Monitoring the Migrations of Wild Snake River Spring/Summer Chinook Salmon Smolts, 2002

Stephen Achord, Eric E. Hockersmith, Benjamin P. Sandford, Regan A. McNatt,
Blake E. Feist, and Gene M. Matthews

Report of research by

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

for

U.S. Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife
P.O. Box 3621
Portland, Oregon 97208-3621
Project 1991-028-00
Contract No. 00005619

July 2003

EXECUTIVE SUMMARY

This report details the 2002 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 detection data from passive-integrated-transponder tags (PIT tags) had shown distinct differences in migration patterns between wild and hatchery fish for three consecutive years. National Marine Fisheries Service (NMFS) investigators first observed these differences in 1989. The data originated from tagging and interrogation operations begun in 1988 to evaluate smolt transportation 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. 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 2001-2002 are listed below:

1) In July and August 2001, we PIT tagged and released 10,242 wild chinook salmon parr in 11 Idaho streams.

2) Average overall observed mortality from collection, handling, tagging, and after a 24-hour holding period was 1.6%.

3) Using the detection probability expansion method, estimated parr-to-smolt survival to Lower Granite Dam for Idaho and Oregon streams averaged 14.3% (range 6.6-38.1% depending on stream of origin).

4) Length and weights were taken on 483 recaptured fish from 11 Idaho streams at Little Goose Dam in 2002. Fish had grown an average of 39.7 mm in length and 9.0 g in weight over an average of 275 days. Their mean condition factor declined from 1.28 at release (parr) to 1.00 at recapture (smolt).

5) Larger fish at release were detected at a significantly higher rate the following spring and summer than their smaller cohorts ($P < 0.001$).

6) Fish that migrated through Lower Granite Dam in April and May were significantly larger at release than fish that migrated after May ($P = 0.0007$).

7) In 2002, the peak detections at Lower Granite Dam of parr tagged during the late summer in 2001 (from the 11 streams in Idaho and 4 streams in Oregon) occurred during moderate flows of 86.7 kcfs on 4 May. The 50th and 90th percentile passage occurred on 3 and 29 May, respectively.

The estimated parr-to-smolt survivals (revised) from streams of origin from Idaho and Oregon combined to Lower Granite Dam from 1993 to 2002 are:

Migration year	Parr-to-smolt survival (%)
1993	15.3
1994	18.8
1995	13.5
1996	20.6
1997	20.8
1998	24.4
1999	19.9
2000	17.7
2001	19.5
2002	14.3

Over these years, the parr-to-smolt survival estimates for individual populations have varied widely, ranging from 6.0% for South Fork Salmon River in 1996 to 47.6% for Elk Creek in 1998. 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 2002, as well as arrival timing patterns for several stocks over the years.

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, 1998, and 2001 the median passage date at the dam was between 29 April and 9 May, and the 90th percentile 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 both 1992 and 2001, we experienced near record low flows in the Snake River. The overall migration timing patterns of wild fish at the dam were similar in these two years; however, the timing in 1992 was earlier than 2001 due to the very warm spring in 1992.

In 1995, weather conditions in late winter and early spring were moderate compared to those of the previous six 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 the 50th percentile passing by 3 May and the 90th 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 the 50th and 90th percentiles passing in early and late May, respectively. In 2002, the 50th and 90th percentile also passed Lower Granite Dam in early and late May, respectively. However, in 2002, we had slightly lower than normal temperatures and cooler than normal climatic conditions throughout the spring, along with close to normal flows, with the highest flows occurring in mid-April and late-May. Therefore, although our previous observations support the importance of annual climatic conditions influencing overall migration timing of the stocks at Lower Granite Dam; clearly, complex interrelationships of several factors drives the annual migrational timing of the stocks.

CONTENTS

EXECUTIVE SUMMARY iii

INTRODUCTION 1
Background 1
Project Goals 1

METHODS 3
Fish Collection and Tagging 3
Recaptures at Dams 3
Juvenile Migrant Traps 4
Interrogation at Dams 4
Migration Timing 4
Environmental Information 6

RESULTS 7
Fish Collection and Tagging 7
Recaptures at Dams 7
Recaptures at Traps 12
Detections at Dams 12
Migration Timing 14
Lower Granite Dam 14
Comparison with Flows 24
Environmental Information 24

DISCUSSION 33
Relationships with Flow 34
Climatic Influence 35
Cumulative Data: 1989-2002 36

ACKNOWLEDGMENTS 39

REFERENCES 40

APPENDIX: Data Tables and Figures 43

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 three 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 than those of their hatchery-reared counterparts, and exhibited more variable timing patterns over the three years. 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 began a cooperative ongoing project to monitor the migrations of wild chinook salmon smolts (Achord et al.1994; 1995a,b; 1996a; 1997; 1998; 2000; 2001a,b; 2002).

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 (NWPPC 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. More recently, Section 5.9A.1 of the 1994 Fish and Wildlife Program states that field monitoring of smolt movement will be used to determine the best timing for water

storage releases and Section 5.8A.8 states that continued research is needed on survival of juvenile wild fish before they reach the first dam with special attention to water quantity, quality, and several other factors.

In addition to addressing several sections of these Fish and Wildlife Programs, our research also addresses some of the "Reasonable and Prudent Alternatives (RPAs)" in the 2000 NMFS Biological Opinion (NMFS 2001). Section 9.6.5.2, Action 180 advocates a regional monitoring effort on the population status of wild fish stocks and the environmental status of their natal streams and tributaries. Section 9.6.5.5, Action 199 further states that "the required research/monitoring activities will provide data and information necessary to develop annual management strategies to help mitigate hydropower system impacts and to answer important questions related to system operations." Appendix H Research Action 1193 calls for "...research to produce information on the migrational characteristics of Columbia and Snake River basin salmon and steelhead." The smolt monitoring program produces information on the migrational characteristics of various salmon and steelhead stocks...and provides management information for implementing flow and spill measures designed to improve passage conditions in the mainstem lower Snake and Columbia Rivers."

In 2001-2002, we also continued to collect environmental data for the Baseline Environmental Monitoring Program, which was developed from 1993 to 1997. The project collects 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 and estimate parr-to-smolt survival of different stocks of wild Snake River spring/summer chinook salmon smolts at Lower Granite Dam, 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 2001 and the subsequent monitoring of these fish. Fish were monitored as they migrated through juvenile migrant traps in 2001 and 2002 as well as through interrogation systems at Lower Granite, Little Goose, Lower Monumental, McNary, John Day, and Bonneville Dams during 2002.

In addition, data from environmental monitoring in 2001-2002 are reported here. These data consist of water temperature, dissolved oxygen, specific conductance, turbidity, water 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 2001-2002 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 2001. To further alleviate stress associated with the collection and PIT-tagging operations, we used medical grade oxygen in temporary holding containers during seining and electrofishing operations and in the carboys during transport of fish to the tagging site. We also supplied oxygen to all containers at the tagging site during tagging operations.

Recaptures at Dams

While collecting and PIT tagging fish at the dams for various studies, NMFS and other personnel occasionally encounter wild fish that are already PIT tagged. In such cases, biological data from these fish are collected, although very few such fish are handled in this manner at the dams. However, in 2001, NMFS began a concerted effort to gather parr-to-smolt growth information on these previously PIT-tagged wild fish from the various streams. In 2002, we continued this work.

We utilized the PIT-tag separation-by-code system (Downing et al. 2001) at Little Goose Dam to collect this information. A maximum of 100 wild fish from each stream was programmed for separation at this dam for length and weight measurements. All fish that were separated at the dam were handled using water-to-water transfers and other best handling practices. After handling, all tagged and untagged fish were returned to the bypass system for release below the dam.

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

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

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

Juvenile Migrant Traps

During fall 2001 and spring 2002, juvenile migrant fish traps were operated at Knox Bridge on the South Fork of the Salmon River, on the South Fork of the Salmon River below its confluence with the Secesh River, on Lake Creek, near Chinook Campground on the Secesh River, on Marsh Creek, and near the Sawtooth Hatchery on the upper Salmon River (Figure 1). Also during spring 2002, juvenile migrant fish traps were operated on the lower Salmon River near Whitebird, Idaho, and on the Snake River at Lewiston, Idaho (Figure 1). Traps were operated by the Nez Perce Tribe and the Idaho Department of Fish and Game.

Generally, handling procedures for fish at these traps involve anesthetizing the fish and scanning for PIT tags followed by length and weight measurements. Upon recovery, all fish are released back to the streams or rivers.

Interrogation at Dams

During spring and summer 2002, 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 (Figure 1), Little Goose, and Lower Monumental Dams on the Snake River, 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.

Migration Timing

During the years 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 (of all wild PIT-tagged chinook salmon smolts) expanded relative to estimated daily detection probabilities.

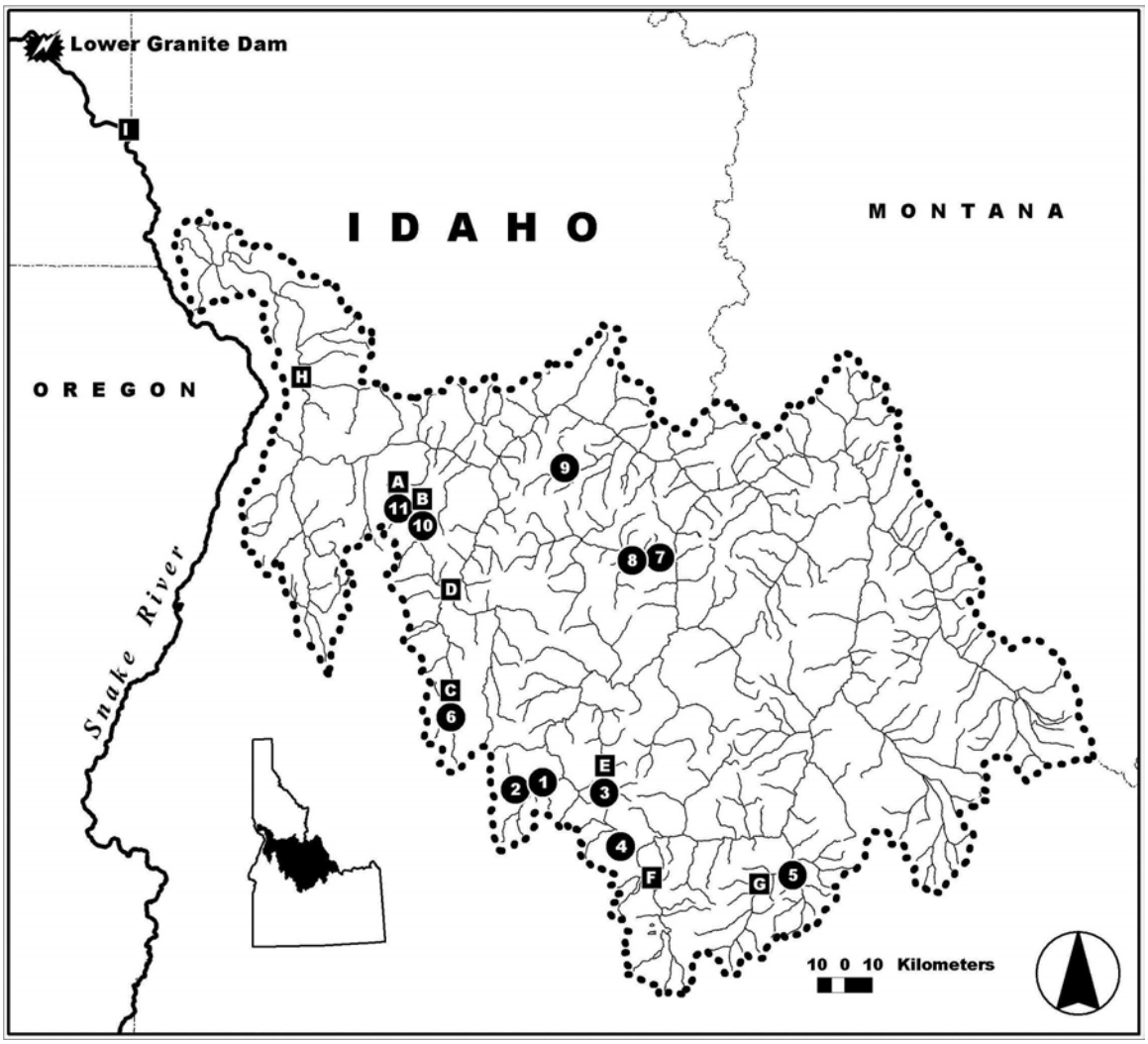


Figure 1. Wild spring/summer chinook salmon parr were PIT tagged during 2001 in the following streams: 1–Bear Valley Creek, 2–Elk Creek, 3–Marsh Creek, 4–Valley Creek, 5–Herd Creek, 6–South Fork Salmon River, 7–Big Creek (lower), 8–Rush Creek, 9–West Fork Chamberlain Creek, 10–Secesh River, and 11–Lake Creek. Juvenile migrant fish traps shown above are as follows: A–Lake Creek, B–Secesh River, C–South Fork Salmon River, D–Lower South Fork Salmon River, E–Marsh Creek, F–Sawtooth, G–East Fork Salmon River, H–Salmon River, and I–Snake River.

Detection probabilities were calculated using the methods of Sandford and Smith (2002) 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, first-time detections were not expanded per above procedures.

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

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 13 streams. The Student-Newmann-Keuls (SNK) multiple comparison method ($\alpha = 0.05$) was used to make comparisons between streams for each statistic (Petersen 1985).

We also examined 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 chose stocks with nine or more years of timing data for these analyses. Comparisons of the 10th, 50th, and 90th percentile passage dates were made among 10 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 (Petersen 1985).

Environmental Information

Environmental data were 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 close to juvenile migrant fish traps.

RESULTS

Fish Collection and Tagging

From 25 July to 27 August 2001, we collected 11,180 wild chinook salmon parr in 11 Idaho streams (Figure 1) over a distance of about 33 stream kilometers and approximately 298,923 m^2 (Table 1; Appendix Table 1). Of these fish, 10,242 were PIT tagged and released back into the streams; the remainder were not tagged because of size, injury, or precocious maturation or because they were collected for genetic studies or were extra collected fish. Numbers released per stream ranged from 14 in Rush Creek to 1,534 in the South Fork of the Salmon River (Table 1 and Appendix Tables 1 and 2). Fork lengths of all collected chinook salmon parr ranged from 43 to 176 mm (mean 66.5 mm) and weights ranged from 1.0 to 45.4 g (mean 4.0 g). Fork lengths of tagged and released chinook salmon parr ranged from 51 to 176 mm (mean 67.1 mm) and weights ranged from 1.3 to 12.7 g (mean 4.0 g) (Appendix Table 1).

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, as we targeted collecting chinook salmon not coincident species.

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 1.5%, and average tagging and 24-hour delayed mortality was 0.1%. The average overall observed mortality was 1.6%.

Recaptures at Dams

From 20 April to 28 June 2002, 484 PIT-tagged wild fish from Idaho streams were recaptured in the separation-by-code system at the Little Goose Dam juvenile fish facility (Table 4). We gathered parr-to-smolt growth information on 483 of these fish. Between tagging in 2001 and recapture in 2002, overall mean length increased by 39.7 mm (range 13-106 mm) and overall mean weight increased by 9.0 g (range 1.3-18.5 g), over a mean recapture interval of 275 days (range 238-335 days). Average growth rates in length between tagging and recapture ranged from 0.13 to 0.16 mm/day and weight gain averaged from 0.030 to 0.034 g/day for fish from these 11 streams. The mean condition factor decreased from 1.28 at release (parr) to 1.00 at recapture (smolt) for these wild fish.

Of the 10 other PIT-tagged wild fish recaptured and handled at the dams, only 4 were measured and 1 was weighed (Table 4).

Table 1. Summary of collection, PIT tagging, and release of wild chinook salmon parr with average fork lengths and weights, approximate distances, and estimated areas sampled in streams of Idaho during July and August 2001.

	Number of fish		Average fish length (mm)		Average fish weight (g)		Collection area to mouth of stream	Estimated area sampled in streams
Tagging location	Collected	Tagged and released	Collected	Tagged	Collected	Tagged	(km)	(m^2)
Bear Valley Creek	1,543	1,495	65.6	65.6	4.0	3.9	9-10 & 12-19	51,991
Elk Creek	1,574	1,519	68.2	68.4	4.0	4.1	0-5 & 9	30,707
Marsh Creek	1,082	1,056	71.7	71.8	4.7	4.8	11-14	32,130
Valley Creek	1,577	1,497	70.8	70.4	5.1	4.7	4 & 6-8 & 18	42,274
Herd Creek	32	24	100.7	89.9	14.3	8.6	1-3	10,452
S. Fork Salmon River	1,678	1,534	62.5	63.4	3.4	3.5	117 & 121	32,160
Big Creek (lower)	432	409	75.6	75.7	5.2	5.2	9-12	32,739
Rush Creek	14	14	76.2	76.2	5.2	5.2	0-1	3,600
W.F. Chamberlain Creek	513	510	67.1	67.2	3.7	3.7	1-2	920
Secesh River	1,891	1,489	61.4	63.5	2.9	3.2	25-27	42,271
Lake Creek	844	695	63.0	63.9	3.5	3.7	1-2	19,679
Totals or averages	11,180	10,242	66.5	67.1	4.0	4.0	33	298,923

Table 2. Summary of species other than chinook salmon parr observed during collection operations in Idaho in July and August 2001. Numbers of steelhead in parentheses were PIT tagged for the Idaho Department of Fish and Game.

Streams	Steelhead	Unidentified fry	Brook trout	Cutthroat trout	Bull trout
Bear Valley Creek	636 (537)	1,756	592	0	8
Elk Creek	131 (127)	631	490	2	4
Marsh Creek	106 (92)	792	1,852	0	1
Valley Creek	259 (128)	255	210	1	2
Herd Creek	294 (139)	784	0	0	2
S. Fork Salmon River	159 (148)	1,325	76	0	2
Big Creek(lower)	451 (236)	645	0	3	0
Rush Creek	93 (45)	14	0	0	0
W.F. Chamberlain Creek	68 (68)	39	1	0	4
Secesh River	172 (147)	692	22	0	5
Lake Creek	105 (87)	203	89	0	19
Totals	2,474	7,136	3,332	6	47

	Sculpin	Dace	Sucker	Whitefish	Shiner
Bear Valley Creek	1,116	63	541	102	0
Elk Creek	208	3	74	1,558	0
Marsh Creek	1,225	0	0	64	0
Valley Creek	2,786	1,354	219	255	0
Herd Creek	506	0	0	51	0
S. Fork Salmon River	1,782	19	0	14	0
Big Creek (lower)	256	86	8	6	0
Rush Creek	83	1	0	1	0
W. F. Chamberlain Creek	15	0	0	35	0
Secesh River	668	97	0	0	0
Lake Creek	760	23	0	32	0
Totals	9,405	1,646	842	2,118	0

Table 3. Mortality percentages for wild chinook salmon parr collected and PIT tagged in Idaho in July and August 2001. No tag loss occurred during the study in 2001.

	Mortality (%)		
Tagging location	Collection	Tagging & 24-hour	Overall
Bear Valley Creek	1.8	0.0	1.8
Elk Creek	2.4	0.2	2.6
Marsh Creek	1.4	0.0	1.4
Valley Creek	1.2	0.4	1.6
Herd Creek	3.1	0.0	3.1
S. Fork Salmon River	0.4	0.2	0.5
Big Creek (lower)	4.4	0.0	4.4
Rush Creek	0.0	0.0	0.0
W. F. Chamberlain Creek	0.0	0.2	0.2
Secesh River	1.0	0.0	1.0
Lake Creek	2.5	0.0	2.5
Totals or averages	1.5	0.1	1.6

Table 4. Recapture information on PIT-tagged wild spring/summer chinook salmon from Idaho that were tagged in summer 2001 and recaptured by the separation-by-code system in the juvenile fish bypass system at Little Goose Dam in 2002 and at various other sites in the summer and fall of 2001. Spring and summer recaptures have interval days greater than 89.

	Number	Length gain (mm)			Weight gain (g)			Condition factor		Recapture interval (days)	
	recaptured	n	range	mean	n	range	mean	release	recapture	range	mean
Streams											
Bear Valley Cr	90	90	17-106	44.0	71	2.0-18.5	9.3	1.36	1.00	272-335	294
Elk Cr	68	68	24-66	41.7	63	4.5-17.8	10.0	1.26	1.01	268-314	290
Marsh Cr	64	64	13-57	37.2	52	1.4-15.4	9.2	1.26	1.02	257-324	288
Valley Cr	71	71	17-65	41.2	45	2.5-17.0	9.8	1.34	1.04	266-319	290
Herd Cr	1	1	45	--	1	13.5	--	--	--	289	-
SF Salmon Riv.	40	40	20-68	42.2	33	4.0-18.1	9.5	1.35	1.05	251-316	276
Big Cr (lower)	45	45	15-50	33.8	21	4.5-12.2	7.8	1.26	0.94	241-288	258
WF Chamberlain Cr	43	42	26-60	39.1	39	4.9-15.2	8.9	1.17	0.97	250-292	264
Secesh River	44	44	17-64	40.9	15	1.3-14.5	8.4	1.23	1.00	238-296	259
Lake Cr	18	18	21-53	37.1	15	3.7-13.3	7.7	1.28	1.00	242-285	258
Totals or averages	484	483	13-106	39.7	355	1.3-18.5	9.0	1.28	1.00	238-335	275
Traps											
South Fork Salmon River											
Knox-fall	79	78	0-8	1.4	55	-1.4-0.4	-0.5	1.33	1.12	1-58	27
Knox-spr.	5	5	6-20	11.6	2	0.3-1.1	0.7	1.30	1.04	230-245	237
Lower-fall	18	17	0-12	4.4	15	-0.8-1.1	-0.1	1.30	1.03	35-74	61
Lower-spr)	1	1	11	-	1	1.6	-	--	--	244	-
Secesh River											
Fall	103	103	0-14	4.4	64	-1.5-0.8	-0.5	1.38	1.00	10-61	34
Spring	1	1	36	-	-	----	-	--	-	349	-
Lake Cr (fall-only)	198	196	0-11	3.0	123	-1.9-1.5	-0.5	1.33	1.10	1-58	23
Marsh Creek											
Fall	112	111	0-14	5.3	3	-0.5-1.0	-0.1	1.29	1.18	1-89	49
Spring	5	5	16-61	37.8	1	3.5	-	1.34	--	250-384	330
Totals	522	517			264						
Collector Dams											
Lower Granite	2	1	42	--	0	--	-	--	--	245-270	257
Ice Harbor	2	1	26	--	0	--	-	--	--	301-318	309
McNary	2	2	47-47	47.0	1	9.4	-	1.40	0.95	266-300	283
John Day	3	0	-	--	0	--	--	--	--	293-308	300
Bonneville	1	0	-	--	0	--	--	--	--	266	-
Totals	10	4	---	--	1	--	--	--	--	---	-
Totals	532	521	-	--	265	--	---	--	--	--	---

Recaptures at Traps

A total of 522 wild fish PIT-tagged in summer 2001 were recaptured above Lower Granite Dam from summer-fall 2001 to summer 2002 (Table 4). Of these, 510 were recaptured in summer-fall 2001 and 12 were recaptured in spring-summer 2002.

For the 79 fish recaptured at the South Fork Salmon River trap at Knox Bridge in summer-fall 2001, the fish had grown an average of 0.05 mm/day in length and lost 0.02 g/day in weight between release in natal rearing areas and recapture at the trap (Table 4). In spring 2002, the five fish recaptured at this trap had grown an average of 0.05 mm/day in length and gained 0.003 g/day in weight between release in summer 2001 and recapture in spring 2002.

The trap on lower South Fork of the Salmon River recaptured 18 of the summer-tagged upstream released fish in summer-fall 2001 and 1 was recaptured at this trap in spring 2002 (Table 4). The 18 recaptured fish in the fall had grown an average of 0.07 mm/day in length and lost an average of 0.002 g/day in weight between release and recapture. The spring recaptured fish had grown 0.05 mm/day in length and 0.007 g/day in weight over a 244-day period (over-winter).

The trap on the Secesh River recaptured 103 of the summer-tagged fish in summer-fall 2001 and 1 was recaptured at this trap in spring 2002 (Table 4). The 103 recaptured fish in the fall had grown an average of 0.13 mm/day in length and lost an average of 0.01 g/day in weight between release and recapture. Fish recaptured in the spring had grown 0.10 mm/day in length over a 349-day period.

The trap on Lake Creek recaptured 198 of the summer-tagged fish in summer-fall 2001 and none were recaptured at this trap in spring 2002 (Table 4). The 198 recaptured fish had grown an average of 0.13 mm/day in length and lost an average of 0.02 g/day in weight between release and recapture.

The Marsh Creek trap recaptured 112 summer-tagged fish in summer-fall 2001 and 5 summer-tagged fish were recaptured at this trap during spring 2002 (Table 4). The 112 recaptured fish in summer-fall had grown an average of 0.11 mm/day in length and lost an average of 0.002 g/day in weight between release and recapture. The five recaptured fish in spring-summer 2002, had grown an average of 0.11 mm/day in length. Only one of these five fish was weighed, and it had gained 0.014 g/day over 250 days.

Detections at Dams

Based on expanded detections (1,382 fish) at Lower Granite Dam from 11 April to 5 July 2002, estimated survival from parr to smolt for Idaho fish averaged 13.5% (range 8.5-38.1%; Table 5; Appendix Tables 4-14; Herd Creek omitted from analysis). An additional 750 first-time detections (unadjusted) were recorded at Little Goose,

Table 5. Summary of first-time detections of PIT-tagged wild spring/summer chinook salmon smolts from Idaho at six dams from April to August 2002. Expanded detections at Lower Granite Dam provide estimates of parr to smolt survival.

	Detections at Dams												
		Lower Granite											
			Expanded	Little Goose		Lower Monumental		McNary		John Day		Bonneville	
Stream	Detected	N	%	N	%	N	%	N	%	N	%	N	%
Bear Valley Creek	56	249	16.7	75	5.0	25	1.7	17	1.1	7	0.5	2	0.1
Elk Creek	35	156	10.3	59	3.9	37	2.4	24	1.6	7	0.5	1	0.1
Marsh Creek	42	169	16.0	50	4.7	33	3.1	21	2.0	5	0.5	4	0.4
Valley Creek	41	169	11.3	52	3.5	23	1.5	7	0.5	6	0.4	2	0.1
Herd Creek	0	0	0.0	1	4.2	1	4.2	0	0.0	0	0.0	0	0.0
South Fork Salmon River	29	131	8.5	33	2.1	14	0.9	7	0.5	4	0.3	3	0.2
Big(lower)/ Rush Creeks	33	161	38.1	40	9.5	17	4.0	6	1.4	2	0.5	4	0.9
West Fork Chamberlain Creek	24	118	23.1	36	7.1	19	3.7	5	1.0	2	0.4	1	0.2
Secesh River	30	150	10.1	35	2.3	21	1.4	11	0.7	0	0.0	2	0.1
Lake Creek	15	79	11.4	13	1.9	12	1.7	3	0.4	1	0.1	0	0.0
Totals or averages	305	1,382	13.5	394	3.8	202	2.0	101	1.0	34	0.3	19	0.2

Lower Monumental, McNary, John Day, and Bonneville Dams (Table 5; Appendix Tables 4-13 and 15-19). By comparing all first-time detections at interrogation dams (1,055) to the expanded number of detections at Lower Granite Dam (1,382), we estimated that 23.7% of the wild fish from Idaho passed through the hydropower system undetected.

For parr tagged in Idaho, average fork length at release was 67.1 mm (Appendix Table 1). However, of fish from this group that were detected the following spring at the dams, average fork length at release was 70.2 mm. These length differences were significant ($P < 0.01$). The release-length distribution of detected fish was also significantly different from that of released fish in all length categories except 65-69 mm ($P < 0.023$; Figure 2).

We also found a significant difference in fork lengths at time of release for fish that migrated through Lower Granite Dam in April and May compared to fish that migrated after May ($P < 0.01$). Fish migrating through the dam in April and May were on average 4.3 mm larger when released than fish migrating after May. These data suggest that fish size may influence migration timing or overwintering location with respect to detection at the first dam.

Migration Timing

Lower Granite Dam

Migration timing at Lower Granite Dam varied for fish from the 13 Idaho and Oregon streams (Figure 3). In comparisons among these streams (Herd Creek was omitted and lower Big Creek was combined with Rush Creek; Tables 6a-6b), fish from the Lostine River had a significantly earlier timing for 10th percentile passage than fish from all the other streams except the Secesh River ($P < 0.05$). The overall 10th percentile passage distributions for fish from all 13 streams ranged from 11 April to 26 April (Tables 6a-6b).

Fish from the Secesh River had a significantly earlier 50th percentile passage date at the dam than all other Idaho and Oregon streams except the Lostine River ($P < 0.05$). The overall 50th percentile passage distributions for fish from all 13 streams ranged from 21 April to 20 May (Tables 6a-6b). Fish from Big Creek (lower)/Rush Creek had significantly earlier 90th percentile passage date at the dam than fish from all other streams except the Lostine River, Secesh River, and the Imnaha River ($P < 0.05$). The overall 90th percentile passage distributions for fish from all 13 streams ranged from 7 May to 18 June (Tables 6a-6b).

Table 6a. Accumulated and 2002 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
2001	08 May	16 May	28 May	26 April-17 June
2002	**16 April**	**04 May**	**31 May**	**12 April-26 June**
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
2001	30 April	11 May	27 May	30 April-27 May
2002	**16 April**	**29 April**	**02 June**	**13 April-05 July**
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]	---	---	---	---

Table 6a. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
Sulphur Creek(Continued)				
1999	24 April	19 May	27 May	22 April-29 May
2000	15 April	07 May	24 May	12 April-30 May
2001[a]	---	---	---	---
2002[a]	---	---	---	---
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
2001[a]	---	---	---	---
2002[a]	---	---	---	---
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
2001[a]	---	---	---	---
2002[a]	---	---	---	---
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

Table 6a. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
Marsh Creek (Continued)				
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
2001[a]	---	---	---	---
2002	**18 April**	**04 May**	**23 May**	**14 April-26 May**
Valley Creek				
1989	24 April	14 May	12 June	09 April-17 June
1990	16 April	08 May	05 June	12 April-29 June
1991	11 May	20 May	20 June	21 April-13 July
1992	15 April	30 April	27 May	13 April-04 June
1993	30 April	16 May	02 June	24 April-06 June
1994	24 April	04 May	03 June	22 April-09 June
1995	04 May	02 June	08 July	22 April-18 July
1996[a]	---	---	---	---
1997[a]	---	---	---	---
1998[a]	---	---	---	---
1999	24 April	13 May	12 June	19 April-01 July
2000	20 April	12 May	29 May	13 April-14 July
2001	10 May	19 May	01 June	28 April-03 July
2002	**24 April**	**20 May**	**03 June**	**19 April-19 June**
Loon Creek				
1993	05 May	12 May	17 May	03 May-5 June
1994	29 April	10 May	24 May	22 April-07 June
1995	23 April	11 May	28 May	13 April-07 June
1996[a]	---	---	---	---
1997[a]	---	---	---	---
1998[a]	---	---	---	---
1999	30 April	18 May	27 May	22 April-16 June
2000	22 April	08 May	24 May	14 April-01 June
2001[a]	---	---	---	---
2002[a]	---	---	---	---
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

Table 6a. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
East Fork Salmon River (Continued)				
1992	13 April	21 April	16 May	10 April-03 June
1993	25 April	06 May	18 May	22 April-01 June
1994	22 April	28 April	17 May	20 April-25 May
1995	14 April	28 April	10 May	11 April-27 May
1996[a]	---	---	---	---
1997[a]	---	---	---	---
1998[a]	---	---	---	---
1999[a]	---	---	---	---
2000	21 April	07 May	25 May	15 April-27 May
2001[a]	---	---	---	---
2002[a]	---	---	---	---
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]	---	---	---	---
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
2001	30 April	04 May	14 May	28 April-07 June
2002[b]				
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

Table 6a. Continued.

Year	Percentile passage dates at Lower Granite Dam			
	10th	50th	90th	Range
South Fork Salmon River (Continued)				
2001	29 April	14 May	01 June	26 April-07 July
2002	**15 April**	**03 May**	**24 May**	**11 April-09 June**
Big Creek (upper)				
1990	27 April	30 May	22 June	17 April-18 July
1991	18 May	10 June	26 June	26 April-01 July
1992	22 April	08 May	03 June	15 April-26 June
1993	08 May	18 May	26 May	26 April-15 June
1994	03 May	19 May	19 July	25 April-30 August
1995	05 May	23 May	09 June	02 May-26 June
1996[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
2001[a]	---	---	---	---
2002[a]	---	---	---	---
Big (lower)/Rush Creeks				
1993	24 April	29 April	13 May	21 April-16 May
1994	23 April	29 April	11 May	21 April-15 June
1995	19 April	01 May	14 May	11 April-05 June
1996[a]	---	---	---	---
1997[a]	---	---	---	---
1998[a]	---	---	---	---
1999	19 April	28 April	23 May	04 April-30 May
2000	19 April	30 April	13 May	16 April-26 May
2001[a]	---	---	---	---
2002	**15 April**	**25 April**	**07 May**	**12 April-22 May**
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]	---	---	---	---

Table 6a. Continued.

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

[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 2002 passage dates at Lower Granite Dam for PIT-tagged wild spring/summer chinook salmon smolts from streams in Oregon.

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

Table 6b. Continued.

Year	Percentile passage dates at Lower Granite Dam 10th	50th	90th	Range
Imnaha River (lower)(Continued)				
1999[b]	---	---	---	---
2000[b]	---	---	---	---
2001[b]	---	---	---	---
2002[b]	---	---	---	---
Imnaha River (upper)				
1993	24 April	14 May	28 May	15 April-23 June
1994	24 April	08 May	09 June	20 April-11 August
1995	13 April	02 May	03 June	10 April-07 July
1996	16 April	26 April	18 May	14 April-12 June
1997	11 April	19 April	11 May	03 April-02 June
1998	11 April	28 April	13 May	03 April-24 May
1999	22 April	08 May	26 May	17 April-03 June
2000	14 April	02 May	24 May	12 April-16 June
2001	21 April	30 April	16 May	08 April-28 May
2002	**16 April**	**04 May**	**17 May**	**15 April-31 May**
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
2001	25 April	09 May	22 May	10 April-12 June
2002	**11 April**	**21 April**	**13 May**	**28 March-29 May**
Minam River				
1999	08 April	28 April	25 May	31 March-02 June
2000	15 April	03 May	22 May	10 April-29 May
2001	25 April	07 May	23 May	08 April-12 June
2002	17 April	03 May	20 May	**16 April-31 May**

[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.

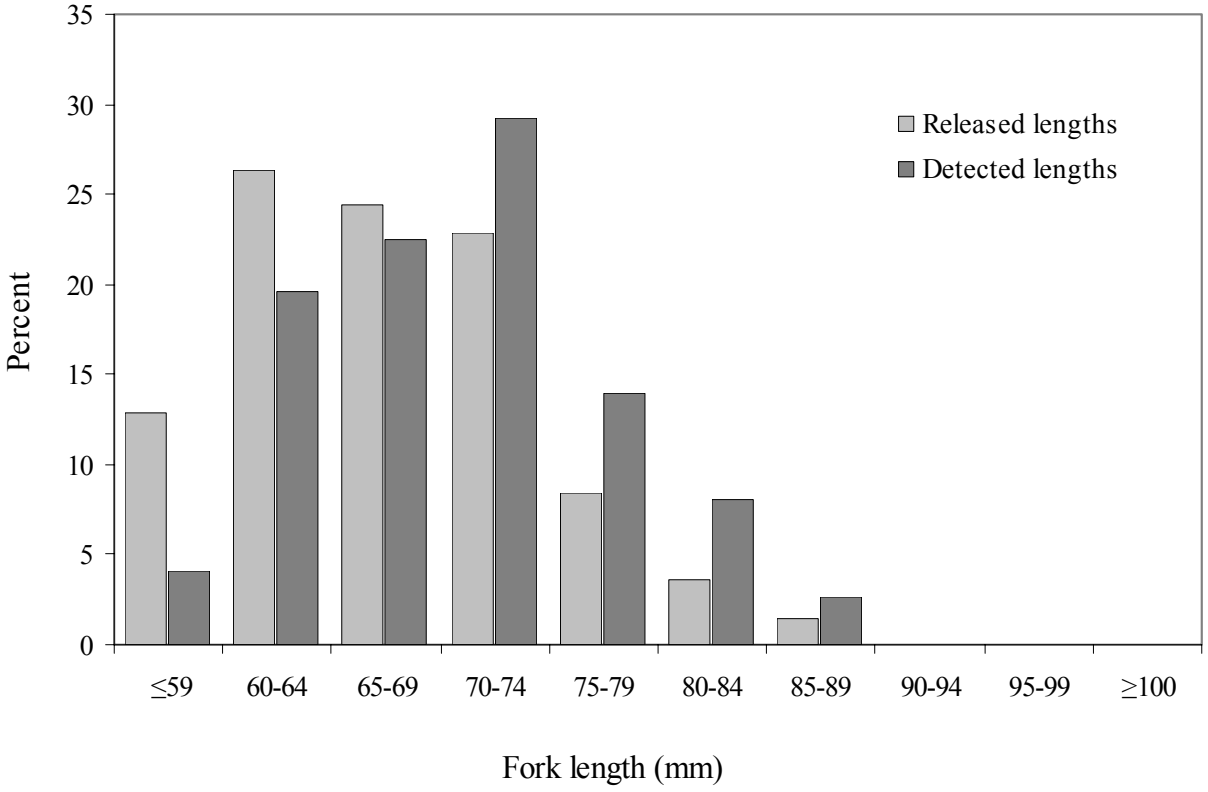


Figure 2. Percent by fork length increments, of PIT-tagged wild spring/summer chinook salmon parr released in Idaho streams in 2001 (n = 10,226) and percent of fish detected for these length increments at dams in spring and summer 2002 (n = 1,000).

Passage distributions of the middle 80% were of significantly shorter duration (22 days) for fish from Big Creek (lower)/Rush Creek than for fish from the Secesh River, Marsh Creek, South Fork Salmon River, Valley Creek, Bear Valley Creek, Elk Creek, Lake Creek, and Catherine Creek (34-55 days; $P < 0.05$) (Tables 6a-6b). The middle 80% passage distributions for fish from the other four streams ranged from 24 to 33 days.

Comparison with Flows

We combined all first-time detections (expanded) at Lower Granite Dam of wild fish from Idaho streams and compared the timing with river flows and spill during the same periods (Figure 4 and Appendix Table 14). Overall, passage occurred between early April and early July, with the middle 80% of wild fish passing from mid-April to late May (Table 7). The peak passage dates were 25 April and 4 May which coincided with low to moderate flows of 62.4 and 86.7 kcfs, respectively (Appendix Table 14). However, when we combined the first-time detections (expanded) from all Idaho and Oregon streams, peak detections coincided with moderate-to-high flows of 112.2 kcfs on 16 April and 4 May under moderate flows of 86.7 kcfs (Figure 5).

Environmental Information

In 2001-2002, we collected hourly measurements of temperature, dissolved oxygen, specific conductance, turbidity, water depth, and pH from five environmental monitoring stations in the Salmon River Basin. We recorded these data, as well as data from previous years, in the Baseline Environmental Monitoring Program database (Perkins 1998).

Environmental data collected during 2001-2002 are presented in Appendix Figures 1-6, which compare various water quality parameters to chinook salmon fry, parr, and smolt movements through adjacent traps (Figure 1) in 2001-2002. Appendix Tables 20-24 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 2001 to July 2002.

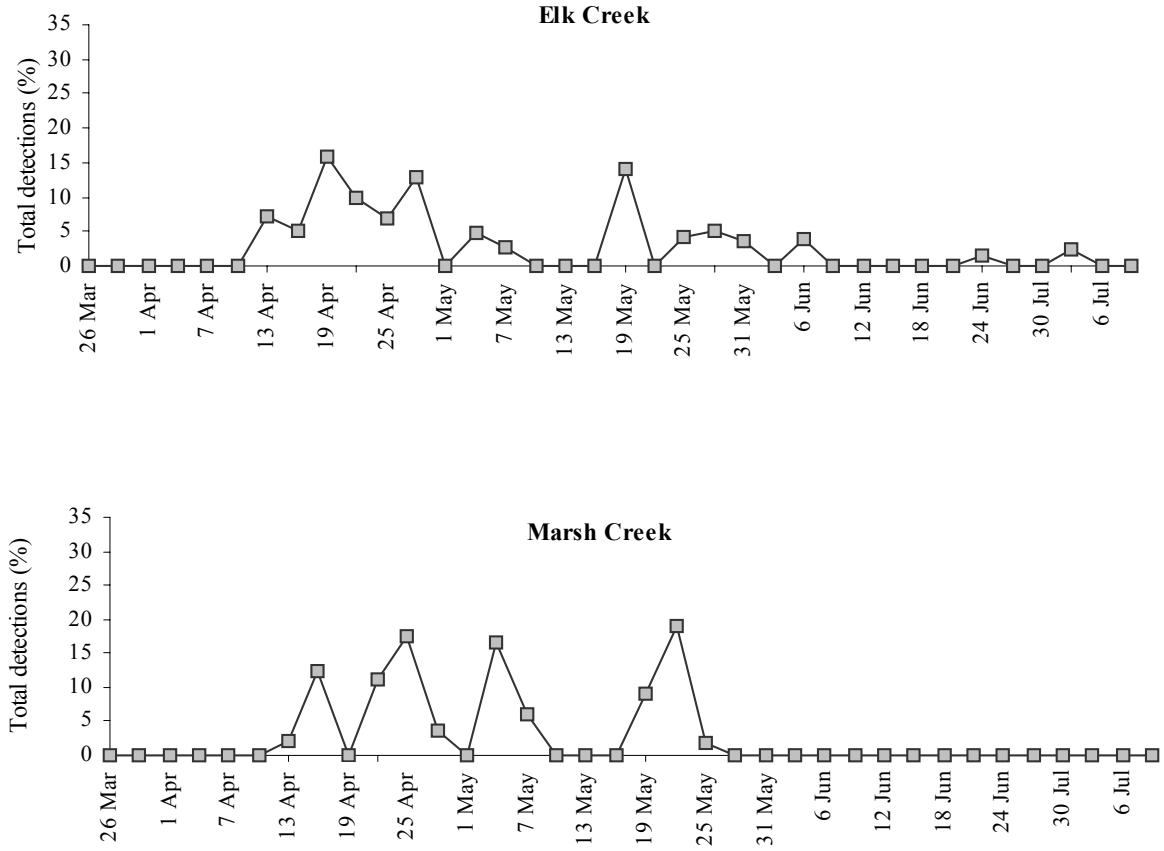


Figure 3. The migration timing (expanded by estimated detection probabilities) at Lower Granite Dam in 2002 of wild spring/summer chinook salmon smolts from individual streams in Idaho and Oregon PIT tagged during summer 2001.

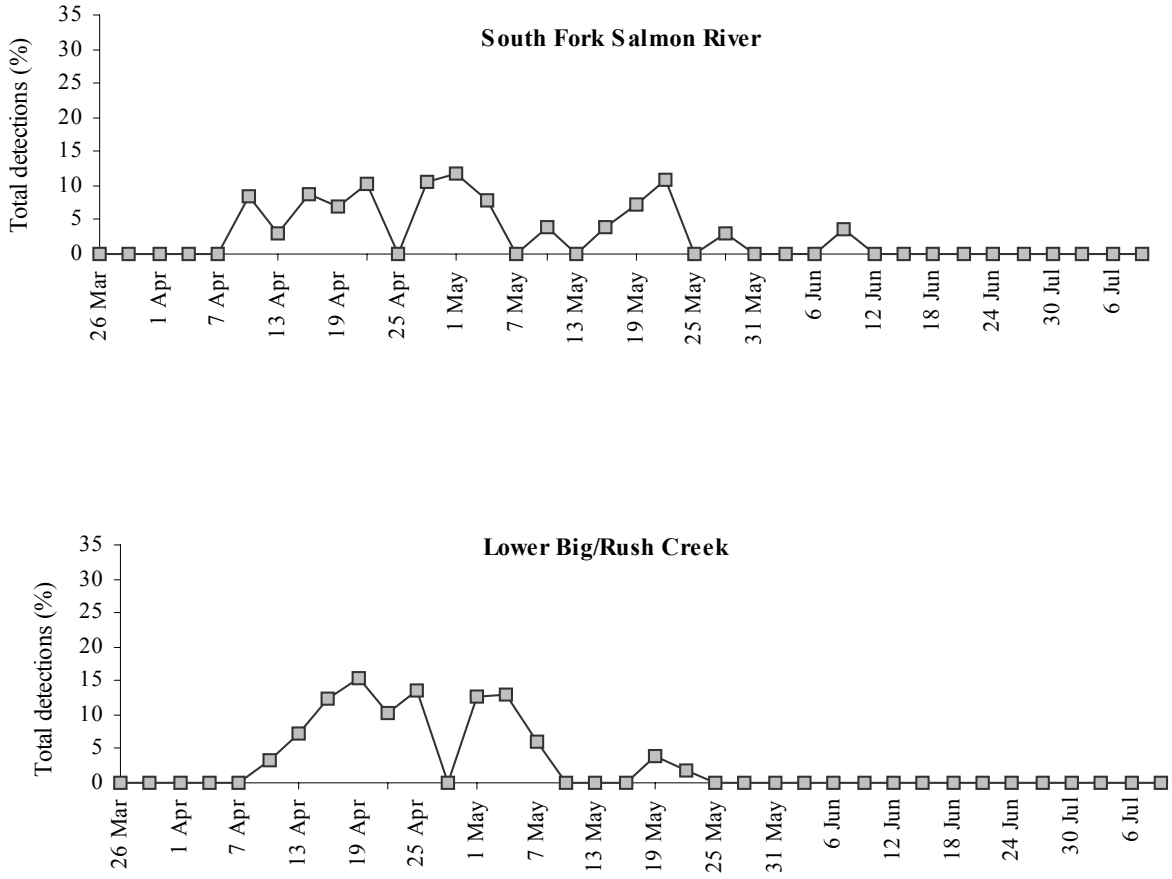


Figure 3. Continued.

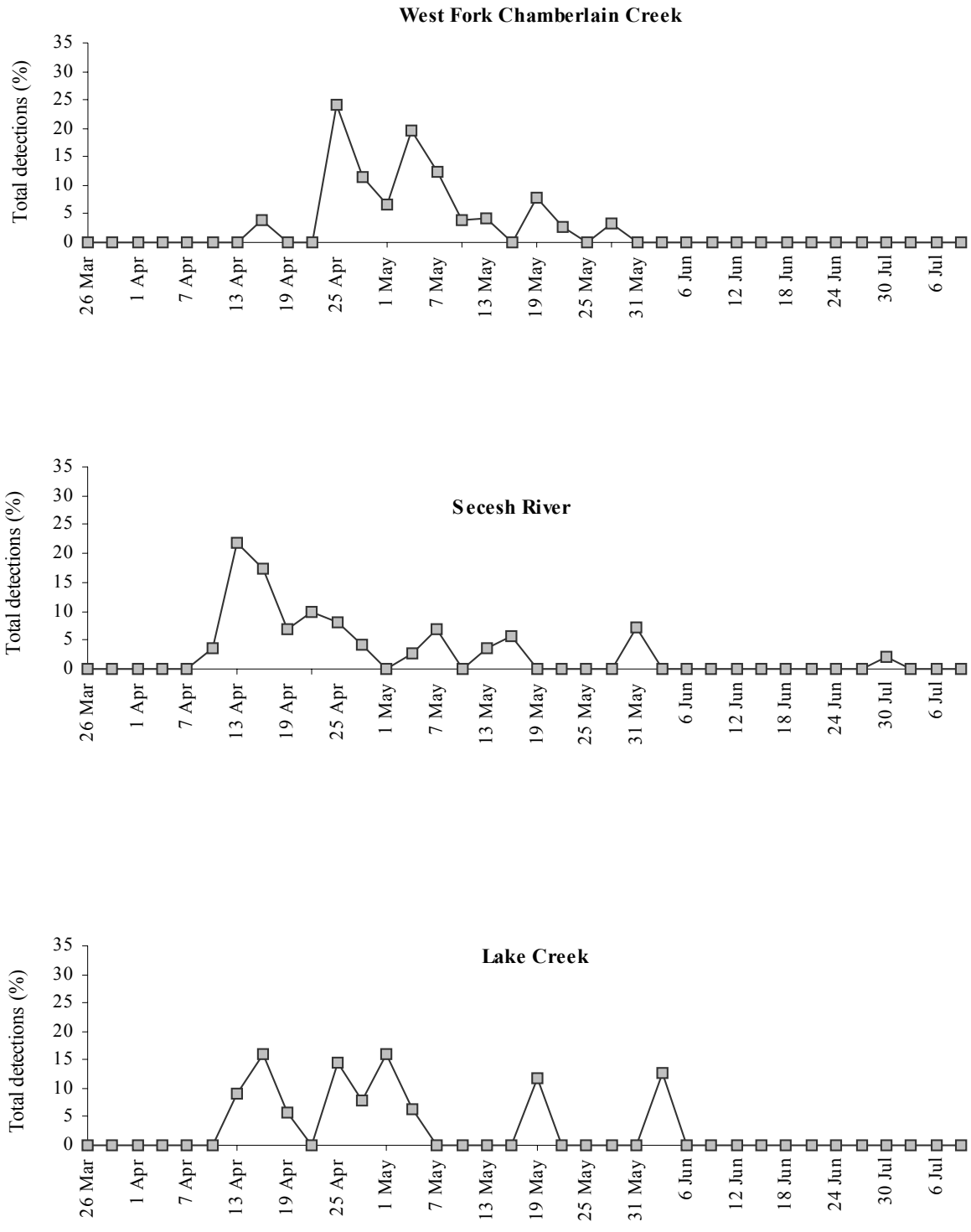


Figure 3. Continued.

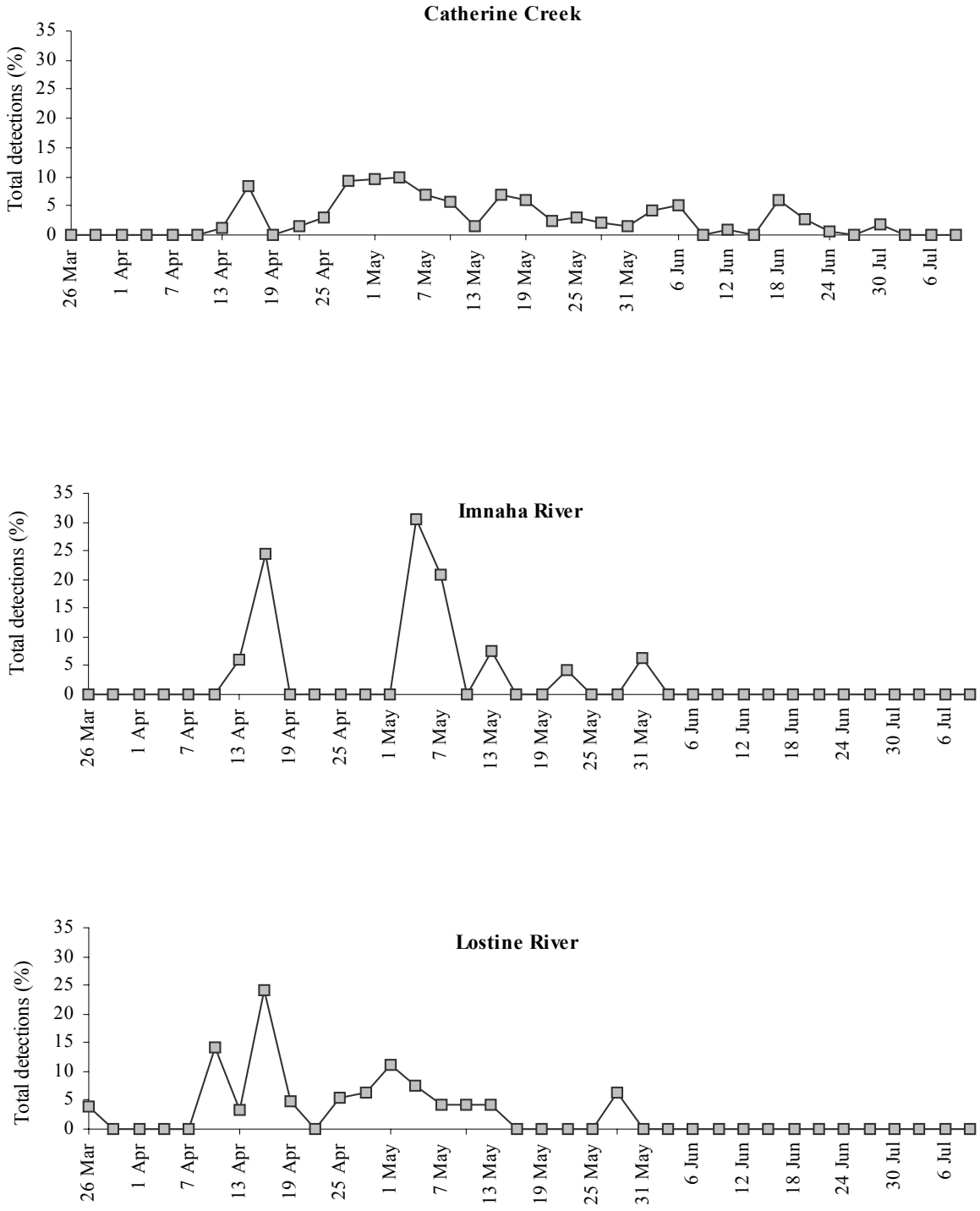


Figure 3. Continued.

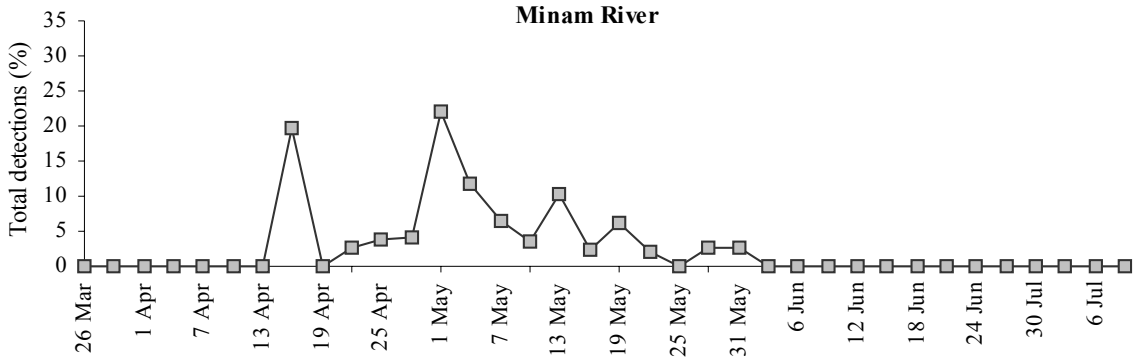


Figure 3. Continued.

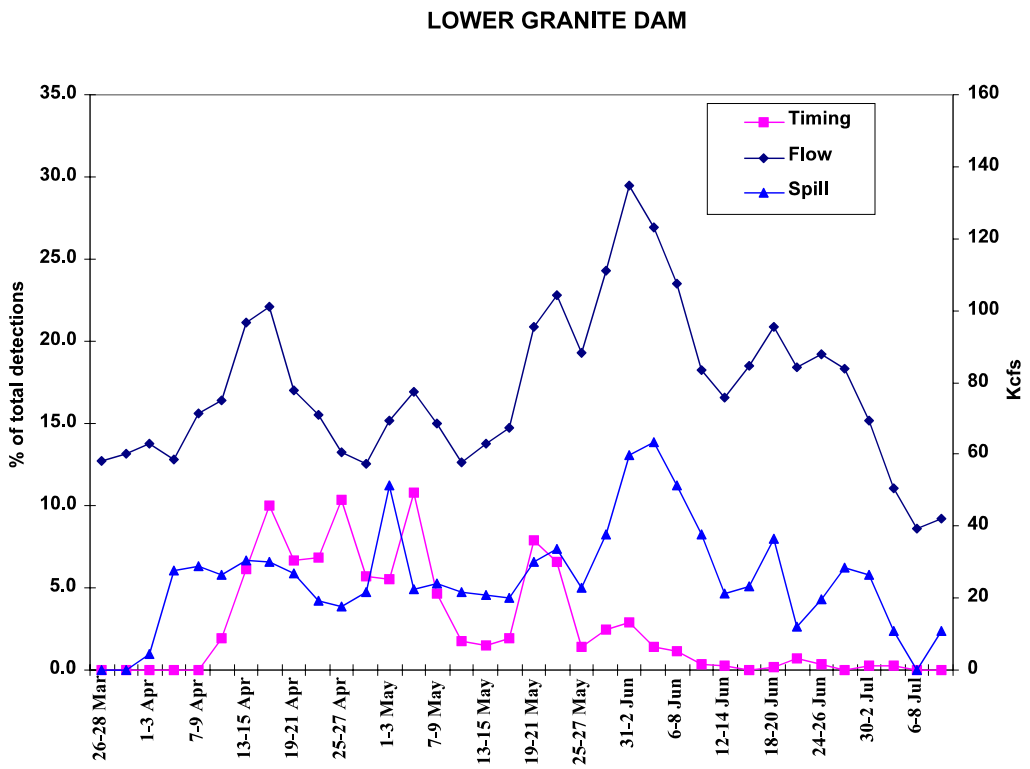


Figure 4. The overall migration timing of PIT-tagged wild spring/summer chinook salmon smolts from Idaho at Lower Granite Dam in 2002, with associated river flows and spill at the dam. Data represents detections from nine Idaho streams pooled in 3-day intervals and expanded based on daily detection probability. River flows and spill at the dam were averaged daily over the same periods.

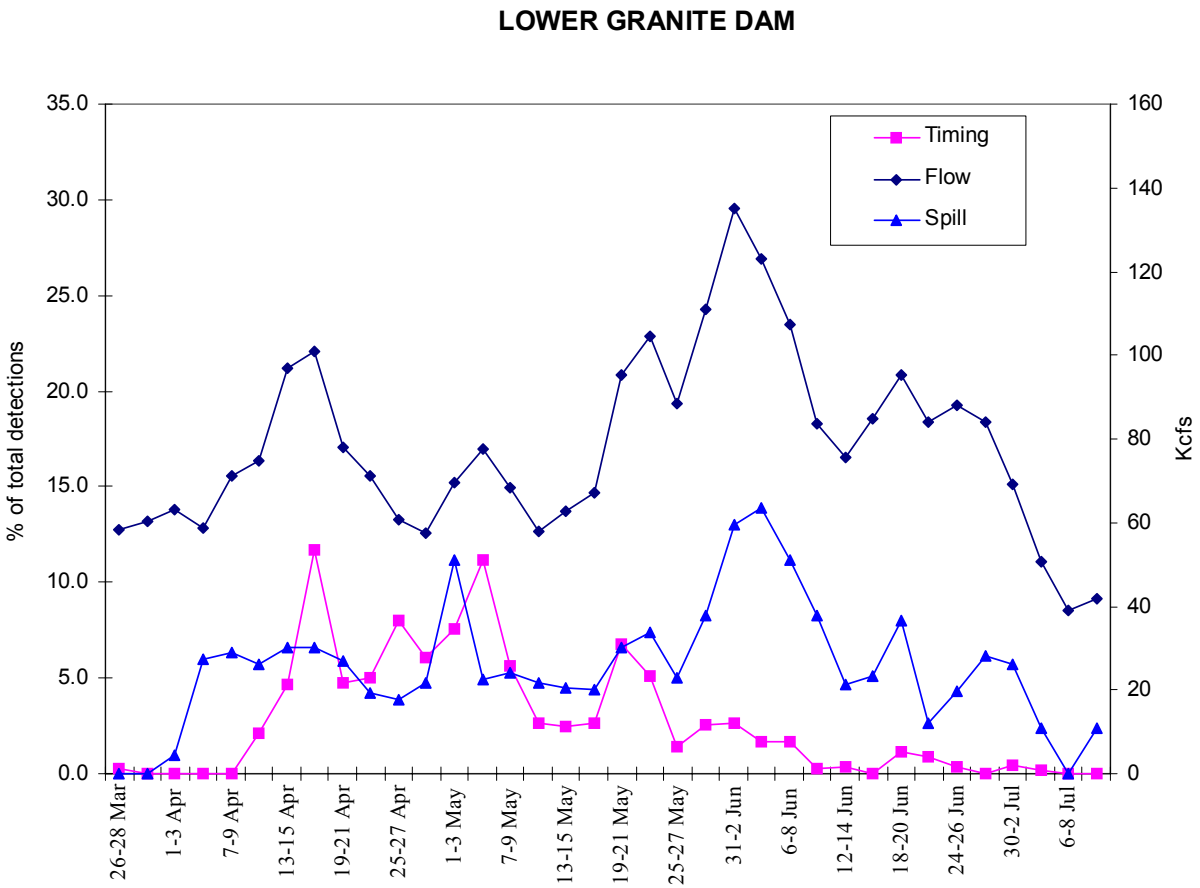


Figure 5. Overall migration timing of PIT-tagged wild spring/summer chinook salmon smolts with associated river flows and spill at Lower Granite Dam, 2002. Daily detections from nine Idaho and four Oregon streams were pooled in 3-day intervals and expanded based on daily detection probability. River flows and spill at the dam were averaged daily over the same periods.

Table 7. Passage dates based on first-time detections 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 11 streams in Idaho in 2002.

	Percentile passage dates			
Site	10th	50th	90th	Range
Lower Granite Dam	16 April	02 May	28 May	11 April-05 July
Little Goose Dam	01 May	16 May	02 June	18 April-23 July
Lower Monumental Dam	04 May	14 May	04 June	22 April-27 July
McNary Dam	02 May	14 May	01 June	25 April-01 July
John Day Dam	09 May	24 May	12 June	28 April-18 June
Bonneville Dam	16 May	24 May	15 June	13 May-16 June

DISCUSSION

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

Overall mean length and weight gains from parr-to-smolt for wild fish from Idaho streams as measured at Little Goose Dam in 2002 were 39.7 mm in length and 9.0 g in weight over an average recapture interval of 275 days. Thus the mean growth rate was 0.14 mm/day and 0.033 g/day. This growth rate was less than that observed at Little Goose Dam in 2001, when mean growth rates were 0.16 mm/day and 0.042 g/day for wild fish from many of the same streams (Achord et al. 2002). The higher densities of parr in the streams in summer 2001 compared to summer 2000, and a much cooler spring in 2002 than 2001, may have contributed to the reduced growth of wild fish observed in 2002 compared to 2001.

The average time between tagging and recapture for fish captured at the South Fork Salmon River Knox Bridge trap in summer-fall 1998, 1999, 2000, and 2001 was 19, 22, 32, and 27 days, respectively. The average length gain over these time frames was 2.9, 2.0, 3.8, and 1.4 mm, respectively. Thus, growth rates averaged from 0.05 to 0.15 mm/day for these fish over the four years. This information shows that growth rates of wild fish from the South Fork Salmon River in late summer and fall were quite variable over these four years. However, these growth rates follow a parr density-dependent trend, with lower growth rates of parr in higher-density years. Similar analyses for wild fish recaptured at the other traps will be performed as more data are collected and analyzed.

Yearly, overall parr-to-smolt survival estimates (revised) for the wild stocks from Idaho and Oregon streams to Lower Granite Dam were as follows:

Migration year	Parr-to-smolt survival (%)
1993	15.3
1994	18.8
1995	13.5
1996	20.6
1997	20.8
1998	24.4
1999	19.9
2000	17.7
2001	19.5
2002	14.3

Parr-to-smolt survival estimates for the individual populations have been quite variable over these years ranging from 6.0% for South Fork of the Salmon River fish in 1996 to 47.6% for Elk Creek fish in 1998. The higher parr densities observed in natal rearing areas in summer 2001 may have contributed to the lower parr-to-smolt survival estimates to Lower Granite Dam in 2002 than in the last several years (Achord et al. 2003). Another high parr density year, 1994, also produced an overall low parr-to-smolt survival estimate in 1995 (13.5%).

Length-distribution curves for data collected over the last 14 years have generally shown that wild fish released and subsequently detected at dams are slightly larger at release than fish released but not detected. The reason for this difference in detection rates is unknown, but we speculated that larger fish survived better than smaller fish. However, Zabel and Achord (in review) compared length, weight, and condition index for these stocks to parr-to-smolt survival over a 5-year period and found that mean population length and weight were not related to survival. However, year and site effects were detected. Consistent patterns across years of selection for length and weight were found, but condition factor was selectively neutral. These results imply that the relative size of individuals within populations was important, but the average size of a population was not, at least in terms of performance during the juvenile life stage.

Another consistent trend that has emerged over the years is the difference in arrival timing at Lower Granite Dam with respect to size at release. In 2002, we again observed that wild fish detected at the dam in April and May had been significantly larger at release than fish migrating after May. This suggests that size is an important factor related to either the initiation of smoltification or to other life-history dynamics that affect the migration timing of wild fish.

Relationships with Flow

In 2002, peak detections of wild fish at Lower Granite Dam from 13 Idaho and Oregon streams coincided with moderate-to-high flows of 112.2 kcfs on 16 April (Figure 5). Detections peaked again on 4 May under moderate flows of 86.7 kcfs. As observed at Lower Granite Dam from 1989 through 2001, 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 and 2002, 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.

Climatic Influence

Annual overall climatic variation was thought to be 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, 1998, and 2001, the median passage date at the dam was between 29 April and 9 May, and the 90th percentile 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 8 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 six years), and we observed intermediate passage times of 9 May and 5 June for the 50th and 90th percentile 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 the 50th percentile passing by 3 May and the 90th by 28 May (Achord et al. 2001a). Flows during 2000 were 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 50th percentile passing by 6 May and the 90th by 29 May.

In 2002, the 50th and 90th percentiles of wild fish also passed Lower Granite Dam in early and late May, respectively. However, in 2002, we had slightly lower than normal temperatures and cooler than normal conditions throughout the spring, along with close to normal flows, with the highest flows occurring in mid-April and late-May. Therefore, although our previous observations support the importance of annual climatic conditions influencing overall migration timing of the stocks at Lower Granite Dam, clearly, complex interrelationships of several factors drives the annual migrational timing of the stocks.

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 related to annual climatic conditions and probably several other factors.

Cumulative Data: 1989-2002

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 nine years of migration-timing data for fish from 10 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).

Results showed that Secesh River fish had significantly earlier timing of the 10th percentile passage than fish from Elk Creek, Bear Valley Creek, Marsh Creek, Valley Creek, or Catherine Creek ($P < 0.05$). The 10th percentile passage of fish from the Secesh River was also earlier than those of fish from the Lostine, South Fork of the Salmon, or Imnaha Rivers or from Lake Creek though the differences were 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 all the other streams except Lake Creek ($P < 0.05$). However, for the 90th percentile passage, the Lostine River fish had significantly earlier timing at the dam than fish from the other streams, except the Imnaha River and Marsh Creek ($P < 0.05$).

We also examined the length of time that encompassed passage of the middle 80% as a measure of protracted or compressed timing characteristics for stocks from individual streams and from wild fish from all these streams combined. The middle 80% passage at Lower Granite Dam averaged 42 days (range 29 to 51 days) for fish from these 10 streams over the years. The Lostine River, Marsh Creek, Imnaha River, and Catherine Creek fish had a significantly shorter passage duration (middle 80%) at the dam (34-38 days) than fish from the Secesh River, South Fork Salmon River, and Lake Creek (48-50 days; $P < 0.05$).

Table 8. The 95% confidence interval passage dates at Lower Granite Dam for wild fish from 7 streams in Idaho and 3 streams in Oregon that have 9 or more years of migration timing data from1989 to 2002.

		Percentile passage dates at Lower Granite Dam			
Stream	95% CI	10th	50th	90th	Data years
Secesh River	Lo CI	11 April	22 April	22 May	14
	Up CI	18 April	30 April	10 June	
	Mean	14 April	26 April	01 June	
South Fork Salmon River	Lo CI	14 April	06 May	01 June	13
	Up CI	24 April	14 May	13 June	
	Mean	19 April	10 May	07 June	
Catherine Creek	Lo CI	23 April	10 May	27 May	12
	Up CI	01 May	18 May	09 June	
	Mean	27 April	14 May	03 June	
Imnaha River (upper)	Lo CI	13 April	27 April	15 May	10
	Up CI	20 April	07 May	29 May	
	Mean	17 April	02 May	22 May	
Bear Valley Creek	Lo CI	19 April	04 May	28 May	11
	Up CI	29 April	14 May	09 June	
	Mean	24 April	09 May	03 June	
Elk Creek	Lo CI	14 April	01 May	23 May	10
	Up CI	26 April	12 May	07 June	
	Mean	20 April	06 May	30 May	
Valley Creek	Lo CI	20 April	08 May	31 May	11
	Up CI	02 May	20 May	16 June	
	Mean	26 April	14 May	08 June	
Marsh Creek	Lo CI	17 April	30 April	22 May	9
	Up CI	24 April	11 May	01 June	
	Mean	21 April	06 May	27 May	
Lake Creek	Lo CI	12 April	25 April	25 May	10
	Up CI	20 April	04 May	15 June	
	Mean	16 April	29 April	05 June	
Lostine River	Lo CI	11 April	30 April	15 May	11
	Up CI	22 April	09 May	25 May	
	Mean	17 April	04 May	20 May	

The Lostine River, Marsh Creek, Imnaha River, and Catherine Creek fish also had shorter passage durations at the dam than fish from Bear Valley Creek, Elk Creek, and Valley Creek but the differences were not significant (40-42 days; $P > 0.05$).

In examining wild chinook salmon smolt passage timing at the dams over the last 14 years, it has become clear that several factors influence passage timing. Complex yearly interrelationships between flow and annual climatic conditions are primary factors contributing to passage timing. However, water temperature, turbidity, physiological development, variability in stock behavior, fish size, and other yet unknown factors may all contribute substantially to wild smolt passage timing at dams.

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 endangered species of Pacific salmon.

Action 152 of the RPAs 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 2002, 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.

ACKNOWLEDGMENTS

We thank Neil N. Paasch, Kenneth W. McIntyre, Gordon A. Axel, Richard Burland, Richard W. Zabel, Gary Foust, and Jeffery L. Moser for their excellent assistance in collecting and PIT tagging fish for this study. Also, thanks to personnel from the Idaho Department of Fish and Game for providing data from trapping operations in natal rearing areas.

REFERENCES

Achord, S., G. A. Axel, E. E. Hockersmith, B. P. Sandford, M. B. Eppard, and G. M. Matthews. 2001a. Monitoring the migrations of wild Snake River spring/summer chinook salmon smolts, 1999. Report of the National Marine Fisheries Service to the Bonneville Power Administration, Portland, Oregon. Available: www.efw.bpa.gov/cgi-bin/efw/FW/welcome.cgi.

Achord, S., G. A. Axel, E. E. Hockersmith, B. P. Sandford, M. B. Eppard, and G. M. Matthews. 2001b. Monitoring the migrations of wild Snake River spring/summer chinook salmon smolts, 2000. Report of the National Marine Fisheries Service to the Bonneville Power Administration, Portland, Oregon. Available: www.efw.bpa.gov/cgi-bin/efw/FW/welcome.cgi.

Achord, S., G. A. Axel, E. E. Hockersmith, B. P. Sandford, M. B. Eppard, and G. M. Matthews. 2002. Monitoring the migrations of wild Snake River spring/summer chinook salmon smolts, 2001. Report of the National Marine Fisheries Service to the Bonneville Power Administration, Portland, Oregon. Available: www.efw.bpa.gov/cgi-bin/efw/FW/welcome.cgi.

Achord, S., M. B. Eppard, E. E. Hockersmith, B. P. Sandford, G. A. Axel, and G. M. Matthews. 2000. Monitoring the migrations of wild Snake River spring/summer chinook salmon smolts, 1998. Report of the National Marine Fisheries Service to the Bonneville Power Administration, Portland, Oregon. Available: www.efw.bpa.gov/cgi-bin/efw/FW/welcome.cgi.

Achord, S., M. B. Eppard, E. E. Hockersmith, B. P. Sandford, and G. M. Matthews. 1997. Monitoring the migrations of wild Snake River spring/summer chinook salmon smolts, 1996. Report of the National Marine Fisheries Service to the Bonneville Power Administration, Portland, Oregon.

Achord, S., M. B. Eppard, E. E. Hockersmith, B. P. Sandford, and G. M. Matthews. 1998. Monitoring the migrations of wild Snake River spring/summer chinook salmon smolts, 1997. Report of the National Marine Fisheries Service to the Bonneville Power Administration, Portland, Oregon. Available: www.efw.bpa.gov/cgi-bin/efw/FW/welcome.cgi.

Achord, S., M. B. Eppard, B. P. Sandford, and G. M. Matthews. 1996a. Monitoring the migrations of wild Snake River spring/summer chinook salmon smolts, 1995. Report of the National Marine Fisheries Service to the Bonneville Power Administration, Portland, Oregon.

Achord, S., J. R. Harmon, D. M. Marsh, B. P. Sandford, K. W. McIntyre, K. L. Thomas, N. N. Paasch, and G. M. Matthews. 1992. Research related to transportation of juvenile salmonids on the Columbia and Snake Rivers, 1991. Report of the National Marine Fisheries Service to the U.S. Army Corps of Engineers, Walla Walla, Washington.

Achord, S., D. J. Kamikawa, B. P. Sandford, and G. M. Matthews. 1995a. Monitoring the migrations of wild Snake River spring/summer chinook salmon smolts, 1993. Report of the National Marine Fisheries Service to the Bonneville Power Administration, Portland, Oregon.

Achord, S., D. J. Kamikawa, B. P. Sandford, and G. M. Matthews. 1995b. Monitoring the migrations of wild Snake River spring/summer chinook salmon smolts, 1994. Report of the National Marine Fisheries Service to the Bonneville Power Administration, Portland, Oregon.

Achord, S., P. S. Levin, and R. W. Zabel. 2003. Density-dependent mortality in Pacific salmon: the ghost of impacts past? Ecology Letters 6:335-342.

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

Achord, S., G. M. Matthews, D. M. Marsh, B. P. Sandford, and D. J. Kamikawa. 1994. Monitoring the migrations of wild Snake River spring and summer chinook salmon smolts, 1992. Report of the National Marine Fisheries Service to the Bonneville Power Administration, Portland, Oregon.

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

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

Matthews, G. M., S. Achord, J. R. Harmon, O. W. Johnson, D. M. Marsh, B. P. Sandford, N. N. Paasch, K. W. McIntyre, and K. L. Thomas. 1992. Evaluation of transportation of juvenile salmonids and related research on the Columbia and Snake Rivers, 1990. Report of the National Marine Fisheries Service to the U.S. Army Corps of Engineers, Walla Walla, Washington.

Matthews, G. M., J. R. Harmon, S. Achord, O. W. Johnson, and L. A. Kubin. 1990. Evaluation of transportation of juvenile salmonids and related research on the Snake and Columbia Rivers, 1989. Report of the National Marine Fisheries Service to the U.S. Army Corps of Engineers, Walla Walla, Washington.

NMFS (National Marine Fisheries Service). 2001. Operation of the federal Columbia River power system including the juvenile fish transportation program and the Bureau of Reclamation's 31 projects, including the entire Columbia Basin Project. Endangered Species Act, Section 7 consultation, Biological Opinion. NMFS Northwest Regional Office, Hydropower Program, Portland, Oregon.

NWPPC (Northwest Power Planning Council). 1980. Pacific Northwest Electric Power Planning Council and Conservation Act. Columbia River Basin Fish and Wildlife Program, Northwest Power Planning Council, Portland, Oregon.

Perkins, W.A. 1998. Baseline environmental monitoring program: Salmon River Basin. Online interactive database. Available: www.bemdata.nwfsc.noaa.gov/baseline/intro.html.

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

Prentice, E. F., T. A. Flagg, and C. S. McCutcheon. 1990. PIT-tag monitoring systems for hydroelectric dams and fish hatcheries. American Fisheries Society Symposium 7:323-334.

Raymond, H. L. 1979. Effects of dams and impoundments on migrations of juvenile chinook salmon and steelhead from the Snake River, 1966 to 1975. Transactions of the American Fisheries Society 108(6):505-529.

Sandford, B. P., and S. G. Smith. 2002. Estimation of smolt-to-adult return percentages for Snake River Basin anadromous salmonids, 1990-1997. Journal of Agricultural Biological and Environmental Statistics 7(2):243-263.

Zabel, R. W., and S. Achord. In review. Relating condition of individuals to stage-specific performance within and among populations of wild Snake River spring/summer chinook salmon. Available Rich.Zabel@noaa.gov.

APPENDIX

Data Tables and Figures

Appendix Table 1. Summary of tagging dates, numbers collected, tagged, released, and minimum, maximum, and mean lengths and weights of wild chinook salmon parr, collected and PIT tagged in various Idaho streams, 2001.

Tagging dates	Number of fish			Length (collected)		Weight (collected)		Length (tagged & released)		Weight (tagged & released)	
	Collected	Tagged	Released	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Bear Valley Creek											
25-29 Jul	1,543	1,495	1,495	45-132	65.6	1.1-28.2	4.0	52-86	65.6	1.8-8.1	3.9
Elk Creek											
27, 31 Jul; 1-2 Aug	1,574	1,522	1,519	43-85	68.2	1.2-9.6	4.0	52-85	68.4	1.3-9.6	4.1
Marsh Creek											
03, 06 Aug	1,082	1,056	1,056	47-137	71.7	1.6-10.6	4.7	55-137	71.8	1.9-10.6	4.8
Valley Creek											
07-09 Aug	1,577	1,504	1,497	47-176	70.8	1.5-41.9	5.1	53-176	70.4	2.0-11.0	4.7
Herd Creek											
13-Aug	32	24	24	73-158	100.7	5.6-45.4	14.3	73-103	89.8	5.6-12.7	8.6
South Fork Salmon River											
16-17 Aug	1,678	1,537	1,534	44-113	62.5	1.1-16.9	3.4	51-86	63.4	1.6-8.6	3.5
Big Creek (lower)											
21-22 Aug	432	409	409	61-101	75.6	2.5-9.3	5.2	61-101	75.7	2.5-9.3	5.2
Rush Creek											
22-Aug	14	14	14	64-85	76.2	3.7-6.7	5.2	64-85	76.2	3.7-6.7	5.2
West Fork Chamberlain Creek											
21-Aug	513	511	510	46-86	67.1	1.1-8.6	3.7	54-86	67.2	1.7-8.6	3.7
Secesh River											
24-25 Aug	1,891	1,489	1,489	43-105	61.4	1.0-16.1	2.9	52-83	63.5	1.7-6.5	3.2
Lake Creek											
27-Aug	844	695	695	45-116	63.0	1.2-17.9	3.5	51-84	63.9	1.8-8.6	3.7
Totals or means											
---	11,180	10,256	10,242	43-176	66.5	1.0-45.4	4.0	51-176	67.1	1.3-12.7	4.0

Appendix Table 2. Summary of tagging dates, start tagging times and temperatures (°C), release dates, times, and temperatures, method of capture, distance (in kilometers) from the mouth of the stream to the release point, number released (in 2001), and number/percent of first-time detections (unadjusted) for each tag group at six downstream dams during 2002.

Tagging					Release					Detected	
Group	Date (2001)	Time	Temp. (°C)	Capture method	Date (2001)	Time	Temp. (°C)	River km	n	n	%
Bear Valley Creek											
SA01206.BV1	25 Jul	07:05	15.0	Shock	26 Jul	05:50	13.0	9	144	15	10.4
SA01207.BV1	26 Jul	06:52	12.0	Shock	26 Jul	12:00	13.0	12	187	26	13.9
SA01208.BV1	27 Jul	09:57	13.5	Shock	27 Jul	13:00	16.0	14	201	24	11.9
SA01209.BV1	28 Jul	05:39	12.0	Shock	28 Jul	12:00	12.5	15	162	13	8.0
SA01209.BV2	28 Jul	08:39	13.0	Shock	28 Jul	10:00	16.0	18	442	63	14.3
SA01210.BV1	29 Jul	07:27	11.0	Shock	29 Jul	11:00	12.5	19	359	41	11.4
Elk Creek											
SA01208.EC1	27 Jul	05:30	10.0	Bch. seine	27 Jul	09:30	12.5	1	508	59	11.6
SA01208.EC2	27 Jul	08:39	12.5	Bch. seine	27 Jul	11:00	13.0	1	244	27	11.1
SA01212.EC1	31 Jul	06:54	10.0	Bch. seine	31 Jul	12:00	10.0	3	19	1	5.3
SA01212.EC2	31 Jul	08:29	10.0	Shock	01 Aug	06:45	13.0	4	95	15	15.8
SA01212.EC3	31 Jul	11:11	13.0	Shock	31 Jul	13:45	15.0	5	124	12	9.7
SA01213.EC1	01 Aug	07:13	10.0	Shock	01 Aug	14:30	15.0	6	439	44	10.0
SA01214.EC1	02 Aug	10:08	14.0	Shock	02 Aug	12:00	15.0	9	90	5	5.6
Marsh Creek											
SA01215.MC1	03 Aug	07:22	08.5	Shock	04 Aug	08:30	09.0	11	126	24	19.0
SA01215.MC2	03 Aug	09:09	10.0	Shock	03 Aug	12:30	13.0	12	236	30	12.7
SA01218.MC1	06 Aug	06:51	08.0	Shock	06 Aug	12:00	13.0	14	694	101	14.6

Appendix Table 2. Continued.

Tagging					Release					Detected	
Group	Date	Time	Temp. (°C)	Capture method	Date	Time	Temp. (°C)	River km	n	n	%
Valley Creek											
SA01219.VC1	07 Aug	07:04	11.5	Shock	08 Aug	06:30	12.5	4	119	6	5.0
SA01219.VC2	07 Aug	08:11	12.0	Shock	07 Aug	12:00	15.0	4	484	33	6.8
SA01220.VC1	08 Aug	07:01	12.5	Shock	08 Aug	11:30	16.0	6	544	44	8.1
SA01221.VC1	09 Aug	06:58	11.0	Shock	09 Aug	11:00	12.0	18	350	48	13.7
Herd Creek											
SA01225.HC1	13 Aug	07:42	08.5	Shock	14 Aug	09:50	09.5	2	24	2	8.3
South Fork Salmon River											
SA01228.SF1	16 Aug	06:33	12.0	Shock	17 Aug	06:30	11.0	117	83	5	6.0
SA01228.SF2	16 Aug	07:10	13.0	Shock	16 Aug	12:00	14.0	118	743	48	6.5
SA01229.SF1	17 Aug	06:55	11.0	Shock	17 Aug	12:20	12.5	122	708	37	5.2
Big Creek (lower)											
SA01233.LB1	21 Aug	09:54	14.0	Shock	22 Aug	07:00	12.5	9	133	31	23.3
SA01233.LB2	21 Aug	11:18	14.5	Shock	21 Aug	13:45	16.0	10	140	37	26.4
SA01234.LB1	22 Aug	07:07	12.0	Shock	22 Aug	12:30	15.5	11	136	30	22.1
Rush Creek											
SA01234.RC1	22 Aug	10:53	15.0	Shock	22 Aug	12:00	12.0	1	14	4	28.6
West Fork Chamberlain Creek											
SA01233.WC1	21 Aug	08:00	08.0	Bch. Seine	22 Aug	08:00	08.0	1	112	17	15.2
SA01233.WC2	21 Aug	08:45	08.5	Bch. Seine	21 Aug	12:00	12.0	2	398	70	17.6
Secesh River											
SA01236.SE1	24 Aug	07:53	09.0	Shock	25 Aug	07:00	09.0	25	105	6	5.7
SA01236.SE2	24 Aug	08:38	09.0	Shock	24 Aug	14:30	15.0	26	581	38	6.5
SA01237.SE1	25 Aug	07:14	08.0	Shock	25 Aug	12:50	13.0	27	803	55	6.8
Lake Creek											
SA01239.LC1	27 Aug	07:55	09.5	Shock	28 Aug	11:20	11.0	2	127	9	7.1
SA01239.LC2	27 Aug	08:48	09.5	Shock	27 Aug	12:30	13.0	2	568	35	6.2

Appendix Table 3. Summary of observed total mortality for PIT-tagged wild chinook salmon parr collected from Idaho streams during July and August 2001. Number rejected includes fish too small to tag, precocious males, injured fish, fish collected for genetic evaluation, previously tagged fish, and in some cases extra collected fish. The proportion of rejects that are precocious males are in parentheses.

Stream	Number collected	Number tagged	Number rejected	Percent rejected (%)	Observed mortality			
					Collection	Tagging and delayed	Total	%
Bear Valley Creek	1,543	1,495	23 (5)	1.5	28	0	28	1.8
Elk Creek	1,574	1,519	14 (0)	0.9	38	3	41	2.6
Marsh Creek	1,082	1,056	11 (0)	1.0	15	0	15	1.4
Valley Creek	1,577	1,497	56 (21)	3.6	19	7	26	1.6
Herd Creek	32	24	7 (7)	21.9	1	0	1	3.1
S. Fork Salmon R.	1,678	1,534	135 (1)	8.0	6	3	9	0.5
Big Creek (lower)	432	409	4 (0)	0.9	19	0	19	4.4
Rush Creek	14	14	0	0.0	0	0	0	0.0
WF Chamberlain Cr	513	510	2 (0)	0.4	0	1	1	0.2
Secesh River	1,891	1,489	384 (1)	20.3	18	0	18	1.0
Lake Creek	844	695	128 (4)	15.2	21	0	21	2.5
Totals or averages	11,180	10,242	764	6.8	165	14	179	1.6

Appendix Table 4. Detections during 2002 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 1,495 wild chinook salmon from Bear Valley Creek released 26-29 July 2001. Release sites were 629-639 km above Lower Granite Dam.

Bear Valley Creek							
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
12 Apr	1	5					
13 Apr	1	7					
14 Apr	1	4					
15 Apr	1	4					
16 Apr	4	16					
17 Apr	1	4					
18 Apr	3	14					
20 Apr	1	5					
21 Apr	1	6					
22 Apr	1	4					
24 Apr			1				
25 Apr	1	6					
26 Apr	1	6	1		1		
28 Apr	1	6					
29 Apr			1				
30 Apr	1	8			1		
1 May			5		1		
2 May	1	13	2		2		
3 May	1	8	7				
4 May	5	25	8				
5 May	1	4	8		1		
6 May			2	1			
7 May	1	5	1	2	1	1	
8 May	1	5	1	2	1		
10 May					1		
11 May	2	10					
13 May	1	5		2			
14 May				1			
15 May	1	5	3	1	2	1	
16 May				1	1	1	
17 May			3	1			

Appendix Table 4. Continued.

Bear Valley Creek							
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
18 May	1	3	1		1		
19 May	3	10	2	3			
20 May	1	3		1			
21 May	2	6	2				
22 May	3	9	2				
23 May	2	6	5			1	
24 May	2	6	2				
25 May			1	1	1		
26 May					1		
28 May	1	4	3	2			
29 May			1	1			
30 May				1			1
31 May	2	8	3				
1 Jun			2			1	
2 Jun	1	6	1	1			
3 Jun			1	1			
4 Jun			2				
5 Jun	1	4					
7 Jun				1			
8 Jun			2			1	
9 Jun			1		2		
11 Jun				1			
13 Jun						1	
15 Jun							1
17 Jun			1				
21 Jun	2	7					
22 Jun	1	2					
26 Jun	1	3					
06 Jul							
09 Jul							
10 Jul							
23 Jul				1			
Totals	56	249	75	25	17	7	2

Appendix Table 5. Detections during 2002 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 1,519 wild chinook salmon from Elk Creek released 27 July to 2 August 2001. Release locations were 634-643 km above Lower Granite Dam

Elk Creek							
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
13 Apr	1	7					
15 Apr	1	4					
16 Apr	1	4					
17 Apr	1	4					
19 Apr	3	13					
21 Apr	2	11					
22 Apr	1	4	1				
23 Apr	2	11					
25 Apr	1	6	2		1		
26 Apr			1				
27 Apr	1	5	2				
28 Apr	1	6	1			1	
29 Apr	1	6	1				
30 Apr	1	8					
1 May				1			
2 May			5		3		
3 May			5		3		
4 May			5	7			
5 May			5	2			
6 May	2	7	1		1		
7 May				5			
8 May					1		
9 May	1	4			1		
11 May				2			1
12 May					2		
13 May			1		1		
14 May			2	3	1		
15 May			1			1	

Appendix Table 5. Continued.

Elk Creek							
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
16 May					1		
17 May			2		1		
18 May					1		
19 May	2	6		2			
20 May	2	6	1	3			
21 May	3	9	2				
22 May			3	3	1		
23 May				1		1	
24 May			1			1	
25 May	1	3		1	2		
26 May			3	1			
27 May	1	4					
28 May			2	1			
29 May	1	4	1		1		
30 May	1	4					
31 May			2		1		
1 Jun			4				
2 Jun	1	6	3				
3 Jun			1	1			
4 Jun				2	1		
5 Jun			1			1	
7 Jun	1	6					
10 Jun						2	
18 Jun				2			
25 Jun	1	3					
1 Jul					1		
5 Jul	1	4					
Totals	35	156	59	37	24	7	1

Appendix Table 6. Detections during 2002 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 1,056 wild chinook salmon from Marsh Creek released 4-6 August 2001. Release sites were 630-633 km above Lower Granite Dam.

Marsh Creek							
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
14 Apr	1	4					
15 Apr							
16 Apr	2	8					
17 Apr	1	4					
18 Apr	2	9	1				
20 Apr							
21 Apr							
22 Apr	2	8					
23 Apr	1	6					
24 Apr	1	5					
25 Apr	3	17					
26 Apr	2	13					
27 Apr							
28 Apr	1	6					
29 Apr					1		
30 Apr			2	1			
1 May			1				
2 May			1	1			
3 May			5				
4 May	1	5	1	3			
5 May	3	12	3	2			
6 May	3	11	1		1		
7 May	2	10		4	2		
8 May			1		1		
9 May				1	1	1	
10 May							
11 May				1			
12 May					1		

Appendix Table 6. Continued.

Marsh Creek							
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
13 May				2	1		
14 May				2			
15 May			1		1		
16 May						2	1
17 May			1		1		
18 May				1	1		
19 May	1	3	2				
20 May	1	3		2			
21 May	3	9	1	1	2		
22 May	3	9	6		2		
23 May	5	15	3	2	2		
24 May	3	8	3		1	1	1
25 May			2	3			
26 May	1	3	3	1	1		
27 May			3				
28 May				2			1
29 May			2				
31 May							
1 Jun			2				
2 Jun					1		
3 Jun			1				
4 Jun				1	1		
6 Jun			1	1		1	
7 Jun			1				
9 Jun			1				
11 Jun				1			
15 Jun							1
16 Jun							
22 Jun			1				
27 Jul				1			
Totals	42	169	50	33	21	5	4

Appendix Table 7. Detections during 2002 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 1,497 wild chinook salmon from Valley Creek 7-9 August 2001. Release sites were 743-757 km above Lower Granite Dam.

Valley Creek							
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
19 Apr	2	9					
23 Apr	1	6					
24 Apr	1	5					
25 Apr	1	6					
26 Apr	1	6					
27 Apr	1	5					
28 Apr							
30 Apr							
1 May			1	1			
2 May							
3 May			1				
4 May	2	10	2				
5 May			2		1		
6 May	3	11	1				
8 May	1	5	1				
9 May				1			
10 May							
11 May							
12 May	1	5					
13 May				2			
14 May					1		
15 May			1				
16 May	1	5					
17 May	1	4					
18 May							
19 May							
20 May	6	19					
21 May			1	1			1
22 May	4	11	7	3		1	

Appendix Table 7. Continued.

Valley Creek							
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
23 May	2	6	4		1		
24 May			3			1	
25 May	2	6		2			
26 May	1	3	2	1			
27 May			1				
28 May	2	7	3				
29 May	1	4	2	1			
30 May	1	4	3	1	1		
31 May	1	4	2	1			
1 Jun			2		1		
2 Jun	1	6	4				
3 Jun	1	5	3	1			
4 Jun			1	2			
5 Jun			1			1	
6 Jun				1			
7 Jun				1			
8 Jun	1	10	1	3			
10 Jun			1				
12 Jun				1		1	
13 Jun	1	3					
14 Jun			1				
16 Jun			1			1	1
17 Jun					1		
18 Jun						1	
19 Jun	1	3					
26 Jun					1		
29 Jun							
03 Jul							
06 Jul							
09 Jul							
10 Jul							
Totals	41	169	52	23	7	6	2

Appendix Table 8. Detections during 2002 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 24 wild chinook salmon from Herd Creek on 14 August 2001. Release sites were 699-701 km above Lower Granite Dam

Herd Creek							
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
7 May				1			
29 May			1				
Totals	0	0	1	1	0	0	0

Appendix Table 9. Detections during 2002 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 1,534 wild chinook salmon released from South Fork Salmon River, 16-17 August 2001. Release sites were 467-472 km above Lower Granite Dam.

South Fork Salmon River							
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
11 Apr	1	6					
12 Apr	1	5					
15 Apr	1	4					
16 Apr	3	12					
19 Apr	2	9					
22 Apr	2	8	1				
24 Apr	1	5	1				
26 Apr							
28 Apr							
29 Apr	1	6					
30 Apr	1	8					
1 May							
2 May			1				
3 May	2	16	3				
4 May	2	10	1	1	1		
5 May			2				
6 May			1				
7 May				1			
8 May			1			1	
9 May					1		
10 May	1	5					
11 May			1	1			
12 May						1	
13 May							
14 May				2			
15 May					1		
16 May	1	5	1				
17 May			2				1

Appendix Table 9. Continued.

South Fork Salmon River							
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
18 May							
19 May	2	6		3			
20 May			1		1		
21 May	1	3	1	1	2		
22 May	2	6	2				
23 May							
24 May	3	8	2				1
25 May			1				
26 May							
27 May							
28 May				2			
29 May			1				
30 May	1	4	3				
31 May			1	1			
1 Jun			1				
2 Jun							
3 Jun			2	1			
4 Jun							
5 Jun			1				
6 Jun							
7 Jun			1		1		
8 Jun							1
9 Jun	1	5				1	
10 Jun						1	
11 Jun							
14 Jun							
18 Jun							
20 Jun				1			
27 Jun			1				
07 Jul							
12 Jul							
Totals	29	131	33	14	7	4	3

Appendix Table 10. Detections during 2002 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 423 wild chinook salmon from Lower Big Creek/Rush Creek 21-22 August 2001. Release sites were 486-489 km above Lower Granite Dam.

Lower Big Creek/Rush Creek							
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
12 Apr	1	5					
15 Apr	3	12					
16 Apr	3	12					
17 Apr	2	9					
19 Apr	1	4					
20 Apr	2	9	2				
21 Apr	2	11					
22 Apr			1	1			
23 Apr	3	17					
24 Apr			2				
25 Apr	1	6					
26 Apr	1	6	1				
27 Apr	2	10	2				
28 Apr							
29 Apr							
30 Apr			1				
1 May				1			
2 May	1	13	5	1			
3 May	1	8	3				
4 May	1	5	5	2			
5 May	3	12	6	1			
6 May	1	4	1	1	1		
7 May	1	5		2			
8 May							
9 May	1	4					
10 May			1	1			
11 May				1	2		
12 May							

Appendix Table 10. Continued.

Lower Big Creek/Rush Creek							
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
13 May			1				
14 May			1		1		
15 May							
16 May			2		1		
17 May			2	1			1
19 May	2	6	1	1	1		1
20 May				1			
21 May							
22 May	1	3	1				
23 May							1
25 May							1
26 May							
29 May			1				
30 May							
31 May				1			
2 Jun							
5 Jun			1				
6 Jun						1	
7 Jun				1			
12 Jun						1	
16 Jun				1			
Totals	33	161	40	17	6	2	4

Appendix Table 11. Detections during 2002 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 510 wild chinook salmon from West Fork Chamberlain Creek released 22 August 2001. Release sites were 437-438 km above Lower Granite Dam.

West Fork Chamberlain Creek							
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
18 Apr	1	5					
25 Apr	1	6					
26 Apr	2	13					
27 Apr	2	10	1				
28 Apr	1	6					
29 Apr							
30 Apr	1	8	2				
1 May			1				
2 May			2				
3 May	1	8	2				
4 May	3	15	3	1			
5 May	2	8	5				
6 May			3	1			
7 May	2	10		2			
8 May			1	1			
9 May	1	4			1		
10 May				1			
11 May				3			
12 May	1	5	2	1			
13 May	1	5		1	1		
14 May			1				
15 May							
16 May			1				
17 May			1				
18 May			2	1			
19 May	1	3		2			
20 May	1	3	1	1			
21 May	1	3	2				

Appendix Table 11. Continued.

West Fork Chamberlain Creek							
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
22 May			1				1
23 May	1	3					
24 May				1		1	
25 May			1	1			
26 May					1		
27 May						1	
28 May				1			
29 May	1	4			1		
30 May					1		
1 Jun			1	1			
2 Jun							
3 Jun			2				
04 Jun							
06 Jun							
07 Jun							
08 Jun			1				
10 Jun							
11 Jun							
14 Jun							
18 Jun							
07 Jul							
12 Jul							
Totals	24	118	36	19	5	2	1

Appendix Table 12. Detections during 2002 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 1,489 wild chinook salmon from the Secesh River. Releases were made during 24-25 August 2001 at sites 429-431 km above Lower Granite Dam.

Secesh River							
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
11 Apr	1	6					
13 Apr	3	21					
14 Apr	1	4					
15 Apr	2	8					
17 Apr	3	13					
18 Apr	3	14					
20 Apr	1	5	3				
21 Apr	1	6					
22 Apr	1	4					
23 Apr	1	6	1				
24 Apr	1	5	1				
25 Apr	1	6			1		
26 Apr	1	6	1				
27 Apr			1				
28 Apr							
29 Apr	1	6					
30 Apr			1	1			
1 May			1				
2 May			3				
3 May			1	1	1		
4 May			4	6	1		
5 May	1	4	1	2	1		
6 May					2		
7 May	2	10		2			
8 May			1		1		
9 May							
10 May							
11 May				1	1		
12 May			1				

Appendix Table 12. Continued.

Secesh River							
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
13 May							1
14 May				2	1		
15 May	1	5	1				
16 May							
17 May	2	9					
18 May							
20 May			1	1			
21 May			2	1			
22 May			2		1		
23 May			3				
24 May			2				
25 May				1			
26 May							
27 May			1	1			1
28 May				1			
29 May							
30 May							
1 Jun	2	11					
2 Jun					1		
3 Jun			1				
9 Jun				1			
13 Jun							
15 Jun			1				
1 Jul	1	3					
23 Jul			1				
Totals	30	150	35	21	11	0	2

Appendix Table 13. Detections during 2002 of PIT-tagged smolts by date at three Snake River dams and three Columbia River dams for 695 wild chinook salmon from Lake Creek, 27-28 August 2001. Release sites were 451-452 km above Lower Granite Dam.

Lake Creek							
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
13 Apr	1	7					
16 Apr	1	4					
17 Apr	1	4					
18 Apr	1	5					
20 Apr	1	5					
25 Apr	2	11					
29 Apr	1	6					
2 May	1	13	1		1		
3 May			2	2			
4 May	1	5	3	2			
5 May			1				
6 May			1				
7 May				1			
8 May			1	1			
9 May							
10 May				1			
11 May				1			
12 May					1		
13 May							
14 May				1		1	
16 May				1			
17 May			1	1			
18 May			1		1		
20 May	2	6					
21 May	1	3	1				
23 May			1				
24 May							

Appendix Table 13. Continued.

Lake Creek							
	Lower Granite		First Detections				
Detection date	First detection	Expanded	Little Goose	Lower Monumental	McNary	John Day	Bonneville
25 May							
26 May							
28 May							
30 May				1			
31 May							
1 Jun							
3 Jun	2	10					
5 Jun							
7 Jun							
10 Jun							
29 Jun							
2 Jul							
18 Jul							
Totals	15	79	13	12	3	1	0

Appendix Table 14. Daily and expanded detections of PIT-tagged wild spring/summer chinook salmon smolts from Idaho at Lower Granite Dam during 2002, 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
28 Mar	62.5	0.0	6.6	0	0
29 Mar	67.0	0.0	6.1	0	0
30 Mar	57.1	0.0	6.6	0	0
31 Mar	56.9	0.0	6.8	0	0
01 Apr	67.6	0.0	6.5	0	0
02 Apr	60.9	0.0	6.8	0	0
03 Apr	60.8	13.4	7.4	0	0
04 Apr	53.9	26.8	7.5	0	0
05 Apr	55.9	28.5	7.2	0	0
06 Apr	66.3	27.1	7.2	0	0
07 Apr	72.1	35.3	7.4	0	0
08 Apr	71.1	28.6	7.7	0	0
09 Apr	70.8	23.2	7.9	0	0
10 Apr	74.9	26.2	7.8	0	0
11 Apr	76.7	26.6	8.1	2	11
12 Apr	73.2	26.0	8.0	3	16
13 Apr	76.6	24.5	8.1	6	42
14 Apr	91.5	23.8	8.1	3	11
15 Apr	122.1	42.7	8.4	8	32
16 Apr	112.2	30.0	8.1	14	54
17 Apr	100.0	32.2	7.1	9	38
18 Apr	91.1	28.0	7.0	10	45
19 Apr	85.2	24.7	7.6	8	36
20 Apr	75.8	25.7	7.8	5	23
21 Apr	72.3	30.7	7.8	6	34
22 Apr	67.3	24.4	8.1	7	28
23 Apr	73.9	18.6	8.4	8	45
24 Apr	71.8	15.1	9.1	4	21
25 Apr	62.4	14.4	9.3	11	62
26 Apr	59.8	19.6	9.3	8	51
27 Apr	59.7	18.5	9.1	6	30
28 Apr	59.3	19.5	9.4	4	25
29 Apr	61.5	22.1	9.9	4	24
30 Apr	51.8	23.7	9.8	4	30

Appendix Table 14. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature	Numbers detected	Expanded numbers detected
01 May	62.6	43.1	9.6	0	0
02 May	74.1	53.6	10.1	3	38
03 May	71.9	56.8	10.2	5	39
04 May	86.7	27.2	10.6	15	76
05 May	76.1	23.6	10.6	10	40
06 May	69.6	17.0	10.2	9	34
07 May	73.0	22.7	9.6	8	41
08 May	68.5	24.6	9.6	2	9
09 May	63.8	24.8	9.5	3	13
10 May	60.9	24.9	9.2	1	5
11 May	56.3	17.9	9.6	2	10
12 May	56.4	22.1	10.2	2	9
13 May	55.7	22.4	9.9	2	10
14 May	64.2	17.0	9.9	0	0
15 May	68.6	22.7	10.6	2	11
16 May	65.0	24.6	11.9	2	10
17 May	66.1	15.5	11.8	3	13
18 May	70.9	19.5	11.7	1	3
19 May	78.4	22.9	11.7	11	35
20 May	98.2	27.5	11.8	13	42
21 May	109.3	39.9	11.6	11	32
22 May	112.2	42.0	10.9	13	37
23 May	102.0	34.4	9.7	10	30
24 May	98.9	24.8	9.5	8	23
25 May	92.5	22.3	9.7	3	9
26 May	84.0	23.4	10.4	2	6
27 May	88.8	23.4	11.6	1	4
28 May	95.7	23.3	11.6	3	11
29 May	111.5	37.8	12.2	3	12
30 May	125.5	51.7	12.8	3	12
31 May	136.6	60.5	12.4	3	13
01 Jun	136.7	61.1	11.9	2	11
02 Jun	131.5	57.1	11.9	3	17
03 Jun	133.7	61.1	11.8	3	15
04 Jun	120.4	60.3	11.9	0	0
05 Jun	115.1	68.9	12.2	1	4
06 Jun	109.6	59.9	12.5	0	0

Appendix Table 14. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature	Numbers detected	Expanded numbers detected
07 Jun	107.8	53.1	12.6	1	6
08 Jun	104.9	40.6	12.3	1	10
09 Jun	89.6	29.2	12.0	1	5
10 Jun	79.0	55.7	11.8	0	0
11 Jun	82.1	28.0	11.5	0	0
12 Jun	75.0	23.1	11.6	0	0
13 Jun	75.7	22.6	12.6	1	3
14 Jun	76.2	18.0	13.6	0	0
15 Jun	77.6	22.9	14.5	0	0
16 Jun	82.3	19.8	14.9	0	0
17 Jun	94.3	27.3	14.8	0	0
18 Jun	96.9	39.5	15.0	0	0
19 Jun	99.4	40.5	14.8	1	3
20 Jun	89.9	29.1	14.3	0	0
21 Jun	85.9	20.4	13.7	2	7
22 Jun	79.7	4.9	14.3	1	2
23 Jun	87.1	11.3	14.0	0	0
24 Jun	89.5	25.4	14.4	0	0
25 Jun	91.5	25.2	15.0	1	3
26 Jun	83.1	8.0	15.6	1	3
27 Jun	85.5	29.0	15.7	0	0
28 Jun	84.4	36.3	16.3	0	0
29 Jun	81.7	19.5	16.7	0	0
30 Jun	80.2	21.5	16.9	0	0
01 Jul	68.7	36.9	16.8	1	3
02 Jul	59.0	20.5	17.0	0	0
03 Jul	53.3	14.4	16.3	0	0
04 Jul	52.3	18.7	16.6	0	0
05 Jul	46.1	0.0	16.9	1	4
06 Jul	40.1	0.0	17.7	0	0
07 Jul	39.1	0.0	18.7	0	0
08 Jul	38.2	0.0	18.1	0	0
09 Jul	43.0	13.8	19.0	0	0
10 Jul	40.6	7.6	19.5	0	0
11 Jul	42.9	10.9	19.9	0	0
12 Jul	43.8	27.5	20.1	0	0
13 Jul	42.1	9.7	21.7	0	0
14 Jul	38.0	0.0	20.1	0	0

Appendix Table 15. Daily first-time detections of PIT-tagged wild spring/summer chinook salmon smolts from Idaho at Little Goose Dam during 2002, 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	112.0	36.2	8.3	0
17 Apr	97.5	43.9	8.4	0
18 Apr	85.6	48.3	8.4	1
19 Apr	81.6	48.2	7.9	0
20 Apr	74.5	44.3	7.8	5
21 Apr	69.2	42.1	7.8	0
22 Apr	63.2	38.3	8.1	3
23 Apr	74.4	33.1	8.3	1
24 Apr	70.3	33.5	8.7	5
25 Apr	62.0	32.1	8.8	2
26 Apr	59.0	28.6	8.9	4
27 Apr	59.5	28.3	9.3	6
28 Apr	57.0	29.4	9.5	1
29 Apr	60.6	29.9	9.9	2
30 Apr	48.9	26.3	10.6	6
01 May	61.7	14.8	10.3	9
02 May	69.4	14.7	10.0	20
03 May	67.4	14.6	10.2	29
04 May	83.5	17.5	10.1	32
05 May	73.3	21.4	10.1	33
06 May	67.7	22.8	10.2	11
07 May	70.6	23.0	10.3	1
08 May	64.2	23.2	10.5	7
09 May	55.3	22.2	10.5	0
10 May	54.8	22.5	10.0	1
11 May	54.9	23.8	9.9	1
12 May	52.3	21.1	11.3	3
13 May	51.1	22.1	10.8	2
14 May	63.6	21.8	10.0	4
15 May	65.9	22.6	10.0	7
16 May	63.5	22.8	10.5	4
17 May	63.7	22.0	10.6	12
18 May	69.4	22.7	11.3	4
19 May	75.0	21.9	11.8	5
20 May	95.8	20.2	12.0	4
21 May	104.4	19.2	12.0	12

Appendix Table 15. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature	Numbers detected
22 May	109.0	19.3	11.8	24
23 May	99.4	18.9	11.8	16
24 May	104.3	20.6	11.7	13
25 May	89.6	20.6	11.0	5
26 May	81.8	19.4	10.2	8
27 May	86.1	19.3	10.8	5
28 May	92.4	19.2	10.5	8
29 May	108.5	19.0	11.5	9
30 May	116.7	18.8	12.0	6
31 May	135.7	28.2	12.6	8
01 Jun	130.9	28.1	13.1	12
02 Jun	126.3	64.1	12.7	8
03 Jun	130.6	38.0	12.5	11
04 Jun	114.3	39.4	12.5	3
05 Jun	110.2	63.6	12.3	4
06 Jun	103.0	64.1	12.4	1
07 Jun	102.5	40.9	12.6	2
08 Jun	98.3	28.5	12.6	4
09 Jun	86.8	24.3	12.7	2
10 Jun	72.4	19.4	12.6	1
11 Jun	76.0	19.0	13.0	0
12 Jun	71.3	17.5	13.9	0
13 Jun	72.9	15.8	13.6	0
14 Jun	74.4	13.5	13.6	1
15 Jun	73.7	16.0	13.0	1
16 Jun	80.9	12.0	12.7	1
17 Jun	94.2	13.0	13.4	1
18 Jun	90.4	13.5	14.1	0
19 Jun	96.9	14.8	14.7	0
20 Jun	84.5	7.4	15.7	0
21 Jun	85.0	3.2	15.5	0
22 Jun	79.3	0.0	15.3	1
23 Jun	85.1	0.0	14.4	0
24 Jun	86.8	0.0	14.2	0
25 Jun	87.3	0.0	15.3	0
26 Jun	82.4	0.0	15.9	0
27 Jun	83.7	15.7	14.9	1
28 Jun	78.0	30.6	15.4	0
29 Jun	80.2	16.1	15.8	0
23 Jul	30.6	0.0	22.2	1

Appendix Table 16. Daily first-time detections of PIT-tagged wild spring/summer chinook salmon smolts from Idaho at Lower Monumental Dam during 2002, 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
22 Apr	67.4	0.0	8.3	1
23 Apr	77.3	0.0	8.3	0
24 Apr	73.3	0.0	8.8	0
25 Apr	65.9	0.0	8.9	0
26 Apr	61.4	0.0	8.9	0
27 Apr	62.0	0.0	9.0	0
28 Apr	59.2	0.0	9.1	0
29 Apr	64.3	0.0	9.4	0
30 Apr	47.5	0.0	10.4	2
01 May	66.0	0.0	10.5	3
02 May	72.0	0.0	10.4	2
03 May	70.9	0.0	10.6	3
04 May	87.5	0.0	10.4	22
05 May	75.3	0.0	10.3	7
06 May	72.8	0.0	10.3	3
07 May	75.1	0.0	10.2	20
08 May	66.8	0.0	10.6	4
09 May	59.3	0.0	10.8	2
10 May	57.7	0.0	10.9	3
11 May	59.1	0.0	11.1	10
12 May	55.4	0.0	11.4	1
13 May	52.8	0.0	11.1	7
14 May	65.3	0.0	10.8	11
15 May	69.1	0.0	10.9	1
16 May	66.7	0.0	10.9	2
17 May	66.7	0.0	11.1	3
18 May	70.9	0.0	11.2	2
19 May	78.2	0.0	11.4	11
20 May	99.4	0.0	11.5	9
21 May	108.2	0.0	11.9	4

Appendix Table 16. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature	Numbers detected
22 May	113.1	0.0	12.1	6
23 May	103.3	0.0	12.1	3
24 May	109.7	0.0	12.2	1
25 May	92.5	0.0	12.3	9
26 May	84.6	0.0	12.1	3
27 May	91.8	0.0	11.5	1
28 May	94.3	0.0	11.0	9
29 May	112.5	0.0	11.0	2
30 May	119.2	3.2	11.2	3
31 May	139.0	16.3	12.1	3
01 Jun	135.0	12.6	12.6	1
02 Jun	129.0	8.8	13.0	1
03 Jun	135.2	14.5	13.1	4
04 Jun	116.0	5.5	12.7	5
05 Jun	115.6	0.0	12.9	0
06 Jun	107.5	0.0	12.8	2
07 Jun	106.1	0.0	12.5	3
08 Jun	102.3	0.0	12.5	3
09 Jun	89.2	0.0	12.4	1
10 Jun	74.5	0.0	12.7	0
11 Jun	80.6	0.0	12.9	2
12 Jun	72.4	0.0	13.7	1
13 Jun	76.0	0.0	13.8	0
14 Jun	76.0	0.0	14.6	0
15 Jun	74.5	0.0	13.9	0
16 Jun	81.5	0.0	13.4	1
17 Jun	98.0	0.0	13.2	0
18 Jun	91.6	0.0	13.2	2
19 Jun	100.7	0.0	14.2	0
20 Jun	87.4	0.0	15.4	1
23 Jul	30.3	0.0	22.5	1
27 Jul	24.6	0.0	21.3	1

Appendix Table 17. Daily first-time detections of PIT-tagged wild spring/summer chinook salmon smolts from Idaho at McNary Dam during 2002, 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	240.5	112.3	8.6	2
26 Apr	232.2	101.7	8.7	1
27 Apr	205.2	93.8	8.8	0
28 Apr	187.1	77.0	8.9	0
29 Apr	217.2	79.6	9.5	1
30 Apr	224.8	87.3	9.8	1
01 May	211.0	76.2	10.1	1
02 May	214.7	50.2	9.9	6
03 May	224.7	59.0	9.8	4
04 May	239.4	68.3	10.2	2
05 May	217.5	56.9	10.1	3
06 May	212.4	65.0	10.1	5
07 May	241.4	88.0	9.9	3
08 May	247.3	78.4	10.3	4
09 May	201.8	73.2	10.3	4
10 May	196.3	72.0	10.4	1
11 May	208.0	67.2	11.1	3
12 May	156.3	50.8	11.6	4
13 May	213.6	77.7	11.4	3
14 May	210.0	67.4	11.4	4
15 May	211.6	62.1	11.9	4
16 May	202.3	60.0	12.1	3
17 May	216.8	68.5	12.2	2
18 May	208.4	69.8	12.1	4
19 May	209.0	70.9	12.4	1
20 May	226.4	73.2	12.6	1
21 May	276.5	108.0	12.4	4
22 May	269.1	107.3	12.2	4

Appendix Table 17. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature	Numbers detected
23 May	273.2	113.4	12.7	3
24 May	266.0	111.1	13.1	1
25 May	241.8	103.1	13.0	3
26 May	230.7	99.3	13.1	3
27 May	268.4	119.7	13.4	0
28 May	276.3	114.9	13.5	0
29 May	295.1	133.3	13.5	2
30 May	294.8	122.8	13.5	2
31 May	322.2	149.4	13.3	1
01 Jun	345.2	171.0	13.1	1
02 Jun	300.4	129.4	13.2	2
03 Jun	313.1	139.6	13.8	0
04 Jun	358.3	193.2	14.1	2
05 Jun	376.9	221.5	14.1	0
06 Jun	374.0	211.6	14.1	0
07 Jun	344.8	184.1	13.8	1
08 Jun	370.8	212.8	13.3	0
09 Jun	332.6	163.5	12.9	2
10 Jun	294.7	128.4	13.0	0
11 Jun	338.7	168.7	13.5	0
12 Jun	297.8	145.2	14.2	0
13 Jun	308.3	143.8	14.3	0
14 Jun	281.8	121.3	14.5	0
15 Jun	306.1	134.8	15.0	0
16 Jun	271.0	98.0	15.1	0
17 Jun	297.7	141.1	15.2	1
18 Jun	328.2	166.7	15.2	0
19 Jun	345.7	179.5	15.0	0
20 Jun	361.1	188.7	15.0	0
26 Jun	308.1	135.7	17.3	1
01 Jul	308.6	139.5	16.9	1

Appendix Table 18. Daily first-time detections of PIT-tagged wild spring/summer chinook salmon smolts from Idaho at John Day Dam during 2002, 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
28 Apr	181.3	42.3	9.6	1
29 Apr	214.7	65.2	9.8	0
30 Apr	234.5	86.6	9.8	0
01 May	211.5	62.0	9.9	0
02 May	203.7	38.3	10.1	0
03 May	247.9	57.6	10.2	0
04 May	236.4	88.0	10.3	0
05 May	219.5	65.0	10.4	0
06 May	216.2	51.3	10.4	0
07 May	241.2	71.2	10.4	1
08 May	257.6	74.9	10.4	1
09 May	204.1	59.9	10.6	1
10 May	199.2	68.4	10.6	0
11 May	212.2	63.0	10.8	0
12 May	170.7	50.9	11.2	1
13 May	209.8	60.4	11.3	0
14 May	205.9	46.1	11.3	1
15 May	219.1	61.7	11.5	2
16 May	194.3	59.7	11.9	3
17 May	225.2	70.3	12.1	0
18 May	205.0	78.6	12.3	0
19 May	220.1	65.2	12.6	0
20 May	228.9	67.1	12.9	0
21 May	262.3	76.9	12.7	0
22 May	276.7	59.7	12.8	1
23 May	270.7	77.2	13.0	2

Appendix Table 18. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature	Numbers detected
24 May	275.2	76.1	13.2	4
25 May	246.4	74.0	13.2	0
26 May	238.9	89.8	13.2	0
27 May	246.6	70.5	13.4	1
28 May	284.7	77.2	13.6	0
29 May	305.9	80.1	13.8	0
30 May	303.0	82.6	14.0	0
31 May	305.2	92.1	14.2	0
01 Jun	359.2	116.2	14.4	1
02 Jun	308.7	154.7	14.6	0
03 Jun	312.6	141.6	14.5	0
04 Jun	342.6	152.8	14.3	0
05 Jun	377.6	195.9	14.2	2
06 Jun	376.7	185.7	14.4	2
07 Jun	348.0	146.3	14.7	0
08 Jun	376.3	165.2	14.6	1
09 Jun	341.3	132.6	14.4	1
10 Jun	295.2	72.5	14.2	3
11 Jun	349.7	124.3	14.2	0
12 Jun	298.7	89.4	14.2	2
13 Jun	314.7	86.8	14.4	1
14 Jun	278.3	75.5	14.5	0
15 Jun	297.4	76.7	14.7	0
16 Jun	262.2	72.7	15.2	1
17 Jun	303.8	102.2	15.4	0
18 Jun	310.9	83.6	15.5	1

Appendix Table 19. Daily first-time detections of PIT-tagged wild spring/summer chinook salmon smolts from Idaho at Bonneville Dam during 2002, 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 May	220.7	91.6	11.5	1
14 May	205.8	134.6	11.4	0
15 May	215.9	124.4	11.2	0
16 May	208.1	118.9	11.9	1
17 May	221.4	115.4	12.1	2
18 May	227.1	86.0	12.3	0
19 May	229.0	85.0	12.6	1
20 May	232.6	81.6	12.7	0
21 May	268.3	83.9	12.8	1
22 May	293.6	117.2	13.0	1
23 May	271.8	151.1	13.0	1
24 May	276.3	151.0	13.2	2
25 May	259.1	136.8	13.5	1
26 May	245.7	92.7	13.7	0
27 May	246.7	93.0	13.7	1
28 May	290.5	102.9	13.7	1
29 May	313.6	129.1	13.7	0
30 May	295.4	125.4	14.0	1
31 May	312.1	120.0	14.2	0
01 Jun	349.5	134.7	14.5	0
02 Jun	312.8	170.7	14.5	0
03 Jun	308.6	144.4	14.7	0
04 Jun	332.0	184.0	14.9	0
05 Jun	361.9	208.0	14.9	0
06 Jun	375.2	207.0	14.6	0
07 Jun	348.4	166.2	14.3	0
08 Jun	353.2	182.6	14.3	1
09 Jun	321.5	150.9	14.5	0
10 Jun	305.4	118.4	14.6	0
11 Jun	337.1	153.7	14.8	1
12 Jun	298.1	115.3	14.8	0
13 Jun	308.4	118.5	14.9	0
14 Jun	285.2	96.6	15.0	0
15 Jun	300.4	106.3	15.2	2
16 Jun	278.4	101.4	15.2	1
17 Jun	304.5	123.5	15.2	0
18 Jun	298.0	107.8	15.4	0

Appendix Table 20. Monthly environmental data collected from Marsh Creek (RKm 179.5 from the mouth of the Middle Fork Salmon River) from August 2001 through July 2002.

	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Minimum	6.4	3.5	0.6	-0.1	0.7	0.5	0.1	0.0	0.0	0.1	2.9	7.5
Maximum	15.9	15.8	12.5	6.7	2.2	3.7	5.7	9.9	1.2	13.2	15.9	15.9
Average	11.4	9.8	5.3	2.6	0.2	0.6	0.7	2.3	3.9	5.7	9.7	12.3
						Dissolved Oxygen (ppm)						
Minimum	----	----	6.2	3.9	11.3	11.8	7.5	6.5	6.4	----	-----	-----
Maximum	13.7	12.6	14.2	14.2	13.4	14.2	14.2	8.5	8.2	7.9	-----	-----
Average	----	----	12.0	11.8	12.1	13.3	12.8	7.6	7.3	7.0	-----	-----
						Specific Conductance (µS/cm)						
Minimum	6.0	62.0	58.0	6.0	64.0	55.0	63.0	62.0	46.0	26.0	3.0	53.0
Maximum	68.0	7.0	7.0	78.0	83.0	83.0	83.0	74.0	68.0	118.0	55.0	66.0
Average	64.2	66.8	66.3	64.6	77.3	77.8	77.4	67.9	57.6	38.9	44.1	61.5
						Turbidity (ntu)						
Minimum	0.0	0.2	4.2	0.2	0.0	0.1	0.0	0.0	0.5	2.2	1.0	1.7
Maximum	2.5	39.5	49.1	49.5	15.5	49.6	18.7	33.1	42.3	36.4	46.1	27.2
Average	1.5	7.4	25.6	11.6	1.6	2.7	2.7	1.8	6.2	8.4	4.7	4.8
						Depth (feet)						
Minimum	0.8	0.7	0.7	0.2	1.4	1.1	0.8	0.7	0.6	1.3	1.3	1.0
Maximum	1.4	1.2	1.3	1.8	3.6	3.3	3.1	1.9	1.4	3.2	3.4	1.6
Average	1.6	1.2	1.0	1.5	2.4	2.3	1.8	0.7	1.9	1.9	1.9	1.2
						pH						
Minimum	7.3	7.7	7.5	7.5	7.3	7.4	7.4	7.6	7.1	7.0	7.0	7.3
Maximum	8.8	8.7	8.6	8.4	7.8	8.1	8.8	8.9	8.7	8.2	8.4	8.4
Average	8.8	8.5	8.0	7.9	7.5	7.7	7.9	7.9	7.7	7.4	7.5	7.9

Appendix Table 21. Monthly environmental data collected from the Salmon River near Sawtooth Hatchery (RKm 627.9) from August 2001 through July 2002.

	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Minimum	6.4	6.7	2.3	0.1	0.0	0.1	0.0	0.0	1.4	2.5	6.2	1.4
Maximum	15.9	15.9	13.9	1.2	2.8	4.3	6.4	1.5	11.7	15.9	15.9	15.9
Average	12.7	11.7	7.3	4.0	0.7	1.1	1.4	3.4	6.2	8.9	11.9	13.6
						Dissolved Oxygen (ppm)						
Minimum	----	8.3	7.1	6.7	8.0	6.7	----	----	7.6	9.3	9.1	8.7
Maximum	11.2	12.7	14.2	14.2	14.2	14.2	14.2	14.2	14.4	14.2	12.7	13.5
Average	9.1	1.4	11.9	13.0	11.6	12.4	12.9	12.1	11.8	11.7	----	----
						Specific Conductance (µS/cm)						
Minimum	161.0	172.0	152.0	5.0	154.0	161.0	137.0	139.0	19.0	7.0	68.0	96.0
Maximum	188.0	189.0	189.0	172.0	181.0	191.0	19.0	181.0	253.0	125.0	98.0	163.0
Average	178.6	182.8	175.7	163.0	164.8	172.9	173.5	167.6	141.3	13.0	83.8	134.5
						Turbidity (ntu)						
Minimum	0.0	0.2	1.8	0.0	0.0	0.0	0.0	8.7	13.1	-----	-----	-----
Maximum	13.3	49.6	49.6	49.5	19.2	8.6	26.9	47.0	49.4	-----	-----	-----
Average	1.0	1.7	15.8	14.8	0.6	0.6	1.9	27.4	34.0	-----	-----	-----
						Depth (feet)						
Minimum	1.3	1.2	1.3	0.1	1.8	1.8	1.2	0.9	1.5	1.8	2.3	1.9
Maximum	2.2	1.9	2.9	2.2	3.0	2.9	3.5	2.7	2.3	3.2	3.3	2.5
Average	1.6	1.6	1.7	1.6	2.4	2.3	2.4	1.5	1.9	2.3	2.7	2.2
						pH						
Minimum	7.7	7.7	7.7	3.8	7.7	7.7	7.8	7.2	6.9	7.5	7.5	7.7
Maximum	8.9	8.8	8.8	8.7	9.5	9.3	9.3	8.8	8.4	8.7	8.8	8.9
Average	8.2	8.1	8.2	8.4	8.3	8.4	8.5	8.2	7.7	8.6	8.5	8.3

Appendix Table 22. Monthly environmental data collected from Valley Creek (RKm 609.4 from the mouth of the Salmon River) from August 2001 through July 2002.

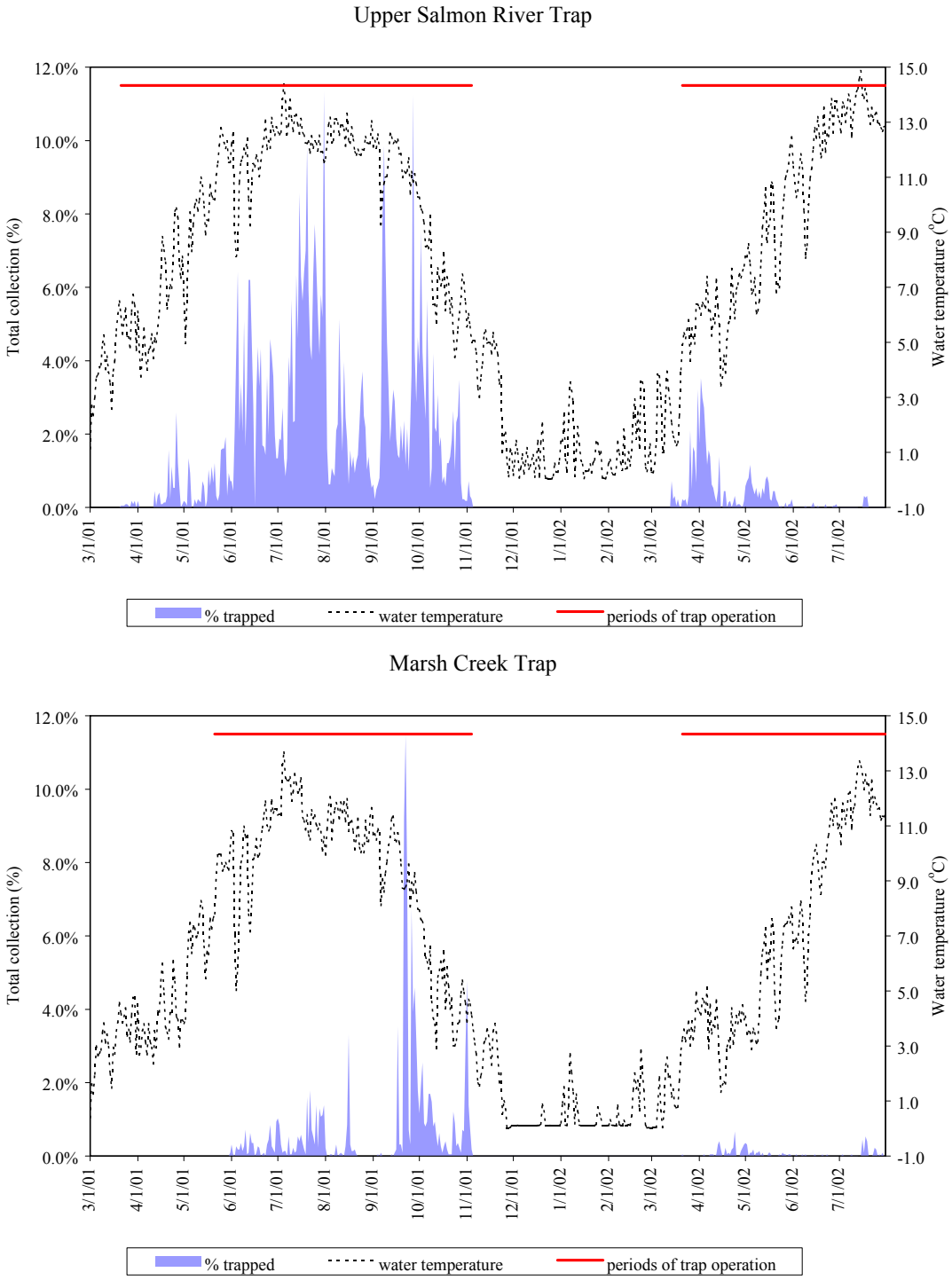
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Minimum	9.2	5.3	1.2	0.5	0.1	0.5	0.5	0.1	0.5	1.0	4.3	9.5
Maximum	15.9	15.9	14.7	7.5	1.0	1.4	1.6	1.1	13.0	15.2	15.8	15.9
Average	13.6	11.7	6.5	2.9	0.5	0.7	0.7	2.8	5.1	8.3	11.1	13.8
						Dissolved Oxygen (ppm)						
Minimum	6.4	7.4	8.7	6.4	11.2	----	11.3	----	6.7	9.4	8.6	7.2
Maximum	9.9	11.7	13.4	14.2	12.4	13.1	14.4	13.0	13.6	14.0	12.9	11.3
Average	8.2	9.4	11.3	12.6	11.7	12.5	13.1	11.9	11.7	11.2	----	9.3
						Specific Conductance (µS/cm)						
Minimum	8.0	94.0	79.0	74.0	77.0	81.0	74.0	87.0	4.0	49.0	47.0	55.0
Maximum	14.0	17.0	12.0	16.0	87.0	92.0	93.0	12.0	94.0	7.0	58.0	82.0
Average	94.2	98.7	94.5	91.4	81.4	84.4	83.7	93.2	70.0	61.3	52.6	69.2
						Turbidity (ntu)						
Minimum	0.1	0.1	0.2	0.3	0.3	2.2	0.6	1.0	2.6	1.6	1.3	0.3
Maximum	31.6	49.7	48.5	5.0	9.5	49.5	49.9	48.1	48.3	23.1	17.5	1.4
Average	1.7	1.6	8.3	7.6	2.2	11.9	21.5	16.7	14.6	5.9	3.7	1.7
						Depth (feet)						
Minimum	0.8	0.7	0.7	0.5	0.9	0.9	0.3	0.0	0.6	1.9	1.5	0.8
Maximum	1.5	1.4	1.4	1.6	2.5	2.0	2.2	0.9	2.3	2.5	2.4	1.7
Average	1.7	1.9	1.1	1.1	1.6	1.5	1.6	0.5	1.1	1.6	2.0	1.2
						pH						
Minimum	7.4	7.6	7.5	7.5	7.8	6.9	6.8	6.8	6.3	6.9	6.9	7.2
Maximum	8.7	8.8	8.7	8.5	7.9	7.4	7.8	8.0	8.2	8.3	8.0	8.4
Average	8.2	8.1	8.5	7.9	7.6	7.1	7.0	7.5	7.2	7.6	7.4	7.8

Appendix Table 23. Monthly environmental data collected from Secesh River (27 km upstream from its confluence with the South Fork Salmon River) from August 2001 through July 2002.

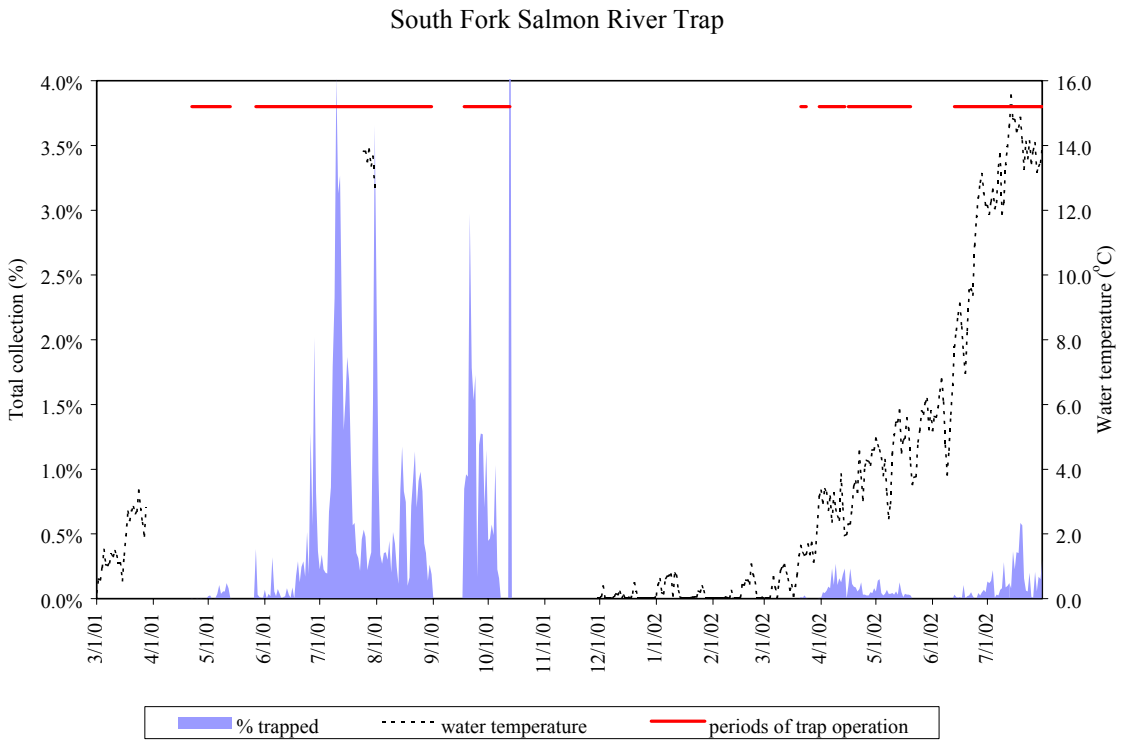
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Minimum	8.1	4.6	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----
Maximum	15.9	15.9	11.4	-----	-----	-----	-----	-----	-----	-----	-----	-----
Average	13.2	1.6	4.4	-----	-----	-----	-----	-----	-----	-----	-----	-----
						Dissolved Oxygen (ppm)						
Minimum	7.3	8.7	9.7	-----	-----	-----	-----	-----	-----	-----	-----	-----
Maximum	11.8	13.1	14.2	-----	-----	-----	-----	-----	-----	-----	-----	-----
Average	9.1	----	12.5	-----	-----	-----	-----	-----	-----	-----	-----	-----
						Specific Conductance (µS/cm)						
Minimum	36.0	44.0	42.0	-----	-----	-----	-----	-----	-----	-----	-----	-----
Maximum	49.0	53.0	51.0	-----	-----	-----	-----	-----	-----	-----	-----	-----
Average	43.5	47.8	45.8	-----	-----	-----	-----	-----	-----	-----	-----	-----
						Turbidity (ntu)						
Minimum	0.1	0.0	0.0	-----	-----	-----	-----	-----	-----	-----	-----	-----
Maximum	49.9	2.6	25.1	-----	-----	-----	-----	-----	-----	-----	-----	-----
Average	3.8	0.4	2.2	-----	-----	-----	-----	-----	-----	-----	-----	-----
						Depth (feet)						
Minimum	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Maximum	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Average	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
						pH						
Minimum	7.0	6.9	6.9	-----	-----	-----	-----	-----	-----	-----	-----	-----
Maximum	8.9	9.1	8.7	-----	-----	-----	-----	-----	-----	-----	-----	-----
Average	7.8	7.9	7.6	-----	-----	-----	-----	-----	-----	-----	-----	-----

Appendix Table 24. Monthly environmental data collected from South Fork Salmon River (112 km from its confluence with the Salmon River) from August 2001 through July 2002.

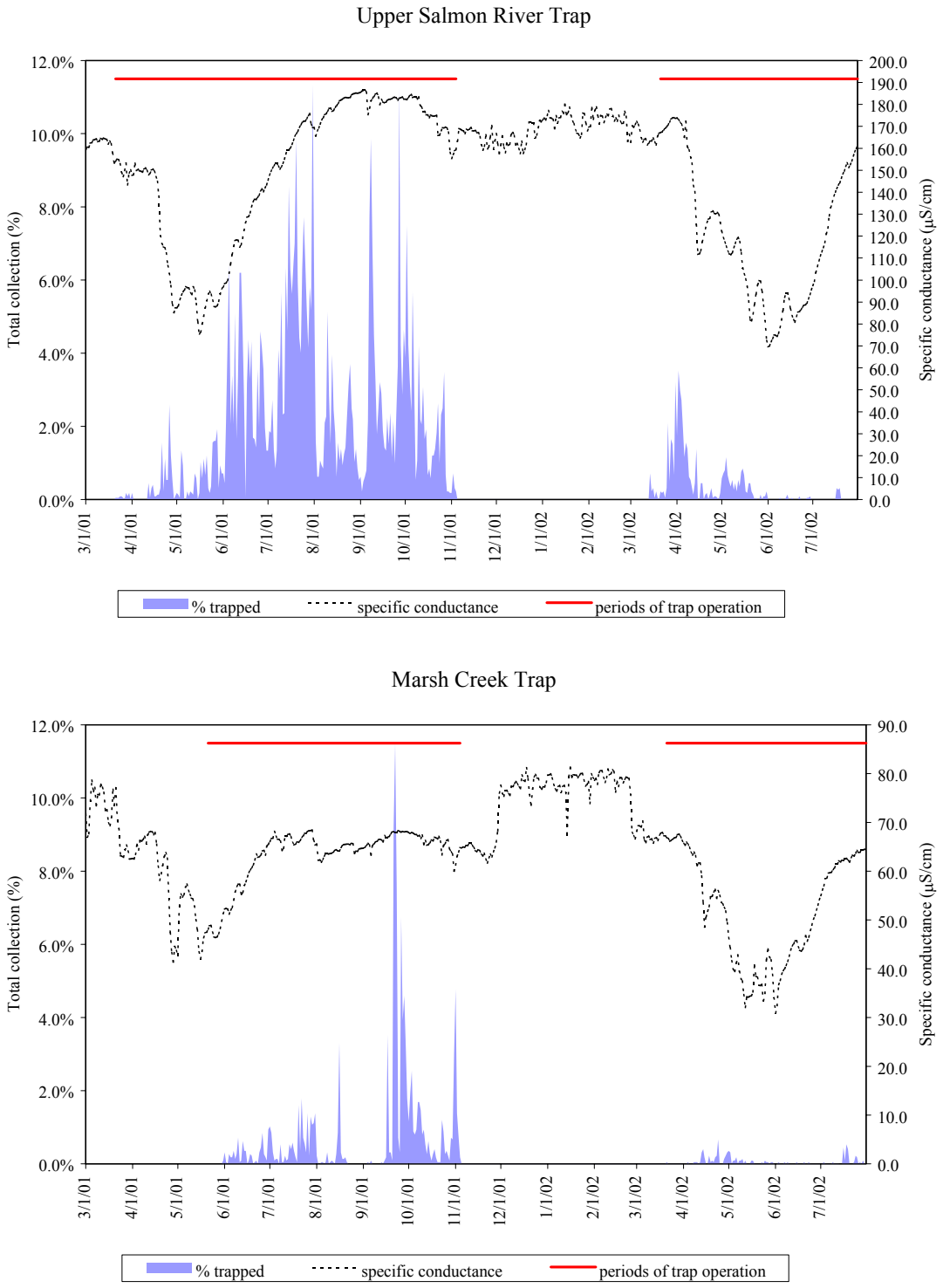
	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul
						Temperature (°C)						
Minimum	-----	-----	-----	0.2	0.0	0.0	0.0	0.0	0.5	0.8	2.7	8.7
Maximum	-----	-----	-----	0.2	1.0	1.6	2.3	5.9	7.9	9.6	15.8	15.9
Average	-----	-----	-----	0.2	0.2	0.3	0.2	1.8	3.3	4.8	8.2	13.7
						Dissolved Oxygen (ppm)						
Minimum	-----	-----	-----	13.7	13.5	13.9	14.2	13.0	12.4	12.4	1.8	9.6
Maximum	-----	-----	-----	13.9	14.2	14.2	14.2	14.2	14.2	14.2	14.2	13.4
Average	-----	-----	-----	13.8	14.0	14.1	14.2	14.3	13.7	13.6	13.0	11.3
						Specific Conductance (µS/cm)						
Minimum	-----	-----	-----	63.0	45.0	49.0	49.0	53.0	27.0	21.0	2.0	35.0
Maximum	-----	-----	-----	63.0	68.0	82.0	7.0	74.0	58.0	36.0	35.0	55.0
Average	-----	-----	-----	63.0	62.4	64.0	64.1	64.4	4.4	29.3	26.2	46.9
						Turbidity (ntu)						
Minimum	-----	-----	-----	0.0	0.0	0.0	0.0	0.0	2.7	1.9	1.2	0.1
Maximum	-----	-----	-----	1.2	3.1	3.8	2.2	4.1	48.1	5.0	15.7	22.7
Average	-----	-----	-----	0.6	0.3	0.5	0.5	0.7	8.0	7.5	3.9	1.4
						Depth (feet)						
Minimum	-----	-----	-----	1.9	0.6	0.7	0.8	0.6	1.3	1.8	1.5	1.7
Maximum	-----	-----	-----	1.9	2.9	2.3	2.6	2.4	2.6	3.0	2.9	1.7
Average	-----	-----	-----	1.9	1.6	1.5	1.7	1.2	1.8	2.3	2.1	1.4
						pH						
Minimum	-----	-----	-----	7.5	7.2	7.4	7.3	7.3	6.7	6.6	6.6	6.8
Maximum	-----	-----	-----	7.6	7.6	8.1	7.7	7.7	7.7	7.6	7.5	8.3
Average	-----	-----	-----	7.5	7.4	7.5	7.5	7.5	7.3	7.7	6.9	7.4



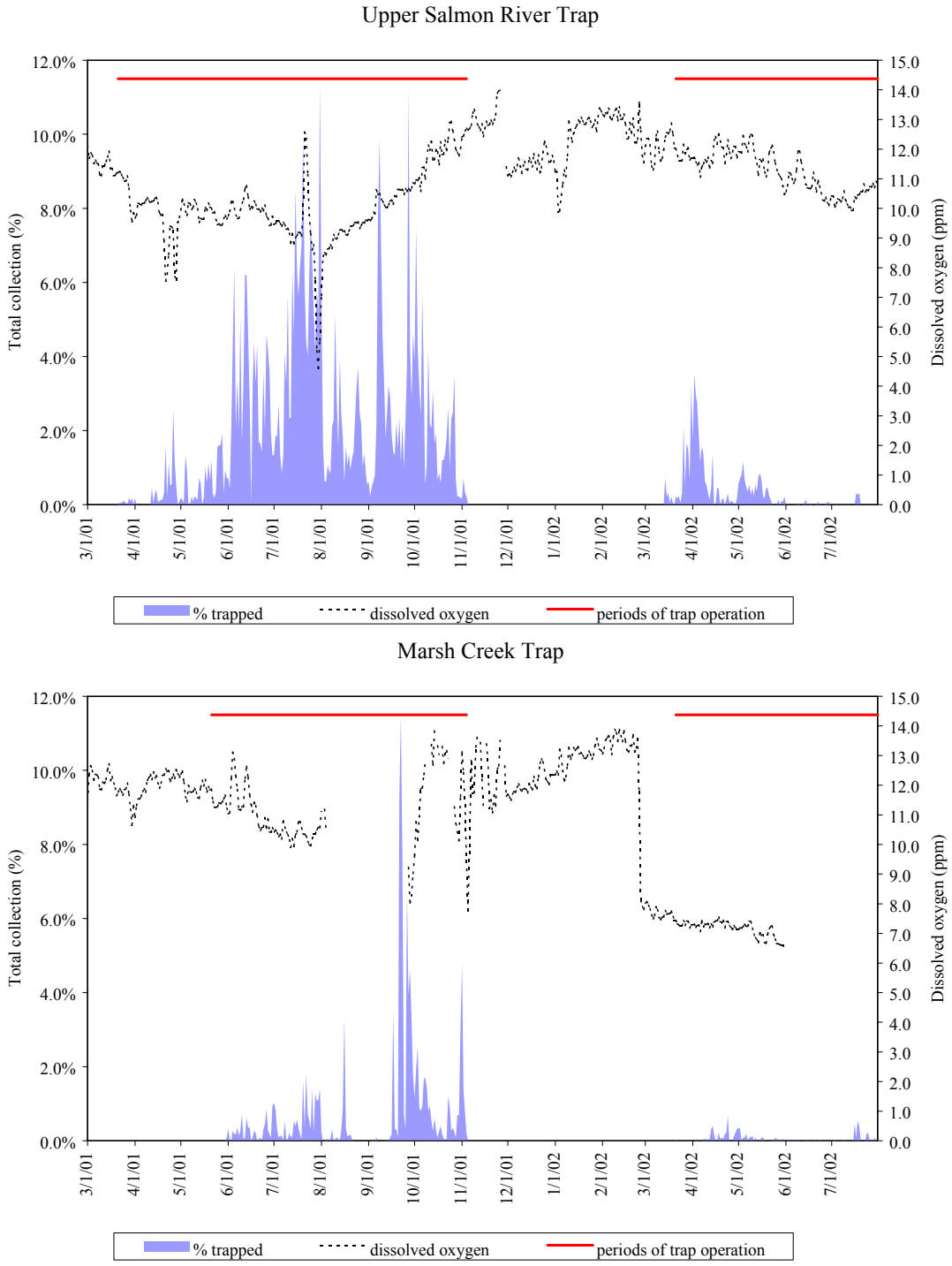
Appendix Figure 1. Daily passage of wild chinook salmon fry, parr, and smolts at three migrant traps, expressed as percentages of total collected, and plotted against average daily water temperatures collected near traps. Periods of trap operation are also shown.



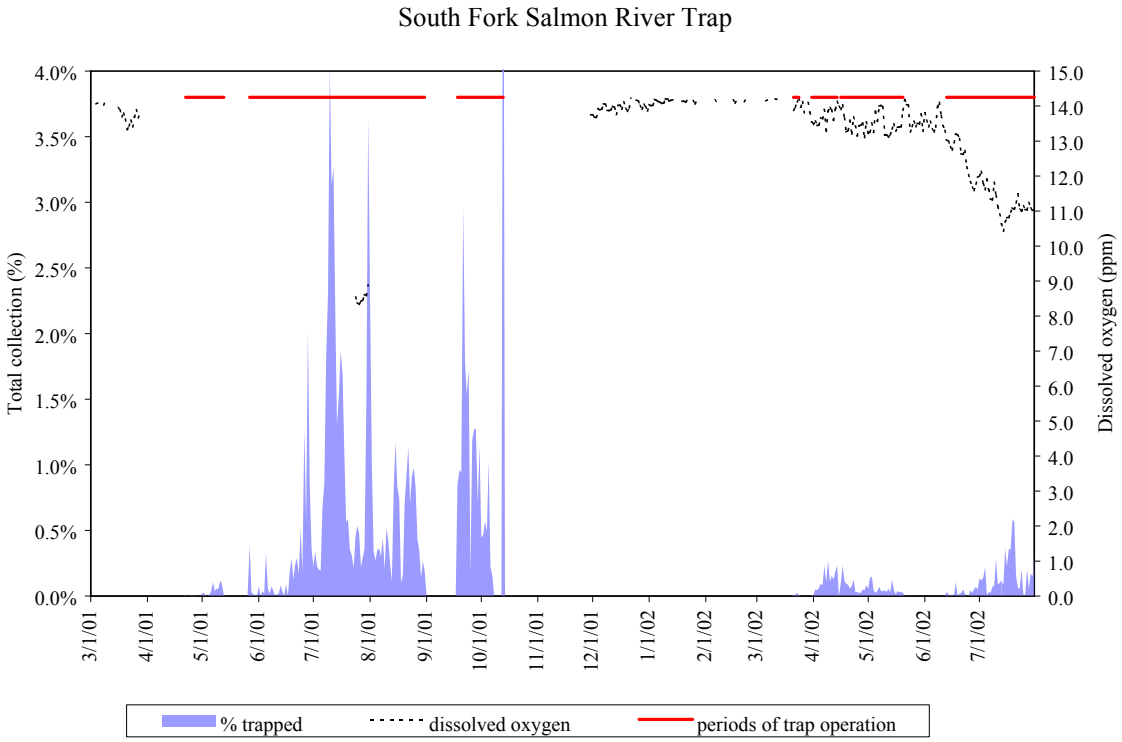
Appendix Figure 1. Continued.



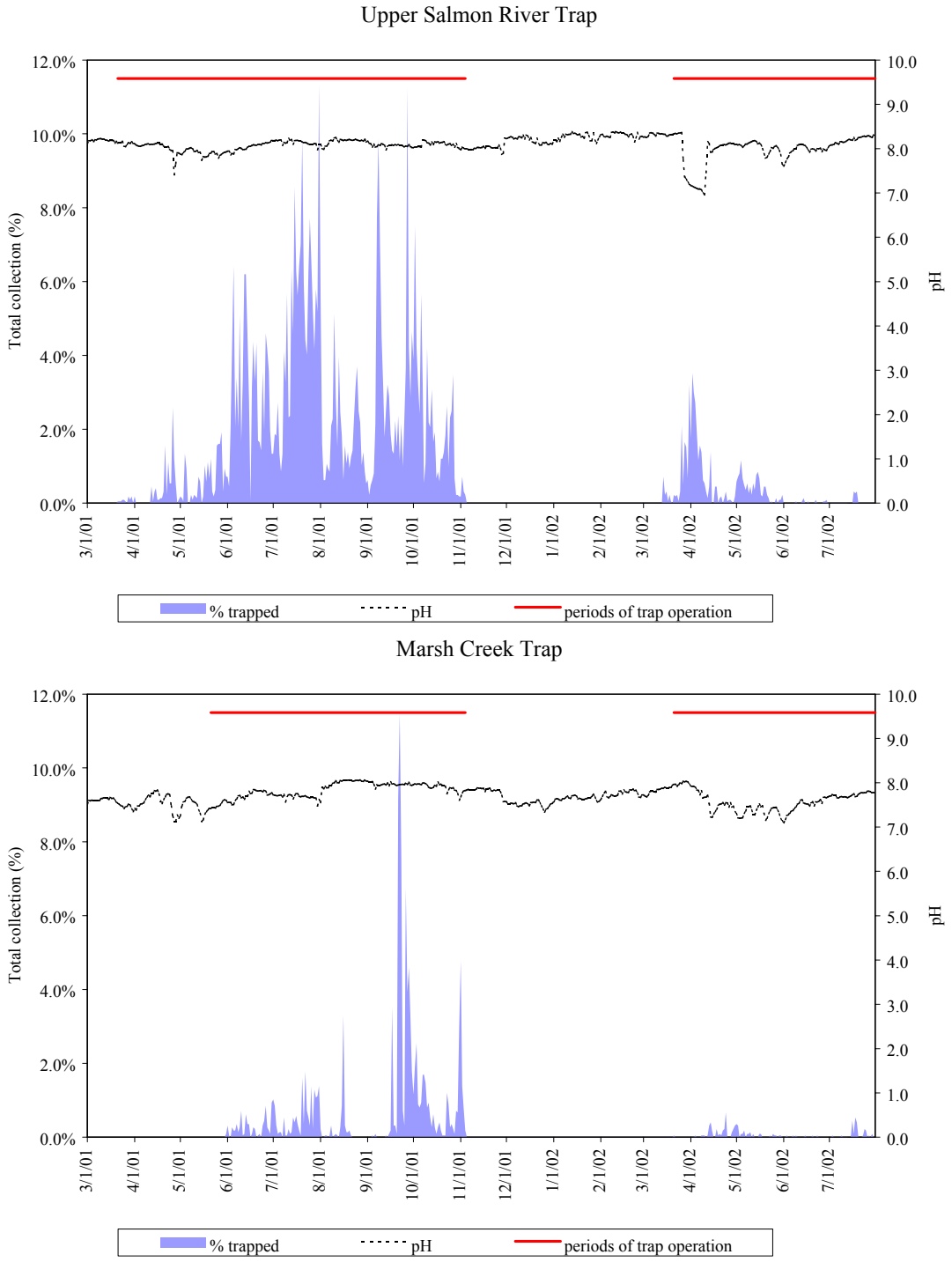
Appendix Figure 2. Daily passage of wild chinook salmon fry, parr, and smolts at three migrant traps, expressed as percentages of total collected, and plotted against average daily specific conductance collected near traps. Periods of trap operation are also shown.



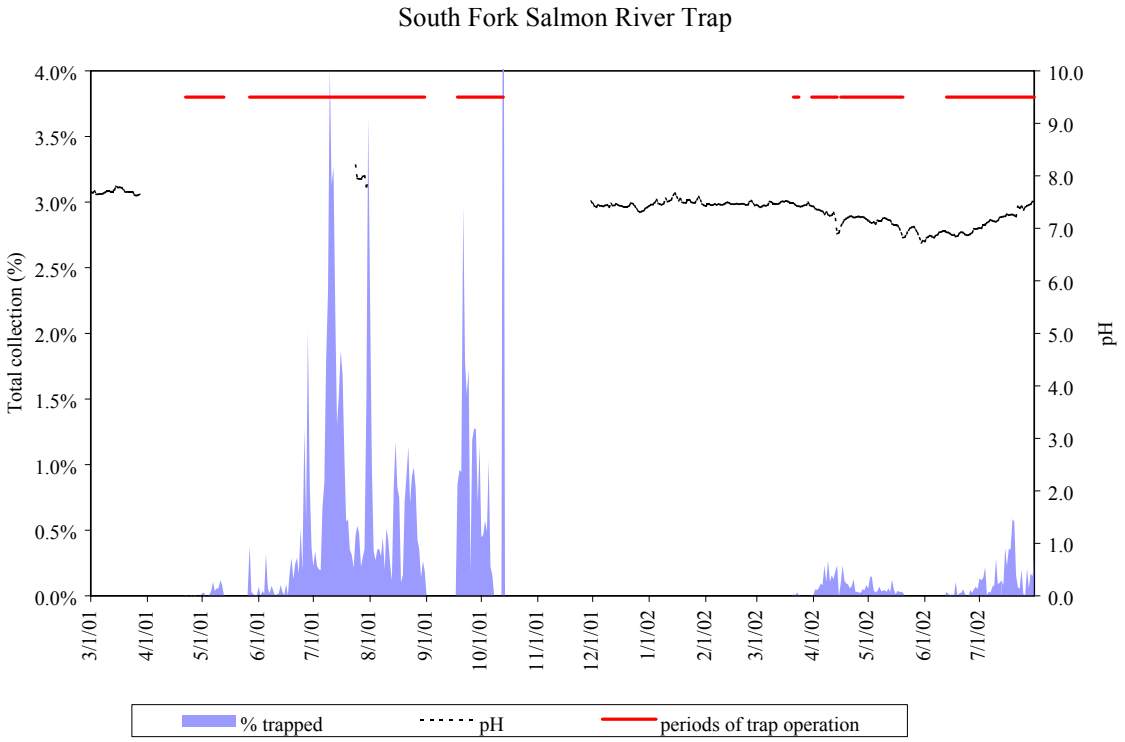
Appendix Figure 3. Daily passage of wild chinook salmon fry, parr, and smolts at three migrant traps, expressed as percentages of total collected, and plotted against average daily dissolved oxygen collected near traps. Periods of trap operation are also shown.



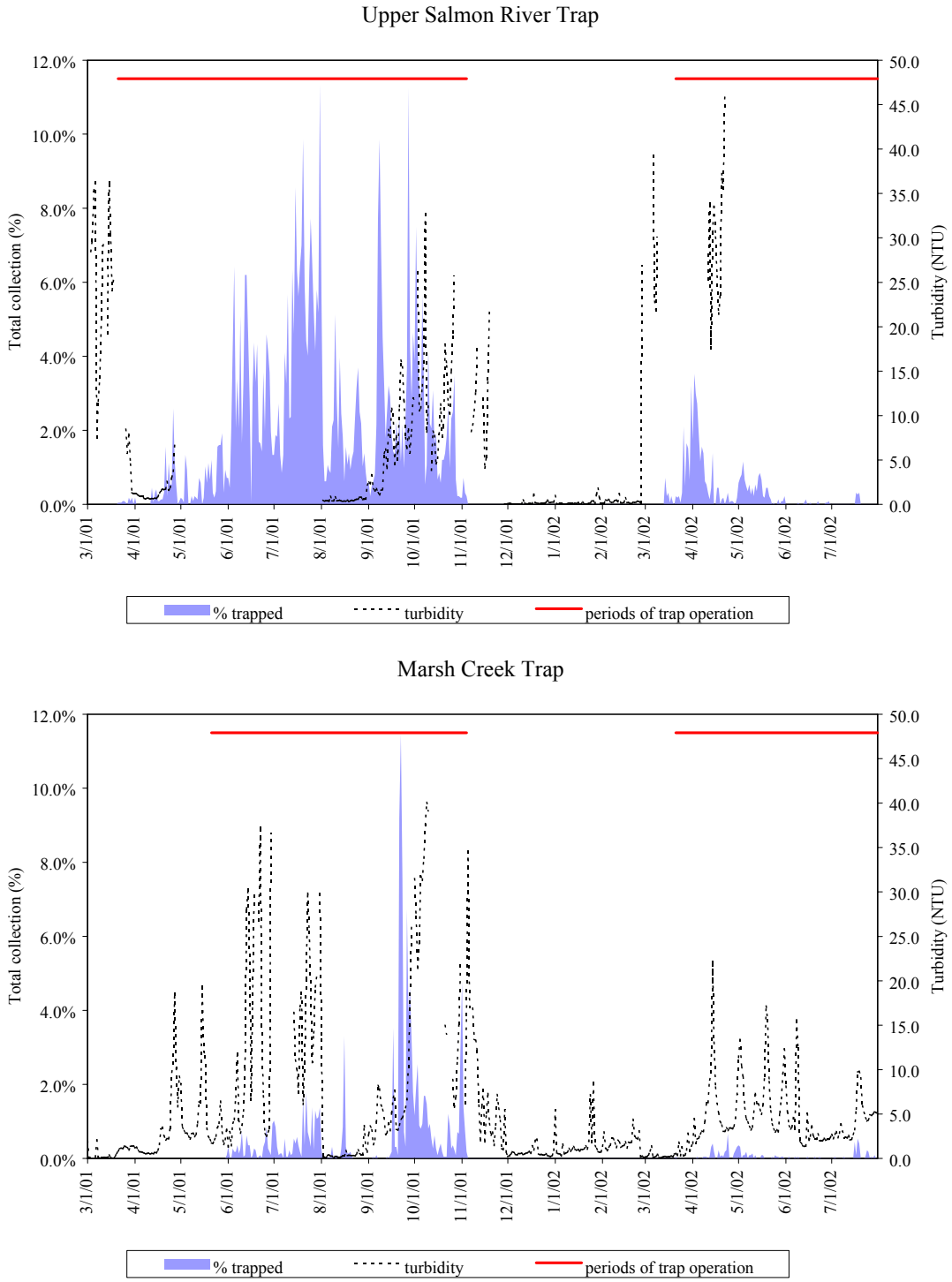
Appendix Figure 3. Continued.



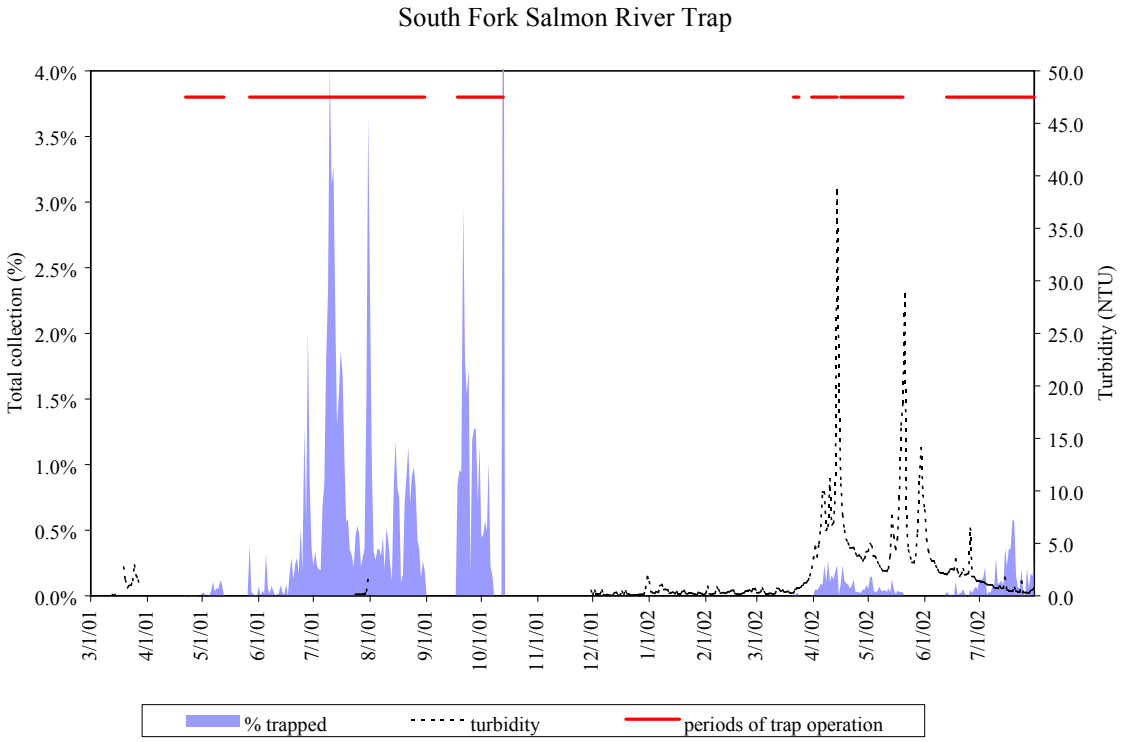
Appendix Figure 4. Daily passage of wild chinook salmon fry, parr, and smolts at three migrant traps, expressed as percentages of total collected, and plotted against average daily pH collected near traps. Periods of trap operation are also shown.



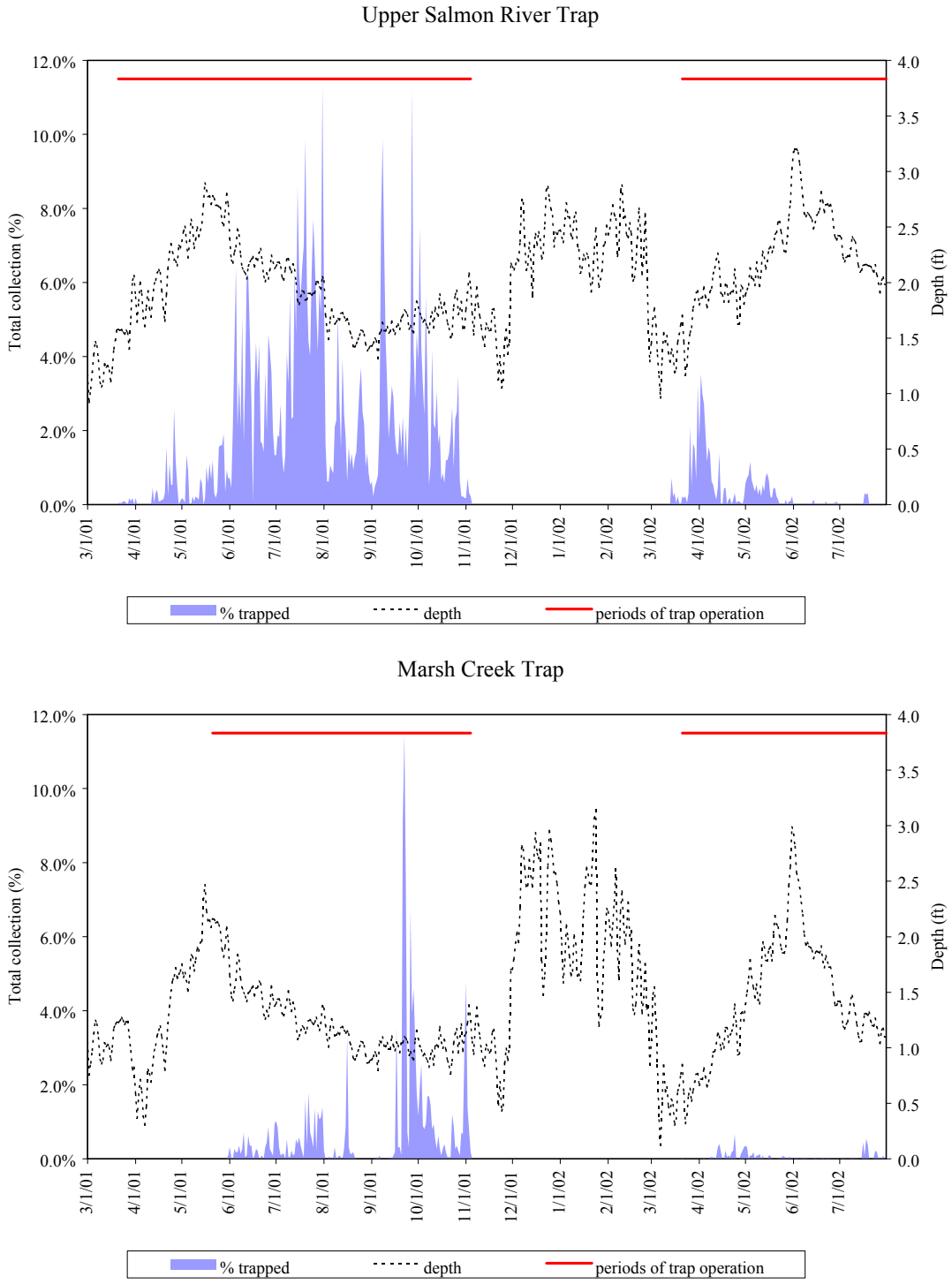
Appendix Figure 4. Continued.



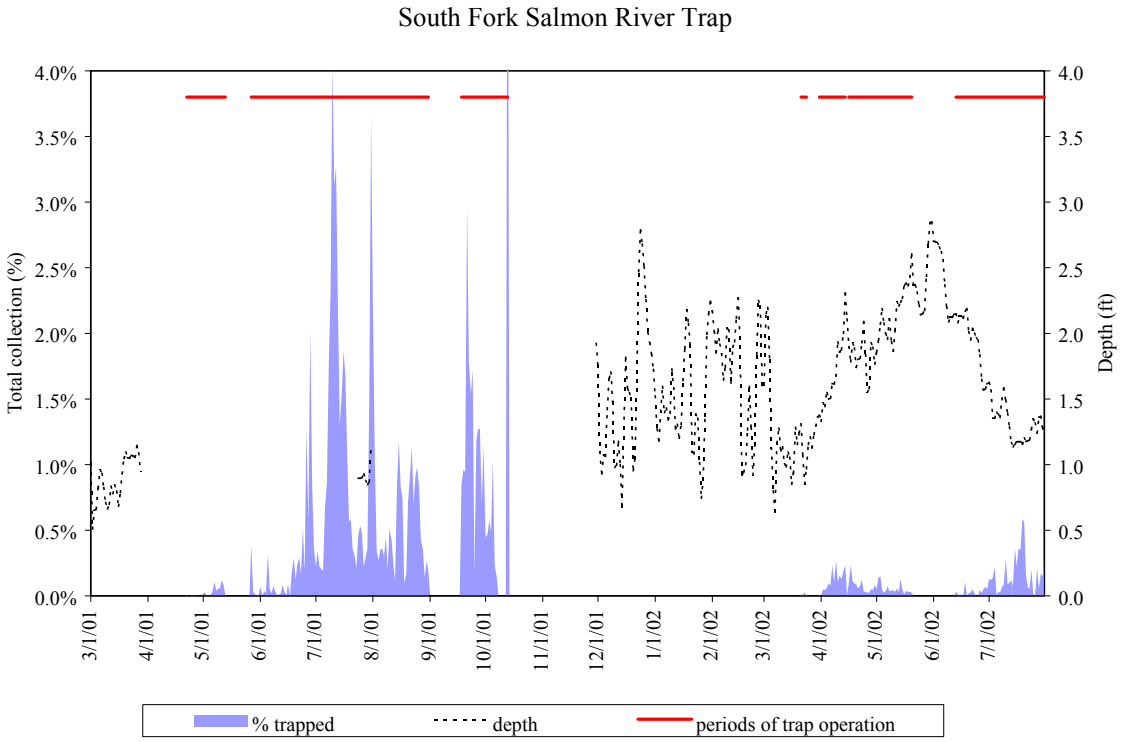
Appendix Figure 5. Daily passage of wild chinook salmon fry, parr, and smolts at three migrant traps, expressed as percentages of total collected, and plotted against average daily turbidity collected near traps. Periods of trap operation are also shown.



Appendix Figure 5. Continued.



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



Appendix Figure 6. Continued.