

**Emigration of Natural and Hatchery Nacó'x̂ (Chinook salmon; *Oncorhynchus tshawytscha*)
and Héeyey (Steelhead; *Oncorhynchus mykiss*) Smolts from the Imnaha River, Oregon
from 5 October 2006 to 21 June 2007**

2007 Annual Report

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EXECUTIVE SUMMARY

This report summarizes the Nez Perce Tribe's Imnaha River juvenile Nacó'x̂ (Chinook Salmon; *Oncorhynchus tshawytscha*) and Héeyey (steelhead; *O. mykiss*) emigration studies conducted from October 5, 2006, to June 21, 2007 (migration year 2007). The studies have been ongoing for 16 years and have contributed information to the Fish Passage Center's Smolt Monitoring Program for 14 years. The study collected and tagged fish in the Imnaha River at rkm 7 during the fall and spring. Tagged fish were detected downstream as they passed through Snake and Columbia River dams. The project evaluated the survival, biological characteristics, and migration performance of natural and hatchery spring/summer Nacó'x̂ (Chinook salmon) and Héeyey (steelhead) at Lower Granite Dam (LGD), Little Goose Dam (LGS), Lower Monumental Dam (LMD), and McNary Dam (MCD). This report continues to use the Nez Perce names for these fish species. These traditional names pre-date both the common and scientific nomenclature.

Imnaha River Nacó'x̂ (Chinook salmon) and Héeyey (steelhead) smolts migrating in the spring had slightly lower than average hydrologic conditions within the Imnaha River. Average monthly discharge from March to June ranged from 234 cfs (March) to 1,003 cfs (June). The average monthly discharge in the Snake River ranged from 26,863 cfs in April to 48,003 cfs in May. Spill at LGD, LGS, LMD, and MCD began in mid-March and lasted until September 1. Maximum water temperatures in the tailraces of LGD, LGS, LMD, and MCD exceeded 18 °C after June 24.

A total of 14,737 natural origin Nacó'x̂ (Chinook salmon smolts and pre-smolts), 74,430 hatchery origin Nacó'x̂ (Chinook salmon), 10,532 natural origin Héeyey (steelhead), and 36,132 hatchery origin Héeyey (steelhead) were captured in migration year 2007. The studies passive integrated transponder (PIT) tagged a total of 11,510 natural Nacó'x̂ (Chinook salmon), 2 hatchery Nacó'x̂ (Chinook salmon), 7,198 natural Héeyey (steelhead), and 1,492 hatchery Héeyey (steelhead). Hatchery Nacó'x̂ (Chinook salmon) had a mean fork length (123 mm) that was significantly different ($p < 0.05$) than the mean fork length of natural Nacó'x̂ (Chinook salmon) (99 mm). Previously PIT tagged hatchery Héeyey (steelhead) had a mean fork length (215 mm) that was significantly larger ($p < 0.05$) than the mean fork length of natural produced Héeyey (steelhead) (169 mm).

The estimated post release survival of previously PIT tagged hatchery Nacó'x̂ (Chinook salmon) from release at the Gumboot acclimation site to the Imnaha River juvenile migrant trap was 91.6% in spring 2007. The post-release survival estimate was similar to previous estimates from 1994 to 2005 of 82.9% to 100%. The post-release survival in 2006 was only 63.3%.

The survival estimate of natural Nacó'x̂ (Chinook salmon) tagged in the fall was 31.8% to LGD. Past survival estimates from the trap to LGD for fall tagged Imnaha River natural Nacó'x̂ (Chinook salmon) have ranged from 21.6% to 60.4% from 1994 to 2006.

Imnaha River smolt estimated survivals from release at the Imnaha trap to LGD in spring of 2007 were 77.5% for natural Nacó'x̂ (Chinook salmon), 70.5% for hatchery Nacó'x̂ (Chinook salmon), 78.8% for natural Héeyey (steelhead), and 94.9% for hatchery Héeyey (steelhead). The estimated survival from the Imnaha trap to LMO was 70.5% for natural Nacó'x̂, 68.2% for hatchery Nacó'x̂ (Chinook salmon), 60.3% for natural Héeyey (steelhead) and 86.2% for hatchery Héeyey (steelhead).

A smolt-to-adult return rate (SAR) index from LGD to LGD was calculated for migrating fall and spring tagged natural Nacó'x̂ (Chinook salmon) for migration years 1998 to 2004. These index SARs characterize Imnaha natural Nacó'x̂ (Chinook salmon) that were utilized in the default PIT tag mode, so when detected bypassed and put back into the river (i.e. not barged). The LGD to LGD SAR index for fall survival tagged natural Nacó'x̂ (Chinook salmon) has ranged from 1.10% (MY 2001) to 6.03% (MY 2000). The LGD to LGD SAR index for spring survival tagged natural Nacó'x̂ (Chinook salmon) has ranged from 0.27% (MY 2003) to 3.08% (MY 2000).

Significant difference ($p < 0.05$) in the median arrival timing of fall and spring PIT tagged natural Nacó'x̂ (Chinook salmon) was observed at LGD. Median arrival timing of fall tagged natural Nacó'x̂ (Chinook salmon) at LGD occurred on April 14: 22 days earlier than the median arrival timing for spring tagged natural Nacó'x̂ (Chinook salmon) smolts. A total of 10 years of arrival data for fall tagged natural Nacó'x̂ (Chinook salmon), 15 years of arrival data for spring tagged natural and hatchery Nacó'x̂ (Chinook salmon), and 16 years of arrival data for natural and hatchery Héeyey (steelhead) at LGD, LGS, LMD, and MCD was summarized for this report. The estimated median arrival time at LGD is as follows: April 16 (± 8 days) for fall tagged natural Nacó'x̂ (Chinook salmon) (1998 to 2007), April 28 (± 8 days) for spring tagged natural Nacó'x̂ (Chinook salmon) smolts (1993 to 2007), May 3 (± 9 days) for hatchery Nacó'x̂ (Chinook salmon), May 10 (± 12 days) for natural Héeyey (steelhead) (1993 to 2007) and May 18 (± 14 days) for hatchery Héeyey (steelhead) (1993 to 2007).

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INTRODUCTION

This report summarizes the Nez Perce Tribe (NPT) Department of Fisheries Resources Management (DFRM) results for the Lower Snake River Compensation Plan (LSRCP) Hatchery Evaluation studies and the Imnaha River Smolt Monitoring Program (SMP) for the 2007 smolt migration from the Imnaha River, Oregon. These studies are closely coordinated and provide information about juvenile natural and hatchery spring/summer Nacó'x̂ (Chinook Salmon; *Oncorhynchus tshawytscha*) and Héeyey (steelhead; *O. mykiss*) biological characteristics, emigrant timing, survival, arrival timing and travel time to the Snake River dams and McNary Dam (MCD) on the Columbia River. These studies provide information on listed Nacó'x̂ (Chinook salmon) and Héeyey (steelhead) for the Federal Columbia River Power System (FCRPS) Biological Opinion (NMFS 2000).

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

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

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

Information is shared with the Fish Passage Center (FPC) on a real time basis during the spring emigration period. The Bonneville Power Administration (BPA) and the United States Fish and Wildlife Service (USFWS) contracted the NPT to monitor emigration timing and tag up to 19,000 emigrating natural and hatchery Nacó'x (Chinook salmon) and Héeyey (steelhead) smolts from the Imnaha River with passive integrated transponder (PIT) tags.

The completion of trapping in the spring of 2007 marked the 16th year of emigration studies on the Imnaha River, and the 14th year of participating in the FPC smolt monitoring program. Monitoring and evaluation objectives were to:

1. Evaluate effects of flow, temperature and other environmental factors on juvenile migration timing.
2. Determine emigration timing, travel time, and in-river survival of PIT tagged hatchery Nacó'x (Chinook salmon) smolts released at the Imnaha River acclimation facility to the Imnaha River juvenile migration trap.
3. Monitor the daily catch and biological characteristics of juvenile Nacó'x (Chinook salmon) and Héeyey (steelhead) smolts collected at the Imnaha River screw trap.
4. Determine spring emigration timing of Nacó'x (Chinook salmon) and Héeyey (steelhead) smolts collected at the Imnaha River juvenile migration trap.
5. Compare emigration characteristics and survival rates of natural fall and spring tagged juvenile Nacó'x (Chinook salmon).
6. Determine arrival timing, travel time and estimated survival of PIT tagged natural and hatchery Nacó'x (Chinook salmon) and natural and hatchery Héeyey (steelhead) smolts from the Imnaha River to Snake and Columbia River dams.

METHODS

Study Area Description

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

Reservoirs encountered by migrating Imnaha River Nacó'x (Chinook salmon) and Héeyey (steelhead) smolts are formed by Lower Granite Dam (LGD), Little Goose Dam (LGS), Lower Monumental Dam (LMD), Ice Harbor Dam (IHD), McNary Dam (MCD), John Day Dam (JDD), The Dalles Dam (TDD), and Bonneville Dam (BON). Juvenile emigration monitoring described in this report occurs at LGD, LGS, LMD, and MCD. Juvenile emigration at Ice Harbor Dam is not monitored because IHD lacks the necessary detection facilities. The four lower Snake River dams became operational between 1961 and 1975. MCD became operational in 1953 (Anonymous 2003b).

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

Equipment Description

A floating rotary screw trap manufactured by E.G. Solutions Inc., Corvallis, Oregon, was used to capture migrating salmonids (Figure 3). Similar traps have been used to capture migrating juvenile salmonid species in New York and Alaska (Kennen et al. 1994; Thedinga et al. 1994). The screw trap used in the spring and fall consists of a 2.1 m diameter-trapping cone supported by a metal A-frame and two six-meter pontoons that provided flotation. Fish entering the trapping cone moves through to a live box (1.68 m wide x 1.25 m long x 0.55 m deep). The live box was fitted with a removable baffle to dissipate water velocity during high flows.

Discharge and Temperature Description

The U.S. Geological Survey provided Imnaha River discharge information online from USGS gauge 13292000 at Imnaha, Oregon at http://waterdata.usgs.gov/usa/nwis/uv?site_no=13292000. Imnaha River water temperature information for this study was collected using a thermograph placed 150 m upstream from the screw trap. Snake River water discharge and temperature information was provided by the USGS gauge 13334300 at Anatone Washington at http://waterdata.usgs.gov/usa/nwis/uv?site_no=13334300. Measurements of outflow, spill, and temperature at LGD, LGS, LMD, and MCD were obtained online from DART at <http://www.cbr.washington.edu/dart/>.

Trap Operations

The trap was operated from October 5 to November 29, 2006, and from March 1 to June 21, 2007. The trap is located 7 rkm from the confluence of the Snake River. The live box of the screw trap was checked at 0800 every morning and several times throughout each night and day, if warranted by large numbers of fish. Non-target piscivorous fish and large numbers of other non-target fish were removed from the live box first. Non-target piscivorous fish were scanned for PIT tags and then released 30-50 m downstream through a discharge tube. The precise location of the tube outlet depends on the observed existence of predator species. The outlet is located to minimize predation of examined smolts. Fish were processed as they were removed from the trap.

Two subsampling routines are used on occasion during trapping. These routines allow crews to continue sampling when the trap gets overwhelmed with smolts. One routine consists of 1) clearing the trap of all fish, 2) collect fish for a fixed period of time, 3) isolate the collected fish from incoming fish, 4) bypass incoming fish through a PIT Tag detector to monitor for recaptures or previously tagged fish, and 5) process all fish collected. The number of processed fish is multiplied by an appropriate time ratio. For instance if the crew collected fish for 15 minutes and then bypassed fish for 45 minutes the ratio would be 1:4. The estimated total number of fish passing would equal the total processed multiplied by four. The second subsampling routine is used when clearing the trap (step one listed above) becomes too difficult. This routine consists of a) isolating all trapped fish within the livebox, b) divert incoming fish through a PIT Tag detector, c) collect one net-full of captured fish for processing, d) collect roughly equal sized net-fulls of the remaining fish and feed them through a separate PIT Tag antenna. This estimate is scaled up in a similar way to the first routine except “net fulls” becomes the multiplier. The subsample consists of a remote monitoring (RM) files of PIT Tag numbers and a text file recording scaled up fish numbers. The PIT Tag data collected are incorporated into recapture numbers and trap efficiency calculations. The scaled up fish numbers are included in the number of fish handled and incidental species counts.

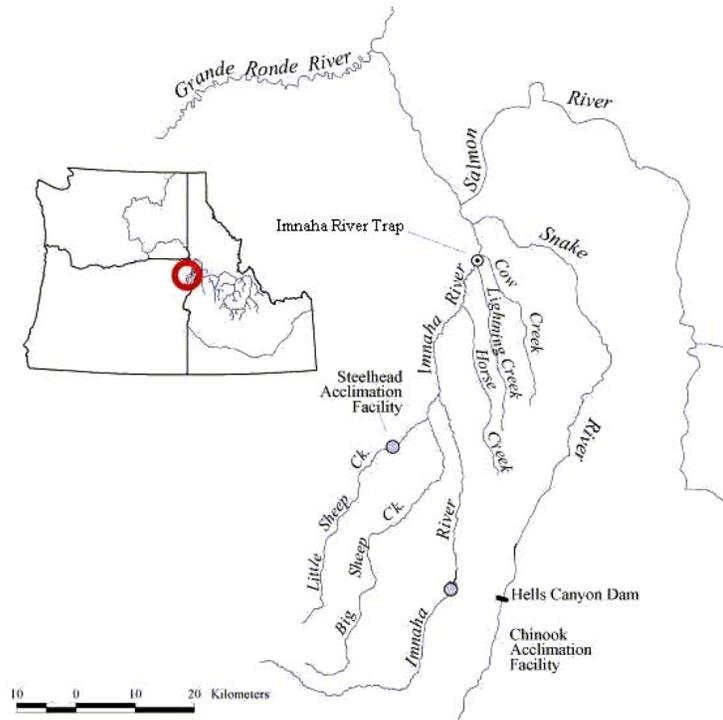


Figure 1. Map of the Imnaha River study area.

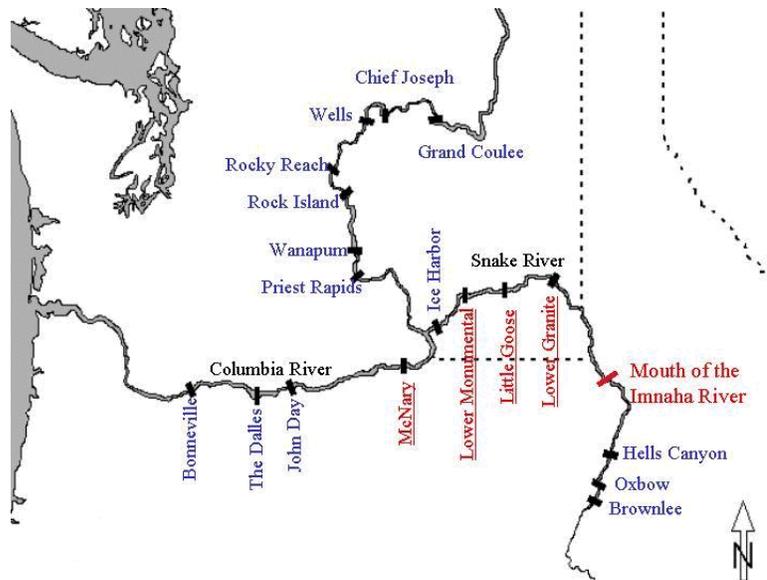


Figure 2. Map of the Columbia River Basin. Dams underlined indicate monitoring points for the Imnaha Smolt Monitoring Program.



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

Daily processing procedures were as follows: 1) fish were anaesthetized in a MS-222 bath (6 ml MS-222 stock solution (100 g/L) per 19 L of water) buffered with Propolyaqua, 2) each fish was examined for existing marks (e.g. fin clips), and PIT tag insertion scars, 3) Nacó'x̂ (Chinook salmon), Héeyey (steelhead) and large piscivorous fish were scanned with a PIT tag scanner, 4) fifty randomly selected natural Nacó'x̂ (Chinook salmon) and natural Héeyey (steelhead) smolts were targeted for use in daily trap efficiency trials, 5) a specified number of each species was selected for PIT tag insertion, 6) all other fish were enumerated and released 30-50 m downstream, depending on the presence of predatory fish, from the trap after recovering from the anesthetic, and 7) all fish mortality was recorded.

PIT Tagging

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

Trap Efficiencies

Daily trap efficiency trials using natural Nacó'x̂ (Chinook salmon) in fall of 2006 and both natural Nacó'x̂ (Chinook salmon) and natural Héeyey (steelhead) smolts in the spring of 2007 were conducted. The daily goal was to randomly tag 50 natural Nacó'x̂ (Chinook salmon) and Héeyey (steelhead). The fork length of all marked fish were measured to the nearest mm and weighed to the nearest 0.1 g. Fish selected for trap efficiency trials during migratory year 2007 were marked with PIT tags. Fish marked for trap efficiency trials were held in perforated containers in the river during daylight hours (up to 12 h) and then transported upstream, approximately 1 km, during evening hours and released after dark.

Daily trap efficiency trials for natural Nacó'x̂ (Chinook salmon) and natural Héeyey (steelhead) were grouped into weekly periods consisting of at least seven marked recaptures under similar flow conditions for both fall and spring trapping periods. Weeks with less than seven recaptures were grouped with either the preceding week or the following week depending on similarity of flow conditions. Trap efficiency was determined by $E = R/M$; where E is estimated trap efficiency, R is number of marked fish recaptured, and M is number of fish marked and released. The reported 95% confidence intervals are based on a bootstrap calculation within the Gauss program (Aptech Systems Inc., Maple Valley, Washington).

Biological Characteristics

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

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

Survival Estimation

Survival probabilities were estimated by the Cormack, Jolly and Seber methodology (1964, and 1965, respectively, as cited in Smith et al. 1994) with the Survival Using Proportional Hazards (SURPH) model (Smith et. al. 1994). The data files for season wide and weekly release groups were created using the program PITPRO version 4.10 (Westhagen and Skalski, 2007).

Data for PITPRO and SURPH was obtained directly from Pit Tag Information System (PTAGIS).

Survival estimates from the trap to downstream dams were calculated for hatchery and natural Héeyey (steelhead) and Nacó'x̂ (Chinook salmon). Season-wide and weekly release groups of natural and hatchery Nacó'x̂ (Chinook salmon) and Héeyey (steelhead) were treated as single release groups. Only weekly release groups of 300 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 Nacó'x̂ (Chinook salmon) in the fall, it was assumed that fish did not migrate past LGD before PIT tag interrogation facilities became operational.

Spring and Fall Emigration Indexes

Spring and fall emigration indexes of juvenile abundance for natural Nacó'x̂ (Chinook salmon) and spring emigration indexes of Héeyey (steelhead) smolts migrating past the trap were estimated using the Gauss program (Aptech Systems Inc., Maple Valley, Washington) with a Bailey trap efficiency estimation method (Steinhorst et al. 2004). The Bailey estimate is a version of the Lincoln-Peterson method and is used to develop the point estimate. The Gauss program utilizes a bootstrap method with 1000 iterations to calculate the confidence intervals and utilizes stratified data when appropriate. This does not represent a total juvenile production estimate from the Imnaha River, as trapping periods are limited. This estimate is a minimum estimate based on trap efficiency trials in the fall of 2006 and spring of 2007. To maintain robustness for analysis, we set a lower limit of seven mark recaptures for any period (Steinhorst et al. 2004).

Smolt to Adult Return Rates (SARs)

Smolt-to adult return rate indices (SAR) were calculated for two groups of PIT tagged juvenile natural Nacó'x̂ (Chinook salmon) emigrants from the Imnaha River, for migration years 1998 through 2006. The two groups were represented by: 1) juvenile (pre-smolts) natural Nacó'x̂ (Chinook salmon) tagged during the fall of the migration year which emigrated past the Imnaha River juvenile migration trap, and 2) natural Nacó'x̂ (Chinook salmon) smolts which emigrated past the Imnaha River juvenile migration trap during the spring. There is not a comprehensive adult detection facility at the Imnaha River, so SAR rates are calculated from the Imnaha River Trap to LGD and LGD to LGD.

Smolt-to adult return rate indices (SAR) were calculated for two groups of PIT tagged juvenile natural Nacó'x̂ (Chinook salmon) emigrants from the Imnaha River, the fall and spring groups for migration years 1998 through 2004. Salmon and steelhead PIT tags are used for two separate SAR calculations, (survival mode and monitor mode), Survival mode utilizes PIT tags that are placed in the default action at the dams, i.e. bypassed back to the river. Monitor mode

tags utilize the Sort by Code (SbyC) system that allows us to designate those fish to be treated like unmarked or run of the river fish. When those PIT tags are detected “no action” occurs and they proceed along as if they were unmarked (barged or bypassed; whatever the current action of the day is). Monitor mode tags have not occurred for very many years so this document will only be reporting the survival mode SARs. The Imnaha River to LGD survival mode SARs are calculated using the ratio of survival PIT tags leaving the Imnaha River (fall and spring groups) to the number of survival mode adults detected at LGD. The LGD to LGD SARs are estimated using survival mode PIT tagged juvenile smolts detected at LGD to the number of survival mode PIT tag adults returning to LGD. PIT tagged adults return at ages three, four, five and six and detections are totaled over the four return years to provide the entire migration year SAR. The SARs characterized in this report represent the in-river and bypassed smolts only and should not be considered representative of the population at large.

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

Arrival timing to LGD, LGS, LMD, and MCD were determined for natural and hatchery Nacó'x̂ (Chinook salmon) and Héeyey (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. The cumulative distributions of arrival times between fall and spring tagged juvenile natural Nacó'x̂ (Chinook salmon) were compared using a Kolmogorov-Smirnov test (Steel et al. 1997 and STATAGRAPHICS 1995).

Travel time is the time it takes an individual tagged fish to travel from either the acclimation facilities or the Imnaha trap to juvenile detectors at specific dams. Weeks with at least 30 PIT tag interrogations at LGD were used to determine median travel time to LGD. A Wilcoxon rank sum test statistic (Ott 1984) was then used to compare medians of each group.

RESULTS AND DISCUSSION

River Discharge and Water Temperature

Innaha River

The mean daily discharge during the study period, unaffected by potential freezing water, ranged from 110 cfs on February 1, 2007 to 1,340 cfs (1 cfs = 0.283168 cms) on May 2 and 3, 2007 (Figure 4). Daily mean water temperatures ranged from -0.6 °C in mid-December, 2006, to 19.9 °C on June 30, 2007.

Monthly average discharge for the Innaha River for the months of March, April, May, and June were 234, 480, 688, and 1,003 cfs respectively (Figure 5). The spring run off for the Innaha River was within the range of monthly average discharge values observed from 1929 to 2007.

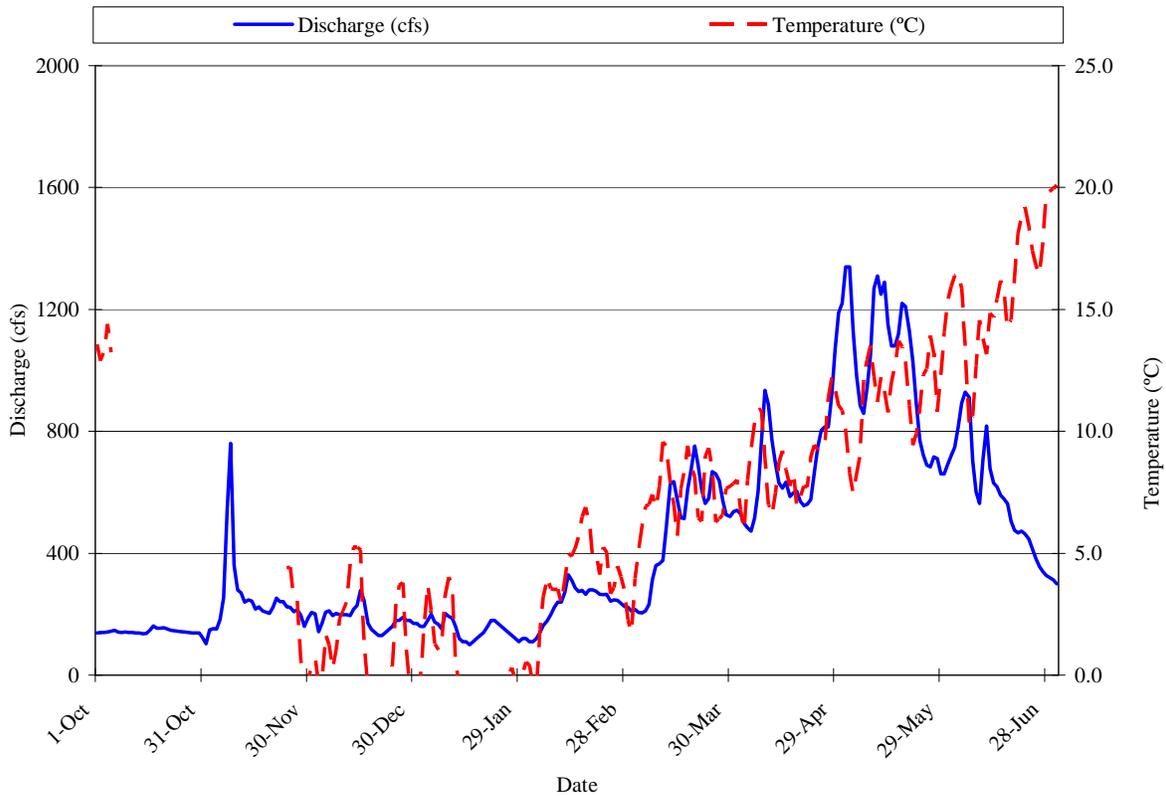


Figure 4. The average daily discharge at the Innaha River USGS gauge 13292000 and the average daily temperature from October 1, 2006, to June 30, 2007, at the Innaha River juvenile migration trap. USGS discharge data is provisional.

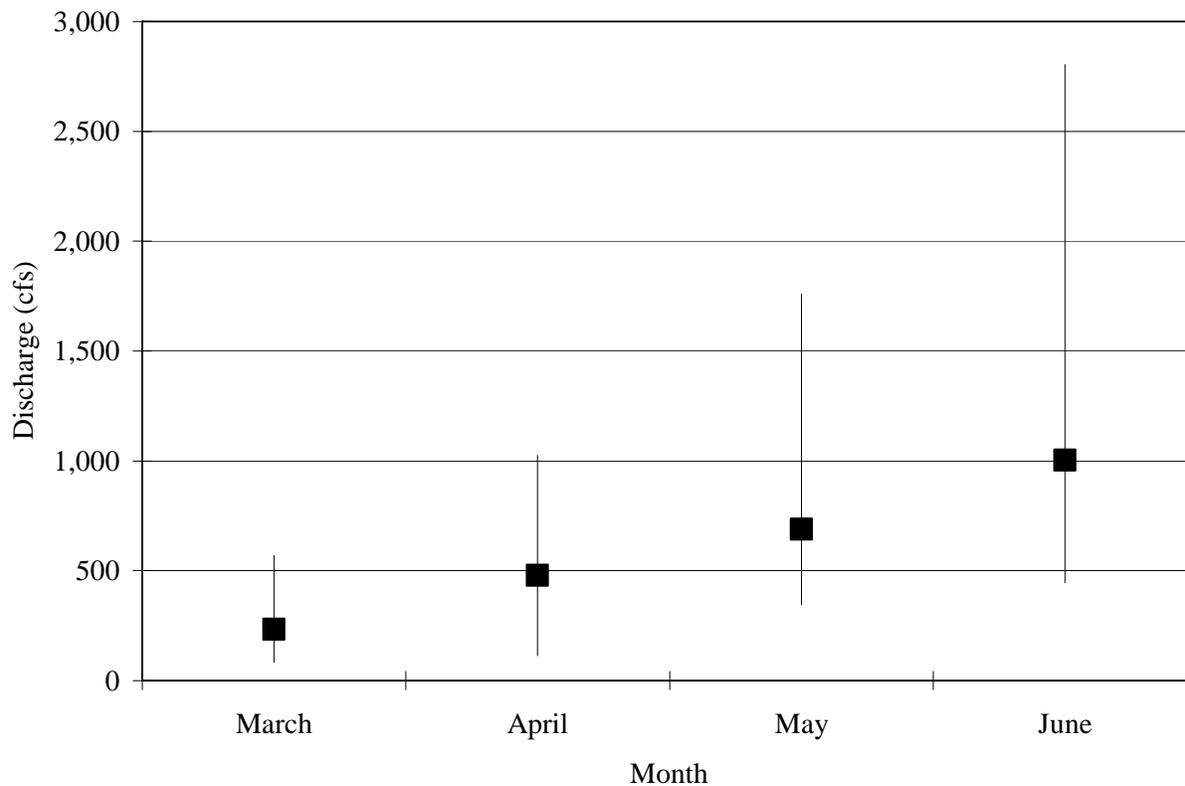


Figure 5. The average monthly discharge for the months of March, April, May, and June for 2007, at the Imnaha River USGS gauge 13292000. Bars indicate the minimum and maximum average monthly discharge values observed from 1929 to 2007. USGS discharge data is provisional.

Snake River

Snake River mean daily discharge during the study period ranged from 12,800 cfs on November 3, 2006, to 59,900 cfs on May 14, 2007 (Figure 6). Daily mean water temperatures ranged from 1.2 °C on February 3, 2007, to 20.0 °C on June 30, 2007.

Monthly average discharge for March, April, May, and June were as follows: 28,571, 26,863, 48,003, and 29,650 cfs respectively (Figure 7). The discharge in the Snake River for the months of March, April and June is characterized as significantly below average for the period of record.

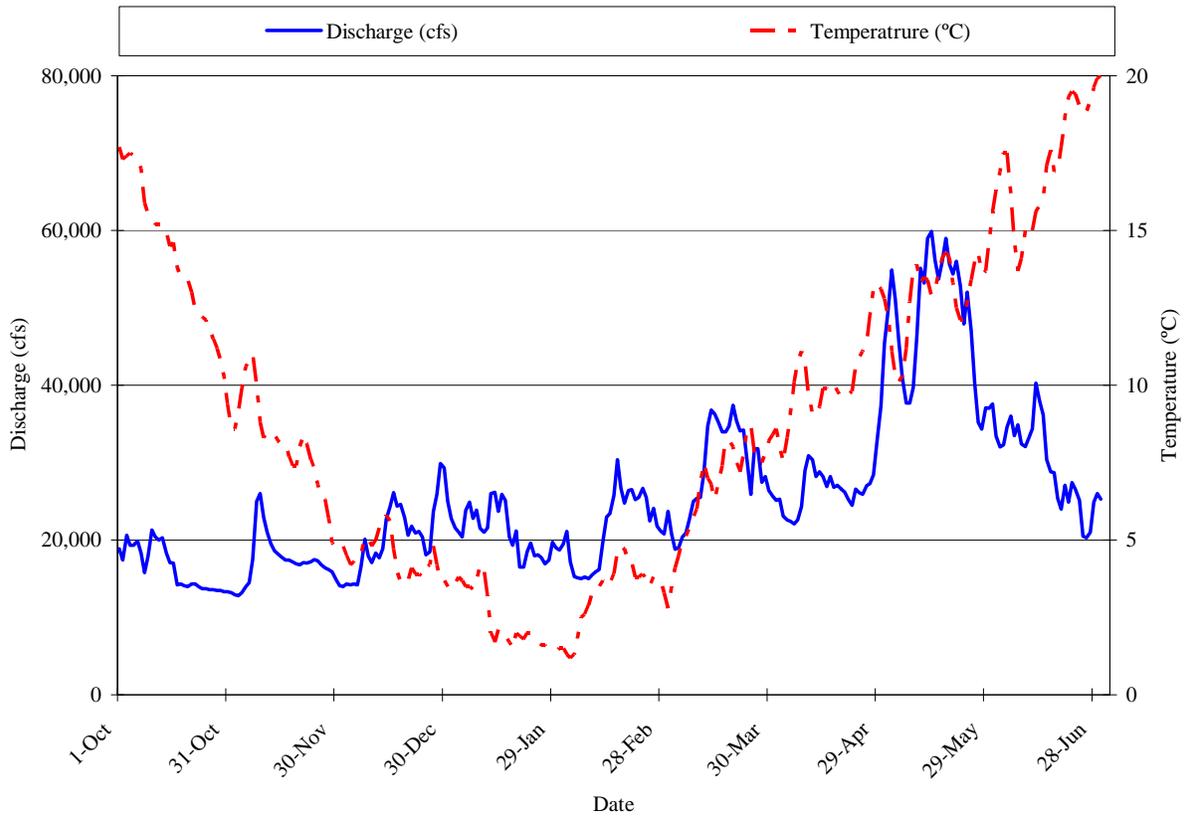


Figure 6. The average daily discharge and temperature at the Snake River gauge 13334300 from October 1, 2006, to June 30, 2007. USGS discharge data is provisional.

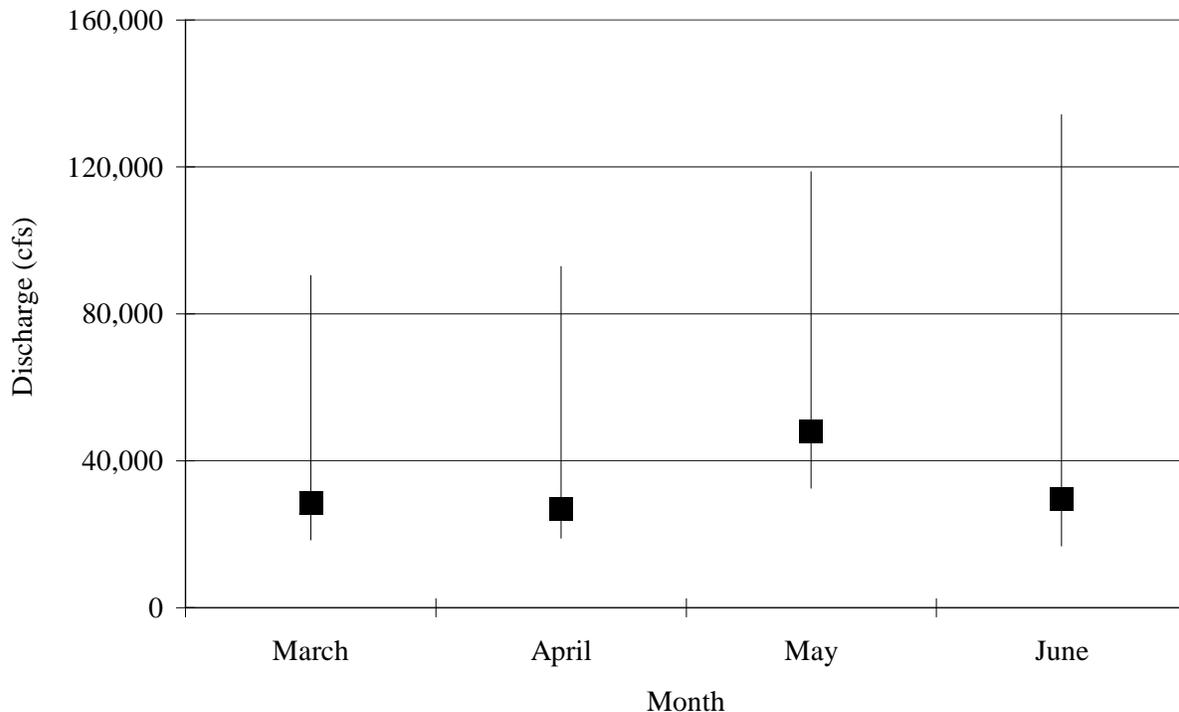


Figure 7. The average monthly discharge for the months of March, April, May, and June for 2007 at the Snake River USGS gauge 13334300. Bars indicate the minimum and maximum average monthly discharge values observed from 1959 to 2007. USGS discharge data is provisional.

Water temperatures measured in the tailraces of LGD, LGS, LMD, and MCD were lowest in March and highest in July and August. Minimum water temperatures in the tailraces were as follows: 3.9 °C at LGD on March 1, 5.8 °C at LGS on March 23, 5.39 °C at LMD on March 24, and 3.7 °C at MCD on March 1. Maximum water temperatures in the tailraces were as follows: 20.6 °C at LGD on July 7, 21.2 °C at LGS on July 11 and August 1, 21.3 °C at LMD on July 16 and August 6, and 21.5 °C at MCD on July 27.

Assuming that spill is beneficial to the survival of emigrating smolts (Berggren and Filardo 1993) and that water temperatures in excess of 18 °C may increase mortality due to increased activity by Qiyexs (northern pike minnow, *Ptychocheilus oregonensis*) (Mesa and Olson 1993), the best environmental conditions for smolt emigration through LGD, LGS, and LMD occurred from early May to late June when spill occurred in the lower Snake River (before water temperatures reached 18 °C) (Figures 8-11). The smolt emigration period for MCD was from early April through late June.

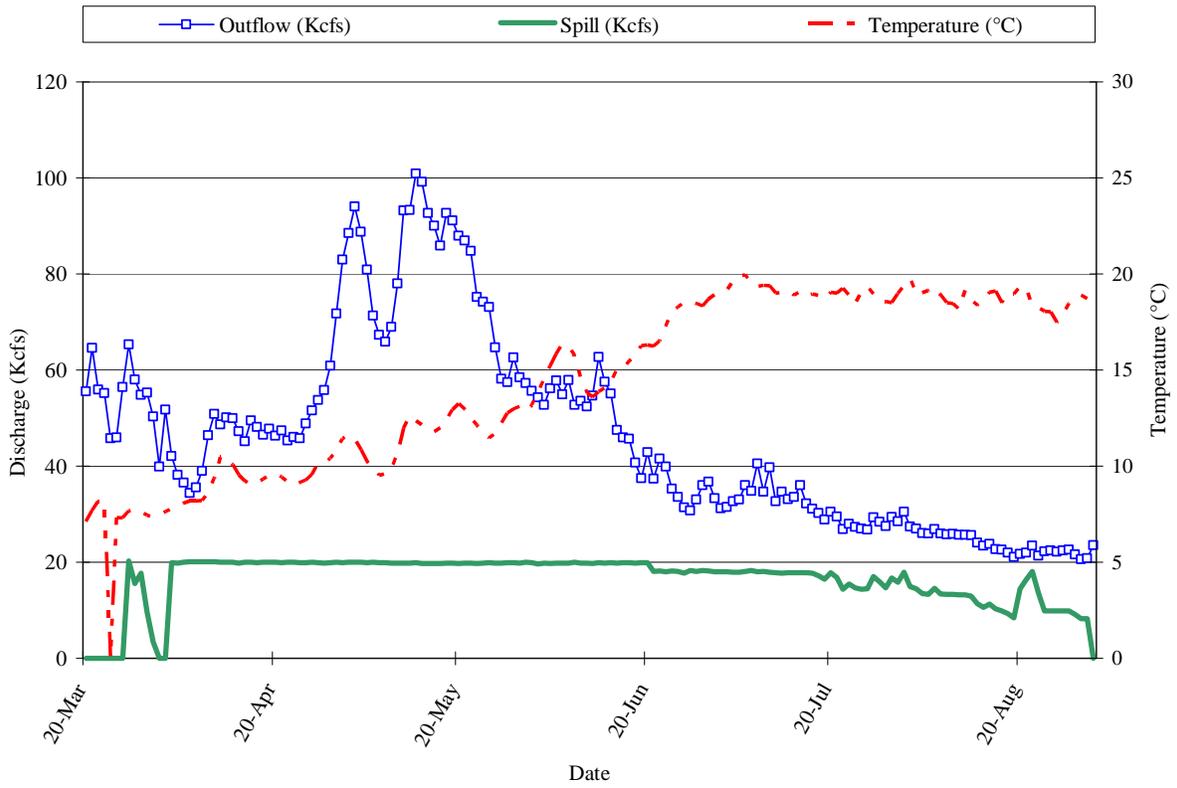


Figure 8. Measurements of outflow, spill, and mean temperature at Lower Granite Dam from March 20 to September 1, 2007. Data obtained online at <http://www.cbr.washington.edu/dart/>.

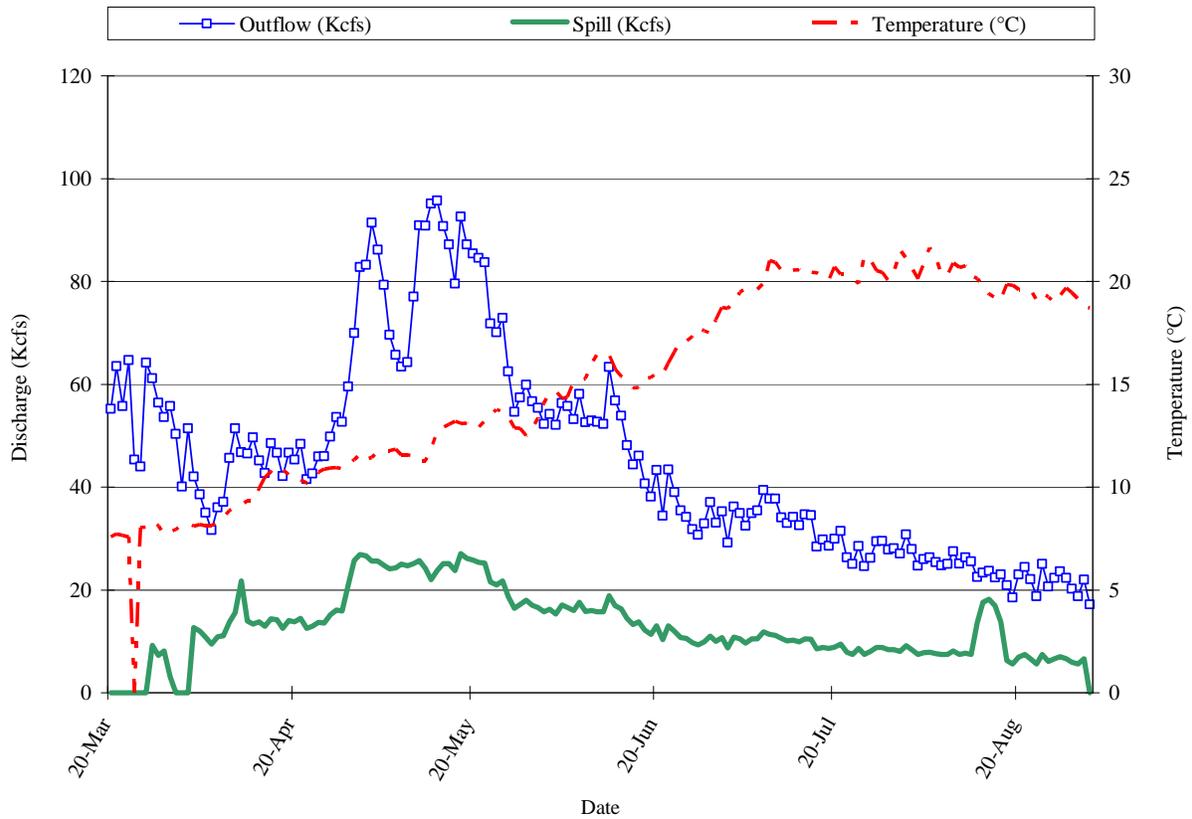


Figure 9. Measurements of outflow, spill, and mean temperature at Little Goose Dam from March 20 to September 1, 2007. Data obtained online at <http://www.cbr.washington.edu/dart/>.

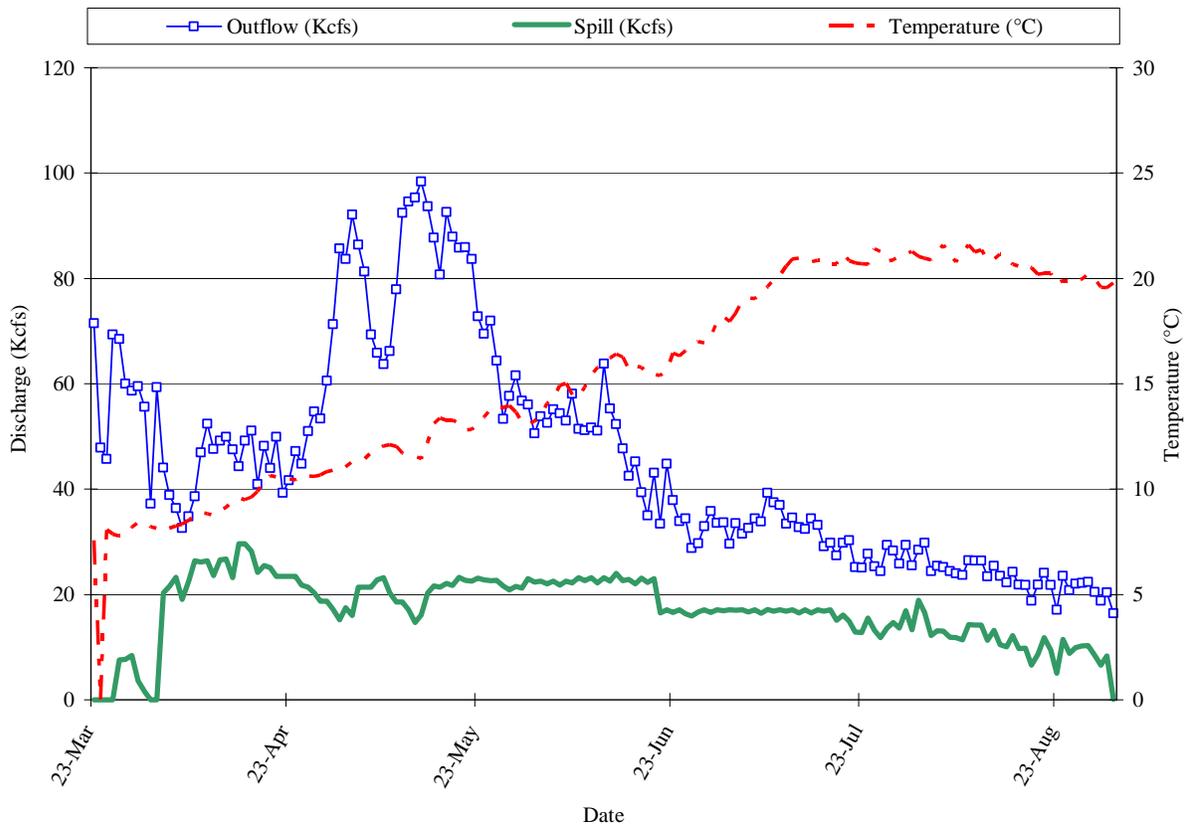


Figure 10. Measurements of outflow, spill, and mean temperature at Lower Monumental Dam from March 20 to September 1, 2007. Data obtained online at <http://www.cbr.washington.edu/dart/>.

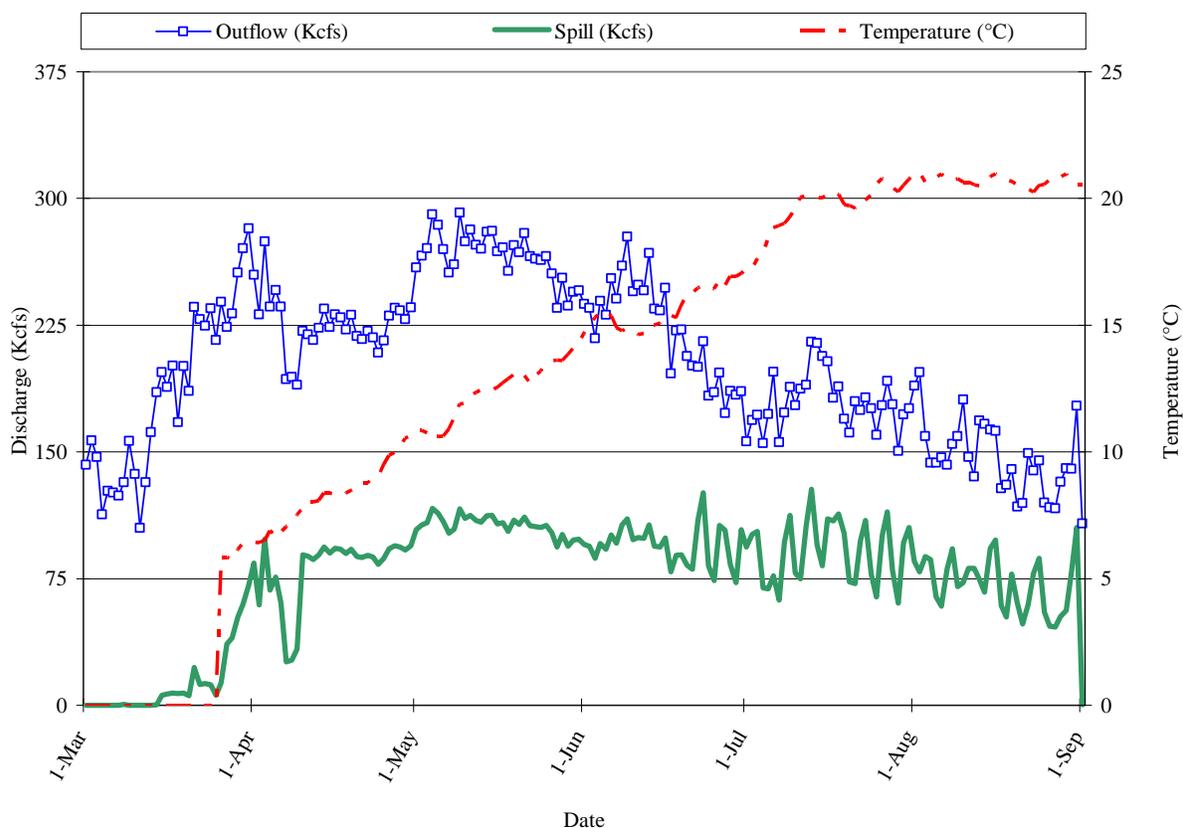


Figure 11. Measurements of outflow, spill, and mean temperature at McNary Dam from March 1 to September 1, 2007. Note that temperature did not begin recording until March 26. Data obtained online at <http://www.cbr.washington.edu/dart/>.

Hatchery Releases

Nacó'x̂ (Chinook salmon)

A total of 432,530 *Nacó'x̂* (Chinook salmon) were released from the Imnaha River Gumboot acclimation facility at rkm 74 (Table 1). Two overlapping volitional releases of *Nacó'x̂* (Chinook salmon) occurred during the 2007 migration season. The first volitional release of 308,798 *Nacó'x̂* (Chinook salmon) arrived at the acclimation facility on March 13 and 14. Hatchery personnel began pulling dam boards on March 21 and fish left volitionally until March 28 when the second volitional release arrived at the facility. Hatchery personnel stopped the original release allowing the second group to acclimate. Volitional release for the combined groups began again on March 31 with force out on April 12. All *Nacó'x̂* (Chinook salmon) were marked with an adipose fin clip, 176,788 (57.3 % of the first release) had a coded wire tag, and 14,928 (0.5% of the first release group) were marked with a PIT tag (D. Eddy, Oregon Fish and Wildlife, personal communication). The entire second group received only the adipose fin clip.

Héeyey (Steelhead)

Hatchery Héeyey (steelhead) were released at two locations in the Imnaha River Subbasin in 2007 and releases totaled 258,141 fish (Table 1). A total of 158,103 Héeyey (steelhead) arrived between March 3 and March 12 at the LSRCP Little Sheep Creek acclimation facility and volitionally released between April 10 and May 1. A total of 21,673 were marked with adipose and left ventral fin clips, coded wire tags (CWT), 295 of which had PIT tags. The remaining 136,430 were marked only with adipose fin clips only. A second release of 100,038 Héeyey (steelhead) occurred from April 9 to April 11, 2007. These fish were released directly into Big Sheep Creek, 299 of which had PIT tags. No other external marks were applied to these smolts (D. Eddy, Oregon Fish and Wildlife, personal communication).

Table 1. Releases of hatchery reared Nacó'x̂ (Chinook salmon) and Héeyey (steelhead) smolts in the Imnaha River Subbasin during migration year 2007 (D. Eddy, Oregon Fish and Wildlife, personal communication, July 14, 2007).

Release Year	Species	Arrival at Acclimation Site	Number Released	Release Dates	Tags / Marks	Release Site
2007	Nacó'x̂ (Chinook salmon)	March 13 - 14	308,798	March 21 – March 28	100% adipose fin clipped with 176,788 CWT (57.3%) and 14,928 PIT tags.	Imnaha River (Gumboot)
2007	Nacó'x̂ (Chinook salmon)	March 28-29	123,732	March 31 – April 12	100% adipose fin clipped.	Imnaha River (Gumboot)
2007	Héeyey (steelhead)	March 3 - 12	158,103	April 10 - May 1	21,673 adipose and left ventral fin clipped with CWT (13.7%) and 295 PIT tags. All other fish 100% adipose fin clipped with NO CWT.	Little Sheep Creek
2007	Héeyey (steelhead)	Direct Stream	100,038	April 9 - 11	100% NO fin clip or other external mark, and NO CWT, and 299 PIT tags.	Big Sheep Creek

Juvenile Nacó'x̂ (Chinook salmon) and Héeyey (Steelhead) Catch

Catch for Migration Year 2007

The catch of natural Nacó'x̂ (Chinook salmon) for migration year 2007 (fall and spring) totaled 14,737 fish. The largest weekly catch during fall trapping occurred during the week of November 12 (n = 1,095). The largest weekly catch during spring trapping occurred during the week of April 8 (n = 3,159). The weekly mean discharge during the week of November 12 was 227 cfs. Water temperature was not recorded that week, (Table 2 and Appendix A). The weekly mean discharge and water temperature during the week of April 8 was 757 cfs and 8.4 °C. During the fall of 2006 and spring of 2007 the weekly catch of natural Nacó'x̂ (Chinook salmon) smolts exceeded 1,000 for four weeks. A total of 74,430 hatchery Nacó'x̂ (Chinook salmon) were captured, with the first captures occurring during the week of March 18 (Table 2 and Appendix A). More than eighty percent (n = 61,632) were captured during the weeks of April 1 and April 8. Total captures include the smolts actually handled plus the scaled up subsampling numbers, subsample numbers that were expanded are shown in italics in Table 2 and Appendix A.

Table 2. The weekly mean discharge (cfs), temperature (°C), and catch, including subsample estimates (shown in italics), of natural and hatchery Nacó'x̂ (Chinook salmon) and Héeyey (steelhead) at the Imnaha River juvenile migration trap from 1 October 2006 to 21 June 2007.

Week	Average Discharge (cfs)	Average Temperature (°C)	Natural Nacó'x̂ (Chinook salmon)	Hatchery Nacó'x̂ (Chinook salmon)	Natural Héeyey (steelhead)	Hatchery Héeyey (steelhead)
10/1/06	141.7	13.5	0	0	0	0
10/8/06	139.1	N/A	114	0	20	0
10/15/06	151.3	N/A	499	0	75	0
10/22/06	142.7	N/A	629	0	74	0
10/29/06	136.1	N/A	232	0	12	0
11/5/06	377.4	N/A	902	0	16	0
11/12/06	226.9	N/A	1,095	0	2	0
11/19/06	229.4	4.4	556	0	1	0
11/26/06	196.1	1.0	33	0	2	0
2/25/07	229.1	3.4	0	0	0	0
3/4/07	270.0	6.7	5	0	0	0
3/11/07	533.6	7.9	277	0	16	0
3/18/07	639.3	8.2	563	127	88	1
3/25/07	588.9	7.3	637	4,779	40	0
4/1/07	520.0	8.4	465	22,973	42	0
4/8/07	757.3	8.4	3,159	38,659	332	3,573
4/15/07	587.0	7.7	875	2,989	154	3,010

Week	Average Discharge (cfs)	Average Temperature (°C)	Natural Nacó'x̂ (Chinook salmon)	Hatchery Nacó'x̂ (Chinook salmon)	Natural Héeyey (steelhead)	Hatchery Héeyey (steelhead)
4/22/07	763.3	10.0	1,000	1,381	760	4,240
4/29/07	1,181.7	9.7	1,181	1,986	3,569	10,826
5/6/07	1081.1	11.9	686	1,087	2330	6,975
5/13/07	1164.3	12.5	321	236	1,378	3,498
5/20/07	845.0	11.4	246	119	699	903
5/27/07	701.1	14.0	454	71	286	566
6/3/07	773.7	13.4	527	19	573	1,926
6/10/07	660.3	14.8	171	3	56	520
6/17/07	484.3	17.1	110	1	7	94
Totals			14,737	74,430	10,532	36,132

The catch of natural Héeyey (steelhead) totaled 10,532 fish (Table 2 and Appendix A). The largest weekly catch occurred during the week of April 29 and totaled 3,569 fish. The mean weekly discharge and water temperature during the week of April 29 was 1,182 cfs and 9.7 °C. The catch of hatchery Héeyey (steelhead) was 36,132 fish with the largest weekly catch of hatchery Héeyey (steelhead) totaling 10,826, also occurring during the week of April 29.

PIT Tagging

A total of 11,510 natural Nacó'x̂ (Chinook salmon) were PIT tagged at the Imnaha trap for the 2007 migration year. Thirty-four percent of the PIT tagged natural Nacó'x̂ (Chinook salmon) (n = 3,949) were tagged in the fall of 2006 (Table 3 and Appendix B).

PIT tagged natural Héeyey (steelhead) totaled 7,198 fish (Table 3 and Appendix B). A goal was set to tag weekly release groups of hatchery Héeyey (steelhead) of no more than 250 fish. This effort was designed to spread the tagging out through the season resulting in a better representation of the hatchery Héeyey (steelhead) smolts. A total of 1,492 hatchery origin Héeyey (steelhead) were PIT tagged (Table 3 and Appendix B).

Recaptures of Previously PIT Tagged Smolts

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

We recaptured 24 of the 1,000 natural Nacó'x̂ (Chinook salmon) that were previously PIT tagged by Oregon Department of Fish and Wildlife (ODFW) on September 6, 2006 (Appendix C). Recaptured fish averaged 100.6 mm in fork length, 13.4 g in weight, and 1.25 for

a condition factor (Table 4). Fork length, weight, condition factor and sample sizes in Table 4 represent the number of times each attribute was recorded and summarized for this report.

Table 3. The number of natural and hatchery Nacó'x̂ (Chinook salmon) and Héeyey (steelhead) PIT tagged weekly at the Imnaha River juvenile migration trap from 1 October 2006 to 20 June 2007.

Week	Natural Nacó'x̂ (Chinook salmon)	Hatchery Nacó'x̂ (Chinook salmon)	Natural Héeyey (steelhead)	Hatchery Héeyey (steelhead)
10/1/06	0	0	0	0
10/8/06	51	0	0	0
10/15/06	416	0	0	0
10/22/06	673	0	0	0
10/29/06	268	0	0	0
11/5/06	608	0	0	0
11/12/06	1,201	0	0	0
11/19/06	694	0	0	0
11/26/07	38	0	1	0
2/25/07	0	0	0	0
3/4/07	4	0	0	0
3/11/07	277	0	16	0
3/18/07	560	0	88	0
3/25/07	635	0	40	0
4/1/07	463	0	41	0
4/8/07	771	0	128	255
4/15/07	875	1	154	239
4/22/07	905	0	701	217
4/29/07	823	0	1,550	285
5/6/07	472	0	1,494	249
5/13/07	318	1	1,376	247
5/20/07	235	0	695	0
5/27/07	451	0	286	0
Totals	11,510	2	7,198	1,492

A total of 1,735 previously PIT tagged hatchery Nacó'x̂ (Chinook salmon) released from the Imnaha River Gumboot acclimation facility were recaptured at the Imnaha juvenile migration trap. They averaged 121.9 mm in fork length, 22.3 g in weight, and a 1.21 condition factor. The first occurrence of a previously PIT tagged hatchery Nacó'x̂ (Chinook salmon) occurred on March 22, one day after the volitional release at the Gumboot acclimation facility began. Fifty and 90 percent of the fish arrived 19 and 29 days, respectively, after the volitional release began (Table 4 and Figure 12).

The earliest 90% arrival time for hatchery Nacó'x̂ (Chinook salmon) occurred in 1998. The release strategy in 1998 was direct stream release. Ninety percent of all previously PIT tagged hatchery Nacó'x̂ (Chinook salmon) arrived eight days after the release in 1998 (Figure 12). Migratory year 2007 had an average arrival time for an acclimated volitional release; with 50% arrival occurring 19 days after the volitional release began (Table 4 and Figure 12).

A total of 60 previously PIT tagged hatchery Héeyey (steelhead) released from the Little Sheep Creek and Big Sheep Creek acclimation facilities were recaptured at the Imnaha trap. They averaged 212.7 mm in fork length, 105.7 g in weight, and a 1.03 condition factor (Table 4 and Figure 12).

Table 4. Averages, ranges, and standard deviations of fork lengths (mm), weights (g), and condition factors (K) with minimum, maximum, and sample size values for recaptures of previously PIT tagged natural and hatchery Nacó'x̂ (Chinook salmon), and hatchery Héeyey (steelhead) observed during the 2007 migration year, 5 October 2006 to 21 June 2007, at the Imnaha River juvenile migration trap.

Attribute	Statistic	Natural Nacó'x̂ (Chinook salmon)	Hatchery Nacó'x̂ (Chinook salmon)	Hatchery Héeyey (steelhead)
Fork Length (mm)	Sample Size (n)	14	1,735	60
	Average	100.6	121.9	212.7
	Minimum	80	88	159
	Maximum	120	180	388
	Standard Deviation	13.3	11.5	32.8
Weight (g)	Sample Size (n)	14	1,695	57
	Average	13.4	22.3	105.7
	Minimum	6.0	9.1	38.2
	Maximum	21.7	63.7	510.5
	Standard Deviation	5.4	6.3	65.9
Condition Factor (K)	Sample Size (n)	14	1,690	57
	Average	1.25	1.21	1.03
	Minimum	1.07	0.70	0.85
	Maximum	1.42	1.69	1.24
	Standard Deviation	0.11	0.13	0.08

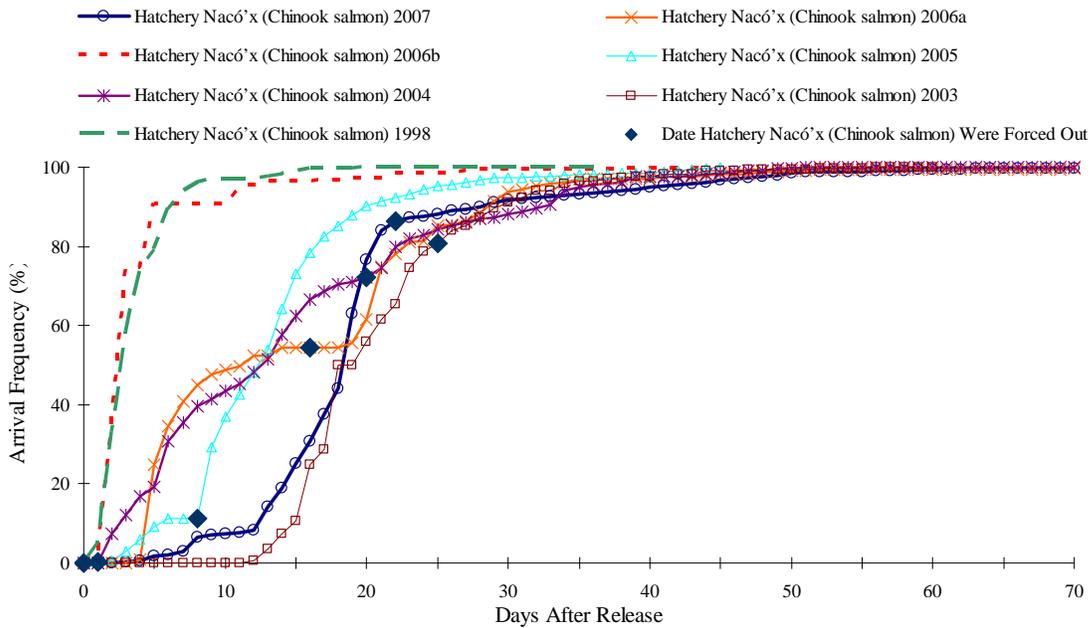


Figure 12. The arrival frequency of previously PIT tagged hatchery Nacó'x (Chinook salmon) captured in the Imnaha River juvenile migration trap during the spring of 1998 and the springs of 2003 to 2007. The release strategy in 1998 and 2006b were direct stream releases. Both releases in 2007 were acclimated volitional releases and have been combined for clarity. All other releases were acclimated volitional releases.

Biological Characteristics

Annual Biological Characteristics

The length frequency distribution of fall tagged natural Nacó'x (Chinook salmon) (defined as pre-smolts within this document) is shown in Figure 13. These fish averaged 83.0 mm in fork length, 6.6 g in weight, and had an average condition factor of 1.10 (Table 5). Natural Nacó'x (Chinook salmon) smolts captured in the spring averaged 99.0 mm, 12.6 g, and a condition factor of 1.2. Hatchery Nacó'x (Chinook salmon) had a larger fork length of 123.0 mm. Hatchery Nacó'x (Chinook salmon) had an average weight of 22.2 g and a condition factor of 1.2. The 123.0 mm median fork length of hatchery Nacó'x (Chinook salmon) was significantly different from the 99 mm median fork length of natural Nacó'x (Chinook salmon) ($p < 0.05$) (Figure 14 and Appendix D).

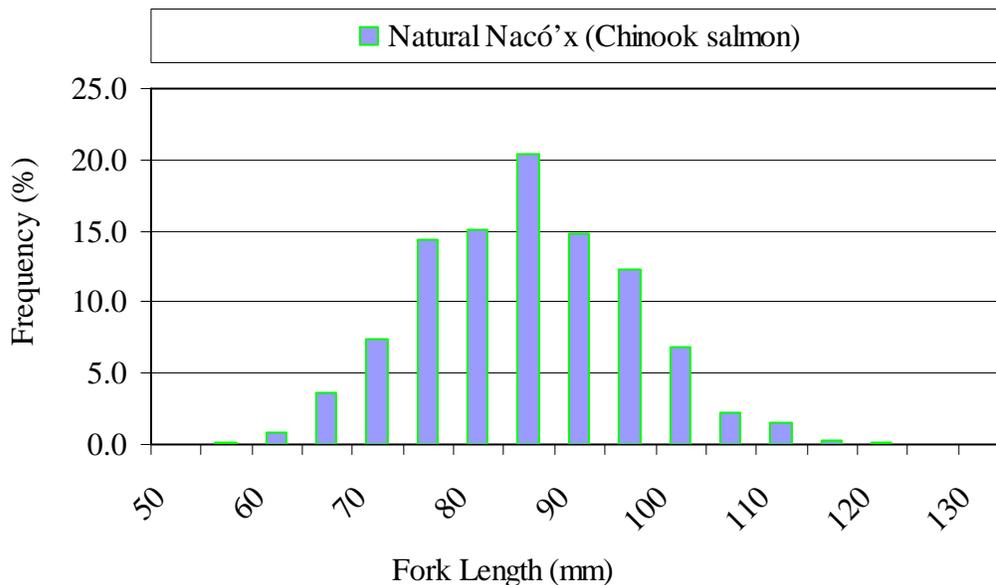


Figure 13. Length frequency distribution of natural Nacó'x (Chinook salmon) pre-smolts trapped in the Imnaha River juvenile migration trap from October 5 to November 21, 2006.

Spring captured natural Héeyey (steelhead) had an average fork length and weight of 169 mm and 53.5 g and a condition factor of 1.1 (Table 5 and Figure 15). Hatchery Héeyey (steelhead) were significantly larger ($p < 0.05$) with an average fork length of 215 mm, weight of 105 g and a condition factor of 1.0 (Table 5, Figure 15 and Appendix D).

Hatchery programs from 1994 to 2007 for the Imnaha River tended to produce significantly larger smolts than in nature. The differences in size should be a concern if differences in downstream survival due to size and adult age structure become apparent.

The weekly trends in the condition factors of captured natural Nacó'x (Chinook salmon) and Héeyey (steelhead) generally increased throughout the spring trapping. There was no detectable trend in either of the hatchery stocks. The highest weekly condition factor of natural Nacó'x (Chinook salmon) (1.31 K) and Héeyey (steelhead) (1.15 K) occurred during the week of June 17, the last week of trapping (Table 6). The mean fork lengths of natural Nacó'x (Chinook salmon) peaked at 106.3 mm with a condition factor of 1.22 K during the week of April 22. The mean fork lengths of natural Héeyey (steelhead) peaked at 189.2 mm with a condition factor of 1.15 K during the week of June 17. The largest weekly mean fork lengths for hatchery Nacó'x (Chinook salmon) (129.6 mm) was measured during the week of March 25. Hatchery Nacó'x (Chinook salmon) averaged from the 118.0 mm to 129.6 mm range for the spring trapping period. Natural Héeyey (steelhead) had weekly mean fork lengths ranging from 141.3 mm to 189.2 mm (Table 6).

Table 5. Sample Size, averages, ranges, and standard deviations of fork lengths (mm), weights (g), and condition factors (K) for natural and hatchery Nacó'x̂ (Chinook salmon) and Héeyey (steelhead) captured during the 2007 migration year, 5 October 2006 to 21 June 2007, at the Imnaha River juvenile migration trap.

Attribute	Statistic	Fall 2006	Spring 2007			
		Natural Nacó'x̂ (Chinook salmon) (Pre-Smolts)	Natural Nacó'x̂ (Chinook salmon) (Smolts)	Hatchery Nacó'x̂ (Chinook salmon)	Natural Héeyey (steelhead)	Hatchery Héeyey (steelhead)
Fork Length (mm)	Sample Size (n)	4,015	7,547	1,084	7,195	2,360
	Average	83	99	123	169	215
	Minimum	48	32	97	84	129
	Maximum	119	158	168	274	310
	Standard Deviation	10.4	11.8	11.2	19.2	23.6
	Weight (g)	Sample Size (n)	3,964	7,537	1,084	7,155
	Average	6.6	12.6	22.2	53.5	105.0
	Minimum	1.4	1.9	9	7.3	27.5
	Maximum	20.2	45.1	51.8	215	374.1
	Standard Deviation	2.5	4.1	6.2	18.5	37.9
Condition Factor (K)	Sample Size (n)	3,960	7,516	1,084	7,144	2,327
	Average	1.1	1.2	1.2	1.1	1.0
	Minimum	0.7	0.7	0.7	0.8	0.7
	Maximum	1.6	1.7	1.6	1.6	1.4
	Standard Deviation	0.1	0.1	0.1	0.1	0.1

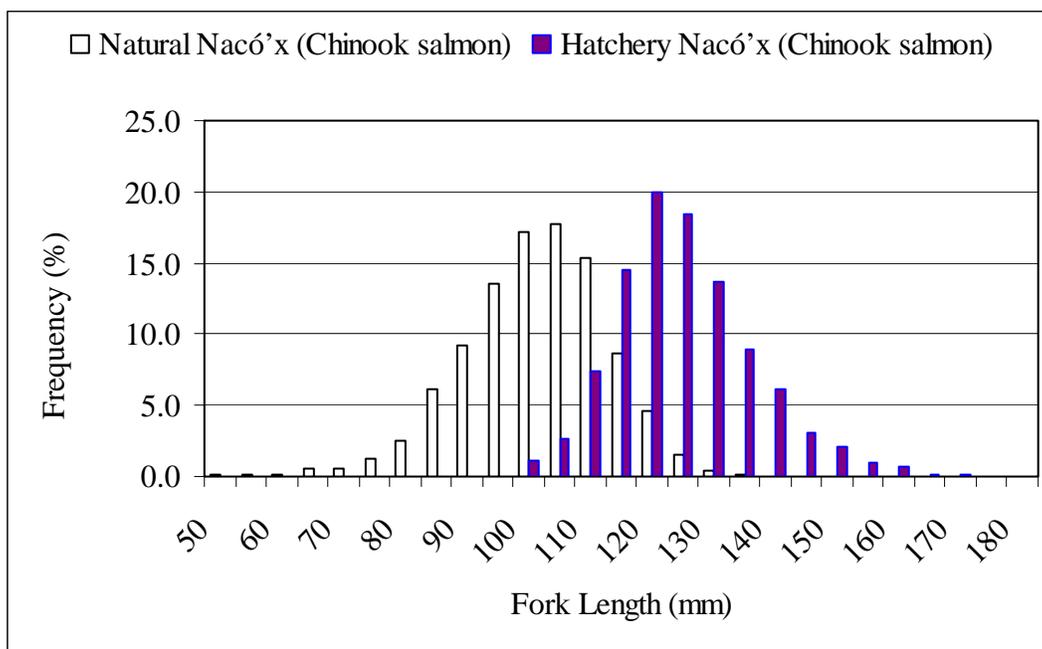


Figure 14. Length frequency distribution of natural and hatchery Nacó'x (Chinook salmon) trapped in the Imnaha River juvenile migration trap, March 1 to June 21, 2007.

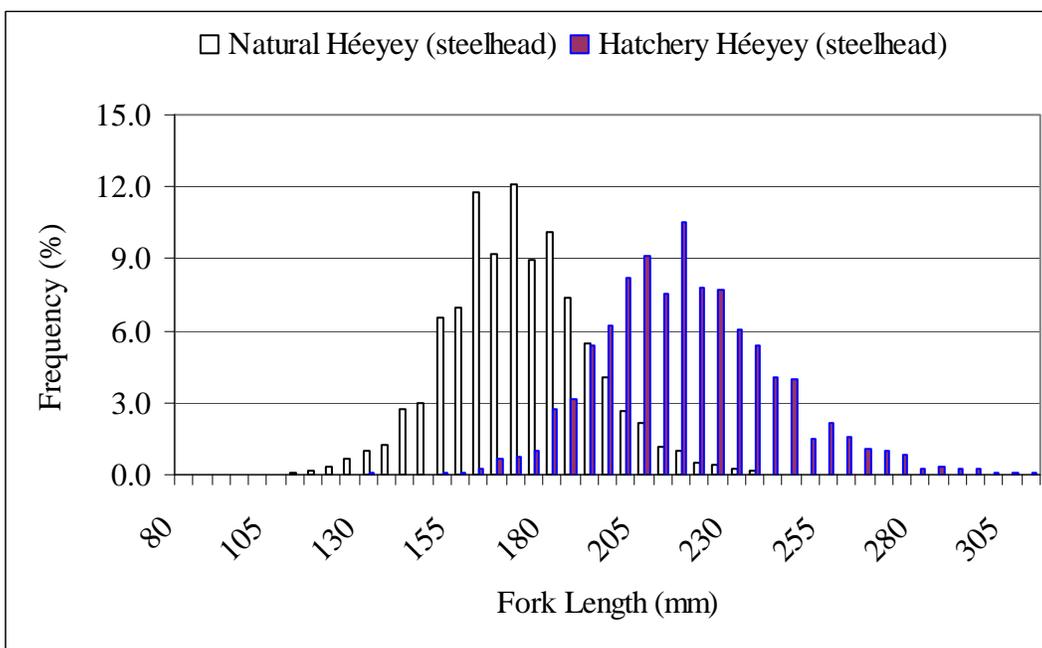


Figure 15. Length frequency distribution of natural and hatchery Héeyey (steelhead) trapped in the Imnaha River juvenile migration trap, March 1 to June 21, 2007.

Table 6. Weekly mean fork lengths (FL) and condition factors (K) for natural and hatchery Nacó'x̂ (Chinook salmon) and Héeyey (steelhead) captured at the Imnaha River juvenile migration trap during the spring of 2007.

Week	Natural Nacó'x̂ (Chinook salmon)		Hatchery Nacó'x̂ (Chinook salmon)		Natural Héeyey (steelhead)		Hatchery Héeyey (steelhead)	
	FL (mm)	K	FL (mm)	K	FL (mm)	K	FL (mm)	K
3/4/07	99.3	1.03						
3/11/07	95.8	1.19			151.1	1.02		
3/18/07	96.1	1.20	125.2	1.19	141.3	1.10	282.0	0.96
3/25/07	97.5	1.21	129.6	1.11	156.8	1.05		
4/1/07	98.9	1.23	126.4	1.17	165.0	1.06		
4/8/07	99.4	1.22	123.6	1.14	166.1	1.06	215.7	1.10
4/15/07	100.2	1.27	122.5	1.13	169.0	1.06	214.8	1.08
4/22/07	106.3	1.22	126.0	1.15	175.8	1.04	223.6	1.04
4/29/07	103.5	1.27	123.4	1.16	172.2	1.09	214.4	1.04
5/6/07	99.7	1.27	118.0	1.22	163.3	1.07	211.4	1.01
5/13/07	99.4	1.29	118.7	1.17	164.1	1.07	209.8	0.97
5/20/07	98.4	1.26	119.5	1.22	170.6	1.07	204.6	1.00
5/27/07	101.9	1.28	120.7	1.23	172.3	1.12	214.5	0.99
6/3/07	94.7	1.26	121.6	1.17	180.0	1.07	214.8	0.99
6/10/07	87.4	1.25	112.0	1.35	175.2	1.12	213.5	1.00
6/17/07	78.8	1.31	122.0	0.95	189.2	1.15	223.5	0.97

Abundance and Survival

Migration Year 2007 Natural Nacó'x̂ (Chinook salmon) and Héeyey (Steelhead) Abundance

Migration year 2007 was our first attempt at developing fall emigration abundance estimates for natural Nacó'x̂ (Chinook salmon) through the use of trap efficiencies. Trap efficiencies for natural Nacó'x̂ (Chinook salmon) ranged from 2.0% to 26.0% through the fall season, and averaged 11.8% (Appendix E). The overall fall emigration abundance estimate for natural Nacó'x̂ (Chinook salmon) smolts was 106,350 with a lower 95% C.I of 72,196 and an upper 95% C.I. of 162,154 (Appendix E). There is no tagging of natural Héeyey (steelhead) in the fall since the sample size is too small to produce an abundance estimate. Trap efficiencies in the spring for natural Nacó'x̂ (Chinook salmon) ranged from 4.4% to 17.6% through the season, and averaged 14.9.0% (Appendix E). The MY 2007 population estimate for natural Nacó'x̂ (Chinook salmon), for the period monitored, totals 172,145 smolts (Appendix E).

Trap efficiencies for natural Héeyey (steelhead) ranged from 14.5% to 21.9% and averaged 17.8%. The overall spring emigration abundance estimate for natural Héeyey (steelhead) smolts was 59,504 with a lower 95% C.I. of 54,695 and an upper 95% C.I. of 65,001 (Appendix F).

These emigration abundance estimates are based on incomplete efficiency trials. An attempt is made to run efficiency calculations continuously while trapping. Migratory year 2007 had few high flow events resulting in very good estimates for fall and spring. However, due to inconsistent recapture rates these estimates are to be considered minimal and not comprehensive and are presented in Appendixes E and F for review.

Post Release Survival of Hatchery Nacó'x̂ (Chinook salmon)

The two combined release groups provided an estimated $396,197 \pm 11,104.6$ (95% C.I.) hatchery Nacó'x̂ (Chinook salmon) which emigrated past the Imnaha River juvenile migration trap during the spring of 2007. The population estimate is based on a post release survival estimate of $91.6\% \pm 2.8\%$ (95% C.I.) from the acclimation facility to the trap. This survival estimate is within the range of previous estimates with the exception of 2006. Past post release survival estimates from the acclimation facility at Gumboot to the Imnaha River juvenile migration trap have ranged from $63.3\% \pm 2.1\%$ (95% C.I.) in 2006 to $100.9\% \pm 14.3\%$ (95% C.I.) in 1994 (Figure 16). The post release survival estimates are useful for evaluating the mortality that occurred within the Imnaha River and comparing that reach specific mortality to other reaches within the Snake and Columbia rivers.

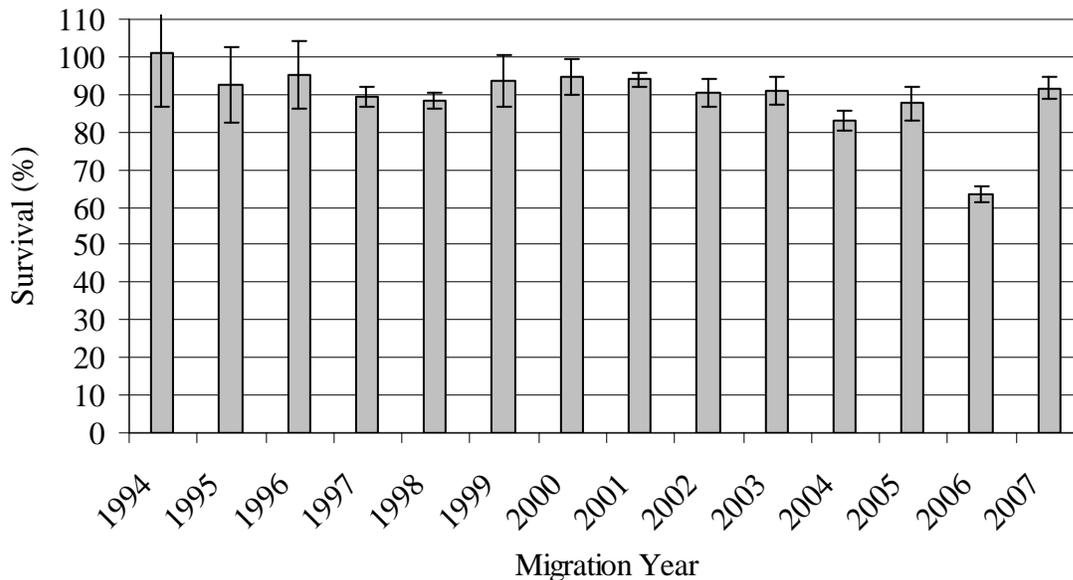


Figure 16. Estimated post release survival of hatchery Nacó'x̂ (Chinook salmon) from the Imnaha River Gumboot acclimation facility to the Imnaha River juvenile migration trap from 1994 to 2007. The error bars indicate the 95% C.I.

Estimated Season Wide Smolt Survival from the Innaha Trap

Trap (fall) to Lower Granite Dam - The survival of fall PIT tagged natural Nacó'x̂ (Chinook salmon) pre-smolts from the Innaha River juvenile migration trap to LGD have been measured for migration years 1994 to 2007. All season wide and weekly survival estimates presented in this and the next section of the report are with 95% confidence intervals in parentheses. The migration year 2007 survival estimate for fall tagged natural Nacó'x̂ (Chinook salmon) pre-smolts from the trap to LGD was 31.8% ($\pm 3.4\%$) (Figure 17). This estimate is within the range of historical estimates from the SMP project. Fall PIT tagged natural Nacó'x̂ (Chinook salmon) survival from the trap to LMD was 26.6% ($\pm 9.3\%$). This survival may be biased due to fall tagged fish migrating through the hydro system while the automated PIT tag readers are off in late fall. The PIT Tag readers at Lower Granite Dam Juvenile detection facility (GRJ) ended on Dec. 16, 2006 and began again on March 25, 2007. Fall PIT tagged natural Nacó'x̂ (Chinook salmon) sample sizes have ranged from 442 (1997) to 6,102 (2005). The historic survival estimates have ranged from 16.5% ($\pm 1.8\%$) for migration year 2006 to 60.4% ($\pm 4.1\%$) for migration year 1998 (Figure 17).

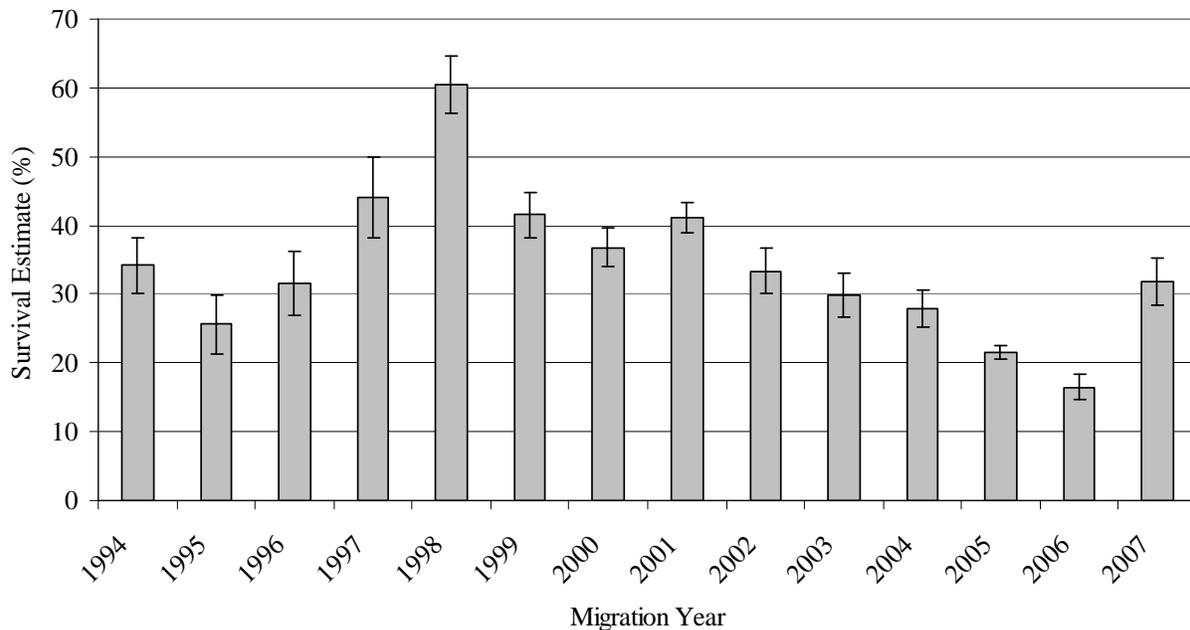


Figure 17. Estimated survival from the Innaha River juvenile migration trap to Lower Granite Dam of natural Nacó'x̂ (Chinook salmon) tagged in the fall, for migration years 1994 to 2007. Error bars indicate the 95% C.I.

Trap (spring) to Lower Granite Dam - The estimated survival of natural Nacó'x̂ (Chinook salmon) smolts, PIT tagged in the spring, from the juvenile migration trap to LGD in 2007 was 77.5% ($\pm 2.7\%$) (Table 7 and Table 8). The hatchery Nacó'x̂ (Chinook salmon), captured and released at the Innaha River juvenile migration trap had an estimated survival of 70.5% (\pm

4.7%) to LGD. The estimated survival of natural and hatchery Héeyey (steelhead) from the trap to LGD was 78.8% (\pm 4.4%), and 94.9% (\pm 9.6%), respectively. Natural Nacó'x̂ (Chinook salmon) survival from the trap to LGD (1993 to 2007) has ranged from 73.4% in 2004 to 90.9% in 1995. Natural Héeyey (steelhead) estimated survival is the lowest of all estimates from 1995 to 2007; however, it is still within historic ranges considering confidence intervals. Natural Héeyey (steelhead) survival estimates have historically ranged from 79.0% in 2004 to 90.1% in 1997. The estimated survival from release at the Imnaha trap to LGD for hatchery Héeyey (steelhead) was highest on record.

Trap (spring) to Lower Monumental Dam - Estimated survival from the Imnaha River juvenile migration trap to LMD in 2007 was as follows: natural Nacó'x̂ (Chinook salmon) was 70.5% (\pm 6.9%), hatchery Nacó'x̂ (Chinook salmon) was 68.2% (\pm 12%), natural Héeyey (steelhead) was 60.3% (\pm 9.9%), and hatchery Héeyey (steelhead) was 86.2% (\pm 16.5%). The estimated survival for natural Nacó'x̂ (Chinook salmon) from the trap to LMD was within the historic recorded range. Previous survival estimates for natural Nacó'x̂ (Chinook salmon) from the trap to LMD ranged from 53.0% in 2004 to 78.3% in 1999 (Table 9).

Table 7. Estimated survival probabilities for PIT tag release groups of natural and hatchery Nacó'x̂ (Chinook salmon) and Héeyey (steelhead) smolts released from the Imnaha River juvenile migration trap from March 1 to June 21, 2007. Estimates are from release at the trap to Lower Granite Dam and tail race to tail race for all other sites. Abbreviations: LGD -Lower Granite Dam, LGS - Little Goose Dam, LMD - Lower Monumental Dam, MCD – McNary Dam.

Release Group	Trap to	LGD to	LGS to	LMD to	Trap to	Trap to
Number Released	LGD (%)	LGS (%)	LMD (%)	MCD (%)	LMD (%)	MCD (%)
	(95%) C.I.	(95%) C.I.	(95%) C.I.	(95%) C.I.	(95%) C.I.	(95%) C.I.
Natural Nacó'x̂ (Chinook salmon)						
7523	77.5 (2.7)	91.1 (6.0)	100.0 (11.3)	91.4 (10.2)	70.5 (6.9)	64.5 (3.4)
Hatchery Nacó'x̂ (Chinook salmon)						
2983	70.5 (4.7)	99.4 (12.8)	97.3 (20.6)	96.9 (20.2)	68.2 (12.2)	66.1 (6.2)
Natural Héeyey (steelhead)						
7199	78.8 (4.4)	90.7 (8.9)	84.4 (15.5)	100.1 (27.3)	60.3 (9.9)	60.3 (12.4)
Hatchery Héeyey (steelhead)						
1492	94.9 (9.6)	87.2 (12.1)	104.3 (21.8)	92.3 (42.5)	86.2 (16.5)	79.5 (33.2)

Table 8. Spring estimates of survival from the Imnaha River juvenile migration trap to Lower Granite Dam from 1993 to 2007. Ninety-five percent confidence intervals are shown in parentheses.

Migration Year	Natural Nacó'x̂ (Chinook salmon) (%)		Hatchery Nacó'x̂ (Chinook salmon) (%) ¹		Natural Héeyey (steelhead) (%)		Hatchery Héeyey (steelhead) (%)	
1993	80.9	(11.8)						
1994	76.2	(5.3)	67.1	(10.2)				
1995	90.9	(6.7)	72.1	(6.3)	83.7	(7.1)	77.5	(3.1)
1996	81.2	(5.3)	71.4	(9.4)	86.5	(3.9)	64.6	(4.7)
1997	89.5	(12.9)	80.4	(8.0)	90.1	(3.9)	81.4	(2.0)
1998	85.2	(2.0)	75.7	(3.1)	86.0	(2.2)	82.9	(2.3)
1999	88.5	(2.0)	71.6	(4.7)	87.7	(3.1)	85.4	(2.0)
2000	84.8	(2.3)	74.4	(4.3)	84.4	(2.7)	85.8	(2.4)
2001	83.7	(0.8)	80.3	(1.6)	82.7	(1.4)	82.0	(1.6)
2002	86.9	(4.4)	77.3	(4.4)	83.0	(5.4)	81.8	(3.5)
2003	75.9	(2.3)	72.4	(6.8)	82.0	(2.5)	89.4	(3.3)
2004	73.4	(1.2)	74.0	(2.6)	79.0	(1.2)	85.9	(1.3)
2005	73.9	(1.7)	60.8	(3.7)	80.8	(1.4)	82.8	(1.2)
2006	76.7	(8.2)	68.7	(5.0)	91.9	(5.1)	86.1	(3.8)
2007	77.5	(2.7)	70.5	(4.7)	78.8	(4.4)	94.9	(9.6)

¹ Hatchery Nacó'x̂ (Chinook salmon) estimates based on the re-release of captured PIT tagged fish originating from the Nacó'x̂ (Chinook salmon) Gumboot acclimation facility on the Imnaha River.

Table 9. Season-wide estimates of survival from the Imnaha River juvenile migration trap to Lower Monumental Dam from 1997 to 2007. Ninety-five percent confidence intervals are shown in parentheses.

Migration Year	Natural Nacó'x̂ (Chinook salmon) (%)		Hatchery Nacó'x̂ (Chinook salmon) (%) ¹		Natural Héeyey (steelhead) (%)		Hatchery Héeyey (steelhead) (%)	
1997					73.0	(12.0)	64.0	(6.5)
1998	75.3	(4.7)	64.5	(6.7)	67.0	(5.7)	63.2	(4.9)
1999	78.3	(2.4)	61.1	(5.9)	75.1	(4.6)	73.9	(3.3)
2000	73.2	(4.3)	54.9	(7.5)	50.9	(4.7)	57.8	(7.8)
2001	65.6	(1.3)	69.0	(2.5)	49.2	(3.5)	42.8	(6.0)
2002	76.8	(4.5)	68.1	(4.2)	69.9	(4.5)	78.0	(8.4)
2003	60.0	(4.3)	61.5	(20.4)	68.1	(4.8)	82.1	(5.5)
2004	53.0	(2.9)	54.2	(5.1)	62.0	(8.1)	62.0	(6.0)
2005	63.0	(5.2)	47.7	(9.2)	55.1	(3.5)	64.1	(3.3)
2006	63.9	(10.5)	48.4	(2.4)	72.0	(8.2)	73.6	(6.3)
2007	70.5	(6.9)	68.2	(12.0)	60.3	(9.9)	86.2	(16.5)

¹ Hatchery Nacó'x̂ (Chinook salmon) estimates based on the re-release of captured PIT tagged fish originating from the Nacó'x̂ (Chinook salmon) Gumboot acclimation facility on the Imnaha River.

Table 10. Season-wide estimates of survival from the Imnaha River juvenile migration trap to McNary Dam from 1998 to 2007. Ninety-five percent confidence intervals are shown in parentheses.

Migration Year	Natural Nacó'x̂ (Chinook salmon) (%)		Hatchery Nacó'x̂ (Chinook salmon) (%) ¹		Natural Héeyey (steelhead) (%)		Hatchery Héeyey (steelhead) (%)	
1998	78.7	(6.8)	54.3	(8.0)	64.0	(10.1)	63.8	(10.5)
1999	68.5	(4.3)	53.8	(9.8)	71.6	(12.0)	58.8	(7.6)
2000	67.9	(6.3)	54.1	(9.7)	49.9	(12.2)	40.2	(12.5)
2001	47.4	(1.5)	52.1	(5.3)	18.4	(3.1)	13.9	(3.9)
2002	61.9	(5.3)	56.0	(5.6)	37.0	(4.8)	48.7	(13.2)
2003	57.1	(5.6)	49.0	(11.8)	42.0	(5.6)	63.0	(14.5)
2004	52.7	(5.1)	44.8	(4.06)	47.4	(25.3)	29.4	(11.2)
2005	53.9	(7.8)	65.8	(30.8)	41.6	(8.7)	44.7	(7.4)
2006	76.3	(24.6)	44.5	(3.5)	61.8	(16.2)	64.2	(13.5)
2007	64.5	(3.4)	66.1	(6.2)	60.3	(12.4)	79.5	(33.2)

¹Hatchery Nacó'x̂ (Chinook salmon) estimates based on the re-release of captured PIT tagged fish originating from the Nacó'x̂ (Chinook salmon) Gumboot acclimation facility on the Imnaha River.

The 2007 survival estimates for all species monitored from release to LMD were well within historic estimates and may have benefited by the lower than average discharge in the Snake and Imnaha Rivers. Previous survival estimates for hatchery Nacó'x̂ (Chinook salmon) from release to LMD have ranged from 47.7% in 2005 to 69.0% in 2001. Natural Héeyey (steelhead) survival from release to LMD has ranged from 49.2% in 2001 to 75.1% in 1999. Hatchery Héeyey (steelhead) survival from release to LMD has ranged from 42.8% in 2001 to 82.1% in 2003 (Table 9).

Trap (spring) to Lower Monumental Dam - Survival estimates for natural Nacó'x̂ (Chinook salmon), natural Héeyey (steelhead) and hatchery Héeyey (steelhead) from the Imnaha trap to MCD were within the range of estimates from 1998 to 2006 (Table 10). Low sample sizes and/or low recapture rates at the various facilities restricted our ability to provide estimates with small confidence limits. Natural Nacó'x̂ (Chinook salmon) survival from the trap to MCD has ranged from 47.4% during the drought year of 2001 to 78.7% in 1998. Natural Héeyey (steelhead) survival from release to MCD has ranged from 18.4% in 2001 to 71.6% in 1999. Hatchery Héeyey (steelhead) survival from release to MCD has ranged from 13.9% in 2001 to 79.5% in 2007. The lowest estimates of survival for natural and hatchery Héeyey (steelhead) from release to MCD, like natural Nacó'x̂ (Chinook salmon), occurred during the drought year of 2001. Hatchery Nacó'x̂ (Chinook salmon) survival from the Imnaha trap to MCD for MY 2007 was the highest recorded (66.1%, ± 6.2%). Hatchery Nacó'x̂ (Chinook salmon) survival from the Imnaha trap to MCD has historically ranged from 49.0% in 2003 to 65.8% in 2005.

Estimated Weekly Smolt Survival

Weekly release groups of more than 300 fish resulted in a fall estimate from the trap to LGD for natural Nacó'x̂ (Chinook salmon) ranging from 41.6% (\pm 81.6%) released during the week of November 5 to 21.6% (\pm 42.3%) during the week of October 22. The spring estimate for natural Nacó'x̂ (Chinook salmon) ranged from 107.2% (\pm 26.1%) released during the week of May 13 to 33.1% (\pm 22.0%) during the week of June 3 (Table 11). Weekly estimates of survival from the trap to LGD for natural Héeyey (steelhead) ranged from 93.8% (\pm 9.1%) during the week of April 29 to 72.2% (\pm 10.6%) during the week of May 13 (Table 11). The use of this data should be limited due to the wide confidence intervals.

Smolt to Adult Return Rates

Adult detections from fall survival mode PIT tagged Nacó'x̂ (Chinook salmon) from migration years 1998 through 2004 were 42, 35, 42, 9, 22, 8 and 8, respectively (Table 12). The total number adults detected at LGD for spring survival mode PIT tagged Nacó'x̂ (Chinook salmon) from migration years 1998 through 2004 were 59, 105, 98, 41, 25, 11 and 10 fish, respectively. These adult PIT tag detections at LGD are utilized in SARs for both the Imnaha River to LGD and the LGD to LGD calculations.

Fall survival mode tagged natural Nacó'x̂ (Chinook salmon) had a consistent survival advantage from the Imnaha River to LGD SAR index for five out of seven migration years examined when compared to spring survival mode tagged Nacó'x̂ (Chinook salmon) (Table 12). The last two years are the exception. The Imnaha to LGD SAR index for fall survival mode tagged Nacó'x̂ (Chinook salmon) ranges from 0.23% to 1.22%. The Imnaha to LGD SAR index for spring survival mode tagged Nacó'x̂ (Chinook salmon) ranges from 0.21% to 2.58%.

Fall survival mode tagged natural Nacó'x̂ (Chinook salmon) experienced significantly higher (1-3%) LGD to LGD SAR index for six out of seven migration years examined when compared to spring survival mode tagged Nacó'x̂ (Chinook salmon) with the exception of MY 2001. Migratory year 2001 was an extremely low water year that resulted in low smolt survivals for both fall and spring (Table 12). The LGD to LGD SAR index for fall survival mode tagged Nacó'x̂ (Chinook salmon) ranged from 1.10% to 6.03%. The LGD to LGD SAR index for spring survival mode tagged Nacó'x̂ (Chinook salmon) ranged from 0.27% to 3.08% for the same migration years.

Table 11. Estimated survival probabilities for weekly PIT tag release groups of 300 or more natural Nacó'x̂ (Chinook salmon) and natural Héeyey (steelhead) smolts released from the Imnaha River juvenile migration trap from October 15 to November 25 and March 18 to June 9, with 95% confidence intervals in parentheses. Estimates are from release at the trap to Lower Granite Dam and Lower Monumental Dam and tailrace to tailrace for all other sites. Abbreviations: LGD - Lower Granite Dam, LGS - Little Goose Dam, LMD - Lower Monumental Dam. N/A indicates the estimate failed due to low recapture rates at dam sites.

Week of Release	Number Released	Estimated Survival							
		Trap to LGD % (95% C.I.)		LGD to LGS % (95% C.I.)		LGS to LMD % (95% C.I.)		Trap to LMD % (95% C.I.)	
Natural Nacó'x̂ (Chinook Salmon) (Fall 2006)									
15-Oct	491	41.0	(80.4)	56.5	(41.1)	57.1	(25.9)	13.2	(3.1)
22-Oct	622	21.6	(42.3)	108.8	(62.4)	43.8	(24.3)	10.3	(2.5)
5-Nov	871	41.6	(81.6)	80.24	(26.4)	204.2	(242.1)	68.2	(78.7)
12-Nov	1082	32.0	(62.6)	78.9	(21.1)	85.91	(40.3)	21.7	(9.3)
19-Nov	550	28.6	(56.0)	99.4	(38.6)	137.3	(194.7)	39.0	(53.5)
Natural Nacó'x̂ (Chinook Salmon) (Spring 2007)									
18-Mar	560	75.6	(7.9)	101.4	(18.8)	140.0	(83.5)	107.3	(61.5)
25-Mar	635	82.7	(9.2)	91.9	(20.5)	122.5	(120.3)	93.1	(89.3)
1-Apr	463	82.1	(9.9)	103.4	(27.6)	75.5	(24.9)	64.2	(13.1)
8-Apr	771	87.1	(8.2)	96.2	(19.0)	108.1	(38.2)	90.5	(27.0)
15-Apr	875	83.4	(7.8)	96.0	(16.3)	96.7	(23.1)	77.5	(14.7)
22-Apr	905	89.6	(6.8)	88.7	(15.2)	108.7	(33.3)	86.4	(23.3)
29-Apr	823	90.1	(7.7)	76.1	(10.9)	122.4	(28.2)	83.9	(17.9)
6-May	473	87.2	(8.8)	94.1	(23.7)	70.8	(24.9)	58.1	(14.9)
13-May	318	107.2	(26.1)	63.7	(30.5)	108.0	(111.2)	73.7	(69.3)
27-May	451	64.0	(40.0)	82.4	(66.6)	N/A	N/A	N/A	N/A
3-Jun	517	33.1	(22.0)	128.2	(118.7)	N/A	N/A	N/A	N/A

Week of Release	Number Released	Estimated Survival							
		Trap to LGD % (95% C.I.)		LGD to LGS % (95% C.I.)		LGS to LMD % (95% C.I.)		Trap to LMD % (95% C.I.)	
Natural Héeyey (Steelhead) (Spring 2007)									
22-Apr	701	91.0	(18.2)	91.2	(25.4)	68.2	(26.1)	56.6	(18.3)
29-Apr	1,550	93.8	(9.1)	86.8	(14.6)	111.2	(34.2)	90.6	(25.1)
6-May	1,497	88.6	(7.6)	90.9	(16.0)	84.7	(28.6)	68.2	(20.1)
13-May	1,376	72.2	(10.6)	101.5	(31.4)	66.2	(41.7)	48.4	(27.1)
20-May	695	76.4	(20.7)	83.3	(39.2)	N/A	N/A	N/A	N/A
3-Jun	566	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 12. Smolt to adult return rate indices (SARs) from Imnaha River to LGD and LGD to LGD of PIT tagged Imnaha River natural Nacó'x (Chinook salmon) for migration years 1998 to 2004. In-river migrating fish were tagged at the Imnaha River juvenile migration trap and designated as survival mode smolts. Migration year includes fall of one year and spring of the next (i.e. Migration Year 1998 is fall of 1997 and spring of 1998).

Migration Year and Season Tagged	Number PIT Survival Tagged	Estimated Survival Smolts at LGD	Number of Survival Adult Detections at LGD	Age at Return			SAR Imnaha to LGD (%)	SAR LGD to LGD (%)
				III	IV	V		
Fall								
1998	3,429	871	42	9	24	9	1.22	4.82
1999	3,981	841	35	3	29	3	0.88	4.16
2000	3,927	697	42	2	23	17	1.07	6.03
2001	3,862	821	9	0	7	2	0.23	1.10
2002	3,211	659	22	4	17	1	0.69	3.34
2003	2,045	596	8	0	6	2	0.39	1.34
2004	1,188	346	8	0	6	2	0.67	2.31
Spring								
1998	3,913	3,392	59	3	41	15	1.51	1.74
1999	5,219	4,609	105	8	69	28	2.01	2.28
2000	3,798	3,187	98	3	56	39	2.58	3.08
2001	9,996	1,884	41	1	32	8	0.41	2.18
2002	2,297	2,009	25	6	17	2	1.09	1.24
2003	5,300	4,032	11	1	8	2	0.21	0.27
2004	3,208	2,407	10	0	9	1	0.31	0.42

It is interesting to note that in the spring of 2008 there was a single six year old Nacó'x̂ (natural Chinook) returning to the Imnaha River. This individual was tagged at the Imnaha trap in the spring of MY 2004 and is the first documented returning six-year-old pit tagged by this project. This individual was tagged as a SbyC smolt and was subject to transportation schedules and therefore is not included in the SAR calculations. There is a history in the Imnaha Basin of large Nacó'x̂ (natural Chinook) that have survived four years in the ocean.

Arrival Timing at Dams

Natural and Hatchery Nacó'x̂ (Chinook salmon) Arrival Timing for 2007

Arrival timing is calculated from all, both survival and monitor mode, smolts tagged at the Imnaha Trap. Fall tagged pre-smolt natural Nacó'x̂ (Chinook salmon) had statistically significant earlier median and cumulative arrival timing at LGD than spring tagged natural Nacó'x̂ (Chinook salmon) smolts ($p < 0.05$). Statistical tests results are presented in Appendix G. The April 14 median arrival date for fall tagged Nacó'x̂ (Chinook salmon) was earlier than the May 3 median arrival date for spring tagged Nacó'x̂ (Chinook salmon) ($p < 0.05$).

Fall tagged natural Nacó'x̂ (Chinook salmon) arrived at LGD in 2007 from March 25 to May 6, median arrival on April 14 and a 90% arrival timing of April 22. Arrival at the remaining dams occurred during the following times: April 8 to May 13 at LGS, April 17 to May 6 at LMD, and April 18 to May 12 at MCD. Median arrivals occurred April 19, May 1, and April 29 at LGS, LMD, and MCD, respectively. Ninety percent arrival occurred on the following dates: May 1 at LGS, May 6 at LMD, and May 5 at MCD (Appendix H).

Spring tagged natural Nacó'x̂ (Chinook salmon) smolts arrived at LGD from March 29 to July 6, median arrival on May 3, and had a 90% arrival time of May 20 (Appendix I). Arrival at LGS, LMD, and MCD occurred from April 7 to Sept. 5, April 16 to July 7, and April 21 to July 22, respectively. Median arrival timing at these three dams was as follows: May 5 at LGS, May 7 at LMD, and May 9 at MCD. The 90% arrival time at LGS was June 4, May 20 at LMD, and June 9 at MCD.

Previously PIT tagged hatchery Nacó'x̂ (Chinook salmon) smolts recaptured at the Imnaha River juvenile migration trap had the following arrival times at the four dams in 2007: April 13 to Aug. 17 at LGD, April 15 to May 29 at LGS, April 21 to May 30 at LMD, and April 24 to Aug. 13 at MCD (Appendix J). Median arrival timing occurred May 3 at LGD, May 4 at LGS, May 5 at LMD and May 9 at MCD. Ninety percent arrival timing occurred May 11 at LGD, May 14 at LGS, May 15 at LMD and May 17 at MCD.

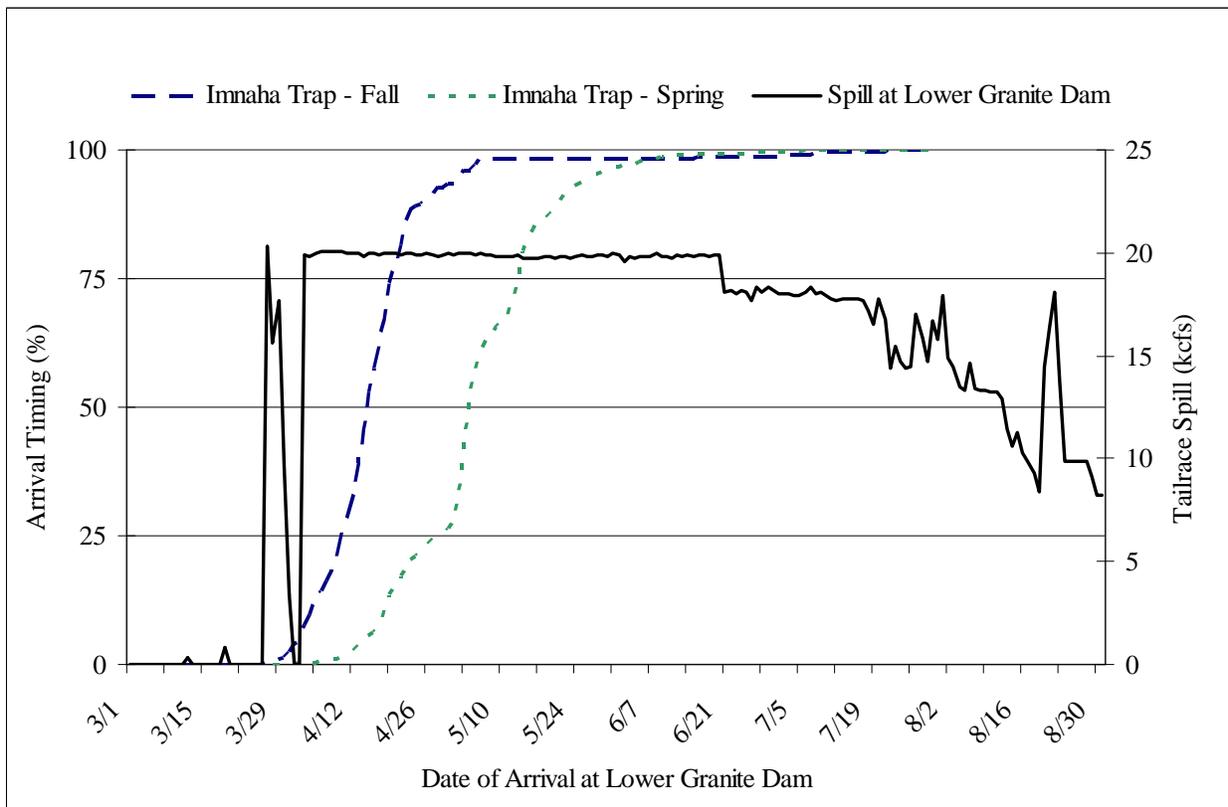


Figure 18. The cumulative arrival timing of all fall and spring tagged natural Nacó'x̂ (Chinook salmon) and tailrace spill at Lower Granite Dam during the 2007 migration year. Fall and spring tagged natural Nacó'x̂ (Chinook salmon) were released in the fall of 2006 and the spring of 2007.

Natural and Hatchery Héeyey (Steelhead) Arrival Timing for MY 2007

Natural Héeyey (steelhead) arrived at LGD, LGS, LMD, and MCD from March 31 to June 18, April 1 to Aug. 8, April 2 to July 12, and April 6 to June 6 (Appendix K). Median arrival timing occurred May 12 at LGS, May 14 at LGS, May 14 at LMD, and May 6 at MCD. The 90% arriving timing occurred on May 25 at LGD, June 4 at LGS, May 23 at LMD, and May 6 at MCD.

Hatchery Héeyey (steelhead) had the following range of arrival times: April 16 to June 6 at LGD, April 20 to June 9 at LGS, May 2 to June 2 at LMD, and April 28 to June 18 at MCD (Appendix L). Median arrival times for hatchery Héeyey (steelhead) migrating in 2007 were May 12 at LGD, May 12 at LGS, May 14 at LMD, and May 17 at MCD. Ninety percent arrival times are as follows: May 20 at LGD, May 21 at LGS, May 22 at LMD, May 29 and MCD.

Average Arrival Timing

This project has collected 10 to 16 years of arrival timing data for all tagged natural and hatchery Nacó'x̂ (Chinook salmon) and Héeyey (steelhead) from the Imnaha River. The annual first, median, 90%, and last arrival times from all years were averaged (Table 13). The mean arrival timing range for fall tagged natural Nacó'x̂ (Chinook salmon) pre-smolts from 1998 to 2007 at LGD is from March 29 (± 7 days) to May 14 (± 19 days), with mean median and 90% arrival timing of April 16 (± 8 days) and April 26 (± 7 days), respectively. Mean median arrival times at LGS, LMD, and MCD for fall tagged natural Nacó'x̂ (Chinook salmon) are April 23 (± 10 days), April 24 (± 12 days), and April 29 (± 10 days), respectively. Mean 90% arrival timing for fall tagged natural Nacó'x̂ (Chinook salmon) was May 2 (± 11 days) at LGS, May 2 (± 14 days) at LMD, and May 6 (± 10 days) at MCD.

Spring tagged natural Nacó'x̂ (Chinook salmon) smolt mean arrival times at LGD from 1993 to 2007 are as follows: mean arrival time range of April 3 (± 14 days) to July 4 (± 44 days), mean median arrival time of April 28 (± 8 days), and mean 90% arrival of May 16 (± 14 days). Mean median arrival times at LGS, LMD, and MCD for natural Nacó'x̂ (Chinook salmon) smolts are May 1 (± 9 days), May 4 (± 14 days), and May 8 (± 11 days). Mean 90% arrival timing is May 19 (± 16 days) at LGS, May 21 (± 14 days) at LMD, and May 25 (± 23 days) at MCD (Table 13).

Hatchery Nacó'x̂ (Chinook salmon) smolt mean arrival times at LGD from 1992 to 2007 are as follows: mean arrival time range of April 10 (± 14 days) to June 1 (± 44 days), mean median arrival time of May 3 (± 9 days), and mean 90% arrival of May 12 (± 7 days). Mean median arrival times at LGS, LMD, and MCD for hatchery Nacó'x̂ (Chinook salmon) smolts are May 7 (± 9 days), May 11 (± 7 days), and May 13 (± 8 days). Mean 90% arrival timing is May 16 (± 9 days) at LGS, May 20 (± 8 days) at LMD, and May 21 (± 6 days) at MCD (Table 13).

Natural Héeyey (steelhead) have a 14-year mean arrival date range of April 11 (± 26 days) to July 8 (± 55 days) at LGD. The mean arrival date range for LGS, LMD, and MCD is as follows: April 15 (± 24 days) to July 9 (± 49 days) at LGS, April 20 (± 25 days) to July 5 (± 69 days) at LMD, and April 24 (± 26 days) to June 18 (± 39 days) at MCD. The 14-year median arrival time at LGD, LGS, LMD, and MCD is as follows: May 10 (± 12 days) at LGD, May 13 (± 11 days) at LGS, May 16 (± 14 days) at LMD, and May 16 (± 14 days) at MCD. The mean 90% arrival timing for natural Héeyey (steelhead) is as follows: May 26 (± 16 days) at LGD, May 27 (± 13 days) at LGS, June 2 (± 32 days) at LMD, and May 27 (± 15 days) at MCD (Table 13).

Table 13. Averaged mean first, median, 90%, and last arrival timing for all fall and spring tagged natural Nacó'x̂ (Chinook salmon) juveniles, hatchery Nacó'x̂ (Chinook salmon) smolts, and natural and hatchery Héeyey (steelhead) smolts, at Lower Granite Dam (LGD), Little Goose Dam (LGS), Lower Monumental Dam (LMD) and McNary Dam (MCD). All fish were captured in the Imnaha River juvenile migration trap. Mean arrival timing is presented with the 95% C.I. ± days.

Rearing, Species, Life Stage, Dam	First Arrival		Median Arrival		90% Arrival		Last Arrival	
	Mean	± days	Mean	± days	Mean	± days	Mean	± days
Fall Tagged Natural Nacó'x̂ (Chinook salmon) Pre-Smolts (1998 to 2007) ¹								
LGD	Mar-29	7	Apr-16	8	Apr-26	7	May-14	19
LGS	Apr-11	11	Apr-23	10	May-02	11	May-19	27
LMD	Apr-17	15	Apr-24	12	May-02	14	May-20	24
MCD	Apr-19	16	Apr-29	10	May-06	10	May-20	24
Spring Tagged Natural Nacó'x̂ (Chinook salmon) Smolts (1993 to 2007)								
LGD	Apr-03	14	Apr-28	8	May-16	14	Jul-04	44
LGS	Apr-13	11	May-01	9	May-19	16	Jul-08	59
LMD	Apr-17	15	May-04	14	May-21	14	Jul-02	46
MCD	Apr-22	11	May-08	11	May-25	23	Jun-25	40
Hatchery Nacó'x̂ (Chinook salmon) Smolts (1992 to 2007)								
LGD	Apr-10	14	May-03	9	May-12	7	Jun-01	44
LGS	Apr-18	12	May-07	9	May-16	9	Jun-02	17
LMD	Apr-22	12	May-11	7	May-20	8	Jun-03	14
MCD	Apr-26	13	May-13	8	May-21	6	Jun-10	40
Natural Héeyey (steelhead) Smolts (1993 to 2007) ²								
LGD	Apr-11	26	May-10	12	May-26	16	Jul-08	55
LGS	Apr-15	24	May-13	11	May-27	13	Jul-09	49
LMD	Apr-20	25	May-16	14	Jun-02	32	Jul-05	69
MCD	Apr-24	26	May-16	14	May-27	15	Jun-18	39
Hatchery Héeyey (steelhead) Smolts (1993 to 2007) ²								
LGD	Apr-21	16	May-18	14	Jun-04	33	Jul-16	63
LGS	Apr-24	16	May-22	14	Jun-12	33	Jul-25	83
LMD	Apr-29	17	May-26	20	Jun-13	36	Jul-24	87
MCD	May-05	19	May-29	25	Jun-13	35	Jul-03	41

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

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

The 14-year mean range of arrival for hatchery Héeyey (steelhead) at LGD is April 21 (\pm 16 days) to July 16 (\pm 63 days). Downstream mean arrival ranges for hatchery Héeyey (steelhead) are as follows: April 24 (\pm 16 days) to July 25 (\pm 83 days) at LGS, April 29 (\pm 17 days) to July 24 (\pm 87 days) at LMD, and May 5 (\pm 19 days) to July 3 (\pm 41 days) at MCD. The fourteen-year median arrival time at LGD, LGS, LMD, and MCD is as follows: May 18 (\pm 14 days), May 22 (\pm 14 days), May 26 (\pm 20 days), and May 29 (\pm 25 days), respectively. Mean 90% arrival occurred on June 4 (\pm 33 days) at LGD, June 12 (\pm 33 days) at LGS, June 13 (\pm 36 days) at LMD, and June 13 (\pm 35 days) at MCD.

One aspect of median arrival times is that on occasion dams further downstream will have an earlier arrival time than those upstream. Median arrival times are highly influenced by flow conditions and detection probabilities at each dam. Throughout the migration season, there are variable detection probabilities at each dam. Early in the monitoring season dams will have a lower detection probability due to high spring flow. As the migration season progresses the detection probabilities will increase as the flows decrease. In examining the SURPH output there is a significant number of smolts undetected until McNary dam. These smolts have passed through the upper three dams undetected due to low detection probabilities.

Travel Time to Lower Granite Dam

Another aspect of arrival timing is Travel Time. Median travel time reflects the time (in days) that it takes groups of smolts to travel from the Imnaha Trap to Lower Granite Dam. Weekly comparison of median travel times between natural and hatchery stocks are limited to weeks that had more than 30 interrogations per category (Table 14). Weekly comparisons for Nacó'x̂ (Chinook salmon) occur for four weeks between April 22 and May 13. Natural Nacó'x̂ (Chinook salmon) weekly median travel times to LGD ranged from almost 14 days during the week of April 22 to 7.4 days during the week of May 13. Hatchery Nacó'x̂ (Chinook salmon) weekly median travel times to LGD ranged from almost 24.8 days during the week of April 22 to 43.7 days during the week of May 13. Natural Nacó'x̂ (Chinook salmon) median travel times ranged from 11 to 25 days shorter than hatchery Nacó'x̂ (Chinook salmon) released in the same week.

Weekly comparisons for Héeyey (steelhead) occur for a four-week period between April 29 and May 20. Natural Héeyey (steelhead) weekly median travel times to LGD ranged from 3.2 to 3.7 days through the four weeks (Table 14). Hatchery Héeyey (steelhead) travel times during this period ranged from 3.2 days (May 13) to 7.9 days (April 29). On average natural Héeyey (steelhead) median travel times are two days earlier than hatchery stocks during the same week. Median travel times to LGD for Nacó'x̂ (Chinook salmon) decreased with an increase in the calendar date. There was no observed similar trend in the Héeyey (steelhead) stocks. The relationship between the decrease in travel times and increase in calendar date has been previously described (Berggren and Filardo 1993) and is probably due to increased river discharge and smoltification (Groot et al. 1995).

Table 14. A comparison of median travel times of natural and hatchery Nacó'x̂ (Chinook salmon) and Héeyey (steelhead) smolts released from the Imnaha River screw trap, and observed at Lower Granite Dam for the weeks of April 22 to May 13 and April 29 to May 20, 2007.

Species	Observation Week	Number Interrogated		Median Travel Time (Days)	
		Hatchery	Natural	Hatchery	Natural
Nacó'x̂ (Chinook salmon) Smolts					
	4/22/2007	93	122	24.8	13.9
	4/29/2007	696	677	32.2	9.0
	5/6/2007	161	256	39.3	9.1
	5/13/2007	54	270	43.7	7.4
Héeyey (steelhead) Smolts					
	4/29/2007	77	361	7.9	3.2
	5/6/2007	89	493	6.3	3.7
	5/13/2007	75	428	3.2	3.6
	5/20/2007	48	285	4.4	3.3

Mortality

Nacó'x̂ (Chinook salmon) and Héeyey (steelhead) Mortality

A total of 162 natural Nacó'x̂ (Chinook salmon), 55 hatchery Nacó'x̂ (Chinook salmon), 36 natural Héeyey (steelhead), and 10 hatchery Héeyey (steelhead) mortalities occurred during the study. Seventy-seven of the natural Nacó'x̂ (Chinook salmon) mortalities occurred during the fall; 1.92% of all natural Nacó'x̂ (Chinook salmon) captured in the fall of 2006 (Appendix M). Trapping caused 73 mortalities, handling caused one, PIT tagging was the source of one, and two additional dead on arrival. No other mortalities occurred during the fall. Eighty-five natural Nacó'x̂ (Chinook salmon) mortalities occurred during the spring: 47 due to trapping, one due to handling, 23 from to PIT tagging and 14 were dead on arrival at the Imnaha screw trap (Appendix N). The total number of mortalities accounted for 0.78 % of the natural Nacó'x̂ (Chinook salmon) captured in the spring of 2007.

There were 36 natural Héeyey (steelhead) mortalities during the spring of 2007. Seven mortalities were attributed to trapping, two for handling, twenty-five for PIT tagging, and two were dead on arrival at the Imnaha screw trap. Hatchery Héeyey (steelhead) had 10 trapping mortalities; eight from trapping, one from handling, none from PIT tagging, and one hatchery Héeyey (steelhead) was dead on arrival. The 36 natural Héeyey (steelhead) mortalities were 0.35

% of the total catch, where the 10 hatchery Héeyey (steelhead) mortalities accounted for 0.03 % of the total catch.

Incidental Catch

Incidental Catch for Migration Year MY 2007

The incidental catch during the fall and spring of migration year 2007, including scaled up subsamples, totaled 3,841 fish. It was comprised of six families of fishes: Salmonidae, Centrarchidae, Catostomidae, Cyprinidae, Cottidae, and Petromyzotidae (Appendix O). The catch of Salmonidae consisted of 74 adult Héeyey (steelhead), 1,004 rainbow trout, 116 Cimey (mountain whitefish; *Prosopium williamsoni*), and 185 Islam (bull trout; *Salvelinus confluentus*). The juvenile rainbow were resident fish based on morphological characteristics and are not a subset of the catch of natural Héeyey (steelhead) reported in earlier sections of this report. The two Centrarchidae captured were smallmouth bass (*Micropterus dolomieu*). A total of 149 Muq'uc (bridgelip suckers; *Catostomus columbianus*), 23 Muq'uc (largescale suckers; *Catostomus macrocheilus*), and 729 unidentified Muq'uc species represented the family Catostomidae. The catch of Cyprinidae was as follows: 12 Tite'wxc (chislemouth; *Acrocheilus alutaceus*), 612 longnose dace (*Rhinichthys cataractae*), 42 Qiyex (northern pikeminnow; *Ptychocheilus oregonensis*), 6 reidside shiner (*Richardsonius balteatus*) and 13 Peamouth (*Mylocheilus caurinus*). Fifty-two *Cottus* species (sculpins) of the family Cottidae were captured during the migration year 2007. Additionally 1,422 juvenile Heesu (Pacific Lampreys; *Lampetra tridentata*) of the family Petromyzotidae were caught in the spring of 2007.

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APPENDICES

Appendix A. The number of hours sampled and the catch, including subsample estimates (presented in italics), of natural and hatchery Nacó'x̂ (Chinook salmon) and Héeyey (steelhead) at the Imnaha River juvenile migration trap from 5 October 2006 to 21 June 2007. Sampling periods exceeded 24 hours when trapping continued past the hour the trap was started from the previous day (e.g. 8:30 am on October 17 to 8:45 am on October 18). N/A indicates the trap was not operated on that date.

Sample End Date	Hours fished ¹	Natural Nacó'x̂ (Chinook salmon)	Hatchery Nacó'x̂ (Chinook salmon)	Natural Héeyey (steelhead)	Hatchery Héeyey (steelhead)
10/05/06	13.00	0	0	0	0
10/06/06	24.00	0	0	0	0
10/07/06	24.00	0	0	0	0
10/08/06	24.00	0	0	0	0
10/09/06	24.00	0	0	0	0
10/10/06	24.00	7	0	0	0
10/11/06	24.00	2	0	0	0
10/12/06	27.00	17	0	7	0
10/13/06	23.00	27	0	8	0
10/14/06	25.00	61	0	5	0
10/15/06	23.00	17	0	2	0
10/16/06	24.00	45	0	6	0
10/17/06	24.25	46	0	30	0
10/18/06	23.75	63	0	12	0
10/19/06	16.50	88	0	10	0
10/20/06	23.00	103	0	5	0
10/21/06	21.00	137	0	10	0
10/22/06	26.50	118	0	21	0
10/23/06	24.00	108	0	28	0
10/24/06	23.00	56	0	18	0
10/25/06	22.50	113	0	7	0
10/26/06	25.75	87	0	0	0
10/27/06	23.75	62	0	0	0
10/28/06	24.00	85	0	0	0
10/29/06	23.75	62	0	0	0
10/30/06	24.75	110	0	0	0
10/31/06	23.50	20	0	0	0
11/01/06	24.00	9	0	0	0
11/02/06	24.00	10	0	4	0
11/03/06	24.00	16	0	6	0
11/04/06	24.50	5	0	2	0
11/05/06	23.00	2	0	2	0
11/06/06	24.50	7	0	1	0
11/07/06	22.00	286	0	8	0

Sample End Date	Hours fished ¹	Natural Nacó'x̂ (Chinook salmon)	Hatchery Nacó'x̂ (Chinook salmon)	Natural Héeyey (steelhead)	Hatchery Héeyey (steelhead)
11/08/06	24.00	338	0	5	0
11/09/06	N/A	N/A	N/A	N/A	N/A
11/10/06	N/A	N/A	N/A	N/A	N/A
11/11/06	26.50	269	0	0	0
11/12/06	22.00	147	0	1	0
11/13/06	19.00	145	0	1	0
11/14/06	24.00	150	0	0	0
11/15/06	23.00	156	0	0	0
11/16/06	25.00	154	0	0	0
11/17/06	24.00	194	0	0	0
11/18/06	24.00	149	0	0	0
11/19/06	24.00	73	0	0	0
11/20/06	24.50	214	0	0	0
11/21/06	23.00	135	0	0	0
11/22/06	23.50	45	0	0	0
11/23/06	24.00	56	0	0	0
11/24/06	23.00	27	0	0	0
11/25/06	23.50	6	0	1	0
11/26/06	24.50	5	0	0	0
11/27/06	23.50	21	0	0	0
11/28/06	24.50	5	0	1	0
11/29/06	23.50	2	0	1	0
3/1/07	15.00	0	0	0	0
3/2/07	25.00	0	0	0	0
3/3/07	23.00	0	0	0	0
3/4/07	24.00	0	0	0	0
3/5/07	24.00	0	0	0	0
3/6/07	24.00	0	0	0	0
3/7/07	24.00	1	0	0	0
3/8/07	25.00	2	0	0	0
3/9/07	24.00	0	0	0	0
3/10/07	24.50	2	0	0	0
3/11/07	24.00	7	0	2	0
3/12/07	23.00	4	0	3	0
3/13/07	24.00	13	0	0	0
3/14/07	13.25	48	0	3	0
3/15/07	16.50	96	0	7	0
3/16/07	22.50	53	0	1	0
3/17/07	24.00	56	0	0	0

Sample End Date	Hours fished ¹	Natural Nacó'x̂ (Chinook salmon)	Hatchery Nacó'x̂ (Chinook salmon)	Natural Héeyey (steelhead)	Hatchery Héeyey (steelhead)
3/18/07	24.00	40	0	13	0
3/19/07	24.00	51	0	14	0
3/20/07	21.00	72	0	25	1
3/21/07	23.50	116	0	18	0
3/22/07	25.50	174	0	8	0
3/23/07	23.50	72	81	5	0
3/24/07	24.00	38	46	5	0
3/25/07	24.50	19	317	9	0
3/26/07	26.50	117	550	11	0
3/27/07	22.50	126	189	9	0
3/28/07	21.50	161	764	3	0
3/29/07	27.50	95	2,168	1	0
3/30/07	23.00	78	624	2	0
3/31/07	25.00	41	167	5	0
4/1/07	24.00	48	115	6	0
4/2/07	23.00	56	839	4	0
4/3/07	23.50	123	5,648	3	0
4/4/07	23.00	61	3,061	2	0
4/5/07	29.50	62	3,918	6	0
4/6/07	20.00	65	3,829	15	0
4/7/07	26.25	50	5,563	6	0
4/8/07	20.50	162	5,059	15	0
4/9/07	25.00	538	13,306	56	0
4/10/07	23.25	1,400	12,050	121	85
4/11/07	23.50	645	5,654	59	338
4/12/07	26.00	251	1,462	41	1,399
4/13/07	22.50	104	563	21	1,167
4/14/07	23.00	59	565	19	584
4/15/07	24.00	75	567	13	560
4/16/07	23.50	173	664	15	590
4/17/07	24.50	108	226	12	291
4/18/07	24.00	169	574	16	536
4/19/07	26.00	156	567	31	400
4/20/07	24.00	85	203	35	318
4/21/07	25.25	109	188	32	315
4/22/07	23.25	105	178	23	174
4/23/07	24.25	79	110	36	216
4/24/07	20.75	165	309	108	694
4/25/07	24.50	206	202	130	653
4/26/07	27.00	189	277	166	1,002

Sample End Date	Hours fished ¹	Natural Nacó'x̂ (Chinook salmon)	Hatchery Nacó'x̂ (Chinook salmon)	Natural Héeyey (steelhead)	Hatchery Héeyey (steelhead)
4/27/07	21.00	113	139	109	530
4/28/07	25.50	143	166	188	971
4/29/07	23.00	265	408	638	2,676
4/30/07	23.50	272	530	910	2,282
5/1/07	24.00	134	154	600	1,330
5/2/07	25.00	71	152	284	1,344
5/3/07	11.25	77	225	732	1,621
5/4/07	8.50	136	210	215	1,126
5/5/07	26.00	226	307	190	447
5/6/07	22.00	125	127	178	342
5/7/07	23.75	81	64	139	306
5/8/07	27.75	103	148	350	983
5/9/07	22.50	84	170	305	870
5/10/07	12.50	139	302	454	1,835
5/11/07	24.00	135	257	752	2,314
5/12/07	8.00	19	19	152	325
5/13/07	24.00	26	25	197	641
5/14/07	24.00	40	42	192	501
5/15/07	23.50	52	25	156	321
5/16/07	22.00	44	28	166	458
5/17/07	24.50	55	30	190	481
5/18/07	24.25	47	40	179	569
5/19/07	24.00	57	46	298	527
5/20/07	23.75	37	20	199	280
5/21/07	26.00	40	35	204	265
5/22/07	24.00	47	18	120	134
5/23/07	22.00	47	16	106	134
5/24/07	23.50	23	7	26	38
5/25/07	24.00	28	10	26	34
5/26/07	25.00	24	13	18	18
5/27/07	24.00	40	16	14	39
5/28/07	24.00	50	14	72	99
5/29/07	25.00	83	9	106	100
5/30/07	22.50	49	7	23	57
5/31/07	25.50	77	7	23	75
6/1/07	23.50	72	9	31	105
6/2/07	25.50	83	9	17	91
6/3/07	23.50	130	4	55	181
6/4/07	26.25	146	7	91	291
6/5/07	21.75	57	6	78	328

Sample End Date	Hours fished ¹	Natural Nacó'x̂ (Chinook salmon)	Hatchery Nacó'x̂ (Chinook salmon)	Natural Héeyey (steelhead)	Hatchery Héeyey (steelhead)
6/6/07	24.00	11	1	200	764
6/7/07	24.00	69	1	125	288
6/8/07	22.50	74	0	16	42
6/9/07	23.00	40	0	8	32
6/10/07	24.00	46	2	8	84
6/11/07	25.00	28	1	29	251
6/12/07	23.00	12	0	10	83
6/13/07	23.50	22	0	2	32
6/14/07	25.50	20	0	2	20
6/15/07	24.75	23	0	3	28
6/16/07	23.00	20	0	2	22
6/17/07	25.00	17	0	2	15
6/18/07	22.75	31	1	3	22
6/19/07	24.25	19	0	0	12
6/20/07	23.75	18	0	0	10
6/21/07	24.00	25	0	2	35
Total	3,887.5¹	14,737	74,430	10,532	36,132

¹We fished 3,887.5 hours out of a possible total of 4,056 hours (169 days) or 95.85% .

Appendix B. The number of Nacó'x̂ (Chinook salmon) and Héeyey (steelhead) PIT tagged at the Imnaha River juvenile migration trap from 5 October 2006 to 21 June 2007. N/A indicates the trap was not operated on that date.

Sample End Date	Natural Nacó'x̂ (Chinook salmon)	Hatchery Nacó'x̂ (Chinook salmon)	Natural Héeyey (steelhead)	Hatchery Héeyey (steelhead)
10/05/06	0	0	0	0
10/06/06	0	0	0	0
10/07/06	0	0	0	0
10/08/06	0	0	0	0
10/09/06	0	0	0	0
10/10/06	6	0	0	0
10/11/06	2	0	0	0
10/12/06	17	0	0	0
10/13/06	26	0	0	0
10/14/06	60	0	0	0
10/15/06	16	0	0	0
10/16/06	45	0	0	0
10/17/06	46	0	0	0
10/18/06	61	0	0	0
10/19/06	87	0	0	0
10/20/06	101	0	0	0
10/21/06	135	0	0	0
10/22/06	118	0	0	0
10/23/06	107	0	0	0
10/24/06	56	0	0	0
10/25/06	110	0	0	0
10/26/06	85	0	1	0
10/27/06	62	0	0	0
10/28/06	84	0	0	0
10/29/06	60	0	0	0
10/30/06	69	0	0	0
10/31/06	20	0	0	0
11/01/06	9	0	0	0
11/02/06	10	0	0	0
11/03/06	16	0	0	0
11/04/06	5	0	0	0
11/05/06	2	0	0	0
11/06/06	7	0	0	0
11/07/06	281	0	0	0
11/08/06	313	0	0	0
11/09/06	N/A	N/A	N/A	N/A
11/10/06	N/A	N/A	N/A	N/A

Sample End Date	Natural Nacó'x̂ (Chinook salmon)	Hatchery Nacó'x̂ (Chinook salmon)	Natural Héeyey (steelhead)	Hatchery Héeyey (steelhead)
11/11/06	268	0	0	0
11/12/06	146	0	0	0
11/13/06	141	0	0	0
11/14/06	148	0	0	0
11/15/06	156	0	0	0
11/16/06	153	0	0	0
11/17/06	189	0	0	0
11/18/06	149	0	0	0
11/19/06	73	0	0	0
11/20/06	214	0	0	0
11/21/06	133	0	0	0
11/22/06	45	0	0	0
11/23/06	53	0	0	0
11/24/06	27	0	0	0
11/25/06	5	0	0	0
11/26/06	5	0	0	0
11/27/06	21	0	0	0
11/28/06	5	0	1	0
11/29/06	2	0	0	0
3/1/07	0	0	0	0
3/2/07	0	0	0	0
3/3/07	0	0	0	0
3/4/07	0	0	0	0
3/5/07	0	0	0	0
3/6/07	0	0	0	0
3/7/07	0	0	0	0
3/8/07	2	0	0	0
3/9/07	0	0	0	0
3/10/07	2	0	0	0
3/11/07	7	0	2	0
3/12/07	4	0	3	0
3/13/07	13	0	0	0
3/14/07	48	0	3	0
3/15/07	96	0	7	0
3/16/07	53	0	1	0
3/17/07	56	0	0	0
3/18/07	40	0	13	0
3/19/07	51	0	14	0
3/20/07	71	0	25	0

Sample End Date	Natural Nacó'x̂ (Chinook salmon)	Hatchery Nacó'x̂ (Chinook salmon)	Natural Héeyey (steelhead)	Hatchery Héeyey (steelhead)
3/21/07	114	0	18	0
3/22/07	174	0	8	0
3/23/07	72	0	5	0
3/24/07	38	0	5	0
3/25/07	19	0	9	0
3/26/07	116	0	11	0
3/27/07	125	0	9	0
3/28/07	161	0	3	0
3/29/07	95	0	1	0
3/30/07	78	0	2	0
3/31/07	41	0	5	0
4/1/07	48	0	6	0
4/2/07	56	0	4	0
4/3/07	122	0	3	0
4/4/07	61	0	2	0
4/5/07	62	0	6	0
4/6/07	65	0	15	0
4/7/07	49	0	5	0
4/8/07	38	0	7	0
4/9/07	86	0	10	0
4/10/07	142	0	22	0
4/11/07	96	0	8	0
4/12/07	250	0	41	30
4/13/07	103	0	21	125
4/14/07	56	0	19	100
4/15/07	75	0	13	0
4/16/07	173	1	15	0
4/17/07	108	0	12	41
4/18/07	169	0	16	0
4/19/07	156	0	31	89
4/20/07	85	0	35	70
4/21/07	109	0	32	39
4/22/07	103	0	23	0
4/23/07	77	0	36	0
4/24/07	78	0	50	50
4/25/07	203	0	129	72
4/26/07	188	0	166	64
4/27/07	113	0	109	0
4/28/07	143	0	188	31
4/29/07	217	0	309	33

Sample End Date	Natural Nacó'x̂ (Chinook salmon)	Hatchery Nacó'x̂ (Chinook salmon)	Natural Héeyey (steelhead)	Hatchery Héeyey (steelhead)
4/30/07	153	0	183	32
5/1/07	64	0	185	31
5/2/07	71	0	284	34
5/3/07	37	0	264	56
5/4/07	56	0	135	99
5/5/07	225	0	190	0
5/6/07	124	0	177	39
5/7/07	80	0	139	41
5/8/07	103	0	348	55
5/9/07	84	0	304	50
5/10/07	44	0	182	41
5/11/07	18	0	192	23
5/12/07	19	0	152	0
5/13/07	25	0	197	39
5/14/07	40	0	192	37
5/15/07	52	0	156	40
5/16/07	43	0	166	42
5/17/07	54	0	189	35
5/18/07	47	1	179	30
5/19/07	57	0	297	24
5/20/07	36	0	199	0
5/21/07	39	0	204	0
5/22/07	46	0	117	0
5/23/07	47	0	105	0
5/24/07	23	0	26	0
5/25/07	26	0	26	0
5/26/07	18	0	18	0
5/27/07	37	0	14	0
5/28/07	50	0	72	0
5/29/07	83	0	106	0
5/30/07	49	0	23	0
5/31/07	77	0	23	0
6/1/07	72	0	31	0
6/2/07	83	0	17	0
6/3/07	127	0	55	0
6/4/07	144	0	89	0
6/5/07	57	0	78	0
6/6/07	10	0	195	0
6/7/07	69	0	125	0
6/8/07	71	0	16	0

Sample End Date	Natural Nacó'x̂ (Chinook salmon)	Hatchery Nacó'x̂ (Chinook salmon)	Natural Héeyey (steelhead)	Hatchery Héeyey (steelhead)
6/9/07	39	0	8	0
6/10/07	43	0	8	0
6/11/07	28	0	29	0
6/12/07	11	0	10	0
6/13/07	19	0	2	0
6/14/07	19	0	2	0
6/15/07	19	0	3	0
6/16/07	18	0	2	0
6/17/07	14	0	2	0
6/18/07	28	0	2	0
6/19/07	16	0	0	0
6/20/07	16	0	0	0
6/21/07	24	0	2	0
Totals	11,510	2	7,198	1,492

Appendix C. Previously PIT tagged natural Nacó'x̂ (Chinook salmon) recaptured in the Imnaha River juvenile migration trap during the fall of 2006 and spring 2007.

Migration Year	Tagging Agency	Recapture file	Tag ID	Date Tagged	Date Recaptured	Travel Time (Days)
2007	ODFW	BDM06293.NT1	3D9.1BF22C98E1	9/6/2006	10/20/2006	44
2007	ODFW	BDM06294.NT1	3D9.1BF22C50C3	9/6/2006	10/21/2006	45
2007	ODFW	BDM06311.NT2	3D9.1BF22C5910	9/6/2006	11/8/2006	63
2007	ODFW	BDM06315.NT1	3D9.1BF22C9027	9/6/2006	11/11/2006	66
2007	ODFW	BDM07092.NT1	3D9.1BF22B19EC	9/6/2006	4/2/2007	208
2007	ODFW	BDM07099.NT1	3D9.1BF22C6D8F	9/6/2006	4/10/2007	216
2007	ODFW	BDM07101.NT1	3D9.1BF22C524F	9/6/2006	4/12/2007	218
2007	ODFW	BDM07101.NT1	3D9.1BF22C9C4C	9/6/2006	4/12/2007	218
2007	ODFW	BDM07113.NT1	3D9.1BF22C5382	9/6/2006	4/23/2007	229
2007	ODFW	BDM07114.NT2	3D9.1BF22B232B	9/6/2006	4/25/2007	231
2007	ODFW	BDM07118.NT2	3D9.1BF22B1B8B	9/6/2006	4/29/2007	235
2007	ODFW	BDM07118.NT2	3D9.1BF22CAB49	9/6/2006	4/29/2007	235
2007	ODFW	BDM07119.NT1	3D9.1BF22C732E	9/6/2006	4/30/2007	236
2007	ODFW	BDM07130.NT1	3D9.1BF22B546E	9/6/2006	5/10/2007	246
2007	ODFW	BDM07146.NT1	3D9.1BF22C69C6	9/6/2006	5/26/2007	262
2007	ODFW	BDM07099.RM1*	3D9.1BF22B09A1	9/6/2006	4/9/2007	215
2007	ODFW	BDM07100.RM1*	3D9.1BF22B17F7	9/6/2006	4/10/2007	216
2007	ODFW	BDM07101.RM1*	3D9.1BF22B1EFE	9/6/2006	4/11/2007	217
2007	ODFW	BDM07101.RM1*	3D9.1BF22B2383	9/6/2006	4/11/2007	217

Migration Year	Tagging Agency	Recapture file	Tag ID	Date Tagged	Date Recaptured	Travel Time (Days)
2007	ODFW	BDM07101.RM1*	3D9.1BF22C416E	9/6/2006	4/11/2007	217
2007	ODFW	BDM07100.RM1*	3D9.1BF22C5798	9/6/2006	4/10/2007	216
2007	ODFW	BDM07101.RM1*	3D9.1BF22C5D4A	9/6/2006	4/11/2007	217
2007	ODFW	BDM07101.RM1*	3D9.1BF22C6AB7	9/6/2006	4/11/2007	217
2007	ODFW	BDM07100.RM1*	3D9.1BF22CA44D	9/6/2006	4/10/2007	216

* Indicates a remote monitoring file. No condition factors were collected on these fish.

Appendix D. Statistical comparisons of median fork lengths between groups of smolts captured in the Imnaha River smolt trap during the spring of migration year 2007.

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 Nacó'x̂ (Chinook salmon)	Hatchery Nacó'x̂ (Chinook salmon)	7,547	1,084	99	123	46.949	0.000
Natural Héeyey (steelhead)	Hatchery Héeyey (steelhead)	7,195	2,360	169	215	64.341	0.000

Appendix E. Gauss population estimates for the Imnaha River by group and totals for natural Nacó'x̂ (Chinook salmon) captured in the Imnaha River juvenile migration trap during fall 2006 and spring 2007.

Week	Group	Caught	Marked	Recaptured	Trap Efficiency (%)	Population	Lower 95% C.I.	Upper 95% C.I.	SE
10/8 to 10/21	1	537	424	30	7.0	7,362	5,224	10,316	1,350.2
10/22 to 10/28	2	681	349	90	26.0	2,619	2,211	3,089	227.3
10/29 to 11/4	3	312	170	35	21.0	1,482	1,197	1,829	158.0
11/5 to 11/18	4	1,853	466	12	3.0	66,566	39,646	118,454	20,328.4
11/19 to 12/2	5	738	306	7	2.0	28,321	15,470	56,738	10,377.6
Fall totals		4,121	1,715	174	11.8	106,350	72,196	162,154	21,829.8
3/4 to 3/17	1	282	160	7	4.4	5,675	2,811	11,646	2,277.5
3/18 to 4/14	2	4,824	1,020	180	17.7	27,212	19,886	38,165	4,662.1
4/15 to 4/28	3	1,875	683	113	16.5	11,250	8,133	15,948	2,060.5
4/29 to 5/12	4	1,867	502	82	16.3	11,315	8,092	16,007	2,153.4
5/16 to 6/9	5	1,548	689	121	17.6	8,755	6,252	12,121	1,477.8
6/10 to 6/24	6	281	112	19	17.0	1,588	1,136	2,339	300.9
Spring totals		10,677	3,166	522	14.9	65,795	59,974	74,027	3,568.7
MY 2007 Totals		14,798	4,881	696	14.9	172,145	139,357	228,282	22,690.6

Appendix F. Gauss population estimates for the Imnaha River by group and totals for natural Héeyey (steelhead) captured in the Imnaha River juvenile migration trap during the spring 2007.

Week			Group	Caught	Marked	Recaptured	Trap Efficiency (%)	Population	Lower 95% C.I.	Upper 95% C.I.	SE
3/11	to	4/7	1	186	131	19	14.5	1,228	816	1,899	267.6
4/8	to	4/21	2	486	183	40	21.9	2,181	1,614	2,996	367.1
4/22	to	6/9	3	9,595	2,058	353	17.2	55,808	39,060	78,606	1,0819.8
6/10	to	6/15	4	56	40	7	17.5	287	181	443	65.3
MY 2007 Totals				10,323	2,412	419	17.8	59,504	54,695	65,001	2,698.2

Appendix G. A statistical comparison of median arrival date at LGD between natural Nacó'x̂ (Chinook salmon) pre-smolts released in the fall of 2006 and smolts released in the spring of 2007 from the Imnaha River juvenile migration trap during migration year 2007. Arrival date includes both survival and monitor mode smolts.

Group 1	Group 2	Sample Sizes		Median Arrival Date		Wilcoxon Value (W)	Significance Level p = 0.05
		Group 1	Group 2	Group 1	Group 2		
Pre-Smolts	Smolts	295	1,895	4/14/07	5/03/07	22.66	0.000

Appendix H. Arrival timing of Imnaha River natural Nacó'x̂ (Chinook salmon) smolts PIT tagged at the Imnaha River trap during fall of 2006 to Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1998 to 2007. Arrival timing includes both survival and monitor mode smolts.

Dam	Year	Sample Size (n)	Date Range	Arrival Timing	
				Median	90%
Lower Granite	1998	428	Mar-27 - May-12	Apr-14	Apr-24
	1999	103	Apr-03 - May-02	Apr-19	Apr-25
	2000	262	Apr-04 - May-12	Apr-14	Apr-23
	2001	644	Apr-03 - May-26	Apr-26	Apr-30
	2002	162	Apr-01 - May-20	Apr-16	Apr-30
	2003	715	Mar-26 - May-28	Apr-16	Apr-30
	2004	360	Mar-26 - May-08	Apr-14	May-02
	2005	1,087	Mar-30 - May-24	Apr-17	Apr-27
	2006	89	Mar-29 - May-02	Apr-11	Apr-26
	2007	295	Mar-25 - May-06	Apr-14	Apr-22

Dam	Year	Sample Size (n)	Date Range	Arrival Timing	
				Median	90%
Little Goose	1998	228	Apr-11 - May-12	Apr-25	May-02
	1999	364	Apr-08 - May-09	Apr-19	Apr-25
	2000	239	Apr-12 - May-12	Apr-17	Apr-24
	2001	135	Apr-23 - Jun-16	Apr-30	May-11
	2002	159	Apr-13 - May-16	May-01	May-05
	2003	406	Apr-02 - May-16	Apr-21	May-01
	2004	223	Apr-10 - May-26	Apr-24	May-06
	2005	381	Apr-15 - Jun-09	Apr-30	May-08
	2006	159	Apr-08 - May-04	Apr-18	Apr-29
	2007	223	Apr-08 - May-13	Apr-19	May-01
Lower Monumental	1998	202	Apr-19 - May-19	Apr-25	May-04
	1999	144	Apr-10 - May-21	Apr-19	Apr-25
	2000	62	Apr-13 - May-06	Apr-21	Apr-26
	2001	21	Apr-28 - May-17	NA	NA
	2002	100	Apr-30 - Jun-04	May-05	May-16
	2003	78	Apr-14 - May-18	Apr-22	May-06
	2004	204	Apr-13 - May-28	Apr-19	Apr-25
	2005	138	Apr-22 - Jun-12	May-02	May-09
	2006	145	Apr-07 - May-07	Apr-19	Apr-30
	2007	51	Apr-17 - May-06	May-01	May-06
McNary	1998	239	Apr-20 - May-23	Apr-30	May-04
	1999	64	Apr-10 - May-10	Apr-21	Apr-28
	2000	35	Apr-18 - May-06	Apr-27	May-04
	2001	5	May-05 - May-18	NA	NA
	2002	86	Apr-21 - May-26	May-05	May-15
	2003	314	Apr-17 - May-21	Apr-28	May-09
	2004	182	Apr-13 - May-31	Apr-30	May-07
	2005	105	May-02 - Jun-16	May-08	May-11
	2006	83	Apr-13 - May-09	Apr-24	May-06
	2007	360	Apr-18 - May-12	Apr-29	May-05

Appendix I. Arrival timing of Imnaha River natural Nacó'x̂ (Chinook salmon) smolts PIT tagged at the Imnaha River trap during spring 2007 to Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1993 to 2007. Arrival timing includes both survival and monitor mode smolts.

Dam	Year	Sample Size (n)	Date Range	Arrival Timing	
				Median	90%
Lower Granite	1993	109	Apr-21 - Jun-12	May-04	May-14
	1994	348	Apr-14 - Jun-23	Apr-24	May-11
	1995	184	Apr-11 - Jul-11	May-01	May-11
	1996	421	Apr-06 - Jun-12	Apr-30	May-18
	1997	74	Apr-06 - May-18	Apr-22	May-11
	1998	1,630	Apr-01 - Jun-27	Apr-25	May-06
	1999	1,218	Mar-28 - Jul-15	Apr-27	May-22
	2000	1,291	Apr-02 - Aug-08	Apr-22	May-11
	2001	6,857	Mar-30 - Aug-13	Apr-28	May-12
	2002	489	Apr-02 - Jun-27	May-05	May-20
	2003	1,685	Mar-28 - Jul-25	Apr-29	May-24
	2004	4,438	Mar-26 - Jul-16	May-01	May-18
	2005	1,962	Apr-02 - Jul-02	Apr-30	Jun-04
	2006	276	Mar-06 - Jun-06	Apr-06	May-06
	2007	1,893	Mar-27 - Jul-06	May-03	May-20
Little Goose	1993	46	Apr-27 - Jun-02	May-03	May-16
	1994	194	Apr-23 - Jun-17	Apr-28	May-07
	1995	144	Apr-15 - Jul-15	May-07	May-20
	1996	358	Apr-12 - Jun-16	Apr-27	May-20
	1997	70	Apr-15 - May-22	Apr-26	May-11
	1998	837	Apr-14 - Jun-25	May-03	May-12
	1999	2,099	Apr-09 - Aug-01	Apr-29	May-22
	2000	1,103	Apr-11 - Jul-14	Apr-23	May-11
	2001	1,216	Apr-16 - Jul-23	May-02	May-17
	2002	519	Apr-15 - Jun-20	May-07	May-23
	2003	782	Apr-13 - Aug-04	May-04	May-27
	2004	2,653	Apr-07 - Aug-24	May-05	May-22
	2005	1,165	Apr-13 - Jul-02	May-07	Jun-02
	2006	392	Apr-07 - Jun-21	Apr-27	May-09
	2007	1,107	Apr-07 - Sep-05	May-05	Jun-04

Dam	Year	Sample Size (n)	Date Range	Arrival Timing	
				Median	90%
Lower Monumental	1993	37	May-03 - Jun-02	May-08	May-13
	1994	215	Apr-25 - Jul-26	May-01	May-24
	1995	142	Apr-19 - Aug-04	May-08	Jun-04
	1996	359	Apr-13 - Jun-15	May-10	May-22
	1997	74	Apr-20 - Jun-01	Apr-30	May-14
	1998	289	Apr-19 - Jun-08	Apr-30	May-11
	1999	688	Apr-09 - Aug-04	May-01	May-23
	2000	335	Apr-13 - Jul-12	Apr-25	May-29
	2001	131	Apr-28 - Jul-18	May-13	May-20
	2002	336	Apr-22 - Jun-14	May-13	May-22
	2003	163	Apr-13 - Jul-12	May-14	May-31
	2004	1,106	Apr-05 - Jul-31	Apr-23	May-28
	2005	489	Apr-22 - Jun-19	May-09	May-26
	2006	224	Apr-10 - Jun-09	Apr-25	May-11
	2007	472	Apr-16 - Jul-07	May-07	May-20
McNary	1993	20	May-03 - Jun-15	May-09	May-21
	1994	229	Apr-29 - Jul-16	May-12	May-28
	1995	89	Apr-28 - Jul-09	May-12	May-21
	1996	148	Apr-19 - Jun-08	May-14	May-24
	1997	24	Apr-22 - May-19	May-01	May-12
	1998	187	Apr-19 - Jun-02	May-01	May-15
	1999	152	Apr-18 - Jun-27	May-06	May-21
	2000	192	Apr-18 - Jul-04	May-07	May-29
	2001	45	Apr-29 - Jun-05	May-18	May-31
	2002	189	Apr-23 - Jun-10	May-14	May-23
	2003	439	Apr-18 - Jun-28	May-08	May-20
	2004	1,058	Apr-18 - Aug-01	May-03	May-24
	2005	413	Apr-28 - Jul-02	May-16	Jun-28
	2006	111	Apr-14 - Jul-07	Apr-29	May-16
	2007	1,554	Apr-21 - Jul-22	May-09	Jun-09

Appendix J. Arrival timing of ODFW and FPC tagged Imnaha River hatchery Nacó'x̂ (Chinook salmon) smolts to Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1992 to 2007. Arrival timing includes both survival and monitor mode smolts.

Dam	Year	Sample Size (n)	Date Range		Arrival Timing	
					Median	90%
Lower Granite	1992 ¹	273	Apr-12	- Jun-06	Apr-21	May-06
	1994	129	Apr-24	- May-18	May-12	May-12
	1995 ²	128	Apr-13	- Jun-07	May-02	May-13
	1995 ³	83	Apr-16	- May-22	May-08	May-15
	1996	169	Apr-13	- May-26	May-07	May-16
	1997	227	Apr-16	- May-22	May-05	May-14
	1998	696	Apr-15	- May-22	May-02	May-09
	1999	267	Apr-18	- May-25	May-05	May-14
	2000	782	Apr-07	- May-24	May-03	May-13
	2001	1,725	Mar-31	- May-27	Apr-29	May-10
	2002	461	Apr-01	- May-23	May-07	May-19
	2003	475	Apr-14	- May-25	May-02	May-15
	2004	7,892	Apr-05	- Jun-19	May-03	May-09
	2005	7,342	Apr-04	- Jun-13	May-02	May-07
	2006	3,414	Mar-31	- May-14	May-02	May-09
	2007	3,442	Apr-13	- Aug-17	May-03	May-11
Little Goose	1992 ¹	116	Apr-17	- May-22	Apr-27	May-05
	1994	65	Apr-28	- Jun-02	May-14	May-21
	1995 ²	114	Apr-26	- Jun-11	May-10	May-20
	1995 ³	67	Apr-27	- Jun-07	May-12	May-23
	1996	131	Apr-23	- Jun-06	May-13	May-20
	1997	267	Apr-20	- May-27	May-09	May-18
	1998	391	Apr-25	- May-26	May-07	May-14
	1999	387	Apr-16	- Jun-06	May-10	May-19
	2000	450	Apr-14	- May-24	May-03	May-13
	2001	509	Apr-15	- May-29	May-07	May-16
	2002	544	Apr-13	- Jun-01	May-12	May-22
	2003	227	Apr-19	- May-27	May-06	May-18
	2004	5,378	Apr-10	- Jun-11	May-06	May-15
	2005	4,596	Apr-16	- Jun-09	May-08	May-12
	2006	4,861	Apr-06	- Jun-25	May-04	May-16
	2007	2,014	Apr-15	- May-29	May-04	May-14

Dam	Year	Sample Size (n)	Date Range		Arrival Timing		
					Median	90%	
Lower Monumental	1994	73	Apr-30	-	Jun-07	May-14	May-20
	1995 ²	106	Apr-27	-	Jun-10	May-12	May-21
	1995 ³	71	Apr-29	-	Jun-09	May-17	May-26
	1996	136	Apr-23	-	May-29	May-15	May-23
	1997	199	Apr-25	-	Jun-03	May-10	May-19
	1998	143	Apr-23	-	May-26	May-08	May-15
	1999	124	Apr-23	-	May-25	May-11	May-20
	2000	107	Apr-19	-	May-26	May-05	May-22
	2001	79	Apr-27	-	Jun-04	May-12	May-25
	2002	457	Apr-30	-	Jun-11	May-14	May-23
	2003	34	Apr-27	-	May-27	May-15	May-22
	2004	801	Apr-11	-	Jun-11	May-15	May-27
	2005	1,532	Apr-20	-	Jun-13	May-10	May-15
	2006	2,480	Apr-08	-	Jun-10	May-07	May-17
	2007	1,322	Apr-21	-	May-30	May-05	May-15
McNary	1992 ¹	61	Apr-27	-	Jun-01	May-08	May-17
	1994	119	May-06	-	Jun-17	May-21	May-26
	1995 ²	67	Apr-29	-	Jun-09	May-16	May-23
	1995 ³	36	May-03	-	May-30	May-16	May-22
	1996	55	May-01	-	May-27	May-16	May-23
	1997	61	May-01	-	Jun-01	May-10	May-19
	1999	56	May-02	-	May-26	May-19	May-24
	2000	99	Apr-24	-	May-30	May-13	May-27
	2001	25	May-05	-	May-31	NA	NA
	2002	220	Apr-16	-	Jun-10	May-15	May-25
	2003	156	Apr-26	-	May-27	May-15	May-22
	2004	1,301	Apr-17	-	Jun-08	May-10	May-22
	2005	1,291	Apr-26	-	Jun-25	May-14	May-19
2006	1,542	Apr-13	-	Jun-26	May-10	May-18	
2007	3,516	Apr-24	-	Aug-13	May-09	May-17	

¹ Hatchery Nacó'x̂ (Chinook salmon) smolts PIT tagged and released in 1992 were over a two day period only for survival estimation.

² HxW crossed Nacó'x̂ (Chinook salmon) smolts PIT tagged for NPT and released at dark.

³ HxW crossed Nacó'x̂ (Chinook salmon) smolts PIT tagged for the FPC and released one hour after tagging and recovery.

Appendix K. Arrival timing of Imnaha River natural Héeyey (steelhead) smolts PIT tagged at the Imnaha River trap during spring 2007 to Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1993 to 2007. Arrival timing includes both survival and monitor mode smolts.

Dam	Year	Sample Size (n)	Date Range	Arrival Timing	
				Median	90%
Lower Granite	1993	101	May-03 - Jun-13	May-26	Jun-08
	1994 ¹	332	Apr-25 - Aug-15	May-08	Jun-01
	1994 ²	207	May-03 - Aug-20	May-09	May-30
	1995	128	Apr-28 - Jun-19	May-02	May-09
	1996	537	Apr-19 - Jun-10	May-06	Jun-04
	1997	368	Apr-20 - Jul-10	May-08	May-24
	1998	1,474	Apr-02 - Jun-12	May-03	May-22
	1999	649	Apr-19 - Jun-26	May-18	Jun-05
	2000	2,262	Apr-06 - Aug-03	May-08	May-25
	2001	2,736	Mar-29 - Sep-09	May-14	May-18
	2002	979	Apr-10 - Jun-26	May-18	May-31
	2003	1,887	Mar-26 - Jul-03	May-14	May-25
	2004	3,695	Mar-27 - Jul-19	May-08	May-22
	2005	2,530	Apr-07 - Jun-30	May-08	Jun-04
	2006	821	Mar-28 - Jun-19	May-05	May-16
2007	1,720	Mar-31 - Jun-18	May-12	May-25	

Dam	Year	Sample Size (n)	Date Range	Arrival Timing	
				Median	90%
Little Goose	1993	48	May-06 - Jun-11	May-24	Jun-07
	1994 ¹	159	Apr-29 - Jul-29	May-12	May-31
	1994 ²	121	May-06 - Jul-26	May-15	Jun-01
	1995	70	May-01 - Jun-23	May-07	May-12
	1996	365	Apr-20 - Jun-14	May-09	May-28
	1997	319	Apr-20 - Jun-19	May-10	May-26
	1998	481	Apr-14 - Jun-19	May-08	May-26
	1999	717	Apr-08 - Jun-24	May-21	May-25
	2000	458	Apr-11 - Jun-26	May-08	May-29
	2001	219	Apr-07 - Aug-19	May-16	May-24
	2002	856	Apr-13 - Aug-28	May-21	Jun-02
	2003	1,085	Apr-04 - Jun-29	May-18	May-26
	2004	2,280	Apr-01 - Jul-29	May-13	May-29
	2005	2,683	Apr-14 - Jun-26	May-11	Jun-03
	2006	808	Apr-01 - Jun-25	May-02	May-17
2007	1,550	Apr-01 - Aug-08	May-14	Jun-04	
Lower Monumental	1993	43	May-06 - Jun-15	May-30	Jun-11
	1994 ¹	148	May-01 - Aug-08	May-12	Jul-08
	1994 ²	91	May-09 - Jul-31	May-15	Jul-10
	1995	81	May-03 - May-17	May-09	May-14
	1996	397	Apr-22 - Jun-15	May-14	May-29
	1997	264	Apr-21 - Jun-06	May-11	May-25
	1998	213	Apr-16 - Jun-11	May-10	May-27
	1999	342	Apr-19 - Jun-21	May-23	May-27
	2000	246	Apr-12 - Aug-12	May-14	May-30
	2001	23	May-06 - Oct-03	NA	NA
	2002	828	Apr-30 - Aug-08	May-22	Jun-03
	2003	497	Apr-02 - Jun-21	May-25	May-28
	2004	871	Apr-05 - Jun-19	May-25	Jun-02
	2005	1,274	Apr-17 - Jun-20	May-13	Jun-01
	2006	420	Apr-03 - Jun-11	May-03	May-18
2007	592	Apr-02 - Jul-12	May-14	May-23	

Dam	Year	Sample Size (n)	Date Range	Arrival Timing	
				Median	90%
McNary	1993	17	May-11 - Jun-13	May-25	May-31
	1994 ¹	66	May-05 - Jun-22	May-18	Jun-09
	1994 ²	42	May-13 - Jun-25	May-18	Jun-06
	1995	35	May-05 - May-27	May-11	May-17
	1996	157	Apr-25 - Jun-11	May-11	May-21
	1997	62	Apr-24 - Jun-05	May-13	May-18
	1998	53	Apr-20 - Jun-04	May-07	May-28
	1999	55	Apr-17 - May-31	May-25	May-27
	2000	58	Apr-15 - Jun-16	May-24	Jun-07
	2001	4	May-16 - Aug-05	NA	NA
	2002	124	Apr-29 - Jun-07	May-22	May-27
	2003	210	Apr-01 - Jun-14	May-24	May-27
	2004	172	Apr-17 - Jun-20	May-15	Jun-03
	2005	399	May-01 - Aug-01	May-15	May-25
	2006	103	Apr-06 - Jun-06	May-06	May-06
2007	408	Apr-06 - Jun-06	May-06	May-06	

¹ NPT PIT tagged fish released at dark.

² FPC PIT tagged fish released after recovery.

Appendix L. Arrival timing of ODFW hatchery Héeyey (steelhead) smolts PIT tagged at the Innaha River trap during spring 2007 to Lower Granite, Little Goose, Lower Monumental, and McNary dams from 1993 to 2007. Arrival timing includes both survival and monitor mode smolts.

Dam	Year	Sample Size	Date Range		Arrival Timing		
		(n)			Median	90%	
Lower Granite	1993	224	May-03	-	Jun-28	May-17	May-31
	1994 ¹	164	Apr-29	-	Aug-20	May-29	Jul-15
	1994 ²	306	May-06	-	Aug-21	May-25	Jun-23
	1995	661	May-06	-	Jul-12	May-31	Jun-16
	1996	440	Apr-23	-	Jul-14	May-28	Jun-14
	1997	2,346	Apr-19	-	Jul-24	May-23	Jun-13
	1998	1,683	Apr-25	-	Jul-29	May-15	May-26
	1999	1,973	Apr-18	-	Aug-05	May-24	Jun-18
	2000	3,249	Apr-08	-	Jul-24	May-16	May-25
	2001	2,541	Apr-21	-	Sep-23	May-16	May-26
	2002	442	Apr-15	-	Jun-27	May-17	May-31
	2003	1,261	Apr-14	-	Jun-23	May-13	May-26
	2004	3,015	Apr-17	-	Jul-25	May-19	Jun-12
	2005	3,442	Apr-18	-	May-17	May-07	May-10
	2006	470	Apr-14	-	Jun-16	May-06	May-17
2007	305	Apr-16	-	Jun-06	May-12	May-20	
Little Goose	1993	106	May-05	-	Jul-08	May-25	Jun-02
	1994 ¹	86	May-02	-	Jul-30	May-31	Jul-17
	1994 ²	165	May-10	-	Aug-12	May-27	Jul-09
	1995	409	May-08	-	Jul-13	Jun-03	Jun-20
	1996	261	Apr-24	-	Jul-11	May-25	Jun-16
	1997	1,844	Apr-21	-	Aug-23	May-26	Jun-13
	1998	555	May-03	-	Jul-10	May-25	May-30
	1999	1,593	Apr-20	-	Aug-22	May-25	Jun-18
	2000	309	Apr-13	-	Jul-22	May-22	Jul-01
	2001	121	Apr-28	-	Oct-30	May-20	Jun-21
	2002	326	Apr-19	-	Jun-29	May-24	Jun-03
	2003	1,015	Apr-16	-	Jun-04	May-21	May-27
	2004	2,675	Apr-23	-	Oct-15	May-24	Jun-10
	2005	4,102	Apr-22	-	Jun-22	May-10	May-31
	2006	676	Apr-15	-	Jun-17	May-07	May-19
2007	490	Apr-20	-	Jun-09	May-12	May-21	

Dam	Year	Sample Size	Date Range		Arrival Timing		
		(n)			Median	90%	
Lower Monumental	1993	92	May-07	-	Jun-14	May-26	Jun-05
	1994 ¹	30	May-05	-	Aug-05	Jun-03	Jul-17
	1994 ²	75	May-11	-	Aug-24	Jun-18	Jul-21
	1995	410	May-09	-	Jul-13	Jun-06	Jun-16
	1996	232	May-06	-	Jul-07	May-27	Jun-15
	1997	1,432	Apr-22	-	Aug-06	May-27	Jun-15
	1998	253	May-05	-	Jul-15	May-26	Jun-03
	1999	790	Apr-21	-	Jul-20	May-26	Jun-19
	2000	243	Apr-16	-	Aug-18	May-25	Jul-03
	2001	28	May-08	-	Oct-25	NA	NA
	2002	406	Apr-30	-	Oct-18	May-28	Jun-09
	2003	734	Apr-21	-	Jun-09	May-26	May-29
	2004	1,425	Apr-23	-	Aug-12	May-29	Jun-11
	2005	2,145	Apr-22	-	Jun-22	May-07	Jun-02
	2006	502	Apr-16	-	May-28	May-11	May-20
	2007	271	May-02	-	Jun-02	May-14	May-22
McNary	1993	7	May-11	-	Jun-05	May-19	May-30
	1994 ¹	22	May-17	-	Jul-14	Jun-05	Jul-10
	1994 ²	56	May-20	-	Jul-11	Jun-17	Jul-08
	1995	69	May-15	-	Jul-17	Jun-05	Jun-27
	1996	30	Apr-27	-	Jul-03	May-23	Jun-07
	1997	245	Apr-23	-	Aug-12	May-27	Jun-18
	1998	31	May-13	-	Jul-02	Jun-01	Jun-19
	1999	79	Apr-27	-	Jul-08	May-28	May-31
	2000	58	May-03	-	Jul-30	Jul-02	Jul-17
	2001	8	May-21	-	Jul-04	NA	NA
	2002	56	May-02	-	Jun-16	May-25	Jun-06
	2003	110	Apr-30	-	Jun-01	May-25	May-29
	2004	167	May-06	-	Jul-28	May-31	Jun-12
	2005	571	May-04	-	Jun-29	May-18	May-27
	2006	154	Apr-21	-	Jun-03	May-11	May-23
2007	81	Apr-28	-	Jun-18	May-17	May-29	

¹ NPT PIT tagged fish released at dark.

² FPC PIT tagged fish released after recovery.

Appendix M. Mortality of Nacó'x̂ (Chinook salmon) and Héeyey (steelhead) smolts due to trapping, handling, PIT tagging and dead on arrival at the Imnaha River juvenile migration trap from October 5 to November 29, 2006.

Source of Mortality	Nacó'x̂ (Chinook salmon)				Héeyey (steelhead)			
	Natural		Hatchery		Natural		Hatchery	
	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
Trapping	73	1.822	0	0	0	0	0	0
Handling	1	0.025	0	0	0	0	0	0
Tagging	1	0.025	0	0	0	0	0	0
DOA	2	0.050	0	0	0	0	0	0
Number Captured	4,006		0		202		0	
Total Mortality	77	1.922	0	0	0	0	0	0

Appendix N. Mortality of Nacó'x̂ (Chinook salmon) and Héeyey (steelhead) smolts due to trapping, handling, PIT tagging and dead on arrival at the Imnaha River juvenile migration trap from February 28 to June 21, 2007.

Source of Mortality	Nacó'x̂ (Chinook salmon)				Héeyey (steelhead)			
	Natural		Hatchery		Natural		Hatchery	
	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
Trapping	47	0.436	16	0.021	7	0.067	8	0.022
Handling	1	0.009	1	0.001	2	0.019	1	0.003
Tagging	23	0.213	0	0	25	0.241	0	0
DOA	14	0.130	38	0.050	2	0.019	1	0.003
Number Captured	10,777		76,274		10,371		36,206	
Total Mortality	85	0.789	55	0.072	36	0.347	10	0.028

Appendix O. The catch of incidental fish during the fall, 5 October to 29 November 2006, and the spring, 28 February to 21 June 2007, at the Imnaha River juvenile fish trap for the 2007 migration year. Catch totals include subsampling estimates.

Family	Common Name	Fall 2006	Spring 2007	Total
Salmonidae	Adult Héeyey (steelhead)	2	72	74
	Rainbow Trout / Héeyey (steelhead)	355	649	1,004
	Cimey (Mountain Whitefish)	112	4	116
	Islam (Bull Trout)	182	3	185
Centrarchidae	Smallmouth Bass	0	2	2
Catostomidae	Muq'uc (Bridgelip Sucker)	1	148	149
	Muq'uc (Largescale Sucker)	0	23	23
	Muq'uc (unidentified species)	85	644	729
Cyprinidae	Tite'wxc (Chislemouth)	2	10	12
	Longnose Dace	1	611	612
	Qiyex (Northern Pikeminnow)	20	22	42
	Redside Shiner	3	3	6
	Peamouth	0	13	13
Cottidae	Sculpin (unidentified species)	6	46	52
Petromyzotidae	Juvenile Hessu (unidentified strain) (Pacific Lamprey)	0	612	612
	Juvenile Hessu (Silver) (Pacific Lamprey)	5	246	251
	Juvenile Hessu (Brown) (Pacific Lamprey)	0	559	559
Total Catch		774	3,067	3,841