BONNEVILLE POWER ADMINISTRATION

Emigration of Natural and Hatchery Chinook Salmon and Steelhead Smolts from the Imnaha River, Oregon

Annual Report 2003 - 2004 June 2006 DOE/BP-00004004-4

This Document should be cited as follows:

Michaels, Brian, Neal Espinosa, Rick Orme, "Emigration of Natural and Hatchery Chinook Salmon and Steelhead Smolts from the Imnaha River, Oregon", 2003-2004 Annual Report, Project No. 199701501, 87 electronic pages, (BPA Report DOE/BP-00004004-4)

Bonneville Power Administration
P.O. Box 3621
Portland, OR 97208

This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views in this report are the author's and do not necessarily represent the views of BPA.

Emigration of Natural and Hatchery Chinook Salmon and Steelhead Smolts from the Imnaha River, Oregon from October 1, 2003 to June 27, 2004

2004 Annual Report

Prepared by:
Brian Michaels
Neal Espinosa
Rick Orme

Nez Perce Tribe
Department of Fisheries Resources Management
Lapwai, Idaho 83540

Prepared for:

U.S. Department of Energy
Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208

and

U.S. Fish and Wildlife Service
Lower Snake River Compensation Plan
1387 Vinnell Way
Boise, Idaho 83709
Cooperative Agreement for FY 2004: 14110-3-J010

BPA Project Number: 1997-015-01
BPA 2004 Contract Number: 00004004

June 2006

EXECUTIVE SUMMARY

This report summarizes the Nez Perce Tribe's Imnaha River juvenile Chinook salmon and steelhead emigration studies conducted from October 1, 2003 to June 27, 2004 (migration year 2004). The studies have been ongoing for the past 13 years and have contributed information to the Fish Passage Center's Smolt Monitoring Program for the past 11 years. The study collected and tagged fish in the Imnaha River at rkm 7 during the fall and spring. Tagged fish were detected downstream as they passed through Snake and Columbia River dams. The project evaluated the survival, biological characteristics, and migration performance of natural and hatchery spring/summer Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*) at Lower Granite Dam (LGR), Little Goose Dam (LGO), Lower Monumental Dam (LMO), and McNary Dam (MCN).

Imnaha River Chinook salmon and steelhead smolts migrating in the spring had lower than average hydrologic conditions in the Imnaha River. Average monthly discharge from March to June ranged from 444 cfs (March) to 1,069 cfs (June). Snake River run-off was lower than average based on the forty-six year record. The average monthly discharge in the Snake River ranged from 29,620 cfs in April to 48,560 cfs in May. Spill at LGR, LGO, LMO, and MCN began from April 1 to April 24 and lasted until July 1. Maximum water temperatures in the tailraces of LGR, LGO, LMO, and MCN exceeded 18 °C after June 27.

A total of 16,439 natural origin Chinook salmon, 54,358 hatchery origin Chinook salmon, 8,416 natural origin steelhead, and 28,180 hatchery origin steelhead were captured in 2004. The studies PIT tagged a total of 13,426 natural Chinook salmon, 2 hatchery Chinook salmon, 5,660 natural steelhead, and 4,489 hatchery steelhead. The catch of hatchery Chinook salmon included 1,747 previously PIT tagged fish. Hatchery Chinook salmon had a mean fork length (118 mm) that was significantly different ($p < 0.05$) than the mean fork length of natural Chinook salmon (95 mm). Previously PIT tagged hatchery steelhead had a mean fork length (203 mm) that was significantly larger ($p < 0.05$) than the mean fork length of natural produced steelhead (169.2 mm).

The estimated post release survival of PIT tagged hatchery Chinook salmon from release at the acclimation site to the Imnaha River Trap was 82.9% ±2.6% (95% C.I.) in 2004. The post-release survival estimate was slightly below previous estimates from 1994 to 2004, of 88.4% to 100%. The survival estimate of natural Chinook salmon tagged in the fall was 27.7% to LGR. Past survival estimates from the trap to LGR for fall tagged Imnaha River natural Chinook salmon have ranged from 25.6% to 60.4% from 1994 to 2004.

Imnaha River smolts estimated survivals from release at the Imnaha trap to LGR in 2004 were 73.4% for natural Chinook salmon, 74.0% for hatchery Chinook salmon, 79.0% for natural steelhead, and 86.0% for hatchery steelhead. The estimated survival from the Imnaha trap to LMO was 53.0% for natural Chinook salmon, 54.2% for hatchery Chinook salmon, 62.0% for both natural and hatchery steelhead.

A smolt-to-adult return rate (SAR) index from LGR to LGR was calculated for migrating fall and spring tagged natural Chinook salmon for brood years 1996 to 1999 (migration years 1998 to 2001). These SARs characterize Imnaha natural Chinook that were mostly bypassed when detected at the dams and traveled in-river (i.e. not barged). The LGR to LGR SAR index for fall tagged natural Chinook salmon are as follows: 3.08% (BY 1996), 2.41% (BY 1997), 2.98% (BY 1998), and 0.60% (BY 1999). Smolt-to-adult return rate index for spring tagged natural Chinook salmon was lower: 1.75% (BY 1996), 2.24% (BY 1997), 2.94% (BY 1998), and 0.27% (BY 1999).

Significant difference ($p < 0.05$) in the median arrival timing of fall and spring PIT tagged natural Chinook salmon was observed at LGR. Median arrival timing of fall tagged natural Chinook salmon at LGR occurred on April 14: 17 days earlier than the median arrival timing for spring tagged natural Chinook salmon smolts. A total of seven years of arrival data for fall tagged natural Chinook salmon, 12 and 13 and years of arrival data for spring tagged natural and hatchery Chinook salmon, and 13 years of arrival data for natural and hatchery steelhead at LGR, LGO, LMO, and MCN was summarized for this report. The estimated median arrival time at LGR is as follows: April 17 (± 9 days) for fall tagged natural Chinook salmon (1998 to 2004), April 28 (± 8 days) for spring tagged natural Chinook salmon smolts (1993 to 2004), May 4 (± 7 days) for hatchery Chinook salmon, May 10 (± 13 days) for natural steelhead (1993 to 2004) and May 21 (±12 days) for hatchery steelhead (1993 to 2004).

TABLE OF CONTENTS

EXECUTIVE SUMMARY ..... **ii**
TABLE OF CONTENTS ..... **iv**
LIST OF TABLES ..... **vi**
LIST OF FIGURES ..... **viii**
LIST OF APPENDICIES ..... **x**
INTRODUCTION **12**
METHODS **14**
Study Area Description 14
Equipment Description 14
Trap Operations 15
PIT Tagging 17
Trap Efficiencies 17
Biological Characteristics 17
Survival Estimation 18
Spring Emigration Index 18
Smolt to Adult Return Rates (SARs) 19
Arrival and Travel Timing to Trap Site and Lower Snake River Dams 19
RESULTS AND DISCUSSION **20**
River Discharge and Water Temperature 20
Imnaha River 20
Snake River 21
Hatchery Releases 26
Chinook Salmon 26
Steelhead 26
Juvenile Chinook Salmon and Steelhead Catch 27
Catch for Migration Year 2004 27
PIT Tagging 29
Recaptures of Previously PIT Tagged Smolts 31
Biological Characteristics 33
Annual Biological Characteristics 33
Survival of PIT Tagged Smolts 37
Natural Chinook Salmon and Steelhead Abundance 37
Post Release Survival of Hatchery Chinook 38
Estimated Season Wide Smolt Survival from the Imnaha Trap 38
Estimated Weekly Smolt Survival 42
Smolt to Adult Return Rates 44
Arrival Timing at Dams 45
Natural and Hatchery Chinook Salmon Arrival Timing for 2004 45
Natural and Hatchery Steelhead Arrival Timing for 2004 46
Historic Average Arrival Timing 47
Travel Time to Lower Granite Dam 49
Mortality 50
Chinook Salmon and Steelhead Mortality 50

Incidental Catch 51
Incidental Catch for Migration Year 2004 51
ACKNOWLEDGMENTS 52
LITERATURE CITED 53
APPENDICES 56

LIST OF TABLES

Table 1. Releases of hatchery reared Chinook salmon and steelhead smolts in the Imnaha River Subbasin during migration year 2004 (Eddy 2004 personal communication, July 28, 2004). 27

Table 2. The weekly mean discharge (cfs), temperature (C), and catch of natural and hatchery Chinook salmon and steelhead at the Imnaha River trap from October 5, 2003 to June 27, 2004. 28

Table 3. The number of natural and hatchery Chinook salmon and steelhead PIT tagged weekly at the Imnaha River trap from October 5, 2003 to June 27, 2004. 30

Table 4. Averages, ranges, and standard deviations of fork lengths (mm), weights (g), and condition factors (K) with minimum, maximum, and sample size values for recaptures of previously PIT tagged natural and hatchery Chinook salmon, and hatchery steelhead observed at the Imnaha River trap from March 27, 2004 to June 4, 2004. 32

Table 5. Averages, ranges, and standard deviations of fork lengths (mm), weights (g), and condition factors (K) with minimum, maximum, and sample size values for natural and hatchery Chinook salmon and steelhead captured during the 2004 migration year, October 13, 2003 to June 27, 2004 at the Imnaha River trap. 35

Table 6. Weekly mean fork lengths (FL) and condition factors (K) for natural and hatchery Chinook salmon and steelhead captured at the Imnaha River trap during the spring of 2004. 37

Table 7. Estimated survival probabilities for season-wide PIT tag release groups of natural and hatchery Chinook salmon and steelhead smolts released from the Imnaha River trap from February 25 to June 27, 2004. Estimates are from release at the trap to Lower Granite Dam and tail race to tail race for all other sites. Abbreviations: LGR -Lower Granite Dam, LGO - Little Goose Dam, LMO - Lower Monumental Dam. 40

Table 8. Season-wide estimates of survival from the Imnaha River trap to Lower Granite Dam from 1993 to 2004. Ninety-five percent confidence intervals are shown in parentheses. 41

Table 9. Season-wide estimates of survival from the Imnaha River trap to Lower 41

Table 10. Season-wide estimates of survival from the Imnaha River trap to McNary Dam from 1998 to 2004. Ninety-five percent confidence intervals are shown in parentheses. 42

Table 11. Estimated survival probabilities for weekly PIT tag release groups of 300 or more natural and hatchery Chinook salmon and steelhead smolts released from the lower Imnaha River trap from February 25 to June 27, with 95% confidence intervals in parentheses. Estimates are from release at the trap to Lower Granite Dam and tailrace to tailrace for all other sites. Abbreviations: LGR - Lower Granite Dam, LGO - Little Goose Dam, LMO - Lower Monumental Dam. 43

Table 12. Detections of PIT tagged Imnaha River adult Chinook salmon and smolt to adult return rate indices (SAR) of in-river migrating fish from the lower Imnaha River trap to Lower Granite (LGR) and from LGR to LGR for brood years 1996 to 1999. 45

Table 13. Historical mean first, median, 90%, and last arrival timing for fall and spring tagged natural chinook salmon juveniles, hatchery chinook salmon smolts, and natural and hatchery steelhead smolts, at Lower Granite Dam (LGR), Little Goose Dam (LGO), Lower Monumental Dam (LMO) and McNary Dam (MCN). All fish were captured in the Imnaha River trap. Mean arrival timing is presented with the 95% C.I. (± days). 48

Table 14. A summary of median travel times of natural and hatchery Chinook salmon smolts released from the Imnaha River screw trap, March 8 to June 21, 2004, at Lower Granite Dam. 50

LIST OF FIGURES

Figure 1. Map of the Imnaha River study area. 15

Figure 2. Map of the Columbia River Basin. Dams underlined indicate monitoring points for the Imnaha Smolt Monitoring Program. 16

Figure 3. The Imnaha River trap site with a rotary screw trap operating. 16

Figure 4. The average daily discharge at the Imnaha River USGS gauge 13292000 and the average daily temperature from October 1, 2003 to June 30, 2004 at the Imnaha River trap USGS discharge data is provisional. 20

Figure 5. The average monthly discharge for the months of March, April, May, and June for 2004, at the Imnaha River USGS gauge 13292000. Bars indicate the minimum and maximum average monthly discharge values observed from 1929 to 2004. USGS discharge data is provisional. 21

Figure 6. The average daily discharge and temperature at the Snake River gauge 13334300 from October 1, 2003 to June 30, 2004. USGS discharge data is provisional. 22

Figure 7. The average monthly discharge for the months of March, April, May, and June for 2004 at the Snake River USGS gauge 13334300. Bars indicate the minimum and maximum average monthly discharge values observed from 1959 to 2004. USGS discharge data is provisional. 23

Figure 8. Measurements of outflow, spill, and mean temperature at Lower Granite Dam from February 1 to August 29, 2004. Data was obtained online at http://www.cbr.washington.edu/dart/. 24

Figure 9. Measurements of outflow, spill, and mean temperature at Little Goose Dam from February 1 to August 29, 2004. Data was obtained online at http://www.cbr.washington.edu/dart/. 24

Figure 10. Measurements of outflow, spill, and mean temperature at Lower Monumental Dam from February 1 to August 29, 2004. Data was obtained online at http://www.cbr.washington.edu/dart/. 25

Figure 11. Measurements of outflow, spill, and mean temperature at McNary Dam from February 1 to August 29, 2004. Data was obtained online at http://www.cbr.washington.edu/dart/. 25

Figure 12. The arrival frequency of previously PIT tagged hatchery Chinook salmon captured in the Imnaha River trap during the spring of 1998 to the spring of 2004. The release strategy in

1998 was an acclimated forced release and the remainder of the releases were acclimated volitional releases. 33

Figure 13. Length frequency distribution of natural Chinook salmon pre-smolts trapped in the Imnaha River trap during the fall of 2003. 34

Figure 14. Length frequency distribution of natural and hatchery Chinook salmon trapped in the Imnaha River trap, February 25 to June 27, 2004. 36

Figure 15. Length frequency distribution of natural and hatchery steelhead trapped in the Imnaha River trap, February 25 to June 27, 2004. 36

Figure 16. Estimated post release survival of hatchery Chinook salmon from the Imnaha River acclimation facility at Gumboot to the Imnaha River trap from 1994 to 2004. The error bars indicate the 95% C.I. 38

Figure 17. Estimated survival from the Imnaha River trap to Lower Granite Dam of natural Chinook salmon tagged in the fall, for migration years 1994 to 2004. Error bars indicate the 95% C.I. 39

Figure 18. The cumulative arrival timing of fall and spring tagged natural Chinook salmon and tailrace spill at Lower Granite Dam during the 2004 migration year. Fall and spring tagged natural Chinook salmon were released in the fall of 2003 and the spring of 2004. 46

LIST OF APPENDICIES

Appendix A. The mean daily discharge (cfs) and temperature (°C) for the Imnaha and Snake Rivers from October 1, 2003 to June 30, 2004. Discharge data for USGS gauges 13292000 and 13334300 were obtained online from USGS websites. 56

Appendix B. Mean monthly discharge for the Imnaha River from 1929 to 2004, and the Snake River from1959 to 2004. Discharge data for USGS gauges 132292000 and 13334300 were obtained online from USGS web sites. 63

Appendix C. The number of hours sampled and the catch of natural Chinook salmon and steelhead at the Imnaha River trap from October 1, 2003 to June 27, 2004. Sampling periods exceeded 24 hours when trapping continued past the hour the trap was started from the previous day (e.g. 8:30 am on October 17 to 11:00 am on October 18). 65

Appendix D. The number of Chinook salmon and steelhead PIT tagged at the Imnaha River trap from October 14, 2003 to June 27, 2004. N/A indicates the trap was not operated on that date. 69

Appendix E. Previously PIT tagged natural Chinook salmon recaptured in the Imnaha River trap during the fall of 2003 and spring 2004. 73

Appendix F. Statistical comparisons of median fork lengths between groups of smolts captured in the Imnaha River smolt trap during the spring of migration year 2004. 73

Appendix G. Gauss population estimates by group for natural Chinook salmon captured in the Imnaha River trap during the spring 2004. 74

Appendix H. Gauss population estimates by group for natural steelhead captured in the Imnaha River trap during the spring 2004. 74

Appendix I. A statistical comparison of median arrival date at LGR between natural Chinook salmon pre-smolts released in the fall of 2003 and smolts released in the spring of 2004 from the Imnaha River trap during migration year 2004. 74

Appendix J. Arrival timing of fall PIT tagged Imnaha River natural Chinook salmon smolts to Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1998 to 2004. 75

Appendix K. Arrival timing of spring PIT tagged Imnaha River natural Chinook salmon smolts at Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1993 to 2004. 76

Appendix L. Arrival timing of PIT tagged Imnaha River hatchery Chinook salmon smolts at Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1992 to 2004. 78

Appendix M. Arrival timing of spring PIT tagged Imnaha River natural steelhead smolts at Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1993 to 2004. 80

Appendix N. Arrival timing of ODFW spring PIT tagged Imnaha River hatchery steelhead smolts at Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1993 to 2004..... 82

Appendix O. Mortality of Chinook salmon and steelhead smolts due to trapping, handling, PIT tagging and Dead on Arrival at the Imnaha River trap from October 14 to December 3, 2003... 83

Appendix P. Mortality of Chinook salmon and steelhead smolts due to trapping, handling, PIT tagging and Dead on Arrival at the Imnaha River trap from February 26 to June 27, 2004. 84

Appendix Q. The catch of incidental fish during the fall, October 14 to December 3, 2003, and the spring, February 26 to June 27, 2004 at the Imnaha River juvenile fish trap. 85

INTRODUCTION

This report summarizes the Nez Perce Tribe (NPT) results for the Lower Snake River Compensation Plan (LSRCP) hatchery evaluation studies and the Imnaha River Smolt Monitoring Program (SMP) for the 2004 smolt migration from the Imnaha River, Oregon. These studies are closely coordinated and provide information about juvenile natural and hatchery spring/summer Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*) biological characteristics, emigrant timing, survival, arrival timing and travel time to the Snake River dams and McNary Dam (MCN) on the Columbia River. These studies provide information on listed Chinook salmon and steelhead for the Federal Columbia River Power System (FCRPS) Biological Opinion (NMFS 2000).

The Lower Snake River Compensation Plan program's goal is to maintain a hatchery production program of 490,000 Chinook salmon and 330,000 steelhead for annual release in the Imnaha River (Carmichael et al. 1998, Whitesel et al. 1998). These hatchery releases occur to compensate for fish losses due to the construction and operation of the four lower Snake River hydroelectric facilities. One of the aspects of the LSRCP hatchery evaluation studies in the Imnaha River was to determine natural and hatchery Chinook salmon and steelhead smolt performance, emigration characteristics and survival (Kucera and Blenden 1998). A long term monitoring effort was established to document smolt emigrant timing and post release survival within the Imnaha River, estimate smolt survival downstream to McNary Dam, compare natural and hatchery smolt performance, and collect smolt-to-adult return information.

This project collects information for, and is part of, a larger effort entitled Smolt Monitoring by Federal and Non-Federal Agencies (BPA Project No. 198712700). This larger project provides data on movement of smolts out of major drainages and past dams on the Snake River and Columbia River. Inseason indices of migration strength and migration timing are provided for the run-at large at key monitoring sites. Marked smolts are utilized to measure travel time and estimate survival through key index reaches. Fish quality and descaling measures are taken at each monitoring site and provide indicators of the health of the run.

Co-managers in the Imnaha River subbasin (Ecovista 2004) have identified the need to collect information on life history and movement patterns of juvenile steelhead migration patterns for both steelhead and Chinook salmon, juvenile emigrant abundance, reach specific smolt survivals, and Smolt-to-Adult Return rates (SAR's). The current study provides information related to the majority of the high priority data needs. Current funding does not allow for determination of juvenile emigrant abundance and installation of adult passive integrated transponder (PIT) tag detectors at the mouth of the Imnaha River to calculate tributary specific SAR's.

Information is shared with the Fish Passage Center (FPC) on a real time basis during the spring emigration period. The Bonneville Power Administration (BPA) and the United States Fish and Wildlife Service (USFWS) contracted the Nez Perce Tribe (NPT) to monitor emigration

timing and tag up to 21,200 emigrating natural and hatchery Chinook salmon and steelhead smolts from the Imnaha River with passive integrated transponder (PIT) tags.

The completion of trapping in the spring of 2004 marked the thirteenth year of emigration studies on the Imnaha River, and the eleventh year of participating in the FPC smolt monitoring program. Monitoring and evaluation objectives were to:

1. Determine spring emigration timing of Chinook salmon and steelhead smolts collected at the Imnaha River trap.

2. Evaluate effects of flow, temperature and other environmental factors on emigration timing.

3. Monitor the daily catch and biological characteristics of juvenile Chinook salmon and steelhead smolts collected at the Imnaha River screw trap.

4. Determine emigration timing, travel time, and in-river survival of PIT tagged hatchery Chinook salmon smolts released at the Imnaha River acclimation facility to the Imnaha River Trap.

5. Determine arrival timing, travel time and estimated survival of PIT tagged natural and hatchery Chinook salmon and natural and hatchery steelhead smolts from the Imnaha River to Snake and Columbia River dams.

6. Compare emigration characteristics and survival rates of fall and spring tagged juvenile Chinook salmon.

METHODS

Study Area Description

The Imnaha River subbasin is located in northeastern Oregon (Figure 1) and encompasses an area of approximately 2,538 square kilometers. The mainstem Imnaha River flows in a northerly direction for 129 km from its headwaters in the Eagle Cap Wilderness Area to its confluence with the Snake River (James 1984; Kucera 1989). The Snake River is 1,607 km long and is the longest tributary to the Columbia River. The Columbia River is the largest river system in the Pacific Northwest, 1,953 km in length, and drains an area of 667,931 square kilometers from the Cascade Mountains to the west, Rocky Mountains to the east, and the Great Basin to the south (Anonymous 2003a). The source of the Columbia River is north of Oregon in Canada and is at an elevation of 809 m. The Columbia River runs south of the Canadian border and turns west at the confluence of the Snake River (Figure 2). Annual average discharge at the mouth is approximately 275,000 cfs (7,787 cms; 1 cfs = 0.283168 cms).

Reservoirs encountered by migrating Imnaha River Chinook salmon and steelhead smolts are formed by Lower Granite Dam (LGR), Little Goose Dam (LGO), Lower Monumental Dam (LMO), Ice Harbor Dam (IHR), McNary Dam (MCN), John Day Dam (JDA), The Dalles Dam (TDA), and Bonneville Dam (BON). Juvenile emigration monitoring described in this report occurs at LGR, LGO, LMO, and MCN. Juvenile emigration at Ice Harbor Dam is not monitored because it lacks the necessary facilities. The four lower Snake River dams became operational between 1961 and 1975. MCN became operational in 1953 (Anonymous 2003b).

The Imnaha River drains the eastern escarpment of the Wallowa Mountains and part of an adjacent plateau located between the Wallowa River drainage to the west and Hells Canyon of the Snake River to the east (Kucera 1989). Elevations in the watershed vary from 3,048 m at the headwaters to about 260 m in lower elevations (Kucera 1989).

The 75-year (1929 - 2004) mean annual discharge of the Imnaha River is 511 cfs at Imnaha, Oregon, USGS gauge 13292000 (http://waterdata.usgs.gov/or/nwis/uv/?site_no=13292000). The minimum discharge, 16 cfs was observed November 22, 1931. The maximum river discharge, 20,200 cfs was observed January 1, 1997 (Anonymous 2000c). Maximum river discharge generally occurs from April to June with minimum flows from August to February (Kucera 1989).

Equipment Description

Floating rotary screw traps manufactured by E.G. Solutions Inc., Corvallis, Oregon, were used to capture emigrating salmonids (Figure 3). Similar traps have been used to capture migrating salmonid species in New York and Alaska (Kennen et al. 1994; Thedinga et al. 1994). The screw trap used in the spring and fall consists of a 2.1 m diameter-trapping cone supported by a metal A-frame and two six-meter pontoons that provided flotation. Fish entering the

trapping cone moves through to a live box (1.68 m wide x 1.25 m long x 0.55 m deep). The live box was fitted with a removable baffle to dissipate water velocity during high flows.

Water temperature information for this study was collected using a thermograph placed 150 m upstream from the screw trap. Imnaha River discharge information was provided by the U.S. Geological Survey, USGS gauge 13292000 at Imnaha, Oregon. Snake River water discharge and temperature information were provided by the USGS for the Anatone stream gauge, 13334300. Measurements of outflow, spill, and temperature at LGR, LGO, LMO, and MCN were obtained online from DART at http://www.cbr.washington.edu/dart/.

Trap Operations

The trap was operated from October 13 to December 3, 2003 and from February 25 to June 27, 2004. The trap was located 7 km from the confluence of the Snake River. Trap position varied from one to four meters upstream or downstream adjusted with the use of a cable and pulley system. The position was recorded daily. The live box of the screw trap was checked at 0800 every morning and several times throughout each night and day. Non-target piscivorous fish and large numbers of other non-target fish were removed from the live box first. Non-target piscivorous fish were scanned for PIT tags and then released 30-50 m downstream. Fish were processed as they were removed from the trap.

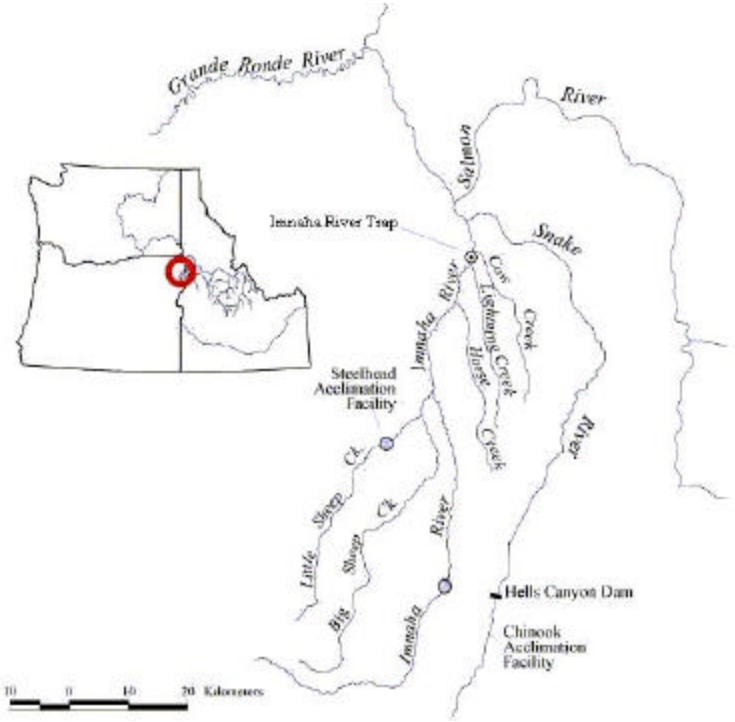

Figure 1. Map of the Imnaha River study area.

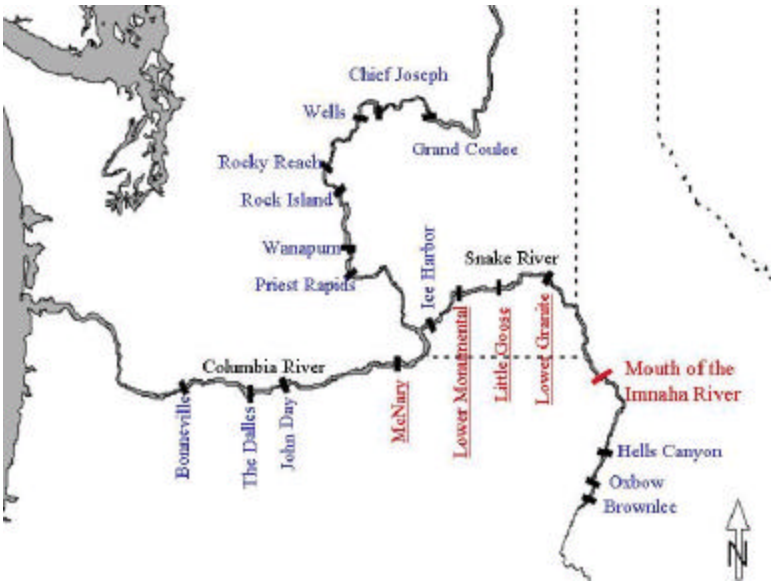

Figure 2. Map of the Columbia River Basin. Dams underlined indicate monitoring points for the Imnaha Smolt Monitoring Program.

Figure 3. The Imnaha River trap site with a rotary screw trap operating.

Daily processing procedures were similar to those used by Ashe et al. (1995) and were as follows: 1) fish were anaesthetized in a MS-222 bath (6 ml MS-222 stock solution (100 g/L) per 19 L of water) buffered with Propolyaqua (PRO-NOVAQUA), 2) each fish was examined for

existing marks (e.g. fin clips), and PIT tag insertion scars, 3) Chinook salmon, steelhead and large piscivorous fish were scanned with a PIT tag scanner, 4) fifty natural Chinook salmon and natural steelhead smolts were targeted for use in daily trap efficiency trials, 5) a specified number of each species was selected for PIT tag insertion, 6) all other fish were enumerated and released 30-50 m downstream from the trap after recovering from the anesthetic, and 7) all fish mortality was recorded.

PIT Tagging

Fish selected for PIT tagging were examined for previous PIT tags, descaling and general health. All PIT tagged fish were measured for fork length and weighed. All Chinook salmon selected for tagging were greater than 60 mm. Fish were PIT tagged using hand injector units following the methods described by Prentice et al. (1986, 1990) and Matthews et al. (1990, 1992). Hypodermic injector units and PIT tags were sterilized after each use in ethanol for at least 10 minutes prior to tagging and allowed to dry. Tagging was discontinued when water temperatures exceeded 15° C. Steelhead smolts were held until fully recovered and then released as a group. Chinook salmon smolts were held in perforated aquatic containers and released after dark. Mortality due to tagging was recorded.

Trap Efficiencies

Daily trap efficiency trials using natural Chinook salmon and natural steelhead smolts were conducted during the spring. The daily goal was to tag up to fifty natural Chinook and steelhead. The fork length of all marked fish were measured to the nearest mm and weighed to the nearest 0.1 g. Fish selected for trap efficiency trials in 2004 were marked with PIT tags. Fish marked for trap efficiency trials were held in perforated containers in the river during daytime hours (up to 12 h) and then transported upstream, approximately one km, during evening hours and released after dark.

Daily trap efficiency trials for natural Chinook salmon and natural steelhead were grouped into weekly periods consisting of at least seven marked recaptures under similar flow conditions from mid-March to June 27. Weeks with less than seven recaptures were grouped with either the preceding week or the following week depending on flow conditions. Trap efficiency was determined by $E = R/M$; where E is estimated trap efficiency, R is number of marked fish recaptured, and M is number of fish marked and released. The reported 95% confidence intervals are based on a bootstrap calculation within the Gauss program.

Biological Characteristics

Length frequency distributions and condition factors were calculated for each fish species and origin. Length frequencies were based on 5 mm classes. Condition factors were calculated using Fulton's condition factor: $(W/L^3) \times 10^5$ (Bagenal and Tesch 1978). Natural steelhead less than 120 mm were assumed not to be actively migrating and therefore were not used in length, weight and condition factor calculations and were reported to the FPC as rainbow trout. Adult

steelhead and large steelhead that had the characteristics of resident rainbow trout were not reported as juvenile steelhead or used in length, weight, and condition factor calculations.

All statistics that compared fish captured and tagged during the spring were performed with STATISTIX7 developed by Analytical Software (2000). A student t-test was used to test for significant differences in mean fork length between various groups of fish. Differences were considered significant at $p < 0.05$. Median fork lengths were compared when standard skewness values were outside the range of ±2 with the Wilcoxon rank sum test statistic (Ott 1984). Differences were considered significant at $p < 0.05$.

Survival Estimation

Survival probabilities were estimated by the Cormack, Jolly and Seber methodology (1964, and 1965, respectively, as cited in Smith et al. 1994) with the Survival Using Proportional Hazards (SURPH) model (Smith et. al. 1994). The data files for season wide and weekly release groups were created using the program PITPRO version 3.3a (Westhagen and Skalski, 2006). Data for PITPRO and SURPH was obtained directly from Pit Tag Information System (PTAGIS). The lower and upper limits of the 95% confidence intervals (C.I.) were approximated from the standard error (SE) calculated by SURPH as follows: 95% C.I. = S ± (1.96(SE)).

Survival estimates from the trap to downstream dams were calculated for hatchery and natural steelhead and Chinook. Season-wide and weekly release groups of natural and hatchery Chinook salmon and steelhead were treated as single release groups. Only weekly release groups of 200 or more fish were analyzed for survival on a weekly basis. The assumptions for the methodology can be found in Smith et al. (1994) and Burnham et al. (1987). When tagging Chinook salmon in the fall, we assumed that fish did not migrate past LGR before PIT tag interrogation facilities became operational.

Spring Emigration Index

Spring emigration index of juvenile abundance for natural Chinook salmon and steelhead smolts migrating past the trap were estimated using the Gauss program (Aptech Systemsn Inc., Maple Valley, Washington) with a Baily trap efficiency estimation method (Steinhorst et al. 2004). The Bailey estimate is a version of the Lincoln-Peterson method and is used to develop the point estimate. The Gauss program utilizes a bootstrap method with 1000 iterations to calculate the confidence intervals and utilizes stratified data when appropriate. This does not represent a total juvenile production estimate from the Imnaha River, as trapping periods are limited. This estimate is a minimum estimate based on trap efficiency trials in the spring of 2004. To maintain robustness for analysis, we set a lower limit of seven mark recaptures for any period (Steinhorst et al. 2004). If a trap period did not contain a sufficient number of recaptures, that period was included with the previous or subsequent period depending on stream and trap conditions.

Smolt to Adult Return Rates (SARs)

SARs were calculated for fall and spring tagged natural Chinook salmon from the Imnaha River trap back to LGR using the ratio of number of PIT tagged fish released to the number of PIT tag adults detected at LGR. A LGR to LGR SAR was estimated using Imnaha River smolt equivalents at LGR. Smolt equivalents to LGR were determined by multiplying the number of fish tagged at the trap by the estimated survival to LGR. SARs characterize bypassed fish only and not the population as a whole.

Arrival and Travel Timing to Trap Site and Lower Snake River Dams

Arrival timing to LGR, LGO, LMO, and MCN were determined for natural and hatchery Chinook salmon and steelhead smolts. Detections and arrival timing at each dam for this report period are based on first-time observations of individual tag codes at each dam. Arrival timing estimates do not include subsequent detections of fish that were captured in the Snake River trap, held in sample rooms or raceways, or had negative travel times. The cumulative distributions of arrival times between fall and spring tagged juvenile natural Chinook salmon were compared using a Kolmogrovov-Smirnov test (Steel et al. 1997 and STATAGRAPHICS 1995).

Travel time is the time it takes an individual tagged fish to travel from either the acclimation facilities or the Imnaha trap to juvenile detectors at specific dams. Weeks with at least 30 PIT tag interrogations at LGR were pooled to determine travel time to LGR. Travel time estimates to LGR do not include fish captured in the Snake River trap. A Wilcoxon rank sum test statistic (Ott 1984) was then used to compare medians of each group.

RESULTS AND DISCUSSION

River Discharge and Water Temperature

Imnaha River

The mean daily discharge during the study period ranged from 90 cfs on November 6, 2003 to 1,890 cfs (1 cfs = 0.283168 cms) on May 28, 2004 (Figure 4 and Appendix A). Daily mean water temperatures ranged from 0.2 °C on November 6, 2003 to 18.3 °C on June 27, 2004.

Monthly average discharge for the Imnaha River for the months of March, April, May, and June were, 604, 1,050, 1,510, and 1,467 cfs respectively (Figure 5 and Appendix B). The spring run off for the Imnaha River was normal and within the range of monthly average discharge values observed from 1929 to 2004.

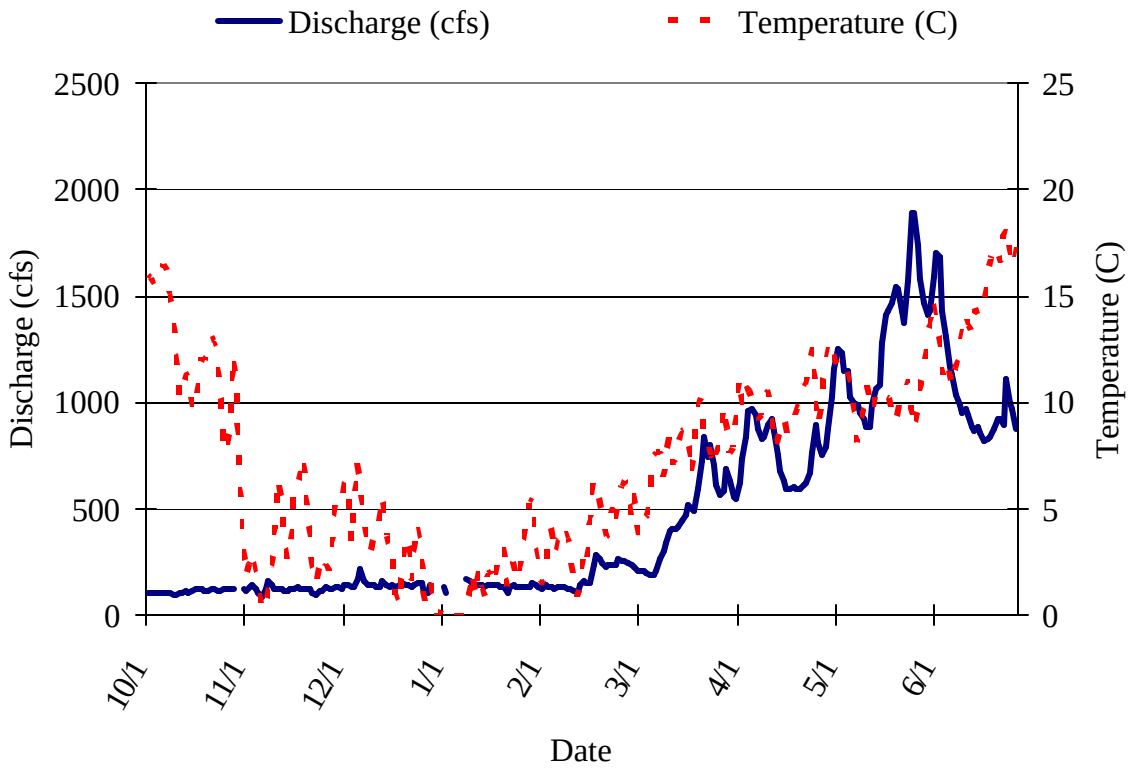

Figure 4. The average daily discharge at the Imnaha River USGS gauge 13292000 and the average daily temperature from October 1, 2003 to June 30, 2004 at the Imnaha River trap USGS discharge data is provisional.

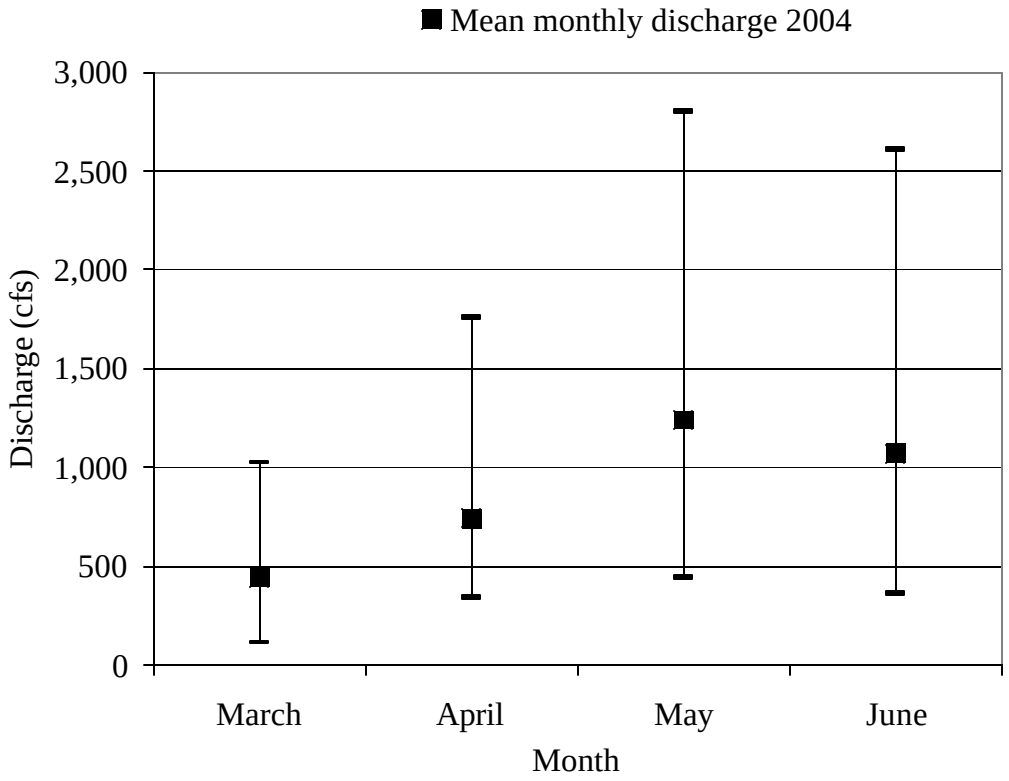

Figure 5. The average monthly discharge for the months of March, April, May, and June for 2004, at the Imnaha River USGS gauge 13292000. Bars indicate the minimum and maximum average monthly discharge values observed from 1929 to 2004. USGS discharge data is provisional.

Snake River

Snake River mean daily discharge during the study period ranged from 12,000 cfs on November 8, 2003 to 71,300 cfs on May 30, 2004 (Figure 6, and Appendix A). Daily mean water temperatures ranged from 4.2 °C on February 25, and March 4, 2004 to 19.6 °C on June 27, 2004.

Monthly average discharge for March, April, May, and June were as follows: 31,140 cfs, 29,620 cfs, 48,560 cfs, and 45,470 cfs (Figure 7 and Appendix B). The months of March and April were characterized as below normal discharge for the Snake River by this study. May and June are characterized as low to normal discharge for the Snake River.

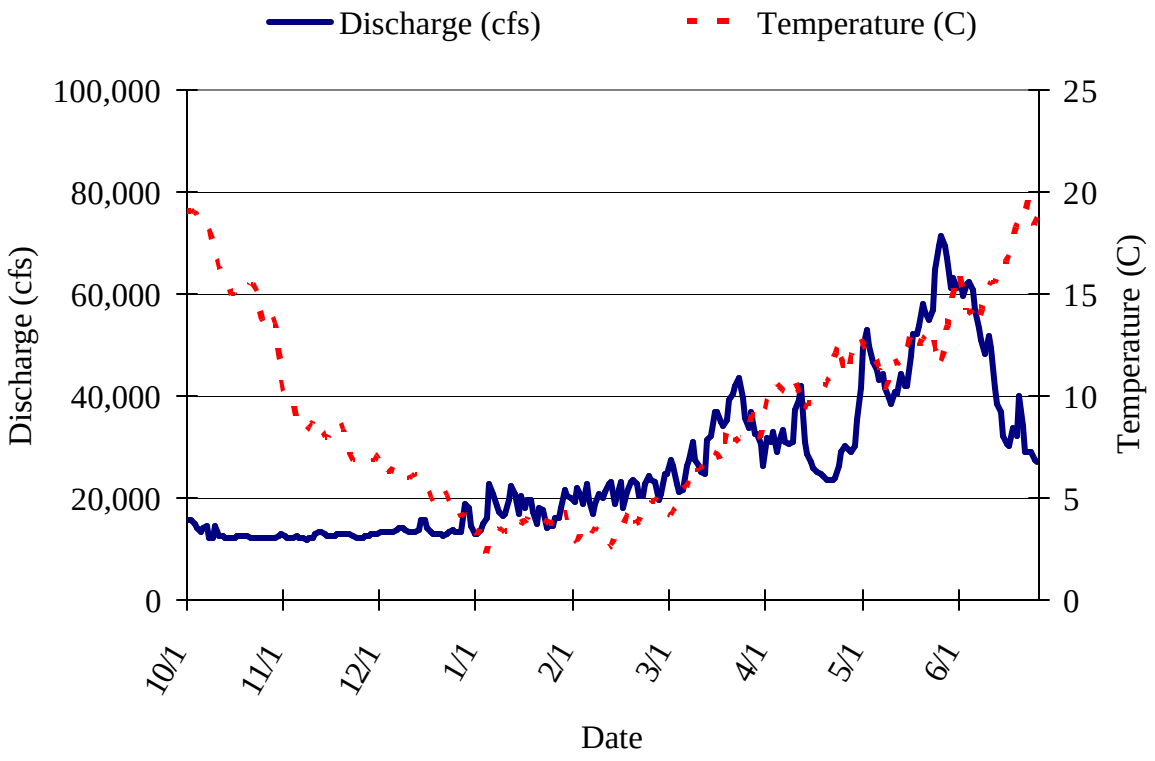

Figure 6. The average daily discharge and temperature at the Snake River gauge 13334300 from October 1, 2003 to June 30, 2004. USGS discharge data is provisional.

A system operation request for Snake River spill at LGR and LGO was made by the multi-agency salmon managers to continue spill until steelhead predominate the fish collection numbers at LGR (FPC SOR#2004-6). Spill in the lower Snake River was not continuous and occurred during two different time periods. Spill began on April 3, 7, 24, and February 13 at LGR, LGO, LMO, and MCN, respectively (Figures 8 - 11). Continuous spill occurred between April 3 to April 23 and again between May 27 and June 9 at LGR. Spill at LGO occurred between April 7 to April 23 and May 28 to June 2. Uninterrupted spill occurred at LMO between April 24 to May 14 and May 28 to June 3. Constant spill at MCN occurred from April 12 to June 23. Spill also occurred at LGR on May 5 for two days and on August 6. It also occurred on June 5 at LGO and June 6 for two days at LMO.

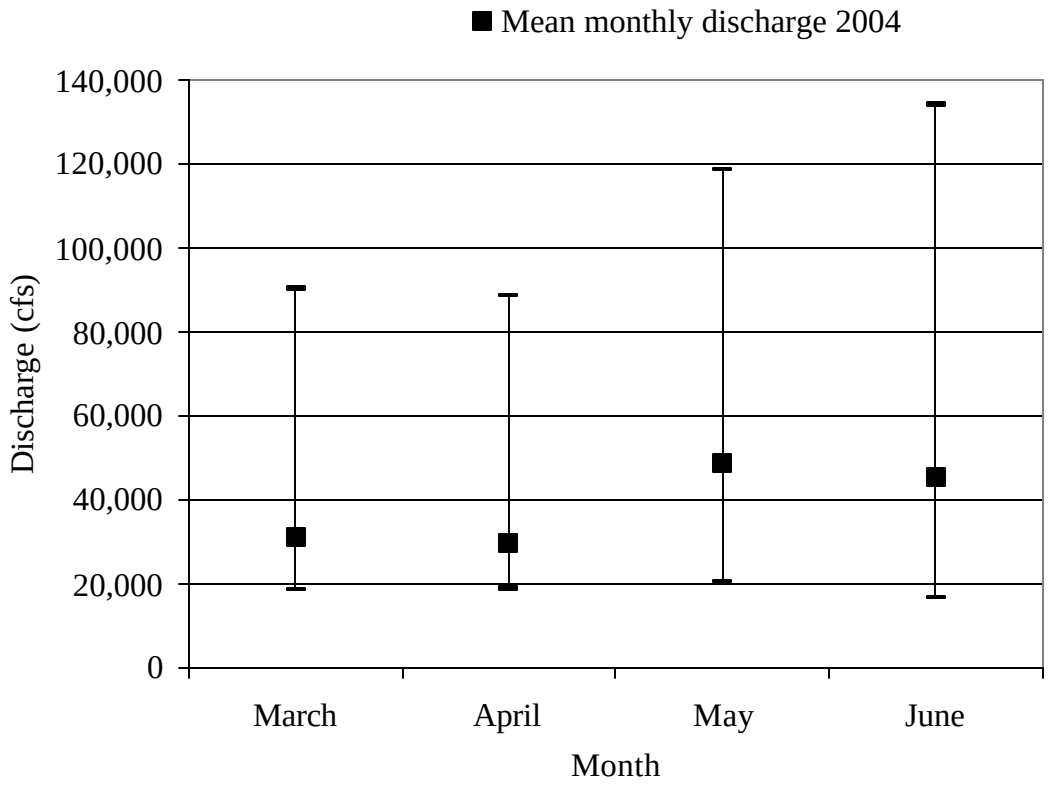

Figure 7. The average monthly discharge for the months of March, April, May, and June for 2004 at the Snake River USGS gauge 13334300. Bars indicate the minimum and maximum average monthly discharge values observed from 1959 to 2004. USGS discharge data is provisional.

Water temperatures measured in the tailraces of LGR, LGO, LMO, and MCN were lowest in February and March and highest in July and August. Minimum water temperatures in the tailraces were as follows: 3.1 °C at LGR on February 21, 5.9 °C at LGO on March 18, 6.3 °C at LMO on March 19, and 3.1 °C at MCN on February 10. Maximum water temperatures in the tailraces were as follows: 19.9 °C at LGR on July 2, 20.6 °C at LGO on July 29, 21.2 °C at LMO on August 2, and 22.2 °C at MCN on August 16.

Assuming that spill is beneficial to the survival of emigrating smolts (Berggren and Filardo 1993) and that water temperatures in excess of 18 °C may increase mortality due to increased activity by Northern Pikeminnows (Mesa and Olson 1993), the best environmental conditions for smolt emigration through LGR, LGO, LMO, and MCN occurred from early April to late April and late May to early June when spill occurred in the lower Snake River (before water temperatures reached 18 °C) (Figures 8-11).

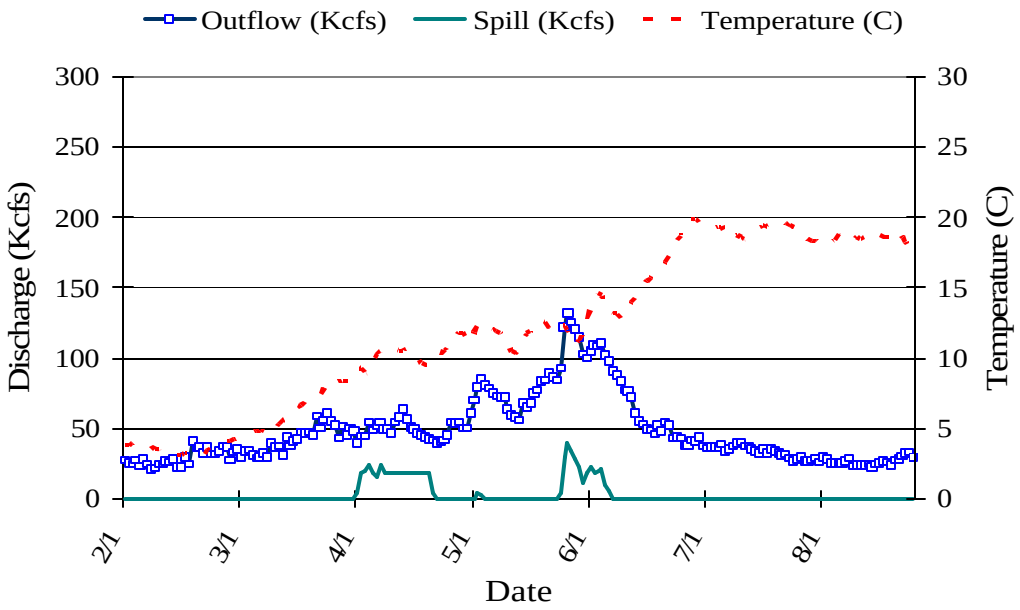

Figure 8. Measurements of outflow, spill, and mean temperature at Lower Granite Dam from February 1 to August 29, 2004. Data was obtained online at http://www.cbr.washington.edu/dart/.

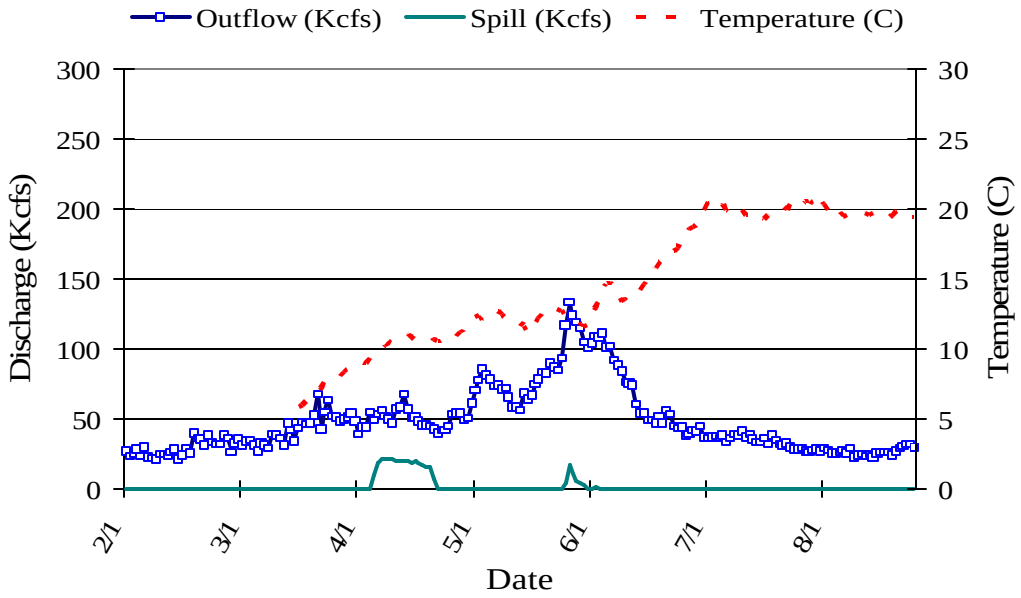

Figure 9. Measurements of outflow, spill, and mean temperature at Little Goose Dam from February 1 to August 29, 2004. Data was obtained online at http://www.cbr.washington.edu/dart/.

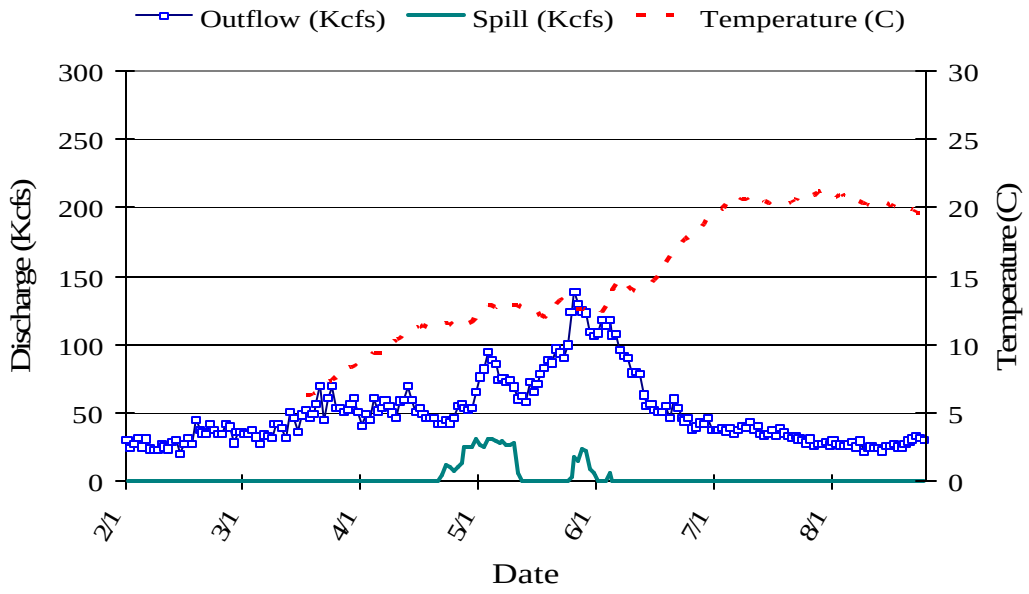

Figure 10. Measurements of outflow, spill, and mean temperature at Lower Monumental Dam from February 1 to August 29, 2004. Data was obtained online at http://www.cbr.washington.edu/dart/.

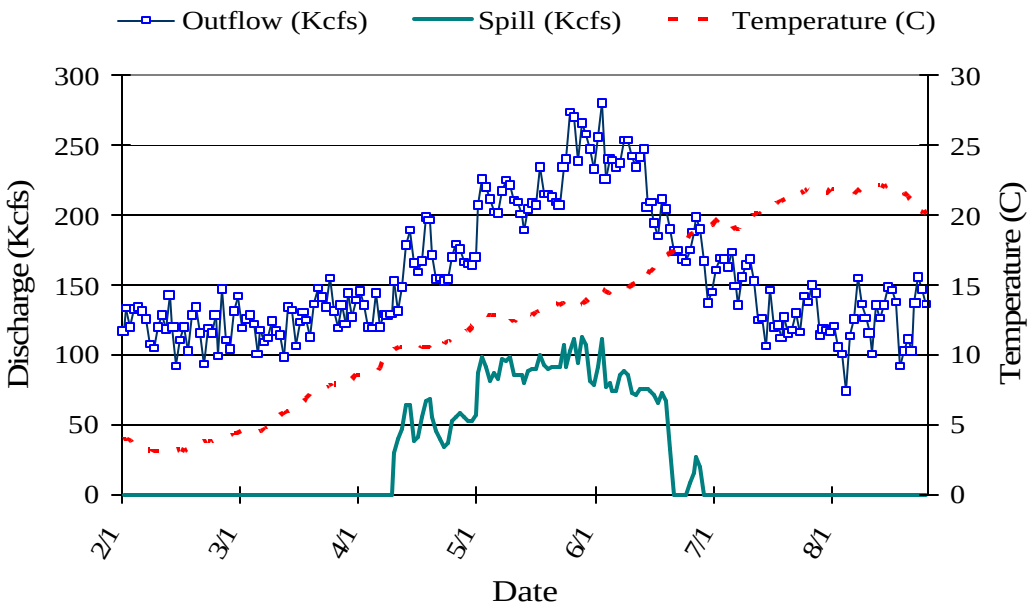

Figure 11. Measurements of outflow, spill, and mean temperature at McNary Dam from February 1 to August 29, 2004. Data was obtained online at http://www.cbr.washington.edu/dart/.

Hatchery Releases

Chinook Salmon

A total of 398,185 Chinook salmon were released from the Imnaha River acclimation facility at rkm 74 (Table 1). Chinook salmon were ponded at the acclimation facility from March 9 through 11. Hatchery personnel began pulling dam boards on March 26 and fish were allowed to leave volitionally until April 15 when the remaining fish were forced into the river. All Chinook salmon were marked with an adipose fin clip, 114,045 (29 %) had a coded wire tag, and 20,910 were marked with a PIT tag (Eddy 2004 personal communication, July 28, 2004 and Berggren, Fish Passage Center, unpublished data).

Steelhead

Steelhead were released at two locations in the Imnaha River Subbasin in 2004 and releases totaled 301,913 fish (Table 1). A total of 130,072 steelhead were ponded between March 4 and March 5 at the LSRCP Little Sheep Creek acclimation facility and released on April 11 and 12. A total of 26,528 were marked with adipose and left ventral fin clips, coded wire tags (CWT), and 251 PIT tags. An additional 53,405 were marked only with adipose fin clips. An additional 50,139 were marked with blank coded wire tags and 230 PIT tags. A second release of 100,002 steelhead occurred from April 12 to April 13, 2004. These fish were released directly into Big Sheep Creek, 49,952 were marked with adipose and left ventral fin clips, CWT, and 220 PIT tags. Fifty thousand and fifty unmarked steelhead were also released into Big Sheep Creek. The final release of 71,839 steelhead occurred from April 28 and 29 at the LSRCP Little Sheep Creek acclimation facility. They were ponded at the acclimation facility between April 13 and April 14. The fish were marked with 45,438 adipose fin clips. An additional 26,401 were marked with adipose and left ventral clips, CWTs and 251 PIT tags (Eddy 2004 personal communication, July 28, 2004).

Table 1. Releases of hatchery reared Chinook salmon and steelhead smolts in the Imnaha River Subbasin during migration year 2004 (Eddy 2004 personal communication, July 28, 2004).

Release Year	Species	Arrival at Acclimation Site	Number Released	Release Dates	Tags / Marks	Release Site
2004	Chinook Salmon	March 9 - 11	398,185	March 26 – April 15	100 % adipose fin clipped with 114,045 (29 %) CWT and 20,910 PIT tags	Imnaha River (Gumboot)
2004	Steelhead	March 4 - 5	130,072	April 11 - 12	53,405 adipose fin clip, 26,528 adipose and left ventral fin clips with CWT and 251 PIT tags, 50,139 blank CWT with no fin clips and 230 PIT tags	Little Sheep Creek
2004	Steelhead	NA[1]	100,002	April 12 - 13	50,050 without marks, 49,952 with CWT, adipose and left ventral fin clips and 220 PIT tags	Big Sheep Creek
2004	Steelhead	April 13 - 14	71,839	April 28 - 29	45,438 adipose fin clip, 26,401 CWT with adipose, left ventral fin clips and 251 PIT tags	Little Sheep Creek

[1] Steelhead were released directly into Big Sheep Creek.

Juvenile Chinook Salmon and Steelhead Catch

Catch for Migration Year 2004

The catch of natural Chinook salmon for migration year 2004 totaled 16,439 fish. The largest weekly catch occurred during the week of March 21 (n = 2,040). The weekly mean discharge and water temperature during the week of March 21 was 700 cfs and 8.5 °C, (Table 2). During the spring of 2004 the weekly catch of natural Chinook smolts exceeded 1,000 for seven weeks between the weeks of March 14 to May 2. A total of 54,358 hatchery Chinook salmon were captured, with the first captures occurring during the week of March 21 (Appendix C). More than half (n = 28,240) were captured during the week of March 28 when the weekly mean discharge was 598 cfs and the weekly mean temperature was 8.5 °C.

The catch of natural steelhead totaled 8,416 fish (Table 2 and Appendix C). The largest weekly catch occurred during the week of April 25 and totaled 2,421 fish. The mean weekly discharge and water temperature during the week of April 25 was 758 cfs and 10.9 °C. The catch of hatchery steelhead was 28,180 fish with the largest weekly catch of hatchery steelhead (n = 8,873) occurring during the week of April 11. The mean weekly discharge and water temperature was 825 cfs and 9.3 °C.

Table 2. The weekly mean discharge (cfs), temperature (C), and catch of natural and hatchery Chinook salmon and steelhead at the Imnaha River trap from October 5, 2003 to June 27, 2004.

Week	Average Discharge (cfs)	Average Temperature (°C)	Natural Chinook Salmon	Hatchery Chinook Salmon	Natural Steelhead	Hatchery Steelhead
10/12/2003	114	10.8	292	0	64	0
10/19/2003	118	11.5	228	0	11	0
10/26/2003	123	7.3	925	0	95	0
11/2/2003	124	1.5	490	0	1	0
11/9/2003	125	4.0	769	0	26	0
11/16/2003	125	5.2	611	0	14	0
11/23/2003	119	2.7	323	0	1	0
11/30/2003	140	5.6	78	0	0	0
2/15/2004	211	4.6	0	0	0	0
2/22/2004	246	5.0	40	0	0	0
2/29/2004	219	4.9	84	0	1	0
3/7/2004	270	7.3	314	0	6	0
3/14/2004	454	7.8	1,213	0	46	0
3/21/2004	700	8.5	2,040	14	159	0
3/28/2004	598	8.5	1,208	28,240	64	1
4/4/2004	847	10.2	701	7,572	145	7
4/11/2004	825	9.3	1,207	11,382	292	8,873
4/18/2004	603	9.5	1,247	2,729	324	585
4/25/2004	758	10.9	1,557	1,822	2,421	3,239
5/2/2004	1,121	12.0	1,755	1,923	1,917	6,581
5/9/2004	951	9.7	541	585	1,362	4,243
5/16/2004	1,246	10.1	121	82	1,084	3,351
5/23/2004	1,603	9.9	17	1	77	248
5/30/2004	1,560	12.5	106	5	213	523
6/6/2004	1,250	11.7	78	0	59	185
6/13/2004	909	13.9	189	2	30	273
6/20/2004	874	16.6	227	1	4	60
6/27/2004	911	17.5	78	0	0	11
Totals			16,439	54,358	8,416	28,180

PIT Tagging

A total of 13,426 natural Chinook salmon were PIT tagged for the 2004 migration year. About one quarter of the PIT tagged natural Chinook (n = 3,572) were tagged in the fall of 2003 (Table 3 and Appendix D). There were 5 weeks during the spring of 2004 where weekly release groups of more than 1,000 fish occurred: March 14 (1,153), March 21 (2,031), April 11 (1,029), April 18 (1,209), and April 25 (1,278). Two hatchery Chinook salmon were PIT tagged during the spring.

PIT tagged natural steelhead totaled 5,660 fish (Table 3). Major tagging efforts resulted in weekly release groups of more than 1,000 fish that occurred during the week of April 25 (n = 1,842) and May 9 (n = 1,173). An effort was made to produce weekly release groups of hatchery steelhead of 600 fish. Weekly release groups of hatchery steelhead from the week of April 11 to the week of May 30 ranged from 200 (week of May 23) to 714 (week of May 9). A total of 4,489 hatchery origin steelhead were PIT tagged (Table 3). Sixty-two natural rainbow trout/steelhead were tagged during the spring of 2004. These fish were less than 120 mm fork length and were not included in our analysis and natural steelhead numbers at the Imnaha River trap. These 62 fish are counted in the rainbow trout numbers in the incidental catch and are excluded from the survival analysis.

Table 3. The number of natural and hatchery Chinook salmon and steelhead PIT tagged weekly at the Imnaha River trap from October 5, 2003 to June 27, 2004.

Week	Natural Chinook Salmon	Hatchery Chinook Salmon	Natural Steelhead	Hatchery Steelhead
10/12/2003	278	0	0	0
10/19/2003	217	0	0	0
10/26/2003	897	0	0	0
11/2/2003	480	0	0	0
11/9/2003	720	0	0	0
11/16/2003	595	0	0	0
11/23/2003	311	0	0	0
11/30/2003	74	0	0	0
2/15/2004	0	0	0	0
2/22/2004	40	0	0	0
2/29/2004	73	0	0	0
3/7/2004	304	0	6	0
3/14/2004	1,153	0	42	0
3/21/2004	2,031	0	139	0
3/28/2004	514	0	43	0
4/4/2004	692	0	143	0
4/11/2004	1,029	1	235	614
4/18/2004	1,209	0	322	318
4/25/2004	1,278	1	1,842	601
5/2/2004	340	0	726	525
5/9/2004	456	0	1,173	714
5/16/2004	69	0	612	603
5/23/2004	16	0	77	200
5/30/2004	101	0	209	455
6/6/2004	76	0	58	161
6/13/2004	184	0	29	236
6/20/2004	224	0	4	53
6/27/2004	76	0	0	9
Totals	13,426	2	5,660	4,489

Recaptures of Previously PIT Tagged Smolts

Several organizations have PIT tagged both natural and hatchery Chinook and hatchery steelhead prior to our spring trapping efforts. During the course of the trapping season, we recaptured a portion of these fish.

We recaptured 17 of the 998 natural Chinook salmon that were previously PIT tagged by Oregon Department of Fish and Wildlife (ODFW) from August 26 to August 27, 2003 (Appendix E). Recaptured fish averaged 94.9 mm in fork length, 10.4 g in weight, and 1.1 for a condition factor (Table 4). Fork length, weight, and condition factor sample sizes in Table 4 represent the number of times each attribute was recorded and summarized for this report.

A total of 1,482 PIT tagged hatchery Chinook salmon released from the Imnaha River acclimation facility were recaptured. They averaged 118.1 mm in fork length, 18.7 g in weight, and a 1.1 condition factor. The first occurrence of a previously PIT tagged hatchery Chinook salmon occurred on March 27, 1 day after the volitional release at the Gumboot acclimation facility began. Fifty and 90% of the fish arrived 13 and 33 days, respectively, after the volitional release began (Figure 12).

The earliest 90% arrival time for hatchery Chinook occurred in 1998. The release strategy in 1998 was an acclimated forced release. Ninety percent of all previously PIT tagged hatchery Chinook salmon arrived 8 days after the release in 1998 (Figure 12). The earliest 90% arrival time for an acclimated volitional release occurred in 2000, which occurred 22 days after the volitional release began. The latest 90% arrival time (34 days) occurred in 1999. The majority of the hatchery Chinook salmon in 1999 (n = 184,567) were acclimated and released volitionally. A small number of hatchery Chinook salmon in 1999 (n = 10,242) were directly released into the Imnaha River (Cleary et al. 2003a).

Twenty-six previously PIT tagged hatchery steelhead were recaptured during the spring of 2004. They averaged 202.9 mm in fork length, 81.5 g in weight, and a condition factor of 1.0 (Table 4).

Table 4. Averages, ranges, and standard deviations of fork lengths (mm), weights (g), and condition factors (K) with minimum, maximum, and sample size values for recaptures of previously PIT tagged natural and hatchery Chinook salmon, and hatchery steelhead observed at the Imnaha River trap from March 27, 2004 to June 4, 2004.

Attribute	Statistic	Natural Chinook Salmon	Hatchery Chinook Salmon	Hatchery Steelhead
Fork Length (mm)	Average	94.9	118.1	202.9
	Standard Deviation	11.8	11	24.3
	Sample Size (n)	15	1482	26
	Minimum	114	90	134
	Maximum	68	171	247
Weight (g)	Average	10.4	18.7	81.5
	Standard Deviation	3.9	5.7	30
	Sample Size (n)	14	1427	22
	Minimum	3.5	6.1	25.6
	Maximum	17.7	61.4	145.1
Condition Factor (K)	Average	1.1	1.1	1.0
	Standard Deviation	0.1	0.1	0.1
	Sample Size (n)	14	1408	22
	Minimum	0.9	0.6	0.8
	Maximum	1.4	1.7	1.1

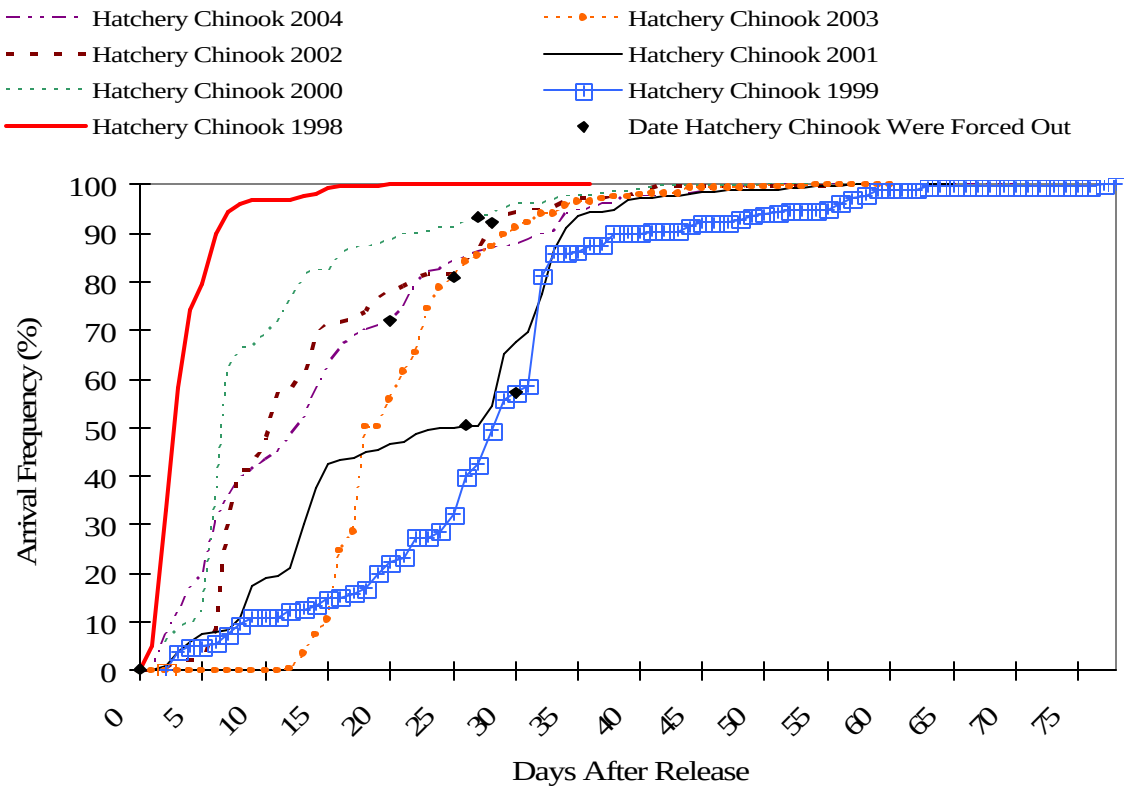

Figure 12. The arrival frequency of previously PIT tagged hatchery Chinook salmon captured in the Imnaha River trap during the spring of 1998 to the spring of 2004. The release strategy in 1998 was an acclimated forced release and the remainder of the releases were acclimated volitional releases.

Biological Characteristics

Annual Biological Characteristics

The length frequency distribution of fall tagged natural Chinook salmon (defined as pre-smolts within this document) is shown in Figure 13. These fish averaged 83.6 mm in fork length, 6.3 g in weight, and had an average condition factor of 0.98 (Table 5). Natural Chinook salmon smolts captured in the spring averaged 100.3 mm, 11.4 g, and had an average condition factor of 1.11. Hatchery Chinook salmon had a larger fork length of 118.2 mm. Hatchery Chinook salmon had an average weight of 18.7 g and an average condition factor of 1.12. The 115 mm median fork length of hatchery Chinook salmon was significantly different from the 100 mm median fork length of natural Chinook salmon ($p < 0.05$) (Figure 14 and Appendix F).

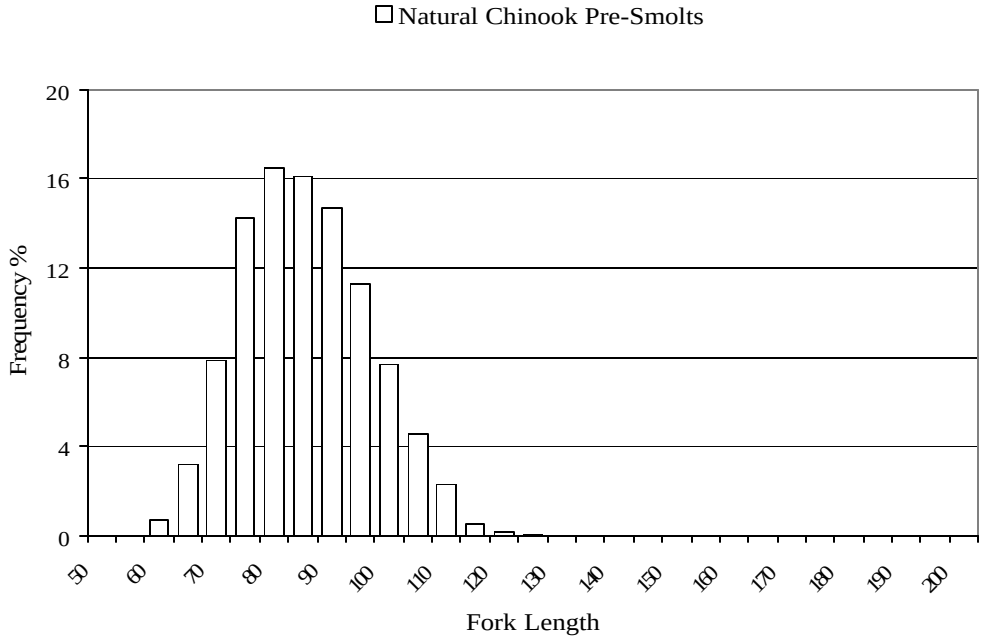

Figure 13. Length frequency distribution of natural Chinook salmon pre-smolts trapped in the Imnaha River trap during the fall of 2003.

Spring captured natural steelhead had an average fork length and weight of 169.2 mm and 50.5 g and a condition factor of 1.00 (Figure 15 and Table 5). Hatchery steelhead were significantly larger ($p < 0.05$) with an average fork length of 215.8 mm and weight of 100.5 g and a condition factor of 0.98 (Figure 15 and Appendix F).

Hatchery programs from 1994 to 2004 for the Imnaha River tended to produce larger smolts than in nature. The differences in size should be a concern if differences in downstream survival due to size and adult age structure become apparent.

There were no distinct weekly trends in the size or condition factors of captured natural and hatchery Chinook salmon and steelhead. The largest weekly mean fork lengths of natural Chinook salmon (107 mm) occurred during the week of May 31 (Table 6). The largest weekly mean fork lengths for hatchery Chinook salmon (125) was measured during the week of March 22. Hatchery Chinook averaged in the 120 mm range for 5 weeks and in the 110 mm range for 7 weeks. Natural steelhead had weekly mean fork lengths greater than 170 mm for 5 weeks from April 12 to the week of June 14. The largest weekly mean fork lengths for hatchery steelhead were 221 mm and 225 mm were measured during the weeks of April 26 and June 21 (Table 6).

Table 5. Averages, ranges, and standard deviations of fork lengths (mm), weights (g), and condition factors (K) with minimum, maximum, and sample size values for natural and hatchery Chinook salmon and steelhead captured during the 2004 migration year, October 13, 2003 to June 27, 2004 at the Imnaha River trap.

		Fall 2003	Spring 2004			
Attribute	Statistic	Natural Chinook Salmon (Pre-Smolts)	Natural Chinook Salmon (Smolts)	Hatchery Chinook Salmon	Natural Steelhead	Hatchery Steelhead
Fork Length (mm)	Average	83.6	100.3	118.2	169.6	215.8
	Standard Deviation	11.2	9.7	10.3	21.0	21.7
	Sample Size (n)	3,684	9,847	2,694	5,652	4,498
	Minimum	54	60	90	120	302
	Maximum	139	138	182	283	115
Weight (g)	Average	6.3	11.4	18.7	50.5	100.5
	Standard Deviation	2.6	3.2	5.3	19.6	31.8
	Sample Size (n)	3,314	9,764	2,632	5,531	4,273
	Minimum	1.7	3.2	6.1	14.2	15.9
	Maximum	19.8	28.3	69.0	268.4	282.4
Condition Factor (k)	Average	0.98	1.11	1.12	1.00	0.98
	Standard Deviation	0.09	0.13	0.13	0.08	0.08
	Sample Size (n)	3,314	9,728	2,613	5,513	4,248
	Minimum	0.50	0.55	0.62	0.61	0.53
	Maximum	1.37	1.80	1.79	1.41	1.67

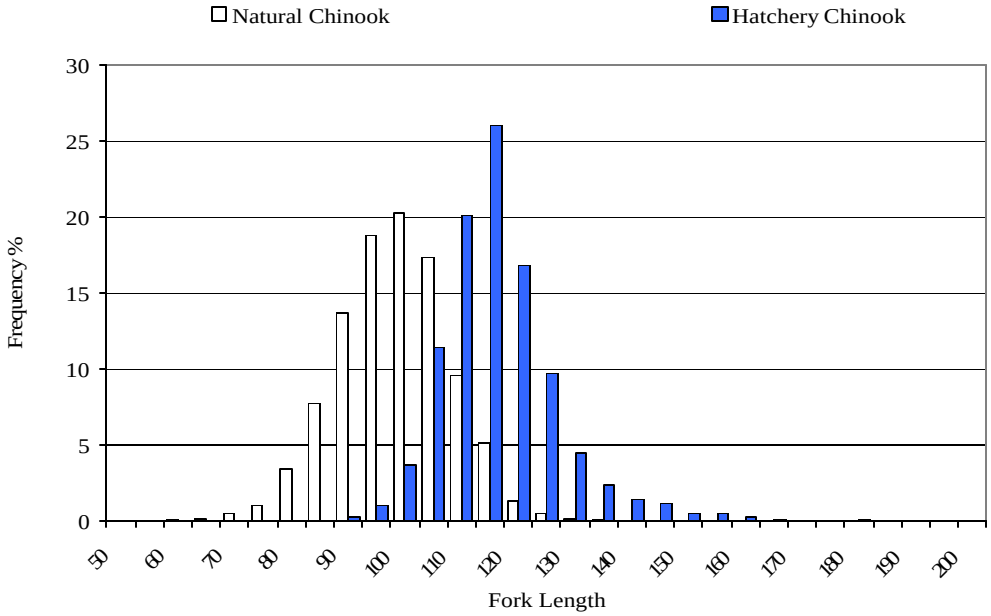

Figure 14. Length frequency distribution of natural and hatchery Chinook salmon trapped in the Imnaha River trap, February 25 to June 27, 2004.

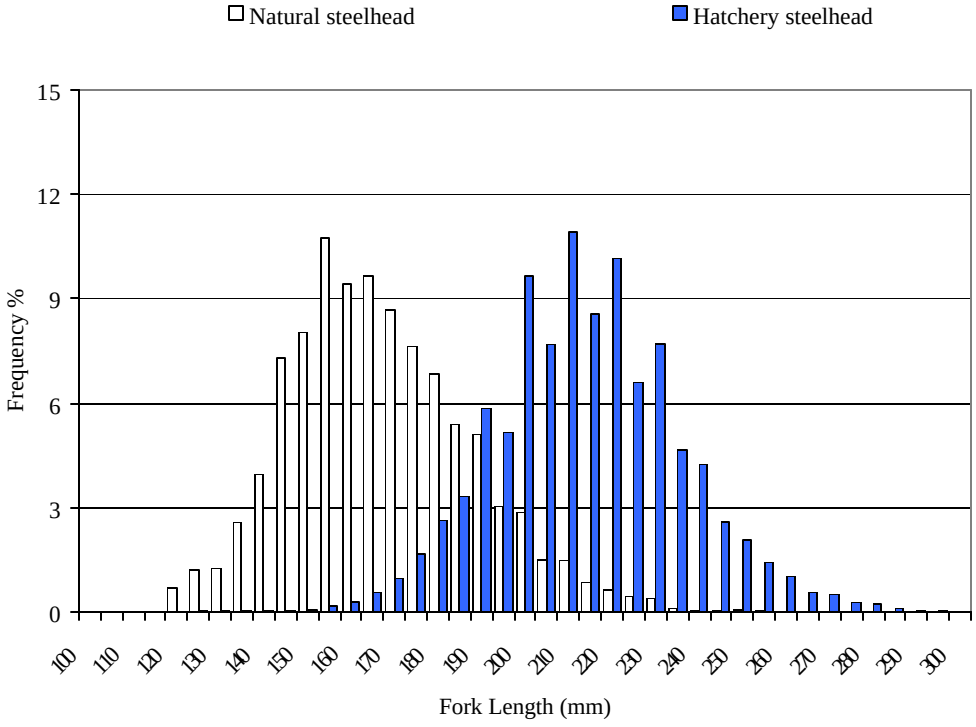

Figure 15. Length frequency distribution of natural and hatchery steelhead trapped in the Imnaha River trap, February 25 to June 27, 2004.

Table 6. Weekly mean fork lengths (FL) and condition factors (K) for natural and hatchery Chinook salmon and steelhead captured at the Imnaha River trap during the spring of 2004.

	Natural Chinook Salmon		Hatchery Chinook Salmon		Natural Steelhead		Hatchery Steelhead	
Week	FL (mm)	K	FL (mm)	K	FL (mm)	K	FL (mm)	K
02/23/04	92.3	1.14						
03/01/04	97.0	1.13						
03/08/04	99.0	1.04			131.8	1.03		
03/15/04	100.5	1.03			139.4	0.99		
03/22/04	98.7	1.09	125.1	1.26	150.5	1.01		
03/29/04	96.9	1.08	120.0	1.13	163.7	0.98	143.0	1.06
04/05/04	101.5	1.15	116.4	1.11	169.0	1.01	214.0	0.85
04/12/04	99.7	1.12	114.5	1.12	172.3	0.98	216.2	1.00
04/19/04	102.2	1.11	116.5	1.12	168.1	1.01	219.4	1.02
04/26/04	103.9	1.13	119.8	1.12	172.6	0.98	221.6	1.00
05/03/04	103.3	1.09	121.4	1.07	172.1	0.98	218.5	0.96
05/10/04	97.9	1.20	116.9	1.14	165.9	1.03	208.6	0.99
05/17/04	100.2	1.13	121.4	1.06	169.7	1.01	214.7	0.95
05/24/04	100.4	1.15	123.0	1.06	165.0	1.03	211.2	0.96
05/31/04	107.4	1.13	118.2	1.11	164.1	1.03	214.5	0.96
06/07/04	98.5	1.18			170.4	1.03	218.2	0.95
06/14/04	93.8	1.20	112.0	1.13	178.6	1.06	216.0	0.94
06/21/04	93.9	1.18	117.0	1.11	165.5	1.10	225.3	0.97

Survival of PIT Tagged Smolts

Natural Chinook Salmon and Steelhead Abundance

Trap efficiencies for natural Chinook ranged from 4.0% during late May to 17% during the week of April 19, and averaged 10.4%. Trap efficiencies for natural steelhead ranged from 3% during late May to 15% during the week of May 10, and averaged 9%. The overall spring emigration abundance estimate for natural Chinook salmon smolts was 93,627 with a lower 95% C.I of 77,057 and an upper 95% C.I. of 119,299. The overall spring emigration abundance estimate for natural steelhead smolts was 76,678 with a lower 95% C.I of 61,537 and an upper 95% C.I. of 98,640. These emigration abundance estimates are minimum estimates based on incomplete efficiency trials. Grouped Gauss population estimates were calculated for several periods during the spring trapping period and are presented in Appendixes G and H.

Post Release Survival of Hatchery Chinook

An estimated 329,697 ±8,572 (95% C.I.) hatchery Chinook salmon emigrated past the Imnaha River trap during the spring of 2004. The population estimate is based on a post release survival estimate of 82.9% ±2.6% (95% C.I.) from the acclimation facility to the trap. This survival estimate is the lowest estimate since the Imnaha SMP project began. Past post release survival estimates from the acclimation facility at Gumboot to the Imnaha River trap have ranged from 88.4% ± 2.0% (95% C.I.) in 1998 to 100.9% ± 14.3% (95% C.I.) in 1994 (Figure 16). The post release survival estimates are useful for evaluating the mortality that occurred within the Imnaha River and comparing that reach specific mortality to other reaches within the Snake and Columbia rivers.

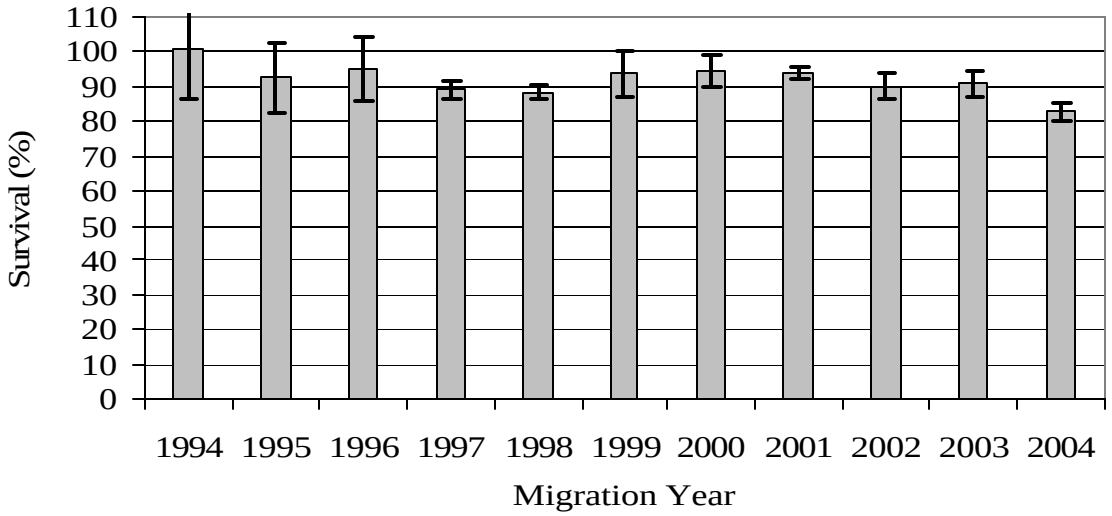

Figure 16. Estimated post release survival of hatchery Chinook salmon from the Imnaha River acclimation facility at Gumboot to the Imnaha River trap from 1994 to 2004. The error bars indicate the 95% C.I.

Estimated Season Wide Smolt Survival from the Imnaha Trap

The survival of fall PIT tagged natural Chinook salmon pre-smolts from the Imnaha River trap to LGR has been measured for migration years 1994 to 2004. All season wide and weekly survival estimates presented in this and the next section of the report are with 95% confidence intervals in parentheses. The migration year 2004 survival estimate for fall tagged natural Chinook salmon pre-smolts from the trap to LGR was 27.7% (± 2.7%) (Figure 17). Fall PIT tagged natural Chinook survival from the trap to LMO was 18.9% (± 2.5%). Fall PIT tagged natural Chinook salmon sample sizes have ranged from 442 (1997) to 3,566 (2004). The survival estimates range from 25.6% (± 4.3%) for migration year 1995 to 60.4% (± 4.1%) for migration year 1998 (Figure 17).

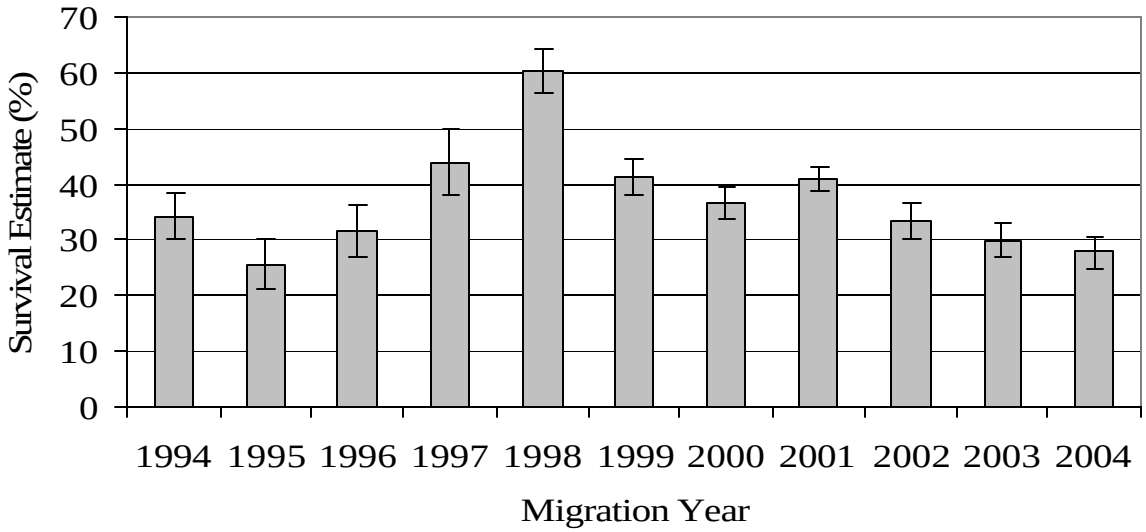

Figure 17. Estimated survival from the Imnaha River trap to Lower Granite Dam of natural Chinook salmon tagged in the fall, for migration years 1994 to 2004. Error bars indicate the 95% C.I.

The estimated survival of natural Chinook salmon smolts, PIT tagged in the spring, from the trap to LGR in 2004 was 73.4% (± 1.2%) (Table 7). The hatchery Chinook salmon, captured and released at the Imnaha River trap had an estimated survival of 74.0% (± 2.6%) to LGR. The estimated survival of natural and hatchery steelhead from the trap to LGR was 79.0% (± 1.2%), and 86.0% (± 1.3%), respectively. The estimate of survival from the Imnaha trap to LGR for natural Chinook salmon smolts was the lowest observed since the initiation of our study (Table 8). Natural Chinook survival from the trap to LGR (1993 to 2004) has ranged from 73.0% in 2004 to 90.9% in 1995. Hatchery Chinook salmon estimated survival from release at the trap to LGR was within the past range of estimates of 67.1% in 1994 to 80.4% in 1997. Natural steelhead estimated survival was lower than previous estimates from 1995 to 2003. Natural steelhead survival estimates have historically ranged from 82.7% in 2001 to 90.1% in 1997. The estimated survival from release at the Imnaha trap to LGR for hatchery steelhead was slightly above the historic range of previous estimates of 64.6% in 1996 to 85.8% in 2000.

Estimated survival from the Imnaha River trap to LMO in 2004 was as follows: natural Chinook salmon was 53.0% (± 2.9%), hatchery Chinook salmon was 54.2% (± 5.08), natural steelhead was 62.0% (± 8.1%), and hatchery steelhead was 62% (± 6.0%). The estimated survival for natural Chinook salmon from the trap to LMO was the lowest since 1998. Previous survival estimates for natural Chinook salmon from the trap to LMO ranged from 60.0% in 2003 to 78.3% in 1999 (Table 9).

A possible explanation for the poor survival of natural Chinook salmon to LGR and LMO could be that survival was affected by the below average discharge during March and April in the Snake River. Past monitoring of Chinook salmon and steelhead estimated survival from LGO and LGR to the Dalles Dam as ranging from 5% during the low-flow year of 1973 to as

high as 42% during more favorable passage conditions of 1975 (Raymond 1979). However, this implies a relationship between flow and survival, which may not have a strong correlation (Smith et al. 2002). The 2004 survival estimates for hatchery Chinook salmon from release to LMO was also the lowest recorded yet and may have been affected by the below average discharge in the Snake River. Previous survival estimates for hatchery Chinook salmon from release to LMO was have ranged from 61.1% in 1999 to 68.1% in 2002. Both estimates of survival from the trap to LMO for natural and hatchery steelhead were within the range of estimates obtained from 1997 to 2003. Natural steelhead survival from release to LMO has ranged from 49.2% in 2001 to 75.1% in 1999 and hatchery steelhead survival from release to LMO has ranged from 42.8% in 2001 to 82.1% in 2003.

Survival estimates for natural and hatchery Chinook salmon and steelhead from the Imnaha trap to MCN were within the range of estimates from 1998 to 2004 (Table 10). The maximum average daily discharge from the Imnaha River in 2001 occurred on May 15 and was 1,150 cfs (32.6 cms) (Cleary et al. 2003b). The maximum average daily discharge from the Imnaha River in 1998 occurred on May 26 and was a magnitude of more than 5 times greater than in 2001 at 5,964 cfs (168.9 cms) (Cleary et al. 2000). Natural Chinook salmon survival from the trap to MCN has ranged from 47.4% during the drought year of 2001 to 78.7% in 1998. Hatchery Chinook salmon survival from the Imnaha trap to MCN has ranged from 49.0% in 2003 to 56.0% in 2002. Natural steelhead survival from release to MCN has ranged from 18.4% in 2001 to 71.6% in 1999. Hatchery steelhead survival from release to MCN has ranged from 13.9% in 2001 to 63.8% in 1998. The lowest estimates of survival for steelhead from release to MCN, like natural Chinook salmon, occurred during the drought year of 2001.

Table 7. Estimated survival probabilities for season-wide PIT tag release groups of natural and hatchery Chinook salmon and steelhead smolts released from the Imnaha River trap from February 25 to June 27, 2004. Estimates are from release at the trap to Lower Granite Dam and tail race to tail race for all other sites. Abbreviations: LGR -Lower Granite Dam, LGO - Little Goose Dam, LMO - Lower Monumental Dam.

Release Group	Number Released	Trap to LGR (%) (95% C.I.		LGR to LGO (%) (95% C.I.		LGO to LMO (%) (95% C.I.		LMO to MCN (%) (95% C.I.		Trap to LMO (%) (95% C.I.		Trap to MCN (%) (95% C.I.	
Natural Chinook Salmon													
	9,844	73.4	1.2	105.0	3.5	69.0	4.4	99.0	10.7	53.0	2.9	52.7	5.1
Hatchery Chinook Salmon													
	1,747	74.0	2.6	97.2	2.4	90.9	8.8	82.7	10.8	54.2	5.1	44.8	4.1
Natural Steelhead													
	5,721	79.0	1.9	91.0	2.2	86.3	11.3	76.4	42.0	62.0	8.1	47.4	25.3
Hatchery Steelhead													
	4,487	85.9	1.3	84.8	1.8	84.5	8.2	48.0	18.8	62.0	6.0	29.4	11.2

Table 8. Season-wide estimates of survival from the Imnaha River trap to Lower Granite Dam from 1993 to 2004. Ninety-five percent confidence intervals are shown in parentheses.

Migration Year	Natural Chinook (%)		Hatchery Chinook (%)		Natural Steelhead (%)		Hatchery Steelhead (%)	
1993	80.9	(11.8)						
1994	76.2	(5.3)	67.1	(10.2)				
1995	90.9	(6.7)	72.1	(6.3)	83.7	(7.1)	77.5	(3.1)
1996	81.2	(5.3)	71.4	(9.4)	86.5	(3.9)	64.6	(4.7)
1997	89.5	(12.9)	80.4	(8.0)	90.1	(3.9)	81.4	(2.0)
1998	85.2	(2.0)	75.7	(3.1)	86.0	(2.2)	82.9	(2.3)
1999	88.5	(2.0)	71.6	(4.7)	87.7	(3.1)	85.4	(2.0)
2000	84.8	(2.3)	74.4	(4.3)	84.4	(2.7)	85.8	(2.4)
2001	83.7	(0.8)	80.3	(1.6)	82.7	(1.4)	82.0	(1.6)
2002	86.9	(4.4)	77.3	(4.4)	83.0	(5.4)	81.8	(3.5)
2003	75.9	(2.3)	72.4[1]	(6.8)	82.0	(2.5)	89.4	(3.3)
2004	73.4	(1.2)	74.0[1]	(2.6)	79.0	(1.2)	85.9	(1.3)

[1] Hatchery Chinook salmon estimates based on the re-release of captured PIT tagged fish originating from the Chinook salmon acclimation facility.

Table 9. Season-wide estimates of survival from the Imnaha River trap to Lower Monumental Dam from 1997 to 2004. Ninety-five percent confidence intervals are shown in parentheses.

Migration Year	Natural Chinook (%)		Hatchery Chinook (%)		Natural Steelhead (%)		Hatchery Steelhead (%)	
1997					73.0	(12.0)	64.0	(6.5)
1998	75.3	(4.7)	64.5	(6.7)	67.0	(5.7)	63.2	(4.9)
1999	78.3	(2.4)	61.1	(5.9)	75.1	(4.6)	73.9	(3.3)
2000	73.2	(4.3)	54.9	(7.5)	50.9	(4.7)	57.8	(7.8)
2001	65.6	(1.3)	69.0	(2.5)	49.2	(3.5)	42.8	(6.0)
2002	76.8	(4.5)	68.1	(4.2)	69.9	(4.5)	78.0	(8.4)
2003	60.0	(4.3)	61.5[1]	(20.4)	68.1	(4.8)	82.1	(5.5)
2004	53.0	(2.9)	54.2[1]	(5.1)	62.0	(8.1)	62.0	(6.0)

[1] Hatchery Chinook salmon estimates based on the re-release of captured PIT tagged fish originating from the Chinook salmon acclimation facility.

Table 10. Season-wide estimates of survival from the Imnaha River trap to McNary Dam from 1998 to 2004. Ninety-five percent confidence intervals are shown in parentheses.

Migration Year	Natural Chinook (%)		Hatchery Chinook (%)		Natural Steelhead (%)		Hatchery Steelhead (%)	
1998	78.7	(6.8)	54.3	(8.0)	64.0	(10.1)	63.8	(10.5)
1999	68.5	(4.3)	53.8	(9.8)	71.6	(12.0)	58.8	(7.6)
2000	67.9	(6.3)	54.1	(9.7)	49.9	(12.2)	40.2	(12.5)
2001	47.4	(1.5)	52.1	(5.3)	18.4	(3.1)	13.9	(3.9)
2002	61.9	(5.3)	56.0	(5.6)	37.0	(4.8)	48.7	(13.2)
2003	57.1	(5.6)	49.0[1]	(11.8)	42.0	(5.6)	63.0	(14.5)
2004	52.7	(5.1)	44.8	(4.06)	47.4	(25.3)	29.4	(11.2)

[1] Hatchery Chinook salmon estimates based on the re-release of captured PIT tagged fish originating from the Chinook salmon acclimation facility.

Estimated Weekly Smolt Survival

Weekly release groups of more than 300 fish resulted in estimates from the trap to LGR for natural Chinook salmon that ranged from 71.2% (± 2.8%) released during the week of April 26 to 83.7% (± 8.5%) released during the week of March 29 (Table 11). Recaptured hatchery Chinook salmon provided two weekly release groups for the weeks of March 29 and April 5. Estimated survival of these groups from the trap to LGR was 74.3% (± 5.9%) and 72.4% (± 5.7%), respectively. Weekly estimates of survival from the trap to LGR for natural steelhead ranged from 78.9% (±2.1%) during the week of May 10 to 85.9% (±10.0%) during the week of April 12. Hatchery steelhead survival estimates ranged from 69.1% (±8.0%) during the week of June 14 to 99.5% (±9.0%) during the week of May 31. The range of weekly estimates from the trap to LMO were as follows: 53.6% to 99.6% for natural Chinook salmon, 80.8% to more than 100% for hatchery Chinook salmon, 28.7% to more than 100% for natural steelhead, and 14.5% to 96.3% for hatchery steelhead.

Table 11. Estimated survival probabilities for weekly PIT tag release groups of 300 or more natural and hatchery Chinook salmon and steelhead smolts released from the lower Imnaha River trap from February 25 to June 27, with 95% confidence intervals in parentheses. Estimates are from release at the trap to Lower Granite Dam and tailrace to tailrace for all other sites. Abbreviations: LGR - Lower Granite Dam, LGO - Little Goose Dam, LMO - Lower Monumental Dam.

		Estimated Survival							
Week of Release	Number Released	Trap to LGR % (95% C.I.)		LGR to LGO % (95% C.I.)		LGO to LMO % (95% C.I.)		Trap to LMO % (95% C.I.)	
Natural Chinook Salmon									
8-Mar	454	79.7	(10.5)	101.4	(25.0)	72.5	(21.2)	58.6	(11.5)
15-Mar	1266	75.2	(5.1)	116.6	(16.4)	61.1	(10.3)	53.6	(5.5)
22-Mar	1,924	81.6	(4.2)	121.3	(14.8)	55.8	(8.5)	55.2	(4.8)
29-Mar	375	83.7	(8.5)	106.3	(26.4)	80.3	(56.1)	71.5	(46.0)
5-Apr	846	82.0	(4.3)	101.5	(9.7)	74.9	(30.4)	62.3	(24.5)
12-Apr	1071	78.2	(2.8)	88.0	(6.1)	144.7	(81.5)	99.6	(56.0)
19-Apr	1135	76.3	(2.6)	98.5	(6.5)	74.5	(26.9)	56.0	(19.9)
26-Apr	1275	71.2	(2.8)	88.3	(5.5)	99.3	(27.9)	62.4	(17.4)
Hatchery Chinook Salmon									
29-Mar	622	74.3	(5.9)	112.3	(19.4)	96.8	(69.5)	80.8	(56.0)
5-Apr	365	72.4	(5.7)	110.3	(18.9)	149.2	(181.7)	119.2	(143.1)
Natural Steelhead									
12-Apr	235	85.9	(10.0)	102.2	(27.4)	124.1	(220.4)	108.9	(191.3)
19-Apr	412	81.4	(4.4)	92.8	(13.8)	50.8	(46.4)	38.4	(34.6)
26-Apr	1,907	79.8	(2.1)	91.5	(5.1)	186.8	(137.9)	136.4	(100.5)
3-May	614	82.3	(3.2)	87.2	(6.7)	83.1	(39.8)	59.6	(28.5)
10-May	1502	78.9	(2.1)	91.3	(2.7)	91.1	(11.2)	65.7	(8.3)
17-May	208	82.5	(5.2)	97.3	(4.4)	105.7	(47.2)	84.8	(38.2)
31-May	209	73.2	(8.6)	86.3	(12.3)	45.5	(12.0)	28.7	(8.1)
Hatchery Steelhead									
12-Apr	614	88.9	(3.9)	94.3	(7.4)	114.9	(59.6)	96.3	(49.6)
19-Apr	418	86.6	(4.1)	90.4	(10.6)	74.5	(38.6)	58.3	(29.6)
26-Apr	500	88.6	(3.7)	89.6	(7.9)	55.8	(20.7)	44.3	(16.2)
3-May	766	85.8	(2.6)	88.4	(3.3)	102.5	(22.5)	77.8	(17.3)
10-May	772	84.1	(2.7)	88.6	(3.0)	86.1	(11.2)	64.1	(8.7)
17-May	303	88.1	(3.9)	88.1	(4.9)	80.2	(15.5)	62.3	(12.5)
24-May	200	83.5	(5.9)	97.6	(5.0)	73.1	(7.2)	59.6	(6.8)
31-May	455	99.5	(9.0)	68.5	(8.2)	54.1	(12.1)	36.9	(8.4)
7-Jun	214	85.7	(5.0)	77.9	(10.9)	67.0	(62.1)	44.8	(41.4)
14-Jun	199	69.1	(8.0)	65.3	(22.2)	32.1	(40.0)	14.5	(17.6)

Smolt to Adult Return Rates

Smolt-to adult return rate indices (SAR) were calculated for two groups of PIT tagged juvenile natural Chinook salmon emigrants from the Imnaha River, for brood years 1996 through 1999. The two groups were represented by: 1) juvenile Chinook salmon tagged during the fall of the migration year which emigrated past the Imnaha River trap, and 2) Chinook salmon smolts which emigrated past the Imnaha River trap during the spring. Estimated SAR indices for these two groups characterize in-river migrating fish (although a few smolts were inadvertently diverted to the transportation system) defined as those fish that migrated by either spill or turbine routes. The estimated SAR provides a SAR index of inriver migrating Imnaha River Chinook salmon. A season wide juvenile survival rate from the Imnaha trap to LGR was used to generate comparable estimated smolt equivalents at LGR, which was then used to estimate SAR's from LGR to LGR. The LGR to LGR SAR was calculated as it provides a SAR comparable to other tributaries.

The total number of Chinook salmon adults detected at LGR for spring PIT tagged Chinook salmon from brood years 1996 through 1999 were 59, 105, 109, and 24 fish, respectively (Table 12). Adult detections from fall PIT tagged Chinook salmon from brood years 1996 through 1999 were 27, 20, 22, and 5, respectively.

Fall tagged natural Chinook salmon evidenced a higher LGR to LGR SAR index for all brood years examined when compared to spring tagged Chinook salmon (Table 12). The LGR to LGR SAR index for fall tagged Chinook salmon ranged from 0.60% to 3.08%. The LGR to LGR SAR index for spring tagged Chinook salmon ranged from 0.27% to 2.94% for the same brood years. Observed differences between fall and spring tag group SAR indexes for brood years 1997 and 1998 were relatively small. The difference between fall and spring tag group SAR indexes for brood year 1999 are substantially different.

Table 12. Detections of PIT tagged Imnaha River adult Chinook salmon and smolt to adult return rate indices (SAR) of in-river migrating fish from the lower Imnaha River trap to Lower Granite (LGR) and from LGR to LGR for brood years 1996 to 1999.

Brood Year	Season Tagged	Number PIT Tagged	Estimated Smolt Equivalents at LGR	Number of Adult Detections at LGR	Age at Return			SAR LGR to LGR (%)
					III	IV	V	
1996	Fall	1,453	878	27	5	15	7	3.08
1997		2,000	830	20	3	16	1	2.41
1998		2,009	739	22	2	12	8	2.98
1999		2,009	834	5	0	3	2	0.60
1996	Spring	3,956	3,370	59	3	41	15	1.75
1997		5,306	4,696	105	8	69	28	2.24
1998		4,369	3,705	109	3	62	44	2.94
1999		10,005	8,854	24	0	16	8	0.27

Arrival Timing at Dams

Natural and Hatchery Chinook Salmon Arrival Timing for 2004

Fall tagged pre-smolt natural Chinook salmon had statistically significant earlier median and cumulative arrival timing at LGR than spring tagged natural Chinook salmon smolts ($p < 0.05$). Statistical test results are presented in Appendix I. The April 14 median arrival date for fall tagged Chinook salmon was earlier than the May 1 median arrival date for spring tagged Chinook salmon ($p < 0.05$).

Fall tagged natural Chinook salmon arrived at LGR in 2004 from March 26 to May 8 and had a 90% arrival timing of May 2. Arrival at the remaining dams occurred during the following times: April 10 to May 26 at LGO, April 13 to May 28 at LMO, and April 13 to May 31 at MCN. Median arrivals occurred April 24, April 19, and April 30 at LGO, LMO, and MCN, respectively. Ninety percent arrival occurred on the following dates: May 6 at LGO, April 25 at LMO, and May 7 at MCN (Appendix J).

Spring tagged natural Chinook salmon smolts arrived at LGR from March 26 to July 16 and had a 90% arrival time of May 18 (Appendix K). Arrival at LGO, LMO, and MCN occurred from April 7 to August 24, April 5 to July 31, and April 18 to August 1, respectively. Median arrival timing at these three dams was as follows: May 5 at LGO, April 23 at LMO, and May 3 at MCN. The 90% arrival time at LGO was May 22, May 28 at LMO, and May 24 at MCN.

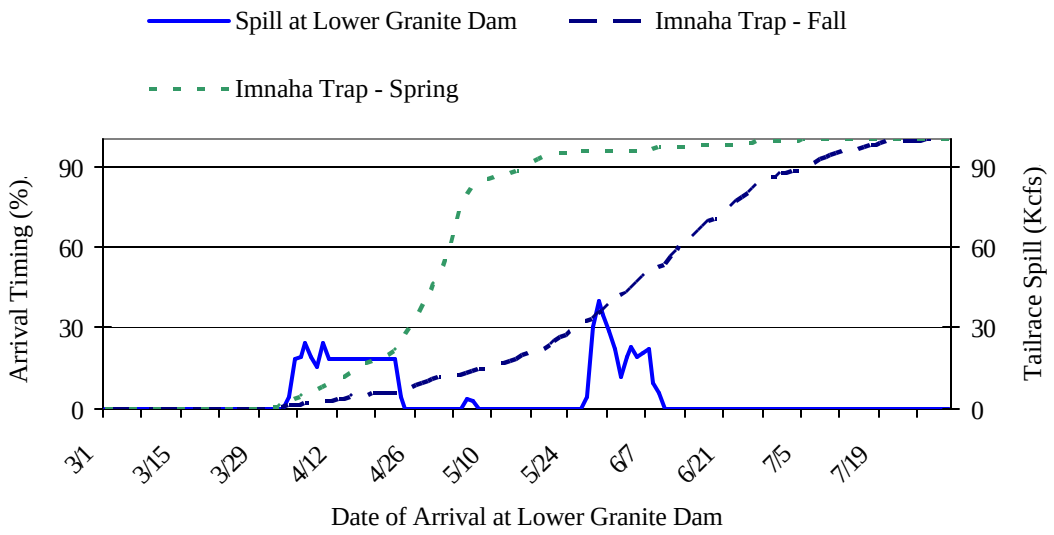

Figure 18. The cumulative arrival timing of fall and spring tagged natural Chinook salmon and tailrace spill at Lower Granite Dam during the 2004 migration year. Fall and spring tagged natural Chinook salmon were released in the fall of 2003 and the spring of 2004.

PIT tagged hatchery Chinook salmon smolts recaptured at the Imnaha River trap had the following arrival times at the four dams in 2004: April 5 to June 19 at LGR, April 10 to June 11 at LGO, April 11 to June 11 at LMO, and April 17 to June 8 at MCN (Appendix L). Median arrival timing occurred May 3 at LGR, May 6 at LGO, May 15 at LMO and May 10 at MCN. Ninety percent arrival timing occurred May 9 at LGR, May 15 at LGO, May 27 at LMO and May 22 at MCN.

Natural and Hatchery Steelhead Arrival Timing for 2004

Natural steelhead arrived at LGR, LGO, LMO, and MCN from March 27 to July 19, April 1 to June 29, April 5 to June 19, and April 17 to June 20 (Appendix M). Median arrival timing occurred May 8 at LGR, May 13 at LGO, May 25 at LMO, and May 15 at MCN. The 90% arriving timing occurred on May 22 at LGR, May 29 at LGO, June 2 at LMO, and June 3 at MCN.

Hatchery steelhead had the following range of arrival times: April 17 to July 25 at LGR, April 23 to October 15 at LGO, April 23 to August 12 at LMO, and May 6 to July 28 at MCN (Appendix N). Median arrival times for hatchery steelhead migrating in 2004 were May 19 at LGR, May 24 at LGO, May 29 at LMO, and May 31 at MCN. Ninety percent arrival times are as follows: June 12 at LGR, June 10 at LGO, June 11 at LMO, June 12 and MCN.

Historic Average Arrival Timing

This project has collected seven to thirteen years of arrival timing data for natural and hatchery Chinook salmon and steelhead from the Imnaha River. The annual first, median, 90%, and last arrival times from previous years were averaged (Table 13). The mean arrival timing range for fall tagged natural Chinook salmon pre-smolts from 1998 to 2004 at LGR is from March 30 (± 8 days) to May 15 (± 19days), with mean median and 90% arrival timing of April 17 (± 9 days) and April 27 (± 7 days), respectively. Mean median arrival times at LGO, LMO, and MCN for fall tagged natural Chinook salmon are April 11 (± 12 days), April 18 (± 15 days), and April 19 (± 16 days), respectively. Mean 90% arrival timing for fall tagged natural Chinook salmon was May 2 (± 12 days) at LGO, May 2 (± 16 days) at LMO, and May 6 (± 11 days) at MCN.

Spring tagged natural Chinook salmon smolt mean arrival times at LGR from 1993 to 2004 are as follows: mean arrival time range of April 4 (± 15 days) to July 4 (± 49 days), mean median arrival time of April 28 (± 8 days), and mean 90% arrival of May 14 (± 11 days). Mean median arrival times at LGO, LMO, and MCN for natural Chinook salmon smolts are May 1 (± 9 days), May 4 (± 14 days), and May 8 (± 11 days). Mean 90% arrival timing is May 17 (± 12 days) at LGO, May 22 (± 15 days) at LMO, and May 22 (± 11 days) at MCN.

Hatchery Chinook salmon smolt mean arrival times at LGR from 1993 to 2004 are as follows: mean arrival time range of April 11 (± 14 days) to May 26 (± 17 days), mean median arrival time of May 4 (± 7 days), and mean 90% arrival of May 13 (± 6 days). Mean median arrival times at LGO, LMO, and MCN for hatchery Chinook salmon smolts are May 8 (± 9 days), May12 (± 7 days), and May 14 (± 8 days). Mean 90% arrival timing is May 17 (± 9 days) at LGO, May 21 (± 6 days) at LMO, and May 22 (± 6 days) at MCN.

Historically, natural steelhead have a thirteen year mean arrival date range of April 14 (± 27 days) to July 12 (± 58 days) at LGR. The mean arrival date range for LGO, LMO, and MCN is as follows: April 17 (± 24 days) to July 9 (± 51 days) at LGO, April 23 (± 24 days) to July 7 (± 75 days) at LMO, and April 26 (± 25 days) to June 15 (± 34 days) at MCN. The thirteen-year median arrival time at LGR, LGO, LMO, and MCN is as follows: May 10 (± 13 days) at LGR, May 14 (± 11 days) at LGO, May 17 (± 14 days) at LMO, and May 17 (± 12 days) at MCN. The mean 90% arrival timing for natural steelhead is as follows: May 26 (± 16 days) at LGR, May 27 (± 12 days) at LGO, June 4 (± 34 days) at LMO, and May 28 (± 15 days) at MCN.

The thirteen-year mean range of arrival for hatchery steelhead at LGR is April 22 (± 17 days) to July 26 (± 50 days). Downstream mean arrival ranges for hatchery steelhead are as follows: April 26 (± 17 days) to August 5 (± 85 days) at LGO, April 30 (± 17 days) to August 4 (± 81 days) at LMO, and May 7 (± 18 days) to July 7 (± 41 days) at MCN. The thirteen year median arrival time at LGR, LGO, LMO, and MCN is as follows: May 21 (± 12 days), May 25 (± 7 days), May 30 (± 14 days), and June 1 (± 24 days), respectively. Mean 90% arrival occurred on June 9 (± 29 days) at LGR, June 16 (± 30 days) at LGO, June 18 (± 33 days) at LMO, and June 17 (± 33 days) at MCN.

Table 13. Historical mean first, median, 90%, and last arrival timing for fall and spring tagged natural chinook salmon juveniles, hatchery chinook salmon smolts, and natural and hatchery steelhead smolts, at Lower Granite Dam (LGR), Little Goose Dam (LGO), Lower Monumental Dam (LMO) and McNary Dam (MCN). All fish were captured in the Imnaha River trap. Mean arrival timing is presented with the 95% C.I. ± days.

Rearing, Species, Life Stage, Dam	First Arrival		Median Arrival		90% Arrival		Last Arrival	
	Mean	± days	Mean	± days	Mean	± days	Mean	± days
Fall Tagged Natural Chinook Salmon Pre-Smolts (1998 to 2004)[1]								
LGR	Mar-30	8	Apr-17	9	Apr-27	7	May-15	19
LGO	Apr-11	12	Apr-23	10	May-02	12	May-19	26
LMO	Apr-18	15	Apr-23	12	May-02	16	May-20	18
MCN	Apr-19	16	Apr-28	9	May-06	11	May-19	17
Spring Tagged Natural Chinook Salmon Smolts (1993 to 2004)								
LGR	Apr-04	15	Apr-28	8	May-14	11	Jul-04	49
LGO	Apr-14	11	May-01	9	May-17	12	Jul-05	55
LMO	Apr-18	16	May-04	14	May-22	15	Jul-04	49
MCN	Apr-22	11	May-08	11	May-22	11	Jun-22	41
Hatchery Chinook Salmon Smolts (1992 to 2004)								
LGR	Apr-11	14	May-04	7	May-13	6	May-26	17
LGO	Apr-19	12	May-08	9	May-17	9	Jun-01	13
LMO	Apr-24	11	May-12	7	May-21	6	Jun-02	13
MCN	Apr-28	13	May-14	8	May-22	6	Jun-02	13
Natural Steelhead Smolts (1993 to 2004)[2]								
LGR	Apr-14	27	May-10	13	May-26	16	Jul-12	58
LGO	Apr-17	24	May-14	11	May-27	12	Jul-09	51
LMO	Apr-23	24	May-17	14	Jun-04	34	Jul-07	75
MCN	Apr-26	25	May-17	12	May-28	15	Jun-15	34
Hatchery Steelhead Smolts (1993 to 2004)[2]								
LGR	Apr-22	17	May-21	12	Jun-09	29	Jul-26	50
LGO	Apr-26	17	May-25	7	Jun-16	30	Aug-05	85
LMO	Apr-30	17	May-30	14	Jun-18	33	Aug-04	81
MCN	May-07	18	Jun-01	24	Jun-17	33	Jul-07	41

1 Median and 90% arrival timing does not include data from migration year 2001 due to the small sample size.

[2] Median and 90% arrival timing does not include data from migration year 2002 due to the small sample size.

Arrival times are frequently expressed as median arrival times within this document. One aspect of median arrival times is that on occasion dams further downstream will have an earlier arrival time than those upstream. Median arrival times are highly influenced by flow conditions and detection probabilities at each dam. Throughout the migration season, there are variable detection probabilities at each dam and between dams. Early in the monitoring season dams will have a lower detection probability due to high spring flow. As the migration season progresses

the detection probabilities will increase as the flows decrease. In examining the SURPH output there is a significant number of smolts undetected until McNary dam. These smolts have passed through the upper three dams undetected due to low detection probabilities.

Travel Time to Lower Granite Dam

Natural Chinook salmon weekly median travel times to LGR ranged from 32 days (March 8) to four days (May 17 and May 24). Weekly comparison of median travel times between natural and hatchery stocks are limited to weeks that had more than 30 interrogations per category (Table 14). Weekly comparisons occur for the five weeks between March 29 and April 26. On average natural Chinook salmon median travel times were five days earlier than hatchery Chinook released in the same week.

Natural steelhead weekly median travel times to LGR ranged from 50 days (March 15) to two days (May 24) (Table 14). Hatchery steelhead travel times ranged from two days (May 31) to 21 days (April 12). The differences in median travel time ranged from zero days for the weeks of May 10, May 17, May 31, and June 7 to eight days during the week of April 12. On average natural steelhead salmon median travel times were two days earlier than hatchery steelhead released in the same week. Median travel times to LGR, for all groups, decreased with an increase in the calendar date. The relationship between the decrease in travel times and increase in calendar date has been previously described (Berggren and Filardo 1993) and is probably due to increased river discharge and smoltification (Groot et al. 1995).

Table 14. A summary of median travel times of natural and hatchery Chinook salmon smolts released from the Imnaha River screw trap, March 8 to June 21, 2004, at Lower Granite Dam.

Species	Release Week	Number Interrogated		Median Travel Time	
		Hatchery	Natural	Hatchery	Natural
Chinook	3/8/2004	0	126	0	32
	3/15/2004	0	364	0	28
	3/22/2004	0	636	0	23
	3/29/2004	228	162	29	25
	4/5/2004	167	362	24	16
	4/12/2004	144	684	19	12
	4/19/2004	52	746	14	10
	4/26/2004	39	730	7	7
	5/3/2004	10	123	5	6
	5/10/2004	18	258	5	7
	5/17/2004	0	18	0	4
	5/24/2004	0	8	0	4
	5/31/2004	0	50	0	5
	6/7/2004	0	47	0	7
	6/14/2004	0	61	0	9
	6/21/2004	0	26	0	12
Steelhead	3/15/2004	0	22	0	50
	3/22/2004	0	90	0	39
	3/29/2004	0	12	0	32
	4/5/2004	0	63	0	9
	4/12/2004	334	97	21	13
	4/19/2004	302	284	11	6
	4/26/2004	343	1241	8	5
	5/3/2004	602	464	7	4
	5/10/2004	611	1081	6	5
	5/17/2004	246	160	3	3
	5/24/2004	84	37	3	2
	5/31/2004	170	79	2	3
	6/7/2004	178	44	4	4
	6/14/2004	121	12	5	6
	6/21/2004	24	0	8	0

Mortality

Chinook Salmon and Steelhead Mortality

A total of 171 natural Chinook salmon, 27 hatchery Chinook salmon, 19 natural steelhead, and 40 hatchery steelhead mortalities occurred during the study. Thirty-three of the natural Chinook salmon mortalities occurred during the fall; 0.89 % of all natural Chinook salmon captured in the fall of 2003 (Appendix O). Trapping caused 24 mortalities, handling

caused five, and PIT tagging was the source of 14. No other mortalities occurred during the fall. One hundred thirty eight natural Chinook salmon mortalities occurred during the spring: 24 due to trapping, 5 due to handling, 104 from to PIT tagging and 5 were dead on arrival at the Imnaha screw trap (Appendix P). The total number of mortalities accounted for 1.09 % of the natural Chinook salmon captured in the spring of 2004. Twenty-one trapping, two handling, one PIT tagging, and three dead on arrival mortalities occurred to hatchery Chinook salmon with the total mortality accounted for 0.05 % of the catch in the spring of 2004.

There were 19 natural steelhead mortalities during the spring of 2004. Nine mortalities were attributed to trapping, four for handling, six for PIT tagging, and none were dead on arrival at the Imnaha screw trap. Hatchery steelhead had thirty-four trapping mortalities, four from handling, one from PIT tagging and one hatchery steelhead was dead on arrival. The 19 natural steelhead mortalities were 0.23 % of the total catch, where the 40 hatchery steelhead mortalities accounted for 0.15 %.

Incidental Catch

Incidental Catch for Migration Year 2004

The incidental catch during the fall and spring of migration year 2004 totaled 2,488 fish. It was comprised of five families of fishes: Salmonidae, Centrarchidae, Catostomidae, Cyprinidae, and Cottidae (Appendix Q). The catch of Salmonidae consisted of 43 adult steelhead, 1 adult fall Chinook salmon, 1,065 rainbow / juvenile steelhead, 368 mountain whitefish (*Prosopium williamsoni*), and 125 bull trout (*Salvelinus confluentus*). The juvenile rainbow/steelhead were resident fish based on morphological characteristics and are not a subset of the catch of natural steelhead reported in earlier sections of this report. The 26 Centrarchidae captured were smallmouth bass (*Micropterus dolomieui*). A total of 35 bridgelip suckers (*Catostomus columbianus*), 12 largescale suckers (*Catostomus macrocheilus*), and 412 unidentified sucker species represented the family Catostomidae. The catch of Cyprinidae was as follows: 24 chislemouth (*Acrocheilus alutaceus*), 176 longnose dace (*Rhinichthys cataractae*), 24 speckled dace (*Rhinichthys osculus*), 71 northern pikeminnow (*Ptychocheilus oregonensis*), and 29 redside shiner (*Richardsonius balteatus*). Fourteen *Cottus* species (sculpins) of the family Cottidae were captured during the spring of 2004.

ACKNOWLEDGMENTS

The Nez Perce Tribe extends the administrative support necessary to complete these projects and this report. Project funding from the U.S. Fish and Wildlife Service's Lower Snake River Compensation Plan program initiated the Imnaha River emigration project investigations in 1992 and the project continues today. The Bonneville Power Administration also provides significant project cost share funding for the Imnaha Smolt Monitoring Program. We wish to thank the following NPT employees for their hard work and dedication gathering the necessary data for this report: Cameron Albee, David Bright, Collin Edwards-Hill, Delbert Ellenwood, Katie Frenyae, Ryan Jain, David Kane, Stephen Marks, Joe McCormack, and Neal Meshell. Jay Hesse and Jason Vogel provided technical support and advice for these studies. We also acknowledge the Oregon Department of Fish and Wildlife for PIT tagging under BPA program number 199602000 and releasing the hatchery Chinook salmon from the acclimation facility. We extend our gratitude to the United States Forest Service for allowing us the use of the Thorn Creek guard station facilities, and Jack and Scott McClaren for allowing us access to their land for trapping purposes. The Fish Passage Center's Data System Administrative Manager, Henry Franzoni, and Senior Data Analyst, Sergie Rasskazov provided software that assisted with daily tasks.

LITERATURE CITED

Anonymous 2003a. USGS/Cascade Volcano Observatory. [online] Available at http://vulcan.wr.usgs.gov/volcanoes/washington/columbia_river/discription_columbia_river.html.

Anonymous 2003b. Walla Walla District Hydropower Dams [online] Available at http://www.usace.army.mil/.

Anonymous 2000c. 13292000-IMNAHA RIVER AT IMNAHA, OR. [online] Available at http://oregon.usgs.gov/rt-cgi/gen_stn_pg?station=13292000.

Ashe, B. L., A. C. Miller, P. A. Kucera, and M. L. Blenden. 1995. Spring Outmigration Of Wild And hatchery Chinook Salmon and Steelhead Smolts From The Imnaha River, March 1 - June15, 1994. FPC Technical Report. NPT DFRM Lapwai, Idaho.

Bagenal, T. B., and F. W. Tesch. 1978. Age and growth. Pages 101-136 in T.B.Bagenal, editor. Methods for assessment of fish production in fresh waters, 3rd edition. Blackwell Scientific Publications, Oxford, England.

Berggren, T.J., and M.J. Filardo. 1993. An Analysis of Variables in Influencing the Migration of Juvenile Salmonids in the Columbia River Basin. North American Journal of Fisheries Management 13:48-63.

Burnham, K.P., D.R. Anderson, G.C. White, C. Brownie, and K.H. Pollock. 1987. Design and Analysis Methods for Fish Survival Experiments Based on Release-Recapture. American Fisheries Society, Bethesda, Maryland.

Cleary, P.J., M.L. Blenden, and P.A. Kucera. 2000. Emigration of Natural and Hatchery Chinook Salmon and Steelhead Smolts from the Imnaha River, Oregon October 14, 1997 to June16, 1998. Bonneville Power Administration Technical Report. Contract #97AM30423.

Cleary, P.J., P.A. Kucera, M.L. Blenden, and K. Gillogly. 2003a. Emigration of Natural and Hatchery Chinook Salmon and Steelhead Smolts from the Imnaha River, Oregon October 20, 1999 to June 15, 2000.Bonneville Power Administration Technical Report. Contract # 97AM30423.

Cleary, P.J., P.A. Kucera, M.L. Blenden, N. Espinosa, and C.M. Albee. 2003b. Emigration of Natural and Hatchery Chinook Salmon and Steelhead Smolts from the Imnaha River, Oregon October 17, 2000 to June 12, 2002. Bonneville Power Administration Technical Report. Contract # 97AM30423.

Ecovista. 2004. Imnaha Subbasin Plan. Plan includes Assessment, Inventory, and Management Plan. For Nez Perce Tribe as part of Northwest Power and Conservation Council's Fish and Wildlife Program. http://www.nwcouncil.org/fw/subbasinplanning/imnaha/plan/.

Groot, C., L. Margolis, and W.C. Clarke (editors). 1995. Physiology of Ecology of Pacific Salmon. UBC Press. Vancouver, B.C.

James, G. 1984. Imnaha River basin recommended salmon and steelhead habitat improvement measures. Working paper. Confederated Tribes of the Umatilla Indian Reservation.

Kennen, J. G., S. J. Wisniewski, N. H. Ringler, and H. M. Hawkins. 1994. Application and modification of an auger trap to quantify emigrating fishes in Lake Ontario tributaries. North American Journal of Fisheries Management 14:828-836.

Kucera, P. A. 1989. Nez Perce Tribal review of the Imnaha River Lower Snake River Compensation Plan. Working paper. LSRCP Technical Report AFF1/LSR-89-08. Nez Perce tribe Fisheries Management, Lapwai, Idaho.

Kucera, P.A., and M.L. Blenden. 1998. Emigration of hatchery and natural chinook salmon from the Imnaha River. Lower Snake River Compensation Plan Status Review Symposium. USFWS Lower Snake River Compensation Plan Office. Boise, Idaho. pp.141-153.

Matthews, G. M., J. R. Harmon, S. Achord, O. W. Johnson, and L. A. Kubin. 1990. Evaluation of transportation on the Columbia and Snake Rivers, 1989. Report to the U.S. Army Corps of Engineers, Contract DACW68-84-H0034. NMFS. Seattle, Washington.

Matthews, G. M., S. Accord, 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. Columbia and Snake Rivers, 1990.Report to USACE, Seattle, Washington.

Mesa, M.G. and T.M. Olson. 1993. Prolonged Swimming Performance of Northern Squawfish. Transactions of the American Fisheries Society. 122:1104-1110.

National Marine Fisheries Service (NMFS). 2000. Endangered Species Act - Section 7 Consultation - Biological Opinion: Reiteration of consultation on operation of the Federal Columbia River Power System, including the Juvenile Fish Transportation Program, and 19 Bureau of Reclamation projects in the Columbia Basin. National Marine Fisheries Service, Northwest Region. December 2000.

Ott, L. 1984. An introduction to statistical methods and data analysis. PWS Publishers. Boston, Massachusetts.

Prentice, E. F., D. L. Park, T. A. Flagg, and S. McCutcheon. 1986. A study to determine the biological feasibility of a new fish tagging system, 1985-1986. Report to the Bonneville Power Administration. Contract DE-A179-83BP11982, Project 83-119. NMFS.

Prentice, E. F., T. A. Flagg, C. S. McCutcheon, D. F. Brastow, and D. C. Cross. 1990. Equipment, methods, and an automated data-entry station for PIT tagging. American Fisheries Society Symposium 7:335-340.

Raymond, H.L. 1979. Effects of Dams and Impoundments on Migrations of Juvenile Chinook Salmon and Steelhead from the Snake River, 1966 to 1975. Transactions of the American Fisheries Society. 6:505-528.

Smith, S.G., J.R. Skalski, J.W. Schlechte, A. Hoffmann, and V. Cassen, J.R.. 1994. Statistical Survival Analysis of Fish and Wildlife Tagging Studies. Contract DE-BI79-90BP02341. Project 89-107. Bonneville Power Administration. Portland, Oregon.

Smith, S.G., W.D. Muir, J.G. Williams, and J.R. Skalski. 2002. Factors Associated with Travel Time and Survival of Migrant Yearling Chinook Salmon and Steelhead in the Lower Snake River. North American Journal of Fisheries Management. 22:385 - 405.

Steel, R.G.D., J.H. Torrie, D.A. Dicky. 1997. Principles and Procedures of Statistics: A Biometrical Aproach. Third Edition. McGraw-Hill, Inc. New York, New York.

Steinhorst, K., Y. Wu, B. Dennis, and P. Kline. 2004. Confidence intervals for fish out-migration estimates using stratified trap efficiency methods. Journal of Agricultural, Biological, and Environmental Statistics 9:284-299.

Thedinga, J. F., M. L. Murphy, S. W. Johnson, J. M. Lorenz, and K. V. Koski. 1994. Determination of salmonid smolt yield with rotary screw traps in the Situk River, Alaska, to predict effects of glacial flooding. North American J.F.M. 14:837-851.

Westhagen, P. and J. Skalski. 2006. PITPRO version 3.3a. Columbia Basin Research, School of Aquatic & Fishery Sciences,University of Washington.

Whitesel, T.A., R.W. Carmichael, M.W. Flesher, D.L. Eddy. 1998. Summer Steelhead in the Imnaha River Basin, Oregon. Lower Snake River Compensation Plan Status Review Symposium. USFWS Lower Snake River Compensation Plan Office. Boise, Idaho. pp. 32-42.

APPENDICES

Appendix A. The mean daily discharge (cfs) and temperature (°C) for the Imnaha and Snake Rivers from October 1, 2003 to June 30, 2004. Discharge data for USGS gauges 13292000 and 13334300 were obtained online from USGS websites.

	Imnaha River		Snake River	
Date	Discharge (cfs)	Temperature (°C)	Discharge (cfs)	Temperature (°C)
10/1/2003	106	16.0	16,000	19.1
10/2/2003	105	15.9	15,800	19.1
10/3/2003	104	15.5	15,200	19.0
10/4/2003	105	15.6	14,400	18.9
10/5/2003	106	16.0	13,500	18.8
10/6/2003	106	16.5	14,400	18.8
10/7/2003	106	16.2	14,800	18.8
10/8/2003	103	15.1	12,200	18.2
10/9/2003	98	14.4	12,300	17.6
10/10/2003	99	12.3	14,500	17.1
10/11/2003	102	10.2	12,600	16.3
10/12/2003	109	10.7	12,600	16.0
10/13/2003	110	11.4	12,400	15.9
10/14/2003	105	10.9	12,400	15.5
10/15/2003	110	9.7	12,400	15.0
10/16/2003	122	9.7	12,400	15.0
10/17/2003	121	11.2	12,600	14.8
10/18/2003	121	12.1	12,600	15.0
10/19/2003	117	12.0	12,600	15.1
10/20/2003	114	12.5	12,600	15.3
10/21/2003	119	13.1	12,500	15.5
10/22/2003	120	12.9	12,400	15.5
10/23/2003	118	12.5	12,300	15.2
10/24/2003	118	9.8	12,300	14.5
10/25/2003	120	7.7	12,200	13.8
10/26/2003	122	7.7	12,300	13.4
10/27/2003	124	9.0	12,300	13.4
10/28/2003	124	12.2	12,300	13.9
10/29/2003	Ice	10.5	12,500	13.6
10/30/2003	Ice	6.1	12,700	12.4
10/31/2003	128	3.6	12,900	10.8
11/01/2003	115	1.8	12,700	9.9
11/02/2003	130	2.4	12,300	9.8
11/03/2003	137	3.0	12,300	9.8
11/04/2003	127	2.0	12,400	9.6
11/05/2003	102	1.4	12,600	8.9
11/06/2003	90	0.2	12,500	8.5
11/07/2003	121	0.3	12,300	8.5
11/08/2003	160	1.5	12,000	8.3

	Imnaha River		Snake River	
Date	Discharge (cfs)	Temperature (°C)	Discharge (cfs)	Temperature (°C)
11/09/2003	140	2.3	12,100	8.5
11/10/2003	127	4.1	12,500	8.7
11/11/2003	128	6.4	13,200	9.0
11/12/2003	125	5.4	13,500	8.8
11/13/2003	118	3.7	13,300	8.4
11/14/2003	116	2.6	13,000	8.0
11/15/2003	121	3.6	12,800	8.0
11/16/2003	121	5.7	12,700	8.3
11/17/2003	131	5.7	12,800	8.5
11/17/2003	131	5.7	12,800	8.5
11/18/2003	123	6.8	13,100	8.8
11/19/2003	123	7.5	13,100	8.8
11/20/2003	127	5.2	13,000	8.4
11/21/2003	120	3.6	13,100	8.0
11/22/2003	109	1.7	13,100	7.2
11/23/2003	94	1.5	12,800	6.9
11/24/2003	118	2.3	12,500	6.9
11/25/2003	116	1.9	12,400	6.6
11/26/2003	130	2.4	12,500	6.7
11/27/2003	119	2.1	12,600	6.6
11/28/2003	124	3.4	12,600	6.7
11/29/2003	132	5.6	13,100	6.9
11/30/2003	131	5.6	13,100	6.9
12/01/2003	128	5.5	13,200	7.1
12/02/2003	146	6.3	13,400	7.2
12/03/2003	137	6.1	13,500	7.1
12/04/2003	133	3.4	13,400	6.3
12/05/2003	130	5.3	13,300	6.3
12/06/2003	175	7.2	13,300	6.6
12/07/2003	214	5.8	13,800	6.5
12/08/2003	162	4.6	14,300	6.5
12/09/2003	139	2.9	14,300	6.1
12/10/2003	141	3.0	13,800	6.0
12/11/2003	138	3.6	13,600	6.0
12/12/2003	132	3.8	13,400	6.1
12/13/2003	132	4.9	13,400	6.2
12/14/2003	158	5.6	14,000	6.2
12/15/2003	140	3.7	15,600	5.9
12/16/2003	131	2.7	15,800	5.8
12/17/2003	137	2.8	14,200	5.6
12/18/2003	130	1.0	13,300	5.1
12/19/2003	137	0.5	13,100	4.8
12/20/2003	149	2.1	13,100	4.9
12/21/2003	146	3.3	12,900	5.2
12/22/2003	139	3.7	12,800	5.5

	Imnaha River		Snake River	
Date	Discharge (cfs)	Temperature (°C)	Discharge (cfs)	Temperature (°C)
12/23/2003	131	1.6	13,000	5.2
12/24/2003	146	3.4	13,400	4.9
12/25/2003	157	4.3	13,700	5.0
12/26/2003	148	3.0	13,400	5.0
12/27/2003	109	0.6	13,500	4.4
12/28/2003	105	1.0	13,600	4.1
12/29/2003	146	1.5	19,000	4.3
12/30/2003	Ice	-0.1	18,300	4.1
12/31/2003	Ice	-0.2	14,600	3.9
1/01/2004	Ice	-0.2	12,900	3.5
1/02/2004	131	0.5	13,100	3.2
1/03/2004	107	0.2	13,800	3.5
1/04/2004	Ice	-0.2	15,100	3.0
1/05/2004	Ice	-0.2	16,300	2.3
1/06/2004	Ice	-0.2	22,700	3.1
1/07/2004	Ice	-0.2	20,900	3.2
1/08/2004	Ice	-0.2	18,400	3.3
1/09/2004	174	-0.2	17,500	3.6
1/10/2004	162	1.0	16,500	3.5
1/11/2004	150	2.0	16,900	3.4
1/12/2004	140	0.9	19,600	3.4
1/13/2004	142	2.2	22,300	3.7
1/14/2004	140	1.3	21,000	3.7
1/15/2004	134	0.9	17,200	3.5
1/16/2004	144	2.0	20,400	3.8
1/17/2004	139	2.1	18,100	3.9
1/18/2004	137	1.4	19,700	4.0
1/19/2004	139	2.5	19,700	4.3
1/20/2004	136	2.8	17,300	4.2
1/21/2004	131	3.3	15,000	4.3
1/22/2004	101	1.4	18,200	4.1
1/23/2004	132	2.0	17,900	4.0
1/24/2004	143	2.5	14,100	3.9
1/25/2004	130	1.6	14,700	3.8
1/26/2004	132	2.2	14,600	3.8
1/27/2004	131	3.2	16,200	4.0
1/28/2004	133	4.3	16,400	4.3
1/29/2004	136	5.3	18,000	4.6
1/30/2004	151	5.6	21,500	4.5
1/31/2004	142	3.2	20,300	3.8
2/01/2004	136	2.5	20,200	3.5
2/02/2004	124	1.4	19,300	3.0
2/03/2004	143	2.0	22,000	2.9
2/04/2004	136	3.6	20,500	3.2
2/05/2004	134	4.1	18,800	3.6

	Imnaha River		Snake River	
Date	Discharge (cfs)	Temperature (°C)	Discharge (cfs)	Temperature (°C)
2/06/2004	126	2.8	22,800	3.2
2/07/2004	136	3.5	19,800	3.2
2/08/2004	132	3.7	17,000	3.4
2/09/2004	131	4.2	19,100	3.6
2/10/2004	122	3.6	20,800	3.5
2/11/2004	124	2.8	20,200	3.2
2/12/2004	111	1.7	21,200	2.9
2/13/2004	105	0.8	22,700	2.6
2/14/2004	140	1.8	23,200	2.7
2/15/2004	160	2.8	18,900	3.0
2/16/2004	147	2.4	20,300	2.9
2/17/2004	155	4.5	23,200	3.2
2/18/2004	234	6.3	18,200	3.6
2/19/2004	279	6.0	21,100	4.2
2/20/2004	262	5.5	23,100	4.6
2/21/2004	243	4.4	23,600	4.2
2/22/2004	231	3.7	23,000	3.8
2/23/2004	236	3.8	20,400	3.9
2/24/2004	236	5.1	20,500	4.3
2/25/2004	239	4.2	22,700	4.2
2/26/2004	265	5.6	24,400	4.4
2/27/2004	259	6.1	23,600	4.9
2/28/2004	258	6.3	23,100	4.9
2/29/2004	247	6.1	19,600	5.1
3/01/2004	234	4.7	20,900	4.9
3/02/2004	230	5.7	24,900	4.8
3/03/2004	208	3.8	24,900	4.3
3/04/2004	212	4.5	27,500	4.2
3/05/2004	204	4.5	26,600	4.4
3/06/2004	195	4.7	23,000	4.6
3/07/2004	184	6.1	21,200	4.9
3/08/2004	186	7.5	21,500	5.5
3/09/2004	211	7.7	26,200	5.6
3/10/2004	262	7.7	27,500	5.9
3/11/2004	307	6.5	31,000	5.6
3/12/2004	343	7.5	27,700	6.0
3/13/2004	394	8.3	26,200	6.5
3/14/2004	408	7.1	25,300	6.5
3/15/2004	409	7.3	25,000	6.7
3/16/2004	418	8.3	31,500	6.8
3/17/2004	445	8.7	32,400	7.4
3/18/2004	474	8.8	36,900	7.3
3/19/2004	521	8.0	36,900	7.2
3/20/2004	503	6.6	35,000	6.8
3/21/2004	486	8.4	34,300	7.4

	Imnaha River		Snake River	
Date	Discharge (cfs)	Temperature (°C)	Discharge (cfs)	Temperature (°C)
3/22/2004	596	9.9	35,200	8.2
3/23/2004	727	10.2	39,300	8.6
3/24/2004	837	8.1	40,600	8.2
3/25/2004	746	8.1	42,000	7.8
3/26/2004	799	7.5	43,400	8.0
3/27/2004	710	7.0	39,600	7.9
3/28/2004	614	7.7	35,700	8.1
3/29/2004	562	8.5	33,700	8.5
3/30/2004	586	9.8	36,900	9.1
3/31/2004	692	8.8	32,500	9.1
4/01/2004	628	7.6	32,600	8.1
4/02/2004	556	7.9	30,700	8.0
4/03/2004	550	9.4	26,600	8.9
4/04/2004	618	11.2	31,900	10.0
4/05/2004	731	9.9	31,100	10.1
4/06/2004	836	10.8	33,200	10.0
4/07/2004	959	10.5	29,100	10.6
4/08/2004	971	10.2	31,100	10.5
4/09/2004	938	9.5	33,600	10.3
4/10/2004	876	9.2	31,000	10.1
4/11/2004	831	9.4	30,500	10.1
4/12/2004	843	10.4	30,900	10.4
4/13/2004	891	10.6	37,400	10.7
4/14/2004	918	9.5	39,200	10.3
4/15/2004	866	7.9	41,900	9.8
4/16/2004	749	8.2	31,200	9.3
4/17/2004	680	9.0	28,700	9.7
4/18/2004	632	9.3	27,100	9.7
4/19/2004	590	8.6	25,900	9.9
4/20/2004	593	9.0	25,100	10.0
4/21/2004	603	9.0	24,800	10.2
4/22/2004	596	9.7	24,400	10.2
4/23/2004	595	10.2	23,800	10.7
4/24/2004	615	10.9	23,600	10.9
4/25/2004	625	10.9	23,800	11.4
4/26/2004	665	11.9	24,000	12.1
4/27/2004	762	12.6	26,600	12.7
4/28/2004	894	9.9	29,000	11.8
4/29/2004	810	8.9	30,200	11.0
4/30/2004	759	10.4	29,600	11.3
5/01/2004	790	12.0	29,100	12.0
5/02/2004	875	12.9	30,200	12.6
5/03/2004	1,030	12.9	35,200	12.9
5/04/2004	1,160	12.0	41,600	12.8
5/05/2004	1,250	11.8	49,300	12.5

	Imnaha River		Snake River	
Date	Discharge (cfs)	Temperature (°C)	Discharge (cfs)	Temperature (°C)
5/06/2004	1,230	11.4	53,100	12.2
5/07/2004	1,150	11.6	49,800	11.9
5/08/2004	1,150	11.3	46,800	12.1
5/09/2004	1,030	10.8	45,200	11.8
5/10/2004	1,000	9.6	43,100	11.4
5/11/2004	988	8.1	44,500	10.6
5/12/2004	949	8.7	41,800	10.3
5/13/2004	922	9.6	39,700	10.7
5/14/2004	884	10.8	38,600	11.6
5/15/2004	886	10.0	40,800	11.8
5/16/2004	990	9.6	40,300	11.5
5/17/2004	1,060	10.5	44,500	11.8
5/18/2004	1,080	10.3	42,100	12.5
5/19/2004	1,280	10.5	42,000	12.4
5/20/2004	1,410	10.3	48,000	13.1
5/21/2004	1,430	10.2	52,300	13.1
5/22/2004	1,470	9.6	52,100	13.1
5/23/2004	1,540	9.1	53,800	12.5
5/24/2004	1,530	9.9	58,000	12.8
5/25/2004	1,430	10.1	56,500	13.0
5/26/2004	1,370	10.6	54,800	13.3
5/27/2004	1,570	11.1	56,800	13.2
5/28/2004	1,890	9.7	64,900	12.4
5/29/2004	1,890	8.8	69,500	11.5
5/30/2004	1,740	9.6	71,300	11.7
5/31/2004	1,580	10.8	69,600	12.5
6/01/2004	1,470	12.0	66,900	13.5
6/02/2004	1,410	12.9	61,400	14.4
6/03/2004	1,430	13.7	63,200	15.2
6/04/2004	1,590	14.8	61,200	16.1
6/05/2004	1,700	13.9	62,100	15.9
6/06/2004	1,680	12.7	59,500	15.1
6/07/2004	1,430	11.3	62,100	14.2
6/08/2004	1,310	12.0	62,500	14.2
6/09/2004	1,170	11.5	61,000	14.0
6/10/2004	1,130	10.8	56,900	13.5
6/11/2004	1,040	11.6	53,400	13.7
6/12/2004	991	12.3	51,100	14.3
6/13/2004	954	13.8	48,200	14.9
6/14/2004	968	14.2	52,000	15.4
6/15/2004	939	13.6	49,400	15.6
6/16/2004	886	13.3	41,600	15.6
6/17/2004	870	14.4	38,500	15.9
6/18/2004	885	14.2	37,000	16.2
6/19/2004	858	14.1	32,200	16.1

	Imnaha River		Snake River	
Date	Discharge (cfs)	Temperature (°C)	Discharge (cfs)	Temperature (°C)
6/20/2004	823	14.8	30,600	16.6
6/21/2004	828	15.9	30,400	17.1
6/22/2004	842	16.8	34,000	17.7
6/23/2004	880	17.2	32,200	18.3
6/24/2004	925	17.4	40,200	18.7
6/25/2004	923	16.6	34,400	18.6
6/26/2004	898	17.9	29,000	19.1
6/27/2004	1,110	18.3	29,000	19.6
6/28/2004	1,000	16.9	29,200	19.0
6/29/2004	971	16.4	27,500	18.4
6/30/2004	877	17.4	27,300	18.9

Appendix B. Mean monthly discharge for the Imnaha River from 1929 to 2004, and the Snake River from1959 to 2004. Discharge data for USGS gauges 132292000 and 13334300 were obtained online from USGS web sites.

	Imnaha River				Snake River			
Year	March	April	May	June	March	April	May	June
1929	340	656	1,245	1,207	N/A	N/A	N/A	N/A
1930	294	753	724	705	N/A	N/A	N/A	N/A
1931	218	582	881	433	N/A	N/A	N/A	N/A
1932	306	1,052	2,169	1,349	N/A	N/A	N/A	N/A
1933	191	754	1,383	2,187	N/A	N/A	N/A	N/A
1934	478	813	699	439	N/A	N/A	N/A	N/A
1935	177	758	1,243	1,034	N/A	N/A	N/A	N/A
1936	204	973	1,151	597	N/A	N/A	N/A	N/A
1937	194	476	1,200	838	N/A	N/A	N/A	N/A
1938	574	1,578	2,602	2,123	N/A	N/A	N/A	N/A
1939	506	795	967	510	N/A	N/A	N/A	N/A
1940	579	1,146	1,133	823	N/A	N/A	N/A	N/A
1941	546	921	1,363	1,532	N/A	N/A	N/A	N/A
1942	337	1,608	1,748	1,408	N/A	N/A	N/A	N/A
1943	415	1,567	1,323	1,451	N/A	N/A	N/A	N/A
1944	162	671	867	968	N/A	N/A	N/A	N/A
1945	276	727	1,661	1,579	N/A	N/A	N/A	N/A
1946	390	1,273	1,807	1,229	N/A	N/A	N/A	N/A
1947	475	824	1,398	933	N/A	N/A	N/A	N/A
1948	254	1,241	2,804	2,339	N/A	N/A	N/A	N/A
1949	416	1,049	1,666	930	N/A	N/A	N/A	N/A
1950	326	725	1,307	1,542	N/A	N/A	N/A	N/A
1951	303	1,147	1,515	972	N/A	N/A	N/A	N/A
1952	244	1,532	2,421	1,753	N/A	N/A	N/A	N/A
1953	330	943	1,544	1,881	N/A	N/A	N/A	N/A
1954	363	884	1,349	1,026	N/A	N/A	N/A	N/A
1955	141	512	1,505	1,386	N/A	N/A	N/A	N/A
1956	642	1,760	2,381	1,796	N/A	N/A	N/A	N/A
1957	475	815	2,661	1,394	N/A	N/A	N/A	N/A
1958	372	928	2,552	2,004	N/A	N/A	N/A	N/A
1959	307	989	1,482	1,550	26,150	38,080	45,170	68,620
1960	500	923	1,316	1,094	31,990	41,700	53,050	61,850
1961	395	635	1,355	1,329	28,030	26,850	42,510	54,250
1962	287	1,192	1,336	1,371	26,390	49,480	55,730	60,800
1963	408	891	1,561	1,291	23,800	28,640	64,420	83,850
1964	165	719	1,525	1,752	23,250	38,190	65,369	98,320
1965	419	1,426	1,845	1,791	54,870	71,080	93,730	102,400
1966	414	952	1,210	786	25,870	29,770	37,050	34,060
1967	377	533	1,990	2,132	23,600	23,760	56,789	87,320
1968	464	570	1,283	1,258	25,840	27,050	38,440	56,620
1969	351	1,492	2,083	1,491	48,410	74,380	86,150	59,460
1970	309	384	1,820	1,715	28,740	31,090	70,330	96,840

	Imnaha River				Snake River			
Year	March	April	May	June	March	April	May	June
1971	378	1,068	2,777	1,965	52,430	82,970	117,200	116,900
1972	869	758	1,708	1,673	90,400	67,300	81,060	98,400
1973	255	517	1,148	767	28,310	26,179	42,060	38,530
1974	761	1,264	1,876	2,612	59,350	88,700	90,500	132,700
1975	272	557	2,249	2,284	43,870	60,929	85,360	100,800
1976	242	839	1,734	921	43,200	78,290	102,200	77,860
1977	114	345	445	423	18,680	18,880	20,610	24,380
1978	729	1,611	1,528	1,306	39,330	55,379	67,670	70,000
1979	437	681	1,802	912	38,290	40,140	56,899	44,080
1980	307	1,049	1,602	1,496	25,820	40,100	75,480	75,730
1981	393	888	1,501	1,397	26,500	32,880	58,660	75,340
1982	699	1,117	2,116	2,044	65,740	73,680	97,820	110,700
1983	970	1,007	1,933	1,710	77,140	64,080	97,250	106,600
1984	504	1,046	1,839	1,949	60,270	86,710	118,700	134,200
1985	282	1,078	1,285	1,157	36,080	63,280	57,550	48,920
1986	993	981	1,361	1,329	90,330	77,470	80,640	93,230
1987	518	704	764	417	24,820	27,430	38,620	21,210
1988	246	646	707	713	19,810	25,890	40,320	32,500
1989	510	961	1,099	1,014	40,740	58,460	51,800	44,630
1990	401	1,084	965	1,159	23,230	30,400	38,270	45,260
1991	228	531	1,177	914	18,910	19,840	45,160	48,240
1992	371	451	571	361	21,950	24,460	32,570	16,850
1993	432	871	2,172	1,510	37,920	49,890	86,760	77,750
1994	320	771	1,003	613	22,880	31,310	44,270	24,850
1995	1,026	1,149	2,197	1,759	36,540	41,510	78,030	92,740
1996	618	1,345	1,648	1,396	71,970	84,250	82,110	105,800
1997	657	1,398	2,038	1,681	77,640	85,020	109,600	117,800
1998	582	940	2,500	1,661	40,040	49,040	105,900	90,590
1999	606	1,066	1,997	1,801	68,600	67,530	76,880	99,650
2000	358	1,247	1,245	989	38,290	56,210	53,600	42,620
2001	240	438	757	383	20,360	23,730	39,370	22,410
2002	227	953	1,267	1,173	24,030	39,470	44,880	53,190
2003	605	1,056	1,504	1,450	28,270	36,840	56,000	62,649
2004	444	742	1,240	1,069	31,140	29,620	48,560	45,470

Appendix C. The number of hours sampled and the catch of natural Chinook salmon and steelhead at the Imnaha River trap from October 1, 2003 to June 27, 2004. Sampling periods exceeded 24 hours when trapping continued past the hour the trap was started from the previous day (e.g. 8:30 am on October 17 to 11:00 am on October 18).

Sample End Date	Hours fished	Natural Chinook salmon	Hatchery Chinook salmon	Natural Steelhead	Hatchery Steelhead
10/14/2003	17.0	10	0	6	0
10/15/2003	23.0	57	0	13	0
10/16/2003	24.0	23	0	24	0
10/17/2003	26.5	202	0	21	0
10/20/2003	17.0	51	0	0	0
10/21/2003	21.0	33	0	4	0
10/22/2003	24.0	34	0	2	0
10/23/2003	24.5	50	0	2	0
10/24/2003	24	60	0	3	0
10/27/2003	17	152	0	20	0
10/28/2003	23	274	0	15	0
10/29/2003	24	274	0	20	0
10/30/2003	23	142	0	13	0
10/31/2003	23.5	83	0	27	0
11/3/2003	16	43	0	1	0
11/4/2003	24.5	179	0	0	0
11/5/2003	23	148	0	0	0
11/6/2003	22.5	80	0	0	0
11/7/2003	23.5	40	0	0	0
11/10/2003	18	74	0	2	0
11/11/2003	24.5	85	0	3	0
11/12/2003	19.5	153	0	16	0
11/13/2003	30	211	0	2	0
11/14/2003	18.5	246	0	3	0
11/17/2003	19	152	0	5	0
11/18/2003	25.5	61	0	2	0
11/19/2003	22.5	144	0	2	0
11/20/2003	24.0	142	0	4	0
11/21/2003	24.0	112	0	1	0
11/24/2003	23.7	71	0	0	0
11/25/2003	24.0	135	0	1	0
11/26/2003	24.0	117	0	0	0
12/1/2003	25.5	31	0	0	0
12/2/2003	23.5	40	0	0	0
12/3/2003	23.0	7	0	0	0
2/26/2004	24.0	3	0	0	0
2/27/2004	24.5	26	0	0	0
2/28/2004	24.0	11	0	0	0
2/29/2004	23.5	7	0	1	0
3/1/2004	24.0	8	0	0	0
3/2/2004	24.0	13	0	0	0

Sample End Date	Hours fished	Natural Chinook salmon	Hatchery Chinook salmon	Natural Steelhead	Hatchery Steelhead
3/3/2004	27.0	12	0	0	0
3/4/2004	20.5	5	0	0	0
3/5/2004	24.0	28	0	0	0
3/6/2004	24.0	11	0	0	0
3/7/2004	23.0	10	0	0	0
3/8/2004	18.0	9	0	0	0
3/9/2004	25.0	5	0	0	0
3/10/2004	23.5	19	0	0	0
3/11/2004	20.5	72	0	3	0
3/12/2004	24.5	104	0	0	0
3/13/2004	22.5	95	0	3	0
3/14/2004	24.0	157	0	9	0
3/15/2004	24.5	154	0	7	0
3/16/2004	24.0	117	0	3	0
3/17/2004	23.5	118	0	0	0
3/18/2004	24.0	162	0	5	0
3/19/2004	24.0	214	0	9	0
3/20/2004	27.0	291	0	13	0
3/21/2004	20.5	271	0	7	0
3/22/2004	24.0	265	0	16	0
3/23/2004	24.0	240	0	14	0
3/24/2004	23.0	183	0	30	0
3/25/2004	18.0	217	0	39	0
3/26/2004	25.0	476	0	27	0
3/27/2004	23.5	388	14	26	0
3/28/2004	20.5	222	4057	14	0
3/29/2004	24.5	550	6098	10	1
3/30/2004	22.5	138	3818	10	0
3/31/2004	24	20	1398	1	0
4/1/2004	27	43	3403	3	0
4/2/2004	23	148	7674	25	0
4/3/2004	22.5	87	1792	1	0
4/4/2004	23	25	645	2	0
4/5/2004	24	35	683	5	0
4/6/2004	26	38	594	6	0
4/7/2004	23	110	1051	19	0
4/8/2004	13	84	1110	45	7
4/9/2004	24	227	1856	36	0
4/10/2004	24	182	1633	32	0
4/11/2004	24	179	1272	32	0
4/12/2004	24	133	904	38	0
4/13/2004	26	155	778	22	681
4/14/2004	24	200	867	74	4720
4/15/2004	25	88	2029	42	1834
4/16/2004	23	142	3644	26	1144

Sample End Date	Hours fished	Natural Chinook salmon	Hatchery Chinook salmon	Natural Steelhead	Hatchery Steelhead
4/17/2004	16	310	1888	58	494
4/18/2004	25	227	706	32	129
4/19/2004	19	106	255	21	61
4/20/2004	25.5	248	611	28	94
4/21/2004	21.5	186	319	44	82
4/22/2004	26.5	208	420	75	82
4/23/2004	23.5	151	258	54	62
4/24/2004	24.5	121	160	70	75
4/25/2004	26	152	208	122	112
4/26/2004	23	181	187	143	96
4/27/2004	24	216	249	186	119
4/28/2004	23.5	165	230	345	379
4/29/2004	24.5	350	441	947	1363
4/30/2004	20.5	269	322	396	423
5/1/2004	23.5	224	185	282	747
5/2/2004	23.5	167	146	187	1484
5/3/2004	25	1420	1574	752	1690
5/4/2004	4.5	48	63	144	404
5/5/2004	6	8	46	89	1212
5/6/2004	0	N/A	N/A	N/A	N/A
5/7/2004	7.5	28	5	353	760
5/8/2004	24	84	89	392	1031
5/9/2004	24	63	100	233	754
5/10/2004	26	180	159	246	655
5/11/2004	24	115	137	244	878
5/12/2004	22	71	78	208	545
5/13/2004	11	25	37	168	457
5/14/2004	24	45	45	127	446
5/15/2004	23	42	29	136	508
5/16/2004	25.5	28	46	179	607
5/17/2004	23.5	52	9	658	1836
5/18/2004	12	17	6	99	488
5/19/2004	12.5	9	13	73	226
5/20/2004	6.5	15	8	75	194
5/21/2004	0	N/A	N/A	N/A	N/A
5/22/2004	0	N/A	N/A	N/A	N/A
5/23/2004	0	N/A	N/A	N/A	N/A
5/24/2004	0	N/A	N/A	N/A	N/A
5/25/2004	0	N/A	N/A	N/A	N/A
5/26/2004	8	6	0	27	89
5/27/2004	12	9	1	48	149
5/28/2004	10.5	2	0	2	10
5/29/2004	0	N/A	N/A	N/A	N/A
5/30/2004	0	N/A	N/A	N/A	N/A
5/31/2004	17.5	6	1	12	22

Sample End Date	Hours fished	Natural Chinook salmon	Hatchery Chinook salmon	Natural Steelhead	Hatchery Steelhead
6/1/2004	24.5	4	0	20	28
6/2/2004	24	20	0	24	52
6/3/2004	21	16	0	38	66
6/4/2004	23.5	28	2	58	170
6/5/2004	20	32	2	61	185
6/6/2004	0	N/A	N/A	N/A	N/A
6/7/2004	13.5	2	0	17	36
6/8/2004	27	15	0	18	43
6/9/2004	21.5	8	0	7	25
6/10/2004	16	18	0	14	49
6/11/2004	29	33	0	3	31
6/12/2004	5.5	2	0	0	1
6/13/2004	19	25	0	7	60
6/14/2004	24.5	33	0	7	96
6/15/2004	23.5	30	0	3	47
6/16/2004	21.5	21	0	5	36
6/17/2004	23.5	37	2	4	12
6/18/2004	24.5	26	0	1	14
6/19/2004	23	17	0	3	8
6/20/2004	25.5	41	0	1	20
6/21/2004	23.5	20	1	1	10
6/22/2004	24	28	0	0	6
6/23/2004	24	35	0	0	3
6/24/2004	26	36	0	1	3
6/25/2004	24	35	0	1	13
6/26/2004	24	32	0	0	5
6/27/2004	25	78	0	0	11
Total	3,282.7[1]	16,439	54,358	8,416	28,180

[1] We fished 3,282.7 hours out of a possible total of 3792 hours (158 days) or 86.6%

Appendix D. The number of Chinook salmon and steelhead PIT tagged at the Imnaha River trap from October 14, 2003 to June 27, 2004. N/A indicates the trap was not operated on that date.

Date	Natural Chinook salmon	Hatchery Chinook salmon	Natural steelhead	Hatchery steelhead
10/14/03	10	0	0	0
10/15/03	54	0	0	0
10/16/03	22	0	0	0
10/17/03	192	0	0	0
10/18/03	N/A	N/A	N/A	N/A
10/19/03	N/A	N/A	N/A	N/A
10/20/03	44	0	0	0
10/21/03	31	0	0	0
10/22/03	33	0	0	0
10/23/03	49	0	0	0
10/24/03	60	0	0	0
10/25/03	N/A	N/A	N/A	N/A
10/26/03	N/A	N/A	N/A	N/A
10/27/03	148	0	0	0
10/28/03	264	0	0	0
10/29/03	261	0	0	0
10/30/03	140	0	0	0
10/31/03	82	0	0	0
11/01/03	N/A	N/A	N/A	N/A
11/02/03	N/A	N/A	N/A	N/A
11/03/03	42	0	0	0
11/04/03	177	0	0	0
11/05/03	144	0	0	0
11/06/03	77	0	0	0
11/07/03	37	0	0	0
11/08/03	N/A	N/A	N/A	N/A
11/09/03	N/A	N/A	N/A	N/A
11/10/03	72	0	0	0
11/11/03	64	0	0	0
11/12/03	148	0	0	0
11/13/03	196	0	0	0
11/14/03	240	0	0	0
11/15/03	N/A	N/A	N/A	N/A
11/16/03	N/A	N/A	N/A	N/A
11/17/03	150	0	0	0
02/27/04	3	0	0	0
02/28/04	26	0	0	0
02/29/04	11	0	0	0
03/01/04	7	0	0	0
03/02/04	8	0	0	0
03/03/04	8	0	0	0
03/04/04	8	0	0	0
03/05/04	4	0	0	0

Date	Natural Chinook salmon	Hatchery Chinook salmon	Natural steelhead	Hatchery steelhead
03/06/04	28	0	0	0
03/07/04	10	0	0	0
03/08/04	7	0	0	0
03/09/04	5	0	0	0
03/10/04	4	0	0	0
03/11/04	19	0	0	0
03/12/04	72	0	3	0
03/13/04	103	0	0	0
03/14/04	94	0	3	0
03/15/04	157	0	8	0
03/16/04	154	0	6	0
03/17/04	117	0	3	0
03/18/04	113	0	0	0
03/19/04	159	0	4	0
03/20/04	212	0	9	0
03/21/04	241	0	12	0
03/22/04	270	0	7	0
03/23/04	265	0	11	0
03/24/04	238	0	9	0
03/25/04	182	0	28	0
03/26/04	215	0	35	0
03/27/04	474	0	24	0
03/28/04	387	0	25	0
03/29/04	163	0	14	0
03/30/04	113	0	10	0
03/31/04	81	0	10	0
04/01/04	17	0	1	0
04/02/04	41	0	3	0
04/03/04	47	0	4	0
04/04/04	52	0	1	0
04/05/04	24	0	2	0
04/06/04	33	0	5	0
04/07/04	38	0	6	0
04/08/04	108	0	19	0
04/09/04	84	0	45	0
04/10/04	223	0	35	0
04/11/04	182	0	31	0
04/12/04	178	0	31	0
04/13/04	132	0	38	0
04/14/04	122	0	20	0
04/15/04	66	0	20	151
04/16/04	88	0	42	171
04/17/04	137	0	26	151
04/18/04	306	1	58	141
04/19/04	225	0	32	0

Date	Natural Chinook salmon	Hatchery Chinook salmon	Natural steelhead	Hatchery steelhead
04/20/04	105	0	21	46
04/21/04	246	0	28	68
04/22/04	154	0	42	54
04/23/04	207	0	75	54
04/24/04	151	0	54	44
04/25/04	121	0	70	52
04/26/04	151	1	122	100
04/27/04	178	0	142	79
04/28/04	213	0	186	89
04/29/04	148	0	345	191
04/30/04	114	0	369	101
05/01/04	266	0	396	21
05/02/04	208	0	282	20
05/03/04	164	0	187	0
05/04/04	72	0	163	213
05/05/04	22	0	107	167
05/06/04	8	0	89	0
05/07/04	N/A	N/A	N/A	N/A
05/08/04	8	0	63	145
05/09/04	66	0	117	0
05/10/04	29	0	75	242
05/11/04	168	0	245	148
05/12/04	85	0	218	224
05/13/04	69	0	205	100
05/14/04	25	0	168	0
05/15/04	41	0	127	0
05/16/04	39	0	135	0
05/17/04	27	0	179	149
05/18/04	10	0	225	151
05/19/04	17	0	99	156
05/20/04	9	0	73	74
05/21/04	6	0	36	73
05/22/04	N/A	N/A	N/A	N/A
05/23/04	N/A	N/A	N/A	N/A
05/24/04	N/A	N/A	N/A	N/A
05/25/04	N/A	N/A	N/A	N/A
05/26/04	N/A	N/A	N/A	N/A
05/27/04	6	0	27	74
05/28/04	8	0	48	116
05/29/04	2	0	2	10
05/30/04	N/A	N/A	N/A	N/A
05/31/04	N/A	N/A	N/A	N/A
06/01/04	6	0	12	18
06/02/04	4	0	20	25
06/03/04	20	0	24	48

Date	Natural Chinook salmon	Hatchery Chinook salmon	Natural steelhead	Hatchery steelhead
06/04/04	16	0	37	56
06/05/04	23	0	55	144
06/06/04	32	0	61	164
06/07/04	N/A	N/A	N/A	N/A
06/08/04	2	0	17	33
06/09/04	14	0	17	37
06/10/04	8	0	7	20
06/11/04	18	0	14	42
06/12/04	32	0	3	28
06/13/04	2	0	0	1
06/14/04	22	0	7	53
06/15/04	32	0	7	83
06/16/04	28	0	3	33
06/17/04	20	0	5	36
06/18/04	35	0	4	12
06/19/04	26	0	1	11
06/20/04	17	0	2	8
06/21/04	40	0	1	16
06/22/04	20	0	1	8
06/23/04	28	0	0	6
06/24/04	34	0	0	3
06/25/04	35	0	1	3
06/26/04	35	0	1	12
06/27/04	31	0	0	5
06/28/04	76	0	0	9
Total	13,426	2	5,660	4,489

Appendix E. Previously PIT tagged natural Chinook salmon recaptured in the Imnaha River trap during the fall of 2003 and spring 2004.

Migration Year	Tagging Agency	Recapture file	Tag ID	Date Tagged	Date Recaptured	Travel Time (Days)
2004	ODFW	JAH03302.NT1	3D9.1BF1BCBF3A	08/26/03	10/29/03	63
2004	ODFW	JAH03308.NT1	3D9.1BF1BC496A	08/26/03	11/04/03	70
2004	ODFW	JAH03309.NT1	3D9.1BF1BCC810	08/26/03	11/05/03	70
2004	ODFW	JAH03324.NT1	3D9.1BF1BCB1EB	08/26/03	11/20/03	86
2004	ODFW	JAH04080.NT1	3D9.1BF1BBC3F4	08/26/03	03/20/04	207
2004	ODFW	JAH04085.NT1	3D9.1BF1BBA55B	08/26/03	03/25/04	212
2004	ODFW	JAH04086.NT1	3D9.1BF1BB9D4C	08/27/03	03/26/04	212
2004	ODFW	JAH04087.NT1	3D9.1BF1BC8A8D	08/26/03	03/27/04	214
2004	ODFW	JAH04091.NT1	3D9.1BF1BB9F35	08/27/03	03/29/04	215
2004	ODFW	JAH04101.NT1	3D9.1BF1BBA04E	08/27/03	04/08/04	225
2004	ODFW	JAH04080.NT1	3D9.1BF1BB9AD3	08/27/03	04/10/04	228
2004	ODFW	JAH04080.NT1	3D9.1BF1BBB1A5	08/26/03	04/11/04	229
2004	ODFW	JAH04080.NT1	3D9.1BF1BB9C83	08/27/03	04/16/04	233
2004	ODFW	JAH04080.NT1	3D9.1BF1BBC91D	08/26/03	04/20/04	238
2004	ODFW	JAH04080.NT1	3D9.1BF1BD6CBB	08/26/03	04/20/04	238
2004	ODFW	JAH04080.NT1	3D9.1BF1BD8BC6	08/27/03	04/30/04	247
2004	ODFW	JAH04141.NT1	3D9.1BF1BBA5D4	08/26/03	05/20/04	267

Appendix F. Statistical comparisons of median fork lengths between groups of smolts captured in the Imnaha River smolt trap during the spring of migration year 2004.

Group 1	Group 2	Sample Sizes		Median Fork Length (mm)		Wilcoxon Value (W)	Significance Level p = 0.05
		Group 1	Group 2	Group 1	Group 2		
Natural Chinook Salmon	Hatchery Chinook Salmon	10330	2718	100	115	66.3	0.000
Natural Steelhead	Hatchery Steelhead	5825	4536	165	215	76.4	0.000

Appendix G. Gauss population estimates by group for natural Chinook salmon captured in the Imnaha River trap during the spring 2004.

Week			Group	Caught	Marked	Recaptured	Trap Efficiency	Population	Lower 95% C.I.	Upper 95% C.I.	SE
03/15/04	to	03/22/04	1	999	209	19	9	10490	7078	16240	2478.3
03/22/04	to	03/29/04	2	1674	366	43	12	13963	9822	20259	2723
03/29/04	to	04/05/04	3	963	245	27	11	8461	5791	12558	1723.2
04/05/04	to	04/12/04	4	356	345	56	16	2161	1570	2982	370.4
04/12/04	to	04/19/04	5	837	370	43	12	7057	4993	9928	1287
04/19/04	to	04/26/04	6	857	358	60	17	5044	3719	7003	820.4
04/26/04	to	05/03/04	7	1218	339	35	10	11503	7805	17430	2621.4
05/03/04	to	05/10/04	8	1574	181	9	5	28647	16882	51170	9734.7
05/10/04	to	05/17/04	9	274	267	33	12	2160	1482	3127	449.3
05/17/04	to	06/21/04	10	110	400	17	4	2451	1309	4935	941
06/21/04	to	06/27/04	11	115	190	12	6	1690	990	2970	507.7
		Totals		8977	3270	354	10.4	93627	77057	119299	10847.8

Appendix H. Gauss population estimates by group for natural steelhead captured in the Imnaha River trap during the spring 2004.

Week			Group	Caught	Marked	Recaptured	Trap Efficiency	Population	Lower 95% C.I.	Upper 95% C.I.	SE
04/12/04	to	04/26/04	1	244	369	28	8	3113	2220	4551	581.2
04/26/04	to	05/10/04	2	3744	594	37	6	58623	40420	86901	12650.6
05/10/04	to	05/17/04	3	1012	350	54	15	6458	5089	8097	806.8
05/17/04	to	05/24/04	4	882	201	27	13	6363	4901	8335	891.4
05/24/04	to	06/27/04	5	76	306	10	3	2121	1168	4132	779.9
		Totals		5958	1820	156	9.0	76678	61537	98640	9507.8

Appendix I. A statistical comparison of median arrival date at LGR between natural Chinook salmon pre-smolts released in the fall of 2003 and smolts released in the spring of 2004 from the Imnaha River trap during migration year 2004.

Group 1	Group 2	Sample Sizes		Median Arrival Date		Wilcoxon Value (W)	Significance Level p = 0.05
		Group 1	Group 2	Group 1	Group 2		
Pre-Smolts	Smolts	359	4422	4/14/04	5/01/04	18.3	0.000

Appendix J. Arrival timing of fall PIT tagged Imnaha River natural Chinook salmon smolts to Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1998 to 2004.

Dam	Year	Sample Size (n)	Date Range	Arrival Timing	
				Median	90%
Lower Granite	1998	428	Mar-27 - May-12	Apr-14	Apr-24
	1999	103	Apr-03 - May-02	Apr-19	Apr-25
	2000	262	Apr-04 - May-12	Apr-14	Apr-23
	2001	644	Apr-03 - May-26	Apr-26	Apr-30
	2002	162	Apr-01 - May-20	Apr-16	Apr-30
	2003	715	Mar-26 - May-28	Apr-16	Apr-30
	2004	360	Mar-26 - May-08	Apr-14	May-02
Little Goose	1998	228	Apr-11 - May-12	Apr-25	May-02
	1999	364	Apr-08 - May-09	Apr-19	Apr-25
	2000	239	Apr-12 - May-12	Apr-17	Apr-24
	2001	135	Apr-23 - Jun-16	Apr-30	May-11
	2002	159	Apr-13 - May-16	May-01	May-05
	2003	406	Apr-02 - May-16	Apr-21	May-01
	2004	223	Apr-10 - May-26	Apr-24	May-06
Lower Monumental	1998	202	Apr-19 - May-19	Apr-25	May-04
	1999	144	Apr-10 - May-21	Apr-19	Apr-25
	2000	62	Apr-13 - May-06	Apr-21	Apr-26
	2001	21	Apr-28 - May-17	NA	NA
	2002	100	Apr-30 - Jun-04	May-05	May-16
	2003	78	Apr-14 - May-18	Apr-22	May-06
	2004	204	Apr-13 - May-28	Apr-19	Apr-25
McNary	1998	239	Apr-20 - May-23	Apr-30	May-04
	1999	64	Apr-10 - May-10	Apr-21	Apr-28
	2000	35	Apr-18 - May-06	Apr-27	May-04
	2001	5	May-05 - May-18	NA	NA
	2002	86	Apr-21 - May-26	May-05	May-15
	2003	314	Apr-17 - May-21	Apr-28	May-09
	2004	182	Apr-13 - May-31	Apr-30	May-07

Appendix K. Arrival timing of spring PIT tagged Imnaha River natural Chinook salmon smolts at Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1993 to 2004.

Dam	Year	Sample Size (n)	Date Range	Arrival Timing	
				Median	90%
Lower Granite	1993	109	Apr-21 - Jun-12	May-04	May-14
	1994	348	Apr-14 - Jun-23	Apr-24	May-11
	1995	184	Apr-11 - Jul-11	May-01	May-11
	1996	421	Apr-06 - Jun-12	Apr-30	May-18
	1997	74	Apr-06 - May-18	Apr-22	May-11
	1998	1,630	Apr-01 - Jun-27	Apr-25	May-06
	1999	1218	Mar-28 - Jul-15	Apr-27	May-22
	2000	1291	Apr-02 - Aug-08	Apr-22	May-11
	2001	6857	Mar-30 - Aug-13	Apr-28	May-12
	2002	489	Apr-02 - Jun-27	May-05	May-20
	2003	1685	Mar-28 - Jul-25	Apr-29	May-24
	2004	4438	Mar-26 - Jul-16	May-01	May-18
Little Goose	1993	46	Apr-27 - Jun-02	May-03	May-16
	1994	194	Apr-23 - Jun-17	Apr-28	May-07
	1995	144	Apr-15 - Jul-15	May-07	May-20
	1996	358	Apr-12 - Jun-16	Apr-27	May-20
	1997	70	Apr-15 - May-22	Apr-26	May-11
	1998	837	Apr-14 - Jun-25	May-03	May-12
	1999	2,099	Apr-09 - Aug-01	Apr-29	May-22
	2000	1103	Apr-11 - Jul-14	Apr-23	May-11
	2001	1216	Apr-16 - Jul-23	May-02	May-17
	2002	519	Apr-15 - Jun-20	May-07	May-23
	2003	782	Apr-13 - Aug-04	May-04	May-27
	2004	2653	Apr-07 - Aug-24	May-05	May-22

Dam	Year	Sample Size (n)	Date Range	Arrival Timing	
				Median	90%
Lower Monumental	1993	37	May-03 - Jun-02	May-08	May-13
	1994	215	Apr-25 - Jul-26	May-01	May-24
	1995	142	Apr-19 - Aug-04	May-08	Jun-04
	1996	359	Apr-13 - Jun-15	May-10	May-22
	1997	74	Apr-20 - Jun-01	Apr-30	May-14
	1998	289	Apr-19 - Jun-08	Apr-30	May-11
	1999	688	Apr-09 - Aug-04	May-01	May-23
	2000	335	Apr-13 - Jul-12	Apr-25	May-29
	2001	131	Apr-28 - Jul-18	May-13	May-20
	2002	336	Apr-22 - Jun-14	May-13	May-22
	2003	163	Apr-13 - Jul-12	May-14	May-31
	2004	1106	Apr-05 - Jul-31	Apr-23	May-28
McNary	1993	20	May-03 - Jun-15	May-09	May-21
	1994	229	Apr-29 - Jul-16	May-12	May-28
	1995	89	Apr-28 - Jul-09	May-12	May-21
	1996	148	Apr-19 - Jun-08	May-14	May-24
	1997	24	Apr-22 - May-19	May-01	May-12
	1998	187	Apr-19 - Jun-02	May-01	May-15
	1999	152	Apr-18 - Jun-27	May-06	May-21
	2000	192	Apr-18 - Jul-04	May-07	May-29
	2001	45	Apr-29 - Jun-05	May-18	May-31
	2002	189	Apr-23 - Jun-10	May-14	May-23
	2003	439	Apr-18 - Jun-28	May-08	May-20
	2004	1058	Apr-18 - Aug-01	May-03	May-24

Appendix L. Arrival timing of PIT tagged Imnaha River hatchery Chinook salmon smolts at Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1992 to 2004.

Dam	Year	Sample Size (n)	Date Range			Arrival Timing Median	Arrival Timing 90%
Lower Granite	1992[1]	273	Apr-12	-	Jun-06	Apr-21	May-06
	1994	129	Apr-24	-	May-18	May-12	May-12
	1995[2]	128	Apr-13	-	Jun-07	May-02	May-13
	1995[3]	83	Apr-16	-	May-22	May-08	May-15
	1996	169	Apr-13	-	May-26	May-07	May-16
	1997	227	Apr-16	-	May-22	May-05	May-14
	1998	696	Apr-15	-	May-22	May-02	May-09
	1999	267	Apr-18	-	May-25	May-05	May-14
	2000	782	Apr-07	-	May-24	May-03	May-13
	2001	1,725	Mar-31	-	May-27	Apr-29	May-10
	2002	461	Apr-01	-	May-23	May-07	May-19
	2003	475	Apr-14	-	May-25	May-02	May-15
	2004	7892	Apr-05	-	Jun-19	May-03	May-09
Little Goose	1992[1]	116	Apr-17	-	May-22	Apr-27	May-05
	1994	65	Apr-28	-	Jun-02	May-14	May-21
	1995[2]	114	Apr-26	-	Jun-11	May-10	May-20
	1995[3]	67	Apr-27	-	Jun-07	May-12	May-23
	1996	131	Apr-23	-	Jun-06	May-13	May-20
	1997	267	Apr-20	-	May-27	May-09	May-18
	1998	391	Apr-25	-	May-26	May-07	May-14
	1999	387	Apr-16	-	Jun-06	May-10	May-19
	2000	450	Apr-14	-	May-24	May-03	May-13
	2001	509	Apr-15	-	May-29	May-07	May-16
	2002	544	Apr-13	-	Jun-01	May-12	May-22
	2003	227	Apr-19	-	May-27	May-06	May-18
	2004	5378	Apr-10	-	Jun-11	May-06	May-15
Lower Monumental	1994	73	Apr-30	-	Jun-07	May-14	May-20
	1995[2]	106	Apr-27	-	Jun-10	May-12	May-21
	1995[3]	71	Apr-29	-	Jun-09	May-17	May-26
	1996	136	Apr-23	-	May-29	May-15	May-23
	1997	199	Apr-25	-	Jun-03	May-10	May-19
	1998	143	Apr-23	-	May-26	May-08	May-15
	1999	124	Apr-23	-	May-25	May-11	May-20
	2000	107	Apr-19	-	May-26	May-05	May-22
	2001	79	Apr-27	-	Jun-04	May-12	May-25
	2002	457	Apr-30	-	Jun-11	May-14	May-23
	2003	34	Apr-27	-	May-27	May-15	May-22
	2004	801	Apr-11	-	Jun-11	May-15	May-27

Dam	Year	Sample Size (n)	Date Range			Arrival Timing Median	Arrival Timing 90%
McNary	1992[1]	61	Apr-27	-	Jun-01	May-08	May-17
	1994	119	May-06	-	Jun-17	May-21	May-26
	1995[2]	67	Apr-29	-	Jun-09	May-16	May-23
	1995[3]	36	May-03	-	May-30	May-16	May-22
	1996	55	May-01	-	May-27	May-16	May-23
	1997	61	May-01	-	Jun-01	May-10	May-19
	1999	56	May-02	-	May-26	May-19	May-24
	2000	99	Apr-24	-	May-30	May-13	May-27
	2001	25	May-05	-	May-31	NA	NA
	2002	220	Apr-16	-	Jun-10	May-15	May-25
	2003	156	Apr-26	-	May-27	May-15	May-22
	2004	1301	Apr-17	-	Jun-08	May-10	May-22

[1] Hatchery Chinook salmon smolts PIT tagged and released in 1992 were over a two day period only for survival estimation.

[2] HxW crossed Chinook salmon smolts PIT tagged for NPT and released at dark.

[3] HxW crossed Chinook salmon smolts PIT tagged for the FPC and released one hour after tagging and recovery.

Appendix M. Arrival timing of spring PIT tagged Imnaha River natural steelhead smolts at Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1993 to 2004.

Dam	Year	Sample Size (n)	Date Range			Arrival Timing Median	Arrival Timing 90%
Lower Granite	1993	101	May-03	-	Jun-13	May-26	Jun-08
	1994[1]	332	Apr-25	-	Aug-15	May-08	Jun-01
	1994[2]	207	May-03	-	Aug-20	May-09	May-30
	1995	128	Apr-28	-	Jun-19	May-02	May-09
	1996	537	Apr-19	-	Jun-10	May-06	Jun-04
	1997	368	Apr-20	-	Jul-10	May-08	May-24
	1998	1,474	Apr-02	-	Jun-12	May-03	May-22
	1999	649	Apr-19	-	Jun-26	May-18	Jun-05
	2000	2,262	Apr-06	-	Aug-03	May-08	May-25
	2001	2,736	Mar-29	-	Sep-09	May-14	May-18
	2002	979	Apr-10	-	Jun-26	May-18	May-31
	2003	1887	Mar-26	-	Jul-03	May-14	May-25
	2004	3695	Mar-27	-	Jul-19	May-08	May-22
Little Goose	1993	48	May-06	-	Jun-11	May-24	Jun-07
	1994[1]	159	Apr-29	-	Jul-29	May-12	May-31
	1994[2]	121	May-06	-	Jul-26	May-15	Jun-01
	1995	70	May-01	-	Jun-23	May-07	May-12
	1996	365	Apr-20	-	Jun-14	May-09	May-28
	1997	319	Apr-20	-	Jun-19	May-10	May-26
	1998	481	Apr-14	-	Jun-19	May-08	May-26
	1999	717	Apr-08	-	Jun-24	May-21	May-25
	2000	458	Apr-11	-	Jun-26	May-08	May-29
	2001	219	Apr-07	-	Aug-19	May-16	May-24
	2002	856	Apr-13	-	Aug-28	May-21	Jun-02
	2003	1085	Apr-04	-	Jun-29	May-18	May-26
	2004	2280	Apr-01	-	Jul-29	May-13	May-29

Dam	Year	Sample Size (n)	Date Range			Arrival Timing Median	Arrival Timing 90%
Lower Monumental	1993	43	May-06	-	Jun-15	May-30	Jun-11
	1994[1]	148	May-01	-	Aug-08	May-12	Jul-08
	1994[2]	91	May-09	-	Jul-31	May-15	Jul-10
	1995	81	May-03	-	May-17	May-09	May-14
	1996	397	Apr-22	-	Jun-15	May-14	May-29
	1997	264	Apr-21	-	Jun-06	May-11	May-25
	1998	213	Apr-16	-	Jun-11	May-10	May-27
	1999	342	Apr-19	-	Jun-21	May-23	May-27
	2000	246	Apr-12	-	Aug-12	May-14	May-30
	2001	23	May-06	-	Oct-03	NA	NA
	2002	828	Apr-30	-	Aug-08	May-22	Jun-03
	2003	497	Apr-02	-	Jun-21	May-25	May-28
	2004	871	Apr-05	-	Jun-19	May-25	Jun-02
McNary	1993	17	May-11	-	Jun-13	May-25	May-31
	1994[1]	66	May-05	-	Jun-22	May-18	Jun-09
	1994[2]	42	May-13	-	Jun-25	May-18	Jun-06
	1995	35	May-05	-	May-27	May-11	May-17
	1996	157	Apr-25	-	Jun-11	May-11	May-21
	1997	62	Apr-24	-	Jun-05	May-13	May-18
	1998	53	Apr-20	-	Jun-04	May-07	May-28
	1999	55	Apr-17	-	May-31	May-25	May-27
	2000	58	Apr-15	-	Jun-16	May-24	Jun-07
	2001	4	May-16	-	Aug-05	NA	NA
	2002	124	Apr-29	-	Jun-07	May-22	May-27
	2003	210	Apr-01	-	Jun-14	May-24	May-27
	2004	172	Apr-17	-	Jun-20	May-15	Jun-03

[1] NPT PIT tagged fish released at dark

[2] FPC PIT tagged fish released after recovery

Appendix N. Arrival timing of ODFW spring PIT tagged Imnaha River hatchery steelhead smolts at Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1993 to 2004.

Dam	Year	Sample Size (n)	Date Range			Arrival Timing Median	Arrival Timing 90%
Lower Granite	1993	224	May-03	-	Jun-28	May-17	May-31
	1994[1]	164	Apr-29	-	Aug-20	May-29	Jul-15
	1994[2]	306	May-06	-	Aug-21	May-25	Jun-23
	1995	661	May-06	-	Jul-12	May-31	Jun-16
	1996	440	Apr-23	-	Jul-14	May-28	Jun-14
	1997	2,346	Apr-19	-	Jul-24	May-23	Jun-13
	1998	1,683	Apr-25	-	Jul-29	May-15	May-26
	1999	1,973	Apr-18	-	Aug-05	May-24	Jun-18
	2000	3,249	Apr-08	-	Jul-24	May-16	May-25
	2001	2,541	Apr-21	-	Sep-23	May-16	May-26
	2002	442	Apr-15	-	Jun-27	May-17	May-31
	2003	1261	Apr-14	-	Jun-23	May-13	May-26
	2004	3015	Apr-17	-	Jul-25	May-19	Jun-12
Little Goose	1993	106	May-05	-	Jul-08	May-25	Jun-02
	1994[1]	86	May-02	-	Jul-30	May-31	Jul-17
	1994[2]	165	May-10	-	Aug-12	May-27	Jul-09
	1995	409	May-08	-	Jul-13	Jun-03	Jun-20
	1996	261	Apr-24	-	Jul-11	May-25	Jun-16
	1997	1,844	Apr-21	-	Aug-23	May-26	Jun-13
	1998	555	May-03	-	Jul-10	May-25	May-30
	1999	1,593	Apr-20	-	Aug-22	May-25	Jun-18
	2000	309	Apr-13	-	Jul-22	May-22	Jul-01
	2001	121	Apr-28	-	Oct-30	May-20	Jun-21
	2002	326	Apr-19	-	Jun-29	May-24	Jun-03
	2003	1015	Apr-16	-	Jun-04	May-21	May-27
	2004	2675	Apr-23	-	Oct-15	May-24	Jun-10
Lower Monumental	1993	92	May-07	-	Jun-14	May-26	Jun-05
	1994[1]	30	May-05	-	Aug-05	Jun-03	Jul-17
	1994[2]	75	May-11	-	Aug-24	Jun-18	Jul-21
	1995	410	May-09	-	Jul-13	Jun-06	Jun-16
	1996	232	May-06	-	Jul-07	May-27	Jun-15
	1997	1,432	Apr-22	-	Aug-06	May-27	Jun-15
	1998	253	May-05	-	Jul-15	May-26	Jun-03
	1999	790	Apr-21	-	Jul-20	May-26	Jun-19
	2000	243	Apr-16	-	Aug-18	May-25	Jul-03
	2001	28	May-08	-	Oct-25	NA	NA
	2002	406	Apr-30	-	Oct-18	May-28	Jun-09
	2003	734	Apr-21	-	Jun-09	May-26	May-29
	2004	1425	Apr-23	-	Aug-12	May-29	Jun-11

Dam	Year	Sample Size (n)	Date Range			Arrival Timing Median	Arrival Timing 90%
McNary	1993	7	May-11	-	Jun-05	May-19	May-30
	1994[1]	22	May-17	-	Jul-14	Jun-05	Jul-10
	1994[2]	56	May-20	-	Jul-11	Jun-17	Jul-08
	1995	69	May-15	-	Jul-17	Jun-05	Jun-27
	1996	30	Apr-27	-	Jul-03	May-23	Jun-07
	1997	245	Apr-23	-	Aug-12	May-27	Jun-18
	1998	31	May-13	-	Jul-02	Jun-01	Jun-19
	1999	79	Apr-27	-	Jul-08	May-28	May-31
	2000	58	May-03	-	Jul-30	Jul-02	Jul-17
	2001	8	May-21	-	Jul-04	NA	NA
	2002	56	May-02	-	Jun-16	May-25	Jun-06
	2003	110	Apr-30	-	Jun-01	May-25	May-29
	2004	167	May-06	-	Jul-28	May-31	Jun-12

[1] NPT PIT tagged fish released at dark

[2] FPC PIT tagged fish released after recovery

Appendix O. Mortality of Chinook salmon and steelhead smolts due to trapping, handling, PIT tagging and Dead on Arrival at the Imnaha River trap from October 14 to December 3, 2003.

	Chinook Salmon				Steelhead			
	Natural		Hatchery		Natural		Hatchery	
Source of Mortality	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
Trapping	24	(0.296)	0	0	0	(0.000)	0	0
Handling	5	(0.215)	0	0	0	(0.000)	0	0
PIT Tagging	14	(0.377)	0	0	0	(0.000)	0	0
DOA	0	(0.000)	0	0	0	(0.000)	0	0
Number Captured	3,716		0		212		0	
Total Mortality (n)	33	(0.888)	0	0	0	(0.000)	0	0

Appendix P. Mortality of Chinook salmon and steelhead smolts due to trapping, handling, PIT tagging and Dead on Arrival at the Imnaha River trap from February 26 to June 27, 2004.

	Chinook Salmon				Steelhead			
	Natural		Hatchery		Natural		Hatchery	
Source of Mortality	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
Trapping	24	(0.188)	21	(0.039)	9	(0.110)	34	(0.121)
Handling	5	(0.039)	2	(0.004)	4	(0.049)	4	(0.014)
PIT Tagging	104	(0.817)	1	(0.002)	6	(0.073)	1	(0.004)
DOA	5	(0.039)	3	(0.006)	0	(0.000)	1	(0.004)
Number Captured	12,723		54,358		8,204		28,180	
Total Mortality (n)	138	(1.085)	27	(0.050)	19	(0.232)	40	(0.142)

Appendix Q. The catch of incidental fish during the fall, October 14 to December 3, 2003, and the spring, February 26 to June 27, 2004 at the Imnaha River juvenile fish trap.

Family	Common Name	Fall 2003	Spring 2004	Total Catch
Salmonidae	Adult Steelhead	1	42	43
	Adult Chinook	1	0	1
	Rainbow Trout / Steelhead	825	303	1,065
	Mountain Whitefish	366	2	368
	Bull Trout	122	3	125
Centrarchidae	Smallmouth Bass	11	15	26
Catostomidae	Bridgelip Sucker	2	33	35
	Largescale Sucker	4	8	12
	Sucker (unidentified species)	80	332	412
Cyprinidae	Chislemouth	1	23	24
	Longnose Dace	5	171	176
	Speckled Dace	0	24	24
	Northern Pikeminnow	47	24	71
	Redside Shiner	14	15	29
Cottidae	Sculpin (unidentified species)	4	10	14
	Total Catch	1,483	1,005	2,488