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

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Emigration of Natural and Hatchery Chinook Salmon and Steelhead Smolts from the Imnaha River, Oregon, from October 17, 2000 to June 12, 2002

2001-2002 Annual Report

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EXECUTIVE SUMMARY

This report summarizes the emigration studies of the Nez Perce Tribe in the Imnaha River subbasin during the 2001 and 2002 migration years. A migration year for the Imnaha River is defined here as beginning July 31 of the previous year and ending July 30 the following year. The conclusion of the studies at the end of migration year 2002 marked the 11th year of the Nez Perce Tribe's Lower Snake River Emigration Studies. The Nez Perce Tribe has participated in the Fish Passage Center's Smolt Monitoring Program for nine of the 11 years. These studies collect and tag juvenile chinook salmon and steelhead at two locations in the fall, rkm 74 and rkm 7, and at rkm 7 during the spring. Data from captured and tagged fish provide an evaluation of hatchery production and releases strategies, post release survival of hatchery chinook salmon, abundance of natural chinook salmon, and downstream survival and arrival timing of natural and hatchery chinook salmon and steelhead. The hydrologic conditions that migrating fish encountered in 2001 were characterized as a drought and conditions in 2002 were characterized as below average.

Hatchery chinook salmon had a mean fork length that was 34 mm greater in 2001 and 35 mm greater in 2002 than the mean fork length of natural chinook smolts. Hatchery steelhead smolt mean fork lengths were 39 mm greater than natural steehead smolts in 2001 and 44 mm greater than natural steelhead smolt fork lengths in 2002. A significant difference ($p < 0.05$) between hatchery and natural chinook salmon and steelhead fork lengths has been documented by these emigration studies from 1997 to 2002. Hatchery chinook salmon were volitionally released in 2001 and 2002 and the 90% arrivals for 2001 and 2002 at the lower rkm 7 trap were within the range of past observations of 22 to 38 days observed in 1999 and 2000. We estimated that 93.9% of the 123,014 hatchery chinook salmon released in 2001 survived to the lower trap and 90.2% of the 303,769 hatchery chinook salmon released in 2002 survived to the lower trap. Post release survival estimates for hatchery chinook salmon were within the range of past estimates; 88.4% in 1998 to 100.9% in 1994. An estimated 7,646 to 23,249 (95% C.I.) natural chinook salmon smolts migrated past the lower Imnaha River trap from April 4 to April 22. An additional 6,767 to 14,706 (95% C.I.) natural chinook salmon smolts migrated past the lower Imnaha River trap from April 23 to May 14, 2002.

Natural chinook salmon captured and tagged at the upper rkm 74 trap survived to Lower Granite Dam (LGR) at a rate of 28.8% during migration year 2001 and 21.9% during migration year 2002. The survival estimate for fall tagged natural chinook salmon from the lower trap to LGR was 41.9% in 2001 and 33.3% in 2002. Differences between survival from release to LGR for fall tagged natural chinook salmon from the lower trap have been 5.9% to 16.9% higher than for fall tagged natural chinook salmon from the upper trap from 1994 to 2002.

Spring PIT tag release groups of natural chinook salmon, hatchery chinook salmon, and hatchery steelhead produced estimates of survival from the trap to LGR within the range of past estimates since 1993. Estimated survival from release to LGR for 2001 and 2002 were as follows: 83.7% and 86.9% for natural chinook salmon, 80.3% and 77.3% for hatchery chinook salmon, 82.7% and 81.8% for natural steelhead, and 82.0% and 83.0% for hatchery steelhead.

Estimates of survival for spring tagged fish from the trap to Lower Monumental Dam (LMO) during the drought of 2001 were the lowest estimates of survival from 1998 to 2002 for natural chinook salmon, and from1997 to 2002 for natural and hatchery steelhead. Estimates of migration year 2001 survival from the trap to LMO were as follows: 65.6% - natural chinook salmon, 68.9% - hatchery chinook salmon, 49.7% natural steelhead, and 42.9% - hatchery steehead. Estimates of migration year 2002 survival from the trap to LMO were as follows: 76.8% - natural chinook salmon, 68.1% - hatchery chinook salmon, 69.9% natural steelhead, and 78.0% - hatchery steehead.

A smolt-to-adult return rate (SAR) index from LGR to LGR was calculated for migrating pre-smolt and smolt natural chinook salmon, that were PIT tagged in the fall and spring at the lower trap, for brood years 1996 to 1998 (migration years 1998 to 2000). The SARs are representative of in-river Imnaha natural chinook salmon. The LGR to LGR SAR index for presmolt chinook salmon is as follows: 3.08% (BY 1996), 2.41% (BY 1997), and 2.98% (BY 1998). Smolt-to-adult return rate index for spring tagged smolts was lower: 1.75% (BY 1996), 2.24% (BY 1997) and 2.94% (BY 1998).

Fall tagged natural chinook salmon from the upper and lower trap and spring tagged natural chinook salmon from the lower trap all had significantly different ($p < 0.05$) median and cumulative arrival timing at LGR during migration year 2001. There was also significantly different median and cumulative arrival timing at LGR between fall tagged natural chinook salmon from the lower trap and spring tagged natural chinook salmon from the lower trap in migration year 2002 ($p < 0.05$). The median arrival timing of fall tagged natural chinook salmon from the lower trap to LGR was April 26 and April 16 for the 2001 and 2002 migration years, respectively. This was earlier than median arrival timing for fall tagged chinook salmon from the upper trap (April 29, 2001, and May 5, 2002) and spring tagged chinook salmon (April 28, 2001, and May 5, 2002). Median arrival dates for hatchery chinook salmon at LGR of April 29 (2001) and May 7 (2002) were within the range of past median arrival dates of April 21 (1992) to May 12 (1994). Natural steelhead median arrival dates of May 14 (2001) and May 18 (2002) at LGR were also within the past range of observations at LGR of May 2 (1995) to May 26 (1993). Hatchery steelhead median arrival dates at LGR have ranged from May 15 (1998) to May 29 (1994) and median arrival dates of May 16 and May 17 for the 2001 and 2002 migration year were within this range of observations.

Natural chinook salmon released from the week of March 31 to April 28, 2001, and from March 31 to April 28, 2002, had faster weekly median travel times to LGR than hatchery chinook salmon and average weekly travel times decreased as the season progressed. Natural steelhead weekly median travel times to LGR were also faster than their hatchery cohorts from the week of April 15 to May 13, 2001 and from the week of April 28 to May 19, 2002.

The below average hydrologic conditions during the 2001 and 2002 migration years did not notably affect Imnaha River smolt performance factors of survival and arrival timing to LGR. The notable affects of the 2001 drought were seen at LMO where estimates of survival for natural chinook salmon, natural steelhead, and hatchery steelhead were the lowest observed since 1998 for natural chinook salmon, and 1997 for natural and hatchery steelhead.

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INTRODUCTION

This report summarizes the results of the Lower Snake River Compensation Plan (LSRCP) hatchery evaluation studies and the Imnaha River Smolt Monitoring Program (SMP) for the 2001 and 2002 smolt migration from the Imnaha River, Oregon. These studies were designed and closely coordinated to provide information about juvenile natural and hatchery chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*) biological characteristics, behavior and emigrant timing, survival, arrival timing and travel time to the Snake River dams and McNary Dam on the Columbia River. Additionally, these studies are designed to provide information on listed chinook salmon and steelhead for the Federal Columbia River Power System 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. Annual adult hatchery return goals to the Imnaha River are 3,210 chinook salmon and 2,000 adult steelhead. 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). Specifically, 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 potentially collect smolt-to-adult return information.

The Smolt Monitoring Program for the Imnaha River provides information to the Smolt Monitoring Program 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. 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 in-river survival through key index reaches. Fish quality, descaling, and gas bubble trauma measures are taken on fish at each monitoring site, and provide indicators of the health of the run. These data are used for in season shaping of flow and spill management requests, and implementation of the NMFS (2000) Biological Opinion measures relative to flow and spill improving smolt passage.

Co-managers in the Imnaha River subbasin (Bryson et al. 2001) have identified the need to collect information on life history and movement patterns of steelhead, juvenile 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 most of these identified priority data needs. Additional monitoring and evaluation efforts are needed to quantify juvenile emigrant abundance and SAR rates, because current funding does not allow for determination of juvenile emigrant abundance, and installation of

adult PIT tag detectors at the mouth of the Imnaha River to calculate SAR's.

Juvenile emigrant study information collected in the Imnaha River directly responds to LSRCP and SMP program information needs. This information is shared with the Fish Passage Center (FPC) on a real time basis during the spring emigration period. The information is essential to quantify smolt survival rates under the current passage conditions, and to evaluate future recovery strategies that seek to optimize smolt survival through the hydroelectric system. Current smolt survival estimates will also provide a comparative basis for future in river smolt survival quantification and measurement of SAR rates to Lower Granite Dam. The Bonneville Power Administration (BPA) and the U.S. Fish and Wildlife Service contracted the Nez Perce Tribe (NPT) to monitor emigration timing and tag 21,200 emigrating natural and hatchery chinook salmon and steelhead smolts from the Imnaha River during the spring emigration period with passive integrated transponder (PIT) tags.

The completion of trapping in the spring of 2002 marked the eleventh year of emigration studies on the Imnaha River, and the ninth 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 chinook salmon that may utilize the Snake River to overwinter versus overwintering in the Imnaha River.

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 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 a 2003). 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).

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, McNary Dam (MCN), John Day Dam, The Dalles Dam, and Bonneville Dam. Juvenile emigration in this report is monitored 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. McNary Dam became operational in 1953 (Anonymous b 2003).

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). There are diversions for irrigation upstream from the gauging site in the headwaters of the tributary Big Sheep Creek (rkm 32) and Little Sheep Creek. The waters diverted from Big Sheep and Little Sheep creeks are diverted to the Wallowa River Basin (Anonymous 2000). Trapping sites are located at rkm 7 (lower site) and rkm 74 (upper site).

The 72 year (1929 - 2001) mean annual discharge of the Imnaha River is 517 cfs (14.6 cms) at Imnaha, Oregon, USGS gauge 13292000. The minimum discharge, 16 cfs (0.5 cms) was observed November 22, 1931. The maximum river discharge, 20,200 cfs (572.0 cms) was observed January 1, 1997 (Anonymous 2000). 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 salmonid smolts (Figure 3). Similar traps have been used to capture

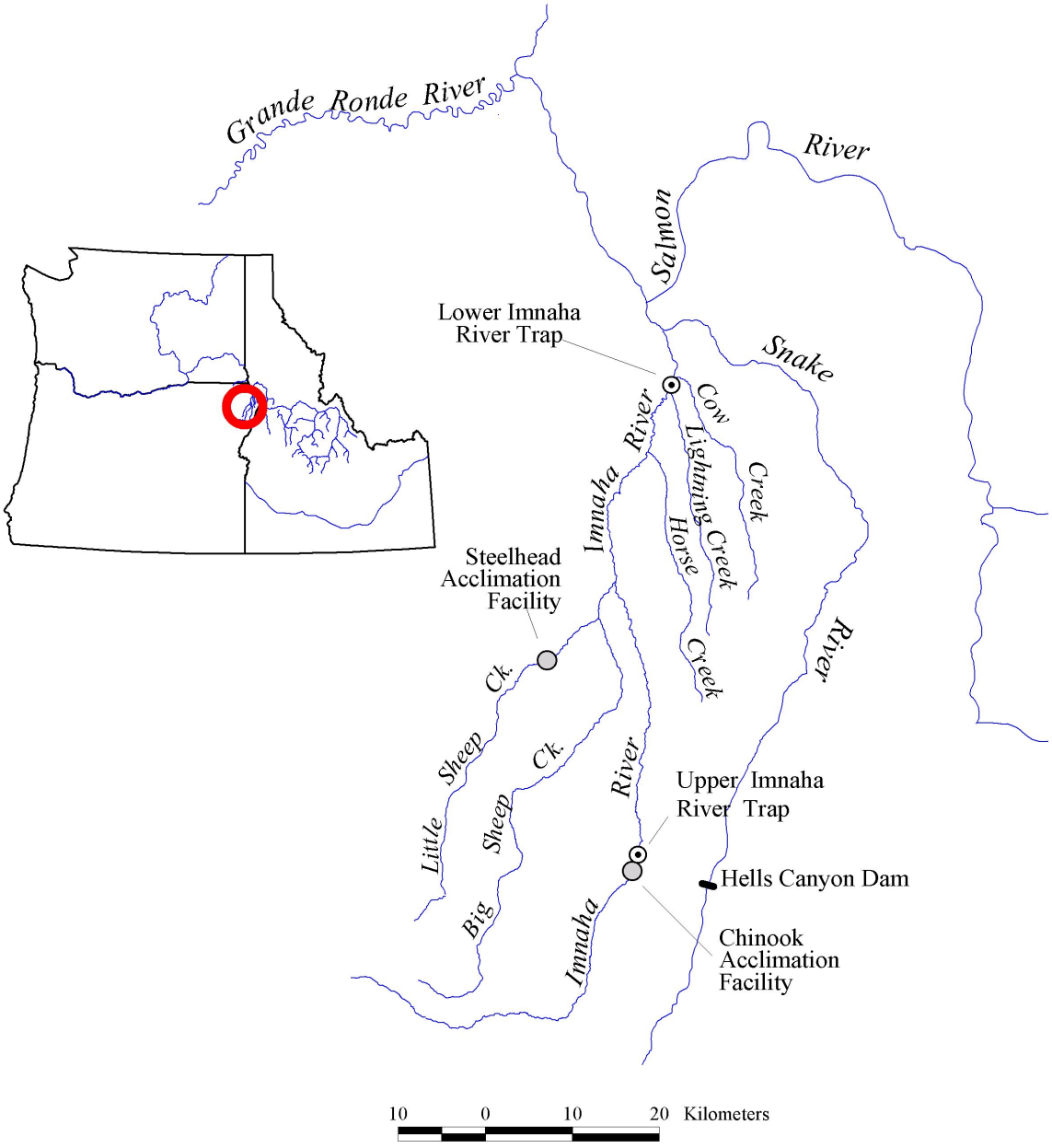

Figure 1. Map of the Imnaha River study area.

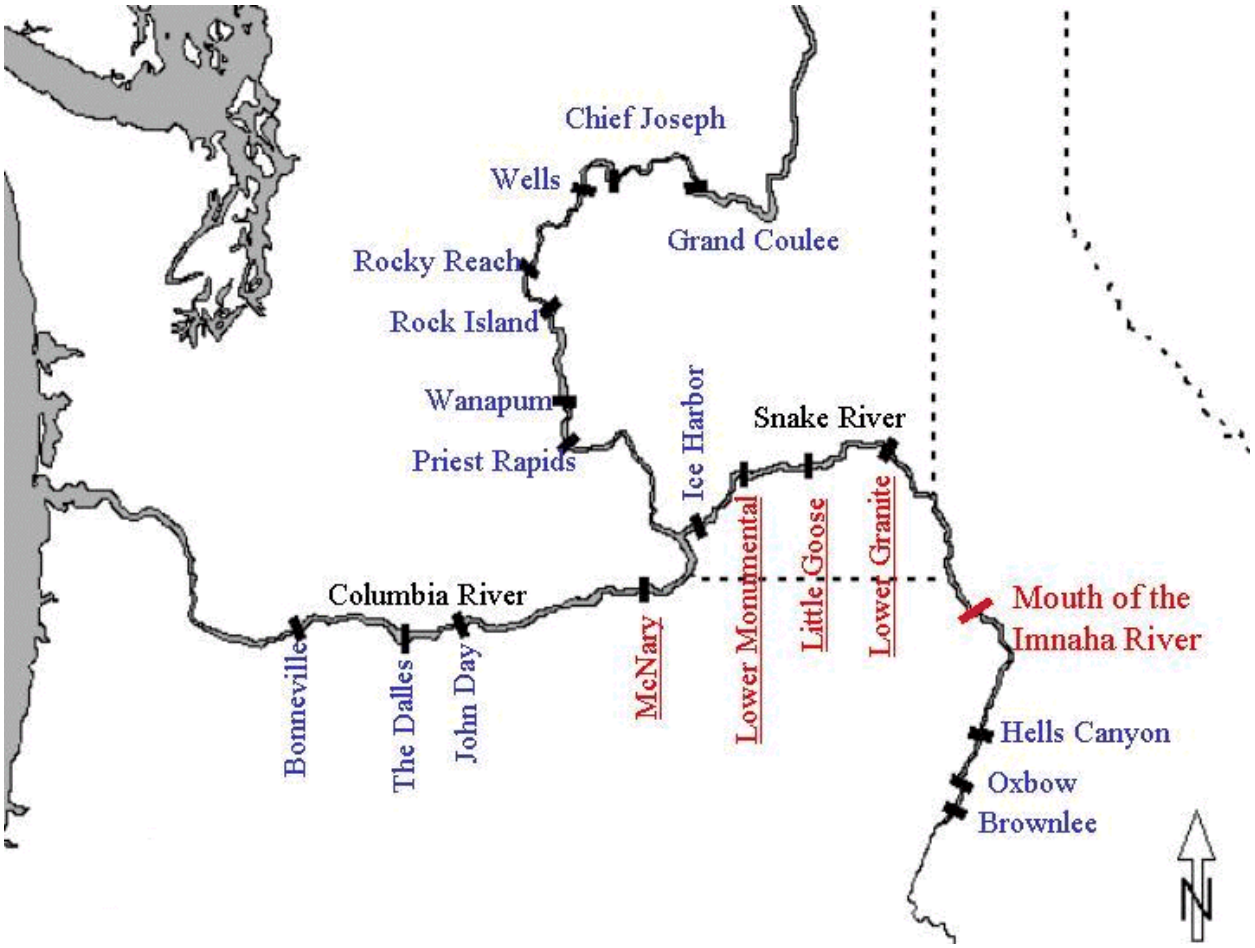

Figure 2. Map of the Columbia River Basin. Dams underlined indicate monitoring points for the Imnaha Smolt Monitoring Program.

migrating salmonid species in New York and Alaska (Kennen et al. 1994; Thedinga et al. 1994). When conditions permitted, two of these traps were fished in tandem. During hatchery releases, trap efficiency trials, high flows or periods of damage to one trap, a single trap was fished. The screw traps used in the spring and fall at the lower site consisted of a non-standard 2.1 m diameter trapping cone supported by a metal A-frame and two six meter pontoons that provided flotation. Fish entering the trapping cones move through to a custom oversize livebox (1.68 m wide x 1.25 m long x 0.55 m deep). A sliding gate and bypass tube fitted with a PIT tag antennae and transceiver was fitted to one trap in 2002 to allow for sub sampling on an hourly bases without netting fish. The live box was fitted with a removable baffle to dissipate water velocity during high flows. A smaller trap, with a 1.5 m diameter cone, was used at the upper site in the fall.

Figure 3. The lower Imnaha River trap site with two rotary screw traps operating. Trap A is on the left and trap B is on the right.

Water temperature information for this study was collected using a thermograph placed 150 m upstream from the screw trap. Discharge information was provided by the U.S. Geological Survey, USGS gauge 13292000 at Imnaha, Oregon. 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.cqs.washington.edu/dart.

Trap Operations

The trap at the upper site was operated from October 17 to November 9, 2000 and from October 18 to November 27, 2001. The upper Imnaha River trap was located at rkm 74 (~ 400 m downstream of the Imnaha River chinook salmon acclimation facility). The trap was operated to collect juvenile chinook salmon for a survival estimate of presmolt survival to LGR. The lower trap was located 6.6 kilometers from the confluence to the Snake River and was operated during

the fall from October 17 to November 15, 2000 and from October 17 to November 27, 2001. During the spring the trap was operated from February 22 to June 21, 2001, and from March 4 to June 12, 2002. The second trap at the lower site, Trap B, was operated March 16 to March 24, 2001, and May 25, and May 29 to May 30 to increase the catch of natural chinook salmon for PIT tagging purposes during the spring of 2001. It was only possible to operate Trap B April 30 to May 2 in 2002. Trap position at the lower site varied from 1 m (position 1) to 4 m (position 4), upstream or downstream 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 piscivorus fish and large numbers of other non-target fish were removed from the live box first. Non-target piscivorus fish were scanned for PIT tags and then released 30-50 meters downstream. Fish were processed as they were removed from the trap.

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 (3 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 piscivorus fish were scanned with a PIT tag scanner, 4) 100 to 300 hatchery chinook salmon 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 anaesthetic, and 7) All fish mortality was recorded.

PIT Tagging

Fish selected for passive integrated transponder (PIT) tagging were examined for previous PIT tags, descaling and general health. They were measured (FL-mm) and weighed (0.1 g). All chinook salmon selected for tagging were greater than 65 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 for a minimum of 12 hours and released after dark. Mortality due to tagging was recorded.

Trap Efficiencies

Efficiency trials using natural and hatchery salmon were conducted during the spring. Marked fish were measured (fork length) to the nearest mm and weighed to the nearest 0.1 g. Fish selected for trap efficiency trials in 2001 were marked with PIT tags or by clipping the distal portion of the fins. The following fin clips were used on a daily basis, Sunday through Saturday respectively: 1) upper and lower caudal, 2) upper caudal, 3) lower caudal, 4) left pelvic, 5) right pelvic, 6) left pectoral, and 7) right pectoral. Fish were marked with PIT tags for trap efficiency

trials in 2002. Fish marked for trap efficiency trials were held in perforated containers in the river during daytime hours (approximately 12 h) and then transported upstream, approximately one km, during evening hours and released after dark. 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.

Biological Characteristics

Length frequency distributions were created and condition factors calculated for each target fish species and origin. Length frequencies were calculated by separating fish into 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 smolts 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, 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 STATGRAPHICS PLUS version 2 software (1995). A student t-test was used to test for significant differences in fork length between various groups of fish (i.e. natural versus hatchery steelhead smolts, previously PIT tagged hatchery chinook salmon smolts versus those not previously PIT tagged, hatchery chinook salmon marked and released for trap efficiency versus trap efficiency recaptures). Differences were considered significant at $p < 0.05$. When the assumption of normality or the standard skewness was violated, the t-test was abandoned in favor of 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, 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 CAPTHIST (Westhagen 1997). Data for input into CAPTHIST was obtained directly from PTAGIS. 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)), where S is a survival estimate of a reach.

Hatchery chinook released from the acclimation facility were treated as a single group. Season-wide and weekly release groups of natural and hatchery chinook salmon and steelhead were also 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.

The point estimate of natural chinook salmon smolts migrating past the trap from March 25 to May 14 was estimated using the Bootstrap method (Efron and Tibshirani 1986). The initial population estimate was calculated as N = U/E, where N is the total number of smolts, U is the number of unmarked natural chinook salmon smolts captured, and E is the trap efficiency estimate. Bootstrap iterations numbered 1,000.

Smolt to Adult Return Rates

An effort began in 1998 to obtain SARs to LGR for natural chinook salmon using passive integrated transponder (PIT) tags. A SARs was calculated for natural chinook salmon smolts and pre-smolts from the lower Imnaha River trap back to LGR using the ratio of number of fish released to the number of PIT tag adults detected at LGR. A LGR to LGR SAR was also calculated because it provides a more comparative SAR, given live stage survival differences. Smolt equivalents to LGR were determined by multiplying the number of fish tagged at the trap by the estimated season-wide survival to LGR for each brood year and life stage. Brood years 1996, 1997, and 1998 were analyzed.

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

Arrival timing to LGR, LGO, LMO, and MCN was determined for natural chinook salmon pre-smolts, natural and hatchery chinook salmon smolts, and natural and hatchery 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, had negative travel times or single coil detections. Release groups of at least 30 fish were pooled weekly to determine travel time to LGR. Travel time estimates to LGR do not include fish captured in the Snake River trap.

Arrival timing between groups of chinook salmon were compared by converting the date of individual detections for each group into a value from 1 to 365 using a perpetual day of the year calender. A Wilcoxon rank sum test statistic (Ott 1984) was then used to compare medians of each group. The commutative distributions of arrival times between groups was also compared using a Kolmogrovov-Smirnov test (Steel et al. 1997 and STATGRAPHICS 1995).

RESULTS AND DISCUSSION

River Discharge and Water Temperature

Imnaha River

Daily discharge from October 14 to November 24, 2000 ranged from 129 cfs (3.7 cms) on November 23 to 258 cfs (7.3 cms) on October 29 (Appendix Table A1). Daily discharge during the spring in the Imnaha River ranged from 126 cfs (3.6 cms) on March 1 to 1,150 cfs (32.6 cms) on May 15 (Figure 4). Historically, daily discharge for the Imnaha River from 1929 to 2002 has ranged from 304 cfs (8.6 cms) on March 4 and 5 to 1,729 cfs (49.0 cms) on May 26 (Appendix Tables A2 - A5). Average monthly discharge from 1929 to 2002 for the month of March in the Imnaha River has ranged from 114 cfs (3.2 cms) in 1977 to 1,026 cfs (29.1 cms) in 1995 (Appendix Table A6). The average monthly discharge of 240 cfs (6.8 cms) for March, 2001, was near the lower end of this range (Figure 5). Average monthly discharge from 1929 to 2002 has ranged from 345 cfs (9.8 cms) in 1977 to 1,760 cfs (49.8 cms) in 1956 for April, 445 cfs (12.6 cms) in 1977 to 2,804 cfs (79.4 cms) in 1948 for May, and 361 cfs (10.2 cms) in 1992 to 2,612 cfs (74.0 cms) in 1974 for June. The 2001 average monthly discharge for April, May, and June of 438 cfs (12.4 cms), 757 cfs (21.4 cms), and 383 cfs (10.8 cms), respectively, were visibly at the lower end of the 1929 to 2002 range of monthly average discharge values.

Water temperatures in the Imnaha River from October 15 to November 20, 2000 ranged from -0.2 °C on November 20 to 12.0 °C on October 19 (Appendix Table B1). The mean water temperature in the Imnaha River from February 18 to June 23, 2001, was 9.7 °C, with a minimum temperature of 2.3 °C occurring on February 28 and a maximum water temperature of 21.0 °C occurring on June 22 (Appendix Table B2 and B3).

The following migration year daily discharge in the Imnaha River, from October 14 to November 24, 2001, ranged from 112 cfs (3.2 cms) on November 12 to 270 cfs (7.6 cms) on October 31. The daily discharge during the spring of 2002 ranged from 135 cfs (3.8 cms) on March 8 to 2,090 cfs (59.2 cms) on April 14 (Figure 4). Monthly averages for March, April, May, and June of 245 cfs (6.9 cms), 1,005 cfs (28.5 cms), 1,260 cfs (35.7 cms), and 1,188 cfs (33.6 cms), respectively, were higher than the averages from the 2001 migration year (Figure 5).

Water temperatures during the fall of 2001 ranged from 3.8 °C to 11.7 °C (Appendix B1). The minimum water temperature during the spring of 2002 was 1.4 °C on March 3 and the maximum water temperature was 14.7 on June 15, 2002 (B4).

Snake River

Daily discharge in the Snake River during the spring of 2001 ranged from 13,500 cfs (382.3 cms) on March 2 to 58,000 (1,642 cms) on May 17 (Figure 6). Average monthly discharge from 1959 to 2002 has ranged from 18,680 cfs (529.0 cms) to 90,400 cfs (2,559.8 cms) for March (Figure 7). Average monthly discharge from 1959 to 2002 has ranged from

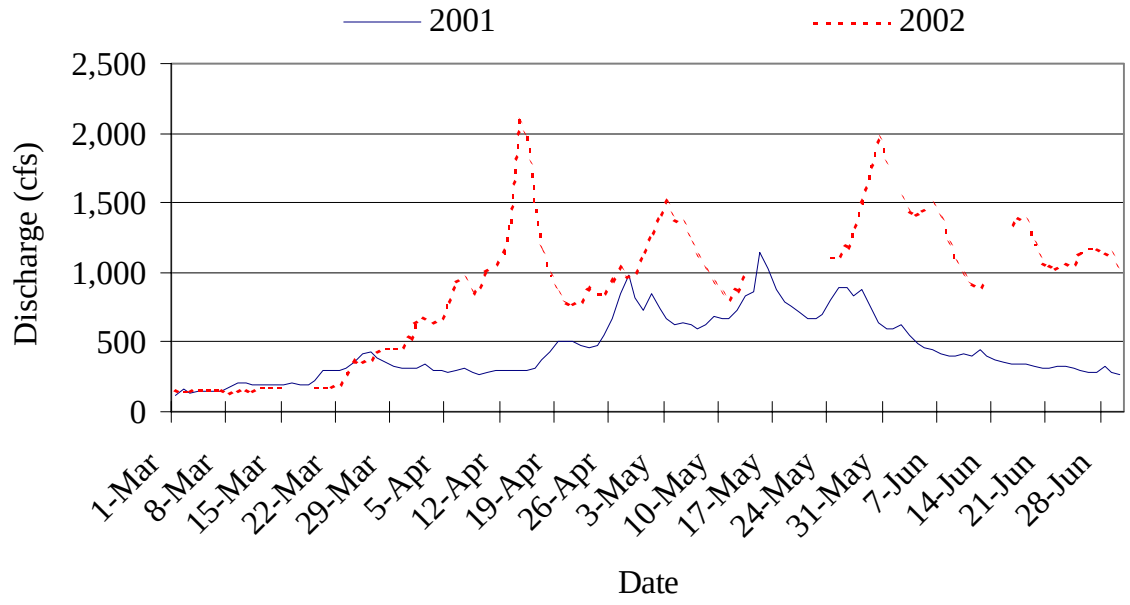

Figure 4. The average daily discharge for 2001 and 2002 from March 1 to June 30, for the Imnaha River USGS gauge 13292000. No data was available from March 16 to March 18, 2002, and from May 14 to May 23, 2002.

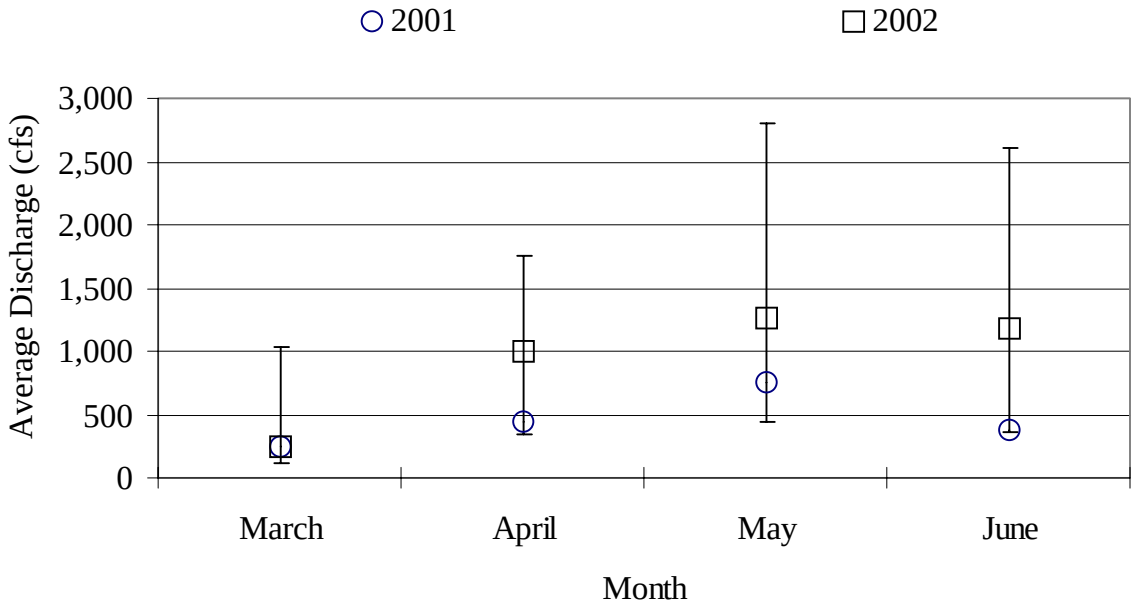

Figure 5. The average monthly discharge for the months of March, April, May, and June, for 2001 and 2002, at the Imnaha River USGS gauge 13292000. Bars indicate the minimum and maximum average monthly discharge values observed from 1929 to 2002.

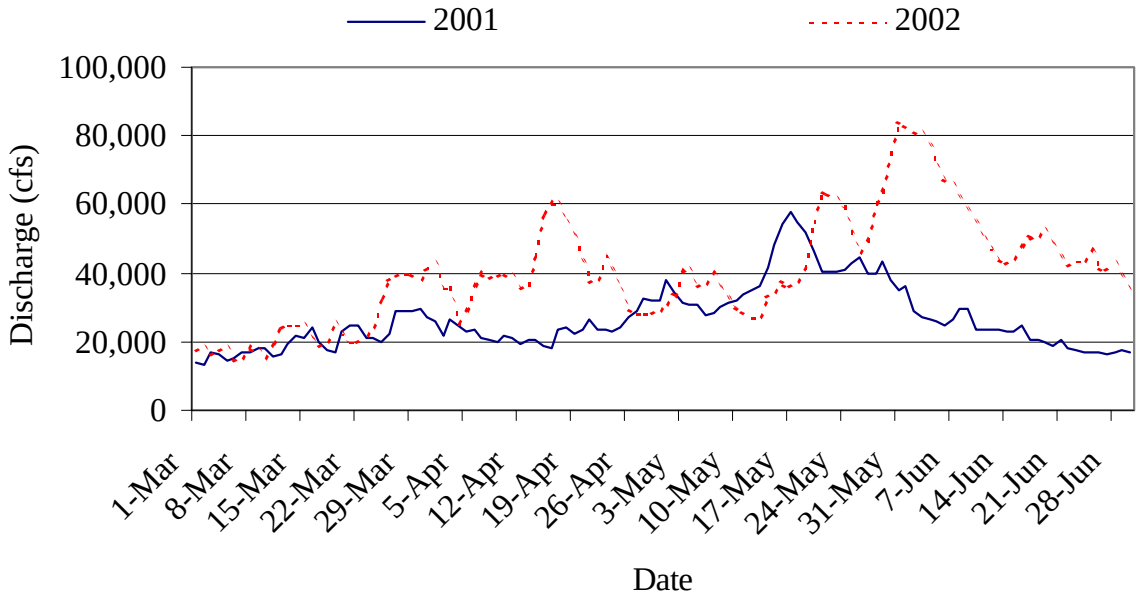

Figure 6. The average daily discharge for 2001 and 2002 from March 1 to June 30, for the Snake River USGS gauge 13334300.

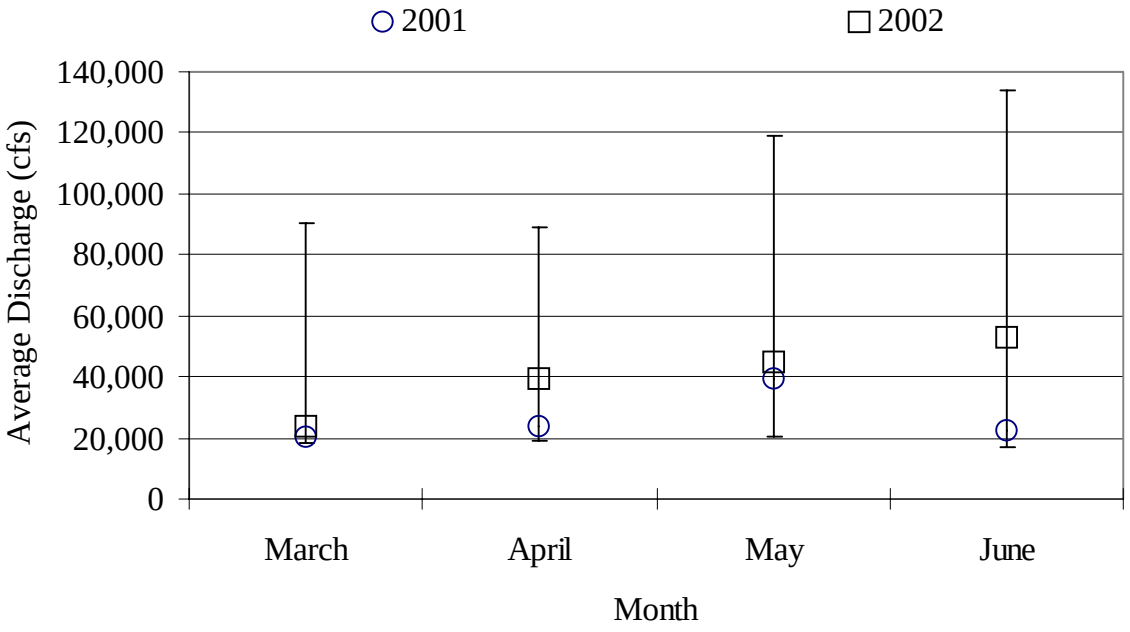

Figure 7. The average monthly discharge for the months of March, April, May, and June, for 2001 and 2002, at the Snake River USGS gauge 13334300. Bars indicate the minimum and maximum average monthly discharge values observed from 1959 to 2002.

18,880 cfs (534.6 cms) to 88,700 cfs (2,511.7 cms) for April, 20,610 cfs (583.6 cms) to 118,700 cfs (3,361.2 cms) for May, and 16,850 cfs (477.1 cms) to 134,200 cfs (3,800.1 cms) for June. The average monthly discharge of 20,365 cfs (576.7 cms), 23,727 cfs (671.9 cms), 39,368 cfs (1,114.8 cms), and 22,413 cfs (634.7 cms) for the months of March, April, May, and June of 2001, respectively, were near the bottom of the 1959 to 2002 range of average monthly discharge values (Figure 7).

The minimum discharge for the spring of 2002 was 14,599 cfs (413.4 cms) and occurred on March 6. The maximum discharge for the spring of 2002 was 84,200 cfs (2,384.3 cms) and occurred on May 31. As observed in 2001, average monthly discharge of 24,019 cfs (680.1 cms), 39,466 cfs (1,117.6 cms), 44,881 cfs (1,270.9 cms), and 53,183 cfs (1,506.0 cms) for the months of March, April, May, and June of 2001, respectively, were near the bottom of the 1959 to 2002 range of average monthly discharge values (Figure 7).

Snake River water temperatures from March 1 to June 21, 2001, ranged from 3.6 °C on March 1 to 18.9 °C on June 21. The following spring the mean water temperature from March 2 to June 15 in the Snake River ranged from 3.1 °C on March 2 to 16.0 °C on June 15.

A brief spill of less than 10 Kcfs occurred at LGR from August 27 to August 30, 2001 (Figure 8). BPA declared a power emergency from April 3 to April 13, 2001 which resulted in the elimination of spill for fish passage (Anonymous 2001). LGO spilled 1.5 Kcfs on June 21. LMO spilled 2.9 to 3.3 Kcfs daily from August 20 to August 22. The largest spill occurred at MCN from May 25 to June 15 where 7.2 to 7.6 Kcfs was spilled daily.

As outflow decreased at LGR, LGO, LMO, and MCN during 2001, water temperatures increased. Maximum water temperatures in the tailraces of the dams were as follows: 20.8 °C on July 8 at LGR, 20.9 °C on July 12 at LGO, 21.1 °C on July 17 at LMO, and 21.9 °C at MCN on August 16. The upper lethal limit for any species of salmon occurs at 25.1°C (Brett 1952, as cited in Groot et al. 1995).

Continuous spill at LGR for migration year 2002 began on April 3 and lasted until July 4 (Figure 9). Spill resumed on July 9 for five days and again on July 15 for two days. LGR spilled an additional three days in August and September with spills of 2.2 Kcfs or less daily. At LGO spill occurred from April 5 to June 21, June 27 to July 4, July 9 to July 13, July 15 to July 16, and from August 19 to August 22. Spill at LMO occurred on eight days: April 15 to April 16, and May 30 to June 4. McNary Dam spilled from April 10 to August 2. As observed in 2001, water temperatures in the tailrace of each dam increased in late July with the following maximum water temperatures observed: 19.9 °C on July 21 at LGR, 20.9 °C on July 29 at LGO, 21.2 °C on August 1 at LMO, and 20.9 °C on August 29 at MCN.

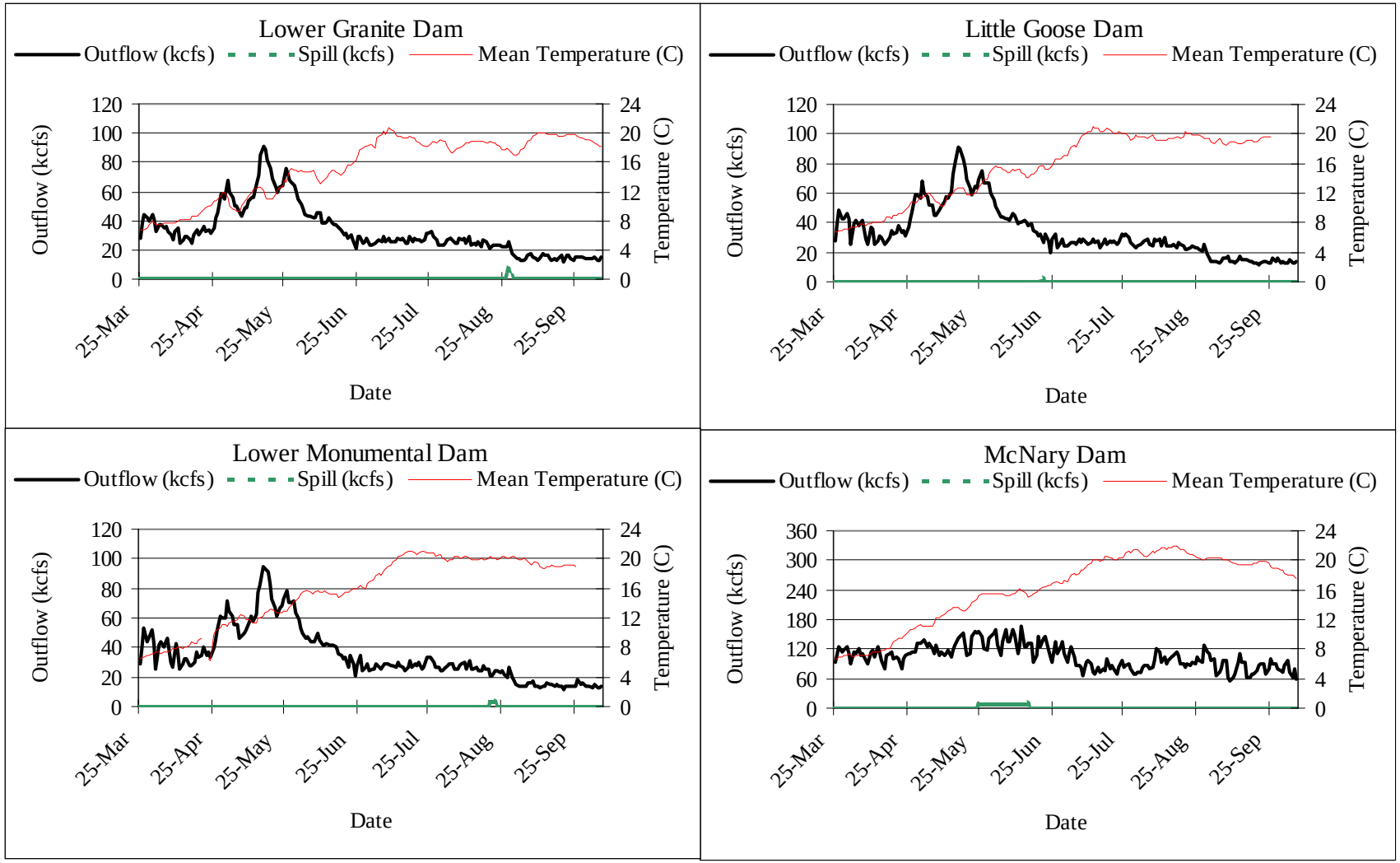

Figure 8. Measurements of outflow, spill, and mean temperature at Lower Granite Dam (top left), Little Goose Dam (top right), Lower Monumental Dam (lower left) and McNary Dam (lower right), from April 2 to September 2, 2001. Data was obtained on line at http://www.cqs.washington.edu/dart .

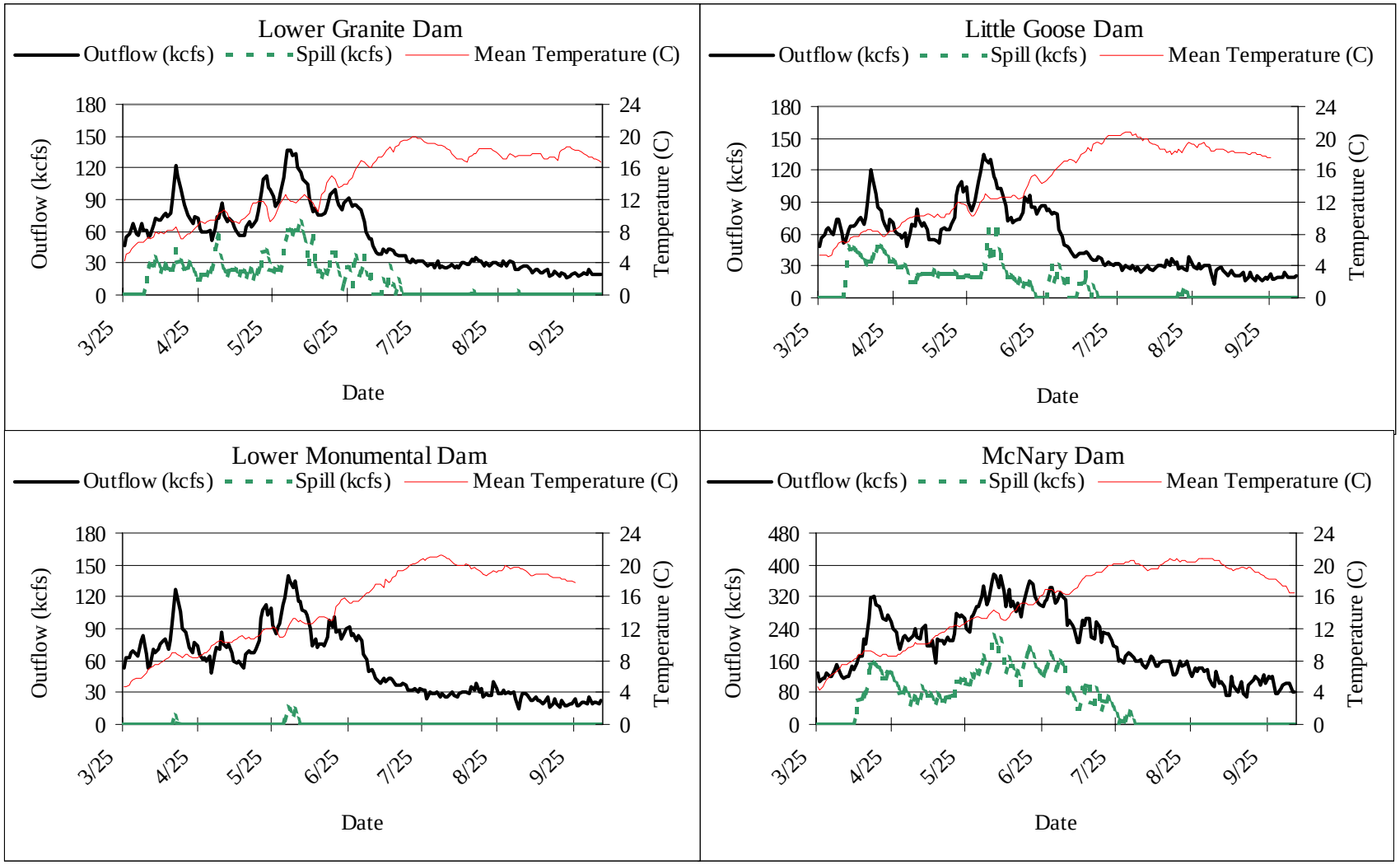

Figure 9. Measurements of outflow, spill, and mean temperature at Lower Granite Dam (top left), Little Goose Dam (top right), Lower Monumental Dam (lower left) and McNary Dam (lower right), from April 2 to September 2, 2002. Data was obtained on line at http://www.cqs.washington.edu/dart .

Hatchery Releases

Hatchery Chinook Salmon Releases

A total of 123,014 hatchery chinook salmon were released into the Imnaha River in 2001 (Table 1). Fish were allowed to leave the acclimation facility volitionally from March 21 to April 19 after being acclimated for 19 to 20 days. Fish that remained in the acclimation facility on April 19 were forced out. All hatchery chinook salmon in 2001 were marked with adipose fin clips and coded wire tags. An additional 20,922 fish were PIT tagged prior to acclimation and release. A total of 303,769 hatchery chinook salmon were volitionally released for the 2002 migration year. The volitional release occurred from March 21 to April 17, 2002. They were acclimated for 16 to 20 days. Any fish remaining in the pond on April 17 were forced out. As in 2001, all hatchery chinook salmon were marked with adipose fin clips and coded wire tags and an additional 20,920 were PIT tagged (Oregon Dept. of Fish and Wildlife 2002a and 2002b, and Eddy 2002).

Hatchery Steelhead Releases

A total of 342,622 hatchery steelhead smolts were released in 2001. Acclimated smolts (159,159) were forced from the steelhead acclimation facility on April 11 and April 12, 2001. A total of 25,282 were marked with an adipose left ventral fin clip, 53,794 were marked with a coded wire tag, and 494 were marked with a PIT tag and adipose fin clip. The remainder had an adipose fin clip. They were acclimated for 34 to 38 days. A second group of 100,166 steelhead smolts were direct stream released into Big Sheep Creek from April 17 to April 20 from the Irrigon Fish Hatchery. The second release included 40,287 steelhead marked only with visual implant tags and 59,879 marked only with an adipose fin clip. A third release of 83,297 acclimated steelhead into Little Sheep Creek occurred from May 9 and 10. The third release of steelhead during the 2001 migration year was marked with 22,646 adipose left ventral fin clips, 253 PIT tagged fish with adipose fin clips, and the remainder was marked with adipose fin clips. They were acclimated for 19 to 24 days.

During the 2002 migration year a total of 305,000 steehead were released into the Imnaha subbasin. The first release of hatchery steelhead occurred on April 11 and April 12 and totaled 128,500 hatchery steelhead with 25,000 adipose left ventral fin clips and a coded wire tag, 50,000 with a blank coded wire tag, and 53,500 with adipose fin clips. Hatchery steelhead released on April 11 and 12 were acclimated for 34 to 39 days. Hatchery steelhead (n = 100,000) were transported from Irrigon Fish Hatchery for a direct stream release into Big Sheep Creek on April 17 and April 18. The Irrigon steelhead were not marked. The final release occurred May 9 and May 10 from the steelhead acclimation facility. A total of 76,500 steelhead with 25,000 adipose left ventral fin clips and coded wire tags, and 51,500 adipose fin clips were released into Little Sheep Creek after an acclimation period of 20 to 32 days (Oregon Dept. of Fish and Wildlife 2002a and 2002b, and Eddy 2002).

Table 1. Releases of hatchery reared chinook salmon and steelhead smolts in the Imnaha River Subbasin during migration years 2001 and 2002 (Oregon Dept. of Fish and Wildlife 2002a and Oregon Dept. of Fish and Wildlife 2002b).

Year	Species	Dates Ponded	Numbers	Release Dates	Tags/Marks	Release Site
2001	Chinook Salmon	March 1 and 2	123,014	Mar. 21 to Apr.19	100% Adipose Fin Clipped and Coded Wire Tagged, with 20,922 PIT tags	Imnaha River
2002	Chinook Salmon	March 1, 4, and 5	303,769	Mar. 21 to Apr. 17	100% Adipose Fin Clipped and Coded Wire Tagged, with 20,920 PIT tags	Imnaha River
2001	Steelhead	March 5, 6, 7, and 8	159,159	Apr. 11 to Apr. 12	25,282 with Adipose Left Ventral Clips, 53,794 with only Coded Wire Tags, 494 PIT tags and Adipose Fin Clips, and 79,589 with only Adipose Fin Clips	Little Sheep Creek
2001	Steelhead	NA (direct stream release)	100,166	Apr. 17 to Apr. 20	40,287 VIE tags without Adipose Fin Clips, 59,879 with Adipose Fin Clips	Big Sheep Creek
2001	Steelhead	April 16, 17, 18, 19, and 20	83,297	May 9 to May 10	22,646 Adipose Left Ventral Fin Clips, 253 PIT tags, 60,398 Adipose Fin Clips	Little Sheep Creek
2002	Steelhead	March 4 and 8	128,500	Apr. 11 to Apr. 12	25,000 with Adipose Left Vental Fin Clips and Coded Wire Tags, 50,000 with Blank Coded Wire Tags, and 53,500 with Adipose Clip only	Little Sheep Creek
2002	Steelhead	NA (direct stream release)	100,000	Apr. 17 to Apr. 18	(no marks)	Big Sheep Creek
2002	Steelhead	April 18 and 19	76,500	May 9 to May 10	25,000 with Adipose Left Vental Fin Clips and Coded Wire Tags, 51,500 with Adipose Fin Clips	Little Sheep Creek

Juvenile Chinook Salmon and Steelhead Catch

Catch for Migration Year 2001

We captured at total of 2,318 natural chinook salmon pre-smolts and 63 natural steelhead at the upper trap from October 17 to November 9, 2000 (Table 2, Appendix Table C1). The largest weekly catch of natural chinook salmon occurred during the week of October 22. Natural chinook salmon pre-smolts (n = 2,981) and natural steelhead (n = 360) were captured at the lower trap from October 17 to November 15, 2000 (Appendix Table C1). The largest weekly catch (n = 1,398) occurred during the week of October 29 and the smallest weekly catch (n = 343) occurred during the week of November 12. Average weekly discharge ranged from 141 cfs during the week of November 11 to 193 cfs during the week of November 29 and average water temperature ranged from 1.4 °C during the week of November 12 to 11.1 °C during the week of October 15.

The majority of the chinook salmon that we captured during the spring of 2001 were smolts. Chinook salmon less than 65 mm were reported to the FPC as age 0 chinook salmon. A total of 10,663 natural chinook salmon, 16,097 hatchery chinook salmon, 6,462 natural steelhead, and 28,451 hatchery steelhead were captured in the lower trap from February 22 to June 21, 2001 (Table 2, Appendix C2). Low discharge during the month of March may have increased the efficiency of the lower trap and allowed a second trap to be fished from March 16 to March 24. When weekly discharge reached a mean of 281 cfs and water temperatures reached a mean of 8.4 °C during the week of March 18, the catch increased to 3,661 natural chinook salmon. Weekly catches of more than 1,000 natural chinook salmon occurred during the weeks of March 18, 25 and April 15. Hatchery chinook salmon were first captured during the week of March 18 and more than 1,000 hatchery chinook salmon were captured from the week of March 25 to the week of April 22. The largest catch of hatchery chinook salmon (n = 6,351) occurred during the week of April 15 when the average weekly discharge was 418 cfs and the average weekly temperature was 9.3 °C. Hatchery chinook salmon were forced from the acclimation facility during the week of April 15, on April 19.

Natural steelhead were captured from the week of February 25 to the week of June 17 and weekly catches of more than 1,000 natural steelhead occurred from the week of April 22 to the week of May 13 when the average weekly discharge ranged from 637 cfs (April 22) to 902 cfs during the week of May 13. The largest weekly catch of natural steelhead occurred during the week of May 6 when 1,451 natural steelhead were captured during weekly discharge of 657 cfs and weekly average temperature of 11.3 °C. More than 1,000 hatchery steelhead were captured weekly from the week of April 15 to the week of May 27. These large weekly catches of hatchery steelhead resulted from the weekly releases of hatchery steelhead in Big Sheep Creek and Little Sheep Creek. The largest weekly catch (n = 11,718) occurred during the week of May 13 and coincided with the release on May 10 at Little Sheep Creek and the highest average weekly spring flow (902 cfs) observed for the Imnaha River in 2001.

Table 2. The weekly mean discharge (cfs), temperature (C) and catch of natural and hatchery chinook salmon and steelhead at the upper and lower Imnaha River from October 17 to November 15, 2000, and February 22 to June 21, 2001.

Trap and Week	Average Discharge (cfs)	Average Temperature (C)	Natural Chinook Salmon	Hatchery Chinook Salmon	Natural Steelhead	Hatchery Steelhead
Upper Trap - Fall of 2000						
10/15			203		4	
10/22			1,181		21	
10/29			568		33	
11/5			366		5	
Lower Trap - Fall of 2000						
10/15	158	11.1	117		43	
10/22	166	7.7	896		88	
10/29	193	7.0	1,398		117	
11/5	165	4.6	227		62	
11/12	141	1.4	343		50	
Lower Trap - Spring of 2001						
2/18	134	5.1	6			
2/25	131	3.4	17		2	
3/4	165	6.5	11		1	
3/11	191	6.5	417		4	
3/18	281	8.4	3,661	117	82	
3/25	359	7.9	1,790	1,608	76	5
4/1	305	7.3	864	4,744	27	1
4/8	289	7.0	600	1,085	47	29
4/15	418	9.3	1,318	6,351	645	2,051
4/22	637	10.9	877	1,682	1,253	2,491
4/29	721	8.9	327	297	1,039	2,952
5/6	657	11.3	299	192	1,451	5,521
5/13	902	10.7	126	13	1,319	11,718
5/20	758	14.5	144	8	357	1,363
5/27	692	14.8	53		107	1,797
6/3	437	13.4	52		37	300
6/10	385	14.1	78		14	178
6/17	319	17.2	23		1	45

Catch for Migration Year 2002

Fall trapping from October 18 to November 27, 2001, resulted in a catch of 1,415 natural chinook salmon pre-smolts and 46 natural steelhead at the upper trap (Table 3, Appendix Table C3). The largest weekly catch of natural chinook salmon pre-smolts (n = 405) at the upper trap occurred during the week of October 21. At the lower trap, 2,149 natural chinook salmon pre-smolts and 948 natural steelhead were captured from October 17 to November 8. The largest weekly catch of natural chinook salmon pre-smolts (n = 835) occurred during the week of October 21 when the average weekly discharge was 130 cfs and average weekly temperatures were 8.4 °C.

A total of 2,693 natural chinook salmon, 26,407 hatchery chinook salmon, 6,956 natural steelhead, and 25,086 hatchery steelhead were captured at the lower trap during the spring of 2002 (Table 3, Appendix Table C4). The largest weekly catch of natural chinook salmon during the spring of 2002 occurred during the week of March 24 when 528 fish were captured. The average weekly discharge was 417 cfs and the average weekly temperature was 6.9 °C. The largest catch of hatchery chinook salmon also occurred during the week of March 24 when 13,174 fish were caught. Weekly catches of more than 1,000 hatchery chinook salmon continued to the week of April 14.

Only one weekly catch of more than 1,000 natural steelhead occurred, during the week of May 12 when average weekly discharge was 938 cfs and average weekly temperature was 10.1 °C. The week of May 12 was also the week when the largest catch of hatchery steelhead (n = 8,286) occurred. This catch coincided with a release from the Little Sheep Creek Acclimation Facility on May 10. Weekly catches of more than 1,000 hatchery steelhead occurred from the week of April 14 to the week of May 26. Due to the forced and direct release strategies for hatchery steelhead, weekly catches are more related to release timing as presented in Table 1 than they are related to the river discharge and temperature presented in Appendices A and B.

PIT Tagging for Migration Year 2001

A total of 13,872 Imnaha River natural chinook salmon were PIT tagged for migration year 2001 (Table 4). Natural chinook salmon tagged for migration year 2001 consisted of three groups: 1,858 natural chinook salmon pre-smolts tagged at the upper trap during the fall of 2000, 2,009 natural chinook salmon pre-smolts tagged at the lower trap during the fall of 2000, and 10,005 natural chinook salmon smolts tagged at the lower trap during the spring of 2001. Weekly PIT tag release groups at the upper trap ranged from 199 fish during the week of October 15 to 801 fish during the week of October 22. PIT tag release groups at the lower trap ranged from 114 fish during the week of October 15 to 883 fish during the week of October 22. No limit was set for weekly PIT tag release groups of natural chinook salmon during the spring of 2001 because sampling was designed to provide for future estimates of smolt to adult returns and the initial sample size estimated by LSRCP required 12,000 natural chinook salmon. Weekly release groups ranged from four fish during the week of February 18 to 3,462 fish during the week of

Table 3. The weekly mean discharge (cfs), temperature (C) and catch of natural and hatchery chinook salmon and steelhead at the upper and lower Imnaha River from October 17 to November 27, 2001, and March 4 to June 12, 2002.

Trap and Week	Average Discharge (cfs)	Average Temperature (C)	Natural Chinook Salmon	Hatchery Chinook Salmon	Natural Steelhead	Hatchery Steelhead
Upper Trap - Fall of 2001						
10/14			137		2	
10/21			405		4	
10/28			338		31	
11/4			293			
11/11			91			
11/18			129		7	
11/25			22		2	
Lower Trap - Fall of 2001						
10/14	118	10.3	153		66	1
10/21	130	8.4	835		319	
10/28	169	9.1	557		448	
11/4	123	5.7	604		115	1
Lower Trap - Spring of 2002						
3/3	157	3.3	11	7	9	
3/10	167	5.5	18	9	14	
3/17	201	5.3	19	143	2	
3/24	417	6.9	528	13,174	74	1
3/31	697	8.2	285	7,201	48	
4/7	1,042	8.4	257	1,968	77	139
4/14	1,325	7.0	384	2,375	190	2,824
4/21	875	8.2	442	842	303	2,493
4/28	1,243	8.9	452	564	776	1,656
5/5	1,037	7.3	60	64	653	4,918
5/12	938	10.1	173	49	3,323	8,286
5/19	1,110	8.9	31	11	839	2,932
5/26	1,585	11.1	11		357	1,359
6/2	1,417	10.6	12		235	325
6/9	962	11.6	10		56	153

Table 4. Weekly numbers of PIT tagged fish released from the upper and lower Imnaha River screw traps, October 17 to November 15, 2000, and February 22 to June 21, 2001.

Week Released	Natural Chinook Salmon	Hatchery Chinook Salmon	Natural Steelhead	Hatchery Steelhead	Weekly Total
Upper Trap - Fall of 2000					
15-Oct	199		1		200
22-Oct	801				801
29-Oct	501				501
5-Nov	357				357
Lower Trap - Fall of 2000					
15-Oct	114				114
22-Oct	883				883
29-Oct	499		1		500
5-Nov	209				209
12-Nov	304				304
Lower Trap - Spring of 2001					
18-Feb	4				4
25-Feb	13				13
4-Mar	25		1		26
11-Mar	403		1		404
18-Mar	3,462	98	78		3,638
25-Mar	1,755	602	77	2	2,436
1-Apr	818	1,147	27		1,992
8-Apr	580	297	46	4	927
15-Apr	1,166	493	451	160	2,270
22-Apr	816	369	438	610	2,233
29-Apr	313		710	602	1,625
6-May	254	2	1,318	1,313	2,887
13-May	67		332	500	899
20-May	140		200	272	612
27-May	49				49
3-Jun	50				50
10-Jun	78				78
17-Jun	12				12
Total	13,872	3,008	3,681	3,463	24,024

March 18.

A total of 3,008 hatchery chinook salmon were PIT tagged for the 2001 migration year. Weekly PIT tag release groups of hatchery chinook salmon ranged from two fish during the week of May 6 to 1,147 fish during the week of April 1. The tagging goal was 600 hatchery chinook salmon for a five week period, but that goal was modified to attempt to accurately represent the catch of hatchery chinook at the Imnaha River trap.

The total number of spring tagged natural steelhead released for the 2001 migration year totaled 3,681 fish. Weekly PIT tag release groups of natural steelhead during the spring of 2001 ranged from one fish during the weeks of March 4 and March 11 to 1,318 fish during the week of May 6. PIT tagged hatchery steelhead totaled 3,463 fish for the 2001 migration year. Weekly PIT tag release groups of hatchery steelhead ranged in size from two fish during the week of March 25 to 1,313 fish during the week of May 6.

PIT Tagging for Migration Year 2002

A total of 1,217 natural chinook salmon pre-smolts were PIT tagged at the upper trap during the fall of 2001 for the 2002 migration year. Weekly release groups ranged from 21 fish during the week of November 25 to 333 fish during the week of October 21 (Table 5). PIT tagging at the lower trap during the fall of 2001 resulted in an annual release group of 2,011 natural chinook salmon pre-smolts. The range in weekly release groups varied from 153 fish during the week of October 14 to 818 fish during the week of October 21. A third group of 2,321 natural chinook salmon were PIT tagged and released during the spring in weekly release groups ranging from seven fish during the week of June 9 to 436 fish during the week of April 28. These three release groups of natural chinook salmon totaled 5,549 fish.

A total of 3,022 hatchery chinook salmon were PIT tagged and released for the 2002 migration year. Weekly release groups of hatchery chinook salmon ranged from one fish during the week of May 19 to 531 fish during the week of April 14.

The total number of PIT tagged natural steelhead released for the 2002 migration year was 4,809 fish. Natural steelhead were tagged during the spring in weekly releases groups ranging from one fish during the week of March 3 to 1,960 fish during the week of May 12. A total of 2,153 hatchery steelhead were released for the 2002 migration year. Hatchery steelhead weekly PIT tag release groups ranged from one fish during the week of June 2 to 309 fish during the week of April 28. Release groups from the week of April 14 to the week of May 19 were more consistent; ranging in size from 300 to 309 fish.

Recaptures of Previously PIT Tagged Fish

During the fall of 2000, 65 previously PIT tagged natural chinook salmon were recaptured in the lower trap (Appendix Table C5). Fifty-seven of these fish were tagged by NPT

Table 5. Weekly numbers of PIT tagged fish released from the upper and lower Imnaha River screw traps, October 17 to November 27, 2001, and March 4 to June 12, 2002.

Week Released	Natural Chinook Salmon	Hatchery Chinook Salmon	Natural Steelhead	Hatchery Steelhead	Weekly Total
Upper Trap - Fall of 2001					
14-Oct	116				116
21-Oct	333				333
28-Oct	263				263
4-Nov	279				279
11-Nov	84				84
18-Nov	121				121
25-Nov	21				21
Lower Trap - Fall of 2001					
14-Oct	153		1		154
21-Oct	818				818
28-Oct	584				584
4-Nov	456				456
Lower Trap - Spring of 2002					
3-Mar	9	6	1		16
10-Mar	18	8	14		40
17-Mar	19	115	2		136
24-Mar	397	470	31		898
31-Mar	175	500	45		720
7-Apr	252	473	75	137	937
14-Apr	374	531	188	300	1,393
21-Apr	428	430	299	305	1,462
28-Apr	436	392	771	309	1,908
5-May	59	57	645	302	1,063
12-May	112	39	1,960	300	2,411
19-May	13	1	173	303	490
26-May	10		308	196	514
2-Jun	12		231	1	244
9-Jun	7		65		72
Total	5,549	3,022	4,809	2,153	15,533

at the upper trap during the fall of 2000. The other eight were tagged by ODFW in August of 2000. In the fall of 2001, six previously PIT tagged natural chinook salmon, all tagged by ODFW in August of 2001, were recaptured at the lower trap (Appendix Table C5).

Transceivers deployed at the lower Imnaha River trap during the spring of 2001 detected 2,526 hatchery chinook salmon, 134 natural chinook salmon, and 40 hatchery steelhead within a catch of 16,097 hatchery chinook salmon, 10,663 natural chinook salmon, and 28,451 hatchery steelhead, respectively, that had been previously PIT tagged. The number of these previously PIT tagged fish that were sampled for length, weight, and condition factors are shown in Table 6. The recaptured PIT tagged hatchery chinook salmon averaged 141 mm in fork length, 29.4 g in weight, and had an average condition factor of 1.05. Recaptured PIT tagged natural chinook salmon averaged 108 mm in fork length, 13.1 g in weight, and had an average condition factor of 1.04. The previously PIT tagged hatchery steelhead recaptured in the lower Imnaha River trap averaged 213 mm in fork length, 99.9 g in weight, and had an average condition factor of 0.97 (Table 6).

Fewer previously PIT tagged hatchery chinook salmon were recaptured during the spring of 2002 than in the spring of 2001. Out of a catch of 26,407 hatchery chinook salmon in 2002, 1,532 previously PIT tagged hatchery chinook salmon were detected. A total of 29 natural chinook salmon and 43 hatchery steelhead previously marked with PIT tags were detected within a catch of 2,693 natural chinook salmon and 25,086 hatchery steelhead. The number of these previously PIT tagged fish sampled for length, weight, and condition factors are shown in Table 7. The hatchery chinook salmon had an average fork length of 134 mm, average weight of 27.2 g, and an average condition factor of 1.09. Previously PIT tagged natural chinook salmon recaptured in 2002 averaged 101 mm in fork length, 11.4 g, and had an average condition factor of 1.08. Hatchery steelhead averaged 202 mm in fork length, 82.9 g, and had an average condition factor of 0.97 (Table 7).

The 90% arrival timing of previously PIT tagged hatchery chinook salmon at the lower trap occurred 34 days after the volitional release began in 2001(Figure 10). The following year 90% arrival at the lower trap for previously PIT tagged hatchery chinook salmon occurred 28 days after release. Lower than average monthly discharge in 2001 may have affected the travel time of hatchery chinook salmon between the acclimation facility and the lower trap.

The earliest 90% arrival time presented in Figure 10 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. The following year (1999) the majority of the hatchery chinook salmon (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. 2003). A total of 1,007 previously PIT tagged hatchery chinook

salmon from the acclimated volitional release group were recaptured at the lower trap. The 1999 acclimated volitional release group had a 90% arrival time of 34 days. All hatchery chinook salmon in 2000 were acclimated and volitionally released. The 2000 hatchery chinook salmon arrival timing at the lower trap of 22 days was the earliest for an acclimated volitional release of hatchery chinook salmon from the Imnaha River.

The chinook salmon acclimation facility was designed as an adult holding pond. Water temperatures in the pond are not regulated from the source, the Imnaha River. Additionally, flow within the pond can be influenced by the Imnaha River (Patterson 2003). Annual variation in temperature and flow, in addition to fish size may influence migration timing and rate. Changes in the water level of the pond due to the build up and removal of ice may also influence the migration timing of hatchery chinook salmon during an acclimated volitional release.

Table 6. Averages, ranges, and standard deviations for fork lengths (mm), weights (g), and condition factors (K) for PIT tag recaptures of hatchery chinook salmon, natural chinook salmon, and hatchery steelhead observed at the lower Imnaha River trap from February 22 to June 21, 2001.

Statistic	Hatchery Chinook Salmon	Natural Chinook Salmon	Hatchery Steelhead
Mean Fork Length (mm)	141	108	213
Sample Size	2,214	95	29
Range	110 - 180	87 - 129	123 - 260
Standard Deviation	10.7	8.9	27.4
Mean Weight (g)	29.4	13.1	99.9
Sample Size	2,059	89	24
Range	14.0 - 61.6	6.8 - 22.2	59.7 - 180.8
Standard Deviation	6.3	3.3	33.6
Mean Condition Factor (K)	1.05	1.04	0.97
Sample Size	2,053	88	24
Range	0.73 - 1.75	0.89 - 1.24	0.84 - 1.05
Standard Deviation	0.09	0.07	0.05

Table 7. Averages, ranges, and standard deviations for fork lengths (mm), weights (g), and condition factors (K) for PIT tag recaptures of hatchery chinook salmon, natural chinook salmon, and hatchery steelhead observed at the lower Imnaha River trap from March 4 to June 12, 2002.

Statistic	Hatchery Chinook Salmon	Natural Chinook Salmon	Hatchery Steelhead
Mean Fork Length (mm)	134	101	202
Sample Size	558	28	33
Range	94 - 181	86 - 119	140 - 238
Standard Deviation	14.4	6.8	20.6
Mean Weight (g)	27.2	11.4	82.9
Sample Size	552	27	31
Range	8.3 - 61.5	6.9 - 16.1	26.9 - 136.2
Standard Deviation	9.1	2.1	25.5
Mean Condition Factor (K)	1.09	1.08	0.97
Sample Size	552	27	31
Range	0.73 - 1.81	0.76 - 1.33	0.85 - 1.11
Standard Deviation	0.10	0.11	0.06

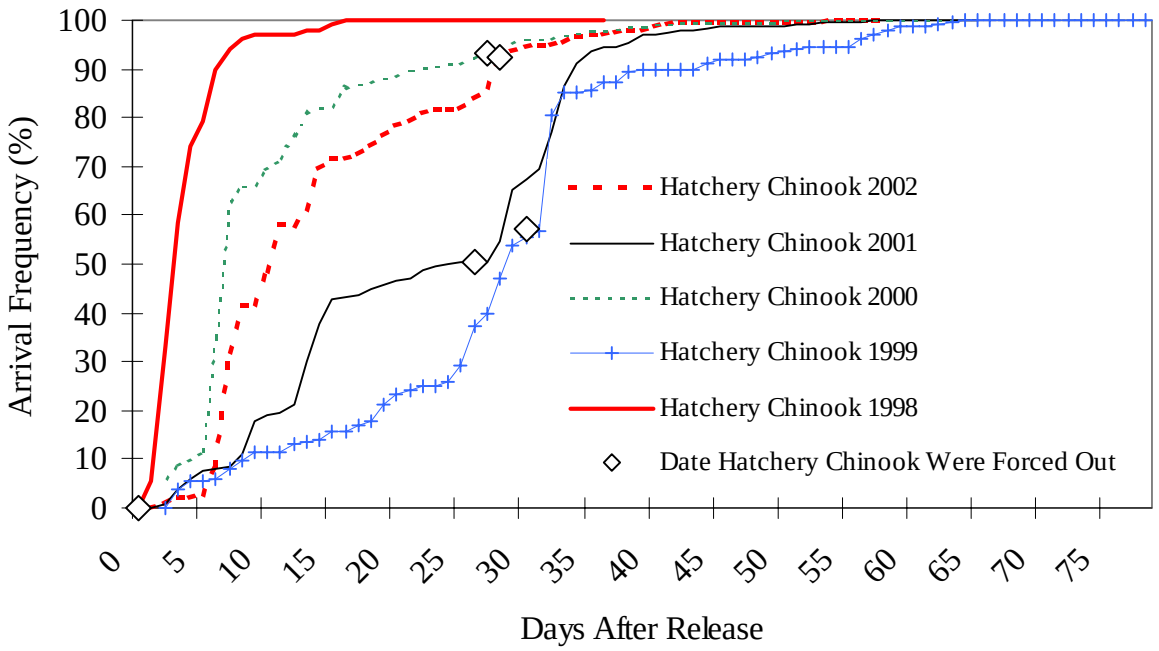

Figure 10. The arrival frequency of previously PIT tagged hatchery chinook salmon captured in the lower Imnaha River trap during the spring of 1998 to the spring of 2002. The release strategy in 1998 was a forced release and the remainder of the releases were volitional.

Biological Characteristics

Annual Biological Characteristics

Natural chinook salmon captured during the fall at the upper trap in 2000 averaged 86 mm in fork length, 7.0 g in weight and had an average condition factor of 1.05 (Table 8). Natural chinook salmon captured at the lower trap averaged 91 mm in fork length, 7.9 g in weight, and had an average condition factor of 1.01. The median fork length for natural chinook salmon captured in the upper trap in the fall of 2000 was 86 mm and it was significantly smaller ($p < 0.05$) than the 90 mm median fork length of natural chinook salmon captured in the lower trap in 2000 (Figure 11). Values for statistical comparisons are shown in Appendix D.

Natural chinook salmon captured during the fall at the upper trap in 2001 averaged 76 mm in fork length, 6.9 g in weight, and had an average condition factor of 1.09. At the lower trap, captured natural chinook salmon averaged 85 mm in fork length, 6.5 g in weight, and had an average condition factor of 0.97. There was no significant difference between median fork lengths of natural chinook salmon captured in the upper trap and lower trap during the fall of 2001 ($p > 0.05$). Natural chinook salmon in the upper trap had a median fork length of 76 mm and the natural chinook salmon captured in the lower trap had a median fork length of 85 mm (Figure 12).

Table 8. A summary of the biological characteristics of natural chinook salmon captured in the upper and lower Imnaha River screw trap from October 17 to November 15, 2000 and from October 15 to November 27, 2001.

	Upper Trap		Lower Trap	
Statistic	2000	2001	2000	2001
Mean Fork Length (mm)	86	76	91	85
Sample Size	1,788	1,385	1,994	1,888
Range	66-122	51-120	68-137	57-117
Standard Deviation	7.72	10.33	9.4	8.51
Mean Weight (g)	7.0	6.9	7.9	6.5
Sample Size	1,720	614	1,478	1,622
Range	4.0-19.3	4.1-13.7	4.0-25.9	4.0-18.4
Standard Deviation	2.01	1.63	2.65	1.82
Mean Condition Factor (K)	1.05	1.09	1.01	0.97
Sample Size	1,708	607	1,468	1,619
Range	0.70-1.40	0.77-1.42	0.69-1.40	0.60-1.38
Standard Deviation	0.09	0.11	0.09	0.08

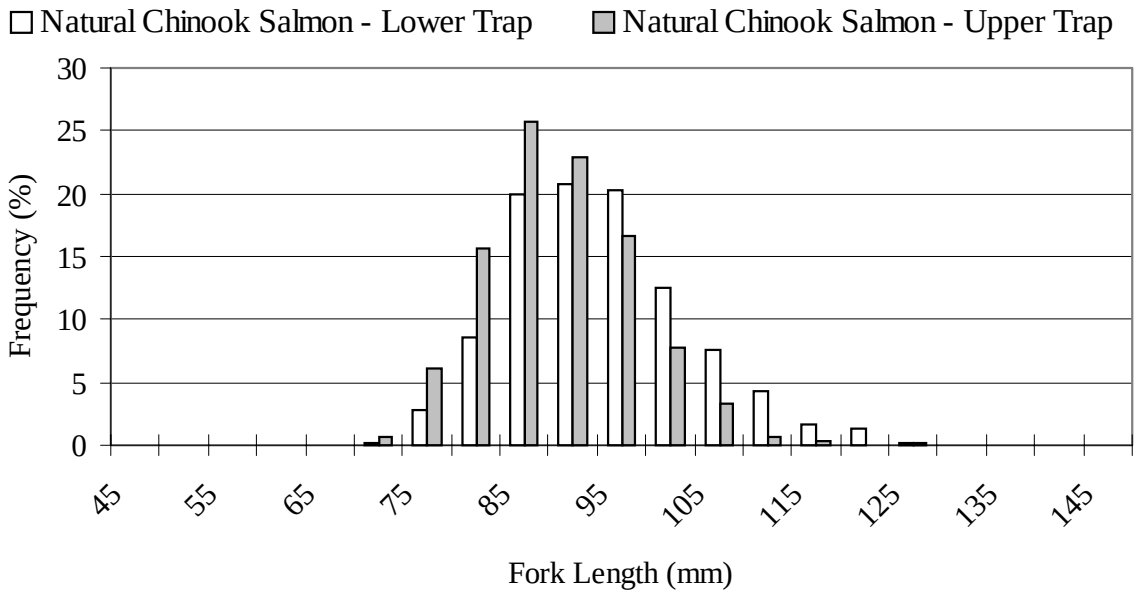

Figure 11. Length frequency distributions of natural chinook salmon trapped in the upper and lower Imnaha River traps during the fall of 2000.

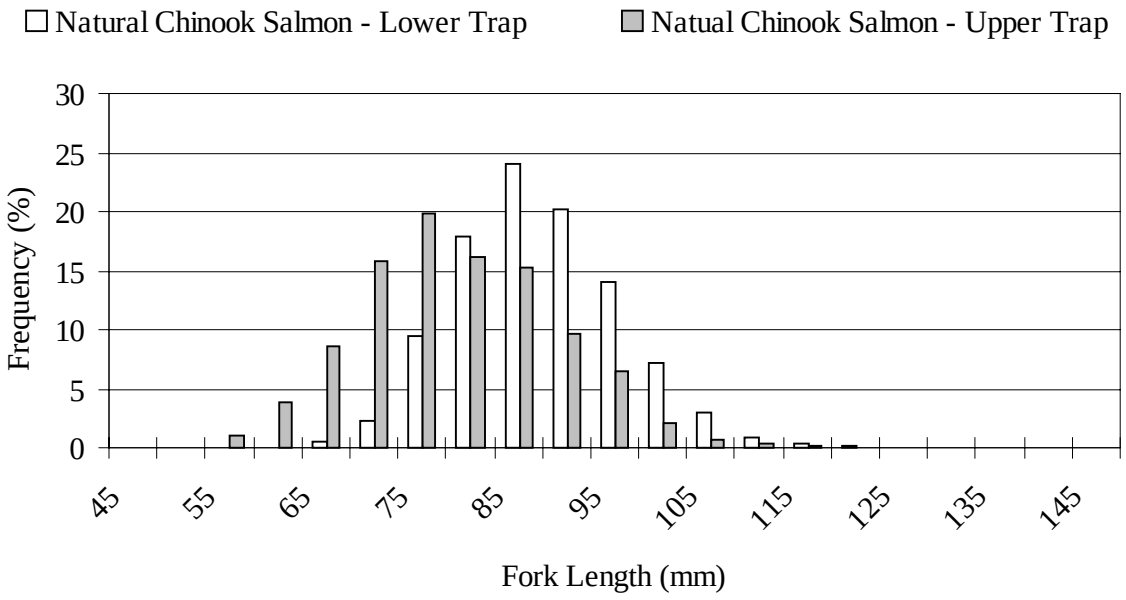

Figure 12. Length frequency distributions of natural chinook salmon trapped in the upper and lower Imnaha River traps during the fall of 2001.

A comparison of the median fork lengths of natural chinook salmon captured in the fall of 2000 at the upper and lower traps to the median fork lengths of natural chinook salmon captured in the fall of 2001 at the upper and lower traps showed that natural chinook captured in the fall of 2000 had significantly smaller fork lengths
($p < 0.05$, Appendix D).

Natural chinook salmon migrating in the spring of 2001 averaged 108 mm in fork length, 13.0 g, and had an average condition factor of 1.00 (Table 9). The minimum fork length of natural chinook salmon observed was 42 mm. This chinook salmon may have been a young of the year spring chinook salmon or a fall run chinook salmon sub-yearling. Weekly, the average fork length of natural chinook salmon during the spring of 2001 ranged from 97 mm during the week of June 10 to 113 mm during the weeks of April 15 and April 22 (Table 10). The condition factors for natural chinook salmon ranged from 0.93 during the week of March 25 to 1.11 during the week of March 11. No significant trends were observed for weekly fork lengths or condition factors.

Hatchery chinook salmon captured in migration year 2001 averaged 142 mm, 30.0 g in weight, and had an average condition factor of 1.03 (Table 9). Weekly mean hatchery chinook salmon fork lengths ranged from 137 mm during the week of April 29 to 150 mm during the week of March 18 (Table 10). Mean condition factors for hatchery chinook salmon ranged from 1.00 (week of March 25) to 1.05 (week of April 1 and April 15). The hatchery chinook salmon

Table 9. A summary of the biological characteristics of natural and hatchery chinook salmon and steelhead captured in the lower Imnaha River screw trap from February 22 to June 21, 2001.

	Chinook Salmon		Steelhead	
Statistic	Natural	Hatchery	Natural	Hatchery
Mean Fork Length (mm)	108	142	178	217
Sample Size	9,956	7,107	3,733	4,365
Range	42 - 165	90 - 241	120 - 281	120 - 310
Standard Deviation	10.0	12.1	24.3	22.7
Mean Weight (g)	13.0	30.0	55.5	98.2
Sample Size	9,506	6,563	3,575	4,065
Range	4.4 - 43.5	7.3 - 137.5	11.9 - 236	14.8 - 301.9
Standard Deviation	3.9	7.5	24.3	31.6
Mean Condition Factor (K)	1.00	1.03	0.94	0.93
Sample Size	9,465	6,542	3,531	4,042
Range	0.61 - 1.80	0.67 - 1.75	0.51 - 1.62	0.52 - 1.65
Standard Deviation	0.09	0.08	0.07	0.07

Table 10. Weekly mean fork lengths (F.L.) and condition factors (K) for natural and hatchery chinook salmon and steelhead captured at the Imnaha River trap during the spring of 2001. All weekly groups represent 30 or more fish.

	Natural Chinook Salmon		Hatchery Chinook Salmon		Natural Steelhead		Hatchery Steelhead	
Week	Average F.L. (mm)	Average K	Average F.L. (mm)	Average K	Average F.L. (mm)	Average K	Average F.L. (mm)	Average K
3/11	102	1.11						
3/18	108	0.99	150	1.03	156	0.92		
3/25	107	0.93	146	1.00	153	0.89		
4/1	108	0.99	143	1.05	174	0.90		
4/8	109	1.01	141	1.04	187	0.97		
4/15	113	1.01	140	1.05	192	0.93	218	0.96
4/22	113	1.04	139	1.03	188	0.94	214	0.95
4/29	105	1.03	137	1.04	179	0.95	221	0.96
5/6	109	1.00	140	1.03	173	0.93	219	0.93
5/13	103	1.03			178	0.95	216	0.93
5/20	106	1.05			169	0.97	209	0.91
5/27	104	1.06			177	0.93	214	0.92
6/3	104	1.08					219	0.91
6/10	97	1.10					214	0.92
6/17							222	0.92

captured in the spring of 2001 appeared to have larger fork lengths than the natural chinook salmon captured in the spring of 2001 (Figure 13). The median fork length of hatchery chinook salmon in 2001 was 140 mm and it was significantly larger ($p < 0.05$) than the 108 mm median natural chinook salmon fork length.

The natural steelhead captured in the spring of 2001 averaged 178 mm in fork length. Natural steelhead averaged 55.5 g in weight and had an average condition factor of 0.94 (Table 9). The largest weekly mean fork lengths for natural steelhead were observed during the week of April 15 (192 mm). The smallest mean fork lengths for natural steelhead (153 mm) were observed during the week of March 25. Weekly mean condition factors for natural steelhead ranged from 0.89 during the week of March 25 to 0.97. Weekly mean natural steelhead condition factors of 0.97 were observed during the week of April 8 and May 20 (Table 10).

The hatchery steelhead released during the spring of 2001 and captured at the lower Imnaha River trap averaged 217 mm in fork length, 98.2 g in weight, and had an average condition factor of 0.93 (Table 9). Hatchery steelhead weekly mean fork lengths ranged from 209 mm during the week of May 20 to 222 mm during the week of June 17. Weekly mean condition factors ranged from 0.91 during the weeks of May 20 and June 3 to 0.96 during the week of April 29 (Table 10). Hatchery steelhead smolt median fork length in 2001 (217 mm) was statistically larger ($p < 0.05$) than the median fork length (175 mm) for natural steelhead in 2001 (Appendix D, Figure 14).

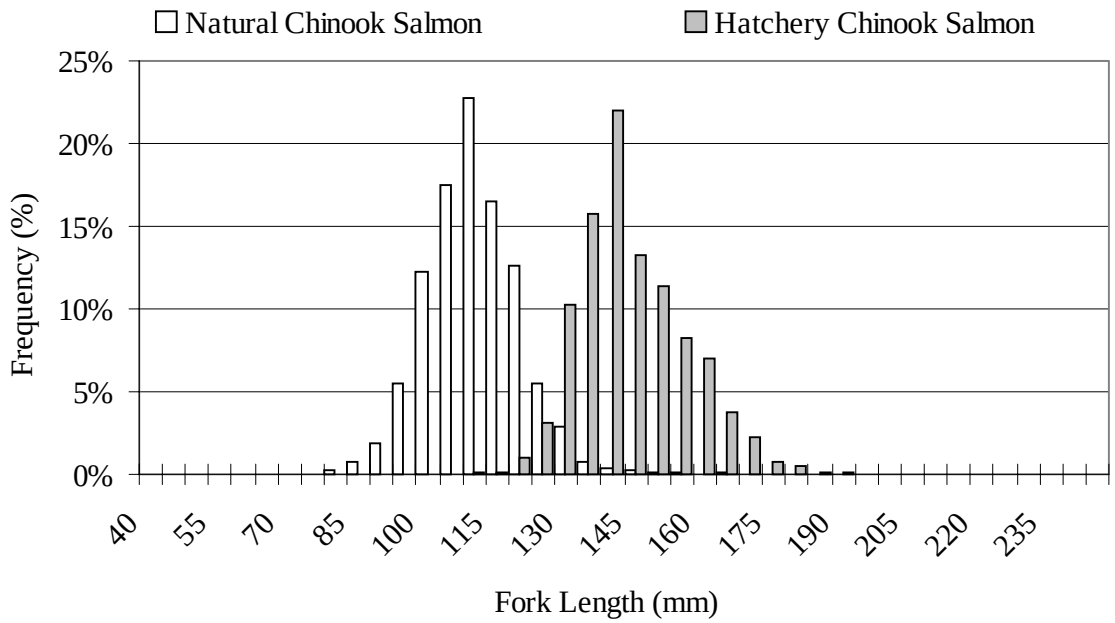

Figure 13. Length frequency distribution of natural and hatchery chinook salmon trapped in the lower Imnaha River trap, February 22 to June 21, 2001.

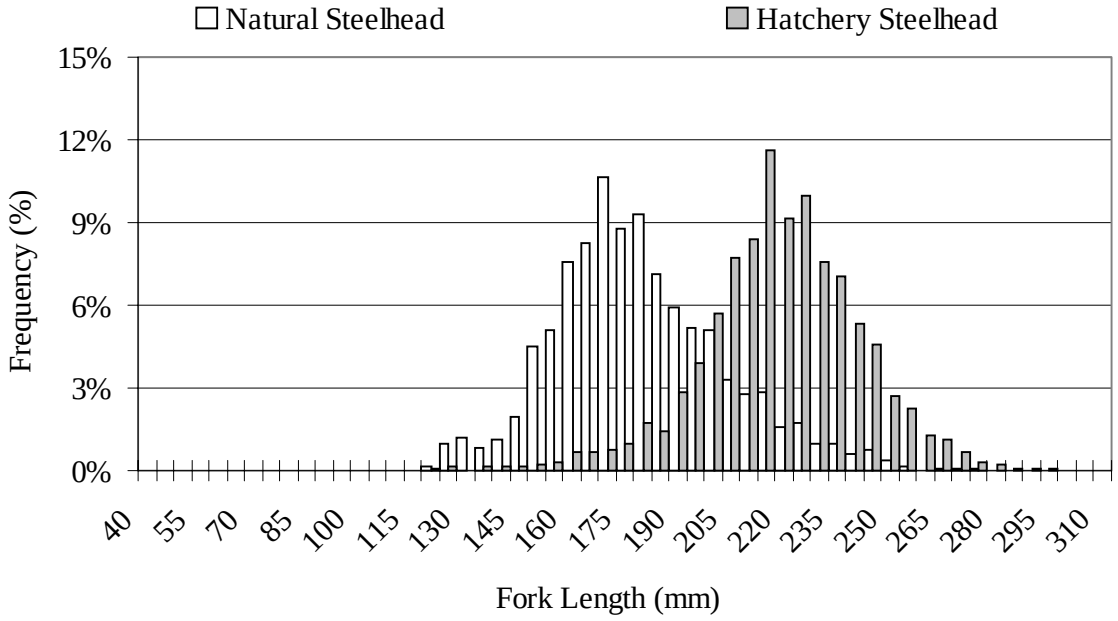

Figure 14. Length frequency distribution of natural and hatchery steelhead trapped in the lower Imnaha River trap, February 22 to June 21, 2001.

Natural chinook salmon observed during the spring of 2002 averaged 104 mm in fork length, 12.3 g in weight, and had an average condition factor of 1.05 (Table 11). As in 2001, the minimum fork length of a natural chinook salmon captured (34 mm) indicates that natural sub-yearling spring chinook salmon or fall chinook salmon may be present in the catch. The weekly mean fork lengths for natural chinook salmon captured in 2002 increased from 101 mm during the week of March 24 to 109 mm during the week of May 12 (Table 12). Weekly mean condition factors for natural chinook salmon ranged from 1.02 during the weeks of March 31 and April 28 to 1.10 during the week of April 14.

Hatchery chinook salmon captured in 2002 weighed in at 28.5 g and had an average fork length of 139 mm and an average condition factor of 1.06. Hatchery chinook salmon weekly mean fork lengths observed during the spring of 2002 tended to decrease over time. The largest weekly mean fork length was observed during the week of March 17 (153 mm) and the smallest was observed during the week of May 5 (131 mm). Condition factors ranged from 0.99 during the week of May 12 to 1.08 during the week of April 14 for hatchery chinook salmon.

Hatchery chinook salmon captured in the spring of 2002 had significantly larger median fork lengths than natural chinook salmon ($p < 0.05$, Figure 15). The median fork length for hatchery chinook salmon was 136 mm and the median fork length for natural chinook salmon was 104 mm. The supplementation program for Imnaha River has produced hatchery chinook salmon smolts that are significantly larger than natural chinook salmon smolts (Kucera and Blenden 1998, Blenden et al. 1998, Cleary et al. 2000, Cleary et al. 2002, and Cleary et al. 2003).

Natural steelhead captured in 2002 had an average fork length of 172 mm, an average weight of 51.1 g, and an average condition factor of 0.96. The range of weekly mean fork lengths for natural steelhead ranged from 143 mm during the week of March 31 to 176 mm during the week of May 12. The weekly mean condition factors for natural steelhead during the spring of 2002 ranged from 0.94 (week of May 12) to 1.03 (week of April 14).

Hatchery steelhead migrating in the spring of 2002 averaged 216 mm in length, 102.7 g in weight, and had an average condition factor of 0.99. Hatchery steelhead weekly mean fork lengths from the week of April 7 to the week of May 12 ranged from 217 mm during the week of April 21 to 223 mm during the week of May 5. Weekly mean fork lengths for hatchery steelhead observed from the week of May 19 to the week of June 9 ranged from 201 mm to 213 mm during the weeks of June 2 to May 26, respectively. Weekly condition factors for these four weeks range from 0.93 for the weeks of May 26 and June 9 to 0.98 for the week of May 19.

The median fork length for hatchery steelhead (217 mm) was statistically larger ($p < 0.05$) than the median fork length for natural steelhead (172 mm) in 2002 (Figure 16). Significant differences between hatchery and natural steelhead fork lengths have been documented (Blenden et al. 1998, Cleary et al. 2000, Cleary et al. 2002, and Cleary et al. 2003).

Table 11. A summary of the biological characteristics of natural and hatchery chinook salmon and steelhead captured in the lower Imnaha River screw trap from March 4 to June 12, 2002.

	Chinook Salmon		Steelhead	
Statistic	Natural	Hatchery	Natural	Hatchery
Mean Fork Length (mm)	104	139	172	216
Sample Size	2,333	3,918	4,738	2,428
Range	34 - 213	84 - 273	84 - 259	116 -292
Standard Deviation	11.4	16.9	19.8	21.2
Mean Weight (g)	12.3	28.5	51.1	102.7
Sample Size	2,020	3,029	3,922	2,305
Range	4.2 - 100.2	4.3 - 212.8	5.7 - 176.1	5.0 - 252.6
Standard Deviation	5.4	11.9	17.3	31.4
Mean Condition Factor (K)	1.05	1.06	0.96	0.99
Sample Size	2,006	3,000	3,868	2,282
Range	0.73 - 1.70	0.73 - 1.68	0.71 - 1.72	0.74 - 1.37
Standard Deviation	0.09	0.08	0.07	0.08

Table 12. Weekly mean fork lengths (F.L.) and condition factors (K) for natural and hatchery chinook salmon and steelhead captured at the Imnaha River trap during the spring of 2002. All weekly groups represent 30 or more fish.

	Natural Chinook Salmon		Hatchery Chinook Salmon		Natural Steelhead		Hatchery Steelhead	
Week	Average F.L. (mm)	Average K	Average F.L. (mm)	Average K	Average F.L. (mm)	Average K	Average F.L. (mm)	Average K
3/17			153	1.07				
3/24	101	1.03	147	1.05	145			
3/31	101	1.02	142	1.06	143			
4/7	101	1.05	135	1.07	158	0.98	222	1.08
4/14	103	1.10	135	1.08	172	1.03	218	1.03
4/21	106	1.05	135	1.03	168	0.98	217	1.02
4/28	108	1.02	137	1.01	175	0.95	221	0.97
5/5	105	1.05	131	1.03	175	0.97	223	1.00
5/12	109	1.04	132	0.99	176	0.94	222	0.96
5/19					171	1.00	210	0.98
5/26					166	0.96	213	0.93
6/2					163	1.01	201	0.95
6/9					166	0.98	202	0.93

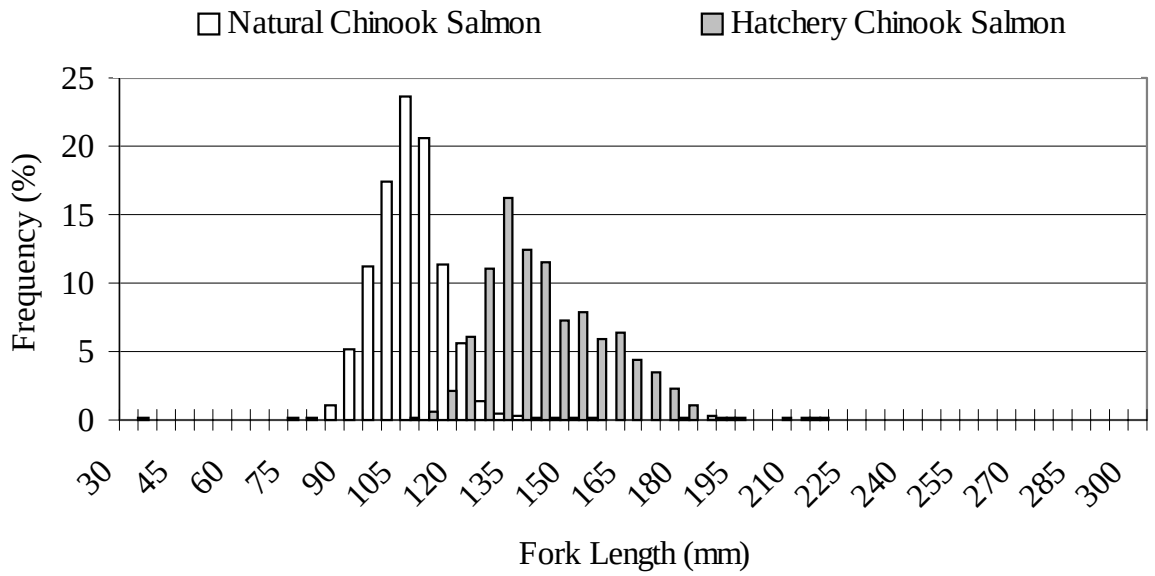

Figure 15. Length frequency distribution of natural and hatchery chinook salmon trapped in the lower Imnaha River trap, March 4 to June 12, 2002.

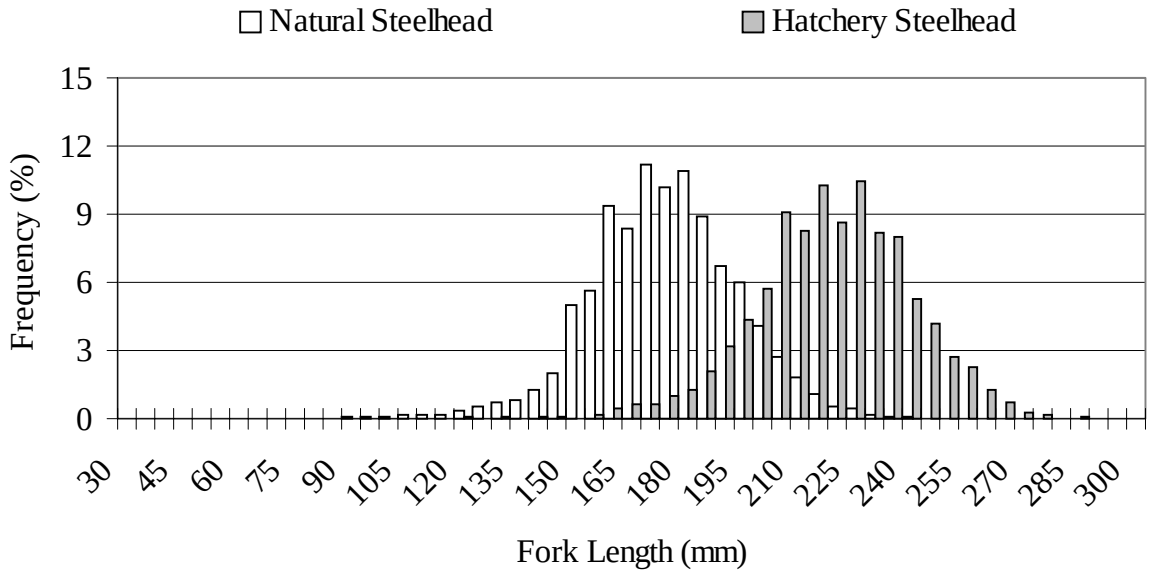

Figure 16. Length frequency distribution of natural and hatchery steelhead trapped in the lower Imnaha River trap, March 4 to June 12, 2002.

Survival of PIT Tagged Smolts

Chinook Salmon Post Release Survival and Abundance

Post release survival of hatchery chinook salmon smolts from the Imnaha River acclimation facility to the lower Imnaha River trap in 2001 was 93.9% (95% C.I. ± 1.9%) (Figure 17). Estimated survival from the acclimation facility to the lower Imnaha River trap was 90.2% in 2002 (95% C.I. ± 3.7%). Since 1994, post release survival estimates calculated with SURPH have ranged from 100.9% in 1994 to 88.4% in 1998. Post release survival estimates using the SURPH model are possible when substantial numbers of PIT tagged fish are released at the acclimation facility. Since 1998 PIT tag interrogations of hatchery chinook salmon at the lower Imnaha River trap have ranged from 4.5% in 1999 to 19.6% in 1997 (Appendix Table E1).

Trap efficiency trials for Bootstrap population estimates were conducted for hatchery chinook salmon. The 29.1% annual trap efficiency for hatchery chinook salmon in 2001 was based on six trials conducted from March 28 to April 8 (Appendix Table E2). The trials were conducted when conditions permitted and may have over-represented the trap efficiency. If the annual trap efficiency for 2001 was used in a post release survival estimate for hatchery chinook salmon it would result in a survival estimate that is 29.7% less than the survival estimate produced by the SURPH model from the acclimation facility to LGR (Appendix Table E1).

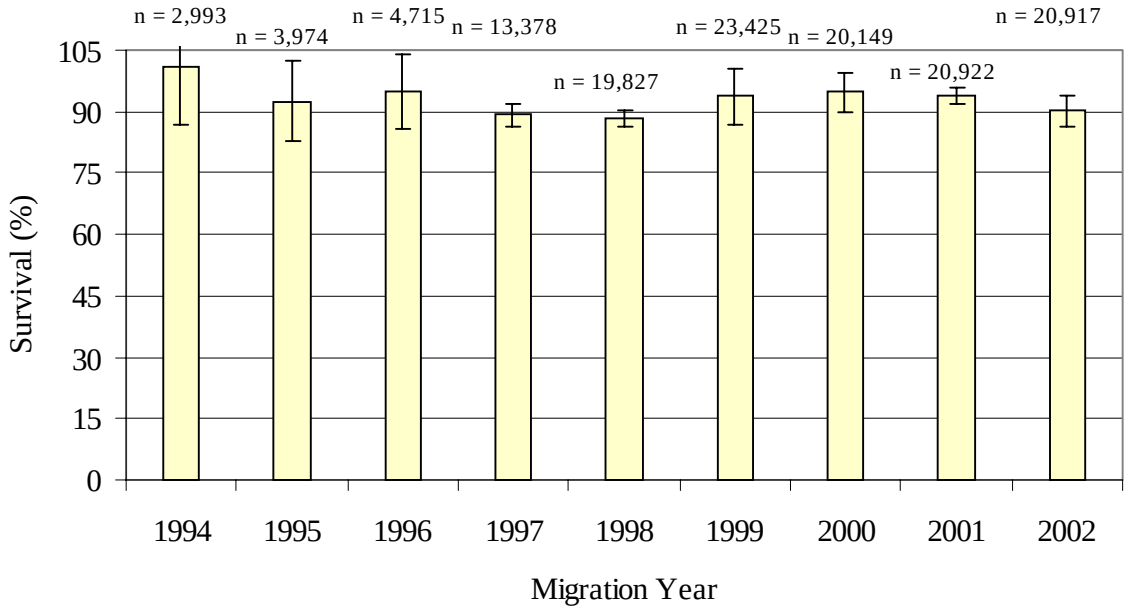

Figure 17. Annual survival of hatchery chinook salmon from the Imnaha River acclimation facility to the lower Imnaha River trap from 1994 to 2002. The size of annual PIT tag release groups are shown above for each year and error bars indicate the 95% C.I..

Thirty-nine trap efficiency trials using hatchery chinook salmon were conducted from March 25, 2002 to May 18, 2002 (Appendix Table E3). The annual trap efficiency trial for hatchery chinook salmon in 2002 was 9.1%. The resulting Bootstrap generated a survival estimate that differed from the SURPH estimate by 5.3%. The relatively small difference between the Bootstrap and SURPH survival estimates in 2002 may be due to the greater number of trials in 2002 that were conducted over a wider range of trapping conditions.

Natural chinook salmon were released and marked in 36 trap efficiency trials from March 25 to May 18, 2002 (Appendix Table E3). The resulting trap efficiency for natural chinook salmon for 2002 was 7.1%. This appeared to be an accurate representation of the lower traps collection efficiency in 2002 because it concurred with the 9.1% trap efficiency trial estimate for hatchery chinook salmon and the 7.3% PIT tag interrogation percent (Appendix Table E1). An estimated 7,646 to 23,249 (95% C.I.) natural chinook salmon smolts migrated past the lower Imnaha River trap from April 4 to April 22. An additional 6,767 to 14,706 (95% C.I.) natural chinook salmon smolts migrated past the lower Imnaha River trap from April 23 to May 14. These estimates do not represent the total spring emigrant smolt abundance in the Imnaha River in 2002. No point estimates are available for the fall because trapping efforts were only designed to collect fish for PIT tagging and estimating survival of to LGR.

Estimated Season Wide Smolt Survival

Survival of fall tagged natural chinook salmon from the upper trap to LGR was estimated to be 28.8% (± 2.1%) for the 2001 migration year (Figure 18). The survival of fall tagged natural chinook salmon from the lower trap to LGR for migration year 2001 was 41.1% (95% C.I. of ± 2.1%). During the 2002 migration year estimated survival from the upper trap to LGR was 21.9% (95% C. I. of ± 3.3%) and survival from the lower trap to LGR was 33.3% (95% C. I. of ± 3.3%). Survival estimates from the upper trap have ranged from 22.4% for migration year 1994 to 45.9% for migration year 1998. Estimated survival of fall tagged chinook salmon from the lower trap to LGR have ranged from 25.6% in 1994 to 60.4% in 1998. Estimated survival of fall tagged juvenile natural chinook salmon from the lower trap to LGR has ranged from 5.9% to 16.9% higher than fall tagged fish from the upper trap from 1994 to 2002.

Season-wide estimated smolt survival for natural chinook salmon is presented with 95% confidence intervals in parentheses (Table 13). Natural chinook salmon tagged in the spring of 2001 at the lower trap survived to LGR at a rate of 83.7% (± 0.8%). Estimates of survival from release to LMO and release to MCN were noticeably less at 65.6% (± 1.3%) and 47.4% (± 1.5%), respectively. The hatchery chinook salmon survival estimate from release to LGR for 2001 was less than the estimate for natural chinook salmon at 80.3% (± 1.6%). But survival estimates of 68.9% (± 2.5%) from release to LMO and 52.1% (± 5.3%) to MCN were higher than for natural chinook salmon. Natural and hatchery steelhead released in 2001 had an

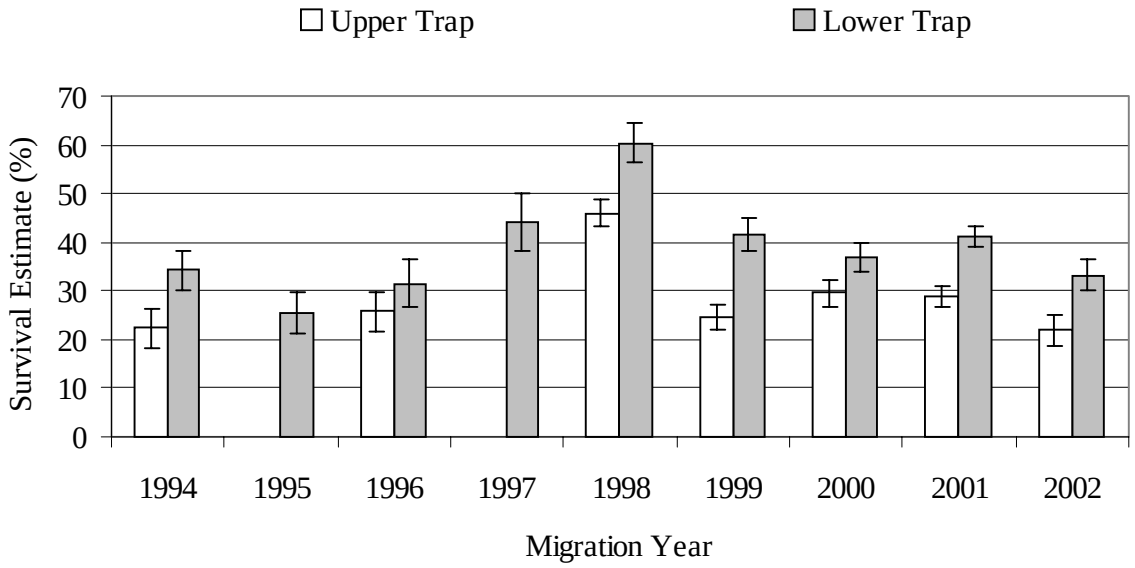

Figure 18. Estimated survival of natural chinook salmon PIT tagged and released in the fall from the upper and lower Imnaha River traps, to Lower Granite Dam, for migration years 1994 to 2002.

estimated survival within the range of the 2001 chinook salmon of 82.7% (± 1.3%) and 82.0% (± 1.6%), respectively, from the trap to LGR. However, the 2001 natural steelhead survival estimates from the trap to LMO (49.7% ± 3.5%) represented the poorest survival documented from 1997 to 2002 (Table 13). Hatchery steelhead survival from the trap to LMO was even lower, at 42.9% (± 6.0%). The survival estimate for natural steelhead from release to MCN was only 18.4% (± 3.1%) and was the worst ever recorded. The survival estimate for hatchery steelhead from release to MCN was 13.9% (± 3.9%).

The 2002 season wide survival estimate from release to LGR was as follows: natural chinook salmon - 86.9% (± 4.4%), hatchery chinook salmon - 77.3% (± 4.4%), natural steelhead - 81.8% (± 3.5%), and hatchery steelhead - 83.0% (± 5.4%). Natural chinook salmon survived from the trap to LMO at a rate of 76.8% (± 4.5%) an to MCN at a rate of 61.9% (± 5.3%). Hatchery chinook estimated survival from the trap to LMO was 68.1% (± 4.2%) and 56.0% (± 5.6%) from the trap to MCN. Natural and hatchery steelhead estimated survival from release to LMO was 69.9% (± 4.5%) and 78.0% (± 8.4%), respectively. The estimated survival of natural steelhead from release to MCN was poor (37.0% ± 4.8%) and was less than estimated hatchery steelhead survival of 48.7% in 2002. The hatchery steelhead survival estimate was much more variable with a 95% C.I. of ± 13.2%.

Migration conditions in the mainstem corridor in 2001 were poor and represented drought conditions. Natural chinook salmon survival estimates from the trap to LGR for 2001 and 2002 fit into the past range of estimates (76.2% to 90.9%) documented from 1993 to 2002 (Figure 19). Imnaha River natural chinook salmon smolt survival to LMO (Table 13) and MCN in 2001

Table 13. Estimated survival probabilities for season-wide PIT tag release groups of natural and hatchery chinook salmon and steelhead smolts released from the lower Imnaha River trap from February 22 to June 21, 2001 and March 4 to June 12, 2002 with 95% confidence intervals in parentheses. Estimates are from release to the tail race for 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, MCN -McNary 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.)
Spring PIT Tag Releases in 2001							
Natural Chinook Salmon	10,005	83.7 (0.8)	94.0 (0.9)	83.5 (1.5)	72.1 (2.1)	65.6 (1.3)	47.4 (1.5)
Hatchery Chinook Salmon	3,008	80.3 (1.6)	95.6 (1.7)	89.8 (2.9)	75.5 (4.4)	68.9 (2.5)	52.1 (5.3)
Natural Steelhead	3,678	82.7 (1.3)	82.1 (2.1)	73.2 (5.0)	37.1 (5.8)	49.7 (3.5)	18.4 (3.1)
Hatchery Steelhead	3,463	82.0 (1.6)	73.8 (4.1)	70.8 (10.3)	32.3 (9.9)	42.9 (6.0)	13.9 (3.9)
Spring PIT Tag Releases in 2002							
Natural Chinook Salmon	2,321	86.9 (4.4)	88.9 (5.6)	99.5 (6.7)	80.5 (8.0)	76.8 (4.5)	61.9 (5.3)
Hatchery Chinook Salmon	3,021	77.3 (4.4)	91.5 (6.6)	96.2 (7.1)	82.2 (9.2)	68.1 (4.2)	56.0 (5.6)
Natural Steelhead	4,808	81.8 (3.5)	88.6 (5.1)	96.6 (7.1)	52.9 (7.7)	69.9 (4.5)	37.0 (4.8)
Hatchery Steelhead	2,153	83.0 (5.4)	96.5 (9.5)	97.4 (12.7)	62.4 (18.1)	78.0 (8.4)	48.7 (13.2)

represented the worst survival recorded by this study. Estimated hatchery chinook salmon survival from 2001 and 2002 also fit into the past range of estimates from 1994 to 2000 of 67.1% (1994) to 80.4% in 1997 (Figure 20). Season wide estimates of survival for natural steelhead for 2001 and 2002 were lower than the range of estimates from 1995 to 2000 of 83.7% (± 7.1%) in

1995 to 90.1% (± 3.9%) in 1997 (Figure 21). The season wide survival estimates from the trap to LGR for hatchery steelhead in 2001 and 2002 were within the range of past estimates from 1995 to 2000 of 64.6% in 1996 to 85.8% (± 2.4%) in 2000 (Figure 22).

The lowest estimate of survival from 1998 to 2002 from the lower trap to LMO for spring tagged natural chinook salmon, natural steelhead, and hatchery steelhead occurred in 2001 (Table 14). This is not a surprising result given the drought condition and lack of spill that occurred in 2001. What was surprising was that the highest estimate of survival for hatchery chinook salmon from release at the lower Imnaha River trap to LMO occurred in 2001; 68.9% (± 2.5%). The lowest season wide estimate from the lower trap to LMO for hatchery chinook was 54.9% in 2000. The highest estimate of season wide survival for spring tagged natural chinook salmon from release to LMO was 78.3% and it occurred in 1999. Natural steelhead survival from release to LMO has been as high as 75.1% in 1999 and hatchery steelhead survival from release to LMO reached a high of 78.0% in 2002.

Estimated Weekly Smolt Survival

Weekly survival estimates from release to LMO are presented in Table 15 and 16 for the purpose of determining if any weekly trends existed in smolt survival from release to LMO for 2001 and 2002. Weekly survival estimates from release to LGR, LGR to LGO, and LGO to LMO are also presented in Table 15 and 16 for spring tagged natural chinook salmon and steelhead in 2001 and 2002 for the benefit of the reader. All survival estimates below are presented with 95% confidence intervals in parentheses.

Survival estimates of weekly release groups of spring tagged natural chinook salmon to LMO in 2001 ranged from 50.8% (± 8.8%) for the April 29 release group to 71.2% (± 3.7%) for the April 15 release group (Table 15). No discernable trend was evident in weekly survival to LMO in 2001. Weekly survival of hatchery chinook salmon ranged from 60.7% (± 5.6%) for releases that occurred during the week of March 25 to 78.2% (± 6.0%) for releases that occurred during the week of April 15. Other than the fact that the weekly survival estimates peaked the same week as they did for natural chinook salmon, there are no notable trends. Weekly survival estimates for natural steelhead declined over a three week period from 66.4% (± 11.9%) for the week of April 22 to 42.6% (± 4.6%) for releases that occurred during the week of May 6. Hatchery steelhead survival estimates from release to LMO were relatively low and quite variable. Hatchery steelhead weekly survival estimates ranged from 38.1% (± 13.5%) for the April 29 release group to 51.5% (± 14.0%) for the May 6 relese group.

Estimated weekly survival to LMO of natural chinook salmon smolts in 2002 declined from 87.1% (± 15.4%) for the April 7 release group to 66.6% (± 9.5%) for the April 28 release group (Table 16). Confidence intervals around the survival point estimates were quite robust. Weekly survival estimates of hatchery chinook salmon smolts ranged from 61.3% (± 10.0%) for the April

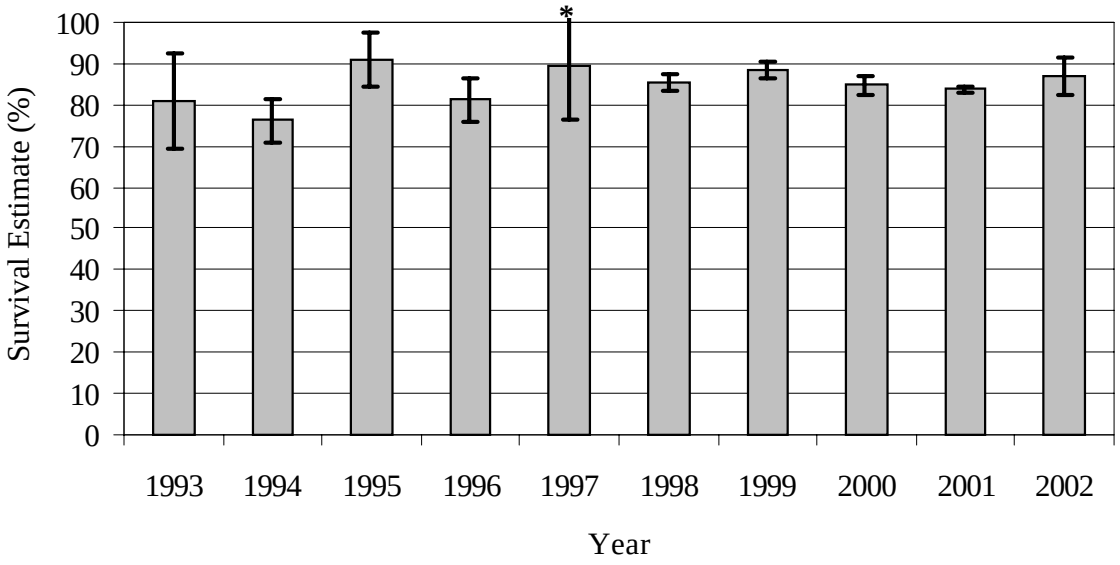

Figure 19. Season-wide survival estimates for natural chinook salmon released from the lower Imnaha River trap to Lower Granite Dam from 1993 to 2002. Error bars indicate 95% confidence limits. The asterisk indicates upper confidence limit exceeds 100%.

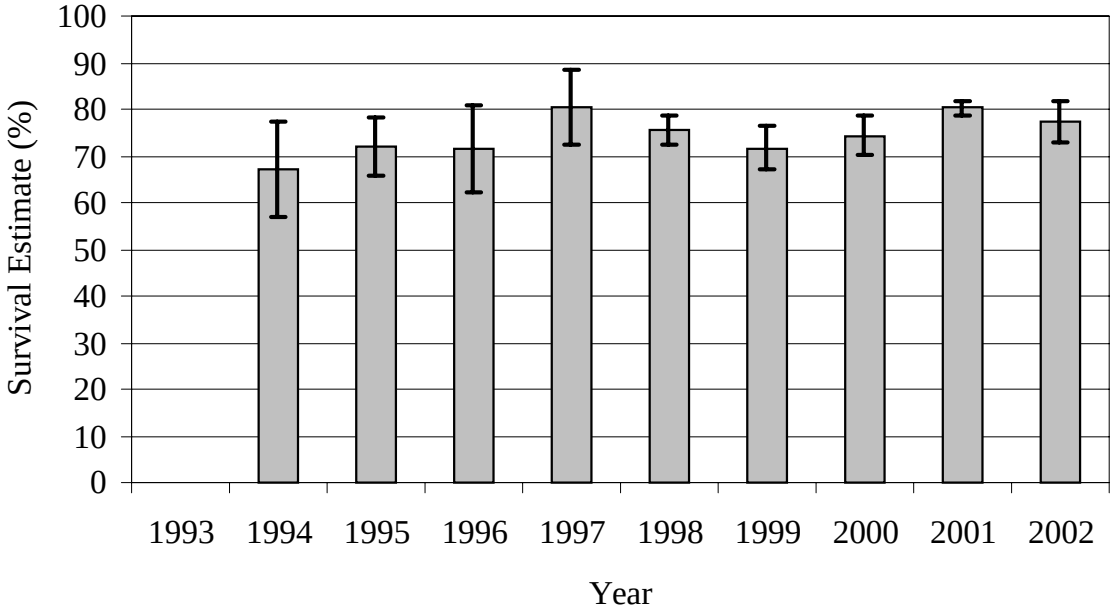

Figure 20. Season-wide survival estimates for hatchery chinook salmon released from the lower Imnaha River trap to Lower Granite Dam from 1994 to 2002. Error bars indicate 95% confidence limits.

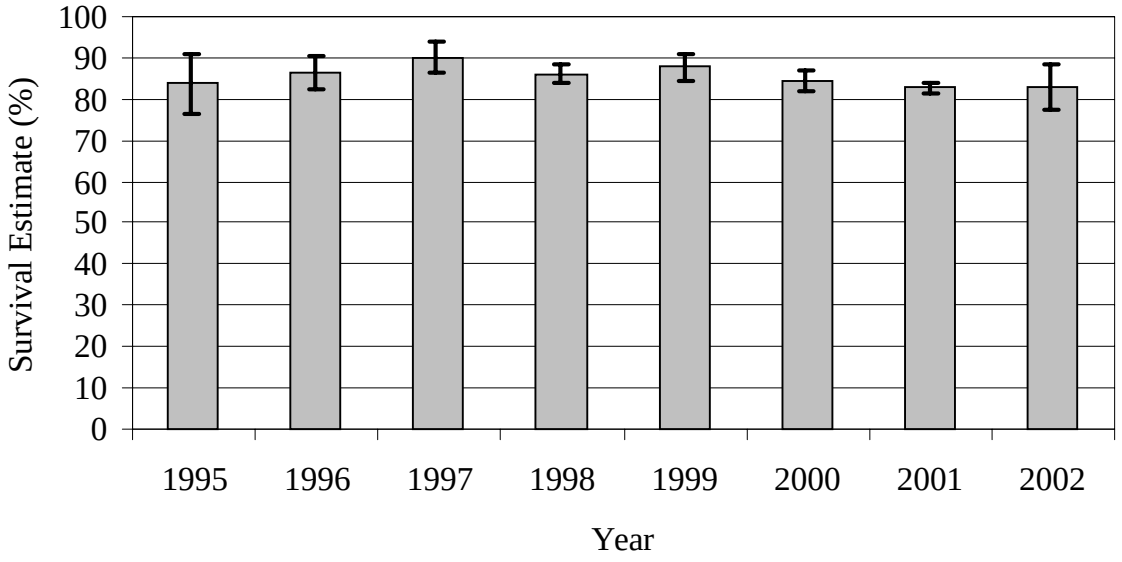

Figure 21. Season-wide survival estimates for natural steelhead released from the lower Imnaha River trap to Lower Granite Dam from 1995 to 2002. Error bars indicate 95% confidence limits.

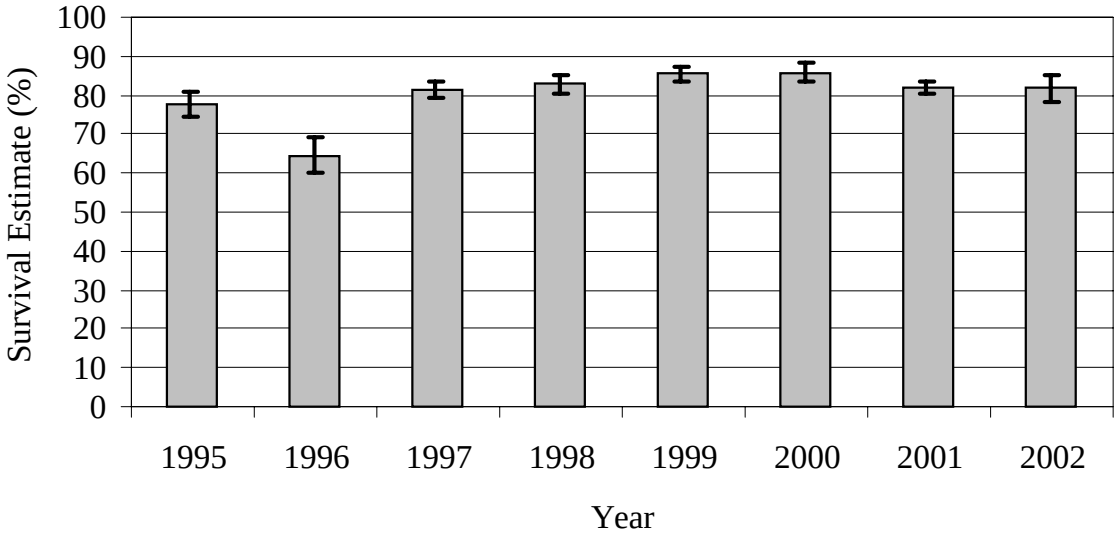

Figure 22. Season-wide survival estimates for hatchery steelhead released from the lower Imnaha River trap to Lower Granite Dam from 1995 to 2002. Error bars indicate 95% confidence limits.

Table 14. Season-wide estimates of survival from the lower Imnaha River trap to Lower Monumental Dam from 1997 to 2002. Ninety-five percent confidence intervals are shown in parentheses.

Migration Year	Natural Chinook Salmon Survival (%)	Hatchery Chinook Salmon Survival (%)	Natural Steelhead Survival (%)	Hatchery Steelhead Survival (%)
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)	68.9 (2.5)	49.7 (3.5)	42.9 (6.0)
2002	76.8 (4.5)	68.1 (4.2)	69.9 (4.5)	78.0 (8.4)

28 release group to 75.8% (± 13.0%) for the April 21 release group in 2001. Natural steelhead weekly survival estimates ranged from 91.3% (± 24.2%) for the April 21 release group to 41.3%(± 19.4%) for the June 2 release group. The maximum weekly survival estimate for hatchery steelhead (90.3% ± 23.4%) was from the April 14 release. The lowest survival estimate from release to LMO was 61.5% (± 13.7%) resulting from the April 21 release group.

Smolt to Adult Return Rates

A SAR was calculated for two groups of PIT tagged juvenile natural chinook salmon emigrants from the Imnaha River, for brood years 1996 to 1998. The two groups were represented by: 1) juvenile chinook salmon pre-smolts PIT tagged during the fall, and 2) chinook salmon smolts PIT tagged during the spring. Estimated SAR's for these two groups represent in-river, or bypassed, 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 in-river migrating Imnaha River chinook salmon. A season wide juvenile survival rate from the lower trap to LGR for the life stage and migration year of interest 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 because it provides a more comparable SAR rate given life stage differences.

The total number of chinook salmon adults detected at LGR for spring PIT tagged smolts from brood years 1996, 1997, and 1998 were 59, 105, and 109 fish, respectively (Table 17). Adult detections from fall PIT tagged pre-smolts from brood years 1996, 1997, and 1998 were 27, 20, and 22 fish, respectively. Adult detections from the fall tagged pre-smolts was below the desired sample size of 30 adults per brood year.

Natural chinook salmon pre-smolts had a higher LGR to LGR SAR index for all brood

Table 15. Estimated survival probabilities for weekly PIT tag release groups of natural and hatchery chinook salmon and steelhead smolts released from the lower Imnaha River trap from February 22 to June 21, 2001 with 95% confidence intervals in parentheses. Estimates are from release to the tail race for 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.

Week of Release	Number Released	Estimated Survival			
		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					
3/11	403	83.8 (3.8)	98.0 (4.3)	84.4 (8.2)	69.0 (6.9)
3/18	3,462	84.0 (1.3)	95.5 (1.4)	84.1 (1.4)	67.5 (2.3)
3/25	1,755	83.2 (1.9)	93.8 (2.0)	85.4 (3.4)	66.7 (3.0)
4/1	810	85.8 (2.6)	94.3 (2.5)	86.1 (2.4)	69.6 (4.3)
4/8	580	88.8 (2.9)	93.1 (3.4)	85.1 (5.4)	70.3 (4.9)
4/15	1,166	90.0 (2.0)	94.1 (2.4)	84.1 (4.1)	71.2 (3.7)
4/22	816	89.2 (2.5)	91.1 (3.2)	82.7 (4.9)	67.2 (4.3)
4/29	313	76.2 (5.0)	95.3 (5.1)	69.9 (8.7)	50.8 (6.9)
5/6	253	76.4 (5.7)	92.2 (6.7)	79.7 (11.6)	56.1 (8.8)
Hatchery Chinook Salmon					
3/25	602	74.7 (3.7)	95.1 (4.1)	85.4 (7.2)	60.7 (5.6)
4/1	1,136	80.2 (2.5)	96.4 (2.7)	90.3 (4.9)	69.8 (4.1)
4/8	297	78.9 (5.0)	96.9 (5.0)	90.9 (8.7)	69.5 (7.5)
4/15	493	87.5 (3.4)	98.0 (3.6)	91.1 (6.7)	78.2 (6.0)
4/22	369	82.2 (4.5)	91.1 (4.6)	93.9 (7.1)	70.3 (6.5)
Natural Steelhead					
4/15	451	88.6 (3.5)	85.4 (6.0)	80.6 (14.7)	60.9 (11.1)
4/22	438	92.5 (3.1)	84.6 (5.7)	84.8 (15.2)	66.4 (11.9)
4/29	710	85.6 (3.1)	76.5 (5.1)	75.6 (13.7)	49.5 (9.1)
5/6	1,318	80.8 (2.3)	84.5 (3.3)	62.5 (6.5)	42.6 (4.6)
5/13	332	80.1 (4.7)	78.5 (9.6)	84.2 (38.2)	52.9 (23.8)
Hatchery Steelhead					
4/22	610	87.1 (3.3)	75.0 (6.7)	59.0 (11.4)	38.5 (7.3)
4/29	601	79.1 (3.9)	68.8 (9.9)	70.1 (25.9)	38.1 (13.5)
5/6	1,313	83.0 (2.4)	78.4 (7.8)	79.1 (22.6)	51.5 (14.0)
5/13	500	85.6 (4.5)	80.9 (16.2)	57.5 (30.9)	39.8 (20.0)

Table 16. Estimated survival probabilities for weekly PIT tag release groups of natural and hatchery chinook salmon and steelhead smolts released from the lower Imnaha River trap from March 4 to June 12, 2002 with 95% confidence intervals in parentheses. Estimates are from release to the tail race for 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.

Week of Release	Number Released	Estimated Survival			
		Trap to LGR % (95% C.I).	LGR to LGO %	LGO to LMO % (95% C.I.)	Trap to LMO % (95%C.I.)
Natural Chinook Salmon					
3/24	397	91.0 (11.9	81.1 (12.7)	105.7 (14.4)	78.0 (10.0)
4/7	252	99.0 (12.6	88.4 (15.2)	99.5 (20.0)	87.1 (15.4)
4/14	374	99.5 (14.6	87.4 (16.4)	96.6 (17.5)	84.0 (12.5)
4/21	428	79.4 (8.2)	95.2 (12.6)	108.8 (18.4)	82.2 (12.4)
4/28	436	79.1 (9.9)	103.1 (18.3)	81.6 (15.7)	66.6 (9.5)
Hatchery Chinook Salmon					
3/24	470	70.2 (12.5	106.0 (23.4)	91.1 (23.4)	67.7 (12.4)
3/31	500	70.6 (9.2)	104.1 (16.4)	96.0 (15.9)	70.5 (9.7)
4/7	473	79.7 (10.0	103.2 (18.7)	80.6 (15.5)	66.3 (9.2)
4/14	531	72.4 (11.2	87.0 (14.4)	111.2 (20.4)	70.0 (13.0)
4/21	430	79.6 (11.2	86.0 (14.4)	110.8 (20.4)	75.8 (13.0)
4/28	392	86.4 (14.6	75.4 (15.8)	94.2 (17.4)	61.3 (10.0)
Natural Steelhead					
4/21	299	98.4 (24.5	71.8 (20.8)	129.4 (37.0)	91.3 (24.3)
4/28	771	86.2 (11.7	83.9 (19.6)	86.5 (19.7)	62.5 (8.3)
5/5	645	80.7 (11.8	86.9 (17.5)	105.2 (25.4)	73.7 (15.0)
5/12	1960	82.6 (4.9)	92.1 (7.1)	91.0 (9.7)	69.2 (6.7)
5/26	308	81.5 (15.9	96.0 (25.3)	92.0 (33.2)	71.9 (22.8)
6/2	231	82.8 (18.3	74.8 (23.3)	66.7 (33.5)	41.3 (19.4)
Hatchery Steelhead					
4/14	300	84.4 (10.9	102.4 (23.9)	104.5 (34.2)	90.3 (23.4)
4/21	305	80.6 (14.3	100.0 (27.9)	76.3 (23.6)	61.5 (13.7)
4/28	309	96.5 (24.8	80.8 (29.1)	101.1 (36.9)	78.8 (21.8)
5/5	302	86.3 (19.9	89.5 (22.7)	115.9 (44.9)	89.5 (29.0)
5/12	300	120.6 (40.1	58.6 (22.1)	112.7 (35.4)	79.7 (23.0)
5/19	303	72.0 (9.6)	98.9 (19.7)	93.2 (36.3)	66.4 (24.0)

years examined when compared to smolts (Table 17). The LGR to LGR SAR index for fall tagged pre-smolts ranged from 2.41% to 3.08%. The LGR to LGR SAR index for spring tagged smolts ranged from 1.75% to 2.94% for the same brood years. The 1996 brood year pre-smolt SAR of 3.08% appeared substantially different from the smolt SAR of 1.75%. Observed differences between the 1997 and 1998 pre-smolt and smolt SAR indexes were relatively small (0.17 % - brood year 1997 and 0.04% - brood year 1998).

The observed SAR index for pre-smolt chinook salmon from the lower Imnaha River trap to LGR ranged from 1.00% to 1.86% for the three brood years examined (Table 17). The SAR index for smolts from the lower Imnaha River to LGR varied from 1.49% to 2.49%.

Table 17. Detections of PIT tagged Imnaha River adult chinook salmon and smolt to adult return rates (SAR %) from the lower Imnaha River trap to Lower Granite Dam (LGR) and from LGR to LGR for brood years 1996 to 1998.

Life Stage	Brood Year	Number Tagged	Estimated Smolt Equivalents	Number of Adult Detections[1]	Age at Return			Trap to LGR SAR (%)	LGR to LGR SAR (%)
					III	IV	V		
Pre-Smolt	1996	1,453	878	27	5	15	7	1.86	3.08
	1997	2,000	830	20	3	16	1	1.00	2.41
	1998	2,009	739	22	2	12	8	1.10	2.98
Smolt	1996	3,956	3,370	59	3	41	15	1.49	1.75
	1997	5,306	4,696	105	8	69	28	1.98	2.24
	1998	4,369	3,705	109	3	62	44	2.49	2.94

Arrival Timing at Dams

Natural and Hatchery Chinook Salmon Arrival Timing

The three PIT tagged groups of natural chinook salmon during migration year 2001 had significantly different arrival times at LGR ($p < 0.05$). Figure 23 shows the cumulative arrival frequency of natural chinook tagged at the upper trap and lower trap in the fall of 2000, and at the lower trap in the spring of 2001 at LGR. The April 26 median arrival date at LGR for natural chinook salmon from the lower trap in the fall was statistically different from the April 29 median arrival data for natural chinook salmon from the upper trap. The April 28 median arrival date for natural chinook salmon from the lower trap in the spring was also significantly different ($p < 0.05$) than the median arrival date for fall tagged fish from the lower trap. A statistical comparison of the distributions using the Kolmogorov-Smirnov test (Statagraphics 1995, Steel et al.1997) also indicated that there was a statistical difference ($p < 0.05$) in the arrival distributions at LGR for all three groups of natural chinook salmon in migration year 2001. Wilcoxon and Kolmogorov-Smirnov test results are presented in Appendix Tables F1 and F2. The range of arrival time, sample sizes, and median and 90% arrival times for natural chinook salmon pre-smolts are presented in Appendix F, Tables F3 and F4. The statistically significant differences in median arrival times and arrival distributions of natural chinook salmon at LGR during migration year 2001 are not significant from a water management point of view since no spill occurred at LGR from March to June of 2001. However, the Cormack Jolly-Seber survival estimate assumes PIT tag release groups are homogenous. Therefore, the statistical differences in arrival timing reinforce the need to estimate NPT Imnaha River natural chinook salmon by life stage and site.

PIT tagged migration year 2002 natural chinook salmon from the upper trap in the fall of 2001 also had significantly different median arrival times and distributions at LGR than natural chinook PIT tagged at the upper trap in the fall of 2001 and at the lower trap in the spring of 2002 ($p < 0.05$). The median arrival time at LGR during migration year 2002 of fall tagged fish from the upper and lower trap was May 5 and April 16, respectively (Figure 24). There was no statistically significant difference in the median arrival or distribution at LGR of fall tagged natural chinook salmon from the upper trap and spring tagged natural chinook salmon from the lower trap in 2002. The median arrival time for spring tagged natural chinook salmon smolts at LGR in migration year 2002 was May 5 (Appendix F, Table F5).

Spill at LGR encompassed the entire migration of fall tagged natural chinook salmon from the upper trap in 2002 (Figure 24). Their 90% migration timing occurred during a spill of 27.5 Kcfs. Five percent of the fall tagged natural chinook salmon from the lower trap arrived at LGR prior to the beginning of spill on April 3. Ninety percent arrival timing for this group occurred during a spill of 23.7 kcfs.

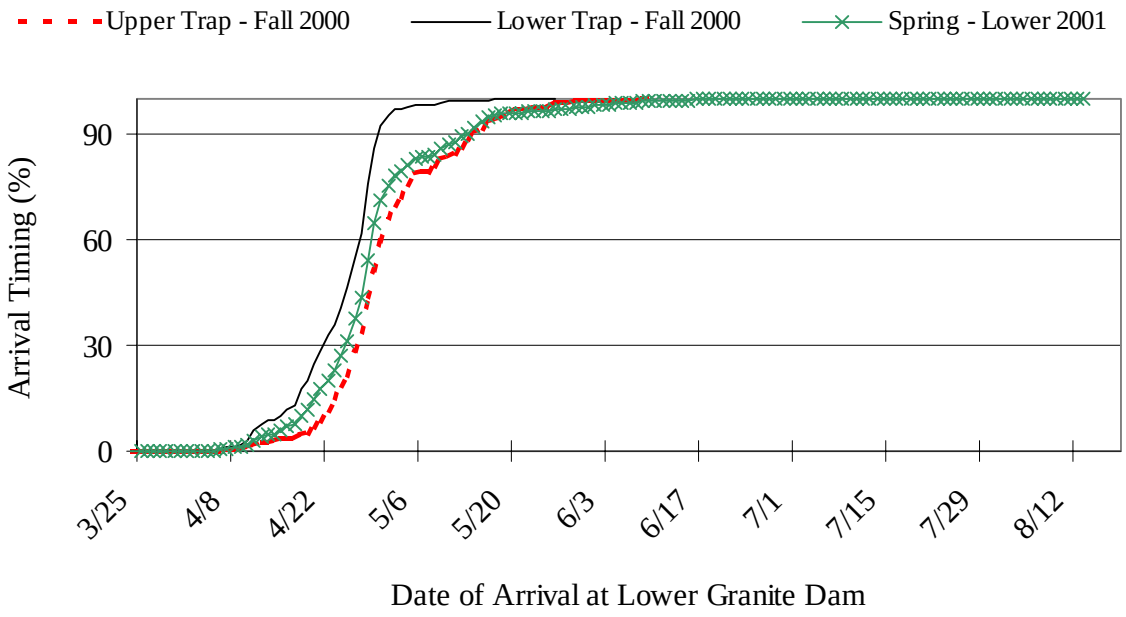

Figure 23. The arrival timing of natural chinook salmon tagged in the fall of 2000 at the upper and lower trap and in the spring of 2001 at the lower trap at Lower Granite Dam during migration year 2001.

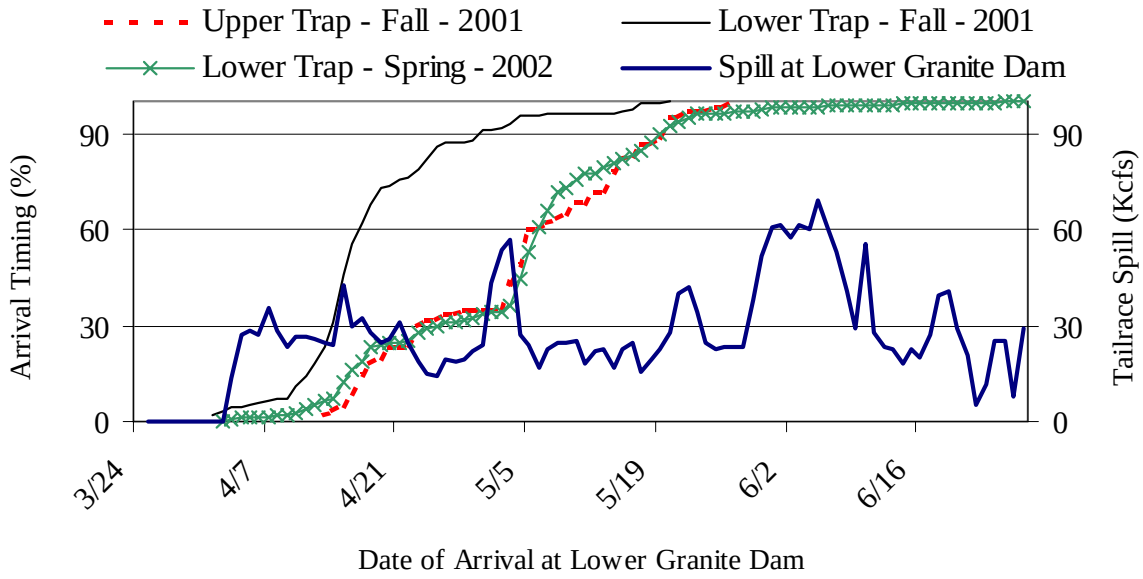

Figure 24. The arrival timing of natural chinook salmon tagged in the fall of 2001 at the upper and lower Imnaha River traps and natural chinook salmon tagged in the spring of 2002 at the lower trap at Lower Granite Dam in relation to the 2002 spill at Lower Granite Dam.

Ninety percent arrival timing at LGR during migration year 2001 for the three groups of natural chinook salmon occurred on the following dates: May 14 - upper trap (fall), April 30 - lower trap (fall), and May 12 (spring). Migration year 2002 90% arrival timing at LGR for the three groups of natural chinook salmon occurred on the following dates: May 20 - upper trap (fall), May 30 - lower trap (fall), and May 20 (spring) (Appendix F3 and F4).

Natural chinook salmon median arrival at LGO in migration years 2001 and 2002 occurred on May 7 for fall tagged fish from the upper site. Fall tagged natural chinook salmon from the lower site had median arrival dates at LGO of April 30 and May 1 for migration years 2001 and 2002, respectively. Spring tagged fish had median arrival dates at LGO of May 2 and May 7 for migration years 2001 and 2002 respectively. The 90% arrival timing in 2001 at LGO occurred on the following dates: May 18 - upper trap, May 11 - lower trap (fall), and May 17 lower trap (spring). The 90% arrival timing in 2002 at LGO occurred on the following dates: May 22 - upper trap, May 5 - lower trap (fall), and May 23 lower trap (spring).

Imnaha River 2001 spring tagged natural chinook salmon arrived at LGR from March 30 to August 13 (Appendix Table F5). They were observed at LGO from April 16 to July 23. At LMO they were first observed on April 28, with median arrival occurring on May 13 and 90% arrival occurring on May 20. They were last seen at LMO on July 18. Forty-five fish from this group were observed at MCN from April 29 to June 5. The spring tagged natural chinook salmon for migration year 2002 arrived at LGR from April 2 to June 27. The range of arrival timing at LGO, LMO, and MCN occurred during the following dates: April 15 to June 20 at LGO, April 22 to June 14 at LMO, and April 23 to June 10 at MCN. Median arrivals occurred on May 7 at LGO, May 13 at LMO, and May 14 at MCN. Ninety percent arrival dates were as follows: May 23 at LGO, May 22 at LMO, and May 23 at MCN.

Fall tagged natural chinook salmon from the upper Imnaha River trap have been observed at LGR as early as April 3 (1998) to as late as June 9 (2001) from 1998 to 2002. The May 5 median arrival timing and the May 20 90% arrival date at LGR were later than usual. The median arrival dates at LGR, from 1998 to 2001, ranges from April 27 to May 5. The 90% arrival timing (1998 to 2001) had ranged from May 9 to May 20. Median arrival times at LGO for 2001 and 2002 were within the April 30 to May 28 range of median observations made from 1998 to 2000. The 2002 90% arrival timing at LGO of May 22 was the latest observation of it's kind for this group since 1998. The prior range of 90% arrivals at LGO occurred from May 11 (2000) to May 18 (1999, 2001).

First observations of fall tagged natural chinook salmon from the lower trap have ranged from March 27 (1998) to April 4 (2000). Last observations for this group have occurred from May 2 (1999) to May 26 (2001). The 2001 median arrival data at LGR of April 26 was the lastest observed at LGR since 1998 and the 2002 90% arrival data at MCN was the latest observed at LGR since 1998. At LGO the first arrivals for 2001 (April 23) and 2002 (April 13) were later than first observations of April 8 (1999) to April 12 (2000) from 1998 to 2000. The last observations made for this group at LGO in 2001 and 2002 (June 16, 2001 and May 16,

2002) were later than the observations of May 9 (1999) to May 12 (1998, 2000) at LGO from 1998 to 2000. The median arrival dates at LGO for this group in 2001 were later than the April 17 (2000) to April 25 (1998) arrival date range from 1998 to 2000 and the 90% arrival dates in 2002 were also later than previous observations of April 24 (2000) to May 2 (1998) of 90% arrival timing at LGO for fall tagged natural chinook salmon from the lower trap.

NPT has monitored the first, median, 90%, and last arrival time for chinook salmon since 1992 (Appendix F). The median arrival time is useful for comparing migration timing (McConnaha et al. 1985). The 90% arrival time is commonly used for management decisions. NPT has used the first and last arrival to define the range of arrival timing at LGR, LGO, LMO, and MCN.

Hatchery chinook salmon smolt arrival timing from 1992 to 2002 is presented in Appendix Table F6. This arrival data quantifies the period of time that survival estimates in the previous section represent. The ranges of the 2001 hatchery chinook salmon arrival dates are as follows: March 31 to May 27 at LGR, April 15 to May 29 at LGO, April 27 to June 4 at LMO, and May 5 to May 31 at MCN. Median arrivals occurred on April 29 at LGR, May 7 at LGO, and May 12 at LMO. Ninety percent arrivals occurred May 10 at LGR, May 16 at LGO, and May 25 at LMO during migration year 2001. Arrivals of Imnaha River hatchery chinook salmon migrating in 2002 were observed from April 1 to May 23 at LGR, April 13 to June 1 at LGO, April 30 to June 11 at LMO, and April 16 to June 10 at MCN. Median arrivals occurred at LGR on May 7, at LGO on May 12, at LMO on May 14, and at MCN on May 15 (2002). The 90% date of arrival at each dam is as follows: May 19 at LGR, May 22 at LGO, May 23 at LMO, and May 25 at MCN during migration year 2002. Spill at LGR almost encompassed the entire period of hatchery chinook salmon during migration year 2002; 1.3% passed prior to the start of spill (Figure 25).

Natural and Hatchery Steelhead Arrival Timing

Natural steelhead arrived at LGR from March 29 to September 9 during the 2001 migration year (Appendix Table F7). The range of arrival timing at LGO for 2001 occurred from April 7 to August 19. At LMO the first arrival occurred on May 6. The last interrogation of an Imnaha River natural steelhead at LMO occurred October 3. Arrivals at MCN ranged from May 16 to August 5. Median dates of arrival occurred at LGR on May 14 and at LGO on May 16. The 2001 90% arrival timing for natural steelhead occurred May 18 at LGR and May 24 at LGO. The range of 2002 arrivals of Imnaha River natural steelhead were as follows: April 10 to June 26 at LGR, April 13 to August 28 at LGO, April 30 to August 8 at LMO, and April 29 to June 7 at MCN. Median arrival occurred on May 18 at LGR, May 21 at LGO, May 22 at LMO, and May 22 at MCN (2002). Ninety percent arrivals for migration year 2002 occurred on May 31 at LGR, June 2 at LGO, June 3 at LMO, and May 27 at MCN. Spill at median arrival at LGR was 19.5 kcfs for natural steelhead (Figure 25).

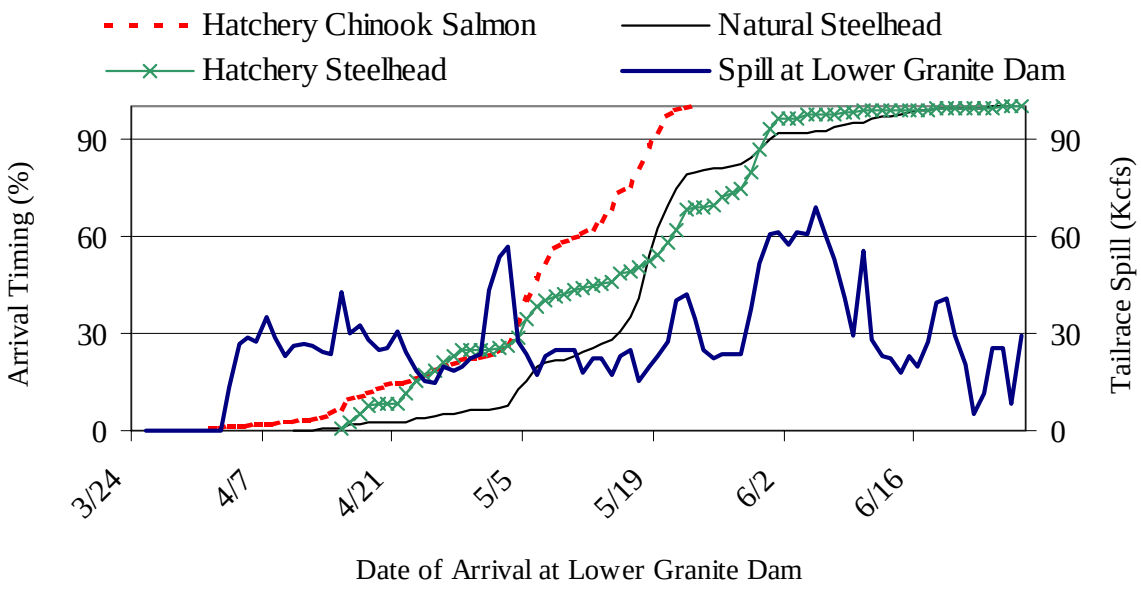

Figure 25. The arrival timing of hatchery chinook salmon and natural and hatchery steelhead tagged in the spring of 2002 at the lower trap, at Lower Granite Dam, in relation to the 2002 spill at Lower Granite Dam.

Imnaha River hatchery steelhead smolt arrival timing for migration years 1993 to 2002 at LGR, LGO, LMO, and MCN is presented in Appendix Table F8. Imnaha River hatchery steelhead smolts migrating in 2001 arrived at LGR from April 21 to September 23, at LGO from April 28 to October 30, at LMO from May 8 to October 25, and at MCN from May 21 to July 4, 2001. They had median arrivals of May 16 at LGR and May 20 at LGO. Ninety percent arrival timing occurred May 26 at LGR, and June 21 at LGO.

Imnaha River hatchery steelhead arrivals at LGR, LGO, LMO, and MCN for the 2002 migration year occurred from April 15 to June 27 at LGR, from April 19 to June 29 at LGO, from April 30 to October 18 at LMO, and from May 2 to June 16 at MCN. Median dates of arrival were May 17 at LGR, May 24 at LGO, May 28 at LMO, and May 25 at MCN. The 90% arrivals occurred on May 31 at LGR, June 3 at LGO, June 9 at LMO, and June 6 at MCN. Spill at median arrival at LGR was 15.5 kcfs for hatchery steelhead.

Travel Time to Lower Granite Dam

Natural chinook salmon weekly median travel times to LGR from March 18, and April 1 to April 22, for the 2001 migration year were significantly faster than hatchery chinook salmon ($p < 0.05$) (Table 18). Natural and hatchery chinook salmon median travel times from releases occurring from the weeks of March 25 to April 22 decreased with an increase in date. A

Table 18. A summary of average and median annual and weekly travel times of natural and hatchery chinook salmon released from the lower Imnaha screw trap, February 22 to June 21, 2001, at Lower Granite Dam (LGR). Weeks with less than 30 interrogations at Lower Granite Dam were not presented. Wilcoxon rank sum statistical test values represent a comparison of median natural and hatchery smolt travel times.

Migration Year	Week Released	Number Interrogated		Median Travel Time (days)		
		Natural	Hatchery	Natural	Hatchery	p value
2001	3/11	272		40.1		
	3/18	2,408	54	33.7	27.4	0.00
	3/25	1,204	341	29.8	29.9	0.13
	4/1	566	662	24.8	25.7	0.00
	4/8	426	171	16.5	20.2	0.00
	4/15	821	283	11.1	12.7	0.00
	4/22	580	213	9.1	11.9	0.00
	4/29	190		11.7		
	5/6	150		6.3		
	5/13	33		10.3		
	5/20	77		8.3		
2002	3/24	81	49	21.5	24.1	0.26
	3/31	37	57	15.4	24.8	0.00
	4/14	71	77	16.0	26.0	0.00
	4/21	95	74	12.1	18.1	0.00
	4/28	82	77	9.5	14.3	0.00

commonly accepted explanation for this trend is that the rate of smoltification is increasing due to increasing water temperatures (Berggren and Filardo 1993, and Smith et al. 2002). Natural chinook salmon median travel times ranged from 6.3 days to 40.1 days, while hatchery chinook salmon median travel times ranged from 11.9 days to 29.9 days.

Median travel times to LGR for natural chinook salmon migrating in the 2002 migration year were significantly faster ($p < 0.05$) than median travel times of hatchery chinook salmon released during the weeks of March 31 to April 28 (Table 18). Median travel times for natural and hatchery chinook salmon decreased from April 14 to April 28. Natural chinook salmon median travel time ranged from 9.5 days (April 28) to 21.5 days (March 24). Median weekly travel time for hatchery chinook salmon ranged from 14.3 days (April 28) to 26.0 days (April 14).

Natural steelhead median travel times to LGR during the 2001 migration year were

significantly faster ($p < 0.05$) than hatchery steelhead for weekly release groups from April 15 to May 13 (Table 19). Median weekly travel times for natural steelhead decreased from the weeks of March 18 (53.6 days) to April 22 (5.6 days). Hatchery steelhead median travel times had no distinct pattern and ranged from 4.8 days for the May 20 release group to 13.7 days for the April 29 release group.

Natural steelhead median travel times to LGR during the 2002 migration year were significantly faster ($p < 0.05$) than hatchery steelhead for weekly release groups from April 28 to May 19 (Table 19). There was no obvious relationship between release date and travel time to LGR for natural or hatchery steelhead in 2002. Median weekly travel times for natural steelhead ranged from three days (May 26) to 10.6 days (April 21). Hatchery steelhead weekly mean travel times ranged from 2.9 days (May 26) to 13.7 days (April 21).

Mortality

Trapping and PIT tagging caused 68 (2.94%), and one (0.04%) mortalities during the fall of 2000 at the upper trap (Appendix Table G1). At the lower trap trapping and PIT tagging caused seven (0.23%) and one (0.03%) mortalities during the fall of 2000 (Appendix Table G2). Forty four natural chinook salmon mortalities occurred at the lower trap during the spring of 2001; 23 due to trapping, two due to handling, and 19 due to PIT tagging (Appendix Table G3). Due to the large catch of natural chinook salmon ($n = 10,663$) the overall percentage of mortality for natural chinook salmon was low (0.41%). Twenty one hatchery chinook salmon mortalities occurred as a result of trapping ($n = 15$) and handling ($n = 6$) at the lower trap during the spring of 2001 (0.13% overall mortality). The five natural steelhead and four hatchery steelhead mortalities that occurred during the spring of 2001 were due to trapping (Appendix Table G3).

Trapping, handling, and PIT tagging caused 19, one, and three natural chinook salmon mortalities during the fall of 2001 at the upper trap for an overall mortality rate of 1.63% (Appendix Table G4). At the lower trap, trapping and PIT tagging caused one, and two mortalities during the fall of 2001 for an overall mortality rate of 0.14% (Appendix Table G5). A total of 14 natural chinook salmon mortalities occurred at the lower trap during the spring of 2002; seven due to trapping, two due to handling, and five due to PIT tagging (Appendix Table G6). Overall mortality rates for natural chinook salmon captured in the spring of 2002 were 0.52%. Fourteen hatchery chinook salmon mortalities occurred due to trapping ($n = 11$) and PIT tagging ($n = 3$) in the spring of 2002. This resulted in an overall mortality rate of 0.05%. Five natural steelhead and 11 hatchery steelhead mortalities occurred at the lower trap in the spring of 2002. All steelhead mortalities were due to trapping. This mortality was 0.07 for natural steelhead and 0.04% for hatchery steelhead.

Incidental Catch

The incidental catch during the fall and spring of migration year 2001 total 1,369 fish. It was comprised of five families of fishes: Salmonidae, Centrarchidae, Catostomidae, Cyprinidae,

Table 19. A summary of average and median annual and weekly travel times of natural and hatchery steelhead released from the lower Imnaha screw trap, March 4 to June 12, 2002, at Lower Granite Dam (LGR). Weeks with less than 30 interrogations at Lower Granite Dam were not presented. Wilcoxon rank sum statistical test values represent a comparison of median natural and hatchery smolt travel times.

Migration Year	Week Released	Number Interrogated		Median Travel Time (days)		
		Natural	Hatchery	Natural	Hatchery	p < value
2001	3/18	44		53.6		
	3/25	52		44.2		
	4/8	33		15.1		
	4/15	342	109	8.7	13.6	0.00
	4/22	358	476	5.6	8.0	0.00
	4/29	537	434	10.1	13.7	0.00
	5/6	969	1,009	5.5	6.6	0.00
	5/13	249	369	4.3	5.1	0.00
	5/20	95	141	5.0	4.8	0.88
2002	4/7	41		5.5		
	4/14	52	86	8.9	5.5	0.09
	4/21	41	61	10.6	13.7	0.75
	4/28	147	47	4.9	7.3	0.00
	5/5	107	44	7.4	12.1	0.00
	5/12	419	40	4.5	5.2	0.03
	5/19	55	83	6.7	7.2	0.04
	5/26	51	39	3.0	2.9	0.62
	6/2	59		5.0		

and Cottidae (Appendix Table H1). The catch of Salmonidae consisted of 123 juvenile rainbow/steelhead, 27 adult natural and hatchery steelhead, 482 mountain whitefish (*Prosopium williamsoni*), and 94 bull trout (*Salvelinus confluentus*). The juvenile rainbow/steelhead reported for the 2001 and 2002 incidental catch were either resident fish or not actively migrating and are not a subset of the catch of natural steelhead in Tables 2 and 3 of this report. Twenty-five Centrarchidae were captured and comprised solely of smallmouth bass (*Micropterus dolomieui*). A total of 200 bridgelip suckers (*Catostomus columbianus*), 30 largescale suckers (*Catostomus macrocheilus*), and four unidentified sucker species represented the family Catostomidae. The catch of Cyprinidae was as follows: 191 longnose dace (*Rhinichthys cataractae*), 21 redside shiner (*Richardsonius balteatus*), 55 northern pike minnow (*Ptychocheilus oregonensis*), 13 chislemouth (*Acrocheilus alutaceus*), and 24 speckled dace (*Rhinichthys osculus*). A total of 88

Cottus species (sculpins) of the family Cottidae were captured during the spring study period.

The incidental catch during the fall and spring of migration year 2002 total 2,842 fish. It was comprised of six families of fishes: Salmonidae, Centrarchidae, Catostomidae, Cyprinidae, Cottidae, and Ictaluridae (Appendix Table H2). One adult chinook salmon was captured in the lower trap during the spring of 2002. The remaining catch of Salmonidae consisted of 728 juvenile rainbow trout/steelhead, 91 adult natural and hatchery steelhead, 300 mountain whitefish, and 151 bull trout. The catch of Centrarchidae consisted of 139 smallmouth bass and two bluegill (*Lepomis macrochirus*). A total of 52 bridgelip suckers, 815 largescale suckers, and 178 unidentified sucker species represented the family Catostomidae. The catch of Cyprinidae was as follows: 217 longnose dace, 28 redsided shiner, 52 northern pikeminnow, 27 chislemouth, six speckled dace, and one Leopard Dace (*Rhinichthys falcatus*). A total of 47 *Cottus* species (sculpins) of the family Cottidae and seven bullhead, representing the family Ictaluridae were captured during migration year 2002.

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APPENDIX A

IMNAHA AND SNAKE RIVER DISCHARGE

Appendix A. Table A1. The mean daily discharge for the Imnaha River gauge 13292000 from October 14 to November 24, 1928 to 2001, and October 14 to November 24, 2000 and 2001.

Date	1928 to 2001	2000	2001
14-Oct	166	158	127
15-Oct	163	161	123
16-Oct	167	159	119
17-Oct	160	155	115
18-Oct	156	152	114
19-Oct	156	153	113
20-Oct	154	151	114
21-Oct	154	173	114
22-Oct	158	166	116
23-Oct	161	155	142
24-Oct	161	154	151
25-Oct	162	152	132
26-Oct	168	151	128
27-Oct	165	198	125
28-Oct	166	189	125
29-Oct	171	258	128
30-Oct	172	214	133
31-Oct	170	192	270
1-Nov	169	180	207
2-Nov	166	172	169
3-Nov	165	167	150
4-Nov	170	171	139
5-Nov	170	173	133
6-Nov	170	169	
7-Nov	173	160	
8-Nov	174	165	115
9-Nov	173	168	115
10-Nov	176	162	114
11-Nov	191	157	113
12-Nov	208	136	112
13-Nov	195	143	113
14-Nov	190	161	118
15-Nov	189	166	122
16-Nov	193	131	118
17-Nov	198	120	116
18-Nov	195	128	117
19-Nov	198	132	114
20-Nov	199	147	113
21-Nov	190	145	138
22-Nov	183	144	147
23-Nov	183	129	147
24-Nov	193	178	129

Appendix A. Table A2. The mean daily discharge for the Imnaha River gauge 13292000 from 1928 to 2001 and 2002, and the mean daily discharge for the Snake River gauge 13334300 from 1958 to 2001 and 2002 for the month of March.

	Imnaha River Gauge 13292000 Mean Daily Discharge (cfs)			Snake River Gauge 13334300 Mean Daily Discharge (cfs)		
Date	1928 to 2001	2001	2002	1958 to 2001	2001	2002
1-Mar	310	126	158	37,620	13,800	17,600
2-Mar	317	160	147	36,690	13,500	17,800
3-Mar	313	133	145	37,040	16,900	16,300
4-Mar	304	142	164	36,640	16,100	17,500
5-Mar	304	143	167	35,300	14,300	17,800
6-Mar	305	147	163	36,330	14,900	14,599
7-Mar	309	153	169	36,710	17,100	15,100
8-Mar	318	175	135	36,960	16,800	18,300
9-Mar	325	204	156	37,590	18,200	17,300
10-Mar	354	202	157	38,050	18,000	15,300
11-Mar	380	193	154	38,170	15,800	19,300
12-Mar	374	187	173	39,090	16,500	23,800
13-Mar	383	187	174	39,390	19,300	24,400
14-Mar	386	198	173	39,660	21,500	25,000
15-Mar	383	197	173	40,060	21,300	24,800
16-Mar	391	201		39,680	23,800	20,400
17-Mar	404	192		40,780	20,100	18,900
18-Mar	412	188		40,910	17,200	19,900
19-Mar	422	218	183	41,280	16,600	25,200
20-Mar	438	295	178	41,580	23,000	22,000
21-Mar	459	291	177	41,990	25,000	19,900
22-Mar	466	295	196	42,220	24,400	19,600
23-Mar	483	316	273	41,790	20,800	21,900
24-Mar	503	361	378	42,930	21,200	23,800
25-Mar	504	412	360	43,250	19,800	32,500
26-Mar	519	432	369	43,060	22,500	37,700
27-Mar	537	384	431	43,640	28,700	39,200
28-Mar	551	350	460	44,430	29,100	39,600
29-Mar	553	331	459	44,280	28,800	39,800
30-Mar	563	316	459	43,780	29,400	38,100
31-Mar	575	308	516	43,730	26,900	41,200
Monthly Average	414	240	245	40,149	20,365	24,019

Appendix A. Table A3. The mean daily discharge for the Imnaha River gauge 13292000 from 1928 to 2001 and 2002, and the mean daily discharge for the Snake River gauge 13334300 from 1958 to 2001 and 2002 for the month of April.

	Imnaha River Gauge 13292000 Mean Daily Discharge (cfs)			Snake River Gauge 13334300 Mean Daily Discharge (cfs)		
Date	1928 to 2001	2001	2002	1958 to 2001	2001	2002
1-Apr	591	319	640	43,770	25,900	43,000
2-Apr	609	338	686	44,290	21,500	35,300
3-Apr	619	303	642	44,870	26,400	35,600
4-Apr	624	296	675	44,720	24,800	25,300
5-Apr	653	284	786	44,890	22,800	29,199
6-Apr	699	297	934	45,310	23,200	36,300
7-Apr	730	309	956	45,430	21,200	39,900
8-Apr	746	289	853	45,600	20,300	38,400
9-Apr	757	266	893	46,390	19,700	39,300
10-Apr	765	287	1,019	47,530	21,800	39,800
11-Apr	775	301	1,050	48,080	21,100	39,000
12-Apr	812	304	1,150	47,320	19,100	35,700
13-Apr	859	301	1,370	47,690	20,700	36,700
14-Apr	914	292	2,090	47,480	20,700	45,200
15-Apr	945	296	1,970	48,020	18,500	57,099
16-Apr	967	311	1,440	48,050	18,100	60,000
17-Apr	1,004	371	1,150	48,960	23,400	60,200
18-Apr	1,038	432	983	49,500	23,900	54,900
19-Apr	1,062	507	852	49,980	22,400	50,500
20-Apr	1,097	510	791	50,090	23,200	43,200
21-Apr	1,113	504	776	51,749	26,400	37,100
22-Apr	1,125	479	794	52,110	23,400	37,900
23-Apr	1,159	462	898	52,550	23,700	44,600
24-Apr	1,202	472	844	53,300	22,900	41,200
25-Apr	1,184	550	847	54,120	23,900	34,700
26-Apr	1,163	671	933	53,600	27,100	29,500
27-Apr	1,233	846	1,030	53,450	29,000	28,299
28-Apr	1,243	975	962	54,690	32,700	28,599
29-Apr	1,241	819	999	54,779	32,200	28,499
30-Apr	1,252	736	1,140	55,140	31,800	28,999
Monthly Average	939	438	1,005	49,115	23,727	39,466

Appendix A. Table A4. The mean daily discharge for the Imnaha River gauge 13292000 from 1928 to 2001 and 2002, and the mean daily discharge for the Snake River gauge 13334300 from 1958 to 2001 and 2002 for the month of May.

	Imnaha River Gauge 13292000 Mean Daily Discharge (cfs)			Snake River Gauge 13334300 Mean Daily Discharge (cfs)		
Date	1928 to 2001	2001	2002	1958 to 2001	2001	2002
1-May	1,285	848	1,280	55,550	37,900	30,600
2-May	1,308	738	1,419	56,289	34,600	33,000
3-May	1,339	668	1,510	56,480	31,400	40,300
4-May	1,385	629	1,390	57,210	30,600	41,100
5-May	1,392	639	1,350	57,999	31,000	36,200
6-May	1,408	620	1,210	58,809	27,600	36,500
7-May	1,469	597	1,120	59,940	28,200	39,500
8-May	1,502	624	1,010	60,629	30,300	35,500
9-May	1,512	686	921	62,060	31,300	32,600
10-May	1,512	664	847	63,370	31,900	30,200
11-May	1,524	667	804	63,740	34,000	28,899
12-May	1,548	723	856	63,730	34,700	27,000
13-May	1,571	828	1,019	63,810	36,200	27,100
14-May	1,574	865		65,140	41,500	33,400
15-May	1,595	1,150		66,970	48,200	34,500
16-May	1,595	1,030		68,200	54,200	36,500
17-May	1,608	879		68,950	58,000	36,300
18-May	1,617	791		69,930	54,900	37,500
19-May	1,633	765		70,590	52,100	41,800
20-May	1,649	717		70,020	46,600	54,700
21-May	1,648	669		69,890	40,100	63,800
22-May	1,649	669		70,600	40,300	63,500
23-May	1,690	706		71,500	40,400	61,300
24-May	1,686	804	1,110	71,990	41,100	59,300
25-May	1,678	895	1,110	73,070	42,700	52,100
26-May	1,729	893	1,170	74,010	44,600	45,700
27-May	1,717	831	1,330	76,090	40,000	49,400
28-May	1,676	882	1,510	76,700	39,600	60,100
29-May	1,638	757	1,750	77,020	43,300	63,900
30-May	1,616	641	1,960	78,610	37,900	74,800
31-May	1,580	597	1,790	78,510	35,200	84,200
Monthly Average	1,559	757	1,260	67,013	39,368	44,881

Appendix A. Table A5. The mean daily discharge for the Imnaha River gauge 13292000 from 1928 to 2001 and 2002, and the mean daily discharge for the Snake River gauge 13334300 from 1958 to 2001 and 2002 for the month of June.

	Imnaha River Gauge 13292000 Mean Daily Discharge (cfs)			Snake River Gauge 13334300 Mean Daily Discharge (cfs)		
Date	1928 to 2001	2001	2002	1958 to 2001	2001	2002
1-Jun	1,554	602		78,330	36,000	83,200
2-Jun	1,531	629	1,540	77,670	29,000	81,100
3-Jun	1,529	555	1,450	77,890	27,400	80,600
4-Jun	1,502	486	1,409	78,710	26,400	76,900
5-Jun	1,509	457	1,440	80,330	25,800	71,000
6-Jun	1,525	447	1,490	82,060	25,000	67,400
7-Jun	1,523	410	1,380	81,830	26,400	65,500
8-Jun	1,502	396	1,210	81,120	29,500	62,000
9-Jun	1,482	404	1,070	79,720	29,600	58,199
10-Jun	1,432	419	989	78,010	23,400	54,600
11-Jun	1,394	407	920	76,740	23,200	50,200
12-Jun	1,398	442	898	76,550	23,200	46,700
13-Jun	1,401	404	932	76,660	23,300	44,100
14-Jun	1,378	375		75,920	23,100	42,600
15-Jun	1,371	354		75,590	22,900	43,700
16-Jun	1,383	346	1,340	75,340	24,500	47,300
17-Jun	1,341	343	1,400	75,080	20,300	50,300
18-Jun	1,305	335	1,370	74,250	20,400	50,500
19-Jun	1,290	323	1,210	73,260	20,100	52,700
20-Jun	1,271	317	1,070	71,920	18,800	47,900
21-Jun	1,240	316	1,050	70,150	20,400	44,500
22-Jun	1,211	323	1,030	68,240	18,100	42,100
23-Jun	1,172	322	1,070	65,680	17,700	43,100
24-Jun	1,137	313	1,060	63,770	16,900	43,200
25-Jun	1,109	299	1,130	61,790	16,800	46,500
26-Jun	1,082	279	1,170	60,480	16,700	41,700
27-Jun	1,049	289	1,180	59,170	16,500	41,200
28-Jun	1,007	334	1,140	56,940	16,700	42,500
29-Jun	980	290	1,130	54,479	17,500	38,900
30-Jun	945	270	1,000	52,080	16,800	35,300
Monthly Average	1,318	383	1,188	71,992	22,413	53,183

Appendix A. Table A6. Average monthly discharge for the Imnaha River from 1929 to 2002 at USGS Gauge 13292000, and for the Snake River from 1959 to 2002 at USGS gauge 13334300.

	Imnaha River				Snake River			
Year	March	April	May	June	March	April	May	June
1929	340	656	1,245	1,207				
1930	294	753	724	705				
1931	218	582	881	433				
1932	306	1,052	2,169	1,349				
1933	191	754	1,383	2,187				
1934	478	813	699	439				
1935	177	758	1,243	1,034				
1936	204	973	1,151	597				
1937	194	476	1,200	838				
1938	574	1,578	2,602	2,123				
1939	506	795	967	510				
1940	579	1,146	1,133	823				
1941	546	921	1,363	1,532				
1942	337	1,608	1,748	1,408				
1943	415	1,567	1,323	1,451				
1944	162	671	867	968				
1945	276	727	1,661	1,579				
1946	390	1,273	1,807	1,229				
1947	475	824	1,398	933				
1948	254	1,241	2,804	2,339				
1949	416	1,049	1,666	930				
1950	326	725	1,307	1,542				
1951	303	1,147	1,515	972				
1952	244	1,532	2,421	1,753				
1953	330	943	1,544	1,881				
1954	363	884	1,349	1,026				
1955	141	512	1,505	1,386				
1956	642	1,760	2,381	1,796				
1957	475	815	2,661	1,394				
1958	372	928	2,552	2,004				
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

Appendix A. Table A6. Continued.

	Imnaha River				Snake River			
Year	March	April	May	June	March	April	May	June
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
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

Appendix A. Table A6. Continued.

	Imnaha River				Snake River			
Year	March	April	May	June	March	April	May	June
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	20,365	23,727	39,368	22,413
2002	245	1,005	1,260	1,188	24,019	39,466	44,881	53,183

APPENDIX B

IMNAHA AND SNAKE RIVER TEMPERATURE DATA FOR MIGRATION YEARS 2001 AND 2002

Appendix B. Table B1. Mean daily water temperature for the Imnaha River from October 15 to November 20, 2000 and from October 14 to November 24, 2001 at the lower Imnaha River trap.

Date	2000	2001
14-Oct		11.7
15-Oct	10.5	10.2
16-Oct	10.9	10.6
17-Oct	11.0	10.9
18-Oct	11.0	8.5
19-Oct	12.0	9.6
20-Oct	11.7	10.7
21-Oct	10.5	9.5
22-Oct	8.1	10.0
23-Oct	6.6	8.8
24-Oct	6.5	7.5
25-Oct	7.1	7.7
26-Oct	7.6	7.2
27-Oct	9.3	7.9
28-Oct	8.7	9.2
29-Oct	9.4	8.2
30-Oct	7.9	9.2
31-Oct	7.8	10.0
1-Nov	7.4	9.5
2-Nov	5.8	9.4
3-Nov	5.3	8.0
4-Nov	5.2	7.3
5-Nov	6.1	7.5
6-Nov	5.5	7.2
7-Nov	4.4	5.6
8-Nov	4.6	3.9
9-Nov	5.0	4.3
10-Nov	3.6	4.4
11-Nov	2.7	4.1
12-Nov	2.0	5.6
13-Nov	1.5	7.2
14-Nov	1.6	9.2
15-Nov	2.5	9.2
16-Nov	0.9	9.2
17-Nov	0.8	9.5
18-Nov	0.5	8.3
19-Nov	0.1	6.4
20-Nov	-0.2	8.3
21-Nov		8.3
22-Nov		7.7
23-Nov		6.7
24-Nov		3.8

Appendix B. Table B2. Mean daily water temperature for the Imnaha and Snake rivers from February 18, 2001 to February 28, 2001.

Date	Imnaha R.	Snake R.
18-Feb	4.2	
19-Feb	4.4	
20-Feb	5.0	
21-Feb	5.3	
22-Feb	5.7	4.5
23-Feb	5.7	4.5
24-Feb	5.6	4.4
25-Feb	4.3	4.3
26-Feb	3.9	4.1
27-Feb	3.0	3.9
28-Feb	2.3	3.7

Appendix B. Table B3. Mean daily temperature for the Imnaha and Snake rivers from March 1, 2001 to June 21, 2001.

Date	Imnaha R.	Snake R.	Date	Imnaha R.	Snake R.	Date	Imnaha R.	Snake R.	Date	Imnaha R.	Snake R.
1-Mar	2.5	3.6	1-Apr	8.0	7.9	1-May	7.6	9.9	1-Jun	16.4	16.6
2-Mar	4.5	4.1	2-Apr	7.2	7.9	2-May	7.9	9.6	2-Jun	14.3	16.3
3-Mar	3.5	4.3	3-Apr	6.6	8.0	3-May	8.4	10.0	3-Jun	11.5	15.3
4-Mar	3.9	4.2	4-Apr	7.5	8.0	4-May	10.5	11.1	4-Jun	10.8	14.7
5-Mar	6.4	4.5	5-Apr	7.4	8.4	5-May	11.3	12.0	5-Jun	11.3	14.1
6-Mar	7.2	5.2	6-Apr	7.8	8.6	6-May	9.5	11.7	6-Jun	13.0	14.2
7-Mar	7.5	5.5	7-Apr	6.4	8.3	7-May	10.5	11.9	7-Jun	13.9	14.5
8-Mar	6.7	5.4	8-Apr	6.4	8.1	8-May	11.6	12.6	8-Jun	16.0	15.5
9-Mar	6.9	5.5	9-Apr	6.5	8.0	9-May	11.8	13.1	9-Jun	17.5	16.4
10-Mar	6.7	5.6	10-Apr	7.0	8.1	10-May	11.6	13.2	10-Jun	15.4	16.5
11-Mar	6.6	5.8	11-Apr	7.3	8.3	11-May	11.6	13.2	11-Jun	13.9	16.0
12-Mar	6.6	5.8	12-Apr	7.3	8.4	12-May	12.6	13.6	12-Jun	12.9	15.6
13-Mar	7.3	6.0	13-Apr	7.3	8.5	13-May	12.3	13.9	13-Jun	11.7	15.3
14-Mar	6.8	6.2	14-Apr	7.2	8.6	14-May	10.2	13.1	14-Jun	13.0	15.2
15-Mar	5.4	5.7	15-Apr	8.6	9.2	15-May	9.7	11.8	15-Jun	15.3	15.6
16-Mar	6.0	5.6	16-Apr	10.0	10.0	16-May	10.1	11.6	16-Jun	16.3	16.4
17-Mar	6.6	5.9	17-Apr	10.4	10.6	17-May	9.6	11.5	17-Jun	16.2	16.4
18-Mar	7.9	6.2	18-Apr	10.0	10.4	18-May	11.5	12.0	18-Jun	15.6	16.7
19-Mar	9.3	7.0	19-Apr	9.2	10.3	19-May	11.7	12.7	19-Jun	16.7	17.3
20-Mar	8.4	7.1	20-Apr	8.2	10.1	20-May	12.2	13.1	20-Jun	18.0	18.2
21-Mar	7.5	6.7	21-Apr	8.5	10.1	21-May	11.8	13.4	21-Jun	19.6	18.9
22-Mar	7.5	6.7	22-Apr	8.6	10.3	22-May	13.7	14.1	22-Jun	21.0	
23-Mar	8.6	7.2	23-Apr	9.8	10.7	23-May	15.4	15.1	23-Jun	20.5	
24-Mar	9.5	7.9	24-Apr	11.2	11.5	24-May	16.6	16.1			
25-Mar	9.3	8.4	25-Apr	12.5	12.7	25-May	16.2	16.5			
26-Mar	7.9	8.4	26-Apr	12.4	13.2	26-May	15.8	16.3			
27-Mar	6.3	7.3	27-Apr	12.2	13.4	27-May	15.4	16.0			
28-Mar	7.6	7.3	28-Apr	9.9	12.7	28-May	15.6	15.9			
29-Mar	8.5	7.7	29-Apr	7.9	10.5	29-May	13.6	15.5			
30-Mar	8.6	8.1	30-Apr	8.7	10.2	30-May	12.9	15.0			
31-Mar	7.0	8.0				31-May	15.3	15.6			

Appendix B. Table B4. Mean daily temperature for the Imnaha and Snake rivers from March 3, 2002 to June 30, 2002.

Date	Imnaha R.	Snake R.	Date	Imnaha R.	Snake R.	Date	Imnaha R.	Snake R.	Date	Imnaha R.	Snake R.
1-Mar			1-Apr	8.5	7.5	1-May	9.6	11.0	1-Jun	10.3	12.4
2-Mar			2-Apr	7.6	7.2	2-May	9.4	11.3	2-Jun	9.8	12.0
3-Mar	1.4	3.1	3-Apr	7.6	7.5	3-May	8.8	11.1	3-Jun	10.9	12.7
4-Mar	2.7	3.3	4-Apr	8.3	8.0	4-May	7.9	10.4	4-Jun	12.0	13.2
5-Mar	4.0	3.6	5-Apr	7.8	8.1	5-May	7.8	10.0	5-Jun	11.8	13.5
6-Mar	5.5	4.0	6-Apr	8.7	8.2	6-May	7.3	9.7	6-Jun	11.7	13.5
7-Mar	4.5	4.1	7-Apr	7.7	8.2	7-May	6.7	9.4	7-Jun	10.0	13.1
8-Mar	2.3	3.8	8-Apr	7.7	8.1	8-May	6.6	9.3	8-Jun	7.8	12.2
9-Mar	3.0	3.7	9-Apr	8.2	8.3	9-May	6.7	9.5	9-Jun	7.8	11.5
10-Mar	4.8	4.2	10-Apr	8.1	8.1	10-May	7.5	9.8	10-Jun	9.0	11.6
11-Mar	6.7	4.7	11-Apr	8.5	8.3	11-May	8.8	10.1	11-Jun	10.3	12.3
12-Mar	7.3	5.4	12-Apr	9.3	8.6	12-May	10.4	11.2	12-Jun	11.8	13.5
13-Mar	5.8	5.2	13-Apr	9.4	8.9	13-May	11.0	12.1	13-Jun	13.6	14.8
14-Mar	5.7	5.2	14-Apr	8.6	8.8	14-May	10.4	12.2	14-Jun	14.3	15.7
15-Mar	4.4	4.7	15-Apr	5.6	7.3	15-May	9.4	12.1	15-Jun	14.7	16.0
16-Mar	4.0	4.8	16-Apr	6.4	7.3	16-May	9.7	12.0			
17-Mar	2.8	4.5	17-Apr	6.8	7.4	17-May	9.6	12.1			
18-Mar	3.0	4	18-Apr	6.5	7.7	18-May	10.6	12.1			
19-Mar	4.3	4.1	19-Apr	7.0	7.9	19-May	11.2	12.7			
20-Mar	5.6	4.6	20-Apr	8.1	8.5	20-May	9.3	12.2			
21-Mar	7.0	5	21-Apr	8.1	9.1	21-May	6.6	10.2			
22-Mar	7.3	5.8	22-Apr	9.5	9.7	22-May	7.5	9.8			
23-Mar	7.1	6.2	23-Apr	8.4	9.9	23-May	8.2	10.1			
24-Mar	5.1	5.9	24-Apr	6.5	9.3	24-May	9.2	10.9			
25-Mar	5.9	5.9	25-Apr	8.3	9.7	25-May	10.7	11.9			
26-Mar	7.0	6.2	26-Apr	8.8	10.1	26-May	11.1	12.3			
27-Mar	7.8	6.7	27-Apr	7.4	9.9	27-May	11.1	12.7			
28-Mar	7.3	6.7	28-Apr	8.3	9.9	28-May	11.9	13.3			
29-Mar	7.1	6.6	29-Apr	9.1	10.6	29-May	12.1	13.3			
30-Mar	8.3	7.1	30-Apr	9.5	11.0	30-May	10.9	13.0			
31-Mar	8.7	7.3				31-May	10.6	12.5			

APPENDIX C

THE CATCH OF CHINOOK SALMON AND STEELHEAD FOR MIGRATION YEARS 2001 AND 2002

Appendix C. Table C1. The catch of natural and chinook salmon and steelhead at the upper and lower Imnaha River traps from October 17 to November 15, 2000.

			Upper Trap		Lower Trap	
Day Sampling Ended	Hours Fished at the Upper Trap	Hours Fished at the Lower Trap	Natural Chinook Salmon	Natural Steelhead	Natural Chinook Salmon	Natural Steelhead
Oct 17	16.0	17.5	90	3	19	5
Oct 18	25.5	23.0	16		23	5
Oct 19	28.0	23.0	39		29	13
Oct 20	24.0	23.0	58	1	46	20
Oct 21						
Oct 22						
Oct 23	15.0	20.0	219		282	23
Oct 24	23.0	22.0	167	2	246	22
Oct 25	23.0	21.0	166		215	27
Oct 26	25.5	24.0	128		153	16
Oct 27	24.0	18.0	501	19		
Oct 28						
Oct 29						
Oct 30	18.0	19.0	176	21	1,398	117
Oct 31	20.0		65			
Nov 1	24.0		116	5		
Nov 2	23.0		72	2		
Nov 3	24.0		139	5		
Nov 4						
Nov 5						
Nov 6	13.5		78	1		
Nov 7	24.0	17.5	157	2	67	22
Nov 8	22.0	24.0	28	1	79	21
Nov 9	27.0	25.0	103	1	81	19
Nov 10						
Nov 11						
Nov 12						
Nov 13		14.5			58	7
Nov 14		23.0			112	16
Nov 15		25.5			173	27
Total	399.5	340	2,318	63	2,981	360

Appendix C. Table C2. The catch of natural and hatchery chinook salmon and steelhead at the lower Imnaha River traps, A and B, from February 22 to June 21, 2001 (daily samples may exceed 24 hours if sampling continued into the following day).

		Trap A				Trap B			
Day Sampling Ended	Hours Fished	Natural Chinook Salmon	Hatchery Chinook Salmon	Natural Steelhead	Hatchery Steelhead	Natural Chinook Salmon	Hatchery Chinook Salmon	Natural Steelhead	Hatchery Steelhead
Feb 22	14.0	1							
Feb 23	22.5	4							
Feb 24	31.0	1							
Feb 25	24.0	2							
Feb 26	24.0	1							
Feb 27	24.0	3		1					
Feb 28	24.0	3							
Mar 1	25.0	4							
Mar 2	25.0	2		1					
Mar 3	22.5	2							
Mar 4									
Mar 5									
Mar 6									
Mar 7	23.0	5							
Mar 8	22.0	1							
Mar 9	29.0	3		1					
Mar 10	20.0	2							
Mar 11	24.0	2							
Mar 12	23.5	9		1					
Mar 13	23.5	3							
Mar 14	25.0	15							
Mar 15	26.0	30							
Mar 16	25.5	126		1		127		2	
Mar 17	25.0	52				53			
Mar 18	26.0	53		1		53			
Mar 19	23.5	48		1		49			
Mar 20	28.0	232		3		234		6	
Mar 21	25.0	491		11		494		19	
Mar 22	23.0	518		2		272		16	
Mar 23	24.0	461	5	5		288	6	8	
Mar 24	18.5	233	66	4		235	40	6	
Mar 25	26.5	193	413	7	1				
Mar 26									
Mar 27	17.0	571	364	14	2				
Mar 28	21.0	684	316	26					
Mar 29	17.0	188	82	12	2				
Mar 30	23.5	90	100	14					
Mar 31	25.0	64	333	3					
Apr 1	28.0	277	1,081	8					

Appendix C. Table C2. Continued.

Day Sampling Ended	Hours Fished	Trap A				Trap B			
		Natural Chinook Salmon	Hatchery Chinook Salmon	Natural Steelhead	Hatchery Steelhead	Natural Chinook Salmon	Hatchery Chinook Salmon	Natural Steelhead	Hatchery Steelhead
Apr 2	19.5	98	258	4					
Apr 3	26.0	208	1,256	7	1				
Apr 4	27.5	115	1,182	2					
Apr 5	21.5	140	817	4					
Apr 6	25.0	17	92	1					
Apr 7	24.0	9	58	1					
Apr 8	26.5	68	202	1					
Apr 9	26.5	90	141						
Apr 10	22.0	68	97						
Apr 11	21.0	42	101	1					
Apr 12	22.5	130	370	11					
Apr 13	21.0	106	113	16	4				
Apr 14	27.0	96	61	18	25				
Apr 15	27.0	107	58	31	52				
Apr 16	22.0	67	32	11	11				
Apr 17	23.0	117	30	14	6				
Apr 18	22.0	235	442	89	13				
Apr 19	18.5	288	2,866	283	312				
Apr 20	22.0	180	1,304	135	710				
Apr 21	25.0	324	1,619	82	947				
Apr 22	22.5	168	738	53	714				
Apr 23	21.0	124	372	36	369				
Apr 24	23.5	65	117	48	150				
Apr 25	24.5	65	43	69	56				
Apr 26	14.0	195	125	261	180				
Apr 27	24.0	236	287	744	872				
Apr 28	1.0	24		42	150				
Apr 29	5.5	46	46	309	1,253				
Apr 30	2.0	12	20	30	93				
May 1	14.5	75	66	229	630				
May 2	12.0	47	67	171	240				
May 3	26.0	79	62	149	420				
May 4	24.0	53	31	116	243				
May 5	26.5	15	5	35	73				
May 6	25.5	43	25	171	248				
May 7	24.5	36	17	96	152				
May 8	24.0	15	11	119	239				
May 9	22.0	34	21	165	439				
May 10	24.5	79	66	411	1,775				
May 11	24.0	52	33	260	1,276				

Appendix C. Table C2. Continued.

Day Sampling Ended	Hours Fished	Trap A				Trap B			
		Natural Chinook Salmon	Hatchery Chinook Salmon	Natural Steelhead	Hatchery Steelhead	Natural Chinook Salmon	Hatchery Chinook Salmon	Natural Steelhead	Hatchery Steelhead
May 12	23.0	40	19	229	1,392				
May 13									
May 14	10.5	12	8	296	3,477				
May 15	24.0	81		619	6,136				
May 16	8.0	8	2	218	1,145				
May 17	9.0	6	1	110	592				
May 18	28.0	19	2	76	368				
May 19									
May 20									
May 21	14.0	10	1	55	288				
May 22	23.0	8		45	189				
May 23	22.5	33	2	48	265				
May 24	25.5	15		21	132	19	2	30	52
May 25	24.5	30	2	27	337	29	1	44	100
May 26									
May 27									
May 28									
May 29	14.0	7		16	549	12		71	206
May 30	24.5	9		23	585	11		39	114
May 31	24.0	5		31	219				
Jun 1	24.0	9		14	124				
Jun 2									
Jun 3									
Jun 4	14.0	9		15	104				
Jun 5	23.0	10		12	72				
Jun 6	21.0	9		10	46				
Jun 7	23.5	11			38				
Jun 8	24.0	13			40				
Jun 9									
Jun 10									
Jun 11	10.0	20			19				
Jun 12	24.0	17		3	74				
Jun 13	24.0	23		6	55				
Jun 14	26.0	18		5	30				
Jun 15	6.0								
Jun 16									
Jun 17									
Jun 18									
Jun 19									
Jun 20	11.0	12		1	23				

Appendix C. Table C2. Continued.

Day Sampling Ended	Hours Fished	Trap A				Trap B			
		Natural Chinook Salmon	Hatchery Chinook Salmon	Natural Steelhead	Hatchery Steelhead	Natural Chinook Salmon	Hatchery Chinook Salmon	Natural Steelhead	Hatchery Steelhead
Jun 21	23.0	11			22				
Totals	2,211.5	8,787	16,048	6,221	27,979	1,876	49	241	472

Appendix C. Table C3. The catch of natural and chinook salmon and steelhead at the upper and lower Imnaha River traps from October 17 to November 27, 2001.

Day Sampling Ended	Hours Fished at the Upper Trap	Hours Fished at the Lower Trap	Upper Trap		Lower Trap	
			Natural Chinook Salmon	Natural Steelhead	Natural Chinook Salmon	Natural Steelhead
Oct 17		20.0			62	21
Oct 18	35.5	24.0	48	2	25	15
Oct 19	23.5	23.5	43		66	30
Oct 20	25.5		46			
Oct 21						
Oct 22						
Oct 23	16.5	19.5	32		68	70
Oct 24	26.5	25.5	274	4	236	120
Oct 25	19.0	25.5	58		367	73
Oct 26	25.0	19.0	41		164	56
Oct 27						
Oct 28						
Oct 29		13.0			43	46
Oct 30	41.0	23.5	20		11	78
Oct 31	24.0	22.5	75	4	169	159
Nov 1	24.0	32.0	175	17	334	165
Nov 2	23.5		68	10		
Nov 3						
Nov 4						
Nov 5	21.0	12.5	34		83	19
Nov 6	22.5	12.0	49		114	28
Nov 7	22.5	13.3	49		162	44
Nov 8	25.5	25.0	53		245	24
Nov 9	25.0		108			
Nov 10						
Nov 11						
Nov 12						
Nov 13	16.5		22			
Nov 14	24.0		33			
Nov 15	24.5		17			
Nov 16	24.0		19			
Nov 17	15.5					
Nov 18						
Nov 19			38			
Nov 20	23.5		51			
Nov 21	25.0		40	7		
Nov 26	13.0		17	2		
Nov 27	24.0		5			
Total	590.5	310.8	1,415	46	2,149	948

Appendix C. Table C4. The catch of natural and hatchery chinook salmon and steelhead at the Imnaha River traps, A and B, from March 4 to June 12, 2002 (daily samples may exceed 24 hours if sampling continued into the following day).

Day Sampling Ended	Hours Fished	Trap A				Trap B			
		Natural Chinook Salmon	Hatchery Chinook Salmon	Natural Steelhead	Hatchery Steelhead	Natural Chinook Salmon	Hatchery Chinook Salmon	Natural Steelhead	Hatchery Steelhead
Mar 3									
Mar 4	17.5	3		1					
Mar 5	25.5	1		4					
Mar 6	25	1		2					
Mar 7	26			1					
Mar 8	24	2	2	1					
Mar 9	24.5	4	5						
Mar 10									
Mar 11	47	5	3	5					
Mar 12	24.5		3	2					
Mar 13	24	1		2					
Mar 14	24	2	1	3					
Mar 15	24	5		1					
Mar 16	24	5	2	1					
Mar 17	24	3		1					
Mar 18	23	10	1	1					
Mar 19	25	3							
Mar 20	23.25		1						
Mar 21									
Mar 22	23	1							
Mar 23	26.25	2	141						
Mar 24	22.5	35	402	1					
Mar 25	25	139	262	5	1				
Mar 26	26	93	148	9					
Mar 27	23	74	1,737	8					
Mar 28	23	67	6,914	35					
Mar 29	22.5	120	3,711	16					
Mar 30									
Mar 31	18.75	23	1,742	12					
Apr 1	24	43	2,677	15					
Apr 2									
Apr 3	18	29	635	10					
Apr 4	15	76	1,366	7					
Apr 5	23	114	781	4					
Apr 6									
Apr 7	16.3	26	187	26					
Apr 8	24.5	54	314	12					
Apr 9	25	100	406	7					
Apr 10	20.5	39	501	10					
Apr 11	24	8	132	6	2				

Appendix C. Table C4. Continued.

Day Sampling Ended	Hours Fished	Trap A				Trap B			
		Natural Chinook Salmon	Hatchery Chinook Salmon	Natural Steelhead	Hatchery Steelhead	Natural Chinook Salmon	Hatchery Chinook Salmon	Natural Steelhead	Hatchery Steelhead
Apr 12	10	25	323	13	92				
Apr 13	11	5	105	3	45				
Apr 14	6	1	92	8	36				
Apr 15									
Apr 16									
Apr 17	11	54	404	28	80				
Apr 18	14	103	400	51	306				
Apr 19	24.5	141	1,193	67	933				
Apr 20	24	85	286	36	1,469				
Apr 21	23.5	97	197	43	1,275				
Apr 22	25	58	151	48	589				
Apr 23	26.5	35	106	44	112				
Apr 24	24.5	90	192	55	205				
Apr 25	23	77	96	30	131				
Apr 26	24	43	46	29	35				
Apr 27	22	42	54	54	146				
Apr 28	30	114	157	81	220				
Apr 29	20	50	65	55	105				
Apr 30	24.5	50	95	85	224	73	43	51	6
May 1	24	56	150	182	562	89	2	122	
May 2	20.5	9	36	49	188	5	1	2	
May 3	23	6	15	149	351				
May 4									
May 5	15	4	11	127	369				
May 6	20.5	9	9	107	256				
May 7	23	15	21	138	255				
May 8	25.5	17	17	128	262				
May 9	24.75	1	1	62	2,469				
May 10	19.25	14	5	91	1,307				
May 11									
May 12	12.25	16	6	243	931				
May 13	24	84	5	442	882				
May 14	24.75	26	16	766	1,388				
May 15	13.75	11	6	718	1,925				
May 16	22	13	7	462	1,372				
May 17	24.5	15	7	390	904				
May 18	11.5	8	2	302	884				
May 19	24	17	9	663	2,402				
May 20									
May 21									
May 22	10.5	6	1	60	237				

Appendix C. Table C4. Continued.

Day Sampling Ended	Hours Fished	Trap A				Trap B			
		Natural Chinook Salmon	Hatchery Chinook Salmon	Natural Steelhead	Hatchery Steelhead	Natural Chinook Salmon	Hatchery Chinook Salmon	Natural Steelhead	Hatchery Steelhead
May 23	13.75	6		51	178				
May 24	25.5	2	1	65	115				
May 25									
May 26									
May 27									
May 28	21	9		186	645				
May 29	12.5	2		124	526				
May 30	9.5			47	188				
May 31									
Jun 1									
Jun 2									
Jun 3	12	2		29	56				
Jun 4	23.25			34	53				
Jun 5	24.5	2		39	66				
Jun 6	24	2		52	51				
Jun 7	23.75	3		46	68				
Jun 8	25.25	3		35	31				
Jun 9	24	7		28	87				
Jun 10	25	1		15	30				
Jun 11	23.25	1		10	17				
Jun 12	23.75	1		3	19				
Totals	1822.8	2,526	26,361	6,781	25,080	167	46	175	6

Appendix C. Table C5. PIT tagged recaptured natural chinook salmon in the lower Imnaha River trap during the fall for migration years 2001 and 2002.

Migration Year	Agency	Recapture File	Tag ID	Date Tagged	Date Recaptured	Travel Time
2001	ODFW	JAH00318.NT1	3D9.1BF100B5D0	8/28/00	11/13/00	76 days 19 hrs 31 mins
2001	ODFW	JAH00291.NT1	3D9.1BF1005F21	8/29/00	10/17/00	48 days 13 hrs 18 mins
2001	ODFW	JAH00304.NT1	3D9.1BF0FF1D8E	8/29/00	10/30/00	61 days 13 hrs 36 mins
2001	ODFW	JAH00304.NT1	3D9.1BF0FF1E01	8/29/00	10/30/00	61 days 13 hrs 17 mins
2001	ODFW	JAH00304.NT1	3D9.1BF0FF7921	8/29/00	10/30/00	61 days 12 hrs 22 mins
2001	ODFW	JAH00298.NT1	3D9.1BF0FF07EE	8/30/00	10/24/00	54 days 20 hrs 52 mins
2001	ODFW	JAH00304.NT1	3D9.1BF1005A32	8/30/00	10/30/00	60 days 20 hrs 37 mins
2001	ODFW	JAH00319.NT1	3D9.1BF100CBD6	8/30/00	11/14/00	75 days 20 hrs 15 mins
2001	NPT	JAH00297.NT1	3D9.1BF0FF743B	10/17/00	10/23/00	5 days 13 hrs 37 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF295D	10/17/00	10/30/00	12 days 13 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF353E	10/17/00	10/30/00	12 days 13 hrs 21 mins
2001	NPT	JAH00293.NT1	3D9.1BF0FF64A8	10/18/00	10/19/00	12 hrs
2001	NPT	JAH00304.NT1	3D9.1BF0FF341E	10/18/00	10/30/00	11 days 12 hrs 51 mins
2001	NPT	JAH00294.NT1	3D9.1BF0FF5B27	10/19/00	10/20/00	11 hrs 40 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF2FE2	10/19/00	10/30/00	10 days 13 hrs 6 mins
2001	NPT	JAH00297.NT1	3D9.1BF0FF35F0	10/20/00	10/23/00	2 days 21 hrs 37 mins
2001	NPT	JAH00299.NT1	3D9.1BF0FF1521	10/20/00	10/25/00	4 days 19 hrs 57 mins
2001	NPT	JAH00320.NT1	3D9.1BF0FFE4AE	10/20/00	11/15/00	25 days 21 hrs 10 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF0549	10/23/00	10/30/00	6 days 13 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF2E86	10/23/00	10/30/00	6 days 13 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF15AA	10/23/00	10/30/00	6 days 13 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF04AA	10/23/00	10/30/00	6 days 13 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF0577	10/23/00	10/30/00	6 days 13 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF755A	10/23/00	10/30/00	6 days 13 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FFA024	10/23/00	10/30/00	6 days 13 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FFA254	10/23/00	10/30/00	6 days 13 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF1011121	10/23/00	10/30/00	6 days 13 hrs 21 mins
2001	NPT	JAH00314.NT1	3D9.1BF10014AC	10/23/00	11/9/00	16 days 14 hrs 1 mins
2001	NPT	JAH00298.NT1	3D9.1BF0FF9EB5	10/23/00	10/24/00	13 hrs 36 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF02C9	10/24/00	10/30/00	5 days 12 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF0D6E	10/24/00	10/30/00	5 days 12 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF2B6B	10/24/00	10/30/00	5 days 12 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF10051A1	10/24/00	10/30/00	5 days 12 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF10059F5	10/24/00	10/30/00	5 days 12 hrs 21 mins
2001	NPT	JAH00314.NT1	3D9.1BF0FFA3F0	10/24/00	11/9/00	15 days 13 hrs 1 mins
2001	NPT	JAH00299.NT1	3D9.1BF0FF33BA	10/24/00	10/25/00	11 hrs 57 mins
2001	NPT	JAH00300.NT1	3D9.1BF0FF385D	10/25/00	10/26/00	12 hrs 16 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF9FCC	10/25/00	10/30/00	4 days 13 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF0780	10/25/00	10/30/00	4 days 13 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF0E06	10/25/00	10/30/00	4 days 13 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF1F36	10/25/00	10/30/00	4 days 13 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF1F61	10/25/00	10/30/00	4 days 13 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF286D	10/25/00	10/30/00	4 days 13 hrs 21 mins

Appendix C. Table C5. Continued.

Migration Year	Agency	Recapture File	Tag ID	Date Tagged	Date Recaptured	Travel Time
2001	NPT	JAH00304.NT1	3D9.1BF0FF25A2	10/26/00	10/30/00	3 days 13 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF2C19	10/26/00	10/30/00	3 days 13 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF32F8	10/26/00	10/30/00	3 days 13 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF7453	10/26/00	10/30/00	3 days 13 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF23B9	10/26/00	10/30/00	3 days 13 hrs 21 mins
2001	NPT	JAH00313.NT1	3D9.1BF101123C	10/26/00	11/8/00	12 days 13 hrs 47 mins
2001	NPT	JAH00314.NT1	3D9.1BF100C0ED	10/26/00	11/9/00	13 days 14 hrs 1 mins
2001	NPT	JAH00304.NT1	3D9.1BF100C521	10/27/00	10/30/00	2 days 12 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF256B	10/27/00	10/30/00	2 days 12 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF0FF2FA2	10/27/00	10/30/00	2 days 12 hrs 21 mins
2001	NPT	JAH00304.NT1	3D9.1BF100574D	10/27/00	10/30/00	2 days 12 hrs 21 mins
2001	NPT	JAH00313.NT1	3D9.1BF0FF0ED5	10/27/00	11/8/00	11 days 12 hrs 47 mins
2001	NPT	JAH00314.NT1	3D9.1BF0FF35BD	10/27/00	11/9/00	12 days 13 hrs 1 mins
2001	NPT	JAH00312.NT1	3D9.1BF0FF31A7	10/30/00	11/7/00	7 days 15 hrs 53 mins
2001	NPT	JAH00312.NT1	3D9.1BF0FF45E5	11/1/00	11/7/00	5 days 15 hrs 53 mins
2001	NPT	JAH00314.NT1	3D9.1BF0FF0DD1	11/1/00	11/9/00	7 days 16 hrs 1 mins
2001	NPT	JAH00312.NT1	3D9.1BF0FF39D4	11/2/00	11/7/00	4 days 15 hrs 53 mins
2001	NPT	JAH00312.NT1	3D9.1BF0FF4653	11/2/00	11/7/00	4 days 15 hrs 53 mins
2001	NPT	JAH00319.NT1	3D9.1BF0FF308D	11/3/00	11/14/00	10 days 18 hrs 59 mins
2001	NPT	JAH00320.NT1	3D9.1BF0FF2ECB	11/3/00	11/15/00	11 days 19 hrs 10 mins
2001	NPT	JAH00320.NT1	3D9.1BF0FF449C	11/3/00	11/15/00	11 days 19 hrs 10 mins
2001	NPT	JAH00320.NT1	3D9.1BF0FF423A	11/3/00	11/15/00	11 days 19 hrs 10 mins
2002	ODFW	JAH01312.NT1	3D9.1BF11B9839	8/27/01	11/8/01	72 days 1 hrs 59 mins
2002	ODFW	JAH01298.NT1	3D9.1BF11AD2B1	8/28/01	10/25/01	57 days 19 hrs 48 mins
2002	ODFW	JAH01312.NT1	3D9.1BF11C0E1B	8/28/01	11/8/01	71 days 20 hrs 57 mins
2002	ODFW	JAH01298.NT1	3D9.1BF11B5A1B	8/28/01	10/25/01	57 days 17 hrs 40 mins
2002	ODFW	JAH01312.NT1	3D9.1BF11C06D1	8/28/01	11/8/01	71 days 17 hrs 19 mins
2002	ODFW	JAH01304.NTA	3D9.1BF11BFC41	8/28/01	10/31/01	64 days 5 hrs 32 mins

APPENDIX D

STATISTICAL COMPARISONS OF MEDIAN FORK LENGTHS OF NATURAL AND HATCHERY CHINOOK SALMON AND STEELHEAD SMOLTS CAPTURED IN THE IMNAHA RIVER SMOLT TRAPS DURING MIGRATION YEARS 2001 AND 2002

Appendix D. Table D1. Statistical comparisons of median fork lengths between groups of smolts captured in the Imnaha River smolt traps during migration years 2001 and 2002.

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 - Upper Trap - Fall of 2000	Natural Chinook Salmon - Upper Trap - Fall of 2001	1,788	1,385	86	76	555,111	$p < 0.05$
Natural Chinook Salmon - Lower Trap - Fall of 2000	Natural Chinook Salmon - Lower Trap - Fall of 2001	1,994	1,888	90	85	$1.27(10^6)$	$p < 0.05$
Natural Chinook Salmon - Upper Trap - Fall of 2000	Natural Chinook Salmon - Lower Trap - Fall of 2000	1,788	1,994	86	90	$1.29(10^6)$	$p < 0.05$
Natural Chinook Salmon - Upper Trap - Fall of 2001	Natural Chinook Salmon - Lower Trap - Fall of 2001	1,385	1,888	76	85	$1.93(10^6)$	$p > 0.05$
Hatchery Chinook Salmon - Lower Trap - Spring of 2001	Natural Chinook Salmon - Lower Trap - Spring of 2001	7,107	9,956	140	108	872,531	$p < 0.05$
Hatchery Steelhead - Lower Trap - Spring of 2001	Natural Steelhead - Lower Trap - Spring of 2001	4,365	3,733	217	175	$1.97(10^6)$	$p < 0.05$
Hatchery Chinook Salmon - Lower Trap - Spring of 2002	Natural Chinook Salmon - Lower Trap - Spring of 2002	3,918	2,333	136	104	192,487	$p < 0.05$
Hatchery Steelhead - Lower Trap - Spring of 2002	Natural Steelhead - Lower Trap - Spring of 2002	2,428	4,738	217	172	724,674	$p < 0.05$

APPENDIX E

IMNAHA RIVER JUVENILE HATCHERY CHINOOK SALMON POST RELEASE SURVIVAL ESTIMATES FROM 1994 TO 2002 AND DAILY TRAP EFFICIENCIES FOR MIGRATION YEARS 2001 AND 2002

Appendix E. Table E1. The number of trap efficiency trials, mean trap efficiency, PIT tag interrogation percentage and estimated survival of hatchery chinook salmon from release at the Imnaha River Acclimation Facility (rkm 74) to the Imnaha River trap (rkm 7), and from release to Lower Granite Dam from 1994 to 2002.

Year	Number of Trials	Mean Trap Efficiency (%)	PIT Tag Interrogations at the Screw Trap (%)	Estimated Survival		
				Release to Trap		Release to Lower Granite Dam (%)[1]
				SURPH (%)	Bootstrap (%)	
2002	39	9.1	7.3	90.2	95.5	67.1
2001	6	29.1	12.0	93.9	45.0	74.7
2000	11	18.1	9.8	94.7	66.9	68.7
1999	51	21.8	4.5	93.7	45.9	68.5
1998	9	29.4	17.0	88.4	66.9	68.3
1997	6	45.9	19.6	89.2	44	61.6
1996	9	11.6	10.6	95.0	101.7	56.8
1995	7	14.8	10.8	92.6	68	61.8
1994	1	13.8	6.2	100.9	88.1	68.5

[1] Estimated as the product of the SURPH Survival estimates from release to the Imnaha River trap, and from the trap to Lower Granite Dam.

Appendix E. Table E2. Daily trap efficiency trials of hatchery chinook salmon released and recaptured in the lower Imnaha River trap during the spring of 2001 migration year.

Sample End Date	Hatchery Chinook Salmon			
	Hours Fished	Released	Recaptured	Efficiency
3/28/2001	21	204	45	22.1
4/2/2001	19.5	277	107	38.6
4/5/2001	21.5	200	73	36.5
4/6/2001	25	304	79	26.0
4/7/2001	24	37	1	2.7
4/8/2001	26.5	27	0	0.0
	Total	1,049	305	29.1

Appendix E. Table E3. Daily trap efficiency trials of hatchery and natural chinook salmon released and recaptured in the lower Imnaha River trap during the spring of 2002 migration year.

Sample End Date	Hours Fished	Hatchery Chinook Salmon			Natural Chinook Salmon		
		Released	Recaptured	Efficiency	Released	Recaptured	Efficiency
3/25/2002	25	59	4	6.8	2	1	50.0
3/26/2002	26	36	4	11.1	18	1	5.6
3/27/2002	23	35	10	28.6	12	2	16.7
3/28/2002	23	41	5	12.2	29	1	3.4
3/29/2002	22.5	30		0.0	17		0.0
3/31/2002	18.75	31	2	6.5	27		0.0
4/1/2002	24	44	4	9.1	2	1	50.0
4/3/2002	18	29		0.0	29	1	3.4
4/4/2002	15	28		0.0	27	2	7.4
4/5/2002	23	39		0.0	24		0.0
4/7/2002	16.3	49		0.0	7		0.0
4/8/2002	24.5	27	10	37.0	25	3	12.0
4/9/2002	25	27	6	22.2	29	2	6.9
4/10/2002	20.5	29	4	13.8	29	2	6.9
4/11/2002	24	30		0.0	30	1	3.3
4/12/2002	10	60	2	3.3	4	2	50.0
4/13/2002	11				19		0.0
4/17/2002	11	50		0.0	5		0.0
4/18/2002	14	36	5	13.9	6		0.0
4/19/2002	24.5	25	5	20.0	30	1	3.3
4/20/2002	24	31	1	3.2	35	3	8.6
4/21/2002	23.5	31	5	16.1	30	2	6.7
4/22/2002	25	32	7	21.9	29	3	10.3
4/23/2002	26.5	28	1	3.6	25	2	8.0
4/24/2002	24.5				30		0.0
4/25/2002	23	30	3	10.0	31	3	9.7
4/26/2002	24	28	4	14.3	30	7	23.3
4/29/2002	20	31	6	19.4	30	3	10.0
4/30/2002	24.5	30	5	16.7			
5/1/2002	24	30	6	20.0	29	6	20.7
5/2/2002	20.5	50	2	4.0	45		0.0
5/3/2002	23				12	1	8.3
5/7/2002	23	21		0.0			
5/8/2002	25.5	19	1	5.3	15	1	6.7
5/9/2002	24.75	15		0.0	17		0.0
5/12/2002	12.25	1		0.0	15	3	20.0
5/13/2002	24	5		0.0	25	1	4.0
5/14/2002	24.75	4		0.0	21	1	4.8
5/15/2002	13.75	10		0.0			
5/16/2002	22	6		0.0			
5/17/2002	24.5	6		0.0			
5/18/2002	11.5	5		0.0			
	Total	1,118	102	9.1	790	56	7.1

APPENDIX F

ARRIVAL TIMING AT SNAKE RIVER AND COLUMBIA RIVER DAMS

Appendix F. Table F1. A statistical comparison of median arrival times of natural chinook salmon at Lower Granite Dam between groups of natural chinook salmon released at the upper and lower Imnaha River traps and between fall and spring releases for migration years 2001 and 2002.

Group 1	Group 2	Sample Sizes		Median Arrival Time		Wilcoxon Value (W)	Significance Level p = 0.05
		Group 1	Group 2	Group 1	Group 2		
Natural Chinook Salmon - Lower Trap - Fall of 2000	Natural Chinook Salmon - Upper Trap - Fall of 2000	644	429	April 26	April 29	75,625	0.00
Natural Chinook Salmon - Lower Trap - Spring 2001	Natural Chinook Salmon - Lower Trap - Fall of 2000	6,772	644	April 28	April 26	$1.58(10^6)$	0.00
Natural Chinook Salmon - Lower Trap - Spring 2001	Natural Chinook Salmon - Upper Trap - Fall of 2000	6,772	429	April 28	April 29	$1.21(10^6)$	0.00
Natural Chinook Salmon - Lower Trap - Fall of 2001	Natural Chinook Salmon - Upper Trap - Fall of 2001	162	60	April 16	May 5	1,475	0.00
Natural Chinook Salmon - Lower Trap - Spring 2002	Natural Chinook Salmon - Lower Trap - Fall of 2001	489	162	May 5	April 16	14,373	0.00
Natural Chinook Salmon - Lower Trap - Spring 2002	Natural Chinook Salmon - Upper Trap - Fall of 2001	489	60	May 5	May 5	14,931	0.82

Appendix F. Table F2. A statistical comparison of cumulative arrival timing of natural chinook salmon at Lower Granite Dam between groups of natural chinook salmon released at the upper and lower Imnaha River traps and between fall and spring releases for migration years 2001 and 2002.

Group 1	Group 2	Sample Sizes		Maximum Distance Between Cumulative Distributions	Kolmogorov - Smirnov Test	Significance Level p = 0.05
		Group 1	Group 2			
Natural Chinook Salmon - Lower Trap - Fall of 2000	Natural Chinook Salmon - Upper Trap - Fall of 2000	644	429	0.423	6.785	0.00
Natural Chinook Salmon - Lower Trap - Spring 2001	Natural Chinook Salmon - Lower Trap - Fall of 2000	6,772	644	0.313	7.581	0.00
Natural Chinook Salmon - Lower Trap - Spring 2001	Natural Chinook Salmon - Upper Trap - Fall of 2000	6,772	429	0.217	4.365	0.00
Natural Chinook Salmon - Lower Trap - Fall of 2001	Natural Chinook Salmon - Upper Trap - Fall of 2001	162	60	0.582	3.852	0.00
Natural Chinook Salmon - Lower Trap - Spring 2002	Natural Chinook Salmon - Lower Trap - Fall of 2001	489	162	0.593	6.539	0.00
Natural Chinook Salmon - Lower Trap - Spring 2002	Natural Chinook Salmon - Upper Trap - Fall of 2001	489	60	0.152	1.112	0.17

Appendix F. Table F3. Arrival timing of PIT tagged Imnaha River natural chinook salmon smolts, tagged and released in the fall at the upper trap site at Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1998 to 2002.

		Sample Size		Arrival Timing	
Trap Site and Dam	Year	(n)	Date Range	Median	90%
Lower Granite	2002	60	April 13 - May 27	May 5	May 20
	2001	429	April 7 - June 9	April 29	May 14
	2000	245	April 8 - May 28	May 1	May 10
	1999	128	April 8 - May 27	May 1	May 17
	1998	454	April 3 - June 5	April 27	May 9
Little Goose	2002	78	April 21 - June 10	May 7	May 22
	2001	85	April 20 - June 1	May 7	May 18
	2000	128	April 14 - June 4	May 28	May 11
	1999	220	April 10 - June 21	April 30	May 18
	1998	410	April 14 - May 28	May 4	May 15
Lower Monumental	2002	44	April 30 - June 12	May 11	May 22
	2001	7	May 1 - May 19	NA	NA
	2000	40	April 17 - May 30	May 29	May 21
	1999	80	April 13 - May 28	May 2	May 20
	1998	304	April 15 - May 29	May 7	May 19
McNary	2002	32	April 27 - May 25	May 12	May 17
	2001	3	May 21 - June 25	NA	NA
	2000	42	April 26 - May 31	May 10	May 21
	1999	18	April 18 - May 30	May 9	May 25
	1998	195	April 18 - June 4	May 4	May 18

Appendix F. Table F4. Arrival timing of PIT tagged Imnaha River natural chinook salmon smolts, tagged and released in the fall at the lower trap site at Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1998 to 2002.

Trap Site and Dam	Year	Sample Size (n)	Date Range	Arrival Timing Median	Arrival Timing 90%
Lower Granite	2002	162	April 1 - May 20	April 16	May 30
	2001	644	April 3 - May 26	April 26	April 30
	2000	262	April 4 - May 12	April 14	April 23
	1999	103	April 3 - May 2	April 19	April 25
	1998	428	March 27 - May 12	April 14	April 24
Little Goose	2002	159	April 13 - May 16	May 1	May 5
	2001	135	April 23 - June 16	April 30	May 11
	2000	239	April 12 - May 12	April 17	April 24
	1999	364	April 8 - May 9	April 19	April 25
	1998	228	April 11 - May 12	April 25	May 2
Lower Monumental	2002	100	April 30 - June 4	May 5	May 16
	2001	21	April 28 - May 17	NA	NA
	2000	62	April 13 - May 6	April 21	April 26
	1999	144	April 10 - May 21	April 19	April 25
	1998	202	April 19 - May 19	Apr 25	May 4
McNary	2002	86	April 21 - May 26	May 5	May 15
	2001	5	May 5 - May 18	NA	NA
	2000	35	April 18 - May 6	April 27	May 4
	1999	64	April 10 - May 10	April 21	April 28
	1998	236	April 20 - May 23	April 30	May 4

Appendix F. Table F5. 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 2002.

Dam	Year	Sample Size (n)	Date Range	Arrival Timing Median	Arrival Timing 90%
Lower Granite	2002	489	April 2 - June 27	May 5	May 20
	2001	6,857	March 30 - August 13	April 28	May 12
	2000	1,291	April 2 - August 8	April 22	May 11
	1999	1,218	March 28 - July 15	April 27	May 22
	1998	1,630	April 1 - June 27	April 25	May 6
	1997	74	April 6 - May 18	April 22	May 11
	1996	421	April 6 - June 12	April 30	May 18
	1995	184	April 11 - July 11	May 1	May 11
	1994	348	April 14 - June 23	April 24	May 11
	1993	109	April 21 - June 12	May 4	May 14
Little Goose	2002	519	April 15 - June 20	May 7	May 23
	2001	1,216	April 16 - July 23	May 2	May 17
	2000	1,103	April 11 - July 14	April 23	May 11
	1999	2,099	April 9 - August 1	April 29	May 22
	1998	837	April 14 - June 25	May 3	May 12
	1997	70	April 15 - May 22	April 26	May 11
	1996	358	April 12 - June 16	April 27	May 20
	1995	144	April 15 - July 15	May 7	May 20
	1994	194	April 23 - June 17	April 28	May 7
	1993	46	April 27 - June 2	May 3	May 16
Lower Monumental	2002	336	April 22 - June 14	May 13	May 22
	2001	131	April 28 - July 18	May 13	May 20
	2000	335	April 13 - July 12	April 25	May 29
	1999	688	April 9 - August 4	May 1	May 23
	1998	289	April 19 - June 8	April 30	May 11
	1997	74	April 20 - June 1	April 30	May 14
	1996	359	April 13 - June 15	May 10	May 22
	1995	142	April 19 - August 4	May 8	June 4
	1994	215	April 25 - July 26	May 1	May 24
	1993	37	May 3 - June 2	May 8	May 13
McNary	2002	189	April 23 - June 10	May 14	May 23
	2001	45	April 29 - June 5	May 18	May 31
	2000	192	April 18 - July 4	May 7	May 29
	1999	152	April 18 - June 27	May 6	May 21
	1998	187	April 19 - June 2	May 1	May 15
	1997	24	April 22 - May 19	May 1	May 12
	1996	148	April 19 - June 8	May 14	May 24
	1995	89	April 28 - July 9	May 12	May 21
	1994	229	April 29 - July 16	May 12	May 28
	1993	20	May 3 - June 15	May 9	May 21

Appendix F. Table F6. Arrival timing of PIT tagged Imnaha River hatchery chinook salmon smolts at Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1992 to 2002.

Dam	Year	Sample Size (n)	Date Range	Arrival Timing Median	Arrival Timing 90%
Lower Granite	2002	461	April 1 - May 23	May 7	May 19
	2001	1,725	March 31 - May 27	April 29	May 10
	2000	782	April 7 - May 24	May 3	May 13
	1999	267	April 18 - May 25	May 5	May 14
	1998	696	April 15 - May 22	May 2	May 9
	1997	227	April 16 - May 22	May 5	May 14
	1996	169	April 13 - May 26	May 7	May 16
	1995[1]	128	April 13 - June 7	May 2	May 13
	1995[2]	83	April 16 - May 22	May 8	May 15
	1994	129	April 24 - May 18	May 12	May 12
	1992[3]	273	April 12 - June 6	April 21	May 6
Little Goose	2002	544	April 13 - June 1	May 12	May 22
	2001	509	April 15 - May 29	May 7	May 16
	2000	450	April 14 - May 24	May 3	May 13
	1999	387	April 16 - June 6	May 10	May 19
	1998	391	April 25 - May 26	May 7	May 14
	1997	267	April 20 - May 27	May 9	May 18
	1996	131	April 23 - June 6	May 13	May 20
	1995[1]	114	April 26 - June 11	May 10	May 20
	1995[2]	67	April 27 - June 7	May 12	May 23
	1994	65	April 28 - June 2	May 14	May 21
	1992[3]	116	April 17 - May 22	April 27	May 5
Lower Monumental	2002	457	April 30 - June 11	May 14	May 23
	2001	79	April 27 - June 4	May 12	May 25
	2000	107	April 19 - May 26	May 5	May 22
	1999	124	April 23 - May 25	May 11	May 20
	1998	143	April 23 - May 26	May 8	May 15
	1997	199	April 25 - June 3	May 10	May 19
	1996	136	April 23 - May 29	May 15	May 23
	1995[1]	106	April 27 - June 10	May 12	May 21
	1995[2]	71	April 29 - June 9	May 17	May 26
	1994	73	April 30 - June 7	May 14	May 20
McNary	2002	220	April 16 - June 10	May 15	May 25
	2001	25	May 5 - May 31	NA	NA
	2000	99	April 24 - May 30	May 13	May 27
	1999	56	May 2 - May 26	May 19	May 24
	1998	53	May 2 - May 30	May 11	May 19
	1997	61	May 1 - June 1	May 10	May 19
	1996	55	May 1 - May 27	May 16	May 23
	1995[1]	67	April 29 - June 9	May 16	May 23
	1995[2]	36	May 3 - May 30	May 16	May 22
	1994	119	May 6 - June 17	May 21	May 26
	1992[3]	61	April 27 - June 1	May 8	May 17

[1] HxW crossed chinook salmon smolts PIT tagged for NPT and released at dark.

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

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

Appendix F. Table F7. Arrival timing of PIT tagged Imnaha River natural steelhead smolts at Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1993 to 2002.

Dam	Year	Sample Size (n)	Date Range	Arrival Timing Median	Arrival Timing 90%
Lower Granite	2002	979	April 10 - June 26	May 18	May 31
	2001	2,736	March 29 - September 9	May 14	May 18
	2000	2,262	April 6 - August 3	May 8	May 25
	1999	649	April 19 - June 26	May 18	June 5
	1998	1,474	April 2 - June 12	May 3	May 22
	1997	368	April 20 - July 10	May 8	May 24
	1996	537	April 19 - June 10	May 6	June 4
	1995	128	April 28 - June 19	May 2	May 9
	1994[1]	332	April 25 - Aug 15	May 8	June 1
	1994[2]	207	May 3 - Aug 20	May 9	May 30
	1993	101	May 3 - June 13	May 26	June 8
Little Goose	2002	856	April 13 - August 28	May 21	June 2
	2001	219	April 7 - August 19	May 16	May 24
	2000	458	April 11 - June 26	May 8	May 29
	1999	717	April 8 - June 24	May 21	May 25
	1998	481	April 14 - June 19	May 8	May 26
	1997	319	April 20 - June 19	May 10	May 26
	1996	365	April 20 - June 14	May 9	May 28
	1995	70	May 1 - June 23	May 7	May 12
	1994[1]	159	April 29 - July 29	May 12	May 31
	1994[2]	121	May 6 - July 26	May 15	June 1
	1993	48	May 6 - June 11	May 24	June 7
Lower Monumental	2002	828	April 30 - August 8	May 22	June 3
	2001	23	May 6 - October 3	NA	NA
	2000	246	April 12 - August 12	May 14	May 30
	1999	342	April 19 - June 21	May 23	May 27
	1998	213	April 16 - June 11	May 10	May 27
	1997	264	April 21 - June 6	May 11	May 25
	1996	397	April 22 - June 15	May 14	May 29
	1995	81	May 3 - May 17	May 9	May 14
	1994[1]	148	May 1 - August 8	May 12	July 8
	1994[2]	91	May 9 - July 31	May 15	July 10
	1993	43	May 6 - June 15	May 30	June 11
McNary	2002	124	April 29 - June 7	May 22	May 27
	2001	4	May 16 - August 5	NA	NA
	2000	58	April 15 - June 16	May 24	June 7
	1999	55	April 17 - May 31	May 25	May 27
	1998	53	April 20 - June 4	May 7	May 28
	1997	62	April 24 - June 5	May 13	May 18
	1996	157	April 25 - June 11	May 11	May 21
	1995	35	May 5 - May 27	May 11	May 17
	1994[1]	66	May 5 - June 22	May 18	June 9
	1994[2]	42	May 13 - June 25	May 18	June 6
	1993	17	May 11 - June 13	May 25	May 31

[1] NPT PIT tagged fish

[2] FPC PIT tagged fish

Appendix F. Table F8. Arrival timing of PIT tagged Imnaha River hatchery steelhead smolts at Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1993 to 2002.

Dam	Year	Sample Size (n)	Date Range	Arrival Timing Median	Arrival Timing 90%
Lower Granite	2002	442	April 15 - June 27	May 17	May 31
	2001	2,541	April 21 - September 23	May 16	May 26
	2000	3,249	April 8 - July 24	May 16	May 25
	1999	1,973	April 18 - August 5	May 24	June 18
	1998	1,683	April 25 - July 29	May 15	May 26
	1997	2,346	April 19 - July 24	May 23	June 13
	1996	440	April 23 - July 14	May 28	June 14
	1995	661	May 6 - July 12	May 31	June 16
	1994[1]	164	April 29 - August 20	May 29	July 15
	1994[2]	306	May 6 - August 21	May 25	June 23
	1993	224	May 3 - June 28	May 17	May 31
Little Goose	2002	326	April 19 - June 29	May 24	June 3
	2001	121	April 28 - October 30	May 20	June 21
	2000	309	April 13 - July 22	May 22	July 1
	1999	1,593	April 20 - August 22	May 25	June 18
	1998	555	May 3 - July 10	May 25	May 30
	1997	1,844	April 21 - August 23	May 26	June 13
	1996	261	April 24 - July 11	May 25	June 16
	1995	409	May 8 - Juyl 13	Jun 3	June 20
	1994[1]	86	May 2 - July 30	May 31	July 17
	1994[2]	165	May 10 - August 12	May 27	July 9
	1993	106	May 5 - July 8	May 25	June 2
Lower Monumental	2002	406	April 30 - October 18	May 28	June 9
	2001	28	May 8 - October 25	NA	NA
	2000	243	April 16 - August 18	May 25	July 3
	1999	790	April 21 - July 20	May 26	June 19
	1998	253	May 5 - July 15	May 26	June 3
	1997	1,432	April 22 - August 6	May 27	June 15
	1996	232	May 6 - July 7	May 27	June 15
	1995	410	May 9 - July 13	Jun 6	June 16
	1994[1]	30	May 5 - August 5	Jun 3	July 17
	1994[2]	75	May 11 - August 24	Jun 18	July 21
	1993	92	May 7 - June 14	May 26	June 5
McNary	2002	56	May 2 - June 16	May 25	June 6
	2001	8	May 21 - July 4	NA	NA
	2000	58	May 3 - July 30	July 2	July 17
	1999	79	April 27 - July 8	May 28	May 31
	1998	31	May 13 - July 2	Jun 1	June 19
	1997	245	April 23 - August 12	May 27	June 18
	1996	30	April 27 - July 3	May 23	June 7
	1995	69	May 15 - July 17	Jun 5	June 27
	1994[1]	22	May 17 - July 14	Jun 5	July 10
	1994[2]	56	May 20 - July 11	Jun 17	July 8
	1993	7	May 11 - June 5	May 19	May 30

[1] NPT PIT tagged fish released at dark

[1] FPC PIT tagged fish released after recovery

APPENDIX G

MORTALITY AT THE IMNAHA RIVER TRAPS DURING MIGRATION YEARS 2001 AND 2002

Appendix G. Table G1. Mortality of chinook salmon and steelhead smolts due to trapping, handling, and PIT tagging at the upper Imnaha River trap from October 17 to November 15, 2000.

	Chinook Salmon				Steelhead			
	Natural		Hatchery		Natural		Hatchery	
Number Captured	2,318		0		63		0	
Mortality	69		0		0		0	
Source	n	(%)	n	(%)	n	(%)	n	(%)
Trapping	68	(2.94)	0	NA	0	(0.00)	0	NA
Handling	0	(0.00)	0	NA	0	(0.00)	0	NA
PIT Tagging	1	(0.04)	0	NA	0	(0.00)	0	NA
Total	69	(2.98)	0	NA	0	(0.00)	0	NA

Appendix G. Table G2. Mortality of chinook salmon and steelhead smolts due to trapping, handling, and PIT tagging at the lower Imnaha River trap from October 17 to November 15, 2000.

	Chinook Salmon				Steelhead			
	Natural		Hatchery		Natural		Hatchery	
Number Captured	2,981		0		360		0	
Mortality			0				0	
Source	n	(%)	n	(%)	n	(%)	n	(%)
Trapping	7	(0.23)	0	NA	0	(0.00)	0	NA
Handling	0	(0.00)	0	NA	0	(0.00)	0	NA
PIT Tagging	1	(0.03)	0	NA	0	(0.00)	0	NA
Total	8	(0.27)	0	NA	0	(0.00)	0	NA

Appendix G. Table G3. Mortality of chinook salmon and steelhead smolts due to trapping, handling, and PIT tagging from February 22 to June 21, 2001.

	Chinook Salmon				Steelhead			
	Natural		Hatchery		Natural		Hatchery	
Number Captured	10,663		16,097		6,681		28,451	
Mortality	44		21		5		4	
Source	n	(%)	n	(%)	n	(%)	n	(%)
Trapping	23	(0.22)	15	(0.09)	5	(0.07)	4	(0.01)
Handling	2	(0.02)	6	(0.04)	0	(0.00)	0	(0.00)
PIT Tagging	19	(0.18)	0	(0.00)	0	0.00	0	(0.00)
Total	44	(0.41)	21	(0.13)	5	(0.07)	4	(0.01)

Appendix G. Table G4. Mortality of chinook salmon and steelhead smolts due to trapping, handling, and PIT tagging at the upper Imnaha River trap from October 17 to November 27, 2001.

	Chinook Salmon				Steelhead			
	Natural		Hatchery		Natural		Hatchery	
Number Captured	1,415		0		46		0	
Mortality	23		0		0		0	
Source	n	(%)	n	(%)	n	(%)	n	(%)
Trapping	19	(1.34)	0	NA	0	(0.00)	0	NA
Handling	1	(0.07)	0	NA	0	(0.00)	0	NA
PIT Tagging	3	(0.21)	0	NA	0	(0.00)	0	NA
Total	23	(1.63)	0	NA	0	(0.00)	0	NA

Appendix G. Table G5. Mortality of chinook salmon and steelhead smolts due to trapping, handling, and PIT tagging at the lower Imnaha River trap from October 17 to November 27, 2001.

	Chinook Salmon				Steelhead			
	Natural		Hatchery		Natural		Hatchery	
Number Captured	2,149		0		948		0	
Mortality	3		0		0		0	
Source	n	(%)	n	(%)	n	(%)	n	(%)
Trapping	1	(0.05)	0	NA	0	(0.00)	0	NA
Handling	0	(0.00)	0	NA	0	(0.00)	0	NA
PIT Tagging	2	(0.09)	0	NA	0	(0.00)	0	NA
Total	3	(0.14)	0	NA	0	(0.00)	0	NA

Appendix G. Table G6. Mortality of chinook salmon and steelhead smolts due to trapping, handling, and PIT tagging from March 4 to June 14, 2002.

	Chinook Salmon				Steelhead			
	Natural		Hatchery		Natural		Hatchery	
Number Captured	2,693		26,407		6,956		25,086	
Mortality	14		14		5		11	
Source	n	(%)	n	(%)	n	(%)	n	(%)
Trapping	7	(0.26)	11	(0.04)	5	(0.07)	11	(0.04)
Handling	2	(0.07)	0	(0.00)	0	(0.00)	0	(0.00)
PIT Tagging	5	(0.19)	3	(0.01)	0	(0.00)	0	(0.00)
Total	14	(0.52)	14	(0.05)	5	(0.07)	11	(0.04)

APPENDIX H

INCIDENTAL CATCH FOR MIGRATION YEARS 2001 AND 2002

Appendix H. Table H1. The catch of incidental fish during the fall, October 15 to November 15, 2000, and the spring, February 22 to June 21, at the upper and lower Imnaha River juvenile fish traps for the 2001 migration year.

Family	Common Name	Fall of 2000 Upper Trap	Fall of 2000 Lower Trap	Spring of 2001 Lower Trap	Total Catch
Salmonidae	Adult Chinook Salmon				
	Adult Steelhead			27	27
	Rainbow Trout / Steelhead	62		61	123
	Mountain Whitefish	33	448	1	482
	Bull Trout	30	62	2	94
					0
Centrarchidae	Smallmouth Bass		22	3	25
	Bluegill				0
					0
Catostomidae	Bridgelip Sucker		142	58	200
	Largescale Sucker			30	30
	Sucker (unidentified species)			4	4
					0
Cyprinidae	Chislemouth			13	13
	Longnose Dace	8	92	93	193
	Speckled Dace			24	24
	Leopard Dace				0
	Northern Pikeminnow		44	11	55
	Redside Shiner		9	12	21
					0
Cottidae	Sculpin (unidentified species)		22	66	88
					0
Ictaluridae	Bullhead (unidentified species)				0
	Total Catch	133	841	405	1,379

Appendix H. Table H2. The catch of incidental fish during the fall, October 17 to November 27, 2001, and the spring, March 4 to June 12, at the upper and lower Imnaha River juvenile fish traps for the 2002 migration year.

Family	Common Name	Fall of 2001 Upper Trap	Fall of 2001 Lower Trap	Spring of 2002 Lower Trap	Total Catch
Salmonidae	Adult Chinook Salmon		4	1	5
	Adult Steelhead			91	91
	Rainbow Trout / Steelhead		577	154	731
	Mountain Whitefish	73	205	22	300
	Bull Trout	12	132	7	151
					0
Centrarchidae	Smallmouth Bass		97	42	139
	Bluegill			2	2
					0
Catostomidae	Bridgelip Sucker		5	47	52
	Largescale Sucker		809	6	815
	Sucker (unidentified species)		1	177	178
					0
Cyprinidae	Chislemouth		10	18	28
	Longnose Dace	4	2	211	217
	Speckled Dace		1	5	6
	Leopard Dace		1		1
	Northern Pikeminnow		35	18	53
	Redside Shiner		14	14	28
					0
Cottidae	Sculpin (unidentified species)	1	2	44	47
					0
Ictaluridae	Bullhead (unidentified species)			7	7
	Total Catch	90	1,895	866	2,851