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

ANNUAL REPORT 1996

Prepared by:

Stephen Achord
M. Brad Eppard
Eric E. Hockersmith
Benjamin P. Sandford
and
Gene M. Matthews

Funded by:

Coastal Zone and Estuarine Studies Division
Northwest Fisheries Science Center
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
Seattle, WA 98 1 12-2097

and

U. S. Department of Energy
Bonneville Power Administration
Environment, Fish and Wildlife
P.O. Box 3621
Portland, OR 9720X-362 1

Project Number 9 l-028
Contract Number DE-AI799 1 BP1 8800

JULY 1997

CONTENTS

EXECUTIVE SUMMARY

We PIT tagged wild spring/summer chinook salmon parr in the Snake River Basin in 1995 and subsequently monitored these fish during their smolt migration through Lower Granite, Little Goose, Lower Monumental, McNary, John Day, and Bonneville Dams during spring and summer 1996. This report details our research and findings, which are summarized below.

1) In August 1995, we PIT tagged and released 1,407 wild chinook salmon parr to the South Fork of the Salmon River and two of its tributaries.
2) Average overall observed mortality from collection, handling, tagging, and after a 24-hour holding period was 1.0%. No PIT tags were lost during this 24-hour holding period to assess delayed mortality from collection, handling, and tagging.
3) In 1996, the overall adjusted percentage of PIT-tagged fish detected at six dams compared to the number of fish released averaged 13.1% (range 9.4 to 17.0%, depending on stream of origin).
4) Fish that were larger at release were detected at a significantly higher rate the following spring and summer than their smaller cohorts ($P < 0.0001$).
5) Wild fish migrating in April were significantly larger at release than fish migrating after April ($P < 0.05$).
6) In 1996, as observed in all previous migration years from 1989 to 1995, peak detections of wild spring/summer chinook salmon smolts at Lower Granite Dam were highly variable and generally independent of river flows before about 9 May; however, in all years, peak detections of wild fish coincided with periods of peak flow at the dam from

9 May to the end of May. In both 1995 and 1996, well over 90% of the wild fish had migrated passed Lower Granite Dam by the time peak flows occurred in June. In 1989, we observed a period of peak detections of wild fish that coincided with peak flows at the dam in June.

7) In 1996, 50 and 90% passage dates of PIT-tagged fish from wild stocks combined (Idaho and Oregon streams) at Lower Granite Dam occurred on 3 and 22 May, respectively. However, unlike previous years, few wild fish were marked as parr in 1995 from Idaho streams; therefore, the 1996 detections at Lower Granite Dam were composed of 91% fish from Oregon streams. Therefore, we caution against comparing migration timing in 1996 to previous years, since in all previous years less than 50% of wild fish detections were from Oregon streams.

8) Before 1995, we observed a 2-week shift in timing of wild stocks passing Lower Granite Dam between relatively warm and relatively cold years. In the cold years of 1989, 1991, and 1993, 50% of all wild fish passed the dam by mid-May, while 90% passed by mid-June (except during 1993, when high flows moved 90% through the dam by the end of May). In the warm years of 1990, 1992, and 1994, 50% of all wild fish passed this dam from 29 April to 4 May, and 90% passed by the end of May. In 1995, we experienced intermediate weather conditions in late winter and early spring (compared to the previous 6 years) and observed intermediate passage timing at the dam, with 50 and 90% passage on 9 May and 5 June, respectively.

INTRODUCTION

Project Goals

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

Background

In 1988, the National Marine Fisheries Service (NMFS) began a cooperative study with the U.S. Army Corps of Engineers (COE) 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 this study demonstrated that the timing of various wild stocks through Lower Granite Dam differed among streams of origin and also differed from timing patterns of hatchery-reared fish. Generally, the migrations of wild spring chinook salmon were later and more protracted than those of their hatchery-reared counterparts, and exhibited variable timing patterns over the 3 years. Conversely, the migrations of wild summer chinook salmon were earlier than those of their hatchery counterparts, though also more protracted..

The present study began with the 1992 migration of wild chinook salmon smolts (Achord et al. 1994). Warm weather and high water temperatures in late winter and spring appeared to elicit an early migration timing for all wild smolts in 1992. The migration

timing of wild spring chinook salmon smolts was earlier in 1992 than in the previous 3 years. Also, most wild summer chinook salmon smolts migrated earlier than wild spring chinook salmon smolts. However, as was observed during previous years, all wild stocks exhibited protracted and variable migration timing at Lower Granite Dam.

In 1993, cold weather and low water temperatures from late winter to early summer appeared to elicit a late migration timing; however, high flows during the third week of May moved a large portion of wild spring/summer chinook salmon through the dams (Achord et al. 1995a). As observed in previous years, wild stocks exhibited variable migration timing at Lower Granite Dam; however, the middle 80% passage time of wild fish stocks at the dam was more compressed in 1993 than in earlier years.

In 1994, migration timing of wild spring/summer chinook salmon smolts at Lower Granite Dam was similar to timing in 1990 and 1992, with peak passage in all 3 years occurring in April; however, peak detections of fish from individual streams in 1994 occurred from late April to late May (Achord et al. 1995b). As observed in 1990 and 1992, 1994 was also warm during late winter and spring.

Before 1995, we observed a 2-week shift in timing of wild fish at Lower Granite Dam between relatively warm and relatively cold years. In the cold years of 1989, 1991, and 1993, 50% of all wild fish passed the dam by mid-May, while 90% passed by mid-June (except in 1993, when high flows moved 90% through the dam by the end of May). In the warm years of 1990, 1992, and 1994, 50% of all wild fish passed this dam from 29 April to 4 May, and 90% passed by the end of May. In 1995, we experienced intermediate weather conditions in late winter and early spring (compared to the previous 6 years) and observed intermediate passage timing at the dam, with 50 and 90% passage occurring on 9 May and

5 June, respectively (Achord et al. 1996a). Sustained high flows from mid-May to early June in that year moved the later half of the wild fish migration through the dam at a more uniform rate than in previous years, and over 90% passed by the time peak flows occurred at the dam on 6 June.

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. In 1992, a more complete approach was undertaken, with the addition of integrated PIT-tag detections of several wild spring and summer chinook salmon stocks at Lower Granite Dam. We initiated a database on wild fish, which addresses several goals of the Columbia River Basin Fish and Wildlife Program of the Pacific Northwest Electric Power Planning Council and Conservation Act (1980). Section 304(d) of the program states: "The monitoring program will provide information on the migrational characteristics of the various stocks of salmon and steelhead within the Columbia Basin." Further, Section 201(b) urges conservation of genetic diversity, which will only be possible if wild stocks are preserved. The advent of PIT-tag technology has provided the opportunity to precisely track the smolt migrations of many wild stocks as they pass through the hydroelectric complex on their way to the ocean.

This report provides information on PIT tagging of wild chinook salmon parr in 1995, and the subsequent monitoring of these fish. Fish were monitored as they migrated through some juvenile migrant traps in 1995 and 1996 as well as Lower Granite, Little Goose, Lower Monumental, McNary, John Day, and Bonneville Dams during 1996.

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 1995-1996 will be reported by ODFW. However, with ODFW's concurrence, NMFS will continue to report the timing at Lower Granite Dam of fish from streams in Oregon where we PIT tagged wild chinook salmon from 1988 to 1991.

We collected and PIT tagged wild chinook salmon parr from three streams in the South Fork of the Salmon River drainage during August 1995 (Fig. 1). Due to extremely low numbers of returning adult spring/summer chinook salmon to Idaho in 1994 and subsequent low numbers of parr in the streams in 1995, the Idaho Department of Fish and Game (IDFG) allowed collection of parr only in the South Fork of the Salmon River drainage.

Collection and PIT-tagging procedures described by Matthews et al. (1990) and Achord et al. (1994, 1995a, 1995b) were used for our field work in 1995.

From 22 to 30 August 1995, we collected 1,885 wild chinook salmon parr in Idaho over a distance of about 11 stream kilometers (Table 1 and Appendix Tables 1 and 6). Of these, 1,407 fish were PIT tagged and released back into the streams. Numbers released per stream ranged from 135 in Lake Creek to 701 in the South Fork of the Salmon River. Fork lengths of tagged and released wild fish ranged from 48 to 103 mm (mean 63 mm), and weights ranged from 1.8 to 11.0 g (mean 3.7 g).

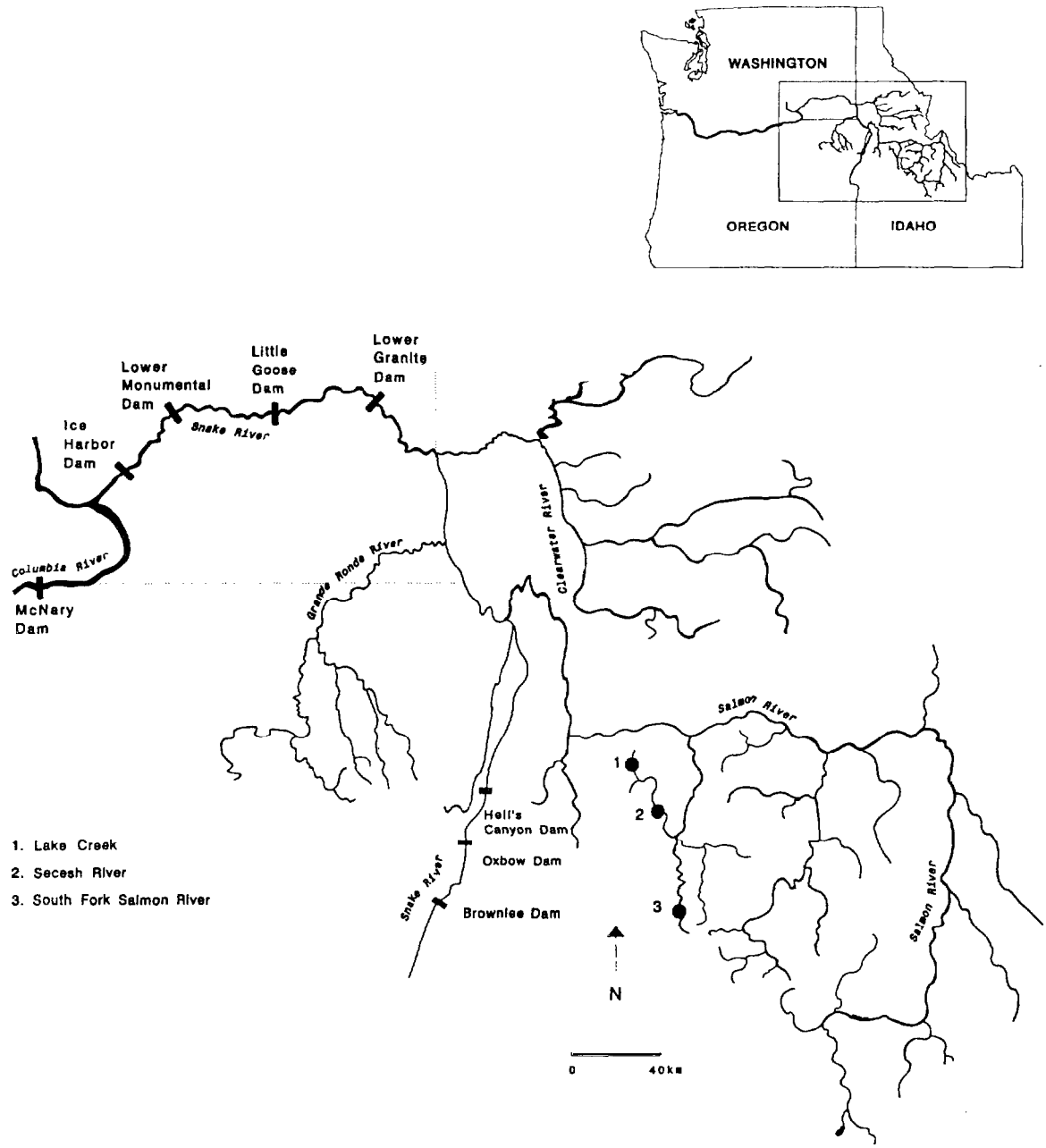

Figure 1. Study area where wild spring/summer chinook salmon parr were PIT tagged during 1995.

Table 1. Summary of wild chinook salmon parr collected, PIT tagged and released, with average fork lengths and weights and approximate distances covered in streams of Idaho in August 1995.

Tagging location	Number collected	Number tagged and released	Average length of tagged fish (mm)	Average weight of tagged fish (g)	Kilometers covered in streams
S. Fork Salmon River	1,129	701	61	3.1	6
Secesh River	617	571	65	4.0	4
Lake Creek	139	135	64	4.0	1
Totals or averages	1.885	1.407	63	3.7	11

Table 2. Summary of species other than chinook salmon observed during collection operations in three Idaho streams in August 1995.

Stream	Steelhead	Brook trout	Whitefish	Cutthroat trout	Bull trout	Sculpin	Dace	Sucker
S. Fork Salmon River	416	15	3	0	0	352	8	0
Secesh River	181	30	1	0	0	309	6	0
Lake Creek	40	56	2	0	0	71	0	0
Totals	637	101	6	0	0	732	70	0

Steelhead and sculpins were the most abundant species other than chinook salmon observed during electrofishing operations (Table 2). However, numbers of fish shown in Table 2 do not represent abundances of other fish in the areas of collection.

Mortality associated with collection and tagging procedures was low, and 24-hour tag loss was zero (Table 3 and Appendix Table 2). Average collection mortality was 0.8%, and average tagging and 24-hour delayed mortality was 0.1%. The average overall observed mortality was 1 .O%.

DETECTIONS AT TRAPS

During fall 1995 and spring 1996, a juvenile migrant fish trap was operated on the South Fork of the Salmon River at Knox Bridge. Also during spring 1996, juvenile migrant fish traps were operated on the lower Salmon River near Whitebird, Idaho, and on the Snake River at Lewiston, Idaho. All traps were operated by IDFG.

A total of 41 previously PIT-tagged wild spring/summer chinook salmon from the South Fork of the Salmon River were detected at the Knox Bridge juvenile migrant fish trap in fall 1995 and spring 1996. Of these, 38 were recaptured at the trap in the fall. They had grown an average of 7.8 mm in length (range O-85 mm) over an average of 5 1.5 days (range 29.9-66.9 days). Three wild fish from the summer tagging were detected at the trap in the spring. They had grown an average of 24 mm in length (range 17-34 mm) over an average of 251.1 days (range 238-265.5 days). The overall average length of fish released from the South Fork of the Salmon River in summer (61 mm), was similar to the overall average length at release for fish detected at the Knox Bridge trap in

Table 3. Mortality and tag loss for wild chinook salmon parr collected and PIT tagged in Idaho, August 1995.

Tagging location	Mortality (%)				24-hour tag loss (%)
	Collection	Tagging	24-hour	Overall	
S. Fork Salmon River	1.1	0.3	0.0	1.2	0.0
Secesh River	0.3	0.0	0.0	0.3	0.0
Lake Creek	1.4	0.0	0.0	1.4	0.0
Averages	0.8	0.1	0.0	1.0	0.0

the fall (62 mm). None of the summer PIT-tagged fish from the South Fork of the Salmon River drainage were detected at the two downstream juvenile migrant fish traps on the Salmon and Snake Rivers in spring 1996.

DETECTIONS AT DAMS

During spring and summer 1996, surviving chinook salmon PIT tagged for this study migrated volitionally downstream through hydroelectric complexes on the Snake and Columbia Rivers. Of the eight dams the smolts passed, four were equipped with complete smolt collection and PIT-tag monitoring systems: Lower Granite, Little Goose, and Lower Monumental Dams on the Snake River, and McNary Dam on the Columbia River (Fig. 1). Below McNary Dam, two additional dams, John Day and Bonneville Dams, were equipped with PIT-tag detection gear within their sub-sampling systems.

At the four smolt collection dams, all smolts guided from the turbine intakes into the juvenile bypass systems were electronically interrogated for PIT tags as they passed through the distribution flumes, which are positioned downstream from the outlet orifices of the fish and debris separators. The PIT-tag monitor 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 through the numbered detector coils in the fish distribution flumes. All detection data were transferred once each day to the mainframe computer operated by the Pacific States Marine Fisheries Commission in Portland, Oregon.

Since the PIT-tag detection/diversion systems (Matthews et al. 1990, 1992; Achord et al. 1992, 1996b) were operational at Lower Granite, Little Goose, Lower Monumental, and McNary Dams throughout the migration season, most PIT-tagged fish were diverted

back to the river below these dams. Therefore, to accurately portray timing at the dams for the various wild stocks of fish, we used first-time detections at each dam and adjusted these detections daily for spill. The following equation was used to adjust daily detections for individual streams and combined populations at each dam:

$$\frac{\text{number detected}}{\text{average daily powerhouse flow}} = \frac{x}{\text{average daily flow spilled}}$$

where x was rounded to the nearest whole number and added to the number detected to produce an adjusted number of PIT-tagged fish passing each dam daily for individual or combined populations'.

From 12 April to 15 July 1996, an adjusted total of 185 wild fish PIT tagged in Idaho were detected (first-time) at the 6 dams (Table 4 and Appendix Tables 3A-5B). Based upon the number of PIT-tagged parr released in 1995 (1,407), the overall average adjusted percentage of first-time detections at the 6 dams was 13.1%, with averages of 6.3, 3.3, 2.7, 0.8, 0.1, and 0.0% at Lower Granite, Little Goose, Lower Monumental, McNary, John Day, and Bonneville Dams, respectively. The adjusted proportions of total fish detected at the six dams were 48.1, 24.9, 20.5, 5.9, 0.5, and 0.0% for Lower Granite, Little Goose, Lower Monumental, McNary, John Day, and Bonneville Dams, respectively. The overall detection rates at the four collector dams varied by stream of origin (Fig. 2 and

[1] Due to rounding, total adjusted numbers for daily detections of fish from combined streams in Appendix Tables 7-10 may not add up to the total adjusted detections for mdividuai streams in Table 4.

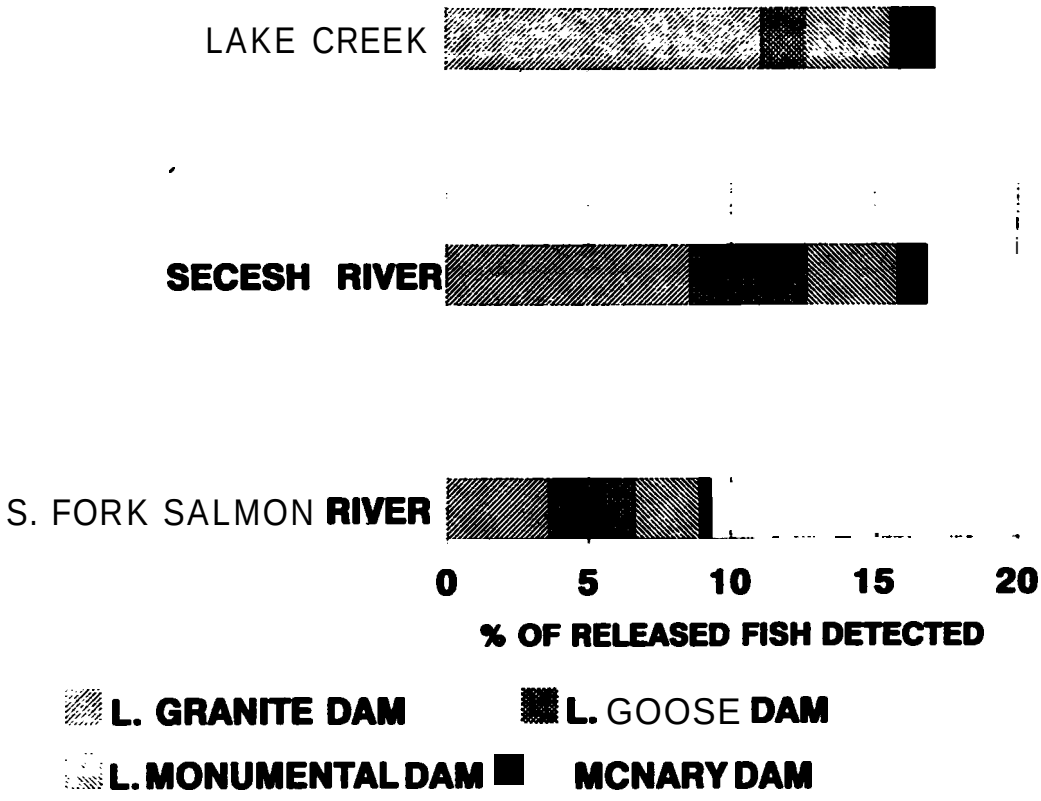

Figure 2. Percent (adjusted for spill) of PIT-tagged-wild spring/summer chinook salmon smolts detected at Lower Granite, Little Goose, Lower Monumental, and McNary Dams in 1996.

Table 4), ranging from 9.4% for South Fork of the Salmon River fish to 17.0% for Lake Creek fish.

At release, the average fork length for all fish was 63 mm. However, for fish detected the following spring at the dams, the average fork length at release was 67 mm. A chi-square comparison of length distributions showed these lengths were significantly different ($P < 0.0001$). The release length distribution of detected fish was significantly different than the length distribution of all released fish ($P < 0.0001$) (Fig. 3). The largest difference was that fish 59 mm or smaller were detected at a significantly lower rate than expected, whereas fish 70-79 mm were detected at a significantly higher rate than expected.

We also found a significant difference in fork lengths at time of release between fish that migrated through the dams in April and fish that migrated after April ($P < 0.0001$). Although fish migrating through the dams in April and May were on average 4 mm larger when released than fish migrating after this time, this difference was not significant ($P > 0.05$) because of the small sample size for wild fish detections after May. These data suggest that fish size may be an important factor influencing migration timing or overwintering location with respect to proximity to the first dam.

MIGRATION TIMING AT DAMS

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

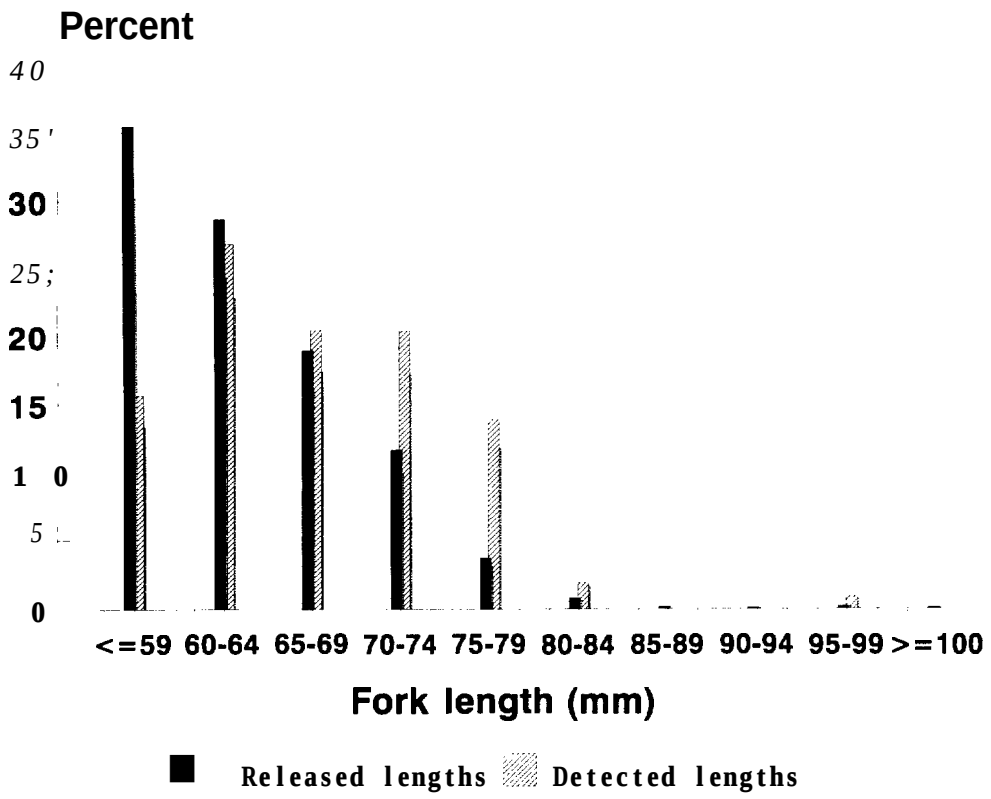

Figure 3. Percent, by fork length increments, of PIT-tagged wild spring/summer chinook salmon parr released in Idaho streams in 1995 and percent of fish detected for these length increments at Lower Granite, Little Goose, Lower Monumental, McNary, and John Day Dams in spring and summer 1996.

(Fig. 4), while migration timing for smolts from all Idaho streams combined was calculated at all four collector dams (Fig. 5).

Fish from Secesh River and Lake Creek in Idaho and the Imnaha River (upper) in Oregon had the earliest timings at Lower Granite Dam (Fig. 4 and Table 5). Over 50% of the fish from these streams passed the dam by 26 April, and most peak passage dates for fish from these streams occurred in April (Appendix Tables 4A, 5A, and Fig. 4). Fish from Lake Creek and the Imnaha River (upper) had the earliest passage period of all streams, while fish from the Secesh River had the most protracted 50 to 90% passage period at the dam.

Fish from the remaining four streams: South Fork of the Salmon River in Idaho and Catherine Creek, Grande Ronde River (upper), and the Lostine River in Oregon showed a later passage period at Lower Granite Dam than the aforementioned streams (Fig. 4 and Table 5). Dates of 50% passage for fish from these streams all occurred in mid-May, as did their peak passage dates (Appendix Table 3A and Fig. 4).

We did not perform statistical comparisons of passage distributions for wild chinook salmon smolts from the three streams in Idaho at Lower Granite Dam in 1996 because of low numbers of fish detected from these streams.

Timing of smolts from individual streams in Idaho is not presented here for Little Goose, Lower Monumental, McNary, John Day, and Bonneville Dams. See Appendix Tables 3A-5B for this information.

We combined all detections of wild fish from Idaho streams at each of the four collector dams and compared the timing at each dam with river flows during the same periods (Fig. 5). Overall, passage occurred between mid-April and mid-July at Lower

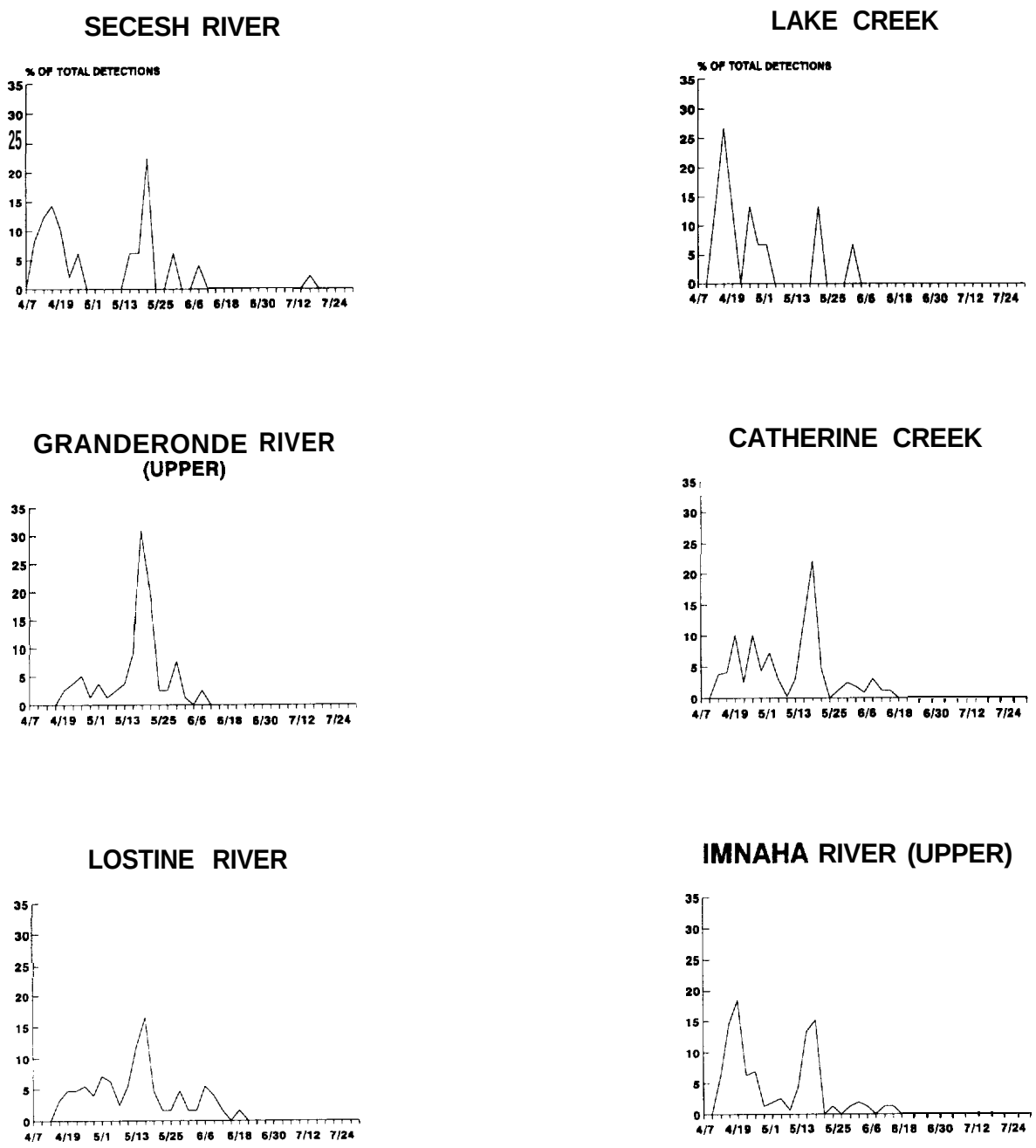

Figure 4. The migration timing (adjusted for spill) at Lower Granite Dam in 1996 of PIT-tagged wild spring/summer chinook salmon smolts from individual streams in Idaho and Oregon.

SOUTH FORK SALMON RIVER

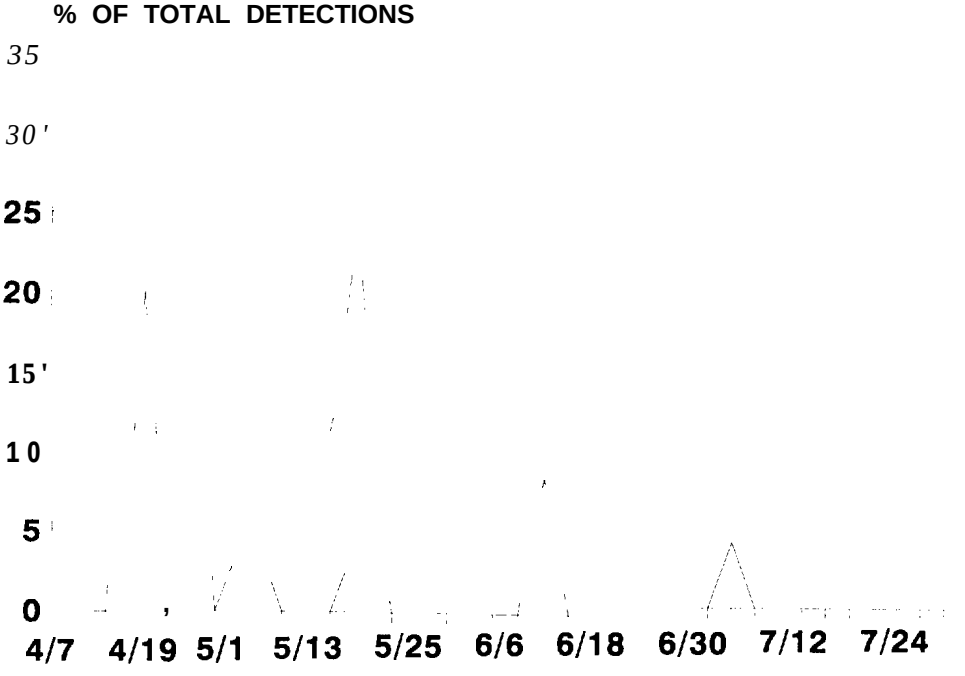

Figure 4. Continued.

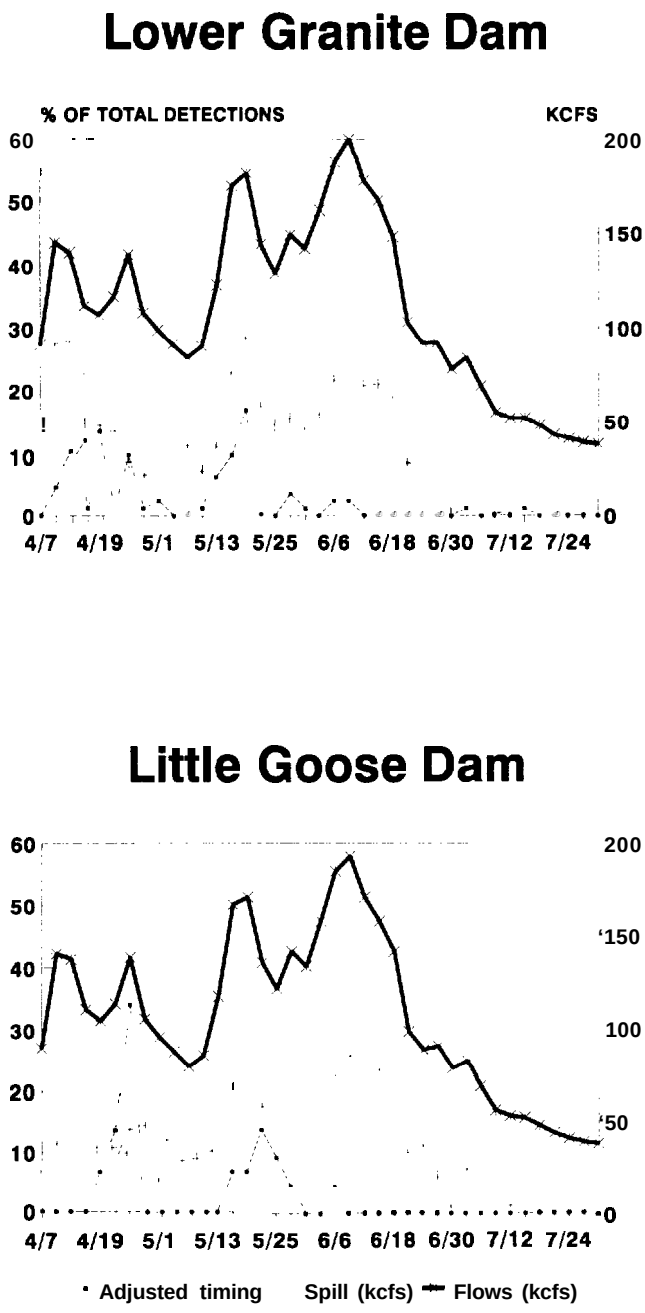

Figure 5. The overall migration timing of PIT-tagged wild spring/summer chinook salmon smolts at Lower Granite, Little Goose, Lower Monumental, and McNary Dams in 1996, with associated river spill and flows at these dams. Data represent detections from three Idaho streams combined by 3-day intervals and average river spill and flows at the dams over the same time periods.

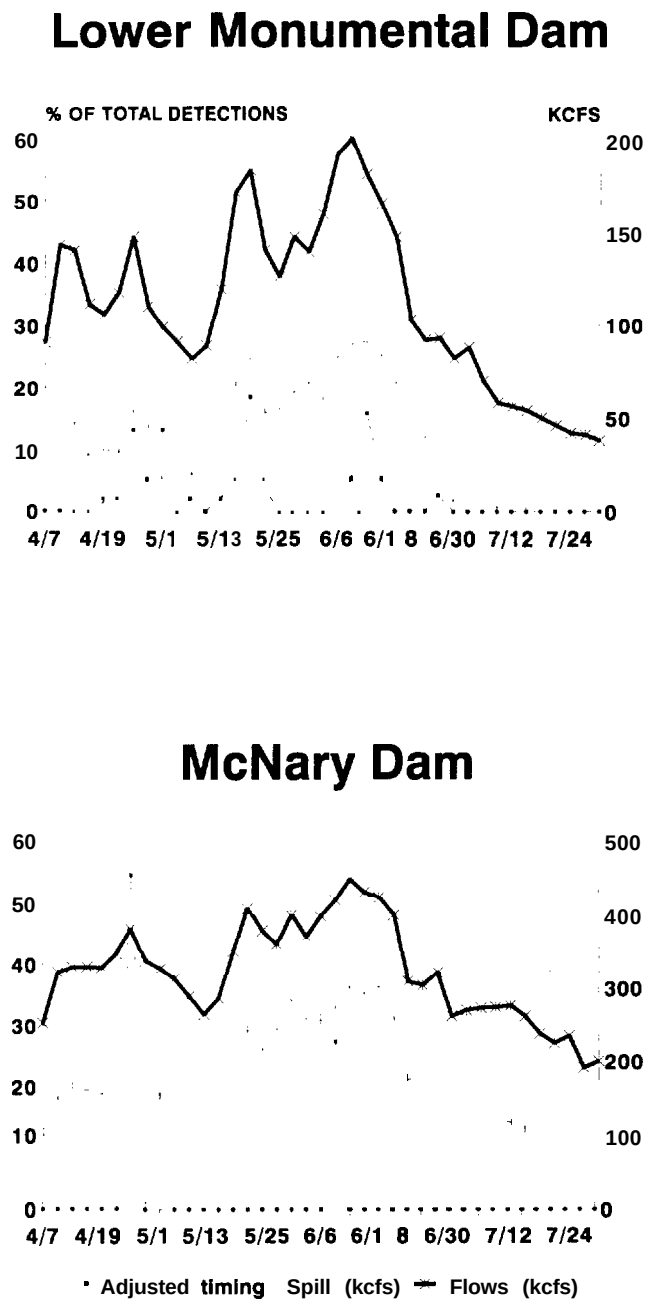

Figure 5. Continued.

Table 5. Historical and 1996 passage dates at Lower Granite Dam for PIT-tagged wild spring/summer chinook salmon smolts from streams in Idaho and Oregon.

Year	Passage dates at Lower Granite Dam 10%	50%	90%	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[b]		--------	--------	
		Elk Creek		
1990[a]		--------	--------	
1991	03 May	20 May	16 June	25 April - 24 June
1992	11 April	30 April	28 May	05 April - 17 July
1993	02 May	16 May	11 June	21 April - 26 June
1994	23 April	04 May	21 May	18 April - 09 July
1995	18 April	11 May	05 June	10 April - 09 July
1996[b]		-------	---------	----------
		Sulphur Creek		
1990	18 April	30 April	31 May	11 April - 27 June
1991[b]		--------	--------	———
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[b]		----------	----------	----------

Table 5. Continued.

Year	Passage dates at Lower Granite Dam 10%	50%	90%	Range
		Cape Horn Creek		
1990[b]		--------	--------	
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[b]		--------	--------	----------
1995	29 April	14 May	19 June	14 April - 28 July
1996[b]		--------	----------	
		Marsh Creek		
1990	17 April	29 April	31 May	09 April - 01 July
1991	26 April	20 May	09 June	17 April - 18 June
1992	17 April	07 May	02 June	10 April - 13 July
1993	29 April	15 May	27 May	24 April - 10 August
1994	23 April	04 May	18 May	16 April - 08 August
1995	17 April	09 May	24 May	11 April - 08 July
1996[b]	———	----------	----------	----------
		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[b]	-------	----------	----------	----------
		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[b]		----------	----------	———

Table 5. Continued.

Year	Passage dates at Lower Granite Dam 10%	50%	90%	Range
		Loon Creek		
1993	05 May	12 May	17 May	03 May - 25 June
1994	29 April	IO May	24 May	22 April - 07 June
1995	23 April	11 May	28 May	13 April - 07 June
1996[b]	----------	----------	----------	----------
		East Fork Salmon River		
1989	22 April	03 May	18 May	07 April - 08 June
1990[b]	----------	----------	----------	----------
1991	22 April	09 May	26 May	16 April - 20 June
1992	13 April	21 April	16 May	IO 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	IO May	I I April - 27 May
1996"	----------	----------	----------	----------
		Herd Creek		
1992	14 April	20 April	IO May	13 April - 18 May
1993	26 April	30 April	18 May	26 April - 31 May
1994[a]	----------	----------	----------	----------
1995	18 April	03 May	14 May	11 April - 28 May
1996[b]	----------	----------	----------	
		South Fork Salmon River		
1989	25 April	13 May	14 June	16 April - 20 June
1990[b]	----------	----------	----------	
1991	20 April	16 May	IO 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	IO May	IO June	13 April - 13 July
1996	19 April	15 May	09 June	19 April - 03 July

Table 5. Continued.

Year	Passage dates at Lower Granite Dam 10%	50%	90%	Range
		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[b]	--------	-- ------	-- --- ---	----------
		Big Creek (lower)/Rush Creek		
1993	24 April	29 April	13 May	21 April - 16 May
1994	23 April	29 April	11 May	21 April - 15 June
1995	19 April	01 May	14 May	11 April - 05 June
1996[b]	----------	- -- - --- --	----- ---	
		West Fork Chamberlain Creek		
1992[a]	15 April	26 April	03 June	12 April - 24 June
1993	28 April	15 May	23 June	23 April - 22 July
1994[a]	24 April	01 May	05 July	24 April - 04 September
1995[c]	16 April	09 May	20 June	12 April - 22 September
1996[b]	———	---------	------ ---	———————
		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

Table 5. Continued.

Year	Passage dates at Lower Granite Dam 10%	50%	90%	Range
		Lake Creek		
1989	23 April	02 May	16 June	12 April - 01 July
1990[a]	--------	--------	--------	
1991[b]		--------	--------	
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	IO May	IO June	14 April - 20 July
1996	15 April	21 April	19 May	15 April - 02 June
		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	II May	20 May	13 April - 26 July
1995	01 May	19 May	09 June	26 April - 02 July
1996	19 April	13 May	29 May	14 April - 14 June
		Grande Ronde River (upper)		
1989	12 May	06 June	19 June	27 April - 22 July
1990[a]		--------	--------	
1991[b]		--------	--------	
1992[a]		--------	--------	———
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[d]	26 April	17 May	29 May	19 April - 06 June

Table 5. Continued.

Year	Passage dates at Lower Granite Dam 10%	50%	90%	Range
		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[a]	--------	--------	--------	
1994[a]	--------	--------	--------	----------
1995[a]	--------	--------	--------	
1996[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
		Lostine River		
1990[a]	--------	--------	--------	----------
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

[a] Insufficient numbers detected to estimate timing.
[b] No fish were tagged for this migration year.
[c] Includes fish from Chamberlain Creek.
[d] All fish tagged at traps in fall or spring for this migration year.

Granite Dam, with the middle 80% passage from mid-April to late May (Table 6). The peak passage date was 19 May, which coincided with peak flow at the dam in May (Appendix Table 7). The middle 80% passage of wild fish occurred between late April and mid-June for Little Goose, Lower Monumental, and McNary Dams (Table 6). Peak passage periods for fish at Little Goose, Lower Monumental, and McNary Dams coincided with high river flows on various dates throughout April, May, and June (Fig. 5 and Appendix Tables 8-10).

ENVIRONMENTAL INFORMATION

One goal of this study is to identify relationships between environmental factors where wild parr reside and subsequent migration timing of smolts the following spring at downstream traps and dams. Since 1993, NMFS has worked with Pacific Northwest National Laboratories (PNNL) to obtain environmental data with funding through Bonneville Power Administration.

In 1993, PNNL personnel conducted an extensive review of historical and current environmental information collected in Idaho study streams. In November and December 1993, they installed environmental monitoring systems at five sites: near Thomas Creek in the Middle Fork of the Salmon River, in Marsh and Valley Creeks, near Sawtooth Hatchery in the upper Salmon River, and in the Salmon River below its confluence with the Yankee Fork. Monitors will be installed in other study streams during the next few years. Achord et al. (1995b) provided additional information about these stream monitors.

In April 1996, PNNL personnel moved the monitor from Yankee Fork to the Krassel U.S. Geological Survey (USGS) site on the South Fork of the Salmon River. We

Table 6. Passage dates at Lower Granite, Little Goose, Lower Monumental, and McNary Dams for combined populations of PIT-tagged wild spring/summer chinook salmon smolts from three streams in Idaho in 1996.

Site	Passage periods at dams			
	10%	50%	90%	Range
Lower Granite Dam	14 April	26 April	29 May	12 April - 15 July
Little Goose Dam	22 April	27 April	27 May	21 April - 8 June
Lower Monumental Dam	27 April	19 May	14 June	19 April - 28 June
McNary Dam	25 April	27 April	7 June	25 April - 7 June

recommended this change because wild fish will only be PIT tagged in the South Fork of the Salmon River drainage in 1995, 1996, and possibly 1997. We will continue to report the environmental information from all monitoring sites to establish a yearly database for future analysis. Appendix Table 11 provides a summary of flow information at five USGS sites in the Salmon River drainage from September 1995 to August 1996. Appendix Tables 12- 17 provide a summary of environmental information collected at the five environmental monitoring sites from August 1995 to July 1996. Within the next year, environmental information collected at these sites will be posted on the Internet.

ADULT RETURNS FROM 1989-1994 SMOLT MIGRATIONS

Although providing analyses of adult returns is not an objective of this study, there is considerable interest concerning the return of PIT-tagged adult wild spring/summer chinook salmon to the Snake River. Of the wild spring/summer chinook salmon PIT tagged and released for the 1989 through 1994 smolt migrations (under coordinator ID "SA"), 20 were detected as adults at the adult trap at Lower Granite Dam through 1996. Of the 20 adults, 12 were transported as smolts from Lower Granite Dam to below Bonneville Dam, 4 were transported as smolts from Little Goose Dam to below Bonneville Dam, and 4 were never detected at any dam during previous smolt migrations.

DISCUSSION

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

Few wild fish released in summer to the South Fork of the Salmon River were detected at the juvenile migrant fish trap on the South Fork of the Salmon River in fall 1995 and spring 1996. Of the 38 summer-released, wild, PIT-tagged fish monitored at this trap in the fall, only one was detected the next spring at the dams. Of the three summer-released, wild, PIT-tagged fish monitored at this trap during the spring, two were subsequently detected at the dams. No survival comparisons can be made from these data due to the low numbers monitored at the trap and at the dams.

Length-distribution curves for data collected over the last 8 years, showed that generally, wild fish released and subsequently detected at dams are slightly larger than fish that are released but not detected. The reason for this slight difference in size is unknown. However, it appears that larger fish, tagged and released the previous summers, survived slightly better and/or were guided slightly better into the collection systems at the dams than smaller fish.

Another consistent trend we have observed over the years is the difference in migration timing at dams with respect to size at tagging. Wild fish migrating in April were significantly larger at release than fish migrating after April. This consistent trend suggests that size is an important factor related to either the initiation of smoltification or other life-history dynamics that affect the migrational timing of wild fish.

Although the 10 to 90% passage dates for fish from the South Fork of the Salmon River and the Secesh River have varied over the years (1989-1996) at Lower Granite Dam, certain patterns have emerged (Table 5). In most years from 1989 to 1996, half of the fish from the Secesh River passed by 1 May, while half of the wild fish from the South Fork of the Salmon River had passed the dam by mid-May. Secesh River fish consistently

exhibited a much more compressed 10 to 50% passage time at the dam than the South Fork of the Salmon River fish. However, Secesh River fish showed a much more protracted 50 to 90% passage time than South Fork of the Salmon River fish at the dam. We offer no explanation for this migration timing difference.

In 1996, the overall detection rate (adjusted) of wild fish from the South Fork of the Salmon River drainage was lower than in 1993 (Achord et al. 1995a), but higher than in 1994 (Achord et al. 1995b) or 1995 (Achord et al. 1996a) at the four collector dams. Overall, 1993 and 1996 were the highest flow years since wild fish have been PIT-tagged in the Snake River basin.

In 1996, peak detections of wild fish at Lower Granite Dam did not coincide well with peak flows before mid-May but did after mid-May (Fig 6). Before about 9 May in 1996, as observed in all previous migration years at Lower Granite Dam from 1989 to 1995, peak detections of wild spring/summer chinook salmon smolts from Idaho and Oregon were highly variable and generally independent of river flows; however, in every year, peak detections of wild fish from 9 May to 3 1 May coincided with periods of peak flows at the dam (Fig. 6). In both 1995 and 1996, the highest flows at the dam occurred in June, well after 90% of the wild fish migration had passed the dam. Raymond (1979) showed that peaks of migration for the composite population of spring and summer chinook salmon smolts (mostly wild) passing Ice Harbor Dam from 1964-l 969 preceded the periods of maximum river discharge in most years. During these years, fish passage peaked between 26 April and 13 May. With respect to river flows, our observations matched those of Raymond for wild fish migrating before mid-May.

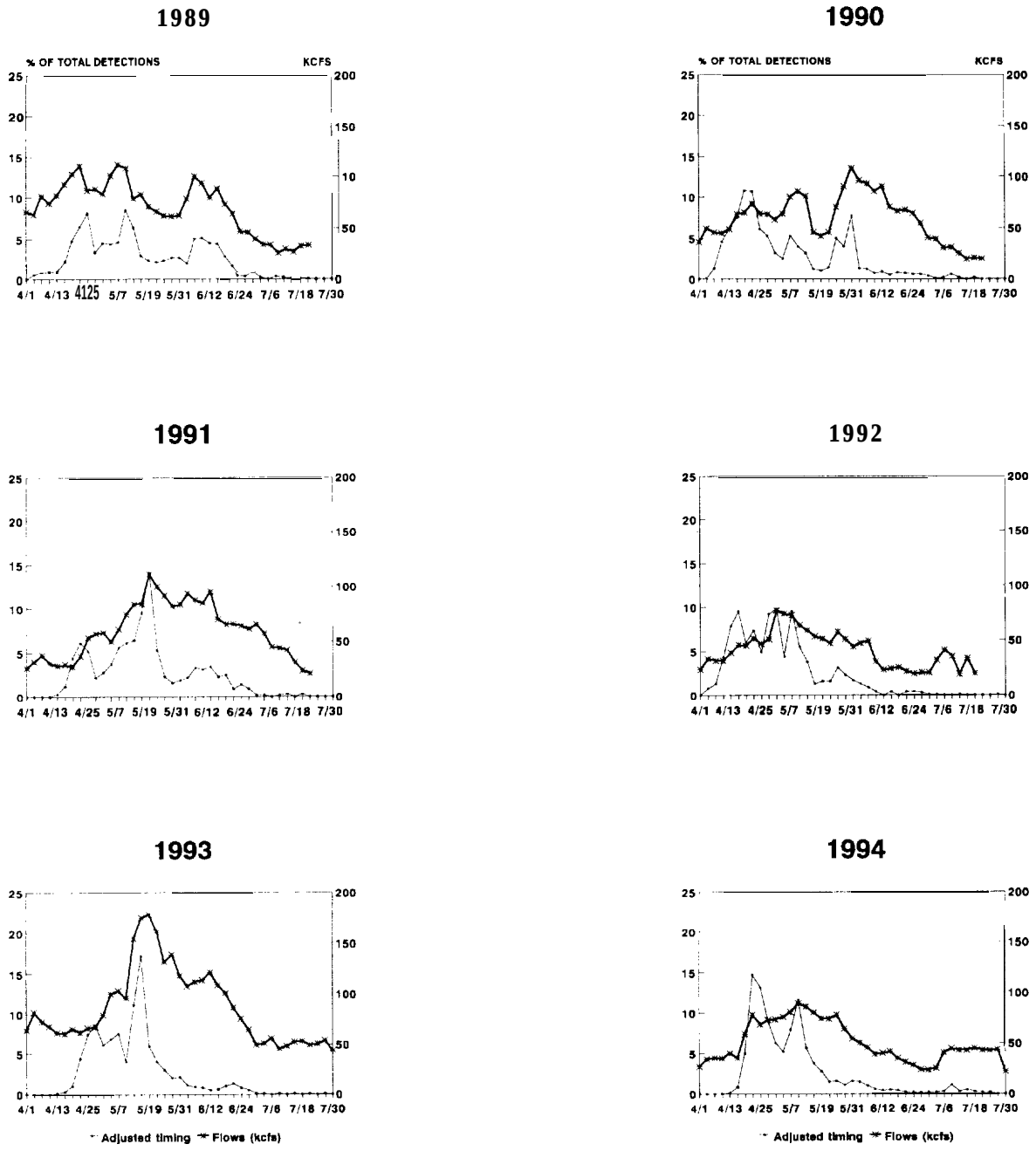

Figure 6. The historical perspective on migration timing (adjusted in spill years) of wild spring/summer chinook salmon smolts at Lower Granite Dam 1989-1996, with associated river flows at the dam. Data represent PIT-tag detections from Idaho and Oregon streams combined by 3-day intervals and average river flows at the dam over the same time periods.

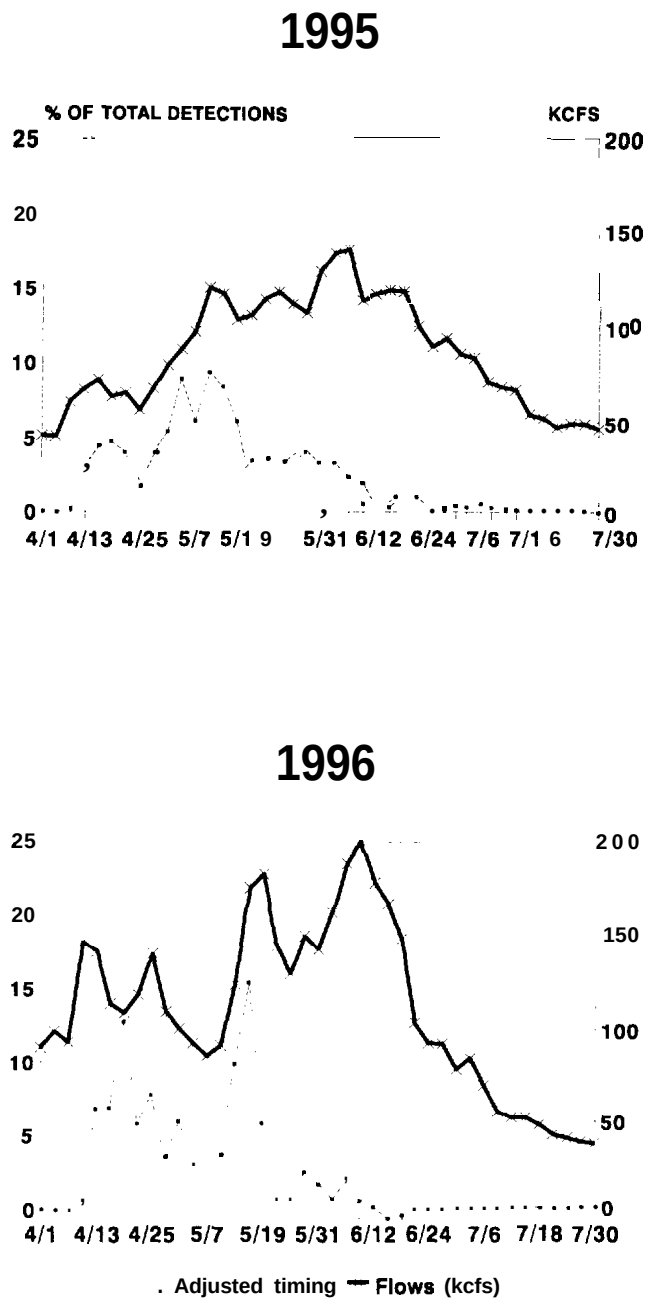

Figure 6. Continued.

Annual overall climatic variation is emerging as an important factor controlling the overall migrational timing of wild spring/summer chinook salmon smolts at Lower Granite Dam. Figures 6 and 7 provide another perspective on timing of combined populations (Idaho and Oregon) of wild spring/summer chinook salmon smolts from 1989 through 1996 at Lower Granite Dam. In the warm years of 1990, 1992, and 1994, 50% of all wild fish had passed this dam from 29 April to 4 May, and 90% had passed by the end of May. In the cold years of 1989, 1991, and 1993, 50% of all wild fish had not passed the dam until mid-May, while 90% had not passed until mid-June (except in 1993, when high flows moved 90% through the dam by the end of May). Within these 6 years, we saw a consistent 2-week shift in timing of wild fish at this dam between relatively warm and relatively cold years. In 1995, intermediate weather conditions prevailed in late winter and early spring (compared to the previous 6 years), and we saw intermediate passage times of 9 May and 5 June for the 50 and 90% passage dates, respectively, for these combined wild populations (Fig. 7).

In 1996, 50 and 90% passage dates of all wild fish at Lower Granite Dam occurred on 3 May and 22 May, respectively. However, overall passage timing of wild fish in 1996 should not be compared to previous years, since 91% of wild fish detections at Lower Granite Dam were from Oregon streams, whereas in all previous years, less than 50% were from Oregon streams. In addition, fish from the Oregon streams and from streams of the South Fork of the Salmon River drainage are known to have earlier timings at the dam than those from other Idaho streams.

Peak detections of wild fish at the collector dams below Lower Granite Dam coincided well with peak river flows in 1992 and 1993. We were unable to determine

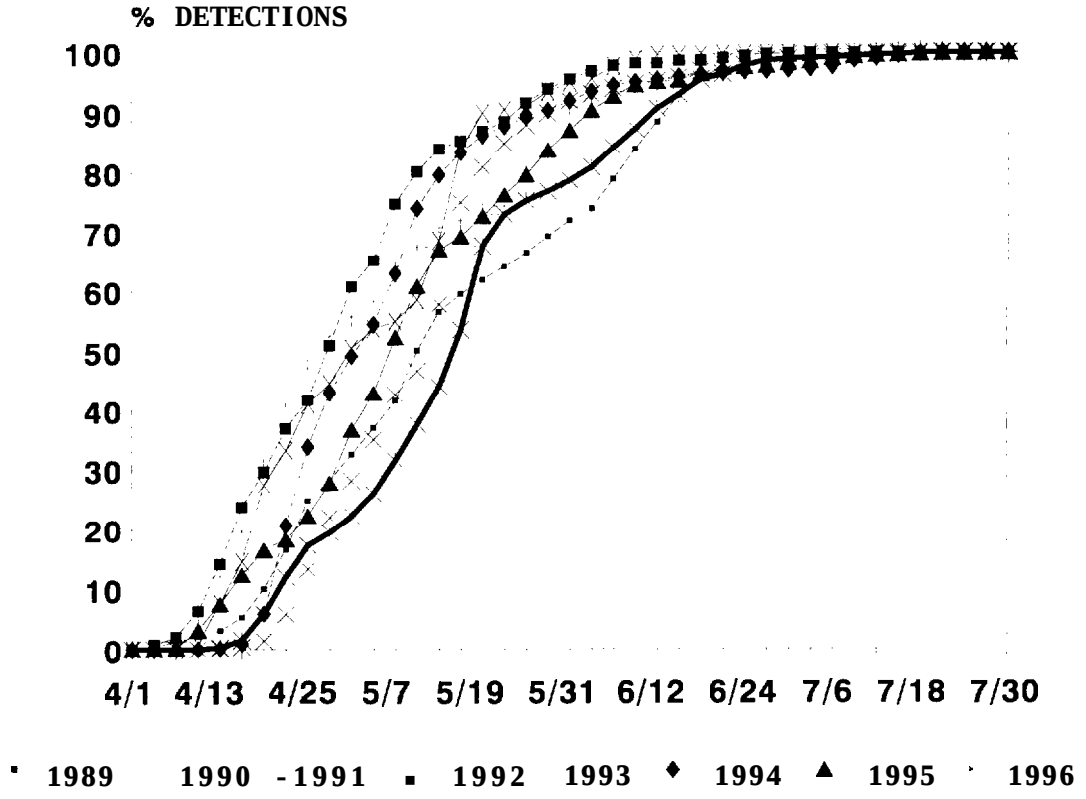

Figure 7. Cumulative percentages of total detections (adjusted for spill) of PIT-tagged wild spring/summer chinook salmon smolts detected at Lower Granite Dam, 1989-1996. Data represent PIT-tag detections from Idaho and Oregon streams combined by 3-day intervals.

whether the increased river flows moved these groups of fish through the reservoirs or were simply coincidental with their arrival at the dams. Since peak detections at these dams have consistently occurred almost simultaneously with increased flow, it is likely that fish were already near the dams and were moved through them rapidly by the increased flow. However, this apparently did not occur in 1994. Peak detections at the lower collector dams did not coincide well with peak flows. In fact, peak flows at these dams coincided with significant decreases in wild fish detections, even though detections were adjusted for spill. We found no explanation for this difference. In 1995, peak detections of wild fish at these dams coincided with medium to high flows prior to peak flows. In 1996, peak detections of wild fish at these dams coincided with high flows at various times throughout April, May, and June.

After examining chinook salmon smolt passage timing at the dams over the last 8 years. it has become clear that flow is only one of several factors that influence passage timing. Other factors, such as annual climatic conditions, water temperature, turbidity, physiological development, variability in stock behavior, fish size, and other yet unknown conditions may equally affect wild smolt passage timing at dams.

ACKNOWLEDGMENTS

We thank Neil N. Paasch, Kenneth W. McIntyre, Douglas M. Marsh, and Ron A. Marr for their excellent assistance in collecting and PIT tagging fish for this study. We also thank Bradley Gilmore of Pacific Northwest National Laboratories for providing environmental information included in this report.

REFERENCES

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

Achord, S., J. R. Harmon, D. M. Marsh, B. P. Sandford, K. W. McIntyre, K. L. Thomas, N. N. Paasch, and G. M. Matthews. 1992. Research related to transportation of juvenile salmonids on the Columbia and Snake Rivers, 1991. Report to U.S. Army Corps of Engineers, Contract DACW68-84-H0034, 57 p. plus Appendix. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle, WA 98 112-2097.)

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

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

Achord, S., G. M. Matthews, 0. W. Johnson, and D. M. Marsh. 1996b. Use of Passive Integrated Transponder (PIT) tags to monitor migration timing of Snake River chinook salmon smolts. N. Amer. J. Fish. Manage. 16:302-3 13, 1996.

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

Matthews, G. M., S. Achord, J. R. Harmon, 0. 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 to U.S. Army Corps of Engineers, Contract DACW68-84-H0034, 51 p. plus Appendix. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle WA 98112-2097.)

Matthews, G. M., J. R. Harmon, S. Achord, 0. W. Johnson, and L. A. Kubin. 1990. Evaluation of transportation of juvenile salmonids and related research on the Snake and Columbia Rivers, 1989. Report to U.S. Army Corp of Engineers, Contract DACW68-84-H0034, 59 p. plus Appendix. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle WA 98112-2097.)

Pacific Northwest Electric Power Planning Council and Conservation Act. 1980. Columbia River Basin Fish and Wildlife Program. Northwest Power Planning Council, Portland, OR.

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

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

APPENDIX TABLES

Appendix Table 1. Summary of tagging dates, number collected, tagged, released, and minimum, maximum, and average lengths and weights of wild chinook salmon parr, PIT tagged in various Idaho streams in 1995.

Stream	Tagging dates	Number collected	Number tagged	Number released	Length (mm) Range	Length (mm) Average	Weight (g) Range	Weight (g) Average
S. F. Salmon River	22 Aug - 24 Aug	1,129	703	701	48 - 103	61.0	1.8 - 11.0	3.1
Secesh River	20 Aug - 29 Aug	617	571	571	52 - 98	65.0	2.0 - 8.0	4.0
Lake Creek	30 Aug	139	135	135	54 - 79	64.0	2.4 - 6.8	4.0
Totals or averages	22 Aug - 30 Aug	1,885	1,409	1,407	48 - 103	63.0	1.8 - 11.0	3.7

Appendix Table 2. A summary of observed total mortality for PIT tagged wild chinook salmon parr collected from Idaho streams during August 1995.

Stream	Collection method	Number collected	Number tagged	Number rejected	Percent rejected (%)	Observed total mortality Mortality	Observed total mortality (%)
S. F. Salmon River	shock	1,129	703	414	(36.7)	14	(1.2)
Secesh River	shock	617	571	44	(7.1)	2	(0.3)
Lake Creek	shock	139	135	2	(1.4)	2	(1.4)
Totals		1,885	1,409	460	(24.5)	18	(1.0)

Appendix Table 3A. Detections of PIT-tagged smolts by date at three Snake River dams for wild chinook salmon from the South Fork of the Salmon River, 1996. Numbers in parentheses are first detections at the dams that have been adjusted for spill.

Tagging site: S. F. Salmon River
Release site: S. F. Salmon River
Release river kilometer(s) above Lower Granite Dam: 457 - 468

Release date: 22 - 24 Aug 1995
Number released: 70 1

Detection date	Lower Granite	Little Goose		Lower Monumental		
	First detection	First detection	Previous detections at 1 dam	First detection	Previous detections at 1 dam	Previous detections at 2 dams
19 Apr	2 (3)					
20 Apr	1 (2)					
22 Apr		1				
24 Apr			1		1	
25 Apr	2 (3)	1 (2)				
26 Apr	1	1				
27 Apr		3 (5)			1	
28 Apr					1	
29 Apr					1	
01 May				2 (3)		
02 May	1					
07 May				1		
08 May					1	
11 May	1					
15 May	2 (3)					

Appendix Table 3A. Continued.

Detection date	Lower Granite	Little Goose		Lower Monumental		
	First detection	First detection	Previous detections at 1 dam	First detection	Previous detections at 1 dam	Previous detections at 2 dams
16 May	1 (2)					
17 May	1 (2)	1 (2)				
18 May	1 (2)					
19 May	1 (2)			1 (2)		
21 May		1 (2)	1	2 (3)		1
23 May		1 (2)		1 (2)		
27 May		1 (2)				
29 May					1	
30 May		1 (2)				
08 Jun		1 (2)				
09 Jun	1 (2)					
11 Jun				1 (2)		
14 Jun				1 (2)		
28 Jun				1		
03 Jul	1					
16 Jul					1	
Total	16 (25)	12 (21)	2	10 (16)	7	1

Appendix Table 3B. Detections of PIT-tagged smolts by date at three Columbia River dams for wild chinook salmon from the South Fork of the Salmon River, 1996. Numbers in parentheses are first detections at the dams that have been adjusted for spill.

Detection date	McNary				John Day					Bonneville					
	First detection	Previous detections 1 dam	2 dams	3 dams	First detection	Previous detections 1 dam	2 dams	3 dams	4 dams	First detection	Previous detections 1 dam	2 dams	3 dams	4 dams	5 dams
03 May					1										
07 May		1													
13 May		1													
16 May		1													
24 May		2													
07 Jun	1 (3)														
03 Jul		1													
Total	1 (3)	6			1										

Appendix Table 4A. Detections of PIT-tagged smolts by date at three Snake River dams for wild chinook salmon from Secesh River, 1996. Numbers in parentheses are first detections at the dams that have been adjusted for spill.

Tagging site: Secesh River
Release site: Secesh River
Release river kilometer(s) above Lower Granite Dam: 430 - 432

Release date: 28 - 29 Aug 1995
Number released: 57 1

Detection date	Lower Granite	Little Goose		Lower Monumental		
	First detection	First detection	Previous detections at 1 dam	First detection	Previous detections at 1 dam	Previous detections at 2 dams
12 Apr	1 (4)					
14 Apr	2 (6)					
16 Apr	1 (2)					
17 Apr	3 (5)					
19 Apr	2 (3)					
20 Apr	1 (2)					
21 Apr		2 (3)				
22 Apr		2				
23 Apr					1	
24 Apr	1	2 (3)	1			
25 Apr	2 (3)	1 (2)			2	
26 Apr			1	1	1	
27 Apr		2 (4)	2	1 (2)		
28 Apr				1 (2)	1	
29 Apr						

Appendix Table 4A. Continued.

Detection date	Lower Granite	Little Goose		Lower Monumental		
	First detection	First detection	Previous detections at 1 dam	First detection	Previous detections at 1 dam	Previous detections at 2 dams
01 May				1		
02 May				1	1	
14 May	2 (3)			1		
16 May				1 (2)		
17 May	2 (3)					
18 May					1	
19 May	4 (9)				1	
20 May	1 (2)			1 (2)		
21 May		1 (2)				
23 May		1 (2)			1	
24 May		1 (2)				
25 May		1 (2)				
28 May	1					
29 May	1 (2)					
30 May					1	
31 May						
01 Jun					1	
04 Jun					1	
05 Jun						1

Appendix Table 4A. Continued.

Detection date	Lower Granite	Little Goose		Lower Monumental		
	First detection	First detection	Previous detections at 1 dam	First detection	Previous detections at 1 dam	Previous detections at 2 dams
06 Jun					1	
08 Jun	1 (2)					
14 Jun				1 (2)		
16 Jun				1 (2)		
15 Jul	1					
20 Jul					1	
Total	26 (49)	14 (23)	8	12 (18)	13	2

Appendix Table 4B. Detections of PIT-tagged smolts by date at three Columbia River dams for wild chinook salmon from the Secesh River, 1996. Numbers in parentheses are first detections at the dams that have been adjusted for spill.

Detection date	McNary				John Day					Bonneville					
	First detection	Previous detections 1 dam	2 dams	3 dams	First detection	Previous detections 1 dam	2 dams	3 dams	4 dams	First detection	Previous detections 1 dam	2 dams	3 dams	4 dams	5 dams
25 Apr	1 (2)														
26 Apr			1												
27 Apr	1 (2)		1												
01 May	1 (2)														
03 May		1													
06 Jun		1													
Total	3 (6)	2	2												

Appendix Table 5A. Detections of PIT-tagged smolts by date at three Snake River dams for wild chinook salmon from Lake Creek, 1996. Numbers in parentheses are first detections at the dams that have been adjusted for spill.

Tagging site: Lake Creek
Release site: Lake Creek
Release river kilometer(s) above Lower Granite Dam: 452

Release date: 30 Aug 1995
Number released: 13 5

Detection date	Lower Granite	Little Goose		Lower Monumental		
	First detection	First detection	Previous detections at 1 dam	First detection	Previous detections at 1 dam	Previous detections at 2 dams
15 Apr	1 (2)					
17 Apr	1 (2)					
18 Apr	1 (2)					
21 Apr	1 (2)					
25 Apr	1	1 (2)	1			
26 Apr	1				1	
27 Apr				1 (2)		
28 Apr	1					
03 May	1					
08 May			1			
09 May					1	
19 May	1 (2)					
29 May			1			
30 May						
02 Jun	1					

Appendix Table 5A. Continued.

Detection date	Lower Granite	Little Goose		Lower Monumental		
	First detection	First detection	Previous detections at 1 dam	First detection	Previous detections at 1 dam	Previous detections at 2 dams
11 Jun					1	
14 Jun				1 (2)		
Total	10 (15)	1 (2)	3	2 (4)	3	1

Appendix Table 5B. Detections of PIT-tagged smolts by date at three Columbia River dams for wild chinook salmon from Lake Creek, 1996. Numbers in parentheses are first detections at the dams that have been adjusted for spill.

Detection date	McNary				John Day					Bonneville					
	First detection	Previous detections: 1 dam	2 dams	3 dams	First detection	Previous detections: 1 dam	2 dams	3 dams	4 dams	First detection	Previous detections: 1 dam	2 dams	3 dams	4 dams	5 dams
26 Apr	1 (2)														
29 Apr			1												
02 May		1													
Totals	1 (2)	1	1												

Appendix Table 6. A summary of the tagging dates, start tagging times and temperatures (°C), release dates, times, and temperatures, method of capture, distance (in kilometer) from the stream's mouth to the release point, number released, unadjusted number detected, and unadjusted percent detected for each tag group at six downstream dams during 1996.

Stream	Tag group	Tagging date	Tagging time	Release date	Release time	Tagging temp. (“C)	Release temp. (“C)	Capture method	Release river km	Number released	Number detected	Percent detected (%)
S. F. Salmon River	SA95234.SF1	22 Aug	09:24	23 Aug	07:30	11.5	14.0	Shock	112	146	9	6.2
	SA95234.SF2	22 Aug	10:34	22 Aug	14:30	13.5	16.0	Shock	113	126	10	7.9
	SA95235.SF1	23 Aug	07:47	23 Aug	12:30	13.5	15.0	Shock	116	130	6	4.6
	SA95235.SF2	23 Aug	09:19	23 Aug	13:30	15.0	16.0	Shock	118	199	11	5.5
	SA95236.SF1	24 Aug	07:24	24 Aug	11:00	11.5	12.0	Shock	121	100	4	4.0
Secesh River	SA95240.SE1	28 Aug	08:12	29 Aug	07:15	9.0	8.0	Shock	25	120	16	13.3
	SA95240.SE2	28 Aug	09:48	28 Aug	13:30	11.5	11.5	Shock	26	150	15	10.0
	SA9524 1 SE 1	29 Aug	07:13	29 Aug	12:00	8.0	10.0	Shock	27	301	24	8.0
Lake Creek	SA95242.LC1	30 Aug	07:32	30 Aug	11:00	7.5	8.0	Shock	2	135	14	10.4

Appendix Table 7. Daily detections of PIT-tagged wild spring/summer chinook salmon smolts from Idaho at Lower Granite Dam during 1996, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam. Adjusted numbers detected are calculated during spill.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature (°C)	Numbers detected	Adjusted numbers detected
07 Apr	82.2	40.8	8.9	0	0
08 Apr	76.1	34.3	8.9	0	0
09 Apr	115.1	61.1	9.1	0	
10 Apr	128.7	64.2	9.3	0	0
11 Apr	151.9	102.4	9.4	0	0
12 Apr	154.1	110.4	9.4	1	4
13 Apr	149.2	106.5	8.9	0	0
14 Apr	139.3	96.2	8.9	2	6
15 Apr	131.5	76.1	8.3	1	2
16 Apr	104.8	42.1	8.6	1	2
17 Apr	115.1	51.7	8.8	4	
18 Apr	116.6	52.1	8.8	1	2
19 Apr	112.8	48.2	9.4	4	7
20 Apr	110.9	46.2	9.6	2	3
21 Apr	96.8	50.5	9.5	1	2
22 Apr	91.3	48.6	9.9	0	0
23 Apr	107.3	45.8	10.0	0	0
24 Apr	152.0	39.5	9.9	1	1
25 Apr	149.4	35.1	9.9	5	7
26 Apr	135.8	24.7	10.0	2	2
27 Apr	132.5	31.6	8.9	0	0
28 Apr	121.8	23.3	9.5	1	1
29 Apr	105.0	22.8	9.5	0	0
30 Apr	98.3	22.0	9.4	0	0
01 May	101.1	22.2	9.7	0	0
02 May	97.1	23.4	9.5	1	1
03 May	98.8	23.5	9.5	1	1
04 May	99.5	26.0	9.3	0	0
05 May	90.9	23.6	9.1	0	0
06 May	84.1	19.1	9.1	0	0

Appendix Table 7. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature (°C)	Numbers detected	Adjusted numbers detected
07 May	88.4	27.9	8.7	0	0
08 May	78.2	39.0	8.8	0	0
09 May	85.0	45.3	8.9	0	0
10 May	90.5	25.3	9.1	0	0
11 May	88.3	25.7	9.9	1	1
12 May	91.6	25.5	10.0	0	0
13 May	103.6	25.8	9.7	0	0
14 May	126.5	42.6	10.2	2	3
15 May	139.4	46.9	10.4	2	3
16 May	160.4	61.8	10.1	1	2
17 May	170.5	72.1	9.2	3	5
18 May	193.9	95.1	8.9	1	2
19 May	199.9	107.1	9.1	6	13
20 May	184.5	99.9	8.9	1	2
21 May	161.0	79.0	8.8	0	0
22 May	149.9	59.8	9.0	0	0
23 May	147.1	57.3	9.3	0	0
24 May	134.5	56.1	9.7	0	0
25 May	127.7	52.9	10.6	0	0
26 May	128.1	44.7	10.8	0	0
27 May	130.0	45.1	10.9	0	0
20 May	140.2	45.6	11.8	1	1
29 May	151.6	51.7	11.8	1	2
30 May	156.2	59.7	11.1	0	0
31 May	145.1	48.9	10.9	0	0
01 Jun	140.8	44.3	11.1	0	0
02 Jun	139.2	44.3	11.5	1	1
03 Jun	140.4	40.5	12.3	0	0
04 Jun	164.2	55.4	12.6	0	0
05 Jun	181.2	65.9	12.7	0	0
06 Jun	189.2	74.0	12.5	0	0
07 Jun	184.3	66.7	12.2	0	0
08 Jun	189.4	76.2	12.6	1	2

Appendix Table 7. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature (°C)	Numbers detected	Adjusted numbers detected
09 Jun	198.7	82.5	12.9	1	2
10 Jun	202.2	86.5	12.7	0	0
11 Jun	198.5	79.4	12.6	0	0
12 Jun	187.3	72.6	12.8	0	0
13 Jun	175.5	68.5	13.0	0	0
14 Jun	170.1	66.4	13.4	0	0
15 Jun	172.1	67.8	13.8	0	0
16 Jun	162.0	71.1	14.0	0	0
17 Jun	166.0	70.6	13.7	0	0
18 Jun	165.1	73.8	13.4	0	0
19 Jun	146.6	51.3	13.4	0	0
20 Jun	133.0	62.7	12.9	0	0
21 Jun	112.6	35.1	12.9	0	0
22 Jun	99.1	28.4	13.0	0	0
23 Jun	96.7	19.3	13.2	0	0
24 Jun	88.0	19.6	13.5	0	0
25 Jun	94.6	34.0	13.3	0	0
26 Jun	93.7	32.3	13.5	0	0
27 Jun	91.3	29.8	13.7	0	0
28 Jun	96.8	24.3	13.9	0	0
29 Jun	88.5	0.0	14.2	0	0
30 Jun	78.3	1.4	14.9	0	0
01 Jul	72.8	0.0	15.8	0	0
02 Jul	82.8	6.0	16.3	0	0
03 Jul	91.4	13.5	16.6	1	2
04 Jul	81.8	24.0	16.1	0	0
05 Jul	80.2	17.5	17.1	0	0
06 Jul	78.1	19.3	17.8	0	0
07 Jul	68.8	13.3	17.9	0	0
08 Jul	60.8	9.6	17.7	0	0
09 Jul	62.1	0.0	18.0	0	0
10 Jul	53.7	0.0	17.9	0	0
11 Jul	50.2	2.1	18.6	0	0

Appendix Table 7. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature (°C)	Numbers detected	Adjusted numbers detected
12 Jul	53.1	0.0	18.9	0	0
13 Jul	52.2	0.0	18.9	0	0
14 Jul	50.9	0.0	19.4	0	0
15 Jul	47.8	0.0	19.4	1	1

Appendix Table 8. Daily detections of PIT-tagged wild spring/summer chinook salmon smolts from Idaho at Little Goose Dam during 1996, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam. Numbers detected represent fish not detected at a previous dam. Adjusted numbers detected are calculated during spill.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature (°C)	Numbers detected	Adjusted numbers detected
10 Apr	125.1	31.3	9.4	0	0
11 Apr	149.2	41.3	10.0	0	0
12 Apr	148.6	42.9	10.0	0	0
13 Apr	146.5	43.3	10.0	0	0
14 Apr	138.2	57.4	----	0	0
15 Apr	128.3	50.1	9.4	0	0
16 Apr	104.4	40.7	8.9	0	0
17 Apr	110.9	32.8	8.9	0	0
18 Apr	116.3	33.5	9.6	0	0
19 Apr	112.4	31.0	10.1	0	0
20 Apr	109.8	42.6	9.4	0	0
21 Apr	93.8	35.0	10.0	2	3
22 Apr	88.4	11.2	----	3	3
23 Apr	103.2	30.4	9.5	0	0
24 Apr	149.8	56.1	10.4	2	3
25 Apr	149.2	51.1	----	3	5
26 Apr	134.5	29.2	10.0	1	1
27 Apr	132.1	57.9	10.3	5	9
28 Apr	116.1	65.9	10.5	0	0
29 Apr	103.4	41.9	10.4	0	0
30 Apr	99.2	36.4	10.6	0	0
01 May	97.8	19.9	10.7	0	0
02 May	94.3	13.0	10.6	0	0
03 May	95.7	22.6	10.6	0	0
04 May	96.1	42.2	10.6	0	0
05 May	89.2	48.5	10.6	0	0
06 May	79.2	30.7	10.6	0	0
07 May	85.8	30.1	10.3	0	0
08 May	75.8	27.3	10.1	0	0
09 May	79.6	29.5	10.0	0	0

Appendix Table 8. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature (°C)	Numbers detected	Adjusted numbers detected
10 May	86.7	29.3	10.1	0	0
11 May	83.5	31.9	10.3	0	0
12 May	88.9	29.6	10.5	0	0
13 May	100.1	30.0	10.8	0	0
14 May	123.1	34.0	11.2	0	0
15 May	131.0	36.9	11.3	0	0
16 May	153.6	50.5	11.9	1	1
17 May	165.0	65.3	11.6	1	2
18 May	181.7	93.1	10.8	0	0
19 May	186.3	89.4	10.3	0	0
20 May	172.8	86.8	10.4	0	0
21 May	153.9	63.5	10.3	2	3
22 May	141.2	53.6	10.0	0	0
23 May	138.2	64.7	10.2	2	4
24 May	128.9	56.9	11.4	1	2
25 May	119.5	57.5	11.6	1	2
26 May	125.0	72.4	11.6	0	0
27 May	121.3	61.4	11.6	1	2
28 May	132.1	71.3	11.8	0	0
29 May	146.7	56.5	12.5	0	0
30 May	148.0	77.0	13.1	1	2
31 May	137.0	69.3	13.0	0	0
01 Jun	133.9	89.2	12.7	0	0
02 Jun	130.5	63.8	13.4	0	0
03 Jun	137.6	42.1	12.7	0	0
04 Jun	160.3	47.2	13.1	0	0
05 Jun	175.6	51.3	13.9	0	0
06 Jun	191.0	67.4	14.4	0	0
07 Jun	176.9	63.1	13.8	0	0
08 Jun	186.8	95.9	13.6	1	2

Appendix Table 9. Daily detections of PIT-tagged wild spring/summer chinook salmon smolts from Idaho at Lower Monumental Dam during 1996, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam. Numbers detected represent fish not detected at a previous dam(s). Adjusted numbers detected are calculated during spill.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature (°C)	Numbers detected	Adjusted numbers detected
13 Apr	149.0	43.4	10.6	0	0
14 Apr	140.7	57.3	10.1	0	0
15 Apr	131.2	43.4	9.8	0	0
16 Apr	108.5	36.4	9.7	0	0
17 Apr	109.1	28.7	9.6	0	0
18 Apr	114.5	26.5	9.5	0	0
19 Apr	111.9	29.3	9.6	1	1
20 Apr	109.6	37.0	9.5	0	0
21 Apr	96.9	31.8	10.1	0	0
22 Apr	89.4	7.9	10.1	0	0
23 Apr	102.6	27.8	11.5	1	1
24 Apr	158.0	60.5	10.4	0	0
25 Apr	162.5	63.9	10.4	0	0
26 Apr	139.8	34.2	10.6	1	1
27 Apr	139.6	62.9	10.2	2	4
28 Apr	124.2	52.8	10.4	1	2
29 Apr	104.5	47.2	10.5	0	0
30 Apr	101.9	39.5	10.5	0	0
01 May	104.4	23.4	10.5	3	4
02 May	95.5	9.2	10.7	1	1
03 May	98.1	20.5	10.7	0	0
04 May	100.2	32.2	10.9	0	0
05 May	91.5	32.0	----	0	0
06 May	80.8	20.3	----	0	0
07 May	88.0	22.8	----	1	1
08 May	75.4	15.9	8.7	0	0
09 May	82.0	21.5	8.7	0	0
10 May	91.4	19.6	8.5	0	0
11 May	85.5	21.0	8.5	0	0
12 May	91.2	26.3	8.6	0	0

Appendix Table 9. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature (°C)	Numbers detected	Adjusted numbers detected
13 May	103.0	19.5	8.4	0	0
14 May	124.1	33.9	8.8	1	1
15 May	130.5	37.1	9.2	0	0
16 May	157.1	54.0	9.6	1	2
17 May	167.2	63.7	9.9	0	0
18 May	188.7	89.1	9.7	0	0
19 May	204.7	101.8	8.9	1	2
20 May	181.8	79.8	8.5	1	2
21 May	161.7	65.3	8.6	2	3
22 May	146.0	50.7	8.4	0	0
23 May	142.4	55.3	8.4	1	2
24 May	133.0	52.9	8.7	0	0
25 May	123.5	45.0	9.0	0	0
26 May	127.9	64.0	9.3	0	0
27 May	125.5	56.0	9.6	0	0
26 May	135.2	59.8	9.7	0	0
29 May	152.0	66.1	9.9	0	0
30 May	152.8	66.1	10.5	0	0
31 May	139.7	65.3	11.9	0	0
01 Jun	142.7	77.0	12.9	0	0
02 Jun	135.2	63.0	13.0	0	0
03 Jun	135.2	40.7	12.8	0	0
04 Jun	163.5	62.4	12.7	0	0
05 Jun	178.4	76.3	13.2	0	0
06 Jun	197.1	91.2	14.1	0	0
07 Jun	182.2	64.9	14.2	0	0
08 Jun	196.6	91.6	14.0	0	0
09 Jun	196.2	87.0	13.6	0	0
10 Jun	206.1	90.3	13.7	0	0
11 Jun	197.1	92.7	14.1	1	2
12 Jun	195.5	97.8	14.2	0	0
13 Jun	178.5	95.3	14.0	0	0
14 Jun	170.2	81.2	14.0	3	6

Appendix Table 9. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature (°C)	Numbers detected	Adjusted numbers detected
15 Jun	169.6	84.5	14.3	0	0
16 Jun	161.9	84.7	14.5	1	2
17 Jun	164.0	82.1	14.6	0	0
18 Jun	164.9	80.1	14.6	0	0
19 Jun	144.6	62.0	14.7	0	0
20 Jun	131.5	65.5	14.6	0	0
21 Jun	112.6	36.3	14.7	0	0
22 Jun	97.2	31.2	14.7	0	0
23 Jun	97.9	22.3	14.4	0	0
24 Jun	68.2	28.9	14.2	0	0
25 Jun	94.6	48.4	14.4	0	0
26 Jun	92.0	43.0	14.5	0	0
27 Jun	91.5	35.6	14.6	0	0
28 Jun	94.6	24.9	14.7	1	1

Appendix Table 10. Daily detections of PIT-tagged wild spring/summer chinook salmon smolts from Idaho at McNary Dam during 1996, with associated river flows (kcfs), spill (kcfs), and water temperatures (°C) at the dam. Numbers detected represent fish not detected at a previous dam(s). Adjusted numbers detected are calculated during spill.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature (°C)	Numbers detected	Adjusted numbers detected
22 Apr	315.5	139.6	8.1	0	0
23 Apr	329.5	149.2	8.1	0	0
24 Apr	396.1	198.0	8.3	0	0
25 Apr	395.3	202.4	8.7	1	2
26 Apr	375.6	193.9	8.9	1	2
27 Apr	373.4	193.9	8.6	1	2
28 Apr	355.1	217.1	9.1	0	0
29 Apr	335.4	193.5	9.1	0	0
30 Apr	321.1	177.5	9.4	0	0
01 May	349.8	179.3	9.1	1	2
02 May	322.6	142.4	9.2	0	0
03 May	304.7	135.9	9.2	0	0
04 May	325.9	142.5	9.8	0	0
05 May	311.5	135.1	9.5	0	0
06 May	302.9	145.7	10.0	0	0
07 May	289.1	120.5	9.7	0	0
08 May	299.3	123.7	10.0	0	0
09 May	279.3	120.4	10.0	0	0
10 May	274.5	109.5	10.0	0	0
11 May	260.2	105.3	10.3	0	0
12 May	257.6	106.1	10.5	0	0
13 May	240.2	80.7	10.2	0	0
14 May	299.3	119.3	10.3	0	0
15 May	318.1	140.4	10.7	0	0
16 May	317.7	149.8	11.4	0	0
17 May	346.0	198.3	11.1	0	0
18 May	387.2	231.7	11.3	0	0
19 May	425.6	258.1	11.1	0	0
20 May	411.5	264.1	11.4	0	0
21 May	387.1	202.7	11.0	0	0

Appendix Table 10. Continued.

Date	Average flow (kcfs)	Average spill (kcfs)	Scroll-case water temperature (°C)	Numbers detected	Adjusted numbers detected
22 May	380.9	201.7	10.6	0	0
23 May	391.3	213.3	10.4	0	0
24 May	360.8	232.6	10.7	0	0
25 May	371.2	244.0	11.0	0	0
26 May	346.1	240.7	11.1	0	0
27 May	361.6	245.9	11.2	0	0
28 May	359.3	254.0	11.3	0	0
29 May	413.8	301.4	11.4	0	0
30 May	423.5	296.8	12.2	0	0
31 May	380.6	244.4	11.9	0	0
01 Jun	389.9	265.4	12.3	0	0
02 Jun	338.4	265.0	12.6	0	0
03 Jun	373.0	241.7	12.9	0	0
04 Jun	406.9	261.5	12.9	0	0
05 Jun	412.5	263.9	13.2	0	0
06 Jun	418.1	268.9	13.5	0	0
07 Jun	405.6	254.9	13.6	1	3

Appendix Table 11. Monthly flow information from September 1995 through August 1996 in cubic feet per second (cfs) for various sites in the Salmon River drainage in Idaho. These data were provided by the U. S. Geological Survey and is cited as provisional data subject to revision.

Flow	September	October	November	December	January	February	March	April	May	June	July	August
					Station number 13295000~-Valley Creek at Stanley, ID							
Mean	84	99	144	166	101	113	92	275	797	1,057	541	162
Min	72	80	59	95	90	75	80	102	382	729	288	108
Max	106	148	350	503	120	198	106	508	1,620	1,540	932	267
					Station number 13302500--Salmon River at Salmon, ID							
Mean	1,069	1,411	1,465	1,458	1,158	1,262	1,276	2,029	4,844	9,430	3,865	1,398
Min	1,000	1,100	1,180	1,010	985	764	1,090	1,220	2,070	5,460	2,160	1,090
Max	1,220	1,700	2,010	2,160	1,350	2,090	1,470	3,040	9,360	15,500	6,390	2,100
					Station number 13310700--South Fork Salmon River near Krassel Ranger Station, ID							
Mean	147	171	323	756	299	626	488	1,161	2,319	2,611	710	----
Min	132	136	127	381	236	222	377	459	992	1,350	331	----
Max	169	269	1,170	1,920	385	1,410	626	2,240	5,340	4,340	1,470	----
					Station number 13314300--South Fork Salmon River at mouth near Mackey Bar, ID							
Mean	604	684	1,019	2,093	950	1,593	1,417	3,232	---	----	3,225	974
Min	527	557	408	1,130	591	543	1,130	1,340	--	----	1,490	733
Max	727	972	2.670	4,520	1,220	3,060	1,750	5,800	----	----	6,870	1,430
					Station number 13317000--Salmon River at White Bird, ID							
Mean	4,723	5,534	6,516	---	----	9,039	9,103	18,820	41,680	61,080	19,430	6,899
Mill	4,410	4,900	4,060	----	---	3,540	6,730	8,440	16,900	33.900	9,930	5,350
Max	5,430	6,560	10,900	----	---_	15,400	11,300	29,900	83,600	94,800	34.900	10,100

Appendix Table 12. Minimum, maximum, and average depth (in feet) by month at five monitoring sites in the Salmon River drainage from August 1995 through July 1996. These data were provided by Pacific Northwest National Laboratories

Marsh Creek (RKm 179.5 from mouth of the Middle Fork Salmon River)

	August	September	October	November	December	January	February	March	April	May	June	July
Average	2.10	1.90	1.83	1.82	2.15	1.99	1.92	1.44	1.91	3.11	3.96	2.70
Minimum	1.70	1.50	1.30	1.30	1.50	0.90	0.90	0.70	1.00	2.14	2.90	2.20
Maximum	2.50	2.20	2.30	2.30	4.80	3.60	3.80	2.10	2.63	4.38	5.04	3.45

Middle Fork Salmon River near Thomas Creek (RKm 97.61

	August	September	October	November	December	January	February	March	April	May	June	July
Average	----	----	----	2.65	3.00	2.20	2.53	2.64	3.71	4.05	----	----
Minimum	----	--_-	----	2.00	2.20	1.40	1.80	1.80	2.20	3.90	----	----
Maximum	----	----	----	3.60	4.50	2.90	3.50	3.20	4.80	4.20	----	____

Salmon River near Sawtooth Hatchery (RKm 627.9)

	August	September	October	November	December	January	February	March	April	May	June	July
Average	3.60	3.45	3.47	3.04	2.35	2.16	2.42	2.36	2.73	2.82	3.01	2.57
Minimum	3.20	3.00	2.80	1.70	1.70	1.40	1.90	1.80	1.80	2.30	2.10	2.00
Maximum	4.10	3.80	4.00	3.90	3.50	2.80	3.00	2.80	3.60	3.30	4.00	3.00

Appendix Table 12. Continued.

Valley Creek (RKm 609.4 from the mouth of the Salmon River)

	August	September	October	November	December	January	February	March	April	May	June	July
Average	2.46	2.10	1.85	2.04	2.19	1.49	1.02	0.88	1.79	3.02	3.14	2.54
Minimum	2.10	1.60	1.30	1.50	1.80	0.40	0.30	0.30	0.50	2.20	2.20	1.80
Maximum	2.90	2.60	2.40	2.90	3.10	2.50	1.80	1.30	3.10	4.00	4.20	3.50

South Fork of the Salmon River near Krassel Ranger Station (RKm 64.0)

	August	September	October	November	December	January	February	March	April	May	June	July
Average	----	----	----	----	----	----	----	----	----	5.45	5.76	3.05
Minimum	----	----	----	----	----	----	----	----	----	3.85	4.09	2.06
Maximum	----	----	----	----	----	----	----	----	----	8.13	7.68	4.57

Appendix Table 13. Minimum, maximum, and average water temperature (“C) by month at five monitoring sites in the Salmon River drainage from August 1994 through July 1995. These data were provided by Pacific National Northwest Laboratories.

Marsh Creek (RKm 179.5 from the mouth of the Middle Fork Salmon River)

	August	September	October	November	December	January	February	March	April	May	June	July
Average	11.48	9.01	4.40	1.93	0.58	0.56	0.96	2.50	2.97	3.80	7.99	11.37
Minimum	5.20	2.60	0.30	0.30	0.30	0.30	0.20	0.20	0.01	0.02	1.79	5.57
Maximum	18.60	16.60	10.50	5.00	3.00	2.60	4.60	7.50	9.90	14.10	15.60	17.87

Middle Fork Salmon River near Thomas Creek (RKm 97.6)

	August	September	October	November	December	January	February	March	April	May	June	July
Average	-----	-----	-----	2.72	1.12	0.53	0.98	3.38	5.22	6.22	-----	-----
Minimum		-----	-----	0.20	0.20	0.20	0.20	0.20	2.40	5.00	-----	-----
Maximum	-----	-----	-----	4.90	4.40	2.30	4.20	6.50	8.60	7.40	-----	-----

Salmon River near Sawtooth Hatchery (RKm 627.9)

	August	September	October	November	December	January	February	March	April	May	June	July
Average	13.51	11.11	6.62	4.01	1.40	1.10	1.89	4.07	5.69	6.90	10.59	14.13
Minimum	8.10	5.60	2.50	0.30	0.20	0.20	0.30	0.30	1.10	1.90	5.30	9.30
Maximum	19.10	17.60	11.80	7.20	4.90	4.20	5.40	9.70	11.50	13.00	15.80	18.90

Appendix Table 13. Continued.

Valley Creek (RKm 609.4 from the mouth of the Salmon River)

	August	September	October	November	December	January	February	March	April	May	June	July
Average	14.33	11.52	5.60	2.47	0.78	0.69	0.78	3.10	3.98	6.33	10.67	13.37
Minimum	7.40	4.00	0.80	0.30	0.20	0.30	0.30	0.30	0.30	0.60	4.90	8.30
Maximum	21.20	19.80	12.40	6.00	3.00	1.60	4.50	8.90	10.20	13.90	16.90	19.60

South Fork of the Salmon River near Krassel Ranger Station (RKm 64.0)

	August	September	October	November	December	January	February	March	April	May	June	July
Average	-----	-----	-----	-----	-----	-----	-----	-----	-----	5.87	8.22	14.22
Minimum	-----	-----	-----	-----	-----	-----	-----	-----	-----	3.63	5.00	9.81
Maximum	-----	-----	-----	-----	-----	-----	-----	-----	-----	8.50	12.37	19.70

Appendix Table 14. Minimum, maximum, and average pH by month at five monitoring sites in the Salmon River drainage from August 1995 through July 1996. These data were provided by Pacific Northwest National Laboratories.

Marsh Creek (RKm 179.5 from the mouth of the Middle Fork Salmon River)

	August	September	October	November	December	January	February	March	April	May	June	July
Average	8.00	7.95	7.65	7.47	----	7.58	7.59	7.80	7.40	7.14	7.27	7.58
Minimum	7.55	7.55	7.23	7.00	----	7.24	7.31	7.57	6.90	6.71	7.03	7.27
Maximum	8.86	9.01	8.46	7.75	----	7.70	7.90	8.49	8.22	7.44	7.51	8.32

Middle Fork Salmon River near Thomas Creek (RKm 97.6)

	August	September	October	November	December	January	February	March	April	May	June	July
Average	-----	-----	-----	7.94	8.36	8.61	8.87	10.41	9.56	9.47	----	-----
Minimum	-----	----	-----	7.55	7.82	8.10	8.02	8.89	8.17	9.00	-----	-----
Maximum	-----	-----	-----	9.41	8.98	9.58	10.94	11.18	11.09	10.39	-----	-----

Salmon River near Sawtooth Hatchery (RKm 627.9)

	August	September	October	November	December	January	February	March	April	May	June	July
Average	8.46	8.25	8.20	8.17	8.12	8.10	8.08	8.15	7.99	7.91	8.21	8.22
Minimum	7.84	7.75	7.84	7.76	7.74	7.84	7.87	7.80	7.72	7.47	7.69	7.85
Maximum	9.38	9.30	9.09	9.16	9.26	9.09	8.87	8.62	8.56	8.48	8.88	8.83

Appendix Table 14. Continued.

Valley Creek (RKm 609.4 from the mouth of the Salmon River)

	August	September	October	November	December	January	February	March	April	May	June	July
Average	7.88	7.17	7.63	7.56	7.40	7.50	7.66	7.87	7.50	7.53	7.71	8.87
Minimum	7.28	5.71	7.27	7.02	6.89	7.32	7.26	7.49	7.18	7.03	7.36	7.59
Maximum	8.75	8.71	8.38	8.30	8.28	8.02	8.66	8.68	8.68	8.14	8.12	10.88

South Fork of the Salmon River near Krassel Ranger Station (RKm 64.0)

	August	September	October	November	December	January	February	March	April	May	June	July
Average	-----	-----	-----	-----	-----	-----	-----	-----	-----	7.25	7.27	7.56
Minimum	-----	-----	-----	-----	-----	-----	-----	-----	-----	6.91	7.00	7.16
Maximum	-----	-----	-----	-----	-----	-----	-----	-----	-----	7.67	8.29	8.50

Appendix Table 15. Minimum, maximum, and average specific conductance (µS/cm) by month at five monitoring sites in the Salmon River drainage from August 1995 through July 1996. These data were provided by Pacific Northwest National Laboratories.

Marsh Creek (RKm 179.5 from the mouth of the Middle Fork Salmon River)

	August	September	October	November	December	January	February	March	April	May	June	July
Average	53.06	59.89	61.22	59.03	38.03	50.22	56.34	58.67	53.25	38.79	34.64	48.67
Minimum	47.00	56.00	55.00	39.00	23.00	38.00	38.00	43.00	40.15	24.60	27.33	34.30
Maximum	60.00	64.00	66.00	70.00	44.00	65.00	64.00	64.00	61.01	52.56	40.80	60.66

Middle Fork Salmon River near Thomas Creek (RKm 97.61

	August	September	October	November	December	January	February	March	April	May	June	July
Average	-----	-----	-----	80.80	82.86	88.75	92.76	97.29	83.99	77.94	-----	-----
Minimum	-----	-----	-----	55.00	57.00	67.00	79.00	81.00	71.00	76.00	-----	-----
Maximum	-----	-----	-----	91.00	97.00	104.00	106.00	104.00	101.00	80.00	-----	----

Salmon River near Sawtooth Hatchery (RKm 627.9)

	August	September	October	November	December	January	February	March	April	May	June	July
Average	115.87	147.35	151.34	141.48	128.30	132.48	131.78	141.42	122.00	78.45	66.07	91.49
Minimum	87.00	129.00	145.00	116.00	110.00	109.00	120.00	135.00	99.00	49.00	33.00	68.00
Maximum	133.00	159.00	195.00	181.00	147.00	156.00	150.00	156.00	145.00	116.00	83.00	115.00

Appendix Table 15. Continued.

Valley Creek (RKm 609.4 from the mouth of the Salmon River)

	August	September	October	November	December	January	February	March	April	May	June	July
Average	52.91	68.47	72.95	69.29	61.01	67.72	63.73	70.01	56.40	37.08	32.07	29.57
Minimum	40.00	57.00	67.00	46.00	37.00	61.00	50.00	64.00	33.00	21.00	21.00	23.00
Maximum	63.00	77.00	79.00	89.00	75.00	78.00	77.00	79.00	76.00	48.00	49.00	35.00

South Fork of the Salmon River near Krassel Ranger Station (RKm 64.0)

	August	September	October	November	December	January	February	March	April	May	June	July
Average	-----	-----	-----	-----	-----	-----	-----	-----	-----	28.59	19.32	31.37
Minimum	-----	-----	-----	-----	-----	-----	-----	-----	-----	20.30	16.17	19.42
Maximum	-----	-----	-----	-----	-----	-----	-----	-----	-----	38.68	23.66	40.56

Appendix Table 16. Minimum, maximum, and average dissolved oxygen (ppm) by month at five monitoring sites in the Salmon River drainage from August 1995 through July 1996. These data were provided by Pacific Northwest National Laboratories.

Marsh Creek (RKm 179.5 from the mouth of the Middle Fork Salmon River)

	August	September	October	November	December	January	February	March	April	May	June	July
Average	6.48	8.88	11.87	12.48	12.53	12.12	11.29	11.30	12.00	12.68	-----	-----
Minimum	4.92	4.84	10.29	11.51	11.83	10.05	10.64	10.26	10.02	11.35	-----	-----
Maximum	8.01	12.61	13.37	13.78	13.21	13.67	12.07	12.31	13.97	13.75	-----	-----

Middle Fork Salmon River near Thomas Creek (RKm 97.6)

	August	September	October	November	December	January	February	March	April	May	June	July
Average	-----	-----		3.30	1.68	1.96	1.54	3.05	2.11	2.90	-----	-----
Minimum	-----	-----	-----	0.12	0.10	0.18	0.21	0.17	0.65	2.47	-----	-----
Maximum	-----	-----	-----	13.91	3.77	4.15	3.50	5.23	5.58	3.14	-----	-----

Salmon River near Sawtooth Hatchery (RKm 627.9)

	August	September	October	November	December	January	February	March	April	May	June	July
Average	9.53	9.79	10.52	11.31	12.15	12.58	13.38	13.98	12.38	11.54	11.32	
Minimum	6.88	8.10	9.09	10.24	10.73	8.13	11.90	11.69	10.16	9.63	10.14	-----
Maximum	14.95	12.30	12.11	13.55	17.64	15.51	15.61	19.14	17.63	13.47	12.85	-----

Appendix Table 16. Continued.

Vallev Creek (RKm 609.4 from the mouth of the Salmon River)

	August	September	October	November	December	January	February	March	April	May	June	July
Average	9.00	10.01	11.84	13.00	13.75	13.63	13.37	13.23	12.76	11.84	-----	-----
Minimum	7.56	7.86	7.78	11.67	10.60	12.73	12.25	11.17	11.11	9.80	-----	-----
Maximum	10.95	12.59	13.86	14.32	15.34	15.14	14.40	14.73	15.70	13.41	-----	-----

South Fork of the Salmon River near Krassel Ranger Station (RKm 64.0)

	August	September	October	November	December	January	February	March	April	May	June	July
Average	-----	-----	-----	-----	-----	-----	-----	-----	-----	11.36	10.79	-----
Minimum	-----	-----	-----	-----	-----	-----	-----	-----	-----	10.42	9.79	-----
Maximum	-----	-----	-----	-----	-----	-----	-----	-----	-----	12.79	il.89	-----

Appendix Table 17. Minimum, maximum, and average turbidity (ntu) by month at two monitoring sites in the Salmon River drainage from August 1995 through July 1996. These data were provided by Pacific Northwest National Laboratories.

Marsh Creek (RKm 179.5 from the mouth of the Middle Fork Salmon River)

	August	September	October	November	December	January	February	March	April	May	June	July
Average										8.75	6.61	17.56
Minimum										1.40	1.80	0.70
Maximum										102.60	241.50	905.20

South Fork of the Salmon River near Krassel Ranger Station (RKm 64.0)

	August	September	October	November	December	January	February	March	April	May	June	July
Average										13.56	8.53	1.26
Minimum										1.00	1.00	0.10
Maximum										133.20	61.10	4.80