	8.5	10.0	Shock	31	204	29	14.2
	SA99222.EF2	10 Aug	08:28	10 Aug	12:30	9.5	12.0	Shock	32	171	16	9.4
Herd Creek	SA99223.HC1	11 Aug	06:43	11 Aug	11:30	9.0	11.0	Shock	2	315	51	16.2

Appendix Table 2. Continued.

Stream	Tag group	Tagging date	Tagging time	Release date	Release time	Tagging temperature	Release temperature	Capture method	Release river km	Number released	Number detected	Percent detected
Big Creek (upper)	SA99228.BC1	16 Aug	07:11	17 Aug	07:30	7.0	6.0	Shock	54	105	11	10.5
	SA99228.BC2	16 Aug	08:18	16 Aug	13:15	8.0	11.5	Shock	55	256	49	19.1
	SA99229.BC1	17 Aug	08:01	17 Aug	13:30	8.0	11.0	Shock	57	248	36	14.5
	SA99230.BC1	18 Aug	07:27	18 Aug	10:30	8.0	8.5	Shock	58	92	2	2.2
S.F. Salmon River	SA99231.SF1	19 Aug	06:57	20 Aug	08:30	10.5	10.5	Shock	117	111	7	6.3
	SA99231.SF2	19 Aug	07:46	19 Aug	13:15	11.0	15.0	Shock	118	435	44	10.1
	SA99232.SF1	20 Aug	06:41	20 Aug	12:00	9.5	12.0	Shock	122	464	33	7.1
Secesh River	SA99235.SE1	23 Aug	07:14	24 Aug	07:15	10.0	12.0	Shock	25	140	18	12.9
	SA99235.SE2	23 Aug	08:27	23 Aug	13:30	11.5	14.5	Shock	26	298	40	13.4
	SA99236.SE1	24 Aug	06:55	24 Aug	13:30	11.5	15.5	Shock	27	469	58	12.4
Lake Creek	SA99237.LC1	25 Aug	06:20	25 Aug	12:30	8.5	12.0	Shock	2	603	72	11.9
Big Creek (lower)	SA99240.LB1	28 Aug	09:05	29 Aug	08:30	14.0	12.5	Shock	9	56	15	26.8
	SA99241.LB1	29 Aug	05:08	29 Aug	13:30	12.0	15.5	Shock	10	104	24	23.1
	SA99241.LB3	29 Aug	08:05	29 Aug	13:30	12.5	15.5	Shock	10	229	63	27.5

Appendix Table 3. A summary of observed total mortality for PIT tagged wild chinook salmon parr collected from Idaho streams during July and August 1999. Number rejected includes fish too small to tag, precocious males, injured fish, fish collected for genetic evaluation, and in some cases extra collected fish.

Stream	Number collected	Number tagged	Number rejected	Percent rejected (%)	Observed total mortality			
					Collection	Tagging	Total	%
Bear Valley Creek	1,198	840	358	29.9	8	3	11	0.9
Elk Creek	710	660	50	7.0	8	0	8	1.1
Sulphur Creek	876	839	37	4.2	12	1	13	1.5
Marsh Creek	777	554	223	28.7	9	0	9	1.2
Cape Horn Creek	1,107	425	682	61.6	6	2	8	0.7
Valley Creek	1,562	1,009	553	35.4	29	0	29	1.9
Loon Creek	940	720	220	23.4	29	1	30	3.2
Camas Creek	972	764	208	21.4	28	1	29	3.0
East Fork Salmon River	818	675	143	17.5	52	1	53	6.5
Herd Creek	324	315	9	2.8	8	0	8	2.5
Big Creek (upper)	864	701	163	18.9	7	0	7	0.8
South Fork Salmon River	2,371	1,010	1,361	57.4	22	0	22	0.9
Secesh River	1,316	907	409	31.1	16	0	16	1.2
Lake Creek	787	604	183	23.3	24	1	25	3.2
Big Creek (lower)/Rush Creek	430	389	41	9.5	24	0	24	5.6
Totals or averages	15,052	10,412	4,640	30.8	282	10	292	1.9

Appendix Table 4. Detections of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for wild chinook salmon from the Secesh River, 2000.

Tagging site: Secesh River Release date: 23-24 Aug 1999
Release site: Secesh River Number released: 907
Release river kilometer(s) above Lower Granite Dam: 429-431

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

Appendix Table 4. Continued.

Detection date	Lower Granite First detection	Lower Granite Expanded	First Detections Little Goose	Lower Monumental	McNary	John Day	Bonneville
12 May			1				
13 May			1	1	1		
14 May					1		
23 May	1	3					
24 May					1		
26 May			1		1		
30 May			1		1		
31 May				1			
02 Jun			2		1		
04 Jun					1		
05 Jun	1	7					
08 Jun			1	1			
11 Jun			1				
22 Jun	1	2					
26 Jun			1				
03 Jul	1	1					
11 Jul	2	3					
Totals	40	117	43	14	13	5	1

Appendix Table 5. Detections of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for wild chinook salmon from Bear Valley Creek, 2000.

Tagging site: Bear Valley Creek Release date: 27-29 Aug 1999
Release site: Bear Valley Creek Number released: 837
Release river kilometer(s) above Lower Granite Dam: 631-635

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

Appendix Table 5. Continued.

Detection date	Lower Granite First detection	Lower Granite Expanded	First Detections Little Goose	First Detections Lower Monumental	First Detections McNary	First Detections John Day	First Detections Bonneville
24 May	3	8					1
25 May	2	5	1				
26 May	1	3					
27 May			1				
29 May	2	8	1	2			
31 May			1	1			
01 Jun			2				
02 Jun	2	15					
04 Jun			1				
18 Jun	1	5					
02 Jul	1	1					
Totals	44	137	46	11	2	3	4

Appendix Table 6. Detections of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for wild chinook salmon from Camas Creek, 2000.

Tagging site: Camas Creek Release date: 10 Aug 1999
Release site: Camas Creek Number released: 763
Release river kilometer(s) above Lower Granite Dam: 526-528

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

Appendix Table 6. Continued.

Detection date	Lower Granite		First Detections				
	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
23 May	1	3		1			
24 May			4				
25 May	4	10		1	2		1
26 May	2	6	1		1		
27 May	3	9		1			
28 May	4	13	2				
29 May	1	4	1				
30 May	1	4	2				
31 May	2	12	2		1		1
01 Jun	1	9	1				1
02 Jun	2	15					1
06 Jun			1				
07 Jun					1		
08 Jun				1			
09 Jun	1	7		1			
10 Jun							1
14 Jun					1		
24 Jun	1	1					
Totals	53	179	38	14	12	1	5

Appendix Table 7. Detections of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for wild chinook salmon from Cape Horn Creek, 2000.

Tagging site: Cape Horn Creek Release date: 03-04 Aug 1999
Release site: Cape Horn Creek Number released: 423
Release river kilometer(s) above Lower Granite Dam: 630-633

	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
16 Apr			1				
20 Apr	1	3					
24 Apr				1			
01 May	4	12					
03 May	1	3	4	1			
04 May			1				
05 May	1	2					
06 May			1		1		
08 May	2	5					
10 May	1	3	1				
11 May			1				
12 May			1	1			1
14 May					1		
17 May			1				
19 May			1		1		
20 May							1
22 May					1		
24 May	1	3		2			
28 May	2	7	1				
29 May			1				
31 May	2	12	2	1			
01 Jun	1	9					
03 Jun				1	1		
09 Jul	1	1					
Totals	17	59	16	7	5		2

Appendix Table 8. Detections of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for wild chinook salmon from Elk Creek, 2000.

Tagging site: Elk Creek Release date: 29-30 Aug 1999
Release site: Elk Creek Number released: 660
Release river kilometer(s) above Lower Granite Dam: 634-637

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

Appendix Table 8. Continued.

Detection date	Lower Granite		First Detections				
	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
23 May	1	3			1		
24 May			2				
25 May							2
26 May	1	3					
27 May				1	1		
28 May	1	3					1
29 May				1			
30 May			1				
31 May			2				
01 Jun			2				
02 Jun			2		1		
04 Jun			1				
07 Jun					1		
08 Jun					1		
14 Jun							1
21 Jun				1			
30 Jun			1				
04 Jul			1				
Totals	42	123	44	8	13		6

Appendix Table 9. Detections of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for wild chinook salmon from Herd Creek, 2000.

Tagging site: Herd Creek Release date: 11 Aug 1999
Release site: Herd Creek Number released: 315
Release river kilometer(s) above Lower Granite Dam: 699-701

	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
14 Apr	1	3					
15 Apr	1	3					
16 Apr	2	6					
19 Apr			1				
20 Apr	1	3					
21 Apr	1	3	2				
22 Apr	1	3					
23 Apr	1	3	1				
24 Apr	1	3					
25 Apr	3	7					
26 Apr			2	1			
27 Apr			1				
28 Apr	1	3	2				
29 Apr					2		
30 Apr	1	3					
01 May			2	1			
02 May	1	3	1				
03 May	2	5	1				
04 May	1	3					
05 May			1				
06 May			1	1			
07 May	1	2			1		
08 May	1	2					
09 May					1		
10 May			1				
11 May	1	3					
12 May				1	1		
13 May				1			
14 May					1		
15 May							1
18 May	1	3					
19 May	1	4					
Totals	23	66	16	5	6		1

Appendix Table 10. Detections of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for wild chinook salmon from Lake Creek, 2000.

Tagging site: Lake Creek Release date: 25 Aug 1999
Release site: Lake Creek Number released: 603
Release river kilometer(s) above Lower Granite Dam: 451-452

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

Appendix Table 10. Continued.

Detection date	Lower Granite		First Detections				
	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
25 May			1				
26 May			1				
28 May	1	3					
30 May			1				
31 May	1	6					
01 Jun				1			
05 Jun	1	7					
07 Jun							1
10 Jun			1				
29 Jun	1	1					
02 Jul	1	1					
18 Jul	2	3			1		
Totals	30	92	26	7	7	1	1

Appendix Table 11. Detections of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for wild chinook salmon from Lower Big Creek, 2000.

Tagging site: Lower Big Creek Release date: 29 Aug 1999
Release site: Lower Big Creek Number released: 389
Release river kilometer(s) above Lower Granite Dam: 486-489

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

Appendix Table 11. Continued.

Detection date	Lower Granite		First Detections				
	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
21 May			1				
25 May			1				
26 May	1	3					
29 May							1
30 May					1		1
31 May				1			
02 Jun					1		
Totals	47	138	35	8	8	1	4

Appendix Table 12. Detections of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for wild chinook salmon from Loon Creek, 2000.

Tagging site: Loon Creek Release date: 06-07 Aug 1999
Release site: Loon Creek Number released: 719
Release river kilometer(s) above Lower Granite Dam: 555-557

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

Appendix Table 12. Continued.

Detection date	Lower Granite First detection	Lower Granite Expanded	First Detections Little Goose	First Detections Lower Monumental	First Detections McNary	First Detections John Day	First Detections Bonneville
20 May			1				
21 May			1		1	1	
22 May			1				
23 May	2	6	1				1
24 May	1	3	2		1		1
26 May			1				3
27 May					1		
28 May			1	1	1		
29 May	1	4	2	1			
30 May			2				
31 May				1	1		
01 Jun	1	9	1				
02 Jun							1
05 Jun					1		
06 Jun					1		
07 Jun						1	
Totals	47	140	52	9	14	2	6

Appendix Table 13. Detections of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for wild chinook salmon from Marsh Creek, 2000.

Tagging site: Marsh Creek Release date: 02-03 Aug 1999
Release site: Marsh Creek Number released: 554
Release river kilometer(s) above Lower Granite Dam: 630-632

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

Appendix Table 13. Continued.

Detection date	Lower Granite		First Detections				
	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
25 May	1	3			1		
27 May	1	3	1				
31 May			1				
02 Jun			2				
16 Jun	1	4					
Totals	23	68	23	14	5	1	2

Appendix Table 14. Detections of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for wild chinook salmon from East Fork Salmon River, 2000.

Tagging site: East Fork Salmon River Release date: 10 Aug 1999
Release site: East Fork Salmon River Number released: 674
Release river kilometer(s) above Lower Granite Dam: 712-714

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

Appendix Table 14. Continued.

Detection date	Lower Granite		First Detections				
	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
27 May	2	6	1				
30 May			1				
31 May			1				
01 Jun			2				
03 Jun			1				
05 Jun					1		
07 Jun			1				
08 Jun				1			
10 Jun			1				
Totals	35	101	33	5	4	1	1

Appendix Table 15. Detections of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for wild chinook salmon from South Fork Salmon River, 2000.

Tagging site: South Fork Salmon River Release date: 19-20 Aug
Release site: South Fork Salmon River Number released: 1,010
Release river kilometer(s) above Lower Granite Dam: 467-472

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

Appendix Table 15. Continued.

Detection date	Lower Granite		First Detections				
	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
25 May	2	5		1			
26 May	2	6					
27 May	2	6			1		
28 May	2	7	1		1		
30 May			1		1		
31 May	1	6	1				
02 Jun					1		
04 Jun					1		
05 Jun					1		
06 Jun					1		
07 Jun					1		
16 Jun	1	4			1		
24 Jun	1	1					
28 Jun	1	1					
03 Jul	1	1					
20 Jul	1	1		1			
Totals	39	114	23	9	12		1

Appendix Table 16. Detections of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for wild chinook salmon from Sulphur Creek, 2000.

Tagging site: Sulphur Creek Release date: 02 Aug 1999
Release site: Sulphur Creek Number released: 838
Release river kilometer(s) above Lower Granite Dam: 604-606

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

Appendix Table 16. Continued.

Detection date	Lower Granite		First Detections				
	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
17 May			1		1		
19 May	2	8			2		
20 May			1		1		
21 May				1	3	1	
23 May	1	3			1		
24 May	1	3	1	1	1		
25 May	1	3					
26 May	1	3			2		
28 May	1	3					
29 May			1				
30 May	1	4	1				
31 May			2				
01 Jun			1				1
02 Jun			1				
04 Jun						1	
07 Jun					1		
09 Jun					1		
10 Jun			1				
12 Jun					1		
Totals	52	152	54	11	15	5	4

Appendix Table 17. Detections of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for wild chinook salmon from Big Creek (upper), 2000.

Tagging site: Big Creek (upper) Release date: 16-18 Aug 1999
Release site: Big Creek (upper) Number released: 701
Release river kilometer(s) above Lower Granite Dam: 530-535

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

Appendix Table 17. Continued.

Detection date	Lower Granite		First Detections				
	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
31 May	3	17	1				
01 Jun			4				
02 Jun			3				
03 Jun			1		1		
04 Jun			1				
05 Jun			1		3		
06 Jun			2				
07 Jun			1				
08 Jun							1
12 Jun			1				
14 Jun	1	11					
16 Jun			1				
21 Jun					1		
22 Jun	1	2					
23 Jun	1	1					
24 Jun	1	1			1		
26 Jun	1	1					
27 Jun							1
29 Jun	1	1					
Totals	44	145	31	2	15		3

Appendix Table 18. Detections of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for wild chinook salmon from Valley Creek, 2000.

Tagging site: Valley Creek Release date: 04-05 Aug 1999
Release site: Valley Creek Number released: 1,009
Release river kilometer(s) above Lower Granite Dam: 743-757

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

Appendix Table 18. Continued.

Detection date	Lower Granite First detection	Lower Granite Expanded	First Detections Little Goose	First Detections Lower Monumental	First Detections McNary	First Detections John Day	First Detections Bonneville
25 May	3	8					1
26 May	3	9	1				
27 May			1	1			
28 May	1	3	1				
29 May	1	4	2	1			
31 May			2				
01 Jun			2				
02 Jun			2				
03 Jun			1	1			
04 Jun					1		
05 Jun	1	7					
06 Jun				1			
07 Jun				1	2	1	
09 Jun				1			
10 Jun			1				
12 Jun				1			
20 Jun			1				
24 Jun	1	1					
26 Jun	1	1					
29 Jun	1	1					
14 Jul	1	2					
Totals	51	150	29	10	5	2	2

Appendix Table 19. Daily and expanded detections of PIT-tagged wild spring/summer chinook salmon smolts from Idaho at Lower Granite Dam during 2000, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature	Numbers detected	Expanded numbers detected
12 Apr	81.3	20.2	9.7	3	11
13 Apr	95.7	23.1	9.8	10	37
14 Apr	105.7	25.0	9.8	15	47
15 Apr	108.8	29.5	9.7	10	30
16 Apr	104.4	25.0	9.3	14	43
17 Apr	96.1	23.7	9.1	9	28
18 Apr	98.1	23.7	9.3	2	6
19 Apr	101.2	23.6	9.7	5	16
20 Apr	105.2	25.7	10.4	11	34
21 Apr	104.4	25.9	10.7	12	38
22 Apr	111.2	27.3	10.7	15	45
23 Apr	115.4	49.7	10.7	14	41
24 Apr	109.3	30.7	10.4	9	26
25 Apr	102.5	24.2	9.9	16	39
26 Apr	98.2	24.2	10.0	11	33
27 Apr	90.4	22.2	10.0	7	21
28 Apr	95.9	23.5	9.9	17	51
29 Apr	98.7	24.6	10.5	12	37
30 Apr	88.8	21.6	11.1	10	27
01 May	92.4	22.6	11.0	17	51
02 May	92.5	22.4	11.0	15	44
03 May	97.7	23.4	11.3	14	38
04 May	96.8	23.8	11.4	17	45
05 May	99.3	24.0	10.9	12	29
06 May	96.3	23.1	10.6	14	35
07 May	88.5	22.0	10.6	18	44
08 May	83.0	21.2	10.6	24	58
09 May	76.1	19.0	10.7	16	41
10 May	79.7	20.1	10.8	18	46
11 May	81.9	20.4	10.9	22	66
12 May	78.5	20.1	10.9	12	40
13 May	72.7	18.6	10.8	3	11

Appendix Table 19 Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature	Numbers detected	Expanded numbers detected
14 May	70.8	17.9	10.8	9	32
15 May	69.7	17.8	11.2	4	10
17 May	67.0	17.8	12.3	2	8
18 May	68.9	17.3	13.1	7	23
19 May	73.4	18.3	13.7	8	30
20 May	76.5	19.5	13.8	4	15
21 May	79.9	20.0	13.6	1	4
22 May	87.6	22.0	13.3	8	27
23 May	99.1	23.6	13.3	10	28
24 May	95.1	23.0	13.6	11	30
25 May	92.0	21.6	13.4	17	44
26 May	89.9	21.6	13.0	16	46
27 May	87.2	20.5	12.6	12	36
28 May	87.2	20.8	12.5	14	47
29 May	88.9	28.1	12.7	9	36
30 May	86.3	29.8	12.8	3	11
31 May	85.6	31.8	12.6	9	52
01 Jun	82.2	31.8	12.5	3	26
02 Jun	76.0	32.4	12.3	4	29
05 Jun	74.2	30.0	13.7	3	20
09 Jun	73.8	32.3	15.5	1	7
14 Jun	75.8	30.3	13.8	2	11
16 Jun	77.7	30.3	14.4	2	9
18 Jun	57.3	27.6	15.5	1	5
22 Jun	53.4	0.0	16.2	2	4
23 Jun	50.4	0.0	16.6	1	1
24 Jun	44.3	0.0	17.0	4	6
26 Jun	41.7	0.0	17.0	2	3
28 Jun	42.7	0.0	18.1	1	1
29 Jun	38.5	0.0	18.4	3	4
02 Jul	33.6	0.0	19.1	2	3
03 Jul	35.8	0.0	19.4	2	3
09 Jul	44.0	0.0	17.9	1	1
11 Jul	42.5	0.0	18.3	2	3
14 Jul	43.4	0.0	18.2	1	2
18 Jul	38.4	0.0	19.0	2	3
20 Jul	38.8	0.0	18.9	1	1

Appendix Table 20. Daily first-time detections of PIT-tagged wild spring/summer chinook salmon smolts from Idaho at Little Goose Dam during 2000, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature	Numbers detected
13 Apr	92.9	21.4	9.3	1
15 Apr	103.8	14.7	10.0	2
16 Apr	102.7	28.6	10.1	5
17 Apr	91.3	21.3	10.2	4
18 Apr	96.1	19.3	9.9	1
19 Apr	97.5	20.4	9.7	5
20 Apr	100.9	23.4	9.8	7
21 Apr	101.7	29.4	10.2	15
22 Apr	106.6	56.3	10.7	13
23 Apr	107.9	58.6	11.1	15
24 Apr	106.5	19.0	10.9	24
25 Apr	100.1	22.4	10.9	22
26 Apr	91.9	19.5	10.9	11
27 Apr	89.5	18.9	10.5	5
28 Apr	89.1	17.1	10.3	13
29 Apr	99.4	20.1	10.4	22
30 Apr	85.1	14.7	10.4	10
01 May	90.0	14.2	10.7	14
02 May	87.7	15.8	11.3	8
03 May	94.5	18.4	11.7	34
04 May	92.5	21.6	11.5	8
05 May	96.1	23.0	11.5	18
06 May	93.1	23.4	11.7	13
07 May	85.7	23.5	11.6	13
08 May	79.8	22.2	11.3	7
09 May	74.1	22.7	11.2	9
10 May	76.2	22.3	11.1	15
11 May	78.5	24.3	11.0	9
12 May	74.9	27.2	11.0	15
13 May	70.2	27.4	11.3	9
14 May	67.6	27.0	11.5	8

Appendix Table 20. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature	Numbers detected
15 May	67.9	27.3	11.7	6
16 May	60.8	25.2	11.7	3
17 May	64.5	25.7	11.7	9
18 May	65.7	26.8	12.1	1
19 May	69.8	26.7	12.4	3
20 May	73.6	27.0	12.9	3
21 May	79.5	25.8	13.7	5
22 May	81.6	24.5	14.3	5
23 May	98.4	24.7	14.5	3
24 May	89.7	24.2	14.2	11
25 May	88.3	23.7	13.9	4
26 May	85.4	15.9	13.9	6
27 May	84.8	21.1	14.0	4
28 May	82.9	22.0	13.7	7
29 May	89.9	22.2	13.3	8
30 May	81.1	24.9	13.1	10
31 May	84.1	27.1	13.1	15
01 Jun	79.8	27.1	13.1	15
02 Jun	75.8	25.9	13.1	12
03 Jun	67.5	24.1	13.2	3
04 Jun	66.5	21.3	13.6	3
05 Jun	67.8	19.3	13.3	1
06 Jun	84.3	18.3	13.3	3
07 Jun	83.0	17.5	13.9	2
08 Jun	79.7	16.6	14.3	1
10 Jun	67.5	18.5	15.2	4
11 Jun	62.5	22.3	15.3	1
12 Jun	59.3	23.6	15.5	1
16 Jun	74.8	26.0	15.1	1
20 Jun	58.3	10.4	15.4	1
26 Jun	41.5	0.0	17.6	1
30 Jun	41.3	0.0	18.1	1
04 Jul	35.3	0.0	18.8	1

Appendix Table 21. Daily first-time detections of PIT-tagged wild spring/summer chinook salmon smolts from Idaho at Lower Monumental Dam during 2000, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature	Numbers detected
16 Apr	108.6	38.5	10.2	1
17 Apr	95.4	37.6	10.3	1
20 Apr	105.5	29.6	10.3	3
21 Apr	106.6	32.3	10.2	1
22 Apr	111.9	44.3	10.4	2
23 Apr	112.4	42.4	10.7	3
24 Apr	112.4	31.2	11.1	12
25 Apr	104.9	30.8	11.1	3
26 Apr	92.6	31.1	11.1	5
27 Apr	92.6	28.3	11.2	3
28 Apr	89.4	27.4	11.1	2
29 Apr	103.5	23.1	10.7	4
30 Apr	85.5	23.1	10.7	3
01 May	92.8	23.1	10.9	4
02 May	89.3	23.0	11.0	2
03 May	95.2	25.6	11.3	6
04 May	94.7	29.0	11.7	5
05 May	97.4	32.2	11.8	3
06 May	96.8	32.7	11.7	6
07 May	88.6	32.3	11.8	2
08 May	81.8	32.5	12.0	1
09 May	73.8	30.4	12.0	2
10 May	77.8	25.7	11.6	3
11 May	80.4	23.3	11.3	4
12 May	75.9	24.2	11.2	5
13 May	72.6	28.8	11.3	2
14 May	69.3	34.9	11.5	2
15 May	69.6	37.7	11.8	2
19 May	70.3	28.4	12.4	1
20 May	76.9	28.3	12.6	2
21 May	80.0	26.1	13.0	2
22 May	81.0	22.1	13.4	1

Appendix Table 21. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature	Numbers detected
23 May	101.9	19.7	14.2	4
24 May	89.8	17.9	14.8	3
25 May	89.9	19.6	14.7	2
27 May	87.2	25.0	14.2	3
28 May	82.4	28.8	14.2	1
29 May	93.6	35.9	14.2	5
31 May	88.4	46.7	13.5	5
01 Jun	81.6	44.6	13.3	1
03 Jun	70.0	35.1	13.7	2
06 Jun	85.2	23.8	14.3	1
07 Jun	83.7	23.5	14.0	1
08 Jun	80.6	23.7	14.0	3
09 Jun	69.9	23.9	14.2	2
12 Jun	60.9	46.9	15.1	1
21 Jun	57.5	0.0	15.3	1
20 Jul	41.8	0.0	19.9	1

Appendix Table 22. Daily first-time detections of PIT-tagged wild spring/summer chinook salmon smolts from Idaho at McNary Dam during 2000, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature	Numbers detected
25 Apr	323.4	150.8	9.9	2
27 Apr	282.2	112.0	9.9	3
29 Apr	282.1	110.0	10.3	4
30 Apr	268.9	106.8	10.5	2
01 May	281.2	109.3	10.9	1
02 May	281.9	111.0	11.0	1
03 May	285.7	118.5	11.1	1
04 May	292.2	120.7	11.2	1
05 May	297.0	125.0	11.2	1
06 May	282.9	115.8	11.2	3
07 May	257.2	106.4	11.5	3
08 May	273.4	113.5	11.8	3
09 May	277.8	116.9	12.0	9
10 May	259.1	111.0	11.8	2
11 May	274.6	114.4	11.4	3
12 May	258.2	98.1	11.4	3
13 May	228.8	98.0	11.6	3
14 May	249.4	107.2	11.8	3
15 May	256.5	104.8	12.2	4
16 May	231.6	107.9	12.4	1
17 May	240.3	100.8	12.8	2
18 May	246.4	110.9	13.0	2
19 May	246.8	114.8	13.2	7
20 May	250.3	107.0	13.4	4
21 May	241.6	74.5	13.6	7
22 May	245.2	107.4	13.8	3
23 May	279.0	148.2	14.1	3
24 May	281.5	127.2	14.2	5
25 May	253.3	114.4	14.8	3
26 May	208.9	71.6	14.1	4
27 May	234.7	72.8	14.2	5

Appendix Table 22. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature	Numbers detected
28 May	225.3	72.1	14.4	2
30 May	218.6	68.9	14.4	3
31 May	249.8	104.7	14.1	2
02 Jun	202.3	79.9	13.8	4
03 Jun	200.7	79.8	14.2	2
04 Jun	195.8	75.6	14.7	3
05 Jun	232.2	79.9	14.8	6
06 Jun	241.4	84.8	15.1	2
07 Jun	224.7	79.5	15.3	6
08 Jun	231.3	84.9	15.3	1
09 Jun	182.3	69.2	15.0	1
12 Jun	197.7	83.6	14.6	1
14 Jun	217.1	84.7	14.9	1
16 Jun	196.2	73.7	16.0	1
21 Jun	227.2	59.4	17.0	1
24 Jun	192.9	28.9	16.5	1
18 Jul	171.7	0.0	19.2	1

Appendix Table 23. Monthly environmental data collected from Marsh Creek (RKm 179.5 from the mouth of the Middle Fork Salmon River) from August 1999 through July 2000.

	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	Jul
Temperature (°C)												
Minimum	6.0	0.3	0.0	0.0	0.0	0.0	-0.1	-0.1	0.0	1.1	1.6	5.6
Maximum	15.7	14.4	11.1	7.3	3.1	3.5	5.6	8.8	10.3	12.8	15.7	15.7
Average	11.0	8.1	4.6	2.2	0.4	0.3	1.3	2.4	3.4	6.1	9.6	11.1
Dissolved Oxygen (ppm)												
Minimum	8.6	9.6	10.3	11.1	10.8	11.1	10.9	9.8	8.8	1.1	----	----
Maximum	11.8	14.1	14.2	14.1	12.7	12.8	13.2	14.0	11.9	12.1	----	----
Average	10.1	11.4	12.4	12.4	11.7	11.8	12.0	12.0	10.4	7.6	----	----
Specific Conductance (µS/cm)												
Minimum	63.0	72.0	63.0	63.0	53.0	61.0	59.0	57.0	22.0	23.0	26.0	41.0
Maximum	76.0	80.0	80.0	80.0	74.0	78.0	75.0	71.0	67.0	42.0	43.0	65.0
Average	72.4	74.8	75.2	73.5	68.9	70.0	68.2	67.8	49.2	29.9	37.7	55.5
Turbidity (ntu)												
Minimum	0.1	0.0	1.0	0.4	0.0	0.0	0.0	0.0	0.3	1.8	18.0	----
Maximum	33.4	8.9	49.4	49.6	4.2	8.9	13.9	9.2	32.4	28.7	49.4	----
Average	0.7	0.7	9.7	4.8	0.3	0.5	0.3	0.5	5.1	11.5	28.5	----
Depth (feet)												
Minimum	0.9	1.0	0.9	0.7	0.6	0.7	0.4	0.4	0.9	1.4	1.4	0.9
Maximum	1.7	1.5	1.5	1.6	2.6	2.7	2.3	1.4	2.5	2.9	2.7	1.5
Average	1.4	1.2	1.2	1.1	1.4	1.6	0.9	0.9	1.4	2.2	2.1	1.2
pH												
Minimum	7.4	7.6	7.3	7.4	7.3	7.3	7.5	7.5	6.8	6.8	7.4	7.5
Maximum	8.6	8.6	9.0	8.7	8.0	7.9	9.0	9.4	7.8	8.3	8.3	8.4
Average	7.9	7.9	7.9	7.7	7.6	7.5	7.8	7.8	7.2	7.4	7.7	7.8

Appendix Table 24. Monthly environmental data collected from the Salmon River near Sawtooth Hatchery (RKm 627.9) from August 1999 through July 2000.

	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	Jul
						Temperature (°C)						
Minimum	8.4	3.0	1.6	0.1	0.0	0.0	0.0	0.1	1.3	3.2	5.3	9.3
Maximum	15.7	15.7	11.5	8.6	4.5	4.7	6.7	10.2	12.9	14.8	15.7	15.5
Average	12.6	10.2	6.5	3.9	1.1	1.0	2.3	3.8	6.4	8.8	11.6	12.7
						Dissolved Oxygen (ppm)						
Minimum	7.3	7.9	8.6	9.1	7.0	10.0	10.0	9.5	8.6	8.6	8.2	8.3
Maximum	11.4	14.1	14.1	14.1	14.1	14.1	14.2	14.2	11.7	11.2	11.3	11.6
Average	8.6	9.7	10.7	10.9	11.6	12.0	11.9	11.5	10.0	9.8	9.6	9.7
						Specific Conductance (µS/cm)						
Minimum	127.0	155.0	147.0	140.0	112.0	127.0	138.0	133.0	87.0	57.0	61.0	95.0
Maximum	156.0	178.0	171.0	175.0	155.0	154.0	157.0	156.0	141.0	89.0	96.0	140.0
Average	145.0	165.0	164.7	157.9	141.6	139.9	145.7	148.3	116.0	73.8	74.2	122.0
						Turbidity (ntu)						
Minimum	0.3	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.6	1.7	1.3	0.2
Maximum	35.8	11.0	27.1	7.7	7.9	29.1	6.3	34.2	38.3	37.2	11.3	2.2
Average	1.1	0.8	1.2	0.8	0.5	0.8	0.7	0.9	4.7	9.6	4.1	0.8
						Depth						
Minimum	1.6	1.6	1.5	1.3	1.5	1.4	1.6	1.5	1.7	1.7	1.6	1.3
Maximum	2.3	2.2	2.3	2.2	3.3	2.6	2.5	2.3	2.8	2.9	2.6	1.7
Average	2.0	1.8	1.9	1.7	2.2	2.0	2.0	2.0	2.2	2.4	2.1	1.5
						pH						
Minimum	7.5	7.8	7.8	7.9	7.3	7.5	7.4	7.9	7.8	7.6	7.5	7.8
Maximum	8.8	8.7	8.9	9.0	9.1	9.3	9.1	8.8	8.4	8.6	8.8	9.0
Average	8.1	8.2	8.2	8.3	8.0	8.1	8.2	8.2	8.0	7.9	7.9	8.2

Appendix Table 25. Monthly environmental data collected from Valley Creek (RKm 609.4 from the mouth of the Salmon River) from August 1999 through July 2000.

	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	Jul
						Temperature (°C)						
Minimum	8.9	0.8	0.5	0.1	0.1	0.1	0.1	0.0	0.5	2.4	3.8	8.1
Maximum	15.7	15.6	12.7	8.5	2.9	1.1	5.8	9.8	13.5	14.7	15.6	15.6
Average	12.8	9.9	5.7	2.6	0.5	0.5	0.8	2.8	5.1	8.3	11.0	12.3
						Dissolved Oxygen (ppm)						
Minimum	6.4	7.3	8.2	4.9	10.8	11.1	11.2	7.0	9.2	6.6	8.7	8.1
Maximum	8.9	11.6	12.2	12.4	12.6	13.4	14.2	14.1	12.4	12.4	12.7	12.4
Average	7.6	8.7	10.0	10.9	11.8	11.9	12.5	12.2	11.0	10.8	10.4	9.8
						Specific Conductance (µS/cm)						
Minimum	49.0	65.0	62.0	59.0	67.0	84.0	84.0	79.0	51.0	47.0	44.0	57.0
Maximum	69.0	75.0	77.0	85.0	94.0	92.0	99.0	102.0	90.0	64.0	59.0	84.0
Average	59.5	70.0	72.1	70.7	83.3	87.3	89.8	94.0	65.7	54.9	51.4	71.4
						Turbidity (ntu)						
Minimum	1.2	0.4	0.2	0.2	0.2	0.3	0.3	0.2	0.9	2.0	----	----
Maximum	29.7	46.0	31.6	13.2	5.2	3.2	6.3	7.0	41.9	16.2	----	----
Average	3.0	2.1	1.8	1.0	0.8	0.9	1.3	0.9	6.6	5.1	----	----
						Depth (feet)						
Minimum	1.0	1.0	0.9	0.8	0.9	0.7	0.7	0.6	1.0	1.2	1.3	0.9
Maximum	1.9	1.5	1.7	1.6	2.1	1.8	1.7	1.4	2.1	2.3	2.7	1.4
Average	1.5	1.3	1.3	1.2	1.5	1.3	1.2	1.2	1.5	1.9	1.9	1.2
						pH						
Minimum	7.6	7.7	7.5	7.5	7.5	7.4	7.4	7.6	7.0	7.0	7.0	7.3
Maximum	8.6	8.8	8.8	8.8	8.0	7.8	8.1	8.5	8.6	8.3	8.3	8.7
Average	8.0	8.1	8.1	8.0	7.7	7.5	7.8	7.9	7.4	7.4	7.5	7.8

Appendix Table 26. Monthly environmental data collected from Secesh River (RKm 27 from its mouth at the S.F. Salmon River) from August 1999 through July 2000.

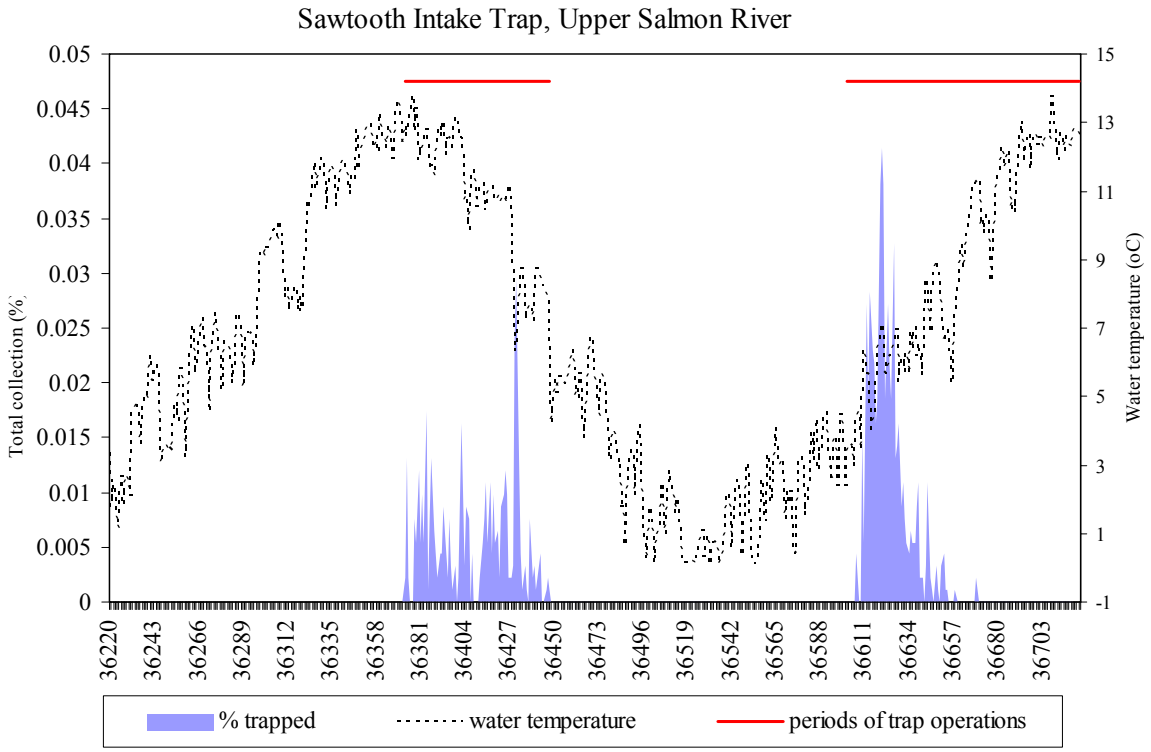
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	Jul
						Temperature (°C)						
Minimum	6.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	2.5	7.4
Maximum	15.7	13.6	9.9	5.2	0.2	0.0	0.0	0.0	8.4	9.6	15.7	15.7
Average	12.3	8.1	3.4	0.9	0.0	0.0	0.0	0.0	2.5	5.1	9.4	12.1
						Dissolved Oxygen (ppm)						
Minimum	7.8	8.7	10.1	10.5	11.1	11.1	11.2	11.4	10.0	9.5	7.9	7.1
Maximum	10.3	13.4	14.0	12.3	12.3	11.6	11.9	12.3	12.4	12.2	12.0	11.4
Average	8.8	10.3	12.1	11.5	11.5	11.4	11.5	11.8	11.5	11.0	10.0	8.9
						Specific Conductance (µS/cm)						
Minimum	27.0	33.0	34.0	15.0	21.0	34.0	36.0	32.0	21.0	22.0	22.0	28.0
Maximum	38.0	42.0	45.0	37.0	36.0	36.0	38.0	38.0	34.0	28.0	31.0	56.0
Average	32.1	37.3	40.1	31.1	33.5	35.2	36.1	35.5	25.9	24.4	25.7	36.6
						Turbidity (ntu)						
Minimum	0.2	4.4	0.5	0.0	0.0	0.0	0.0	0.0	0.6	0.7	0.2	0.1
Maximum	37.7	44.9	47.5	20.2	3.8	1.4	0.6	3.3	41.7	22.1	11.5	45.8
Average	5.2	9.4	16.8	0.8	0.1	0.3	0.2	0.6	5.7	2.7	1.0	2.4
						Depth (feet)						
Minimum	0.6	0.6	0.5	0.1	0.5	0.8	1.1	1.3	0.8	1.4	0.8	0.5
Maximum	1.5	1.2	1.8	1.2	1.9	2.0	2.2	2.5	2.4	2.7	2.4	1.1
Average	1.2	0.9	0.9	0.7	1.5	1.5	1.8	2.0	1.6	2.1	1.7	0.8
						pH						
Minimum	7.0	7.1	7.0	7.1	6.9	7.0	7.0	6.9	6.8	6.6	6.0	6.0
Maximum	8.4	8.4	8.3	7.6	7.5	7.1	7.1	7.1	7.1	7.1	6.9	6.8
Average	7.4	7.4	7.4	7.3	7.1	7.0	7.1	7.0	7.0	6.9	6.5	6.3

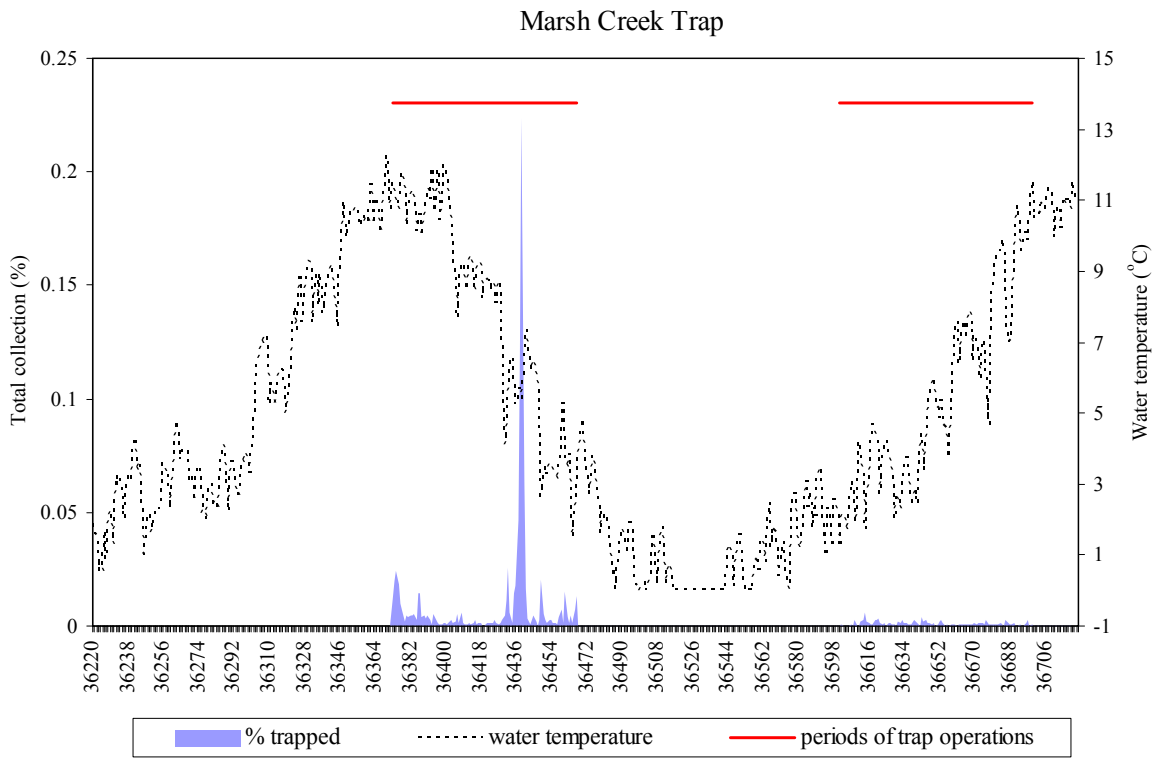
Appendix Table 27. Monthly environmental data collected from South Fork Salmon River (RKm 112 from its mouth at the Salmon River) from August 1999 through July 2000.

	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Aprl	May	Jun	Jul
						Temperature (°C)						
Minimum	7.8	1.8	0.0	0.0	0.1	0.1	0.1	0.0	0.6	1.6	2.6	7.2
Maximum	15.7	14.1	9.8	5.5	2.3	1.8	2.6	6.0	8.3	9.3	15.6	15.7
Average	12.7	8.8	4.6	1.9	0.3	0.3	0.8	1.9	3.7	5.0	9.2	12.2
						Dissolved Oxygen (ppm)						
Minimum	8.4	9.6	11.0	11.2	11.3	12.2	12.5	10.8	9.7	9.5	8.2	7.7
Maximum	11.0	13.9	14.2	14.2	13.0	13.4	14.0	14.2	12.0	11.3	11.2	10.2
Average	9.4	11.1	12.6	13.3	12.4	12.7	13.0	12.9	10.8	10.4	9.6	8.8
						Specific Conductance (µS/cm)						
Minimum	38.0	50.0	47.0	30.0	44.0	51.0	51.0	34.0	23.0	18.0	19.0	33.0
Maximum	52.0	69.0	65.0	66.0	62.0	59.0	60.0	57.0	42.0	26.0	34.0	48.0
Average	45.0	55.3	58.6	52.8	55.3	55.3	54.7	51.0	28.5	22.2	25.0	41.1
						Turbidity (ntu)						
Minimum	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	2.3	1.9	0.9	0.2
Maximum	7.6	0.6	35.9	43.1	18.1	33.8	13.0	22.1	41.9	20.9	22.2	4.8
Average	0.4	0.1	0.5	1.1	0.2	0.2	0.2	1.2	6.7	5.0	2.6	0.6
						Depth (feet)						
Minimum	0.5	0.5	0.4	0.3	0.4	0.5	0.1	0.1	1.0	1.4	1.0	0.7
Maximum	1.2	1.1	1.2	1.6	2.7	2.2	2.2	1.3	2.1	2.5	2.6	1.2
Average	0.9	0.8	0.8	0.9	1.5	1.2	0.8	0.8	1.6	2.1	1.8	1.0
						pH						
Minimum	7.4	7.4	7.2	7.0	7.1	7.1	7.1	6.8	7.1	7.0	7.0	7.2
Maximum	8.4	8.3	8.1	8.6	7.4	7.5	7.5	7.7	7.8	7.5	7.8	8.6
Average	7.7	7.7	7.6	7.5	7.2	7.3	7.3	7.2	7.3	7.2	7.3	7.7

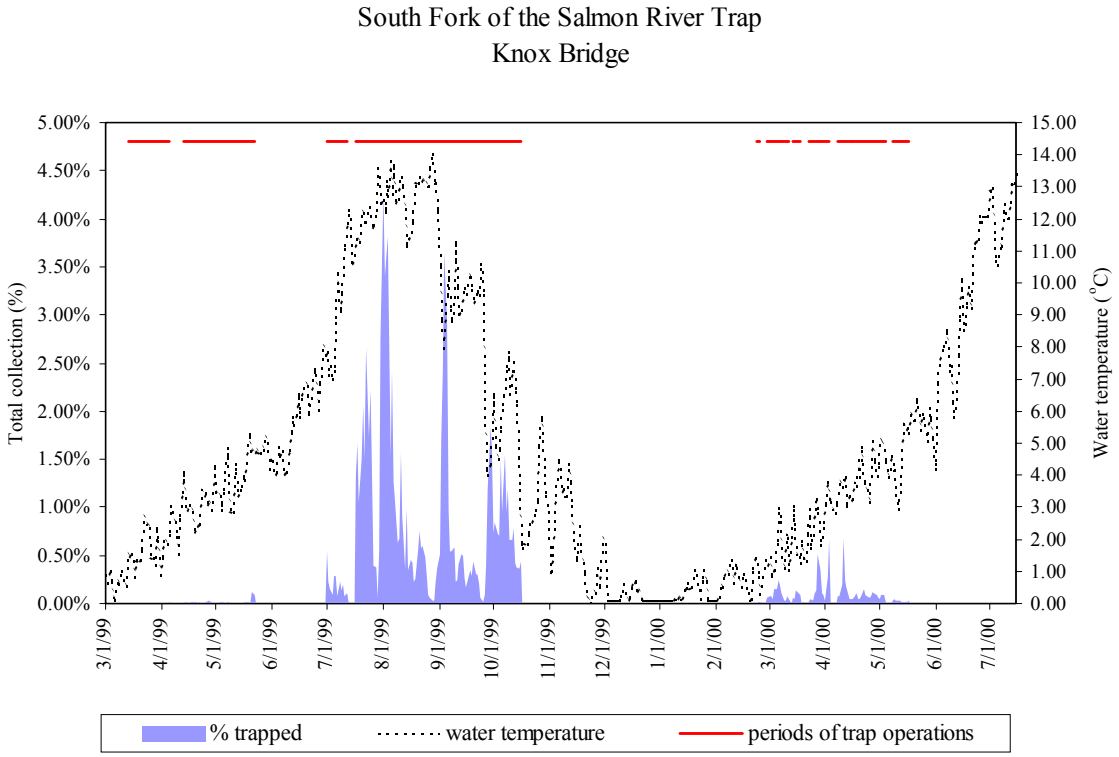
Appendix Table 28. Monthly flow information from August 1999 through July 2000 in cubic feet per second (cfs) for various sites in the Salmon River drainage in Idaho. These data were provided by the U. S. Geological Survey and is cited as provisional data subject to revision.

Flow	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
Station number 13295000--Valley Creek at Stanley, ID												
Mean	147	91	89	101	89	78	81	84	272	454	418	133
Min	109	78	76	62	75	70	70	74	95	278	229	81
Max	199	112	187	188	109	89	87	106	410	677	707	221
Station number 13302500--Salmon River at Salmon, ID												
Mean	1,399	1,067	1,275	1,425	1,216	1,174	1,265	1,269	2,029	3,587	3,333	1,182
Min	1,140	983	1,140	1,220	750	850	1,100	1,200	1,300	2,110	1,830	803
Max	1,680	1,210	1,590	1,590	1,440	1,430	1,350	1,380	2,690	6,000	4,640	1,750
Station number 13310700--South Fork Salmon River near Krassel Ranger Station, ID												
Mean	236	144	139	205	165	125	178	239	967	1,629	1,114	283
Min	171	122	122	119	110	95	150	190	330	1,010	504	173
Max	309	170	288	631	245	140	237	393	1,560	2,400	1,780	478
Station number 13314300--South Fork Salmon River at mouth near Mackay Bar, ID												
Mean	1,033	612	556	705	596	579	641	790	3,006	6,197	4,411	1,126
Min	747	522	481	483	417	318	545	663	972	3,670	1,980	666
Max	1,380	731	1,160	1,620	810	734	873	1,110	5,000	9,570	6,860	1,890
Station number 13317000--Salmon River at White Bird, ID												
Mean	6,523	4,465	4,547	5,102	4,523	4,408	4,641	5,619	15,383	29,223	21,727	6,718
Min	5,060	4,030	4,270	4,260	3,460	3,240	3,300	4,900	6,600	18,800	11,000	4,350
Max	8,130	5,120	5,920	7,510	5,560	4,960	5,290	7,590	23,300	41,600	31,000	10,500



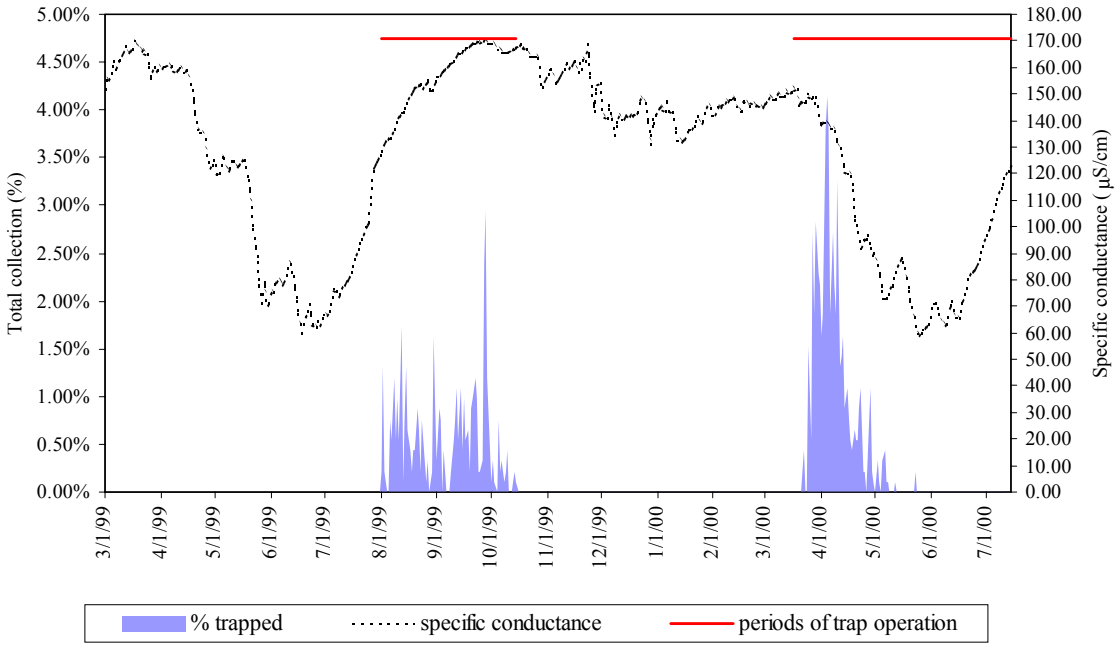


Appendix Figure 1. Daily passage of wild chinook salmon fry, parr, and smolts at three migrant traps, expressed as percentages of total collected, and plotted against average daily water temperatures collected near traps. Periods of trap operations are also shown.

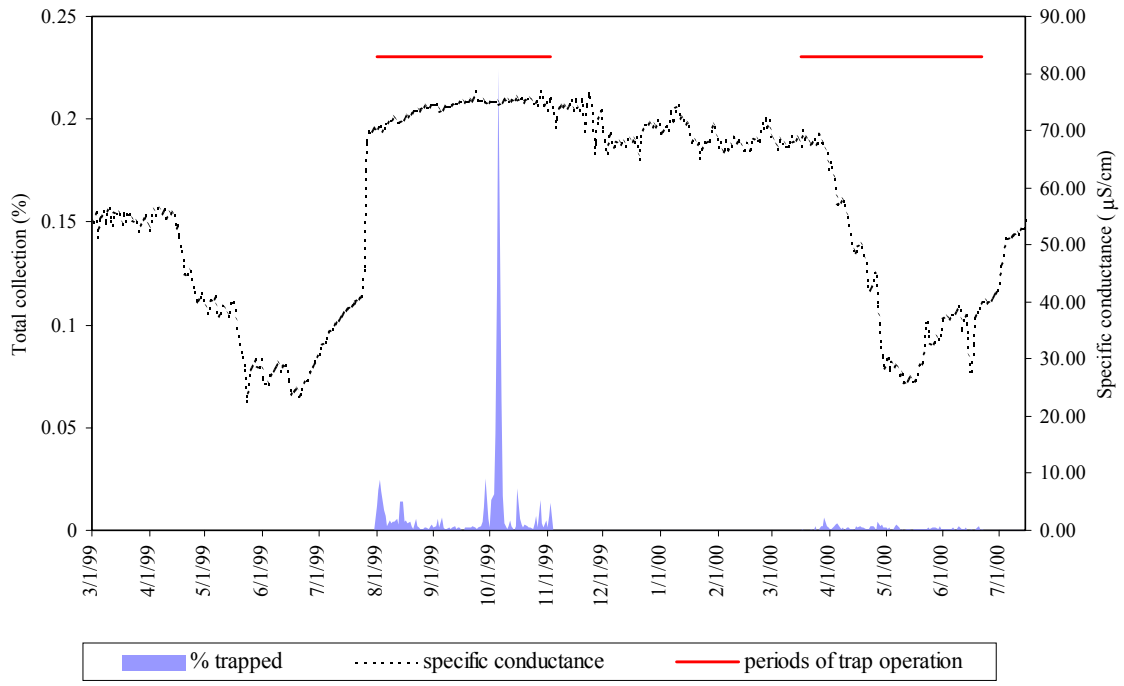


Appendix Figure 1. Continued.

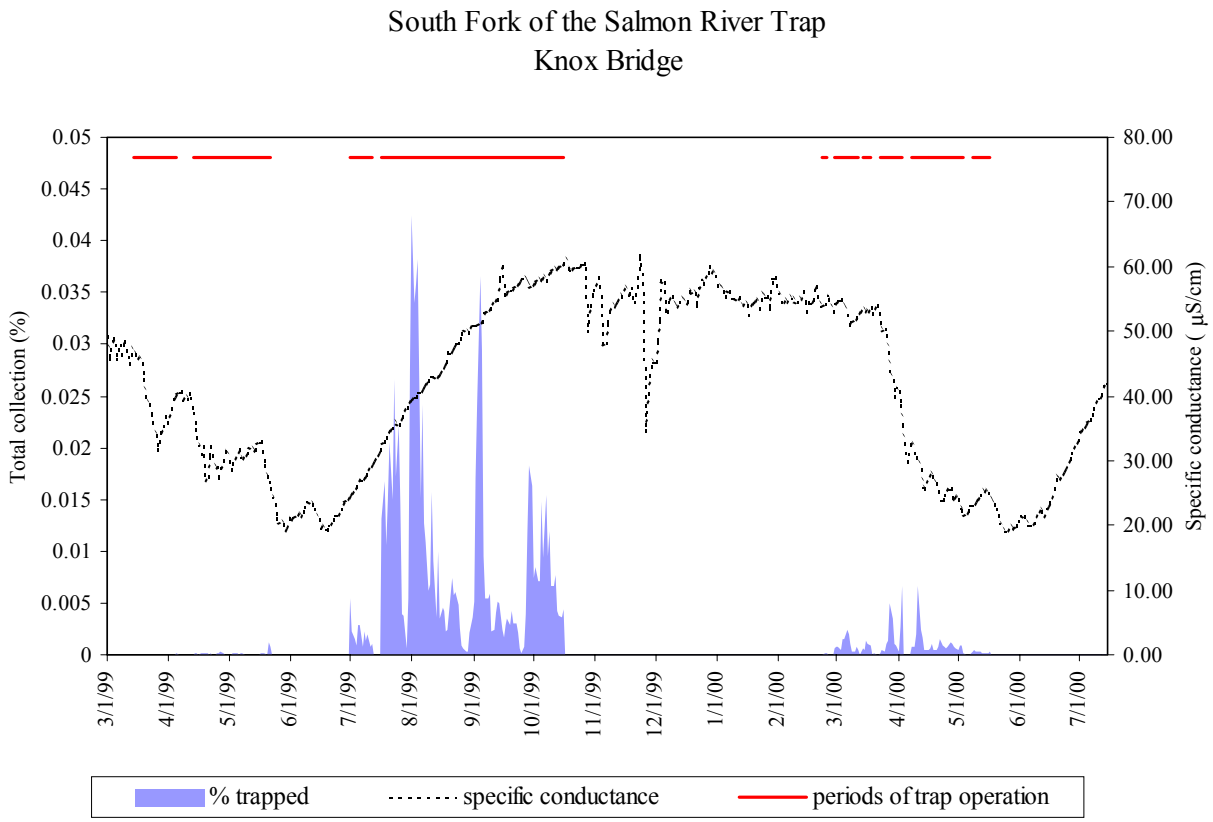
Sawtooth Intake Trap
Upper Salmon River



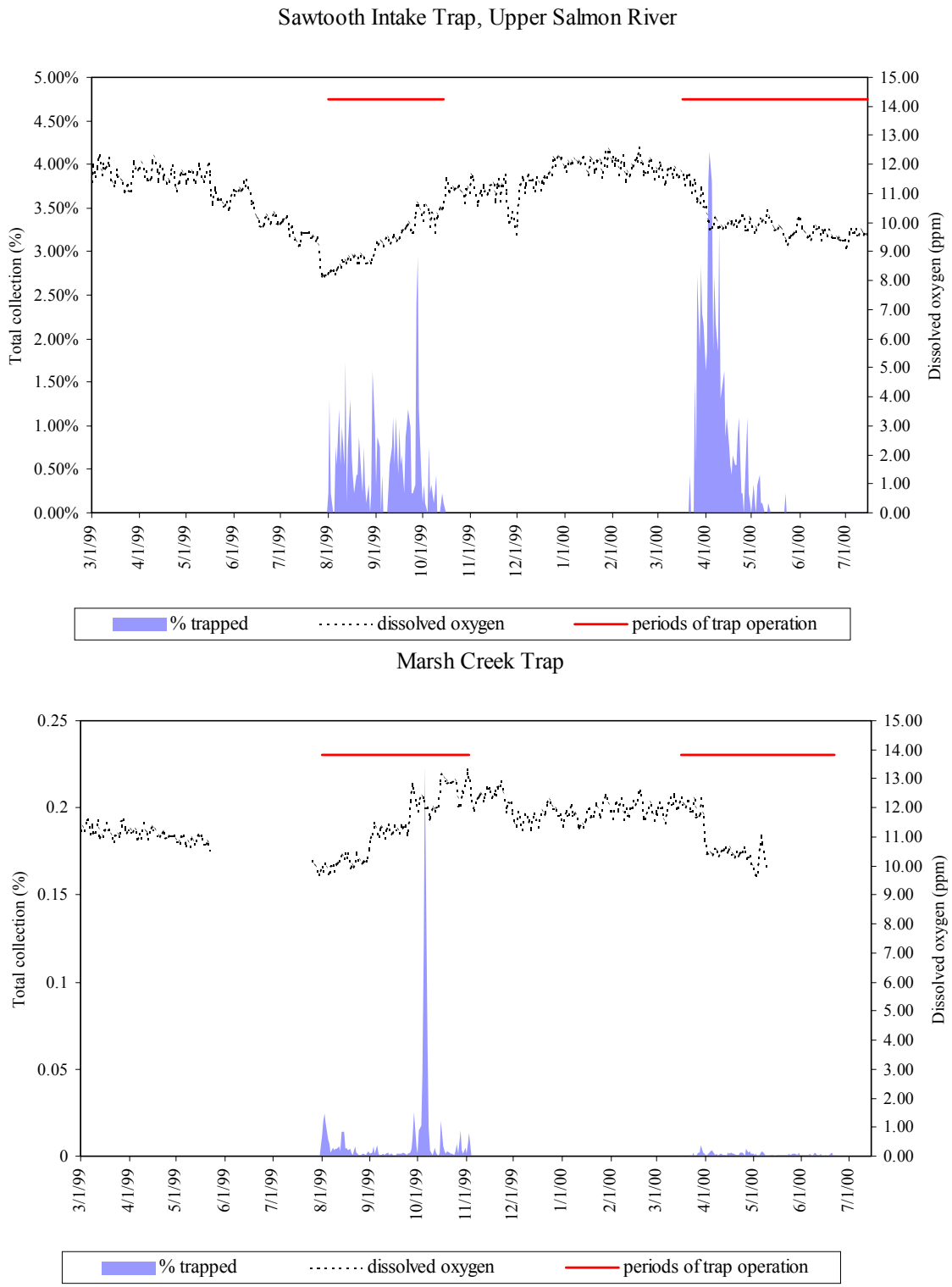
Marsh Creek Trap



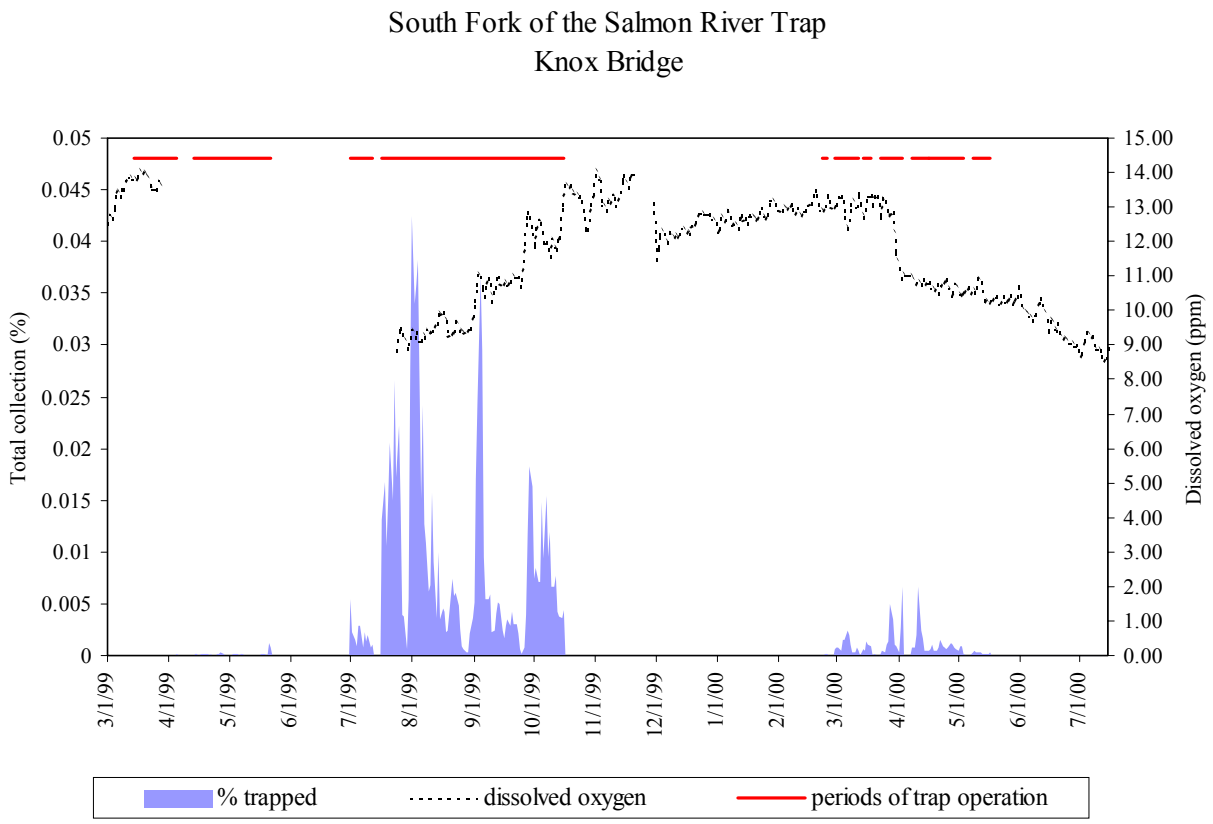
Appendix Figure 2. Daily passage of wild chinook salmon fry, parr, and smolts at three migrant traps, expressed as percentages of total collected, and plotted against average daily water conductivity collected near traps. Periods of trap operations are also shown.



Appendix Figure 2. Continued.

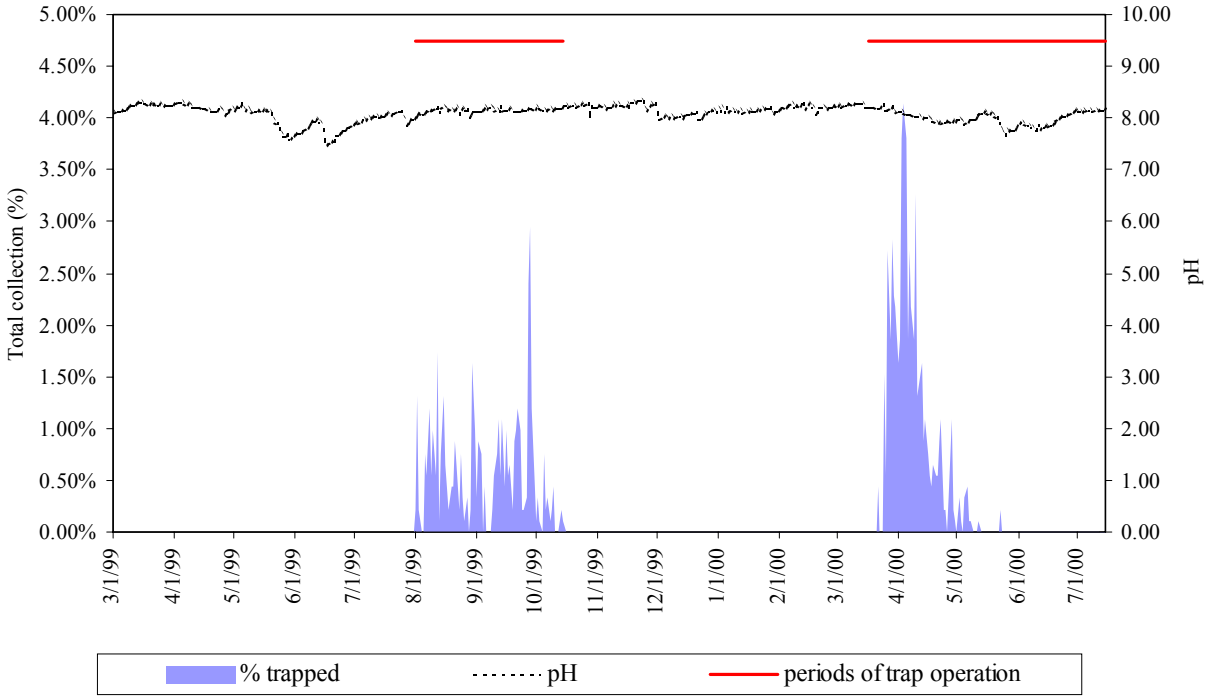


Appendix Figure 3. Daily passage of wild chinook salmon fry, parr, and smolts at three migrant traps, expressed as percentages of total collected, and plotted against average daily water dissolved oxygen collected near traps. Periods of trap operations are also shown.

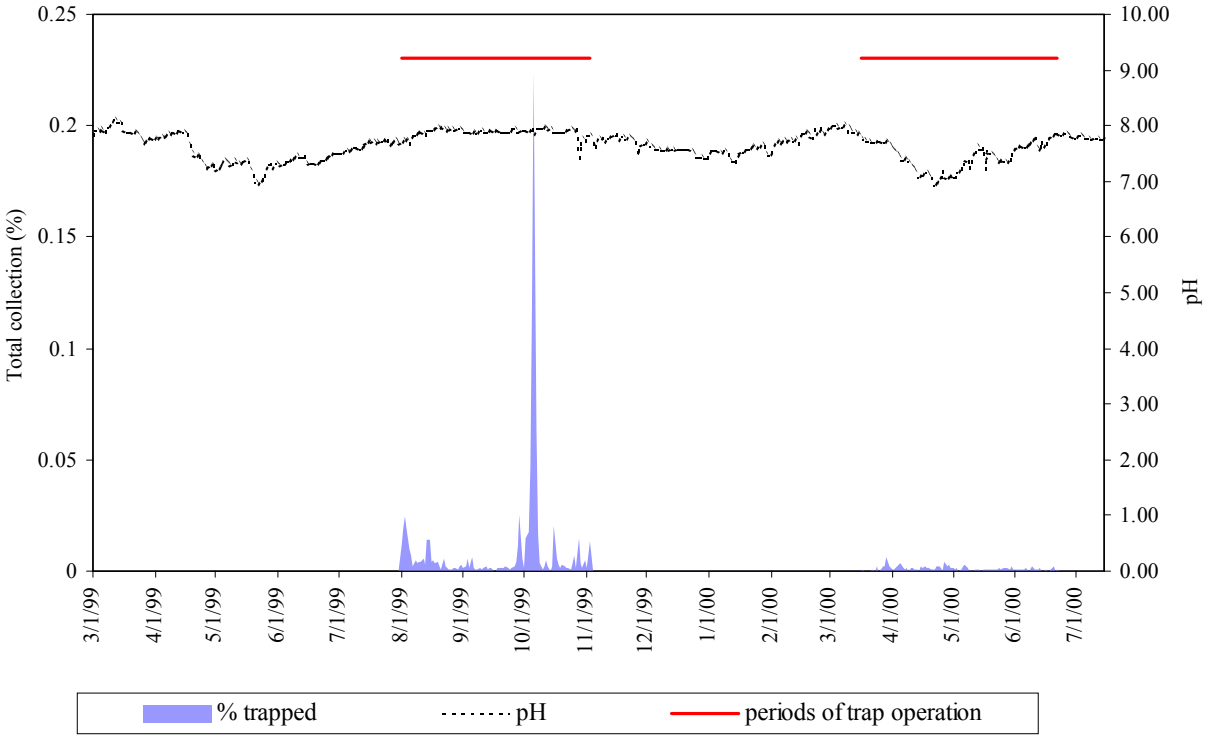


Appendix Figure 3. Continued.

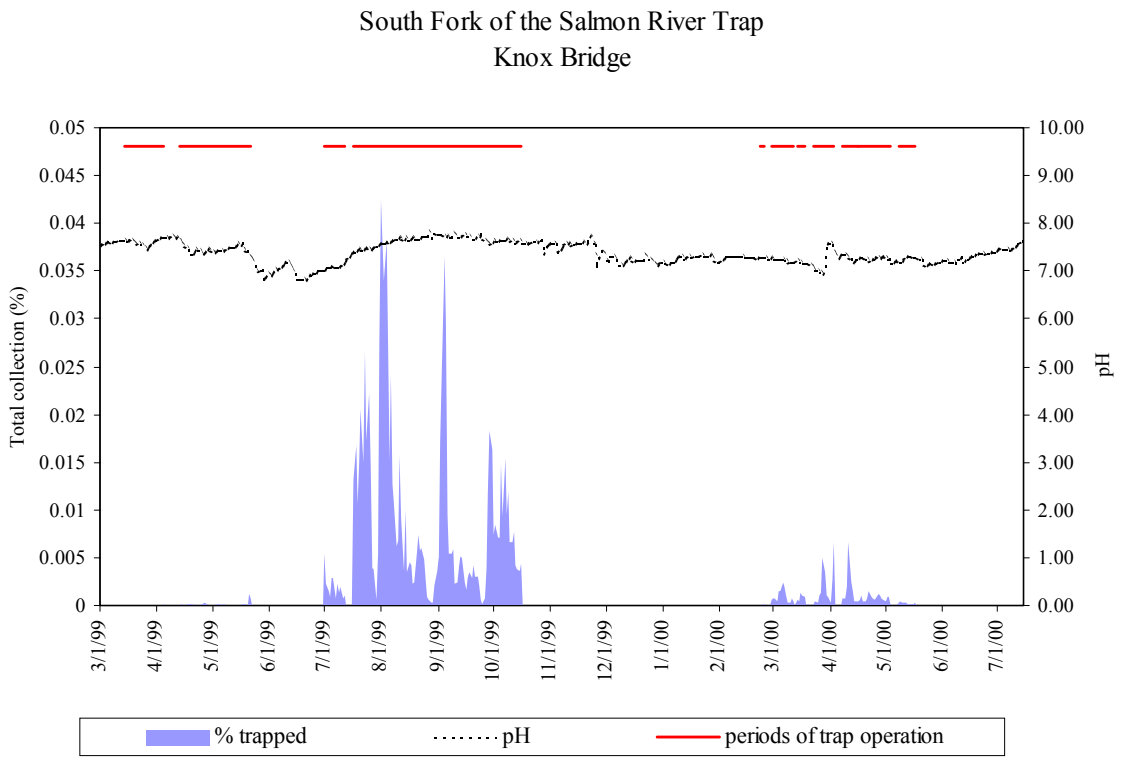
Sawtooth Intake Trap
Upper Salmon River



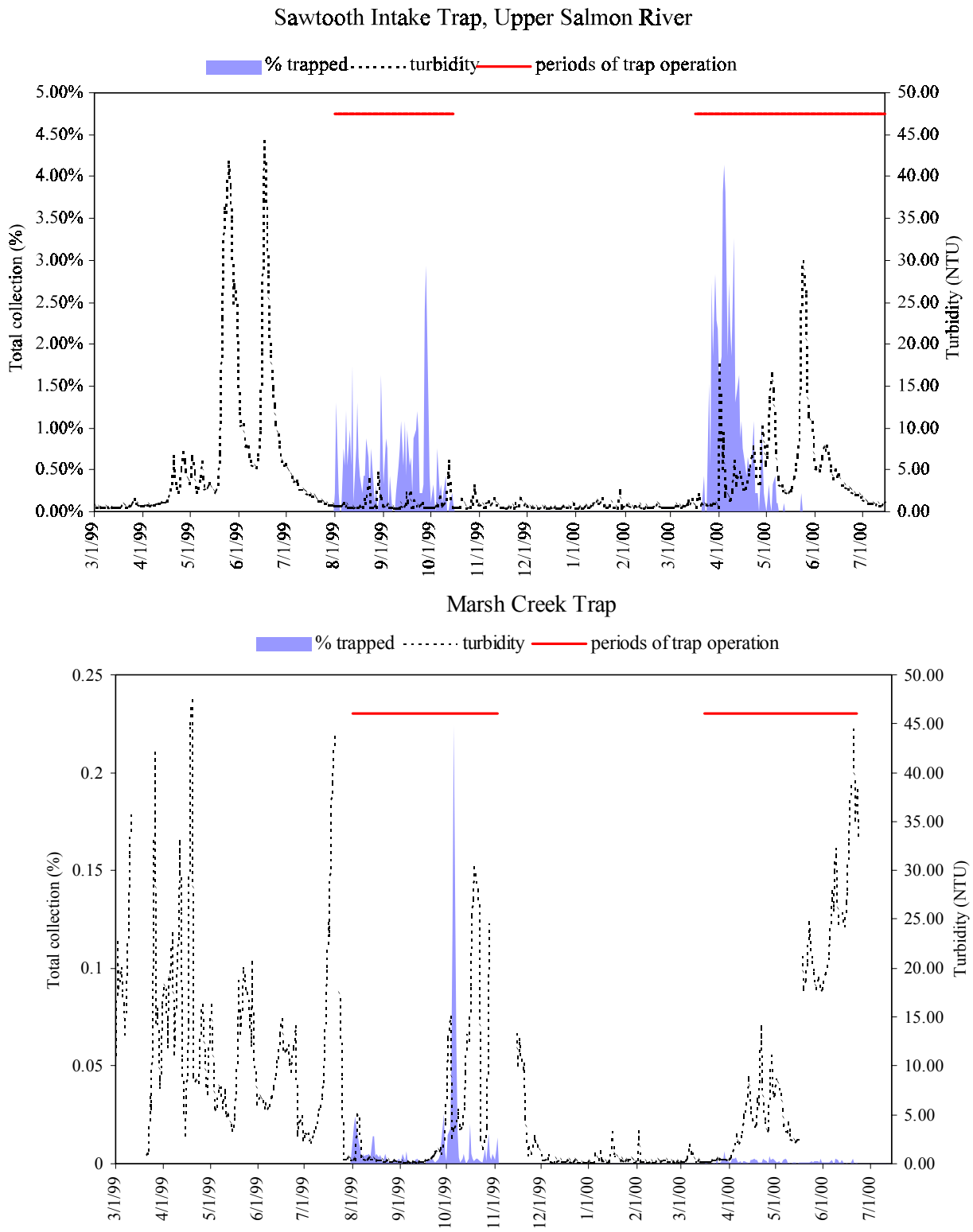
Marsh Creek Trap



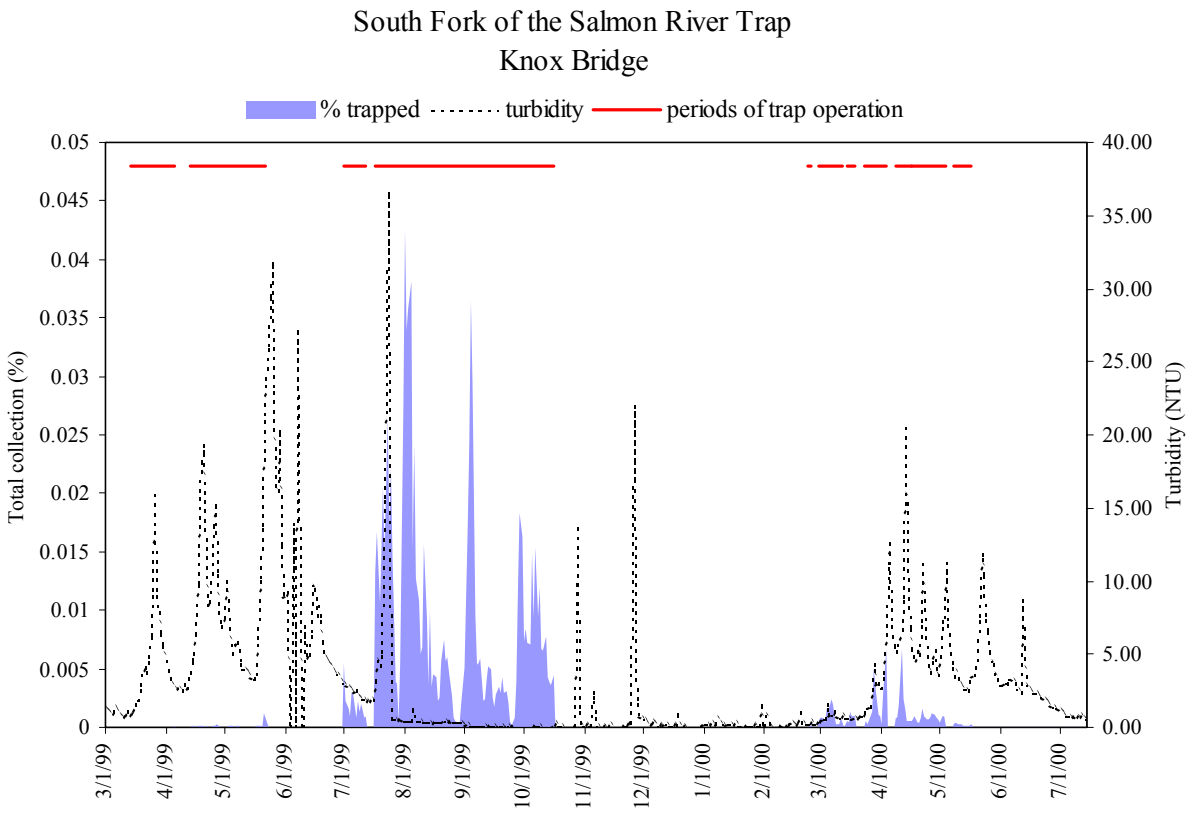
Appendix Figure 4. Daily passage of wild chinook salmon fry, parr, and smolts at three migrant traps, expressed as percentages of total collected, and plotted against average daily water pH collected near traps. Periods of trap operations are also shown.



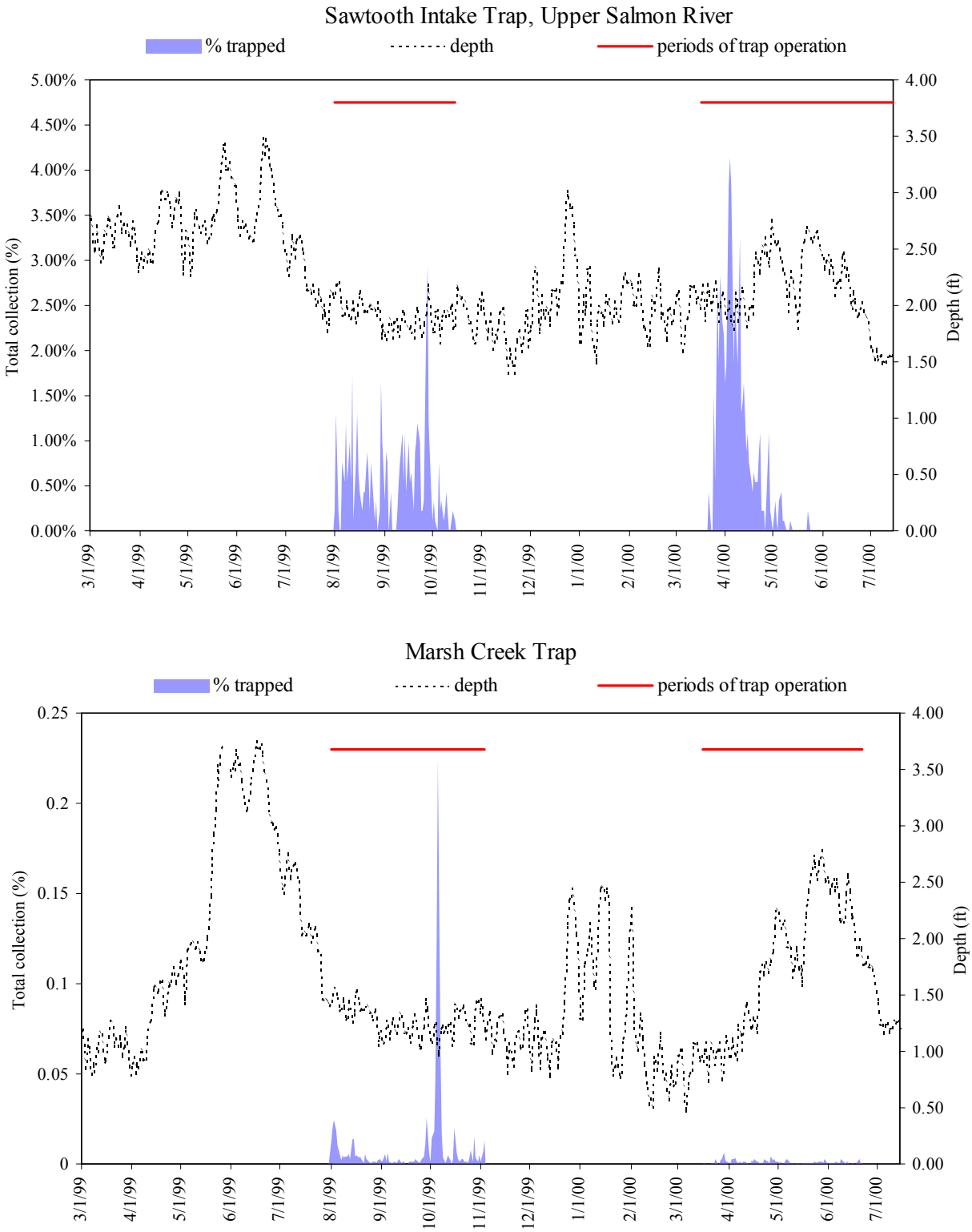
Appendix Figure 4. Continued.



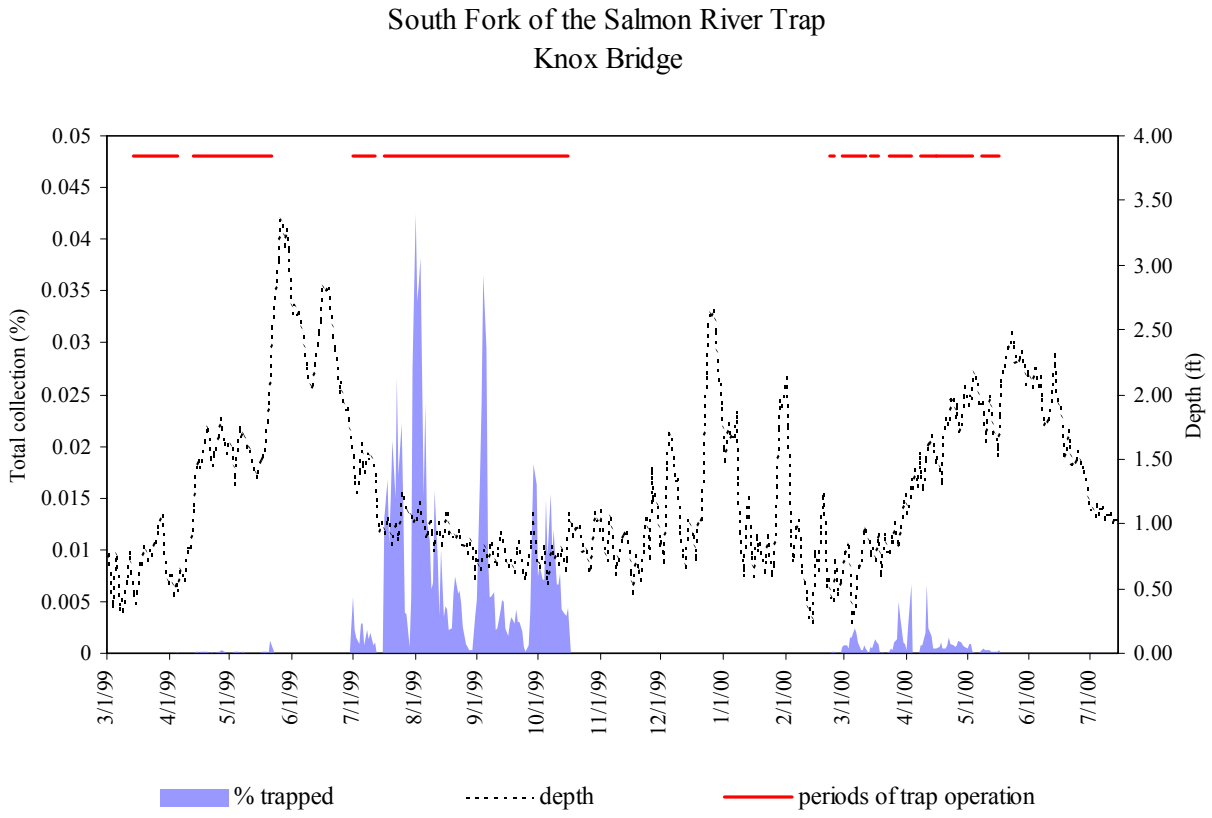
Appendix Figure 5. Daily passage of wild chinook salmon fry, parr, and smolts at three migrant traps, expressed as percentages of total collected, and plotted against average daily water turbidity collected near traps. Periods of trap operations are also shown.



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 water depth collected near traps. Periods of trap operations are also shown.



Appendix Figure 6. Continued.