

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 98112-2097

and

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

Project Number 91-028
Contract Number DE-AI799-1-BP1-8800

JULY 1997

CONTENTS

| | <u>Page</u> |
|---|-------------|
| EXECUTIVE SUMMARY | v |
| INTRODUCTION | 1 |
| Project Goals | 1 |
| Background | 1 |
| FISH COLLECTION AND TAGGING | 4 |
| DETECTIONS AT TRAPS | 7 |
| DETECTIONS AT DAMS | 9 |
| MIGRATION TIMING AT DAMS | 12 |
| ENVIRONMENTAL INFORMATION | 26 |
| ADULT RETURNS FROM 1989-1994 SMOLT MIGRATIONS | 28 |
| DISCUSSION | 28 |
| ACKNOWLEDGMENTS | 35 |
| REFERENCES | 36 |
| APPENDIX TABLES | 38 |

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).

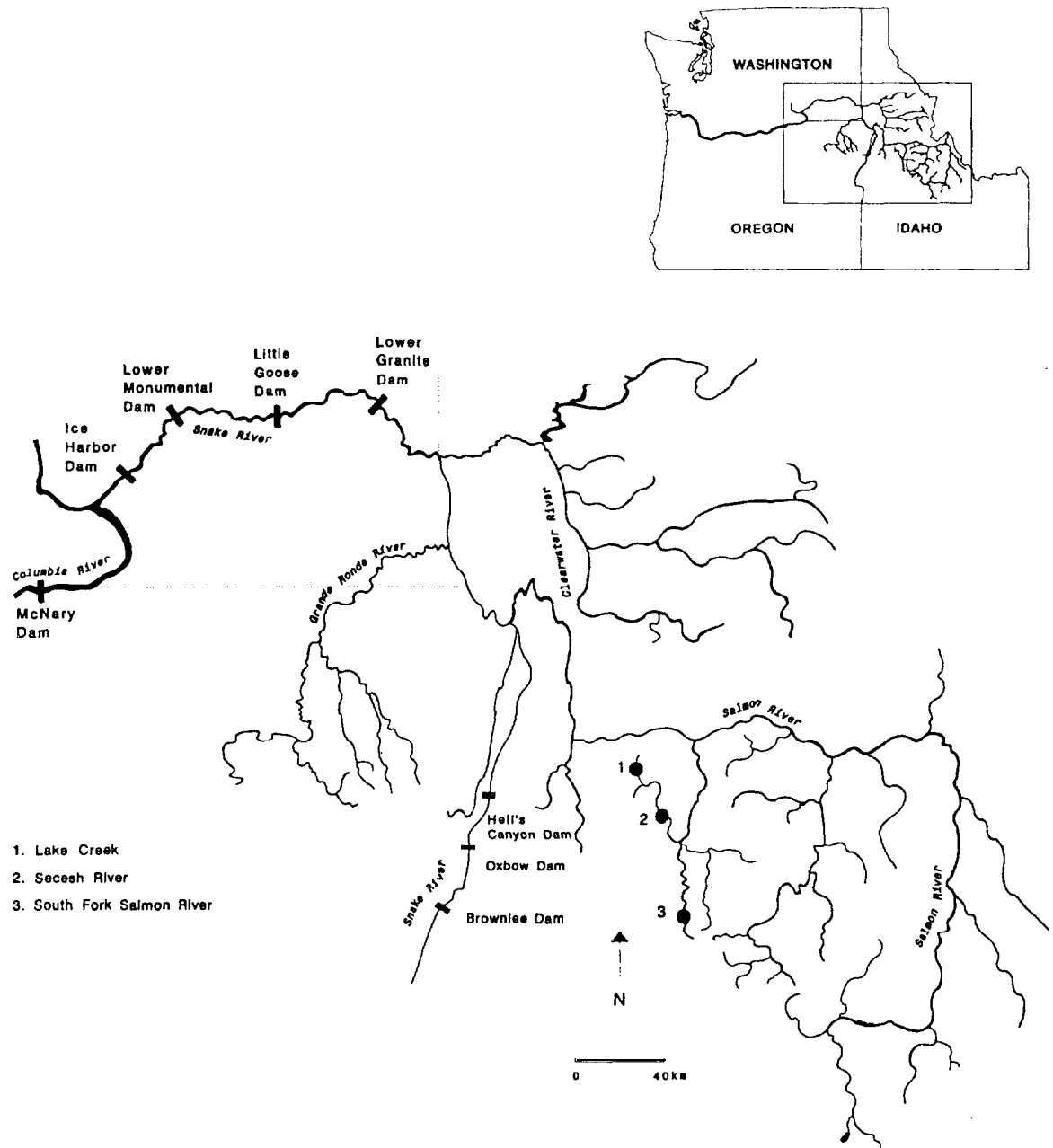


Figure 1. Study area where wild spring/summer chinook salmon parr were PIT tagged during 1995.

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 1.0%.

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 0-85 mm) over an average of 51.5 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 (%) | | | Overall | 24-hour tag loss (%) |
|----------------------|---------------|---------|---------|---------|----------------------|
| | Collection | Tagging | 24-hour | | |
| 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 individual streams in Table 4.

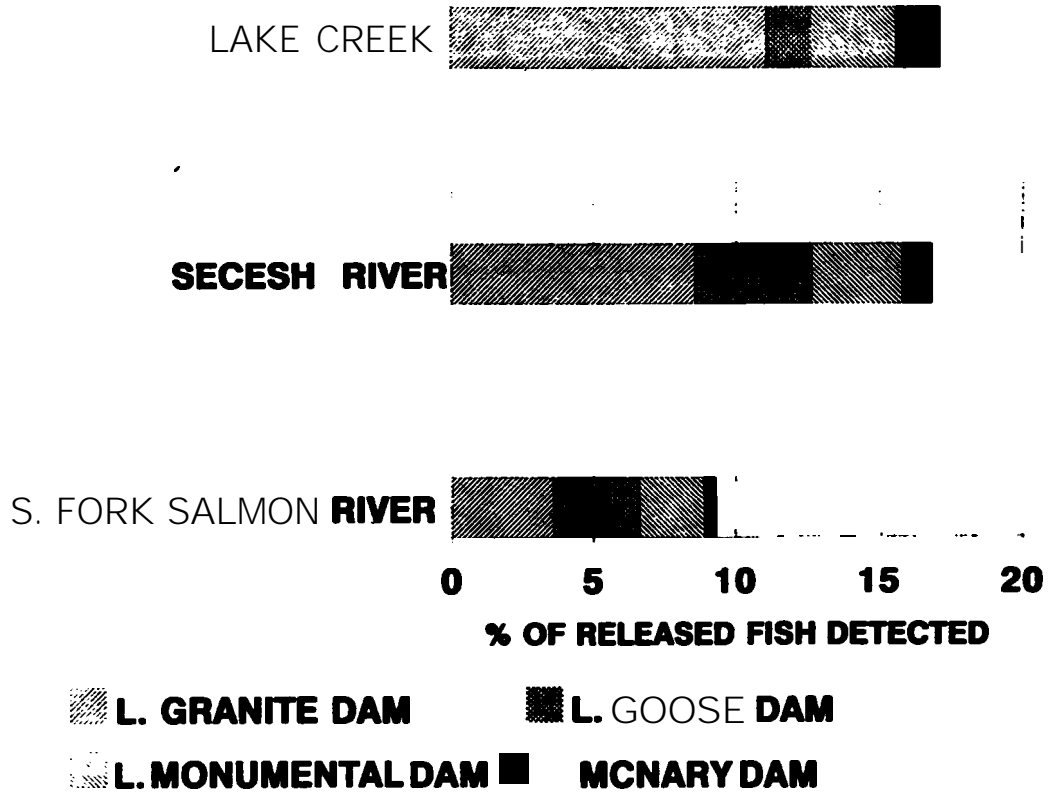


Figure 2. Percent (adjusted for spill) of PIT-tagged-wild spring/summer chinook salmon smolts detected at Lower Granite, Little Goose, Lower Monumental, and McNary Dams in 1996.

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

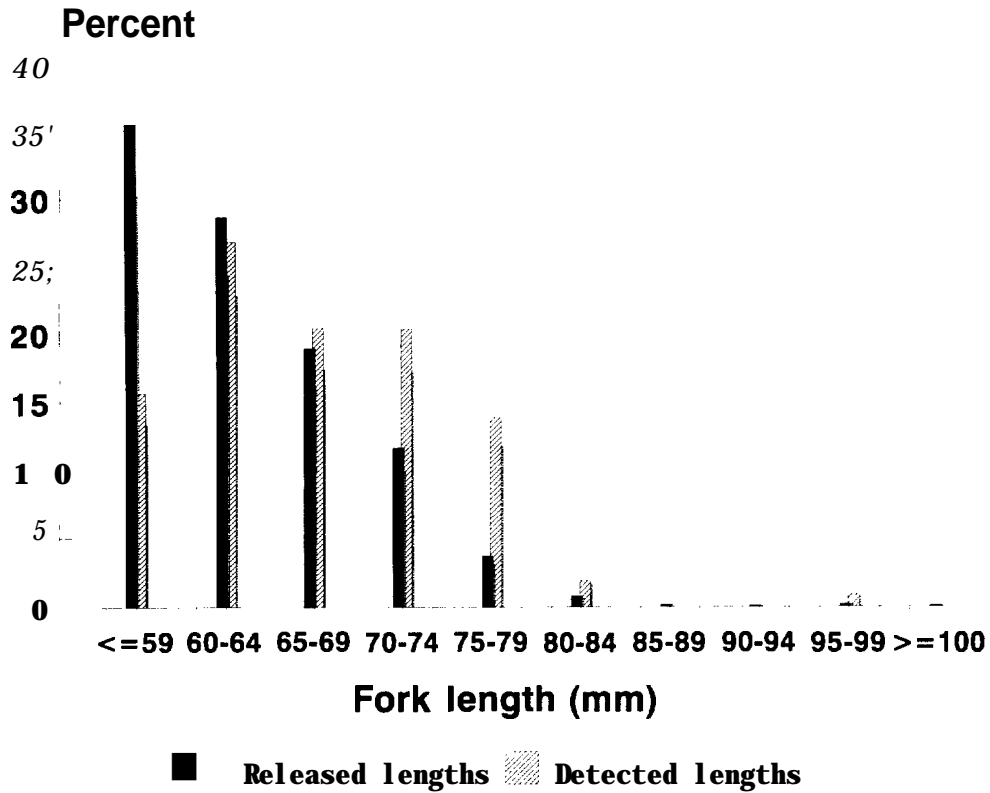


Figure 3. Percent, by fork length increments, of PIT-tagged wild spring/summer chinook salmon parr released in Idaho streams in 1995 and percent of fish detected for these length increments at Lower Granite, Little Goose, Lower Monumental, McNary, and John Day Dams in spring and summer 1996.

(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.

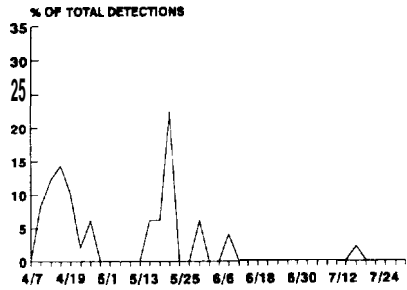
Fish from the remaining four streams: South Fork of the Salmon River in Idaho and Catherine Creek, Grande Ronde River (upper), and the Lostine River in Oregon showed a later passage period at Lower Granite Dam than the aforementioned streams (Fig. 4 and Table 5). Dates of 50% passage for fish from these 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.

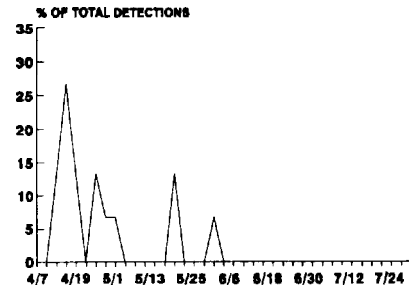
Timing of smolts from individual streams in Idaho is not presented here for Little Goose, Lower Monumental, McNary, John Day, and Bonneville Dams. See Appendix Tables 3A-5B for this information.

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

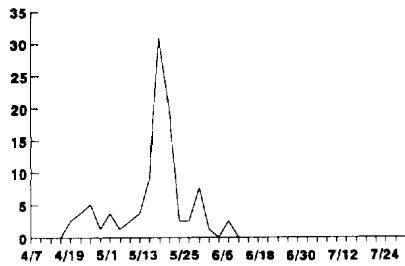
SECESH RIVER



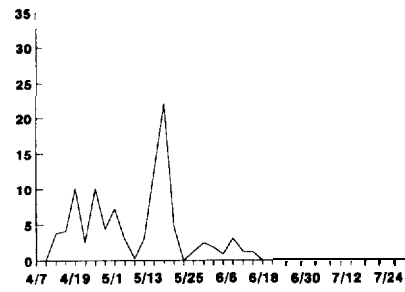
LAKE CREEK



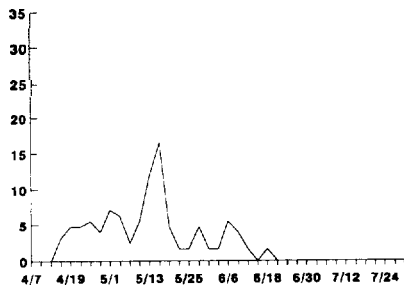
**GRANDERONDE RIVER
(UPPER)**



CATHERINE CREEK



LOSTINE RIVER



IMNAHA RIVER (UPPER)

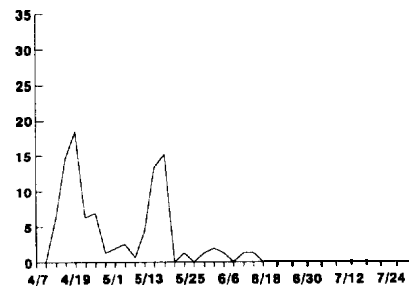


Figure 4. The migration timing (adjusted for spill) at Lower Granite Dam in 1996 of PIT-tagged wild spring/summer chinook salmon smolts from individual streams in Idaho and Oregon.

SOUTH FORK SALMON RIVER

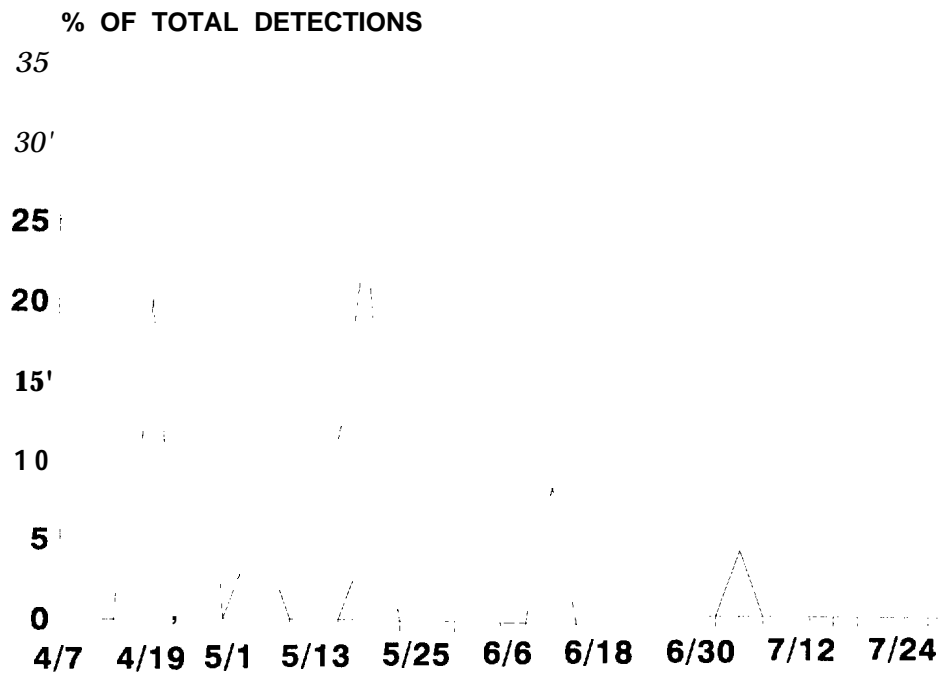
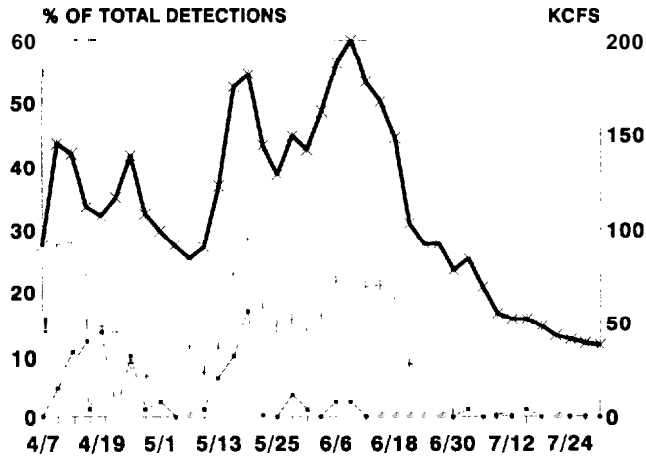


Figure 4. Continued.

Lower Granite Dam



Little Goose Dam

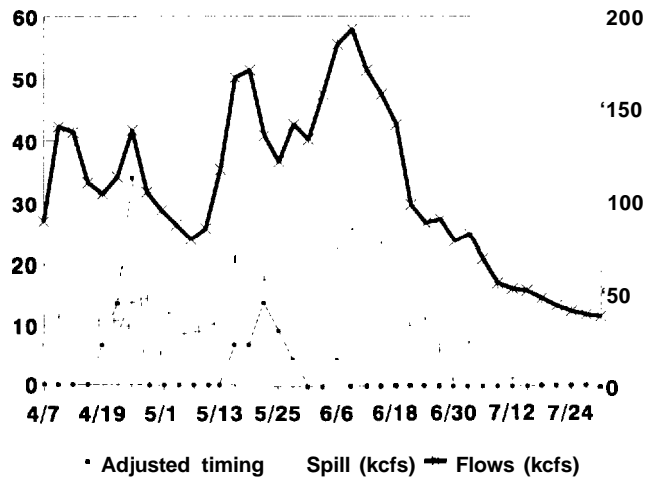
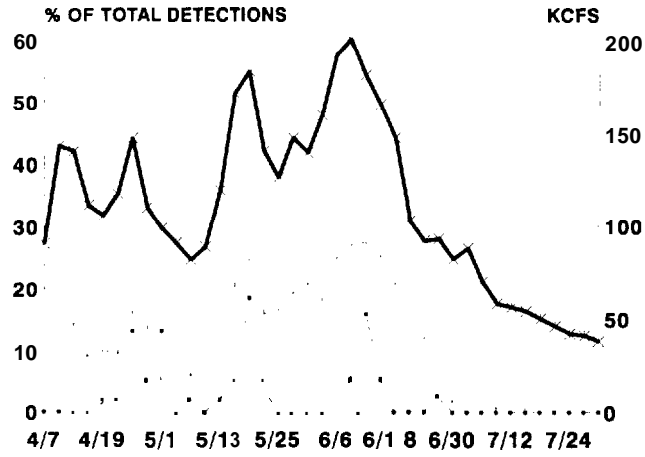


Figure 5. The overall migration timing of PIT-tagged wild spring/summer chinook salmon smolts at Lower Granite, Little Goose, Lower Monumental, and McNary Dams in 1996, with associated river spill and flows at these dams. Data represent detections from three Idaho streams combined by 3-day intervals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

Lower Monumental Dam



McNary Dam

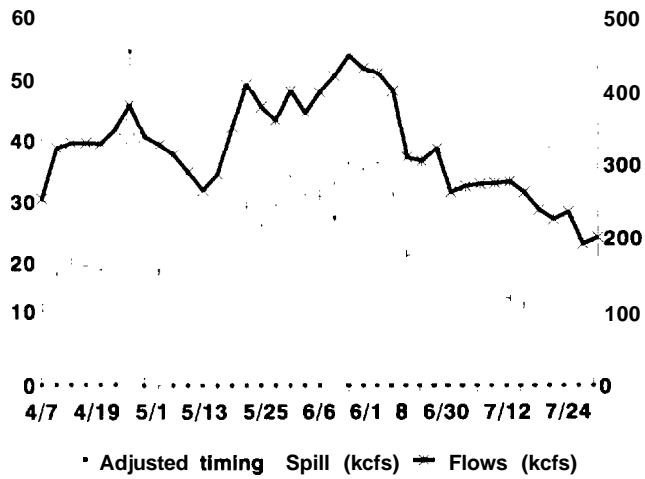


Figure 5. Continued.

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 | | | Range |
|------------------------|------------------------------------|----------|---------|----------------------|
| | 10% | 50% | 90% | |
| 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 | 10 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 | 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 ^b | --- --- | ----- | -- --- | ----- |
| 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 ^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 | 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 |

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 ['] | 15 April | 26 April | 03 June | 12 April - 24 June |
| 1993 | 28 April | 15 May | 23 June | 23 April - 22 July |
| 1994 ['] | 24 April | 01 May | 05 July | 24 April - 04 September |
| 1995 ^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 | | | Range |
|-----------------------------------|------------------------------------|----------|---------|----------------------|
| | 10% | 50% | 90% | |
| 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 | 10 May | 10 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 | 11 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 31 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 1964-1969 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.

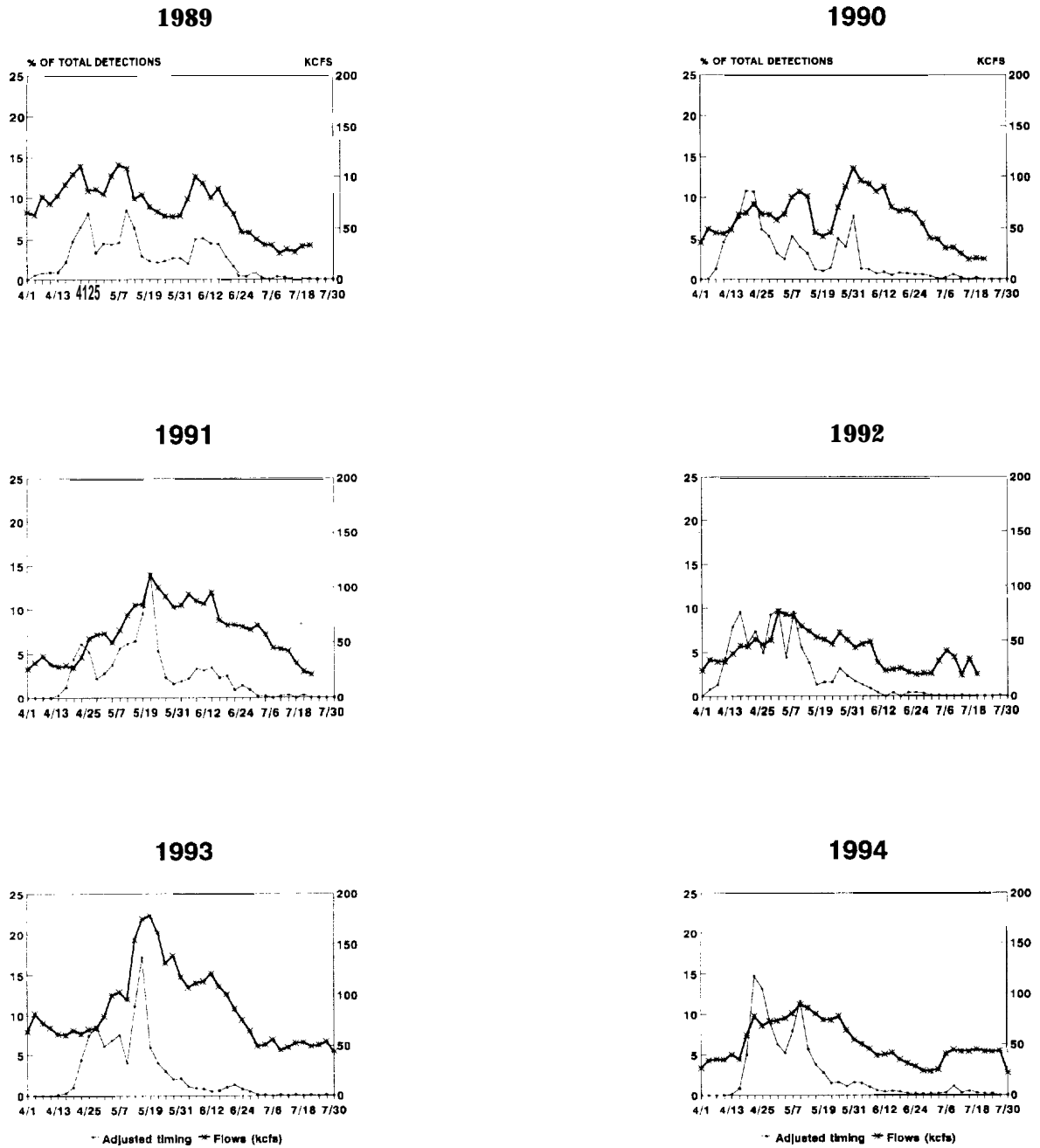
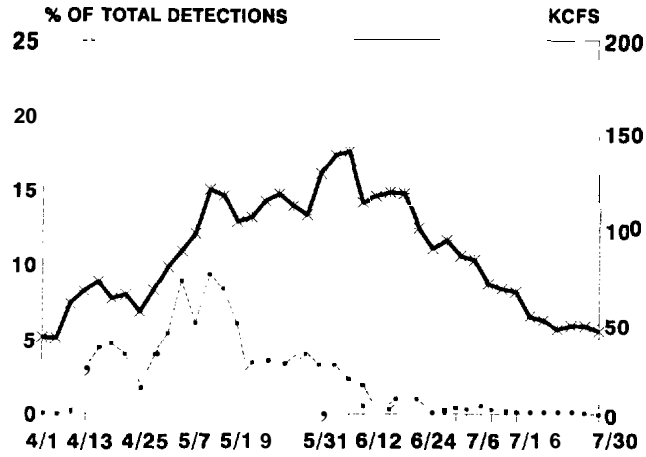


Figure 6. The historical perspective on migration timing (adjusted in spill years) of wild spring/summer chinook salmon smolts at Lower Granite Dam 1989-1996, with associated river flows at the dam. Data represent PIT-tag detections from Idaho and Oregon streams combined by 3-day intervals and average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

1995



1996

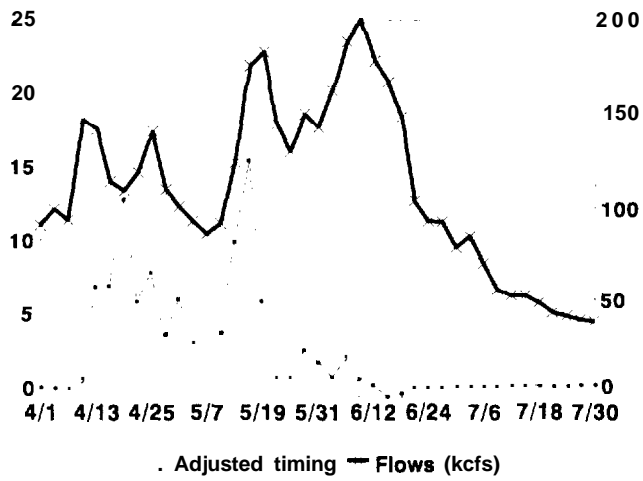


Figure 6. Continued.

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

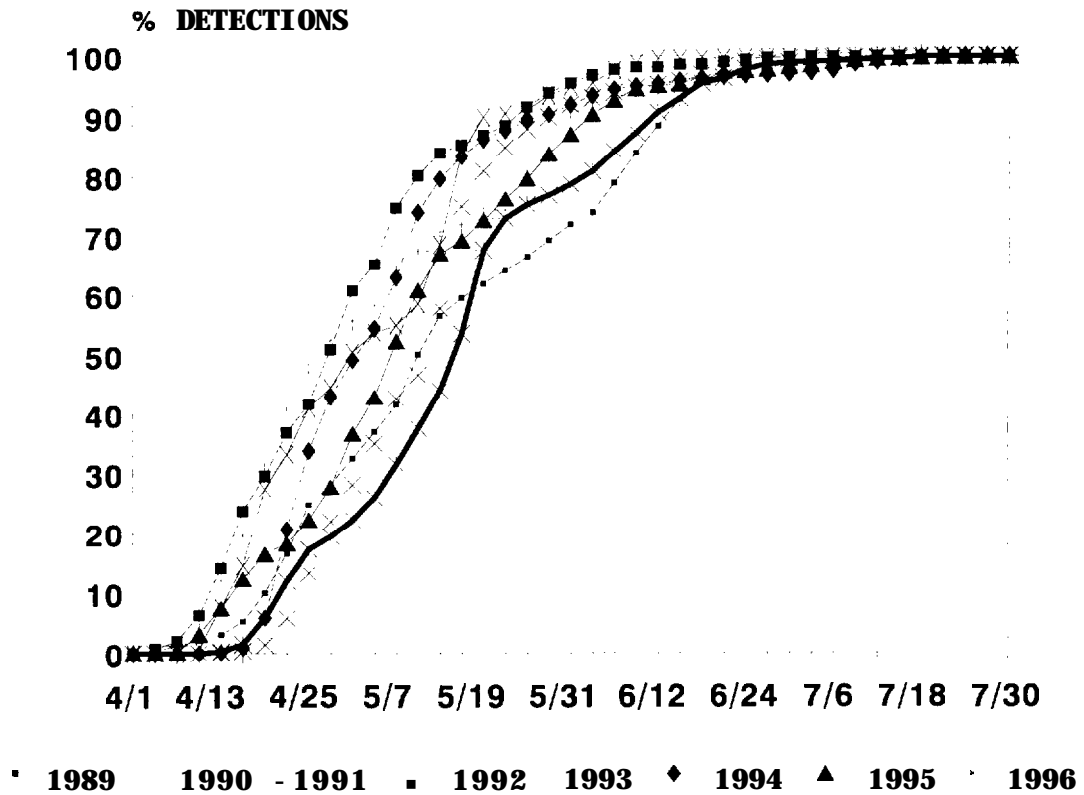


Figure 7. Cumulative percentages of total detections (adjusted for spill) of PIT-tagged wild spring/summer chinook salmon smolts detected at Lower Granite Dam, 1989-1996. Data represent PIT-tag detections from Idaho and Oregon streams combined by 3-day intervals.

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, 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. *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, 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 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, O. W. Johnson, and L. A. Kubin. 1990. Evaluation of transportation of juvenile salmonids and related research on the Snake and Columbia Rivers, 1989. Report to U.S. Army Corp of Engineers, Contract DACW68-84-H0034, 59 p. plus Appendix. (Available from Northwest Fisheries Science Center, 2725 Montlake Blvd. E., Seattle WA 98112-2097.)
- 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) | | Weight (g) | |
|--------------------|-----------------|------------------|---------------|-----------------|-------------|---------|------------|---------|
| | | | | | Range | Average | Range | 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 | (%) |
| 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 date: 22 - 24 Aug 1995

Release site: S. F. Salmon River

Number released: 70 1

Release river kilometer(s) above Lower Granite Dam: 457 - 468

| Detection date | <u>Lower Granite</u> | <u>Little Goose</u> | | <u>Lower Monumental</u> | | |
|----------------|----------------------|---------------------|------------------------------|-------------------------|------------------------------|-------------------------------|
| | 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 | <u>Lower Granite</u> | <u>Little Goose</u> | | <u>Lower Monumental</u> | | |
|----------------|----------------------|---------------------|------------------------------|-------------------------|------------------------------|-------------------------------|
| | 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 | | | First detection | Previous detections | | | | First detection | Previous detections | | | | |
| | | 1 dam | 2 dams | 3 dams | | 1 dam | 2 dams | 3 dams | 4 dams | | 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 date: 28 - 29 Aug 1995

Release site: Secesh River

Number released: 57 1

Release river kilometer(s) above Lower Granite Dam: 430 - 432

| Detection date | <u>Lower Granite</u> | <u>Little Goose</u> | | <u>Lower Monumental</u> | | |
|----------------|----------------------|---------------------|------------------------------|-------------------------|------------------------------|-------------------------------|
| | 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 | <u>Lower Granite</u> | <u>Little Goose</u> | | <u>Lower Monumental</u> | | |
|----------------|----------------------|---------------------|------------------------------|-------------------------|------------------------------|-------------------------------|
| | 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 | <u>Lower Granite</u> | <u>Little Goose</u> | | <u>Lower Monumental</u> | | |
|----------------|----------------------|---------------------|------------------------------|-------------------------|------------------------------|-------------------------------|
| | 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 | | | First detection | Previous detections | | | | First detection | Previous detections | | | | |
| | | 1 dam | 2 dams | 3 dams | | 1 dam | 2 dams | 3 dams | 4 dams | | 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 date: 30 Aug 1995

Release site: Lake Creek

Number released: 13 5

Release river kilometer(s) above Lower Granite Dam: 452

| 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 | <u>Lower Granite</u> | <u>Little Goose</u> | | <u>Lower Monumental</u> | | |
|----------------|----------------------|---------------------|------------------------------|-------------------------|------------------------------|-------------------------------|
| | 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 | | | First detection | Previous detections | | | | First detection | Previous detections | | | | |
| | | 1 dam | 2 dams | 3 dams | | 1 dam | 2 dams | 3 dams | 4 dams | | 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 |
| | SA95241.SE1 | 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 ($^{\circ}\text{C}$) at the dam. Adjusted numbers detected are calculated during spill.

| Date | Average flow (kcfs) | Average spill (kcfs) | Scroll-case water temperature ($^{\circ}\text{C}$) | 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 temperature | water (°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 Ma y | 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 Ma y | 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 temperature | water (°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 temperature (°C) | water (°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 temperature (°C) | water (°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 Ma y | 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 Ma y | 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 temperature (°C) | water 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 temperature (°C) | water (°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 Ma y | 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 |
|---|-----------|---------|----------|----------|---------|----------|--------|--------|--------|--------|--------|--------|
| <u>Station number 13295000--Valley Creek at Stanley, ID</u> | | | | | | | | | | | | |
| 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 |
| <u>Station number 13302500--Salmon River at Salmon, ID</u> | | | | | | | | | | | | |
| 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 |
| <u>Station number 13310700--South Fork Salmon River near Krassel Ranger Station, ID</u> | | | | | | | | | | | | |
| 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 | ---- |
| <u>Station number 13314300--South Fork Salmon River at mouth near Mackey Bar, ID</u> | | | | | | | | | | | | |
| 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 |
| <u>Station number 13317000--Salmon River at White Bird, ID</u> | | | | | | | | | | | | |
| Mean | 4,723 | 5,534 | 6,516 | --- | ---- | 9,039 | 9,103 | 18,820 | 41,680 | 61,080 | 19,430 | 6,899 |
| Min | 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 ($\mu\text{S}/\text{cm}$) 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.

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 | 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 | 11.89 | ----- |

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 |