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Emigration of Natural and Hatchery Nacó'x (Chinook salmon; *Oncorhynchus tshawytscha*) and Héeyey (Steelhead; *Oncorhynchus mykiss*) Smolts from the Imnaha River, Oregon from 3 October 2007 to 21 June 2008

2008 Annual Report and Compilation of SMP Data

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EXECUTIVE SUMMARY

This report summarizes the Nez Perce Tribe's Imnaha River juvenile Nacó'x (Chinook Salmon; *Oncorhynchus tshawytscha*) and Héeyey (steelhead; *O. mykiss*) emigration studies conducted from October 3, 2007, to June 21, 2008 (migration year 2008). The studies have been ongoing for the past 17 years and have contributed information to the Fish Passage Center's Smolt Monitoring Program for the past 15 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'x (Chinook salmon) and Héeyey (steelhead) at Lower Granite Dam (LGD), Little Goose Dam (LGS), Lower Monumental Dam (LMD), and McNary Dam (MCD). This report represents a compilation of the 10 years of SMP operations in addition to the MY 2008 summaries.

Imnaha River Nacó'x (Chinook salmon) and Héeyey (steelhead) smolts migrating in the spring had average hydrologic conditions within the Imnaha and Snake Rivers. Average monthly discharge from February to June ranged from 5 cms (February) to 54 cms (June) with a peak discharge of 70.1 cms in May. The average monthly discharge in the Snake River ranged from 585.6 cms in February to 2,214.0 cms in June. Spill at LGD, LGS, LMD, and MCD began in early April and lasted until September 1. Maximum water temperatures in the tailraces of LGD, LGS, LMD, and MCD exceeded 18 °C after mid-July.

A total of 12,932 natural origin Nacó'x (Chinook salmon smolts and pre-smolts), 75,632 hatchery origin Nacó'x (Chinook salmon), 4,306 natural origin Héeyey (steelhead), and 19,459 hatchery origin Héeyey (steelhead) were captured in Migration year 2008. The studies PIT tagged a total of 10,533 natural Nacó'x (Chinook salmon), 2,382 natural Héeyey (steelhead), and 1 hatchery Héeyey (steelhead). Hatchery Nacó'x (Chinook salmon) had a mean fork length (124.1 mm) that was significantly different ($p < 0.05$) than the mean fork length of natural Nacó'x (Chinook salmon) (98.6 mm). Previously PIT tagged hatchery Héeyey (steelhead) had a mean fork length (210.9 mm) that was significantly larger ($p < 0.05$) than the mean fork length of natural produced Héeyey (steelhead) (166.3 mm).

The estimated post release survival of previously PIT tagged hatchery Nacó'x (Chinook salmon) from release at the Gumboot acclimation site to the Imnaha River juvenile migrant trap was 97.8% in spring of 2008. The post-release survival estimate was the second highest on record. The post-release survival in 2006 was only 63.3%.

The survival estimate of natural Nacó'x (Chinook salmon) tagged in the fall was 40.3% to LGD. Past Survival estimates from the trap to LGD for fall tagged Imnaha River natural Nacó'x (Chinook salmon) have ranged from 21.6% to 60.4% from 1994 to 2008.

Imnaha River smolt estimated survivals from release at the Imnaha River to LGD in spring of 2008 were 84.2% for natural Nacó'x (Chinook salmon), 70.1% for hatchery Nacó'x (Chinook salmon), 89.7% for natural Héeyey (steelhead), and 82.7% for hatchery Héeyey (steelhead). The estimated survival from the Imnaha River to LMD was 88.4% for natural Nacó'x (Chinook salmon), 58.4% for hatchery Nacó'x (Chinook salmon), 86.5% for natural Héeyey (steelhead), and 57.5% 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'x (Chinook salmon) for migration years 1998 to 2005. Each MY after MY 2003 was also divided into "survival" or "monitor" mode groups. The survival mode SARs characterize Imnaha natural Nacó'x (Chinook salmon) that were mostly bypassed when detected at the dams and traveled in-river (i.e. not barged). The monitor mode smolts are intended to represent the run at large juvenile population and are subject to the same migration conditions as the unmarked fish (i.e. transportation, etc.). The survival mode, LGD to LGD SAR index for fall survival tagged natural Nacó'x (Chinook salmon) ranges from 0.46% (MY 2005) to 5.99% (MY 2000) and for spring survival tagged natural Nacó'x (Chinook salmon) SAR ranges from 0.17% (2005) to 2.67% (MY 2000). The monitor mode LGD to LGD SAR index for fall tagged natural Nacó'x (Chinook salmon) ranges from 0.23% (MY 2005) to 1.16% (MY 2004) and for spring monitor tagged natural Nacó'x (Chinook salmon) SAR ranges from 0.00% (2005) to 0.42% (MY 2004).

Significant difference ($p < 0.05$) in the median arrival dates of fall and spring PIT tagged natural Nacó'x (Chinook salmon) was observed at LGD. Median arrival timing of fall tagged natural Nacó'x (Chinook salmon) at LGD occurred on April 22: 21 days earlier than the median arrival timing for spring tagged natural Nacó'x (Chinook salmon) smolts (May 13).

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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 2008 smolt migration from the Imnaha River, Oregon. These studies are closely coordinated and provide information about juvenile natural and hatchery spring/summer Nacó'x (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'x (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'x (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'x (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'x (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 2008 marked the 17th year of emigration studies on the Imnaha River, and the 15th 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 emigration 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.

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 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 3 to November 21, 2007, and from February 28 to June 18, 2008. 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 or excessive debris. 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 1) isolating all trapped fish within the livebox, 2) divert incoming fish through a PIT Tag detector, 3) collect one net-full of captured fish for processing, 4) 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) file of PIT Tag numbers and a text file recording the 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. All other calculations

within this document are based on the actual PIT Tag numbers, not the scaled up numbers of fish handled.

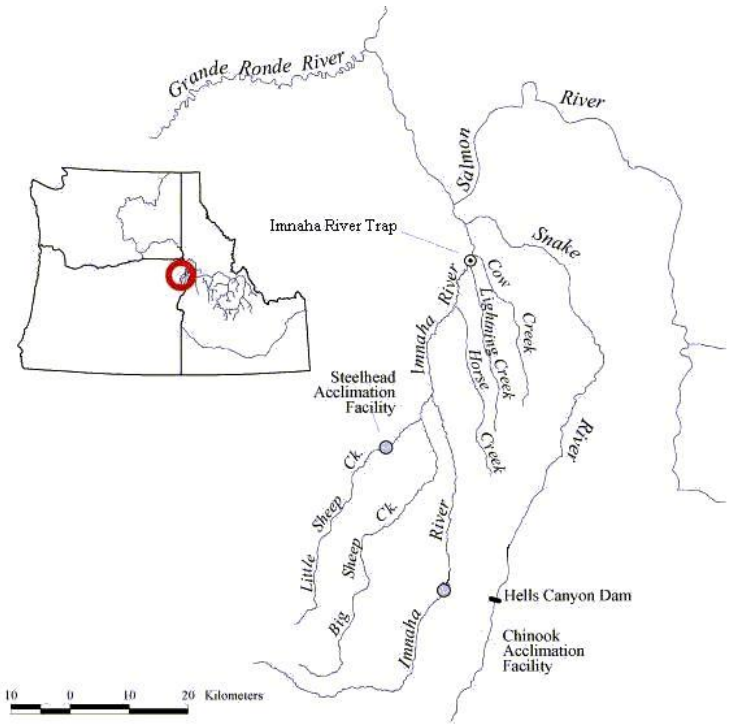

Figure 1. Map of the Imnaha River study area.

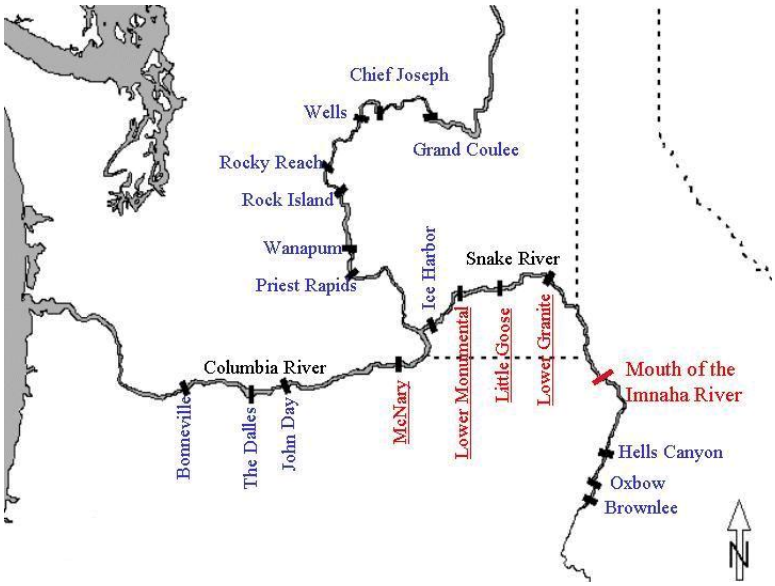

Figure 2. Map of the Columbia River Basin. Dams underlined indicate monitoring points for the Imnaha Smolt Monitoring Program.

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'x (Chinook salmon), Héeyey (steelhead) and large piscivorous fish were scanned with a PIT tag scanner, 4) fifty randomly selected natural Nacó'x (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'x (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'x (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'x (Chinook salmon) in fall of 2007 and both natural Nacó'x (Chinook salmon) and natural Héeyey (steelhead) smolts in the spring of 2008 were conducted. The daily goal was to randomly tag 50 natural Nacó'x (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'x (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 by 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'x (Chinook salmon). Season-wide and weekly release groups of natural and hatchery Nacó'x (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'x (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'x (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 2007 and spring of 2008. 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)

Marks, such as PIT tags are used to generate efficiency estimates of migrating fish through the migration traps and to provide life history specific migration timing and survival estimates to LGD and other mainstem dams. However, once at LGD, tagged and non-tagged fish can experience different migration routes. The current default operations at the hydro-facilities are to return to the river all PIT tagged fish entering the bypass facility, while the vast majority of non-tagged fish that enter the bypass facility are transported to below Bonneville Dam. This default operation incrementally increases the relative proportion of PIT tagged to non-PIT tagged fish in the river. With differential mortality rates between the in-river and transportation passage routes, PIT tagged fish are affected at different rates relative to non-PIT tagged fish. This differential mortality will decrease (bias) the number and the overall proportion of PIT tagged to non-tagged fish that migrate to the ocean. Thus PIT tagged fish no longer represent the general non-tagged population of fish after passing LGD and limits, if not eliminates, our ability to calculate representative smolt-to-adult survival rate (SAR) and returning abundance of the general population. The SAR and adult returns calculated from adult PIT tag detections

potentially only reflect fish that were bypassed or remained in the river undetected, not the entire migrant group.

With the separation by code (SbyC) technology currently operating in the hydro-system bypass facilities, it is now possible to accurately represent non-PIT tagged fish migrating through the hydro-system using a predetermined group of PIT tagged fish. The PIT tag codes from a predefined group of PIT tags can be entered into the SbyC system and given a specific action. The SbyC system has the ability to bypass or transport all, a predetermined portion, or every n^{th} individual entering each bypass facility and can be modified or eliminated as desired at any time during the migration period. To accurately represent non-tagged fish, a "monitor mode" can be designated for a predefined group of PIT tags, resulting in "no action" taken on the detected PIT tags. The "monitor mode" group of PIT tags will be barged, bypassed, or remain undetected in the same relative proportions as non-PIT tagged fish. Thus, returning PIT tagged adults accurately represent non-tagged adults regardless of juvenile detection rates, transportation rates, in-river survival rates, and potential delayed mortality of in-river and transported fish. These adult PIT tag detections are then used to calculate representative SARs and adult run predictions.

One drawback to the SbyC system and the "monitor mode" action is the loss of in-river juvenile survival rate estimates. Multiple mark-recapture estimators are generally applied to PIT tag detections through the hydro-system to estimate project specific survival and detection rates (bypass efficiency). For these estimators, at least two recapture periods are needed. For juvenile survival estimates to LGD, PIT tags must be available for detection at LGD and at another subsequent dam. In general, PIT tags in the "monitor mode" group likely removed from the river system upon first detection thereby eliminating survival rate estimates from this group. To generate survival rates to LGD and through the remainder of hydro-system, a second group of PIT tags are required to migrate through the hydro-system, available for multiple, hydro-system detections.

Juvenile survivals (smolts) to LGD and McNary are determined for all life stages independently. The minimum number of PIT tags needed to generate life stage specific survival rates to LGD are 500 to 1,500 tags depending upon life stage (Lady et al. 2001). Detections from these groups are modeled through the SURPH sample size program to obtain life-stage specific survival estimates from the natal stream to LGD.

Granite-to-Granite SARs and are generated from the number or relative proportion of PIT tags at LGD. Use of PIT tags in conjunction with the SbyC system ultimately allows us to minimize bypass assumptions and base our SAR's and adult run estimates on migration estimates (and associated error) and PIT tag proportions (and associated error).

Migrant trap efficiency estimates are used to calculate the number and confidence interval of life history stage migrating from the natal stream. Lifestage specific migration timing and survival calculated from PIT tagged fish is then applied to the estimated non-tagged migrant population to generate an estimate and confidence interval of the number of migrants that survived to the smolt stage at LGD (smolt equivalents). Survival of PIT-tagged fish to Snake

River and Columbia River dams are estimated by the SURPH.2 model (Smith et al. 1994, Lady et al. 2001). Smolt detections are used to calculate SARs when tagged fish return as adults and are detected. Adult passage through the FCRPS is monitored with queries to the PTAGIS database.

Smolt-to adult return rate indices (SARs) were calculated for four distinct groups of PIT tagged juvenile natural Nacó'x (Chinook salmon) emigrants from the Imnaha River, the fall and spring groups each divided into "survival" and "monitor" mode groups for migration years 1998 through 2005. There are no comprehensive adult PIT Tag detection facilities on the Imnaha River, so SAR rates are calculated from the Imnaha River Trap to LGD and LGD to LGD.

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'x (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'x (Chinook salmon) were compared using a Kolmogrovov-Smirnov test (Steel et al. 1997 and STATAGRAPHICS 1995).

Travel time is the time it takes an individual tagged fish to travel from either the acclimation facilities or the Imnaha trap to juvenile detectors at specific dams. Weeks with at least 30 PIT tag interrogations at 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

Imnaha River

The mean daily discharge during the study period, unaffected by potential freezing water, ranged from 2.9 cms on October 15, 2007 to 146.1 cms on May 19, 2008 (Figure 4). Daily mean water temperatures ranged from -0.6 °C in early January, 2008, to 13.1 °C on June 17, 2008.

Monthly average discharge for the Imnaha River for the months of October, November of 2007 and February, March, April, May, and June of 2008 were 3.5, 4.2, 4.9, 7.7, 15.5, 70.1, and 54.0 cms respectively (Figure 5). The spring runoff for the Imnaha River was within the range of the 80 year monthly median discharge values observed from 1929 to 2008.

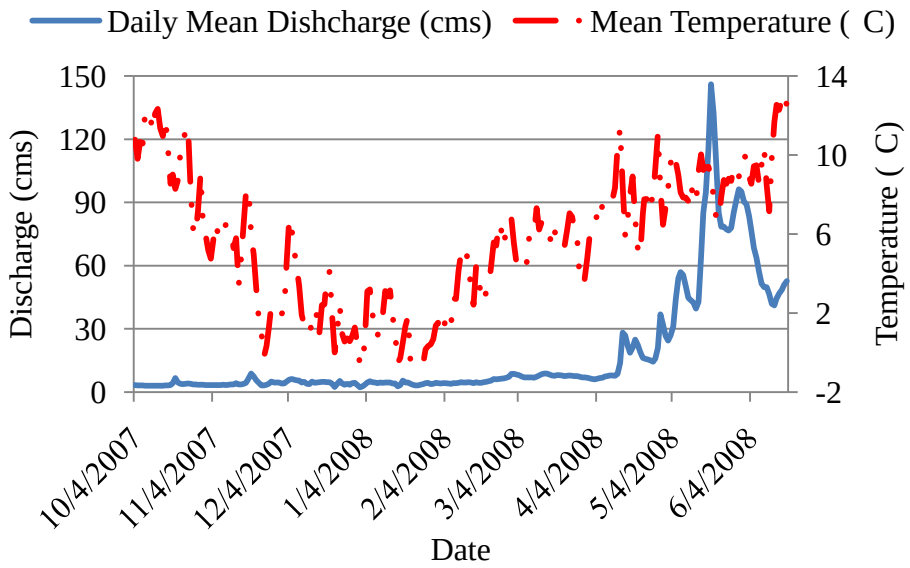

Figure 4. The average daily discharge at the Imnaha River USGS gauge 13292000 and the average daily temperature from October 4, 2007, to June 16, 2008, at the Imnaha River juvenile migration trap.

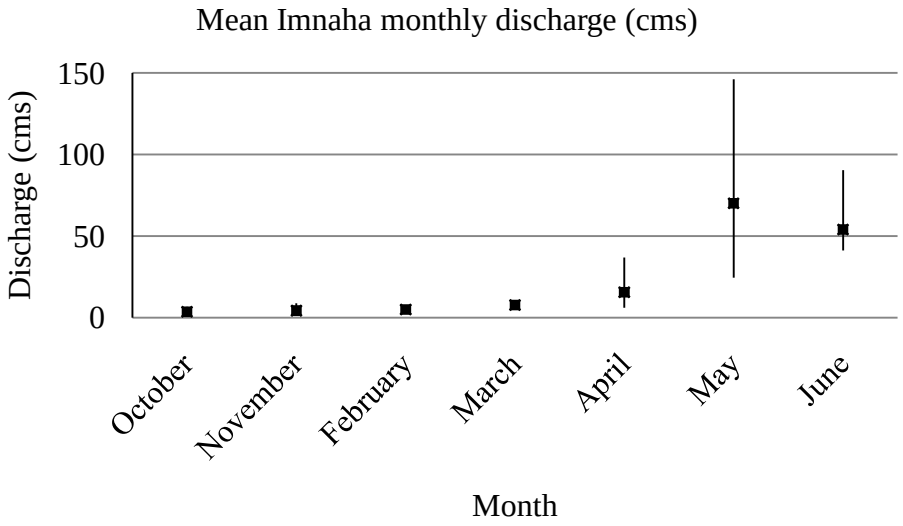

Figure 5. The average monthly discharge for the months of October and November 2007 and February, March, April, May, and June for 2008 at the Imnaha River USGS gauge 13292000. Bars indicate the minimum and maximum average monthly discharge values observed from 1959 to 2008.

Snake River

Snake River mean daily discharge during the study period ranged from 385.1 cms on October 15-17, 2007, to 3,709.5 cms on May 21, 2008 (Figure 6). Daily mean water temperatures ranged from 1.0 °C on January 26, 2008, to 17.2 °C on June 30, 2008.

Monthly average discharge for October, November of 2007 and February, March, April, May, and June of 2008 were as follows: 455.1, 446.8, 585.6, 714.4, 922.0, 2,187.8, and 2,214.1 cms respectively (Figure 7).

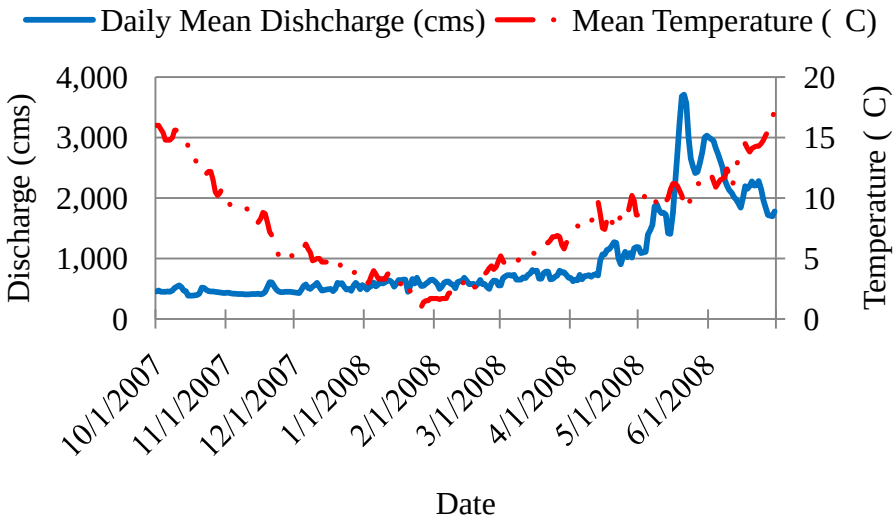

Figure 6. The average daily discharge and temperature at the Snake River gauge 13334300 from October 1, 2007, to June 16, 2008.

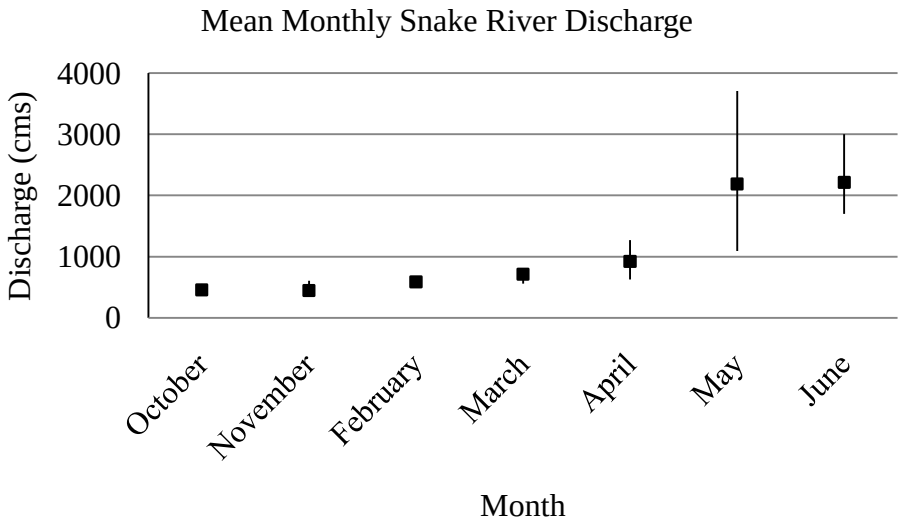

Figure 7. The average monthly discharge for the months of October and November 2007 and February, March, April, May, and June for 2008 at the Snake River USGS gauge 13334300. Bars indicate the minimum and maximum average monthly discharge values observed from 1959 to 2008.

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, 4.1 °C at LGS on March 1, 3.9 °C at LMD on March 1, and 5.2 °C at MCD on March 31. Maximum water temperatures in the tailraces were as follows: 19.5 °C at LGD on August 17, 20.4 °C at LGS on August 15 and August 1, 20.8 °C at LMD on August 20 and August 6, and 21.6 °C at MCD on July 18.

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.

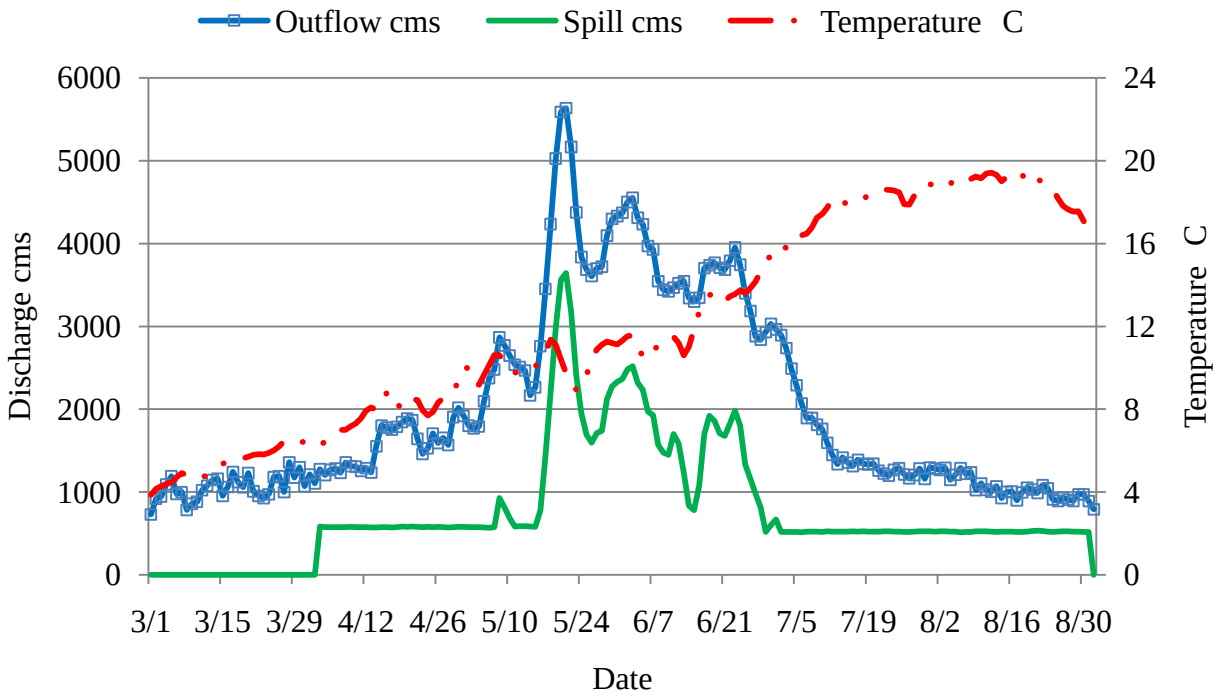

Figure 8. Measurements of outflow, spill, and mean temperature at Lower Granite Dam from March 1 to September 1, 2008. Data obtained online at http://www.cbr.washington.edu/dart/.

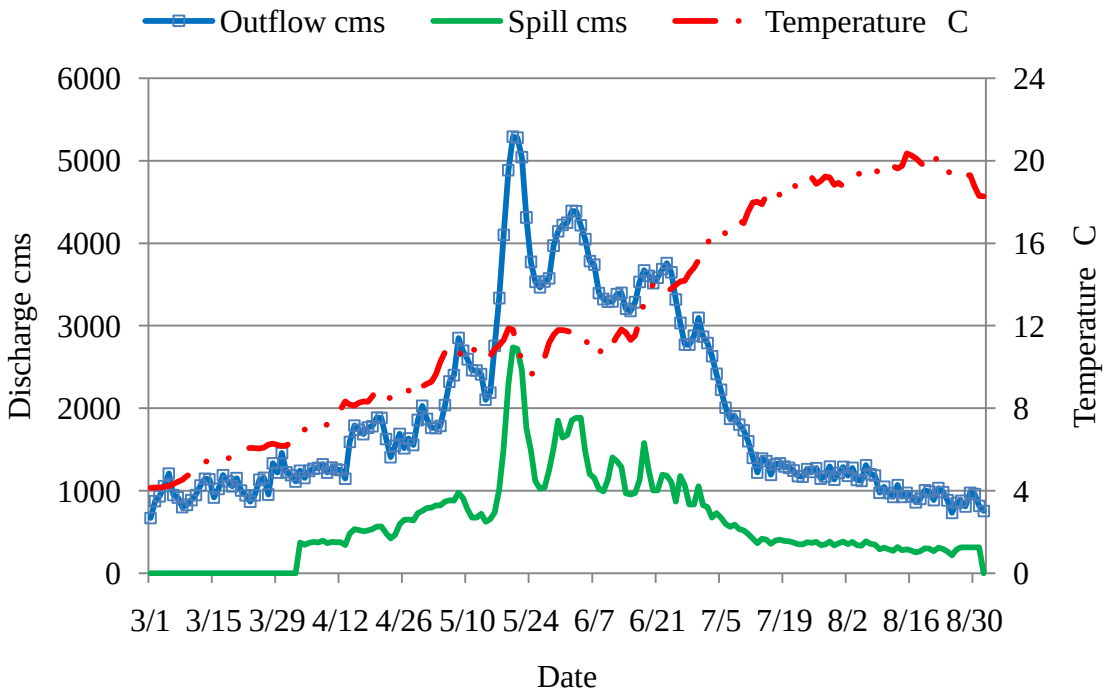

Figure 9. Measurements of outflow, spill, and mean temperature at Little Goose Dam from March 1 to September 1, 2008. Data obtained online at http://www.cbr.washington.edu/dart/.

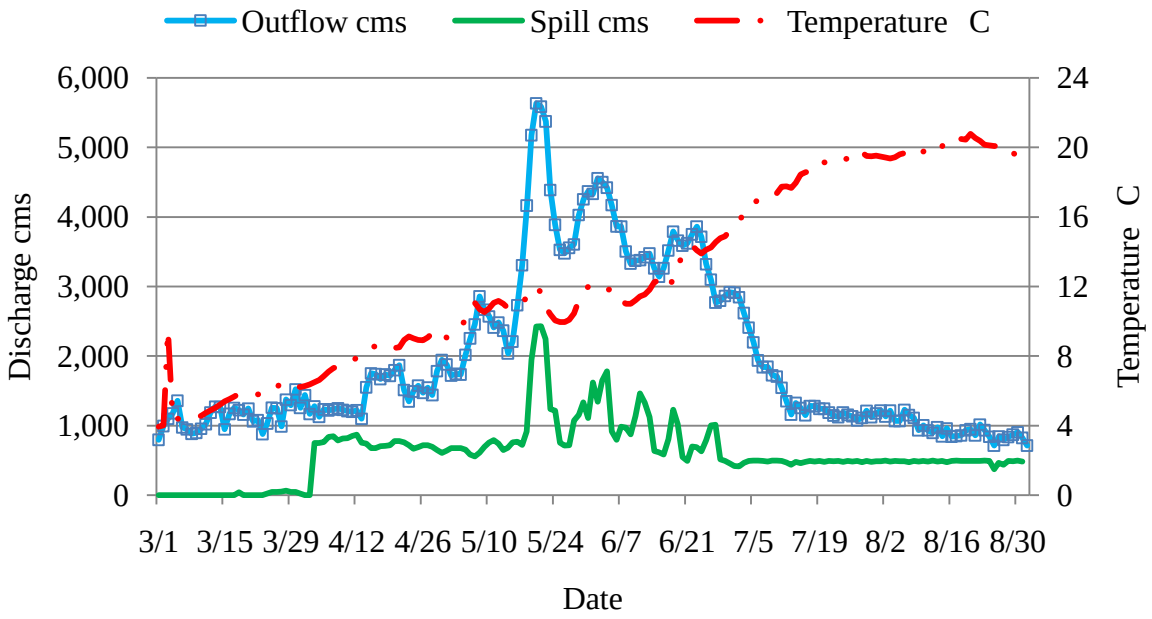

Figure 10. Measurements of outflow, spill, and mean temperature at Lower Monumental Dam from March 1 to September 1, 2008. Data obtained online at http://www.cbr.washington.edu/dart/.

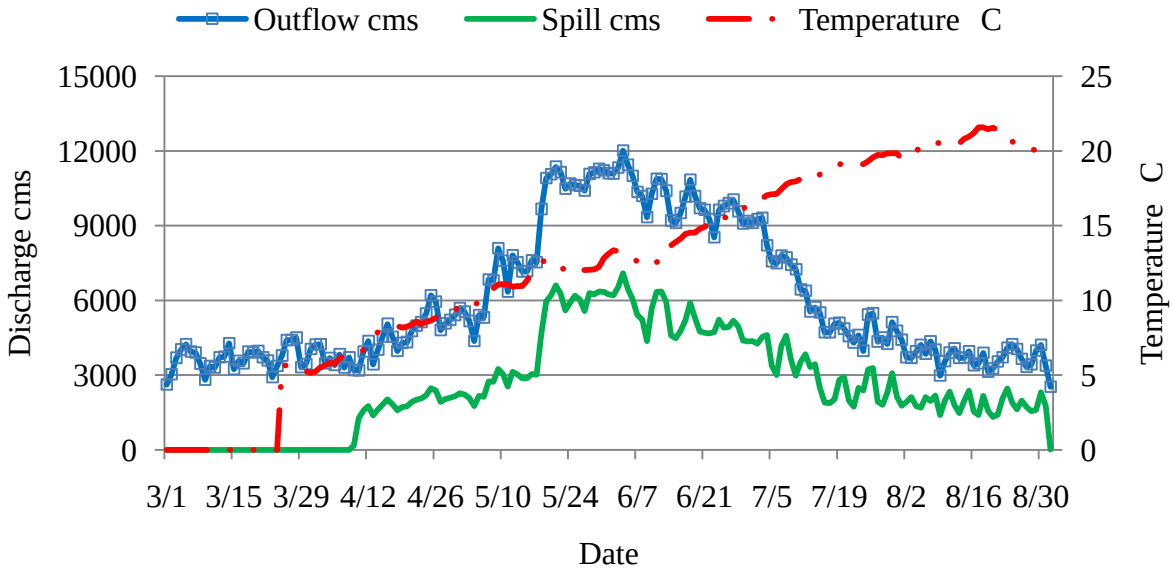

Figure 11. Measurements of outflow, spill, and mean temperature at McNary Dam from March 1 to September 1, 2008. Note that temperature did not begin recording until March 25. Data obtained online at http://www.cbr.washington.edu/dart/.

Hatchery Releases

Nacó'x (Chinook salmon)

A total of 348,910 Nacó'x (Chinook salmon) were released from the Imnaha River Gumboot acclimation facility at rkm 74 (Table 1). One volitional release of Nacó'x (Chinook salmon) occurred during the 2008 migration season. The volitional release of 348,910 Nacó'x (Chinook salmon) arrived at the acclimation facility on March 12 through 14. Hatchery personnel began pulling dam boards on March 25 and fish left volitionally until April 10 when all remaining smolts were forced out. All Nacó'x (Chinook salmon) were marked with an adipose fin clip, 174,995 (50.1 % of the release) had a coded wire tag, and 14,928 (4.3% of the release group) were marked with a PIT tags (D. Eddy, Oregon Fish and Wildlife, personal communication).

Héeyey (Steelhead)

Hatchery Héeyey (steelhead) were released at two locations in the Imnaha River Subbasin in MY 2008 totaling 274,865 smolts (Table 1.) A total of 171,545 Héeyey (steelhead) arrived between March 6 and March 7 at the LSRCP Little Sheep Creek acclimation facility and volitionally released between April 1 and April 29. A total of 23,792 were marked with adipose and left ventral fin clips and coded wire tags (CWT), 9,193 of which had PIT tags. An additional 142,443 were marked with an adipose fin clip, 2,428 of which also had a left ventral fin clip. The remaining 2,882 had no marks. A direct release of 103,320 Héeyey (steelhead) occurred from April 9 to April 14, 2008. No external marks were applied to these smolts, 5,670 of which had PIT tags (D. Eddy, Oregon Fish and Wildlife, personal communication).

Table 1. Releases of hatchery reared Nacó'x (Chinook salmon) and Héeyey (steelhead) smolts to the Imnaha River Subbasin during migration year 2008 (D. Eddy, Oregon Fish and Wildlife, personal communication, December 2009).

Release Year	Species	Arrival at Acclimation Site	Number Released	Release Dates	Tags / Marks	Release Site
2008	Nacó'x (Chinook salmon)	March 12 - 14	348,910	March 25 – April 10	100% adipose fin clipped with 174,995 CWT and 14,928 PIT tags.	Imnaha River (Gumboot)
2008	Héeyey (steelhead)	March 6 - 7	171,545	April 1 - 29	23,792 adipose and left ventral fin clipped with CWT and 9,193 PIT tags. 142,443 adipose fin clipped only, 2,428 left ventral fin clipped but no CWT, and 2,882 no mark.	Little Sheep Creek
2008	Héeyey (steelhead)	Direct Stream	103,320	April 9 - 14	100% No mark and 5,670 PIT tags.	Big Sheep Creek

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

Catch for Migration Year 2008

The catch of natural Nacó'x (Chinook salmon) for migration year 2008 (fall and spring) totaled 12,932 fish. The largest weekly catch during fall trapping occurred during the week of October 21 (n = 2,425) and the next largest catch was November 18 (n = 2,223). The largest weekly catch during spring trapping occurred during the week of April 13 (n = 2,229). The weekly mean discharge during the week of October 21 was 4.0 cms with a mean water temperature of 9.5 °C (Table 2 and Appendix A). The weekly mean discharge and water temperature during the week of April 13 was 22.2 cms and 8.0 °C. During the fall of 2007 and spring of 2008 the weekly catch of natural Nacó'x (Chinook salmon) smolts exceeded 1,000 for four weeks. A total of 75,632 hatchery Nacó'x (Chinook salmon) were captured, with the first captures occurring during the week of March 23 (Table 2 and Appendix A). More than 80

percent (n = 62,620) were captured during the weeks of April 6 and April 13. Total captures include the smolts actually handled plus the estimated subsampling numbers.

Table 2. The weekly mean discharge (cms), temperature (°C), and catch, including subsample estimates, of natural and hatchery Nacó'x (Chinook salmon) and Héeyey (steelhead) at the Imnaha River juvenile migration trap from 3 October 2007 to 21 June 2008.

Week	Average Discharge (cms)	Average Temperature (°C)	Natural Nacó'x (Chinook salmon)	Hatchery Nacó'x (Chinook salmon)	Natural Héeyey (steelhead)	Hatchery Héeyey (steelhead)
9/30/2007	3.3	10.9	67	0	19	0
10/7/2007	3.0	11.8	55	0	8	0
10/14/2007	3.7	10.0	577	0	0	1
10/21/2007	4.0	9.5	2,425	0	8	0
10/28/2007	3.4	6.4	1,033	0	12	0
11/4/2007	3.4	6.1	513	0	10	0
11/11/2007	3.8	5.8	465	0	0	0
11/18/2007	5.6	3.6	2,223	0	0	0
2/24/2008	6.8	6.2	26	0	2	0
3/2/2008	7.6	5.0	227	0	10	0
3/9/2008	7.9	6.3	91	0	7	0
3/16/2008	7.9	5.8	117	0	6	0
3/23/2008	7.5	5.6	454	1,885	13	0
3/30/2008	6.5	5.9	743	9,998	8	43
4/6/2008	7.7	8.3	680	40,662	20	2,870
4/13/2008	22.2	8.0	2,229	21,958	1092	6,699
4/20/2008	16.9	6.9	530	603	317	856
4/27/2008	26.2	8.6	387	463	1567	3,800
5/4/2008	48.1	8.6	36	34	643	2,347
5/11/2008	59.0	8.8	28	25	446	2,254
5/18/2008	106.5	8.1	0	0	2	1
5/25/2008	85.6	8.9	10	2	51	241
6/1/2008	75.6	9.2	0	2	37	118
6/8/2008	46.4	9.9	6	0	25	166
6/15/2008	49.6	12.8	2	0	3	63
Totals			12,924	75,632	4,306	19,459

The catch of natural Héeyey (steelhead) totaled 4,306 fish (Table 2 and Appendix A). The largest weekly catch occurred during the week of April 27 and totaled 1,567 fish. The mean weekly discharge and water temperature during the week of April 27 was 2,626.2 cms and 8.6 °C. The catch of hatchery Héeyey (steelhead) was 19,459 fish with the largest weekly catch of hatchery Héeyey (steelhead) totaling 6,699 occurred on the week of April 13, with a mean discharge of 22.2 cms, and 8.0 °C.

PIT Tagging

A total of 10,533 natural Nacó'x (Chinook salmon) were PIT tagged at the Imnaha trap for the 2008 migration year. Sixty nine percent of the PIT tagged natural Nacó'x (Chinook salmon) (n = 7,267) were tagged in the fall of 2007 (Table 3 and Appendix B). PIT tagged natural Héeyey (steelhead) totaled 2,533 fish (Table 3 and Appendix B). We did not intentionally tag any hatchery Héeyey (steelhead), because 14,887 were previously tagged at Irrigon National Fish Hatchery.

Table 3. The number of natural and hatchery Nacó'x (Chinook salmon) and Héeyey (steelhead) PIT tagged weekly at the Imnaha River juvenile migration trap from 3 October 2007 to 18 June 2008.

Week	Natural Nacó'x (Chinook salmon)	Hatchery Nacó'x (Chinook salmon)	Natural Héeyey (steelhead)	Hatchery Héeyey (steelhead)
9/30/2007	52	0	0	0
10/7/2007	42	0	0	0
10/14/2007	565	0	0	0
10/21/2007	2,404	0	1	0
10/28/2007	1,018	0	0	0
11/4/2007	503	0	0	0
11/11/2007	463	0	0	0
11/18/2007	2,220	0	0	0
2/24/2008	15	0	1	0
3/2/2008	219	0	10	0
3/9/2008	90	0	5	0
3/16/2008	83	0	7	0
3/23/2008	412	0	11	0
3/30/2008	761	0	10	0
4/6/2008	164	0	4	0
4/13/2008	570	0	233	0
4/20/2008	552	0	349	0
4/27/2008	293	0	800	1
5/4/2008	62	0	495	0
5/11/2008	27	0	342	0
5/18/2008	0	0	0	0
5/25/2008	10	0	51	0
6/1/2008	0	0	19	0
6/8/2008	6	0	41	0
6/15/2008	2	0	3	0
Totals	10,533	0	2,382	1

Recaptures of Previously PIT Tagged Smolts

Several organizations have PIT tagged both natural and hatchery Nacó'x (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 22 of the 1,000 natural Nacó'x (Chinook salmon) that were previously PIT tagged by Oregon Department of Fish and Wildlife's (ODFW) Early Life History Program on September 4-6, 2007 (Appendix C). Recaptured fish averaged 80.1 mm in fork length, 6.7 g in weight, and 1.23 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.

A total of 1,358 previously PIT tagged hatchery Nacó'x (Chinook salmon) released from the Imnaha River Gumboot acclimation facility were recaptured at the Imnaha juvenile migration trap. They averaged 123.6 mm in fork length, 22.7 g in weight, and a 1.18 condition factor (Table 4 and Figure 12).

A total of 424 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 211.3 mm in fork length, 103.4g in weight, and a 1.07 condition factor (Table 4).

Table 4. Averages, ranges, and standard deviations of fork lengths (mm), weights (g), and condition factors (K) with minimum, maximum, and sample size values for recaptures of previously PIT tagged natural and hatchery Nacó'x (Chinook salmon), and hatchery Héeyey (steelhead) observed during the 2008 migration year, 3 October 2007 to 18 June 2008, at the Imnaha River juvenile migration trap.

Attribute	Statistic	Natural Nacó'x (Chinook salmon)	Hatchery Nacó'x (Chinook salmon)	Hatchery Héeyey (steelhead)
Fork Length (mm)	Sample Size (n)	20	1,358	424
	Average	80.1	123.6	211.3
	Minimum	60	78	142
	Maximum	102	190	277
	Standard Deviation	10.4	11.7	20.9
Weight (g)	Sample Size (n)	20	1,346	404
	Average	6.715	22.7	103.4
	Minimum	2.4	8.4	30.6
	Maximum	13.9	77	261.4
	Standard Deviation	2.9	6.6	32.4
Condition Factor (K)	Sample Size (n)	20	1,332	404
	Average	1.23	1.18	1.07
	Minimum	1.07	0.69	0.78
	Maximum	1.49	1.77	1.44
	Standard Deviation	0.10	0.13	0.08

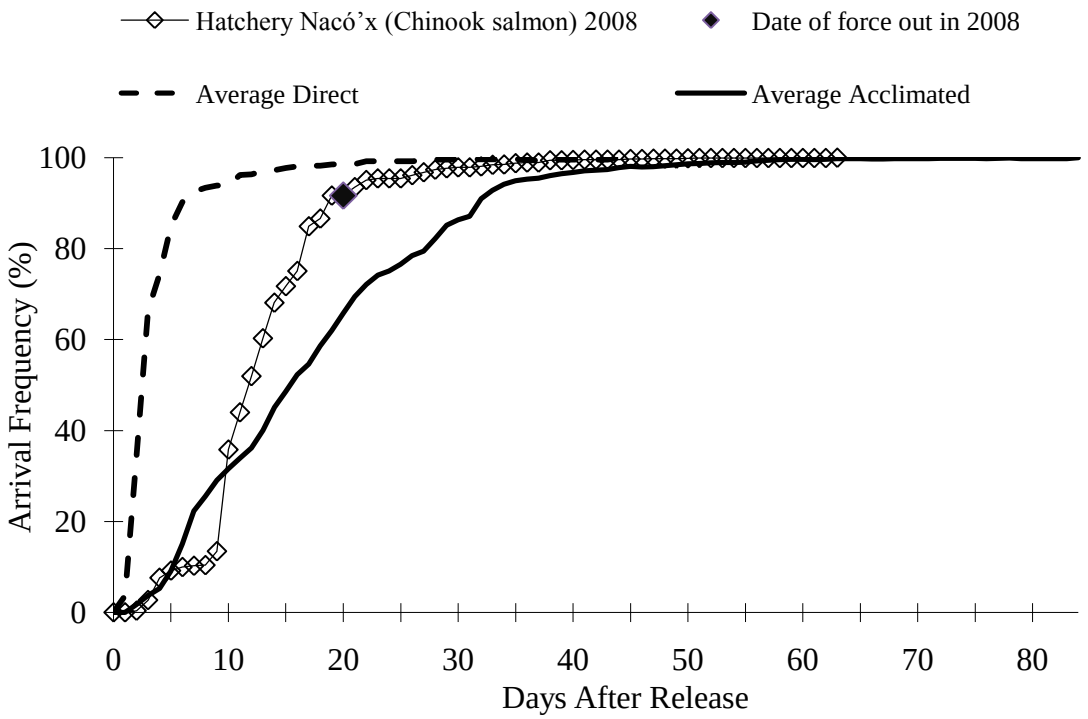

Figure 12. The MY 2008 arrival frequency and averaged arrival frequency of previously PIT tagged hatchery Nacó'x (Chinook salmon) captured in the Imnaha River juvenile migration trap. The Average Direct includes MY 1998 and one release in 2006. The Average Acclimated includes MY 1999 through 2007.

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 79.2 mm in fork length, 6.0 g in weight, and had an average condition factor of 1.18 (Table 5). Natural Nacó'x (Chinook salmon) smolts captured in the spring averaged 98.6 mm, 11.5 g, and a condition factor of 1.18. Hatchery Nacó'x (Chinook salmon) had a larger fork length of 124.1 mm. Hatchery Nacó'x (Chinook salmon) had an average weight of 22.8 g and a condition factor of 1.17. The 124.1 mm median fork length of hatchery Nacó'x (Chinook salmon) was significantly different from the 98.6 mm median fork length of natural Nacó'x (Chinook salmon) ($p < 0.05$) (Figure 14 and Appendix D).

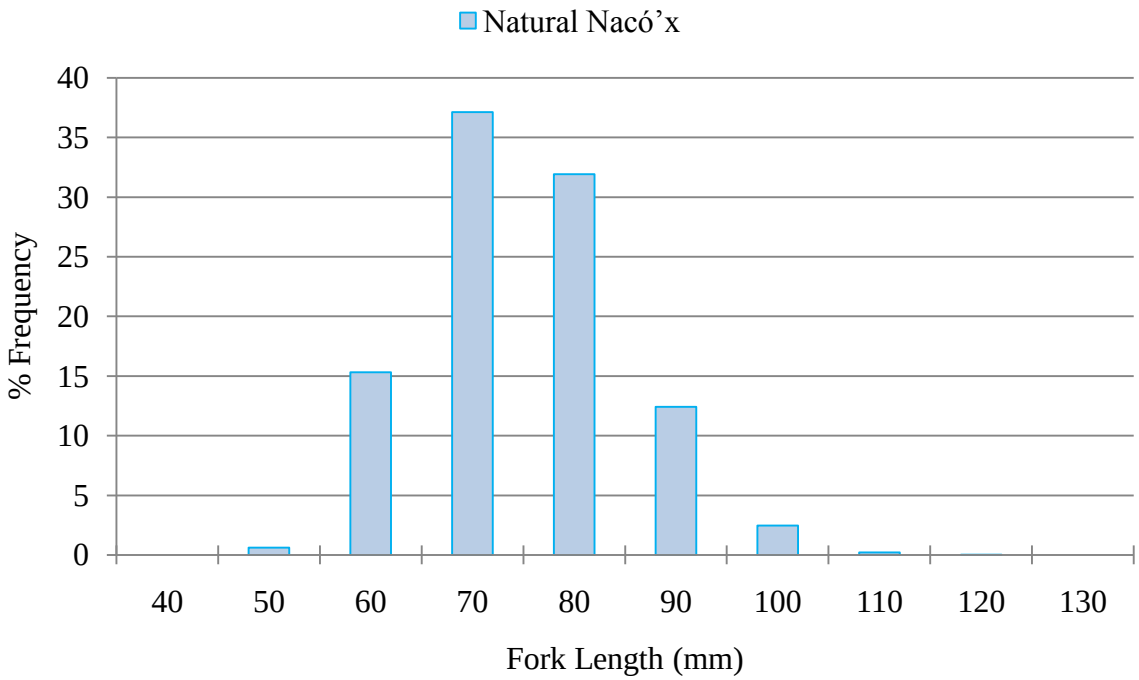

Figure 13. Length frequency distribution of natural Nacó'x (Chinook salmon) pre-smolts trapped in the Imnaha River juvenile migration trap from October 3 to November 21, 2007.

Spring captured natural Héeyey (steelhead) had an average fork length and weight of 166.3 mm and 50.4 g and a condition factor of 1.06 (Table 5 and Figure 15). Hatchery Héeyey (steelhead) were significantly larger ($p < 0.05$) with an average fork length of 210.9 mm, weight of 100.1 g and a condition factor of 1.04 (Table 5, Figure 15 and Appendix D).

Hatchery programs from 1994 to 2008 for the Imnaha River have produced 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) (1.36 K) and Héeyey (steelhead) (1.15 K) occurred during the week of June 15, for natural Nacó'x (the last week of trapping), and June 6 for natural Héeyey (Table 6). This is most likely due to the low numbers caught. The mean fork lengths of natural Nacó'x (Chinook salmon) peaked at 103.2 mm with a condition factor of 1.12 K during the week of April 4. The mean fork lengths of natural Héeyey (steelhead) peaked at 183.9 mm with a condition factor of 1.01 K during the week of March 30. The largest weekly mean fork lengths for hatchery Nacó'x (Chinook salmon) (139.0 mm) was measured during the week of June 1. Hatchery Nacó'x (Chinook salmon) averaged from 119.1 mm to 139.0 mm range for the spring trapping period. Natural Héeyey (steelhead) had weekly mean fork lengths ranging from 147.7 mm to 183.9mm (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'x (Chinook salmon) and Héeyey (steelhead) captured during the 2008 migration year, 3 October 2007 to 18 June 2008, at the Imnaha River juvenile migration trap.

		Fall 2007	Spring 2008			
Attribute	Statistic	Natural Nacó'x (Chinook salmon) (Pre-Smolts)	Natural Nacó'x (Chinook salmon) (Smolts)	Hatchery Nacó'x (Chinook salmon)	Natural Héeyey (steelhead)	Hatchery Héeyey (steelhead)
Fork Length (mm)	Sample Size (n)	7,326	3,269	1,754	2,524	1,030
	Average	79.2	98.6	124.1	166.3	210.9
	Minimum	53	67.0	87.0	120.0	127.0
	Maximum	123	154	184	245	286
	Standard Deviation	9.8	9.5	11.4	19.2	20.5
Weight (g)	Sample Size (n)	7,334	3,266	1,743	2,511	1,010
	Average	6.0	11.5	22.8	50.4	100.1
	Minimum	1.5	3.9	7.7	17.4	25.7
	Maximum	18.2	45.7	64.4	153.2	292.1
	Standard Deviation	2.1	3.3	6.6	17.4	31.0
Condition Factor (K)	Sample Size (n)	7,322	3,262	1,738	2,509	1,010
	Average	1.18	1.18	1.17	1.06	1.04
	Minimum	0.78	0.65	0.69	0.64	0.74
	Maximum	1.69	1.70	1.69	1.67	1.69
	Standard Deviation	0.13	0.13	0.12	0.10	0.09

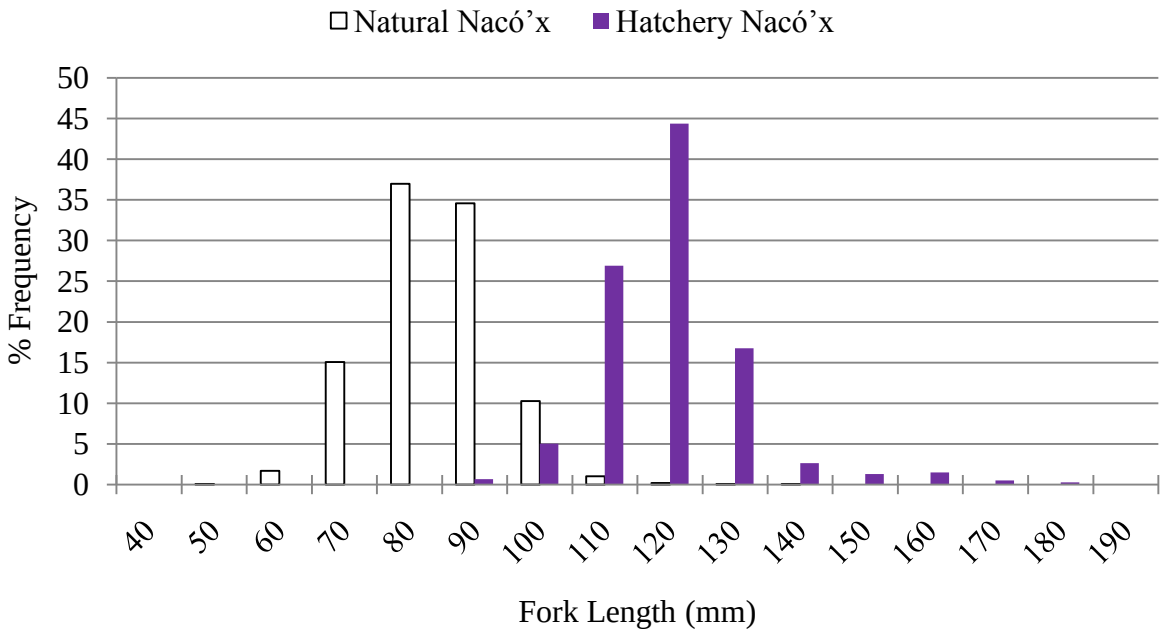

Figure 14. Length frequency distribution of natural and hatchery Nacó'x (Chinook salmon) trapped in the Imnaha River juvenile migration trap, February 28 to June 18, 2008.

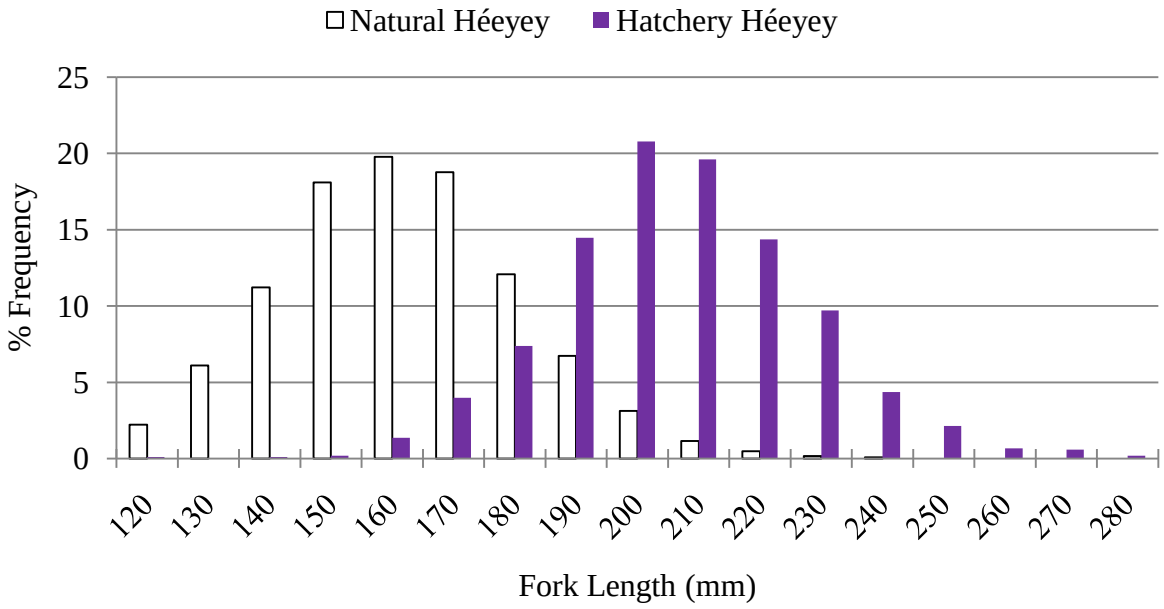

Figure 15. Length frequency distribution of natural and hatchery Héeyey (steelhead) trapped in the Imnaha River juvenile migration trap, February 28 to June 18, 2008.

Table 6. Weekly mean fork lengths (FL) and condition factors (K) for natural and hatchery Nacó'x (Chinook salmon) and Héeyey (steelhead) captured at the Imnaha River juvenile migration trap during the spring of 2008.

	Natural Nacó'x (Chinook salmon)		Hatchery Nacó'x (Chinook salmon)		Natural Héeyey (steelhead)		Hatchery Héeyey (steelhead)	
Week	FL (mm)	K	FL (mm)	K	FL (mm)	K	FL (mm)	K
2/24/2008	90.9	1.23			175.5	1.01		
3/2/2008	93.7	1.16			169.5	1.07		
3/9/2008	96.4	1.12			144.9	1.04		
3/16/2008	102.4	1.06			178.3	1.00		
3/23/2008	101.7	1.11	121.5	1.29	175.5	1.00		
3/30/2008	98.48	1.19	125.6	1.18	183.9	1.01	205.8	1.08
4/6/2008	103.2	1.12	124.8	1.16	170.0	1.04	208.7	1.09
4/13/2008	99.0	1.21	123.6	1.16	163.4	1.04	214.2	1.07
4/20/2008	96.2	1.21	119.1	1.15	163.5	1.00	218.0	1.04
4/27/2008	98.6	1.23	124.2	1.12	165.0	1.07	219.4	1.05
5/4/2008	94.8	1.26	123.2	1.13	171.4	1.08	212.6	1.04
5/11/2008	102.2	1.26	120.8	1.15	170.2	1.10	206.6	1.03
5/18/2008								
5/25/2008	99.9	1.25	126.0	1.07	154.6	1.10	195.0	1.01
6/1/2008			139.0	1.14	162.0	1.10	202.1	0.98
6/8/2008	99.7	1.23			153.4	1.15	203.1	0.97
6/15/2008	84.5	1.36			147.7	1.08	208.4	1.02

Abundance and Survival

Migration Year 2008 Natural Nacó'x (Chinook salmon) and Héeyey (Steelhead) Abundance

Trap efficiencies for natural Nacó'x (Chinook salmon) ranged from 9.0% to 39.0% through the fall season, and averaged 24.7% (Appendix E). The overall fall emigration abundance estimate for natural Nacó'x (Chinook salmon) pre-smolts was 34,120 with a lower 95% C.I of 29,907 and an upper 95% C.I. of 39,315(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'x (Chinook salmon) ranged from 9.0% to 21.0% through the season, and averaged 14.8% (Appendix E). The MY 2008 spring population estimate for natural Nacó'x (Chinook salmon) totaled 39,264 smolts (Appendix E).

The MY 2008 combined estimate (fall and spring) for natural Nacó'x (Chinook salmon) totaled 73,384 with a lower 95% C.I of 56,000 and an upper 95% C.I. of 100,325 (Appendix E).

Trap efficiencies for natural Héeyey (steelhead) ranged from 6.0% to 23% and averaged 11.3%. The overall spring emigration abundance estimate for natural Héeyey (steelhead) smolts was 50,311 with a lower 95% C.I of 39,688 and an upper 95% C.I. of 64,576 (Appendix F).

These emigration abundance estimates are based on incomplete efficiency trials due to down time and the absence of operation in the summer months (July-September). An attempt is made to run efficiency calculations continuously while trapping. Migratory year 2008 fall season had few high flow events resulting in very good estimates; however the spring season had two significant events that reduced the accuracy of these estimates. 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'x (Chinook salmon)

The single release group provided an estimated 396,197 ± 11,104.6 (95% C.I.) hatchery Nacó'x (Chinook salmon) which emigrated past the Imnaha River juvenile migration trap during the spring of 2008. The population estimate is based on a post release survival estimate of 97.8% ± 2.8% (95% C.I.) from the acclimation facility to the trap. This survival estimate is within the range of previous estimates. Past post release survival estimates from the acclimation facility at Gumboot to the Imnaha River juvenile migration trap have ranged from 63.3% ± 2.1% (95% C.I.) in 2006 to 100.9% ± 14.3% (95% C.I.) in 1994 (Figure 16). The post release survival estimates are useful for evaluating the mortality that occurred within the Imnaha River and comparing that reach specific mortality to other reaches within the Snake and Columbia rivers.

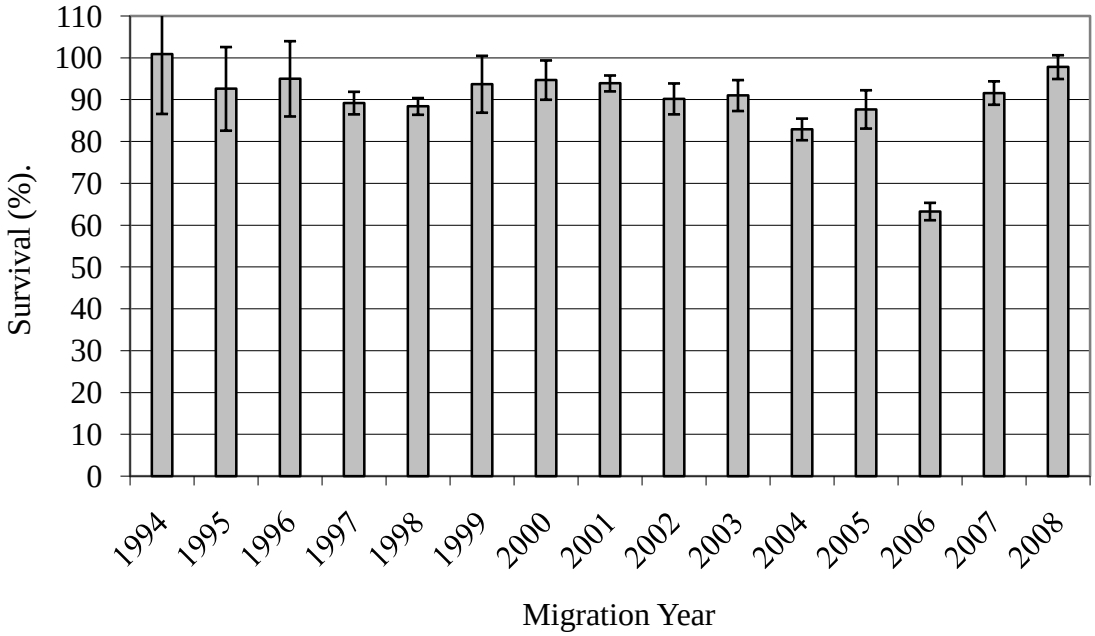

Figure 16. Estimated post release survival of hatchery Nacó'x (Chinook salmon) from the Imnaha River Gumboot acclimation facility to the Imnaha River juvenile migration trap from 1994 to 2008. The error bars indicate the 95% C.I.

Estimated Season Wide Smolt Survival from the Imnaha River

All season wide survival estimates presented in this and the next section of the report are with 95% confidence intervals in parentheses. The survival of fall PIT tagged natural Nacó'x (Chinook salmon) pre-smolts from the Imnaha River juvenile migration trap to LGD have been measured for migration years 1994 to 2008. The migration year 2008 survival estimate for fall tagged natural Nacó'x (Chinook salmon) pre-smolts from the trap to LGD was 40.3% (± 2.1%) (Figure 17). This estimate is within the range of historical estimates from the SMP project. Fall PIT tagged natural Nacó'x (Chinook salmon) survival from the trap to LMD was 38.6% (± 5.5%). 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. There is some evidence of this in PIT tag queries. Fall PIT tagged natural Nacó'x (Chinook salmon) sample sizes have ranged from 442 (1997) to 7,225 (2007). The historic survival estimates have ranged from 16.5% (± 1.8%) for migration year 2006 to 60.4% (± 4.1%) for migration year 1998 (Figure 17).

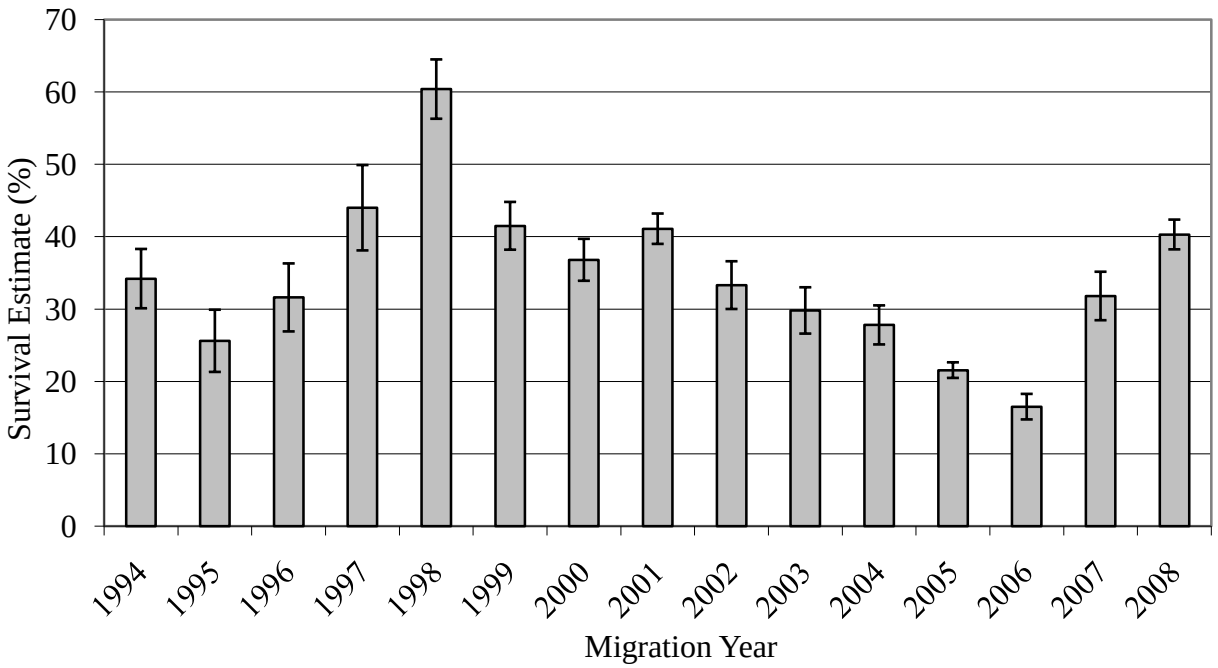

Figure 17. Estimated survival from the Imnaha River juvenile migration trap to Lower Granite Dam (LGD) of natural Nacó'x (Chinook salmon) tagged in the fall, for migration years 1994 to 2008. Error bars indicate the 95% C.I.

The estimated survival of natural Nacó'x (Chinook salmon) smolts, PIT tagged in the spring, from the juvenile migration trap to LGD in 2008 was 84.2 (± 4.2%) (Tables 7 and 8). The hatchery Nacó'x (Chinook salmon), released at the Gumboot acclimation site had an estimated survival of 70.1% (± 2.6%) to LGD. The estimated survival of natural Héeyey (steelhead) from the trap to LGD was 89.7% (± 4.0%). The estimated survival of hatchery Héeyey (steelhead) from the Imnaha River to LGD was 82.7% (± 4.9%).

Estimated survival from the Imnaha River to LMD in 2008 was as follows: natural Nacó'x (Chinook salmon) was 88.4% (± 12.5%), hatchery Nacó'x (Chinook salmon) was 58.8% (± 4.4%), natural Héeyey (steelhead) was 86.5% (± 11.7%), and hatchery Héeyey (steelhead) was 57.5% (± 8.6%) (Table 9).

Table 7. Estimated survival probabilities for PIT tag release groups of natural and hatchery Nacó'x (Chinook salmon) and Héeyey (steelhead) smolts released from the Imnaha River from March 1 to June 21, 2008. Natural estimates are from release at the trap and Hatchery estimates are from release at Acclimation facilities. Estimates are from release to Lower Granite Dam and tail race to tail race for all other dams. Abbreviations: LGD -Lower Granite Dam, LGS - Little Goose Dam, LMD - Lower Monumental Dam, MCD – McNary Dam.

Release Group Number Released	Imnaha River to LGD (%) (95% C.I.		LGD to LGS (%) (95% C.I.		LGS to LMD (%) (95% C.I.		LMD to MCD (%) (95% C.I.		Imnaha River to LMD (%) (95% C.I.		Imnaha River to MCD (%) (95% C.I.	
Natural Nacó'x (Chinook salmon)												
1,627	84.2	(4.2)	93.8	(7.5)	111.9	(17.1)	80.2	(18.6)	88.4	(12.5)	70.9	(13.1)
Hatchery Nacó'x (Chinook salmon)												
20,337	70.1	(2.6)	96.1	(4.3)	88.6	(6.8)	88.7	(9.6)	58.4	(3.8)	51.8	(4.4)
Natural Héeyey (steelhead)												
2,533	89.7	(4.0)	94.3	(6.6)	102.3	(14.9)	74.6	(15.4)	86.5	(11.7)	64.5	(10.0)
Hatchery Héeyey (steelhead)												
14,877	82.7	(4.9)	95.2	(13.6)	73.0	(17.1)	95.6	(20.1)	57.5	(8.6)	55.5	(9.1)

Table 8. Spring estimates of survival from the Imnaha River to Lower Granite Dam from 1993 to 2008. Ninety-five percent confidence intervals are shown in parentheses.

Migration Year	Natural Nacó'x (Chinook salmon) (%)		Hatchery Nacó'x (Chinook salmon) (%)		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)	90.1	(3.9)	81.4	(2)
1998	85.2	(2)	75.7	(3.1)	86.0	(2.2)	82.9	(2.35)
1999	88.5	(2)	71.6	(4.7)	87.7	(3.1)	85.4	(2)
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	73.3	(1.2)	61.0	(0.9)	79.0	(2.2)	86.0	(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)	97.0	(8.82)
2008[1]	84.2	(4.2)	70.1	(2.6)	89.7	(4.0)	82.7	(4.9)

[1] Hatchery Nacó'x (Chinook salmon) and Hatchery Héeyey (steelhead) estimates are based on the release of all PIT tagged fish originating from acclimation facilities on the Imnaha River.

Table 9. Season-wide estimates of survival from the Imnaha River to Lower Monumental Dam from 1997 to 2008. Ninety-five percent confidence intervals are shown in parentheses.

Migration Year	Natural Nacó'x (Chinook salmon) (%)		Hatchery Nacó'x (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	53.2	(2.9)	85.5	(35.9)	62.0	(8.1)	61.5	(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)	81.4	(15.0)
2008[1]	88.4	(12.5)	58.4	(3.8)	86.5	(11.7)	57.5	(8.6)

[1] Hatchery Nacó'x (Chinook salmon) and Hatchery Héeyey (steelhead) estimates are based on the release of all PIT tagged fish originating from acclimation facilities on the Imnaha River.

Table 10. Season-wide estimates of survival from the Imnaha River to McNary Dam from 1998 to 2008. Ninety-five percent confidence intervals are shown in parentheses.

Migration Year	Natural Nacó'x (Chinook salmon) (%)		Hatchery Nacó'x (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)	51.4	(16.5)	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)
2008[1]	70.9	(13.1)	51.8	(4.4)	64.5	(10.0)	55.5	(9.1)

[1] Hatchery Nacó'x (Chinook salmon) and Hatchery Héeyey (steelhead) estimates are based on the release of all PIT tagged fish originating from acclimation facilities on the Imnaha River.

The average monthly discharge for both the Snake River at Anatone and the Imnaha River at Imnaha were typical for the 47-year history of Anatone and the 78-year history of the Imnaha gauging stations. Past monitoring of Nacó'x (Chinook salmon) and Héeyey (steelhead) estimated survival from LGS and LGD to the Dalles Dam as ranging from 5% during the low-flow year of 1973 to as high as 42% during more favorable passage conditions of 1975 (Raymond 1979). This implies a relationship between flow and survival, which may not have a strong correlation (Smith et al. 2002). The 2008 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'x (Chinook salmon) from release to LMD was 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 and hatchery Héeyey (steelhead) survival from release to LMD has ranged from 42.8% in 2001 to 82.1% in 2003 (Table 9).

Survival estimates for natural and hatchery Nacó'x (Chinook salmon), natural and hatchery Héeyey (steelhead) from the Imnaha River to MCD were within the range of estimates from 1998 to 2007 (Table 10). Low sample sizes and/or low recapture rates at the various facilities restricted our ability to provide estimates with small confidence limits. The lowest estimates of survival for natural Nacó'x (Chinook salmon) and both natural and hatchery Héeyey (steelhead) occurred during the drought year of 2001. The lowest Hatchery Nacó'x (Chinook salmon) survival from the Imnaha trap to MCD was MY 2006.

Smolt to Adult Return Rates

Smolt-to adult return rate indices (SARs) were calculated for four distinct groups of PIT tagged juvenile natural Nacó'x (Chinook salmon) emigrants from the Imnaha River, the fall and spring groups each divided into "survival" and "monitor" mode groups for brood years 1997 through 2003. All smolts prior to the fall of MY2003 were treated as survival smolts. In the fall of MY 2003 we participated in the SbyC program which allowed us to designate specific smolts as monitor mode. In the spring of MY2003 we did not participate in the SbyC program. Every migration year after spring of MY2003 we have designated monitor mode smolts. There are no comprehensive adult PIT Tag detection facilities on the Imnaha River, so SAR rates are calculated from the Imnaha River Trap to LGD and LGD to LGD.

Adult detections from fall survival PIT tagged Nacó'x (Chinook salmon) from migration years 1998 through 2005 were 42, 35, 42, 9, 22, 8, 2 and 2 respectively (Table 11). The total number adults detected at LGD for spring survival PIT tagged Nacó'x (Chinook salmon) from migration years 1998 through 2005 were 59, 105, 98, 41, 25, 11, 10 and 2, respectively. Fall survival tagged natural Nacó'x (Chinook salmon) had no consistent survival advantage from the Imnaha River to LGD SAR index for all brood years examined when compared to spring survival tagged Nacó'x (Chinook salmon) (Table 11). Fall survival tagged natural Nacó'x (Chinook salmon) experienced a slightly higher (1-3%) LGD to LGD SAR index for all brood years examined when compared to spring survival tagged Nacó'x (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 11). The Imnaha to LGD SAR index for fall survival tagged Nacó'x (Chinook salmon) ranges from 0.10% to 1.22%. The Imnaha to LGD SAR index for spring survival tagged Nacó'x (Chinook salmon) ranges from 0.11% to 2.58%. The LGD to LGD SAR index for fall survival tagged Nacó'x (Chinook salmon) ranged from 0.46% to 6.03%. The LGD to LGD SAR index for spring survival tagged Nacó'x (Chinook salmon) ranged from 0.15% to 3.08% for the same brood years.

Adult detections from fall monitor mode tagged Nacó'x (Chinook salmon) from migration years 2003 through 2005 were 11, 8, and 2 respectively (Table 12). The total number adults detected at LGD for spring monitor mode tagged Nacó'x (Chinook salmon) from migration years 2004 and 2005 were 21 and zero. There are not enough data to determine any trends in the monitor mode tagged Nacó'x (Chinook salmon).

When comparing the higher trends for the fall tagged survival and monitor mode fish from LGD to LGD the results could be explained by the fact that fish tagged in the fall migrate out of the Imnaha River and over winter in potentially warmer waters than the headwaters of the Imnaha River. This life history adaptation will result in a higher initial mortality due to warmer water and predation prior to being detected at LGD. Thus, the proportion of returning adults to out migrating fall smolts will be higher than in a spring population that passes through the system much quicker. The LGD to LGD SAR is calculated as it provides a SAR comparable to other tributaries with similar study designs.

Table 11. Smolt to adult return rate indices (SARs) for survival mode Imnaha River natural Nacó'x (Chinook salmon) to LGD and LGD to LGD for migration years 1998 to 2005. In-river

migrating fish were tagged at the Imnaha River juvenile migration trap and designated as survival mode smolts. Prior to migration year 2003 all tagged smolts were treated as survival 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 Tagged	Estimated Smolts at LGD	Number of Adult Detections at LGD	Age at Return			SAR Imnaha to LGD (%)	SAR LGD to LGD (%)
Fall				III	IV	V		
1998	3,449	876	42	9	24	9	1.22	4.79
1999	4,001	845	35	3	29	3	0.87	4.14
2000	3,952	701	42	2	23	17	1.06	5.99
2001	3,867	823	9	0	7	2	0.23	1.09
2002	3,228	662	22	4	17	1	0.68	3.32
2003	2,053	599	8	0	6	2	0.39	1.34
2004	1,190	346	2	0	1	1	0.17	0.58
2005	2,034	433	2	0	1	1	0.10	0.46
Spring								
1998	3,956	3,429	59	3	41	15	1.49	1.72
1999	5,306	4,686	105	8	69	28	1.98	2.24
2000	4,369	3,666	98	3	56	39	2.24	2.67
2001	10,005	1,886	41	1	32	8	0.41	2.17
2002	2,321	2,030	25	6	17	2	1.08	1.23
2003	5,145	3,914	11	1	8	2	0.21	0.28
2004	3,220	2,416	10	0	9	1	0.31	0.41
2005	1,611	1,174	2	0	0	2	0.12	0.17

Table 12. Smolt to adult return rate indices (SARs) for monitor mode Imnaha River natural Nacó'x (Chinook salmon) from the Imnaha River to LGD and LGD to LGD for migration years 2003 to 2005. Monitor mode migrating fish were tagged at the Imnaha River juvenile migration trap and designated as monitor mode smolts and represent the population at large. 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 Tagged	Estimated Smolts at LGD	Number of Adult Detections at LGD	Age at Return			SAR Imnaha to LGD (%)	SAR LGD to LGD (%)
Fall				III	IV	V		
2003	5,131	1,496	11	0	9	2	0.21	0.74
2004	2,376	691	8	0	6	2	0.34	1.16
2005	4,067	866	2	0	1	1	0.05	0.23
Spring								
2004	6,627	4,972	21	0	13	7	0.32	0.42
2005	1,853	1,351	0	0	0	0	0.00	0.00

Arrival Timing at Dams

Natural and Hatchery Nacó'x (Chinook salmon) Arrival Timing for 2008

Arrival timing is calculated from all, both survival and monitor mode, smolts tagged at the Imnaha Trap. Fall tagged pre-smolt natural Nacó'x (Chinook salmon) had statistically significant earlier median and cumulative arrival timing at LGD than spring tagged natural Nacó'x (Chinook salmon) smolts ($p < 0.05$) (Figure 18). Statistical test results are presented in Appendix G. The April 21 median arrival date for fall tagged Nacó'x (Chinook salmon) was earlier than the May 4 median arrival date for spring tagged Nacó'x (Chinook salmon) ($p <$

0.05).

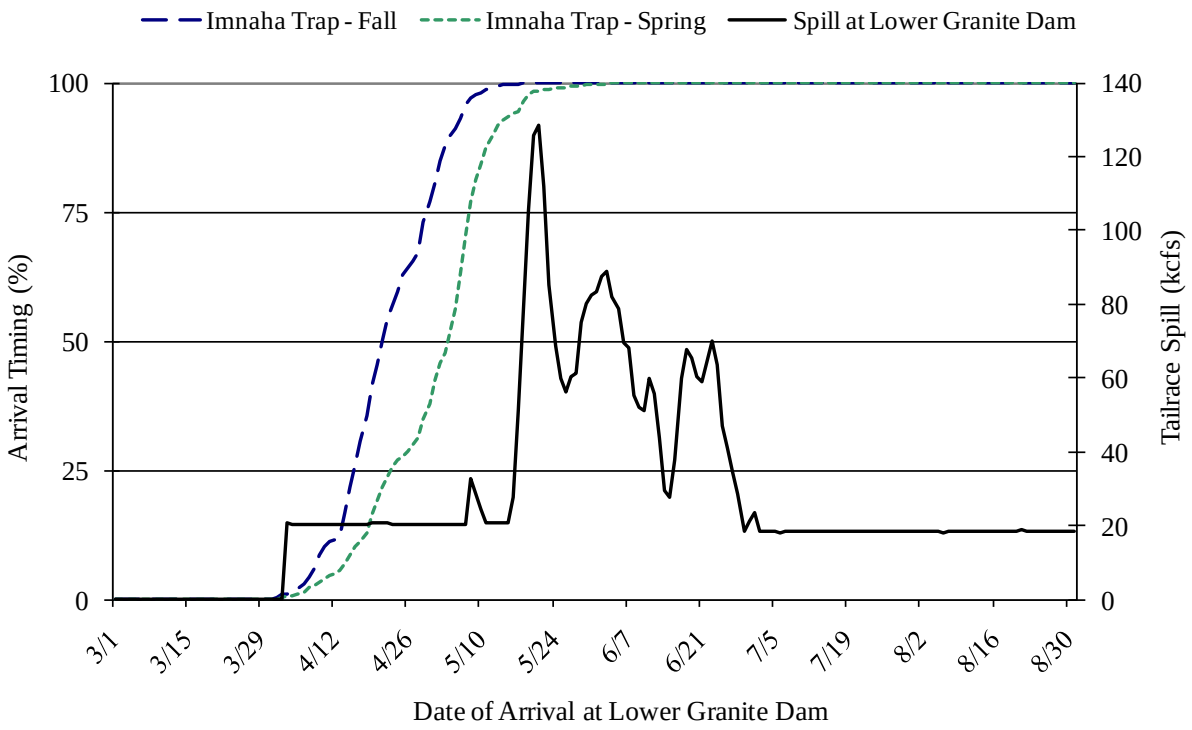

Figure 18. The arrival timing of fall and spring tagged natural Nacó'x (Chinook salmon) and tailrace spill at Lower Granite Dam during the 2008 migration year. Fall tagged natural Nacó'x (Chinook salmon) were released in the fall of 2007.

Fall tagged natural Nacó'x (Chinook salmon) arrived at LGD in 2008 from March 31 to May 19, median arrival on April 22. Arrival at the remaining dams occurred during the following dates: April 13 to May 21 at LGS, April 18 to May 26 at LMD, and April 26 to June 11 at MCD. Median arrivals occurred April 28, May 4, and May 9 at LGS, LMD, and MCD, respectively (Table 12 and Appendix H).

Spring tagged natural Nacó'x (Chinook salmon) smolts arrived at LGD from April 2 to June 4, median arrival on May 4. Arrival at LGS, LMD, and MCD occurred from April 10 to June 21, April 18 to June 21, and April 26 to June 22, respectively. Median arrival timing at these three dams was as follows: May 9 at LGS, May 11 at LMD, and May 12 at MCD. The 90% arrival time at LGS was May 21, May 24 at LMD, and May 23 at MCD (Table 12 and Appendix I).

Previously PIT tagged hatchery Nacó'x (Chinook salmon) smolts recaptured at the Imnaha River juvenile migration trap had the following arrival times at the four dams in 2008: April 12 to May 26 at LGD, April 17 to June 3 at LGS, April 30 to June 7 at LMD, and May 4 to June 9 at MCD. Median arrival timing occurred May 7 at LGD, May 11 at LGS, May 12 at LMD

and May 15 at MCD. Ninety percent arrival timing occurred May 12 at LGD, May 18 at LGS, May 21 at LMD and May 20 at MCD (Table 12 and Appendix J).

Natural and Hatchery Héeyey (Steelhead) Arrival Timing for MY 2008

Natural Héeyey (steelhead) arrived at LGD, LGS, LMD, and MCD from April 7 to June 23, April 16 to June 25, April 29 to June 22, and April 19 to June 22. Median arrival timing occurred May 8 at LGD, May 11 at LGS, May 18 at LMD, and May 14 at MCD. The 90% arriving timing occurred on May 18 at LGD, May 20 at LGS, May 24 at LMD, and May 23 at MCD (Table 13 and Appendix K).

Hatchery Héeyey (steelhead) had the following range of arrival times: April 16 to June 18 at LGD, April 18 to June 21 at LGS, April 26 to June 7 at LMD, and April 26 to May 24 at MCD. Median arrival times for hatchery Héeyey (steelhead) migrating in 2008 were May 8 at LGD, May 10 at LGS, May 18 at LMD, and May 14 at MCD. Ninety percent arrival times are as follows: May 18 at LGD, May 20 at LGS, May 22 at LMD, May 22 and MCD (Table 13 and Appendix L).

One aspect of arrival times is that on occasion dams further downstream will have an earlier arrival time than those upstream. 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.

Table 13. First, median, 90%, and last arrival dates for fall and spring tagged natural Nacó'x (Chinook salmon) juveniles, hatchery Nacó'x (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).

Rearing, Species, Life Stage, Dam	First Arrival	Median Arrival	90% Arrival	Last Arrival
Fall Tagged Natural Nacó'x (Chinook salmon) Pre-Smolts				
LGD	31-Mar	22-Apr	5-May	19-May
LGS	13-Apr	28-Apr	9-May	21-May
LMD	18-Apr	4-May	11-May	26-May
MCD	26-Apr	9-May	15-May	11-Jun
Spring Tagged Natural Nacó'x (Chinook salmon) Smolts				
LGD	2-Apr	4-May	13-May	4-Jun
LGS	10-Apr	9-May	21-May	21-Jun
LMD	18-Apr	11-May	24-May	21-Jun
MCD	26-Apr	12-May	23-May	22-Jun
Hatchery Nacó'x (Chinook salmon) Smolts				
LGD	12-Apr	7-May	12-May	26-May
LGS	17-Apr	11-May	18-May	3-Jun
LMD	30-Apr	12-May	21-May	7-Jun
MCD	4-May	15-May	20-May	9-Jun
Natural Héeyey (steelhead) Smolts				
LGD	7-Apr	8-May	18-May	23-Jun
LGS	16-Apr	11-May	20-May	25-Jun
LMD	29-Apr	18-May	24-May	22-Jun
MCD	19-Apr	14-May	23-May	22-Jun
Hatchery Héeyey (steelhead) Smolts				
LGD	16-Apr	8-May	18-May	18-Jun
LGS	18-Apr	10-May	20-May	21-Jun
LMD	26-Apr	18-May	22-May	7-Jun
MCD	26-Apr	14-May	22-May	22-May

Travel Time to Lower Granite Dam

Median travel time reflects the time (in days) that it takes groups of smolts to travel from the Imnaha River 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'x (Chinook salmon) occur for six weeks between April 13 and May 18. Natural Nacó'x (Chinook salmon) weekly median travel times to LGD ranged from 17.7 days during the week of April 13 to 28.1 days during the week of May 18. On average natural Nacó'x (Chinook salmon) median travel times were 17.2 days earlier than hatchery Nacó'x (Chinook salmon) released in the same week.

Weekly comparisons for Héeyey (steelhead) occur for a four-week period between April 27 and May 18. Natural Héeyey (steelhead) weekly median travel times to LGD ranged from 5.3 to 9.4 days through the four weeks (Table 13). Hatchery Héeyey (steelhead) travel times during this period ranged from 23.9 days (April 27) to 47.0 days (May 18). On average natural Héeyey (steelhead) median travel times are 29.6 days earlier than hatchery stocks during the same week. Median travel times to LGD for Nacó'x (Chinook salmon) increased with an increase in the calendar date.

Table 14. A comparison of median travel times of natural and hatchery Nacó'x (Chinook salmon) and Héeyey (steelhead) smolts released in the Imnaha River, and observed at Lower Granite Dam for the weeks of April 13 to May 18, 2008.

Species	Observation Week	Number Interrogated		Median Travel Time (Days)	
		Hatchery	Natural	Hatchery	Natural
Nacó'x (Chinook salmon) Smolts					
	4/13/2008	36	128	24.4	17.7
	4/20/2008	285	137	29.2	21.8
	4/27/2008	758	210	37.6	27.1
	5/4/2008	3,014	406	43.6	18.2
	5/11/2008	1,173	113	48.2	21.5
	5/18/2008	243	50	54.3	28.1
Héeyey (steelhead) Smolts					
	4/27/2008	298	93	23.9	9.4
	5/4/2008	834	384	33.3	5.3
	5/11/2008	559	130	40.8	5.4
	5/18/2008	743	92	47.0	6.7

Mortality

Nacó'x (Chinook salmon,) Héeyey (steelhead) and Incidental Mortality

A total of 31 natural Nacó'x (Chinook salmon), 10 hatchery Nacó'x (Chinook salmon), 2 natural Héeyey (steelhead), and 11 hatchery Héeyey (steelhead) mortalities occurred during the study. Sixteen of the natural Nacó'x (Chinook salmon) mortalities occurred during the fall; 0.22 % of all natural Nacó'x (Chinook salmon) captured in the fall of 2007 (Appendix M). Trapping caused 11 mortalities, handling caused one, PIT tagging was the source of three, and one additional dead on arrival. Fifteen natural Nacó'x (Chinook salmon) mortalities occurred during the spring: five due to trapping, three due to handling, six from to PIT tagging and one was dead on arrival at the Imnaha screw trap (Appendix N). The total number of mortalities accounted for 0.27 % of the natural Nacó'x (Chinook salmon) captured in the spring of 2008. There were two natural Héeyey (steelhead) mortalities during the spring of 2008. One mortality was attributed to trapping and one for PIT tagging at the Imnaha screw trap. Hatchery Héeyey (steelhead) had 11 mortalities; two from trapping, seven from handling and two hatchery Héeyey (steelhead) were dead on arrival. The two natural Héeyey (steelhead) mortalities were 0.05 % of the total catch, where the 11 hatchery Héeyey (steelhead) mortalities accounted for 0.06 % of the total catch. Nine incidental catch mortalities occurred during the spring of 2008. Seven sculpin, one rainbow trout, and one natural steelhead kelt were all trapping mortalities.

Incidental Catch

Incidental Catch for Migration Year MY 2008

The incidental catch during the fall and spring of migration year 2008, including subsamples that were expanded , totaling 2,413 fish. It was comprised of six families of fishes: Salmonidae, Centrarchidae, Catostomidae, Cyprinidae, Cottidae, and Petromyzotidae (Appendix O). The catch of Salmonidae consisted of 115 adult Héeyey (steelhead), 440 rainbow trout, 122 Cimey (mountain whitefish; *Prosopium williamsoni*), and 182 Islam (bull trout; *Salvelinus confluentus*). The Islam were divided into adults 51 (300 mm and greater), and juveniles 131 (less than 300 mm). 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. One hundred ninety three Centrarchidae captured were smallmouth bass (*Micropterus dolomieui*). A total of seven Muq'uc (bridgelip suckers; *Catostomus columbianus*), eight Muq'uc (largescale suckers; *Catostomus macrocheilus*), and 305 unidentified Muq'uc species represented the family Catostomidae. The catch of Cyprinidae was as follows: 12 Tite'wxc (chislemouth; *Acrocheilus alutaceus*), 86 longnose dace (*Rhinichthys cataractae*), one speckled Dace (*Rhinichthys osculus*), 30 Qiyex (northern pikeminnow; *Ptychocheilus oregonensis*), and 3 redside shiner (*Richardsonius balteatus*). Eighty *Cottus* species (sculpins) of the family Cottidae were captured during the migration year 2008. Additionally 828 juvenile Heesu (Pacific Lampreys; *Lampetra tridentata*) of the family Petromyzotidae were caught in the spring of 2008.

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APPENDICES

Appendix A. The number of hours sampled and the catch, including subsample estimates, of natural and hatchery Nacó'x (Chinook salmon) and Héeyey (steelhead) at the Imnaha River juvenile migration trap from 3 October 2007 to 18 June 2008. 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	Natural Nacó'x	Hatchery Nacó'x	Natural Héeyey	Hatchery Héeyey
10/4/2007	18.00	8	0	3	0
10/5/2007	24.50	27	0	4	0
10/6/2007	23.50	32	0	12	0
10/7/2007	23.50	3	0	0	0
10/8/2007	24.00	35	0	7	0
10/9/2007	24.00	3	0	1	0
10/10/2007	23.50	4	0	0	0
10/11/2007	24.00	6	0	0	0
10/12/2007	24.00	1	0	0	0
10/13/2007	24.00	3	0	0	0
10/14/2007	24.00	6	0	0	0
10/15/2007	24.00	5	0	0	0
10/16/2007	25.50	2	0	0	0
10/17/2007	22.50	5	0	0	0
10/18/2007	24.50	30	0	0	0
10/19/2007	26.50	131	0	0	1
10/20/2007	26.50	399	0	0	0
10/21/2007	25.00	1,015	0	0	0
10/22/2007	24.00	602	0	0	0
10/23/2007	19.00	272	0	0	0
10/24/2007	22.50	98	0	0	0
10/25/2007	25.00	47	0	6	0
10/26/2007	23.50	45	0	1	0
10/27/2007	26.50	348	0	1	0
10/28/2007	24.00	255	0	2	0
10/29/2007	21.00	123	0	1	0
10/30/2007	25.00	42	0	1	0
10/31/2007	24.00	201	0	0	0
11/1/2007	24.75	84	0	0	0
11/2/2007	24.50	168	0	1	0
11/3/2007	23.75	161	0	7	0

Sample End Date	Hours Fished	Natural Nacó'x	Hatchery Nacó'x	Natural Héeyey	Hatchery Héeyey
11/4/2007	24.50	73	0	5	0
11/5/2007	24.00	111	0	2	0
11/6/2007	23.00	67	0	3	0
11/7/2007	24.00	81	0	0	0
11/8/2007	24.50	69	0	0	0
11/9/2007	22.50	59	0	0	0
11/10/2007	24.50	54	0	0	0
11/11/2007	24.00	42	0	0	0
11/12/2007	23.50	39	0	0	0
11/13/2007	24.50	93	0	0	0
11/14/2007	24.00	95	0	0	0
11/15/2007	24.00	54	0	0	0
11/16/2007	24.50	104	0	0	0
11/17/2007	24.00	40	0	0	0
11/18/2007	25.00	114	0	0	0
11/19/2007	29.00	653	0	0	0
11/20/2007	23.50	792	0	0	0
11/21/2007	19.50	665	0	0	0
2/29/2008	27.50	15	0	2	0
3/1/2008	21.50	11	0	0	0
3/2/2008	23.50	38	0	3	0
3/3/2008	23.50	32	0	2	0
3/4/2008	23.50	38	0	2	0
3/5/2008	24.00	39	0	1	0
3/6/2008	24.50	41	0	1	0
3/7/2008	24.00	25	0	1	0
3/8/2008	24.00	14	0	0	0
3/9/2008	25.00	9	0	0	0
3/10/2008	24.00	9	0	0	0
3/11/2008	23.50	4	0	0	0
3/12/2008	23.00	16	0	0	0
3/13/2008	24.50	20	0	0	0
3/14/2008	24.50	20	0	5	0
3/15/2008	23.50	13	0	2	0
3/16/2008	24.00	5	0	0	0

Sample End Date	Hours Fished	Natural Nacó'x	Hatchery Nacó'x	Natural Héeyey	Hatchery Héeyey
3/17/2008	24.00	10	0	0	0
3/18/2008	24.00	14	0	1	0
3/19/2008	24.00	6	0	1	0
3/20/2008	24.00	13	0	1	0
3/21/2008	24.00	23	0	3	0
3/22/2008	24.50	46	0	0	0
3/23/2008	24.00	30	0	1	0
3/24/2008	23.50	33	0	1	0
3/25/2008	24.00	63	0	2	0
3/26/2008	23.50	101	0	0	0
3/27/2008	25.00	76	132	2	0
3/28/2008	25.50	70	545	5	0
3/29/2008	23.00	81	1,208	2	0
3/30/2008	24.00	200	436	2	0
3/31/2008	24.00	125	160	0	0
4/1/2008	24.00	78	43	0	0
4/2/2008	22.50	89	36	1	0
4/3/2008	25.50	93	632	1	0
4/4/2008	24.00	100	4,557	4	9
4/5/2008	21.00	58	4,134	0	34
4/6/2008	24.00	70	4,641	0	49
4/7/2008	24.00	109	3,993	0	20
4/8/2008	24.00	93	6,647	5	17
4/9/2008	24.00	77	11,909	0	53
4/10/2008	24.00	119	5,178	6	198
4/11/2008	24.00	85	4,583	6	914
4/12/2008	24.00	127	3,711	3	1,619
4/13/2008	24.00	178	1,828	17	1,018
4/14/2008	27.50	1,351	17,990	633	4,000
4/15/2008	N/A	N/A	N/A	N/A	N/A
4/16/2008	14.00	409	1,679	232	1,175
4/17/2008	10.00	158	307	87	266
4/18/2008	26.50	75	107	56	87
4/19/2008	25.00	58	47	67	153
4/20/2008	24.00	157	154	109	218
4/21/2008	23.50	158	189	67	250

Sample End Date	Hours Fished	Natural Nacó'x	Hatchery Nacó'x	Natural Héeyey	Hatchery Héeyey
4/22/2008	23.50	69	103	27	160
4/23/2008	23.00	31	22	25	48
4/24/2008	26.50	31	44	30	83
4/25/2008	22.00	52	38	28	23
4/26/2008	25.50	32	53	31	74
4/27/2008	23.50	43	55	28	76
4/28/2008	24.50	26	65	53	157
4/29/2008	23.50	78	175	480	1,265
4/30/2008	12.00	73	61	650	1,197
5/1/2008	10.50	78	64	111	599
5/2/2008	26.50	50	22	129	276
5/3/2008	24.50	39	21	116	230
5/4/2008	24.00	18	8	145	413
5/5/2008	22.00	2	16	388	1368
5/6/2008	N/A	N/A	N/A	N/A	N/A
5/7/2008	N/A	N/A	N/A	N/A	N/A
5/8/2008	N/A	N/A	N/A	N/A	N/A
5/9/2008	9.50	6	2	37	197
5/10/2008	9.50	10	8	73	369
5/11/2008	25.00	2	3	60	326
5/12/2008	25.00	0	4	85	546
5/13/2008	23.50	8	1	68	504
5/14/2008	15.50	7	7	57	382
5/15/2008	11.25	11	10	176	496
5/16/2008	N/A	N/A	N/A	N/A	N/A
5/17/2008	N/A	N/A	N/A	N/A	N/A
5/18/2008	N/A	N/A	N/A	N/A	N/A
5/19/2008	N/A	N/A	N/A	N/A	N/A
5/20/2008	N/A	N/A	N/A	N/A	N/A
5/21/2008	N/A	N/A	N/A	N/A	N/A
5/22/2008	N/A	N/A	N/A	N/A	N/A
5/23/2008	N/A	N/A	N/A	N/A	N/A
5/24/2008	N/A	N/A	N/A	N/A	N/A
5/25/2008	N/A	N/A	N/A	N/A	N/A
5/26/2008	N/A	N/A	N/A	N/A	N/A
5/27/2008	12.50	3	1	26	81

Sample End Date	Hours Fished	Natural Nacó'x	Hatchery Nacó'x	Natural Héeyey	Hatchery Héeyey
5/28/2008	9.00	7	1	23	105
5/29/2008	8.00	0	0	2	8
5/30/2008	8.50	0	0	0	47
5/31/2008	N/A	N/A	N/A	N/A	N/A
6/1/2008	N/A	N/A	N/A	N/A	N/A
6/2/2008	N/A	N/A	N/A	N/A	N/A
6/3/2008	N/A	N/A	N/A	N/A	N/A
6/4/2008	N/A	N/A	N/A	N/A	N/A
6/5/2008	N/A	N/A	N/A	N/A	N/A
6/6/2008	10.50	0	1	19	60
6/7/2008	10.00	0	1	18	58
6/8/2008	11.00	1	0	9	43
6/9/2008	N/A	N/A	N/A	N/A	N/A
6/10/2008	12.00	2	0	12	54
6/11/2008	14.00	1	0	2	27
6/12/2008	11.50	2	0	1	12
6/13/2008	24.50	0	0	0	13
6/14/2008	14.00	0	0	1	17
6/15/2008	16.50	0	0	1	15
6/16/2008	24.00	1	0	1	14
6/17/2008	24.00	1	0	0	18
6/18/2008	24.00	0	0	1	16
Total	3,064.75	12,932	75,632	4,304	19,458

Appendix B. The number of Nacó'x (Chinook salmon) and Héeyey (steelhead) PIT tagged at the Imnaha River juvenile migration trap from 3 October 2007 to 18 June 2008. N/A indicates the trap was not operated on that date.

Sample End Date	Natural Nacó'x	Hatchery Héeyey	Natural Héeyey
10/4/2007	6	0	0
10/5/2007	23	0	0
10/6/2007	23	0	0
10/7/2007	3	0	0
10/8/2007	23	0	0
10/9/2007	3	0	0
10/10/2007	4	0	0
10/11/2007	5	0	0
10/12/2007	1	0	0
10/13/2007	3	0	0
10/14/2007	5	0	0
10/15/2007	4	0	0
10/16/2007	2	0	0
10/17/2007	5	0	0
10/18/2007	29	0	0
10/19/2007	129	0	0
10/20/2007	391	0	0
10/21/2007	1,007	0	0
10/22/2007	594	0	0
10/23/2007	272	0	0
10/24/2007	96	0	0
10/25/2007	45	0	0
10/26/2007	45	0	1
10/27/2007	345	0	0
10/28/2007	254	0	0
10/29/2007	121	0	0
10/30/2007	41	0	0
10/31/2007	196	0	0
11/1/2007	84	0	0
11/2/2007	162	0	0
11/3/2007	160	0	0
11/4/2007	73	0	0
11/5/2007	109	0	0
11/6/2007	64	0	0
11/7/2007	81	0	0

Sample End Date	Natural Nacó'x	Hatchery Héeyey	Natural Héeyey
11/8/2007	65	0	0
11/9/2007	59	0	0
11/10/2007	52	0	0
11/11/2007	42	0	0
11/12/2007	39	0	0
11/13/2007	93	0	0
11/14/2007	94	0	0
11/15/2007	53	0	0
11/16/2007	103	0	0
11/17/2007	39	0	0
11/18/2007	112	0	0
11/19/2007	653	0	0
11/20/2007	791	0	0
11/21/2007	664	0	0
2/29/2008	15	0	1
3/1/2008	11	0	0
3/2/2008	38	0	3
3/3/2008	32	0	2
3/4/2008	38	0	2
3/5/2008	37	0	1
3/6/2008	40	0	1
3/7/2008	23	0	1
3/8/2008	14	0	0
3/9/2008	9	0	0
3/10/2008	8	0	0
3/11/2008	4	0	0
3/12/2008	16	0	0
3/13/2008	20	0	0
3/14/2008	19	0	5
3/15/2008	13	0	2
3/16/2008	5	0	0
3/17/2008	10	0	0
3/18/2008	14	0	1
3/19/2008	6	0	1
3/20/2008	12	0	1
3/21/2008	23	0	2
3/22/2008	46	0	0
3/23/2008	30	0	1

Sample End Date	Natural Nacó'x	Hatchery Héeyey	Natural Héeyey
3/24/2008	33	0	1
3/25/2008	58	0	2
3/26/2008	101	0	0
3/27/2008	74	0	2
3/28/2008	70	0	5
3/29/2008	80	0	2
3/30/2008	198	0	2
3/31/2008	124	0	0
4/1/2008	77	0	0
4/2/2008	89	0	1
4/3/2008	93	0	1
4/4/2008	100	0	4
4/5/2008	18	0	0
4/6/2008	25	0	0
4/7/2008	42	0	0
4/8/2008	24	0	2
4/9/2008	17	0	0
4/10/2008	23	0	1
4/11/2008	15	0	1
4/12/2008	66	0	3
4/13/2008	38	0	2
4/14/2008	93	0	30
4/15/2008	N/A	N/A	N/A
4/16/2008	144	0	57
4/17/2008	155	0	87
4/18/2008	74	0	54
4/19/2008	58	0	66
4/20/2008	156	0	109
4/21/2008	157	0	65
4/22/2008	67	0	26
4/23/2008	31	0	25
4/24/2008	31	0	30
4/25/2008	52	0	28
4/26/2008	31	0	31
4/27/2008	43	0	28
4/28/2008	26	0	52
4/29/2008	77	0	415
4/30/2008	13	0	78
5/1/2008	53	0	73

Sample End Date	Natural Nacó'x	Hatchery Héeyey	Natural Héeyey
5/2/2008	50	0	123
5/3/2008	37	0	114
5/4/2008	18	0	145
5/5/2008	2	0	199
5/6/2008	N/A	N/A	N/A
5/7/2008	N/A	N/A	N/A
5/8/2008	N/A	N/A	N/A
5/9/2008	5	0	37
5/10/2008	10	0	72
5/11/2008	2	0	60
5/12/2008	0	0	85
5/13/2008	8	0	68
5/14/2008	7	0	57
5/15/2008	4	0	150
5/16/2008	N/A	N/A	N/A
5/17/2008	N/A	N/A	N/A
5/18/2008	N/A	N/A	N/A
5/19/2008	N/A	N/A	N/A
5/20/2008	N/A	N/A	N/A
5/21/2008	N/A	N/A	N/A
5/22/2008	N/A	N/A	N/A
5/23/2008	N/A	N/A	N/A
5/24/2008	N/A	N/A	N/A
5/25/2008	N/A	N/A	N/A
5/26/2008	N/A	N/A	N/A
5/27/2008	3	0	26
5/28/2008	7	1	23
5/29/2008	0	0	2
5/30/2008	0	0	0
5/31/2008	N/A	N/A	N/A
6/1/2008	N/A	N/A	N/A
6/2/2008	N/A	N/A	N/A
6/3/2008	N/A	N/A	N/A
6/4/2008	N/A	N/A	N/A
6/5/2008	N/A	N/A	N/A
6/6/2008	0	0	19
6/7/2008	0	0	18
6/8/2008	1	0	9
6/9/2008	N/A	N/A	N/A

Sample End Date	Natural Nacó'x	Hatchery Héeyey	Natural Héeyey
6/10/2008	2	0	12
6/11/2008	1	0	1
6/12/2008	2	0	1
6/13/2008	0	0	0
6/14/2008	0	0	1
6/15/2008	0	0	1
6/16/2008	1	0	1
6/17/2008	1	0	0
6/18/2008	0	0	1
Total	10,537	1	2,533

Appendix C. Recaptures of natural Nacó'x (Chinook salmon) PIT tagged by the Oregon Department of Fish and Wildlife's Early Life History Program at the Imnaha River juvenile migration trap during the fall of 2007 and spring 2008.

Migration Year	Tagging Agency	Recapture file	Tag ID	Date Tagged	Date Recaptured	Travel Time (Days)
2008	ODFW	BDM07281.NT1	3D9.1C2C3CDB8A	9/5/2007	10/8/2007	33
2008	ODFW	BDM07293.NT1	3D9.1C2C3C4A13	9/5/2007	10/20/2007	45
2008	ODFW	BDM07300.NT1	3D9.1C2C351FBA	9/6/2007	10/27/2007	51
2008	ODFW	BDM07302.NT1	3D9.1C2C3CA5B4	9/6/2007	10/29/2007	53
2008	ODFW	BDM07304.NT1	3D9.1C2C3C65E0	9/4/2007	11/1/2007	58
2008	ODFW	BDM07305.NT1	3D9.1C2C3BB8D8	9/5/2007	11/1/2007	57
2008	ODFW	BDM07307.NT1	3D9.1C2C3C742C	9/5/2007	11/3/2007	59
2008	ODFW	BDM07307.NT1	3D9.1C2C3C1B85	9/6/2007	11/3/2007	58
2008	ODFW	BDM07307.NT1	3D9.1C2C3BA9CF	9/4/2007	11/3/2007	60
2008	ODFW	BDM07310.NT1	3D9.1C2C3CD8DC	9/4/2007	11/6/2007	63
2008	ODFW	BDM07310.NT1	3D9.1C2C3BAA82	9/6/2007	11/6/2007	61
2008	ODFW	BDM07317.NT1	3D9.1C2C3BA426	9/4/2007	11/13/2007	70
2008	ODFW	BDM07322.NT1	3D9.1C2C3C2286	9/5/2007	11/18/2007	74
2008	ODFW	BDM07323.NT1	3D9.1C2C3CDDCE	9/6/2007	11/19/2007	74
2008	ODFW	BDM07325.NT1	3D9.1C2C3C5A3C	9/5/2007	11/21/2007	77
2008	ODFW	BDM08074.NT1	3D9.1C2C3CA7AF	9/4/2007	3/14/2008	192
2008	ODFW	BDM08091.NT1	3D9.1C2C3CDF38	9/4/2007	3/31/2008	209

Migration Year	Tagging Agency	Recapture file	Tag ID	Date Tagged	Date Recaptured	Travel Time (Days)
2008	ODFW	BDM08101.RM1	3D9.1C2C3C6A37	9/5/2007	4/11/2008	219
2008	ODFW	BDM08104.NT1	3D9.1C2C3C031E	9/4/2007	4/12/2008	221
2008	ODFW	BDM08108.NT1	3D9.1C2C3C33F9	9/4/2007	4/18/2008	227
2008	ODFW	BDM08111.NT1	3D9.1C2C3CA088	9/4/2007	4/20/2008	229
2008	ODFW	BDM08121.RM2	3D9.1C2C3C68D1	9/5/2007	5/1/2008	239

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 2008.

Group 1	Group 2	Sample Sizes (N)		Median Fork Length (mm)		Wilcoxon Value (W)	Significance Level p = 0.05
		Group 1	Group 2	Group 1	Group 2		
Natural Nacó'x (Chinook salmon)	Hatchery Nacó'x (Chinook salmon)	7,547	1,754	98.6	124.1	55.030	0.000
Natural Héeyey (steelhead)	Hatchery Héeyey (steelhead)	2,524	1,030	166.3	210.9	41.582	0.000

Appendix E. Gauss population estimates for the Imnaha River by group and totals for natural Nacó'x (Chinook salmon) captured in the Imnaha River Juvenile migration trap during fall 2007 and spring 2008.

Week			Group	Caught	Marked	Recaptured	Trap Efficiency (%)	Population	Lower 95% C.I.	Upper 95% C.I.	SE
9/30	to	10/20	1	699	179	17	9.0	6,990	4,643	11,680	1,835.0
10/21	to	10/27	2	2,425	327	89	27.0	8,838	6,892	11,021	1,060.4
10/28	to	11/3	3	1,033	251	97	39.0	2,656	2,245	3,209	253.7
11/4	to	11/10	4	513	259	74	29.0	1,778	1,416	2,295	226.5
11/11	to	11/17	5	465	230	59	26.0	1,790	1,381	2,301	234.2
11/18	to	11/21	6	2,223	265	48	18.0	12,068	8,921	16,373	1,905.6
Fall totals				7,358	1,511	384	24.7	34,120	29,907	39,315	2,486.6
2/29	to	3/8	1	253	137	17	12.0	1,940	1,259	3,119	472.1
3/9	to	3/22	2	208	92	19	21.0	967	707	1,380	174.7
3/23	to	3/29	3	454	221	31	14.0	3,150	2,129	4,830	691.8
3/30	to	4/5	4	743	323	67	21.0	3,540	2,548	5,161	673.0
4/6	to	4/12	5	680	109	10	9.0	6,800	4,220	11,351	1,887.9
4/13	to	4/19	6	2,229	231	33	14.0	15,210	10,145	22,749	3,594.1
4/20	to	4/26	7	530	212	36	17.0	3,051	2,148	4,416	575.4
4/27	to	6/18	8	468	186	18	10.0	4,606	2,937	8,004	1,278.8
Spring totals				5,565	1,511	231	14.8	39,264	26,093	61,010	9,347.8
MY 2007 Totals				12,924	3,022	615	19.8	73,384	56,000	10,0325	11,834.4

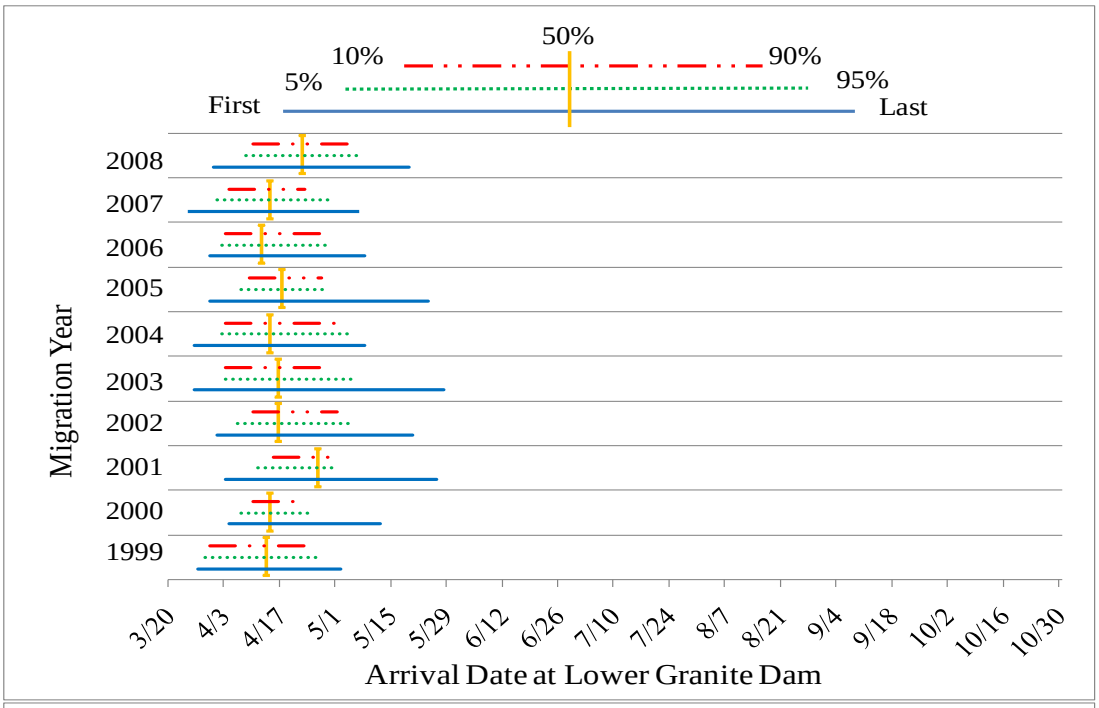
Appendix F. Gauss population estimates for the Imnaha River by group and totals for natural Héeyey (steelhead) captured in the Imnaha River juvenile migration trap during spring 2008.

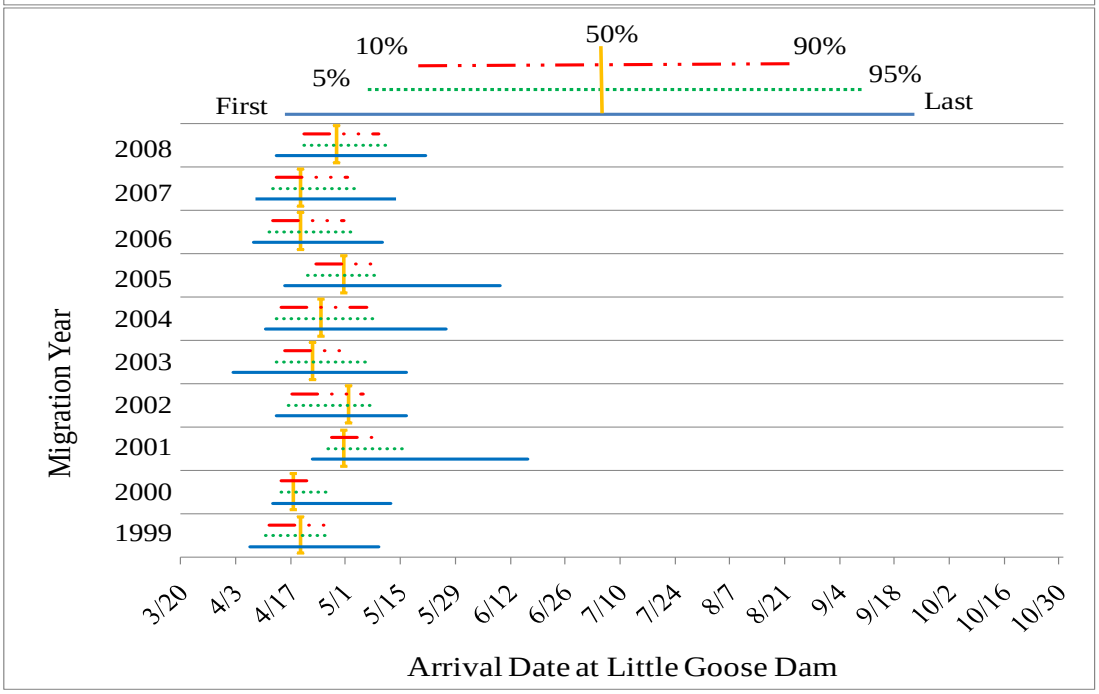
Week			Group	Caught	Marked	Recaptured	Trap Efficiency (%)	Population	Lower 95% C.I.	Upper 95% C.I.	SE
3/11	to	4/7	1	1,158	170	14	8.0	13,201	8,067	22,508	3,717.4
4/8	to	4/21	2	317	104	24	23.0	1,331	1,015	1,771	200.9
4/22	to	6/9	3	2,210	421	34	8.0	26,646	16,719	44,866	7,538.6
6/10	to	6/15	4	562	259	15	6.0	9,133	5,311	16,359	2,908.9
MY 2008 Totals				4247	954	87	11.3	50,311	39,688	64,576	6,410.8

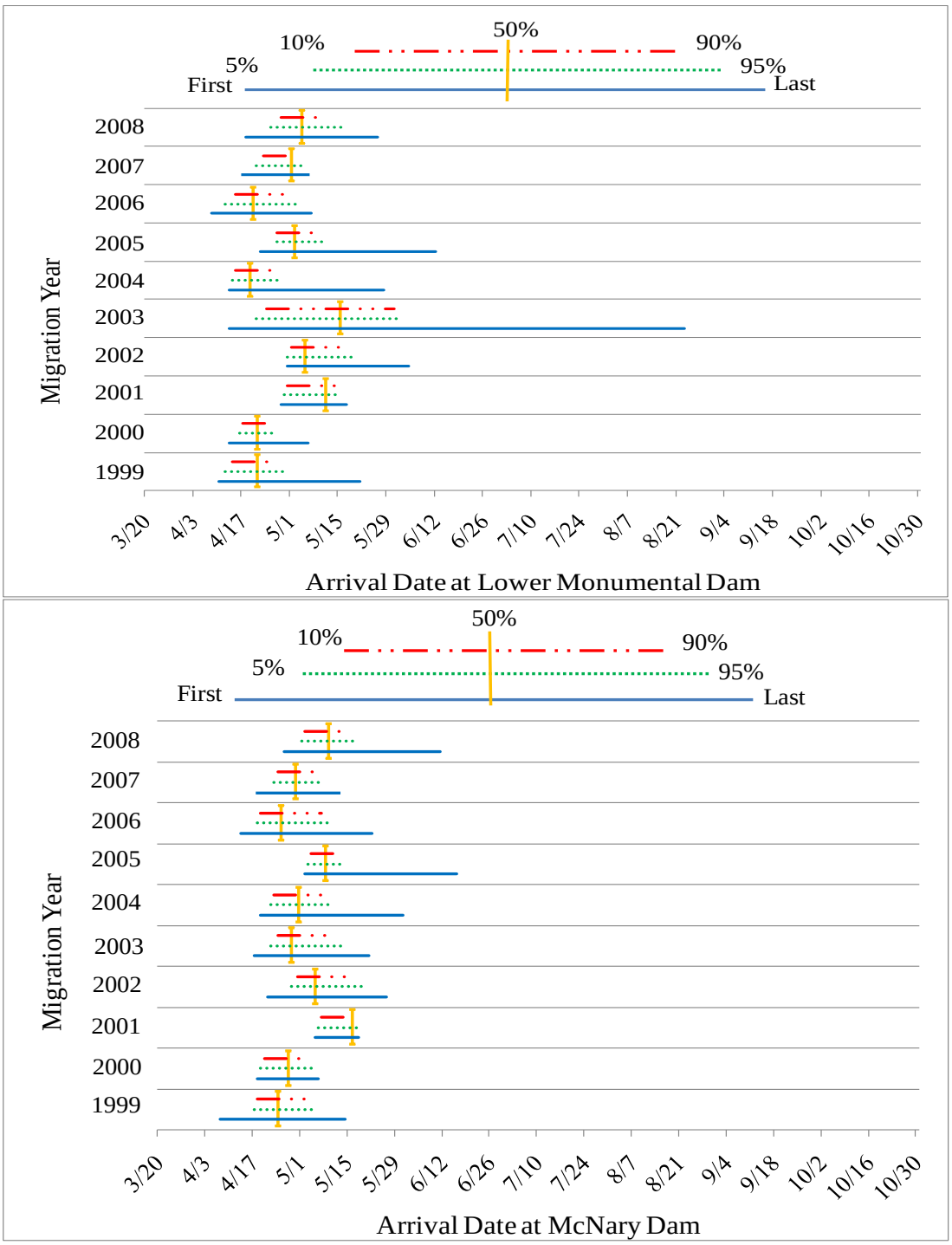
Appendix G. A statistical comparison of median arrival date at LGD between natural Nacó'x (Chinook salmon) pre-smolts released in the fall of 2007 and smolts released in the spring of 2008 from the Imnaha River juvenile migration trap. Arrival date includes both survival and monitor mode smolts.

Group 1	Group 2	Sample Sizes (N)		Median Arrival Date		Wilcoxon Value (W)	Significance Level p = 0.05
		Group 1	Group 2	Group 1	Group 2		
Pre-Smolts	Smolts	1,048	1,109	4/22/08	5/04/08	19.516	0.000

Appendix H. Graphical representation of arrival timing of Imnaha River natural Nacó'x (Chinook salmon) pre-smolts PIT tagged at the Imnaha River trap during fall of 2007 to Lower Granite, Little Goose, Lower Monumental and McNary dams from 1999 to 2008. Arrival timing includes both survival and monitor mode smolts.

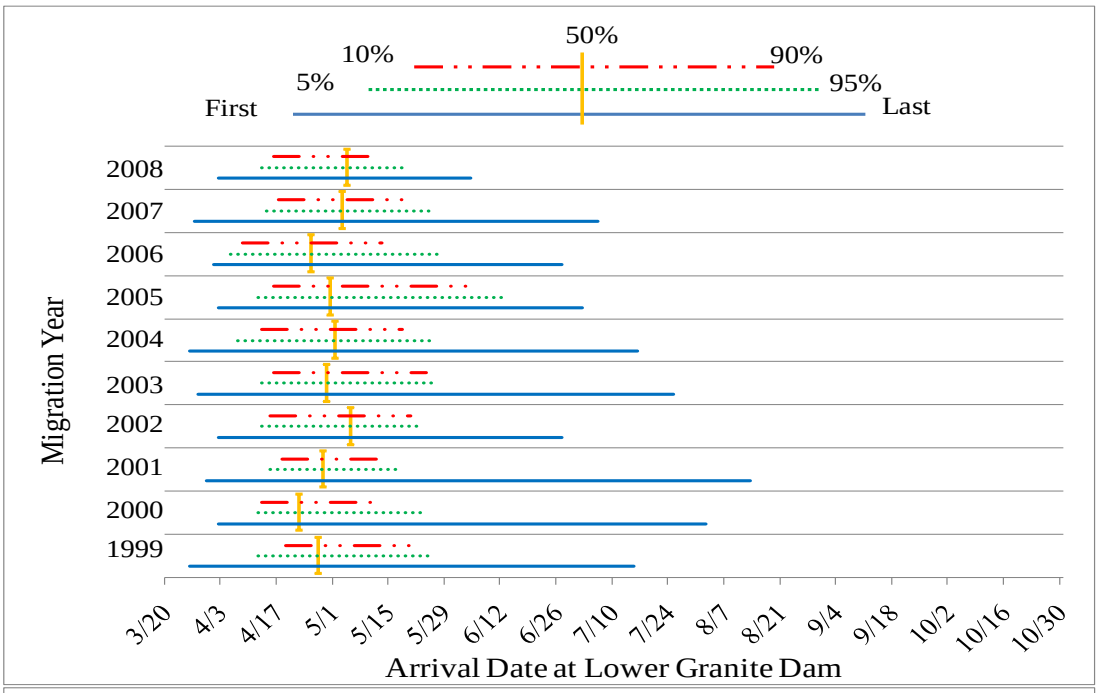


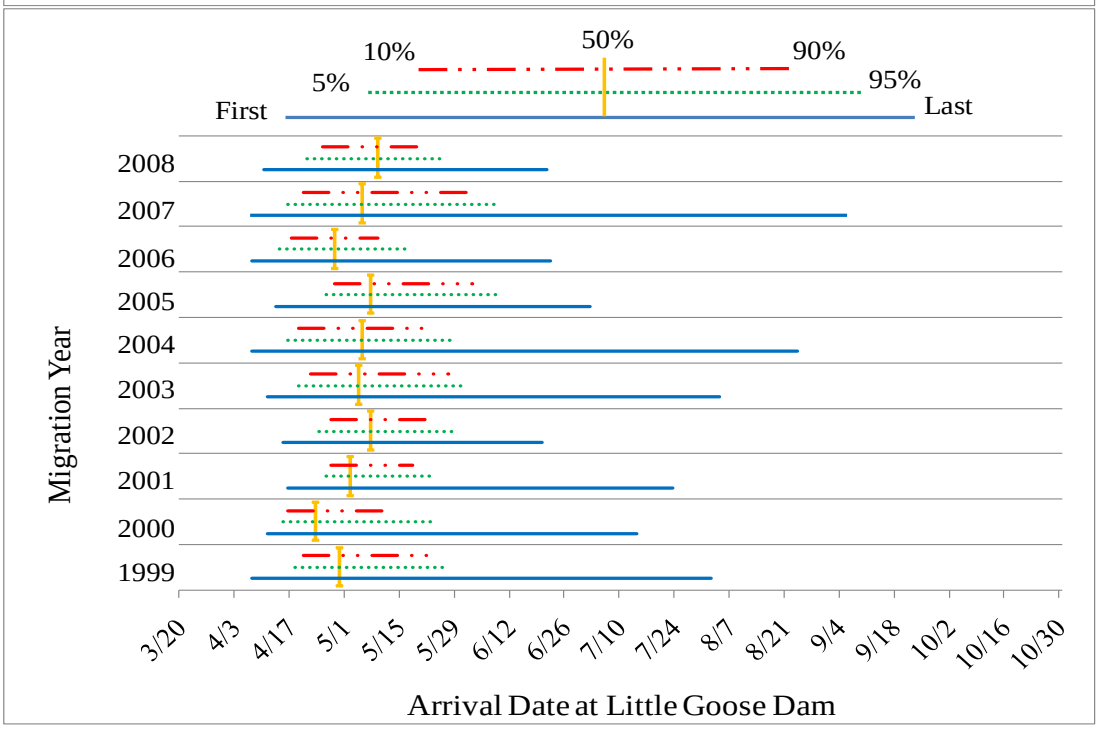


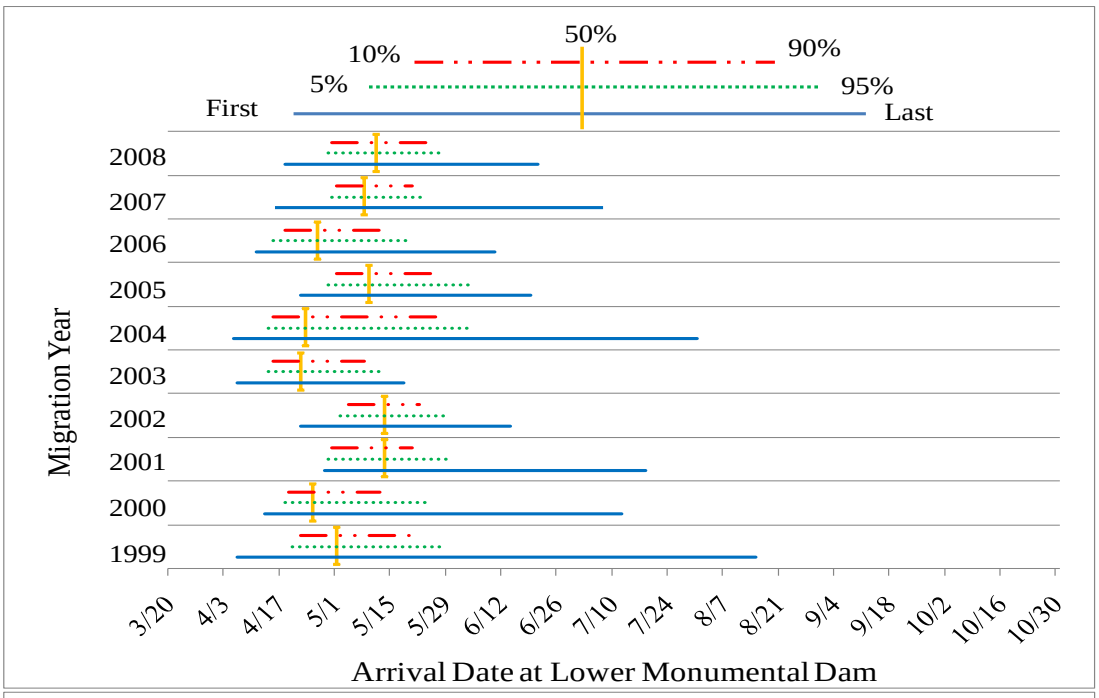


Appendix I. Graphical representation of arrival timing of Imnaha River natural Nacó'x (Chinook salmon) smolts PIT tagged at the Imnaha River trap during spring of 2008 to Lower

Granite, Little Goose, Lower Monumental and McNary dams from 1999 to 2008. Arrival timing includes both survival and monitor mode smolts.



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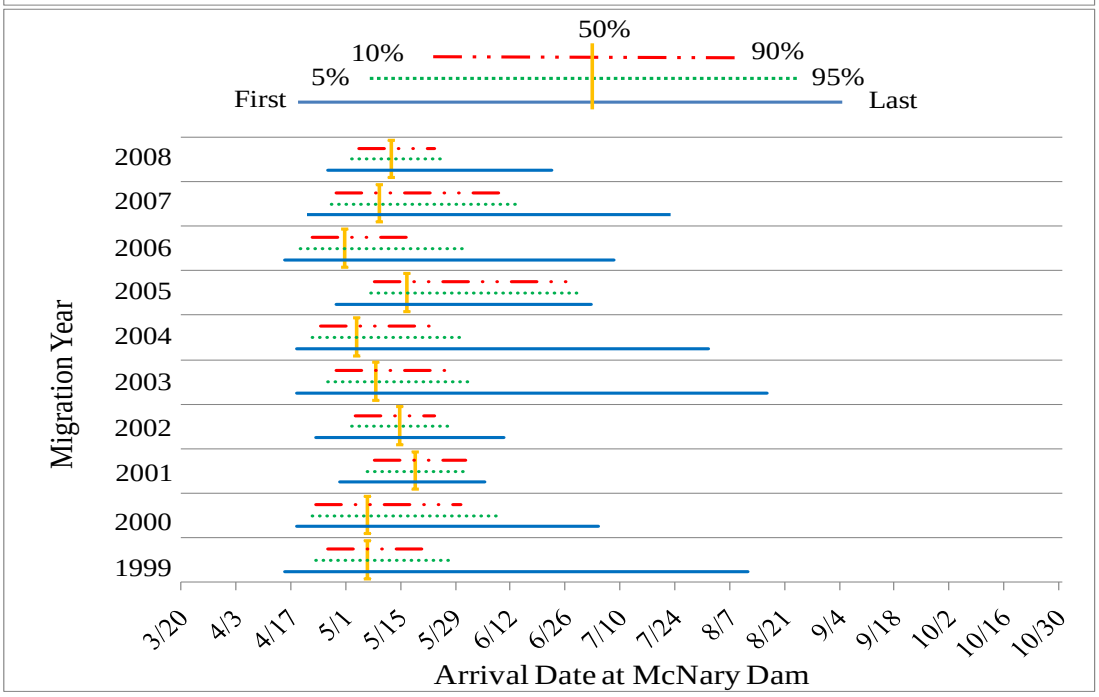
Arrival Date at Lower Monumental Dam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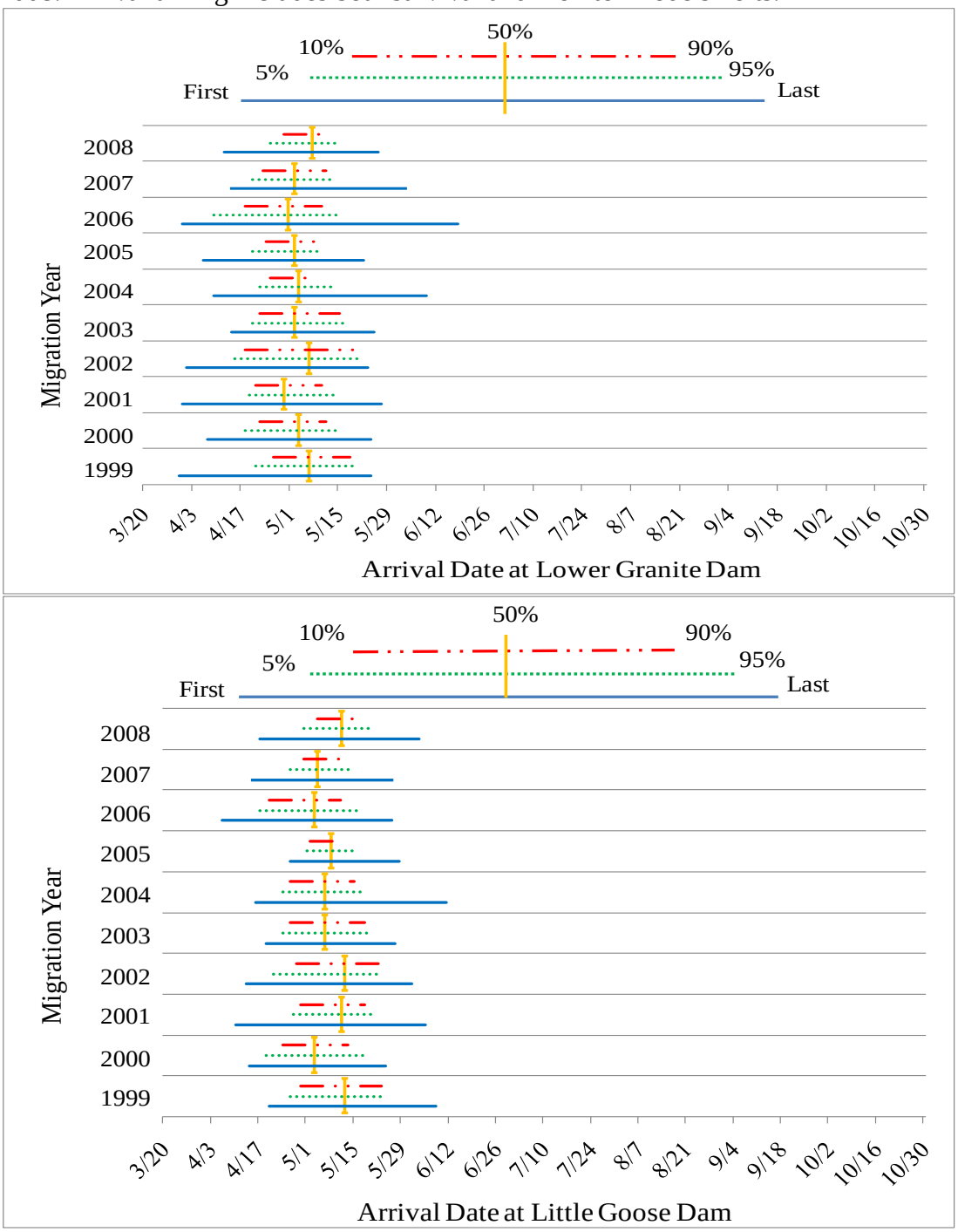
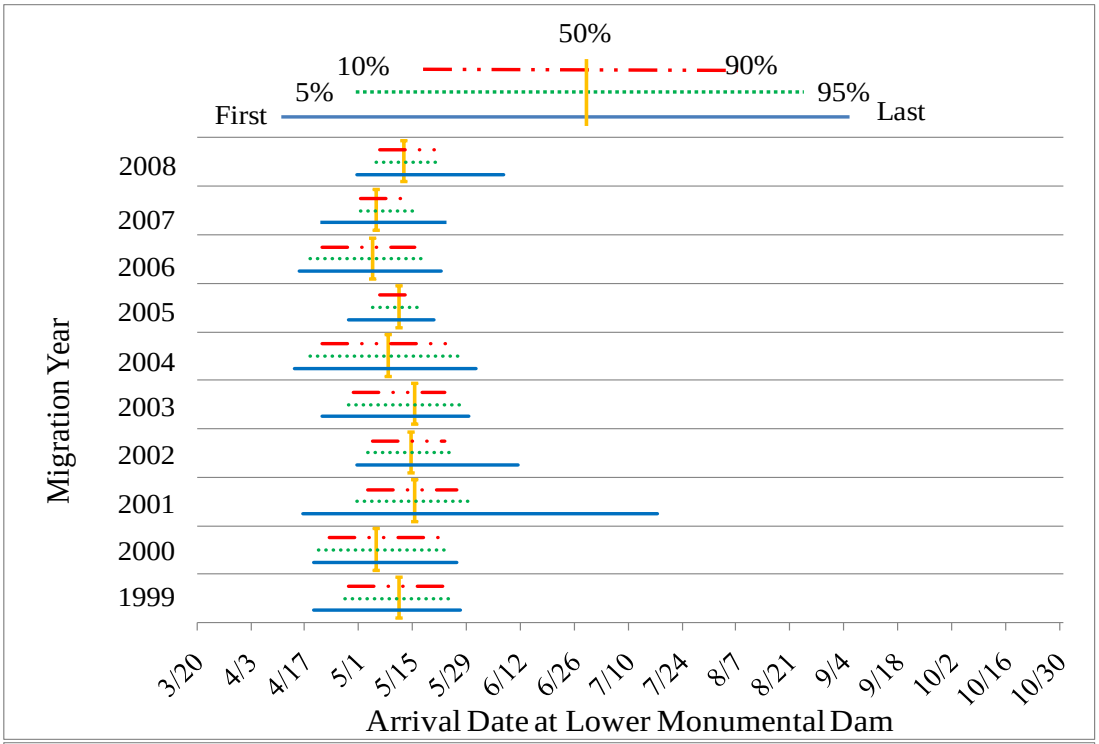
Arrival Date at McNary Dam

Appendix J. Graphical representation of arrival timing of Imnaha River hatchery Nacó'x (Chinook salmon) smolts PIT tagged by ODFW and released in the Imnaha River during spring of 2008 to Lower Granite, Little Goose, Lower Monumental and McNary dams from 1999 to 2008. Arrival timing includes both survival and monitor mode smolts.

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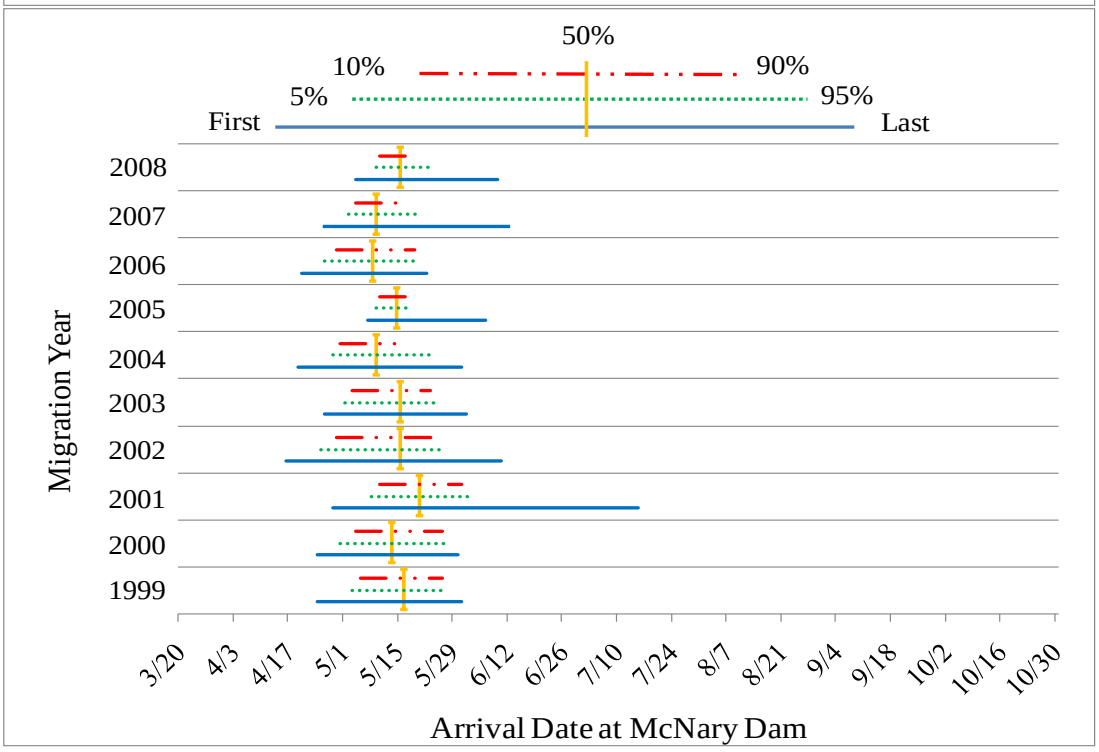
Arrival Date at Lower Monumental Dam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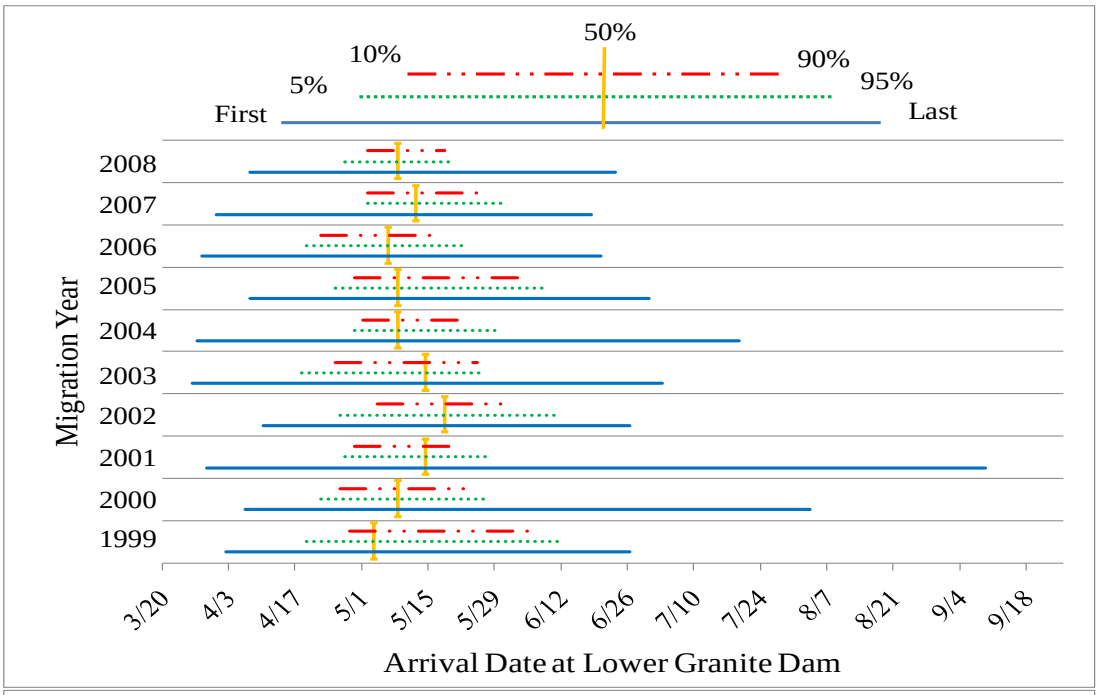
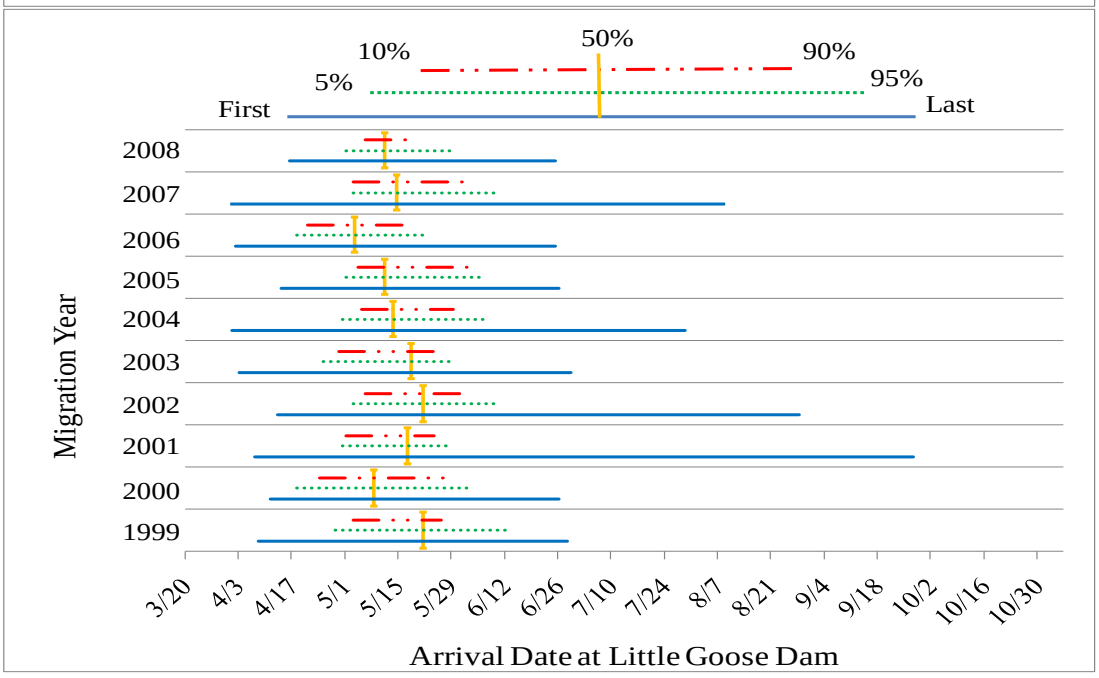
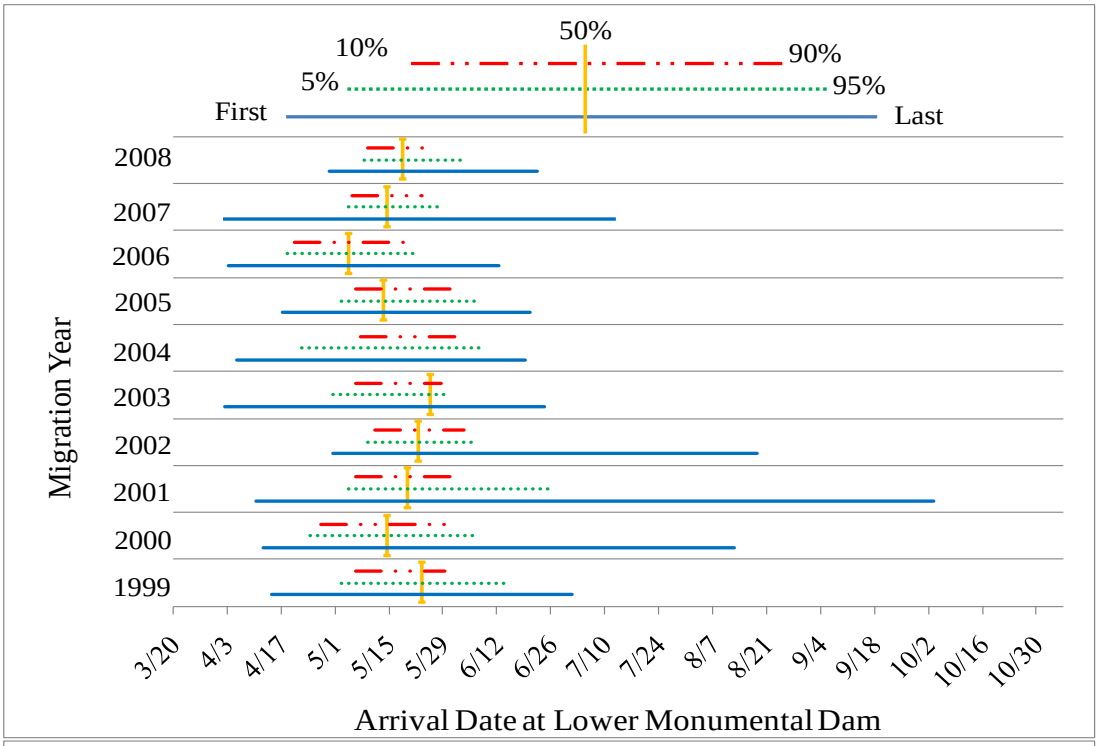
Arrival Date at McNary Dam

Appendix K. Graphical representation of arrival timing of Imnaha River natural Héeyey (steelhead) smolts PIT tagged at the Imnaha River trap during spring of 2008 to Lower Granite, Little Goose, Lower Monumental and McNary dams from 1999 to 2008. Arrival timing includes both survival and monitor mode smolts.



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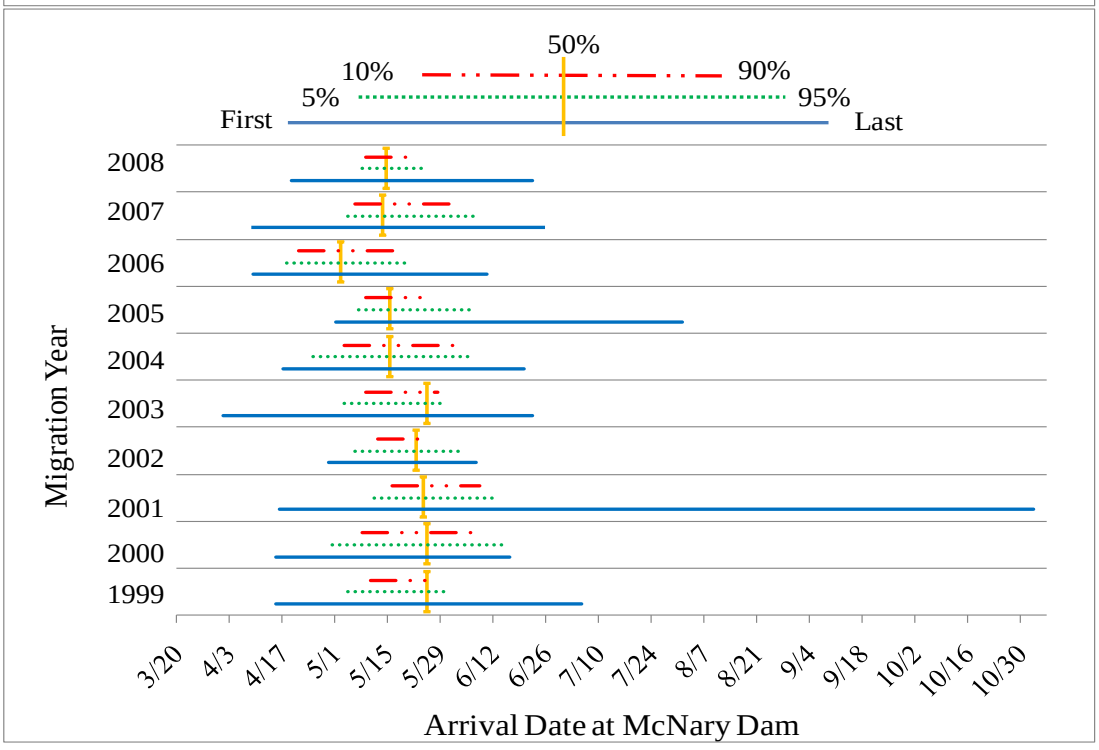
Arrival Date at Lower Monumental Dam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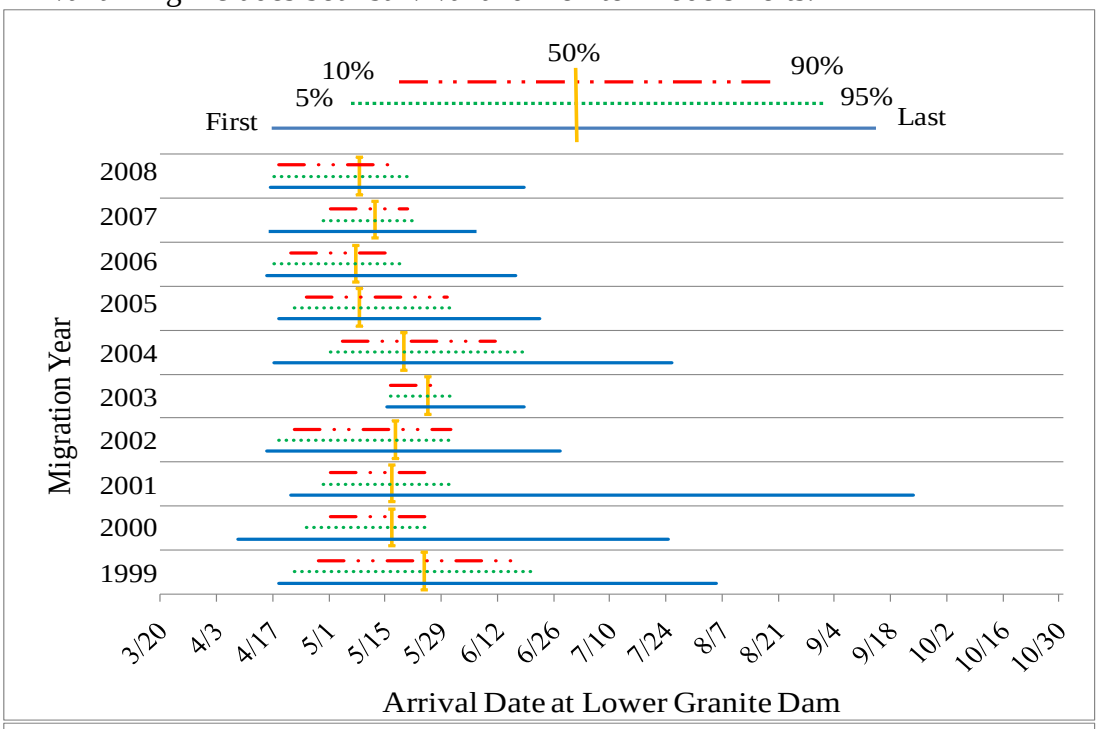
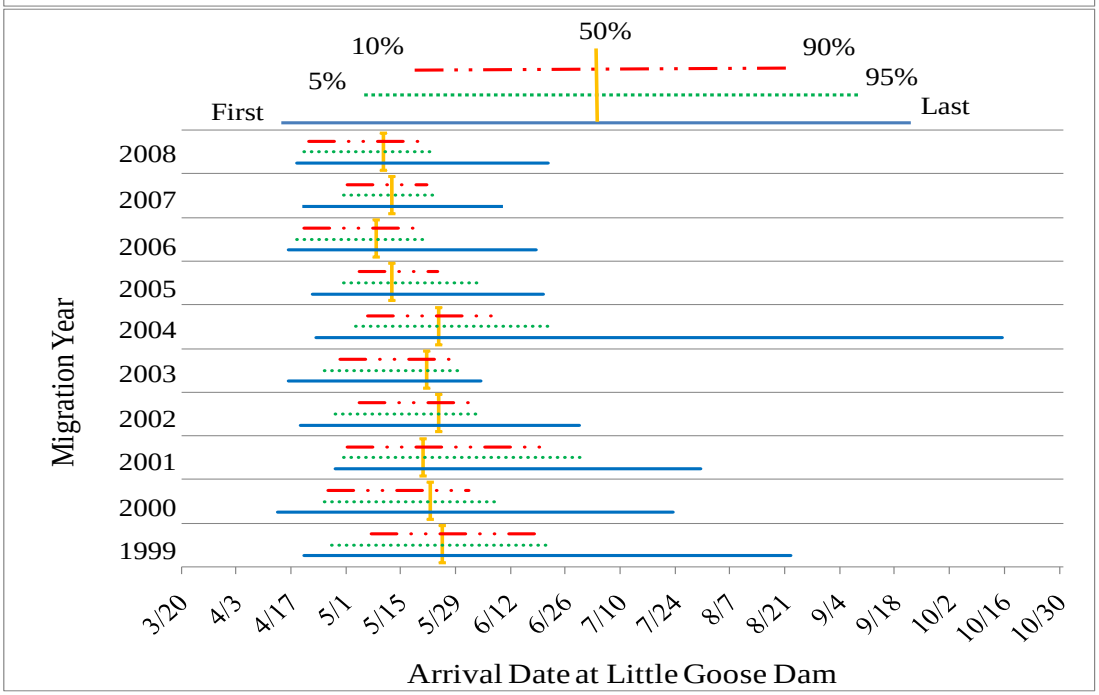
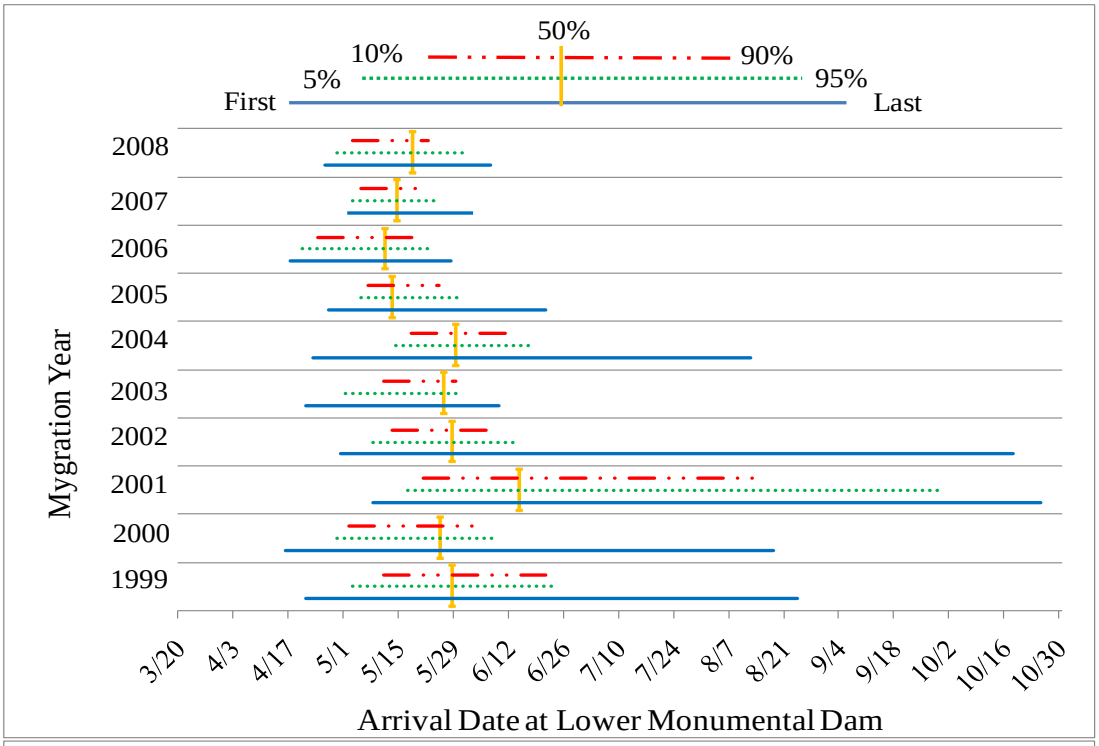
Arrival Date at McNary Dam

Appendix L. Graphical representation of arrival timing of Imnaha River hatchery Héeyey (steelhead) smolts PIT tagged by ODFW and released in the Imnaha River during spring of 2008 to Lower Granite, Little Goose, Lower Monumental and McNary dams from 1999 to 2008. Arrival timing includes both survival and monitor mode smolts.



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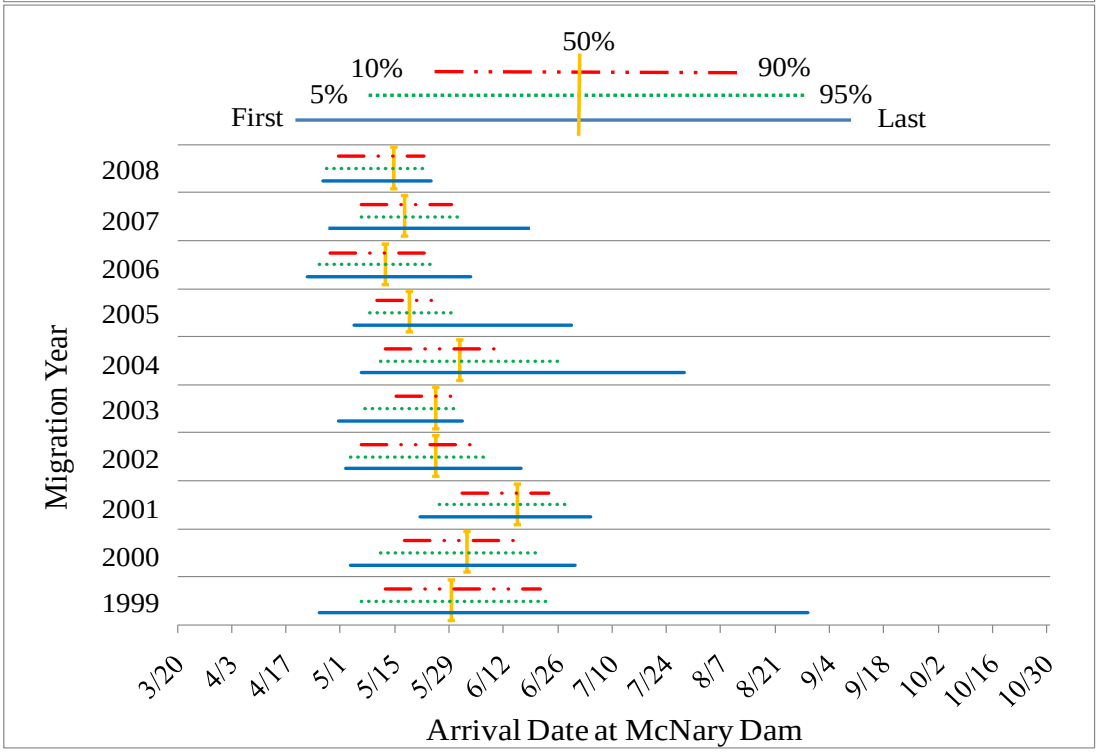
Arrival Date at Lower Monumental Dam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Arrival Date at McNary Dam

Appendix M. Mortality of Nacó'x (Chinook salmon) and Héeyey (steelhead) smolts due to trapping, handling, PIT tagging and dead on arrival at the Imnaha River juvenile migration trap from 3 October to 21 November, 2007.

	Nacó'x (Chinook salmon)				Héeyey (steelhead)			
	Natural		Hatchery		Natural		Hatchery	
Source of Mortality	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
Trapping	11	0.149	0	0	0	0	0	0
Handling	1	0.014	0	0	0	0	0	0
Tagging	3	0.041	0	0	0	0	0	0
DOA	1	0.014	0	0	0	0	0	0
Number Captured	7,366		0		57		1	
Total Mortality	16	0.217	0	0	0	0	0	0

Appendix N. Mortality of Nacó'x (Chinook salmon) and Héeyey (steelhead) smolts due to trapping, handling, PIT tagging and dead on arrival at the Imnaha River juvenile migration trap from 28 February to 18 June, 2008.

	Nacó'x (Chinook salmon)				Héeyey (steelhead)			
	Natural		Hatchery		Natural		Hatchery	
Source of Mortality	(n)	(%)	(n)	(%)	(n)	(%)	(n)	(%)
Trapping	5	0.090	4	0.005	1	0.024	2	0.010
Handling	3	0.054	4	0.005	0	0	7	0.036
Tagging	6	0.108	0	0	1	0.024	0	0
DOA	1	0.018	2	0.003	0	0	2	0.010
Number Captured	5,566		75,632		4,249		19,458	
Total Mortality	15	0.269	10	0.013	2	0.047	11	0.057

Appendix O. The catch of incidental fish during the fall, 3 October to 21 November 2007, and the spring, 28 February to 18 June 2008, at the Imnaha River juvenile fish trap for the 2008 migration year. Catch totals include subsampling estimates.

Family	Common Name	Fall 2007	Spring 2008	Total
Salmonidae	Adult Héeyey (steelhead)	2	113	115
	Adult Nacó'x (Chinook)	1	0	1
	Rainbow Trout / Héeyey (steelhead)	355	85	440
	Cimey (Mountain Whitefish)	112	10	122
	Islam Juvenile (Bull Trout)	130	1	131
	Islam Adult (Bull Trout)	51	0	51
Centrarchidae	Smallmouth Bass	55	138	193
Catostomidae	Muq'uc (Bridgelip Sucker)	1	6	7
	Muq'uc (Largescale Sucker)	0	8	8
	Muq'uc (unidentified species)	85	220	305
Cyprinidae	Tite'wxc (Chislemouth)	2	10	12
	Long nose Dace	1	85	86
	Speckled Dace	1	0	1
	Qiyex (Northern Pikeminnow)	20	10	30
	Redside Shiner	3	0	3
Cottidae	Sculpin (unidentified species)	6	74	80
Petromyzotidae	Juvenile Hessu (Silver) (Pacific Lamprey)	5	111	116
	Juvenile Hessu (Brown) (Pacific Lamprey)	0	712	712
	Total Catch	830	1,583	2,413