LOWER SNAKE RIVER COMPENSATION PLAN:
Oregon Spring Chinook Salmon Evaluation Studies
2012 Annual Progress Report

Oregon Department of Fish and Wildlife
Northeast-Central Oregon Research and Monitoring

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LOWER SNAKE RIVER
COMPENSATION PLAN

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Photo cover: Spring Chinook salmon spawning in a side channel on the Wenaha River above Butte Creek : Photo by Joseph W. Feldhaus.

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Preface

This annual progress report provides summary information for Lower Snake River Compensation Plan (LSRCP) spring Chinook salmon programs operated by the Oregon Department of Fish and Wildlife (ODFW) in the Imnaha and Grande Ronde river basins during 2012. Also included in this report are summaries of data collected at adult broodstock collection facilities operated by our co-managers, the Nez Perce Tribe (Lostine River) and the Confederated Tribes of the Umatilla Indian Reservation (Catherine Creek and Upper Grande Ronde River), and funded by the Bonneville Power Administration. These ongoing monitoring and evaluation programs provide technical, logistical, and biological information to managers charged with maintaining viable natural Chinook salmon populations, and managing hatchery programs and recreational and tribal fisheries in northeast Oregon.

The data in this report serve as the basis for assessing the success of meeting our management objectives and were derived from hatchery inventories and standard databases (e.g., PSMFC, coded-wire tag), through standard sampling techniques or provided by other agencies. As such, specific protocols are usually not described. When possible, data obtained from different sources were cross-referenced and verified. In cases where expansions of data or unique methodologies were used, we describe protocols in more detail. Additional descriptions of protocols can be found in the 2012 work statement (Carmichael and Hoffnagle 2012).

We used coded-wire tag (CWT) data collected from 2012 adult returns to evaluate smolt-to-adult survival rates, harvest, straying, escapement, and specific information on experimental results. In addition, much of the data that we discuss in this report will be used in separate and specific evaluations of ongoing supplementation and research programs for Chinook salmon in the Imnaha and Grande Ronde river basins. We began fish culture evaluations in 1983 and have improved many practices. Progress for work completed in previous years is presented in annual progress reports (Carmichael and Wagner 1983; Carmichael and Messmer 1985; Carmichael et al. 1986a; 1987; 1988; 1999; 2004; Messmer et al. 1989; 1990; 1991; 1992; 1993; Hoffnagle et al. 2005; Monzyk et al. 2006a; b; c; d; e; 2007; 2008a; b; Feldhaus et al. 2010; 2011; 2012a;b; 2014) and United States v. Oregon production report (Carmichael et al. 1986b).

In this report, data are organized into salmon culture monitoring for juveniles and adults, CWT recoveries, compensation goals, estimates for total adult escapement, and natural escapement monitoring. During the period covered in this report, juveniles from the 2011 brood year were hatched, ponded and tagged, Chinook salmon smolts from the 2010 brood year were released, Chinook salmon from the 2007-2009 brood years returned to spawn in 2012, and some of the returning adult Chinook salmon were used to create the 2012 brood year.

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EXECUTIVE SUMMARY

For 2010 brood year (BY) Imnaha River Chinook salmon smolts released in 2012, the green egg-to-smolt survival rate was 90.6% and we released 469,807 smolts. We estimated that 96.4% of these smolts were identifiably marked with an adipose fin clip (ad clip) and/or coded-wire tag. In addition, we released 2010 brood year smolts from the Grande Ronde Basin Spring Chinook Salmon Conventional Hatchery Program (CHP) into four Grande Ronde Basin streams. No Captive Broodstock (CBS) program smolts were released in 2012. The green egg-to-smolt survival rate of BY 2010 Catherine Creek CHP smolts released into Catherine Creek was 91.5%. We released 161,373 CHP smolts into Catherine Creek with 98.6% identifiably marked. The green egg-to-smolt survival rate of Upper Grande Ronde River CHP smolts was 89.6%. We released 285,738 CHP smolts into the upper Grande Ronde River and 99.2% were identifiably marked. The green egg-to-smolt survival rate of Lookingglass Creek CHP smolts released into Lookingglass Creek was 76.1% and we released 228,565 smolts with 98.8% identifiably marked. The green egg-to-smolt survival rate of Lostine River CHP smolts was 80.5%. We released 267,352 CHP smolts into the Lostine River, with over 99.9% identifiably marked.

Mean survival probability of Imnaha River smolts from the release site to Lower Granite Dam was 69%. In the Grande Ronde Basin, the lowest mean smolt survival probability from the release site to Lower Granite Dam was 35% from Catherine Creek CHP smolts released at the Catherine Creek Acclimation site. The highest mean survival probability was 77% for Lookingglass Creek smolts released directly from Lookingglass Fish Hatchery.

After accounting for the estimated number of unmarked hatchery returns, the Oregon Department of Fish and Wildlife trapped 1,478 hatchery-and 475 naturally-produced Chinook salmon at the Imnaha River weir and 1,028 hatchery-and 145 naturally-produced Chinook salmon in Lookingglass Creek. In the Grande Ronde Basin, the Confederated Tribes of the Umatilla Indian Reservation captured 603 hatchery- and 379 naturally-produced Chinook salmon in Catherine Creek and 484 hatchery- and 190 naturally-produced Chinook salmon in the Upper Grande Ronde River. The Nez Perce Tribe captured 803 hatchery-and 486 naturally produced Chinook salmon in the Lostine River.

During the 2012 spawn year at Lookingglass Fish Hatchery, we spawned 71 hatchery and 38 natural females from the Imnaha River and collected 489,198 green eggs. From Catherine Creek, we spawned 22 hatchery and 23 natural females and collected 170,686 green eggs. In the Upper Grande Ronde River, we spawned 45 hatchery and 29 natural females, and collected 267,394 green eggs. In Lookingglass Creek, we spawned 57 hatchery females and 24 natural females and collected 299,475 green eggs. In the Lostine River, we spawned 47 hatchery females and 15 natural females and collected 270,211 green eggs. A greater number of eggs were collected from age 4 than age 5 females and the mean egg weight of age 5 females was greater than that of age 4 females.

We estimated that 2,903 Imnaha River hatchery Chinook salmon returned to the Lower Snake River Compensation Plan compensation area above Lower Granite Dam in 2012, achieving 90.4% of the hatchery compensation goal (3,210) for the Imnaha River Basin. In addition, we estimate that 886 natural origin salmon returned to the Imnaha River. An estimated 630 hatchery Chinook salmon were harvested in sport (ODFW) and tribal (CTUIR and NPT) fisheries in the Imnaha River and an estimated 713 Chinook salmon were harvested in fisheries below Lower Granite Dam. We estimated a total of 3,626 adult Imnaha River hatchery Chinook

salmon returned to the Columbia River in 2012, 22.6% of the total adult production goal of 16,050 hatchery Chinook salmon.

In the Grande Ronde Basin, we estimated that 4,988 hatchery adults (829 Catherine Creek, 702 Grande Ronde River, 2,208 Lookingglass Creek, and 1,249 Lostine River) returned to the compensation area, achieving 85.1% of the compensation goal (5,860) for the Grande Ronde Basin. In 2012, we estimate that 829 hatchery and 417 natural salmon returned to Catherine Creek, 702 hatchery and 240 natural salmon returned to the Upper Grande Ronde River, 2,208 hatchery and 253 natural salmon returned to Lookingglass Creek, and 1,249 hatchery and 768 natural salmon returned to the Lostine River. In Lookingglass Creek, CTUIR and NPT reported that tribal fishers harvested 476 hatchery salmon and ODFW estimated that sport fishers harvested 475 hatchery salmon. The first fishery on Catherine Creek since 1978 was opened in 2012. The sport harvest in Catherine Creek was 24 hatchery adults and CTUIR reported harvesting four hatchery adults. There were no sport or tribal fisheries in the Upper Grande Ronde River in 2012. In the Wallowa River fishery, ODFW estimated that sport anglers harvested zero hatchery salmon and CTUIR and NPT reported that tribal fishers harvested 36 hatchery salmon in a fishery that included the Wallowa River and the Lostine River below the weir. We estimated 977 Grande Ronde Basin hatchery Chinook salmon were harvested in fisheries below Lower Granite Dam, 4.2% of the downstream harvest mitigation goal (23,440). We estimated a total of 6,007 Grande Ronde Basin hatchery Chinook salmon returned in 2012, 20.5% of the total adult production goal of 29,300 hatchery Chinook salmon.

In the Imnaha River, the BY 2007 R:S ratio was 1.3 for naturally spawning salmon, and 10.1 for the hatchery component. In the Grande Ronde Basin, the 2007 brood year R:S for the CHP component was 11.7 in Catherine Creek, 9.7 in the Upper Grande Ronde River, 23.9 in Lookingglass Creek and 25.3 in the Lostine River . The natural component R:S for the 2007 brood year was 3.2 in Catherine Creek, 4.3 in the Upper Grande Ronde River, 1.9 in Lookingglass Creek, and 1.8 in the Lostine River.

In 2012, we observed 774 redds and recovered 457 carcasses during spawning ground surveys in the Imnaha Basin. Hatchery salmon comprised 55.2% of carcass recoveries. During spawning ground surveys in the Grande Ronde Basin, we observed 1,781 redds and recovered 1,267 carcasses. We recovered 32 hatchery salmon outside of the stream into which they were released as smolts. The percentage of hatchery salmon recovered on spawning grounds was 67.4% in Catherine Creek, 93.2% in the Upper Grande Ronde River, 87.1% in Lookingglass Creek, and 62.0% in the Lostine River.

To monitor bacterial kidney disease (BKD), we collected 188 kidney samples from Chinook salmon from Imnaha Basin streams and 451 kidney samples from Grande Ronde Basin streams in 2012. ELISA values remain very low in both the hatchery and in nature and we found no evidence that hatchery salmon releases are causing an increase in BKD prevalence in the monitored streams.

INTRODUCTION

This annual progress report summarizes spring Chinook salmon monitoring data collected by ODFW for the Lower Snake River Compensation Plan (LSRCP) facilities in 2012. Also summarized are the associated adult broodstock monitoring data collected at weirs in the Grande Ronde Basin that are operated by our co-managers, the Nez Perce Tribe (NPT; Lostine River) and Confederated Tribes of the Umatilla Indian Reservation (CTUIR; Catherine Creek and Upper Grande Ronde River). The main objectives of this report are to document and evaluate spring Chinook salmon culture performance for hatchery programs and achievement of management objectives in the Imnaha and Grande Ronde river basins (CTUIR and NPT have specific program goals for Chinook returns to Catherine Creek, the Upper Grande Ronde River, Lookingglass Creek and the Lostine River that are discussed and evaluated in separate reports prepared by each co-management agency). Overall, these data are used to modify fish culture practices, as needed, in order to optimize egg-to-smolt survival rate, smolt quality and smolt-to-adult survival rate, and track spawning in nature by hatchery-reared adults. This report provides information on rearing and release operations for the 2010 brood year of juvenile Chinook salmon smolts, the collection of eggs for the 2012 brood year, numbers and characteristics of adult Chinook salmon in the 2012 return year, the 2012 spawning year at Lookingglass Fish Hatchery and in nature, bacterial kidney disease (BKD) monitoring, and recruit summary and age composition of the 2007 brood year. These metrics document the success of these pograms in meeting the LSRCP objectives for adult salmon returning to the mitigation area above Lower Granite Dam (LGD) and for harvest below LGD.

LSRCP Chinook Salmon Program Objectives

1. Prevent extinction of Imnaha River, Lostine River, Catherine Creek, and Upper Grande Ronde River Chinook salmon populations and ensure a high probability of population persistence well into the future, once causes of basin-wide declines have been addressed.
2. Establish adequate broodstock to meet annual production goals.
3. Establish a consistent total return of Chinook salmon that meets the LSRCP mitigation goal of 3,210 hatchery adults in the Imnaha Basin and 5,860 hatchery adults in the Grande Ronde Basin (Herrig 1990).
4. Establish a consistent total return of Chinook salmon that meets the LSRCP mitigation goal of a 4:1 catch to escapement ratio (commercial catch 3:1 and sport catch 1:1) in the Pacific Ocean and the Columbia River System downstream from the Lower Snake River Project Area (Corps of Engineers 1975). The total adult (ages 3-5) production goal is 16,050 hatchery Chinook salmon from the Imnaha hatchery program (12,840 adults below LGD and 3,210 adults above LGD) and 29,300 hatchery adults from the Grande Ronde Basin hatchery programs (23,440 adults below LGD and 5,860 adults above LGD).
5. Re-establish historic tribal and recreational fisheries.
6. Minimize impacts of hatchery programs on resident stocks of game fish.
7. Operate the hatchery program so that the genetic and life history characteristics of hatchery fish mimic those of wild fish, while achieving mitigation goals.
8. Maintain genetic and life-history characteristics of natural Chinook salmon populations in the Imnaha River, Lostine River, Catherine Creek, and Upper Grande Ronde River.

9. Maintain the genetic and life-history characteristics of the endemic wild populations of Chinook salmon in the Minam and Wenaha rivers.
10. Provide a future basis to reverse the decline in abundance of endemic Chinook salmon populations in the Imnaha and Grande Ronde river basins.

Research Monitoring and Evaluation Objectives

1. Document Chinook salmon rearing and release activities at all LSRCP facilities.
2. Determine optimum rearing and release strategies that will produce maximum survival to adulthood for hatchery-produced Chinook salmon smolts.
3. Document Chinook salmon adult returns to broodstock collection facilities in the Imnaha River, Catherine Creek, Upper Grande Ronde River, Lookingglass Creek, and Lostine River.
4. Estimate annual hatchery returns to the LSRCP compensation area and total hatchery adult production, and determine success in meeting mitigation goals.
5. Estimate annual commercial, sport and tribal harvest of Imnaha River and Grande Ronde Basin hatchery Chinook salmon and determine success in meeting mitigation goals.
6. Estimate annual smolt survival to Lower Granite Dam (LGD) for production and experimental groups.
7. Conduct index, extensive, and supplemental Chinook salmon spawning ground surveys for all populations in northeast Oregon to assess spawn timing and spawning distribution, and estimate natural spawner escapement.
8. Determine the proportion of naturally spawning spring Chinook salmon that are of hatchery origin in the Imnaha and Grande Ronde basin Chinook salmon populations.
9. Determine annual escapement and spawner numbers to estimate and compare productivity (recruits per spawner) for natural- and hatchery-produced fish in the Imnaha and Grande Ronde basin Chinook basins.
10. Compare life history characteristics (age structure, run timing, sex ratio, egg size, and fecundity) of hatchery and natural origin salmon.
11. Coordinate Chinook salmon broodstock marking programs for Lookingglass Fish Hatchery.
12. Participate in planning activities associated with anadromous salmon production and management in the Imnaha and Grande Ronde river basins and participate in ESA permitting, consultation, and recovery planning.

RESULTS AND DISCUSSION

During 2012, spring Chinook salmon from the 2010 brood year produced from the Conventional Hatchery Program (CHP) were released into Catherine Creek, the Upper Grande Ronde River, Lookingglass Creek, Lostine River, and Imnaha River. There were no smolts from the Grande Ronde Basin Spring Chinook Salmon Captive Broodstock Program (CBS) 2010 brood year released into Grande Ronde Basin streams (Gee et al. 2012). Adult Chinook salmon from the 2007-2009 brood years, for all supplemented streams that returned to spawn, were used as broodstock to create the 2012 CHP brood year. These were reared at Lookingglass Fish Hatchery, except for the Lookingglass Creek stock which was reared at Irrigon Fish Hatchery until October 2012 due to capacity limitations at Lookingglass Fish Hatchery. Coded-wire-tag

recoveries from adult hatchery returns were used to assess the success of achieving mitigation goals and management objectives. In addition, much of the data discussed in this report will be used in separate and specific evaluations of ongoing supplementation programs for Chinook salmon in the Imnaha and Grande Ronde river basins.

2010 Brood Year Juveniles

2010 Brood Year Egg to Smolt Survival

Green egg-to-smolt survival rate for the 2010 brood year of Imnaha River Chinook salmon released in 2012 was 90.6% (91.7% green egg-to-eyed egg; 98.9% eyed egg-to-smolt; Table 1). The green egg-to-smolt survival rate for Catherine Creek CHP salmon was 91.5% (91.6% green egg-to-eyed egg; 99.9% eyed egg-to-smolt). For the Upper Grande Ronde River, the green egg-to-smolt survival rate was 89.6% (93.3% green egg-to-eyed egg; 96.0% eyed egg-to-smolt) for CHP offspring. All of the eggs from the Upper Grande Ronde River CBS parents were outplanted into Meadow Creek, a tributary to the Upper Grande Ronde River near Starkey, OR, in small batches as they eyed up. Eyed eggs were released on 26 October, and 2, 9, 16, and 29, 2012. For Lookingglass Creek CHP salmon smolts, the green egg-to-smolt survival rate was 76.1% (86.8% green egg-to-eyed egg; 87.7% eyed egg-to-smolt). For the Lostine River CHP salmon smolts, the green egg-to-smolt survival rate was 80.5% (93.2% green egg-to-eyed egg; 86.4% eyed egg-to-smolt).

Eggs from females with high enzyme-linked immunosorbent assay (ELISA) values were culled in an effort to reduce the incidence of BKD in their offspring. No eggs were culled from females spawned for the 2010 brood year Upper Grande Ronde River CBS production and no females were spawned for the Catherine Creek or Lostine River CBS production (Gee et al. 2011). For all CHP females, the fish health recommendation was that eggs with ELISA levels $\geq$ 0.2 were culled. In 2012, zero eggs were culled due to BK. A total of 251,107 eyed eggs from the Upper Grande Ronde CBS program were placed into Meadow Creek, a tributary to the Upper Grande Ronde River near Starkey, OR, because they were not needed for smolt production.

2010 Brood Year Production and Tagging

The release of 469,807 smolts from the Imnaha River 2010 brood year in 2012 was below the long-term juvenile production goal of 490,000, but well above the specific annual production goal of 360,000[*] for this brood year (Table 1). The recently modified long-term juvenile production goals for the Grande Ronde Basin were set at 150,000 smolts per year for Catherine Creek and 250,000 smolts per year for each of the Lookingglass Creek, Upper Grande Ronde River and Lostine River populations. From the BY 2010 Catherine Creek production, we released 161,373 CHP smolts into Catherine Creek in 2012, achieving 107.6% of the juvenile production goal. From the Upper Grande Ronde River BY 2010 production, we released 285,738 CHP smolts in 2012, achieving 114.3% of the juvenile production goal. In Lookingglass Creek, we released 228,565 smolts from Lookingglass Creek CHP, achieving 91.4% of the juvenile production goal. In the Lostine River, we released 267,352 CHP smolts from the 2010 brood year, 106.9% of the juvenile production goal. While mitigation goals were achieved for nearly all stocks, goals were not met for the Imnaha River or Lookingglass Creek

[*] Due to space limitations at Lookingglass Fish Hatchery, the annual production goal is less than the LSRCP mitigation goal.

stocks. Consistent challenges that have limited smolt production include bacterial kidney disease, low fecundity due to small female size, low adult returns, low capture rates at weirs, and space limitations at Lookingglass Fish Hatchery.

We evaluated the 2010 brood year smolts released in 2012 for mark application success from 6-9 February 2012, a few weeks prior to their release. We sampled at least 500 smolts from each raceway at Lookingglass Fish Hatchery and checked them for the presence of a coded-wire tag (CWT) and adipose fin clip quality (Table 2).

We attempted to mark (ad clip+CWT) 100% of the Imnaha River smolts in four of seven raceways. Smolts in the remaining three raceways received only adipose fin clips. For the portion of smolts receiving ad clip+CWT, we estimated that 91.0% were successfully marked with both marks, 3.5% received an adipose fin clip but no CWT, 2.9% had no adipose fin clip and a wire, and 2.6% were released unmarked. Fin clip application success was estimated at 95.1% for the portion receiving just ad clips and we estimated that 4.9%% of this release group had no identifiable mark (neither ad clip nor CWT).

For smolts released into Catherine Creek, we attempted to mark (ad clip + CWT) 100% of the smolts in two of three raceways. For the portion of smolts receiving ad clip+CWT, we estimated that 93.1% of the CHP smolts were successfully marked with both an ad clip and CWT, 3.4% had just an ad clip, 3.2 % had a CWT but no ad clip, and 0.3% of the smolts released had no identifiable mark. Fin clip application success was estimated at 96.5% for the portion receiving just ad clips, and 3.5% had no identifiable mark (neither ad clip nor CWT).

For smolts released into the Upper Grande Ronde River, we attempted to mark (ad clip + CWT) 100% the CHP smolts in two raceways and two raceways were only marked with CWTs. For the raceways receiving both marks, we estimated that 96.2% were successfully marked with both marks, 1.3 % were only marked with an adipose clip, 2.5% were only marked with a CWT, and 0% were released unmarked. For the two raceways marked with a CWT, 98.5% were successfully marked and 1.6% were released unmarked.

We reared four raceways of smolts from the 2010 Lookingglass Creek adult returns and attempted to mark (ad + CWT) 100% of the smolts in two raceways. The remaining two raceways received only an adipose fin clip. For the raceways receiving both marks, we estimate that 96.0% of the smolts received both marks, 1.8% had just an ad clip, 2.2% had a CWT but no ad clip, and 0% of the smolts released had no identifiable mark. For the two raceways that were only marked with an adipose fin clip, we estimated that 97.5% were successfully marked and 2.5% were released unmarked.

We reared four raceways of Lostine River CHP smolts and attempted to mark (ad clip+CWT) 100% of the smolts in two of four raceways. The remaining two raceways were marked with only an adipose fin clip. For the raceways receiving both marks, we estimated that 98.0% received both marks, 1.3% were only marked with an adipose fin clip, 0.7% were only marked with a CWT, and 0% were released unmarked. For the two raceways marked with only an adipose fin clips, we estimated that 99.3% of the smolts were successfully marked and 0.7% were released unmarked.

2010 Brood Year Downstream Survival

We monitored smolt migration success for all stocks based on survival to Lower Granite Dam (LGD). We compiled release-recapture information for PIT-tagged smolts from each raceway to calculate Cormack-Jolly-Seber survival probabilities (rates) to LGD with a single

release recapture model using the PIT Pro 4 Program (Westhagen and Skalski 2009). Mean stock survival was calculated as the mean of the raceways for each stock.

Five raceways containing Imnaha River 2010 brood year Chinook salmon smolts were transported to the Imnaha River Acclimation Facility on 22 March 2012, and two raceways were released directly into the Imnaha River at the Imnaha River Acclimation Facility on 30 March 2012 (Table 3). Volitional release of the remaining smolts was initiated on 30 March 2012 and smolts were forced out on 6 April 2012. Mean survival rate to LGD for Imnaha River smolts released in 2012 was 69%; 68% for those directly released into the Imnaha River at the acclimation facility and 69% for those that were acclimated.

Two raceways of Catherine Creek CHP smolts were transferred to the Catherine Creek Acclimation Facility on 20 March 2012. Volitional release began on 22 March 2012 and smolts were forced out on 14 April 2012 (Table 3). The remaining raceway of Catherine Creek CHP smolts exhibited chronic elevated mortality and tested positive for IHNV. These smolts were direct-stream released from the bridge at the Catherine Creek Acclimation Facility on 16 April 2012. The mean survival rate to LGD for CHP smolts released into Catherine Creek was 35%.

Two raceways of smolts produced from the Upper Grande Ronde River CHP were transferred to the Upper Grande Ronde River Acclimation Facility on 19 March 2012. Smolts from each raceway were split between two ponds at the acclimation facility. Volitional release of all acclimation ponds was initiated on 21 March 2012. Two of the ponds were forced out on 2 April 2012 and the remaining two ponds were forced out on 14 April 2012, so that half of the smolts from each raceway went out early, and half went out late. One raceway of Upper Grande Ronde CHP smolts was transferred to the acclimation facility on 5 April 2012. Volitional release of these smolts began on 9 April 2012, with force-out occurring on 14 April 2012 (Table 3). The remaining raceway of Upper Grande Ronde River CHP smolts experienced chronic increased loss and also tested positive for IHNV. Smolts from this raceway were direct-stream released into the Upper Grande Ronde River on 16 April 2012. The mean survival rate to LGD for Upper Grande Ronde River CHP was 46%.

Smolts produced from the Lookingglass Creek CHP were volitionally released into Lookingglass Creek directly from the adult holding ponds at Lookingglass Fish Hatchery starting on 30 March 2012, and were forced out into Lookingglass Creek on 13 April 2012 (Table 3). Mean survival rate to LGD for CHP smolts released into Lookingglass Creek was 77%, the highest mean survival probability for smolts released into the Grande Ronde Basin.

Two raceways of Lostine River CHP smolts were transported to the Lostine River Acclimation Facility on 12 March 2012. This group was volitionally released beginning on 22 March 2012, with force-out occurring on 26 March 2012. The two remaining raceways of Lostine River CHP smolts were transferred to the acclimation facility on 3 April 2012. Volitional release was initiated on 13 April 2012 and smolts were forced out on 19 April 2012 (Table 3). The mean survival rate to LGD for CHP smolts released into the Lostine River was 66%.

2012 Return Year Adult Collections

Imnaha River

The Imnaha River weir was installed by ODFW Lookingglass Fish Hatchery personnel on 22 June 2012 and operated until 18 September 2012 (Table 4). Based on adipose fin and

CWT marks, ODFW trapped 1,472 hatchery and 481 natural origin salmon. After adjusting for unclipped returns, we estimate that 1,478 hatchery and 475 natural origin salmon were captured (Table 5). To adjust adult returns, we first determine the age of each salmon based on known ages (CWTs, PIT tags, and scale ages) or estimate age based on length if tags or scales are unavailable (see Appendix A for a more detailed methods description). We then use the percentage of hatchery juveniles from each brood year that were released unmarked (i.e., no CWT and no adipose fin clip) to reduce the number of natural adults and increase the number of hatchery adults from an equivalent age. We retained 218 hatchery and 286 natural salmon for broodstock. To limit the number of hatchery salmon on spawning grounds, 191 were outplanted to Big Sheep Creek and 595 were distributed to Oregon or Nez Perce Tribal food banks. To provide additional harvest opportunities, 123 hatchery salmon were returned to the river below the weir. There were six hatchery and two natural origin trap morts in 2012. The remaining salmon collected at the weir were released above the weir to spawn naturally (345 hatchery, 405 natural). Of the hatchery salmon captured at the weir, 7.5% were age 3, 81.2% were age 4, and 11.3% were age 5. Natural origin returns captured at the weir were comprised of 5.2% age 3, 67.4% age 4, and 27.4% age 5.

There are several limitations to using weir data to characterize the age structure and sex of returning fish. One limitation is that sex determination is based entirely on a visual assessment of external characteristics of a live fish that is not under anesthesia and it is harder to determine the sex of early arriving fish, especially if the fish has not been immobilized. Errors in sex determination result in discrepancies between the weir data and hatchery spawning records (i.e., the number of males and females collected at the weir does not match the number of males and females spawned at the hatchery). Another limitation with weir data is age determination. On the Imnaha River, salmon with fork length $\leq$ 630 mm are generally classified as jacks (i.e., age 3). Since length-at-age distributions overlap, using a fixed length cutoff will classify small age 4 adults as jacks and large jacks as age 4 adults. This has potential to bias the age structure of fish handled at the weir. In this report, we attempt to correct for size overlap by using known age fish (i.e., age determined by a CWT, PIT tag, or scale) to create yearly length-at-age categories. One way to reduce the number of fish without a known age is to release more CWT marked hatchery fish or to collect scales on all fish passed above the weir

Catherine Creek

The Catherine Creek weir was operated by CTUIR from 1 March to 15 August 2012 (Table 4). The first live Chinook was captured on 25 May 2012 and the last new fish (i.e., not a recapture) was captured on 1 August 2012. A total of 603 hatchery and 379 naturally-produced salmon were captured (Table 5). CTUIR retained 40 hatchery and 50 natural origin salmon for broodstock. There were three hatchery and zero natural origin trap morts. One natural origin salmon found dead above the weir 16 April 2012 was excluded from the trap counts because it was not trapped at the weir. To reduce the number of hatchery salmon on the spawning ground, ten were killed for tribal foodbanks and 222 were outplanted (116 to Lookingglass Creek and 106 to Indian Creek). The remaining salmon, 328 hatchery and 329 natural, were passed above the weir to spawn naturally. The age structure of hatchery salmon captured at the weir was 6.1% age 3, 88.6% age 4, and 5.3% age 5. The age structure of natural origin salmon was 3.7% age 3, 84.7% age 4, and 11.6% age 5.

This is the seventh complete brood year return of Catherine Creek hatchery adults from both the CBS and CHP production (brood years 2001-2007). All returns from smolts released

into Catherine Creek from brood year 2007 (age 5 returns) were from the CHP program. Approximately 33.7% of the 2007 brood year smolts were released with only an adipose fin clip and 66.3% were released with both an adipose fin clip and a CWT. As juveniles, all of the CBS and CHP returns from brood year 2008 (age 3) were marked with an adipose fin clip and a CWT and the CHP returns were also marked with a blue visual implant elastomer. Adult returns from the 2009 brood year (age 3) CBS program were marked with an adipose fin clip and a CWT and returns from the CHP program were marked with an adipose fin clip, CWT, and green visual implant elastomer. The age structure of CBS returns was 11.1% age 3, 88.9% age 4, and 0% age 5. The age structure of CHP returns 3.5% age 3; 87.6% age 4, and 8.9% age 5.

Upper Grande Ronde River

The Upper Grande Ronde River weir was operated by CTUIR from 1 March to 22 June 2012 (Table 4). The first fish was captured at the Upper Grande Ronde River weir on 30 March 2012 and the last fish was captured on 22 June 2012. A total of 484 hatchery- and 190 naturally-produced salmon were captured (Table 5). A total of 85 hatchery and 84 natural salmon were retained for broodstock, nine hatchery salmon were sent to a foodbank, and 391 hatchery and 106 natural Chinook were released above the weir to spawn naturally.

This is the seventh year we had a complete brood year return of Upper Grande Ronde River hatchery adults from both the CBS and CHP production (2001 – 2007 brood years). All returning CBS salmon from brood years 2007 (age 5), 2008 (age 4), and 2009 (age 5) were marked with both an adipose fin clip and a CWT. The CHP salmon from brood years 2007-2009 were marked with only a CWT. Age structure of CBS returns handled at the weir was 0.8% age 3, 96.7% age 4, and 2.5% age 5. The age structure of the CHP weir captures was 9% age 3, 84.4% age 4, and 6.6% age 5.

Lookingglass Creek

The Lookingglass Creek weir was operated by Lookingglass Fish Hatchery (ODFW) personnel from 1 March to 18 September 2012 (Table 4). A total of 1,028 hatchery and 145 natural salmon were collected at the weir (Table 5). The trap total includes three strays from Catherine Creek CHP production and 24 strays from the Upper Grande Ronde CHP. Age 3 Catherine Creek CHP stray returns were marked with an adipose fin clip, CWT, and a green VIE while age 4 Catherine Creek CHP program stray returns were marked with an adipose fin clip, CWT, and a blue VIE. One age 4 Catherine Creek stray was kept for broodstock and two were killed. Strays from the Upper Grande Ronde CHP program were identified by the absence of an adipose fin clip and the presence of a CWT. Eight salmon marked with a left OP were excluded from all trap counts because these fish had been previously captured at the Catherine Creek weir and released into Lookingglass Creek. One of the Upper Grande Ronde strays was kept for the Grande Ronde CHP program and 23 were passed above the weir to spawn naturally.

Weir records indicate that of the 1,001 hatchery and 145 natural salmon identified as Lookingglass Creek returns; 831 hatchery and 95 natural origin Chinook were passed above the weir to spawn naturally; one hatchery salmon was passed below the weir, 47 hatchery salmon were killed (foodbank or landfill), and 122 hatchery and 50 natural salmon were kept for broodstock. The number of salmon kept for broodstock does not match the numbers that were used in the broodstock and is a result of unresolvable errors in record keeping. All hatchery salmon captured at the weir (includes strays) were comprised of 5.7% age 3, 91.0% age 4, and

3.3% age 5. Natural origin returns captured at the weir were comprised of 2.8% age 3, 88.9% age 4, and 8.3% age 5.

Lostine River

The Lostine River weir was operated by NPT from 15 February to 29 September 2012 (Table 4). A total of 803 hatchery and 486 natural salmon were collected at the weir (Table 5). NPT retained 100 hatchery and 42 natural origin salmon for broodstock. To reduce the number of hatchery salmon on the spawning grounds, 181 hatchery salmon were sent to Wallowa Fish Hatchery for distribution to Oregon or Nez Perce Tribal foodbanks and 29 hatchery salmon were released into the Wallowa River at the Sunrise Road Bridge below the town of Enterprise, OR. The remaining salmon were passed above the weir to spawn naturally (493 hatchery, 442 natural). Of hatchery salmon captured at the weir, 2.3% were age 3, 86.9% were age 4, and 10.8% were age 5. Natural origin returns captured at the weir were comprised of 5.6% age 3, 85.6% age 4, and 8.8% age 5.

This is the eighth year we had a complete brood year return of Lostine River hatchery adults from both the CBS and CHP programs (2000-2007 brood year). Adults used as broodstock in the 2012 brood year were both natural and hatchery origin (CHP progeny only – returning CBS progeny are allowed to spawn naturally or are removed but are not collected for the CHP broodstock due to domestication concerns). The CBS and CHP salmon from brood year 2009 (age 3) were only marked with a CWT. As juveniles, all CBS smolts released from brood years 2007 (age 5) and 2008 (age 4) were marked with only a CWT. Juvenile CHP salmon smolts released from brood years 2007 and 2008 were marked with both an adipose fin clip and a CWT. Additionally, 66,820 parr marked with only an adipose fin clip (12,654 CBS and 54,166 CHP parr) from brood year 2008 and 64,124 parr (26,130 CBS and 37,994 CHP parr) from the 2007 brood year that were only marked with an adipose fin clip were released into the Lostine River (Gee et al. 2010, 2011, Feldhaus et al. 2012b).

The release of adipose clipped CBS and CHP parr into the Lostine River from the 2007 brood year is problematic because when the adults return to the Lostine River, we have no way of identifying the program from which the adults were produced. Therefore, we assume is that, based on length-at-age relationships, all age 4 and age 5 hatchery returns handled at the Lostine River weir in 2012 that were only marked with an adipose fin clip were from the 2007 and 2008 brood year parr releases. We also assume that CBS and CHP parr had equal parr-to-smolt survival and SAR rates. Therefore, we used the number of CBS and CHP parr released into the Lostine River to proportion the age 4 and 5 year old hatchery returns that were only marked with an adipose fin clip into the adult accounting for the SAR calculations from the CBS and CHP programs. The consequence of this assumption is that the 2007 and 2008 brood year CBS and CHP program SAR calculations will be increased because we are including adult returns from the CBS and CHP parr release. We assume that survival to maturation of the parr release was low. Another potential consequence of releasing CBS parr that are not identifiable is that they could be utilized in the broodstock when they return.

For the 2012 return year, based on length-at-age, the presence of an adipose fin clip and lack of a CWT, we estimate that 99 age 4 salmon handled at the weir were from the 2008 brood year hatchery program of CBS and CHP parr releases and 22 were from the 2009 brood year parr releases. We estimate that the 99 age 4 salmon handled at the weir from the 2008 brood year hatchery parr releases were comprised of 19 CBS and 81 CHP adult returns. The 22 age 4 salmon handled at the weir from the 2007 brood year were estimated to be comprised of 4 CBS

and 18 CHP adult returns. After dividing age 4 and age 5 hatchery adults that were only marked with an adipose fin clip into CBS and CHP production, the age structure of the CBS salmon handled at the weir was 0% age 3, 94.7% age 4, and 5.3% age 5. The age structure of the CHP salmon captured at the weir was 2.5% age 3, 84.9% age 4, and 12.6% age 5.

Adult Accounting Problems

In recent years, accounting for salmon at the Imnaha River, Catherine Creek, Upper Grande Ronde River, Lookingglass Creek, and Lostine River weirs has become increasingly difficult. With increased numbers of hatchery returns and low numbers of natural returns, managers limited the number of hatchery salmon passed above the weirs in order to meet sliding scale management agreements. Subsequently, to reduce hatchery numbers on the spawning grounds, it has been necessary to outplant fish to other tributary streams (e.g., Bear Creek, Big Sheep Creek, Lick Creek, and Wallowa River) and to coordinate distribution of surplus hatchery fish to local and tribal foodbanks. Fish that are distributed to local/tribal food banks are either distributed directly from the weir, or sent to Wallowa Hatchery for distribution. Both the Imnaha River and Lostine River stocks are sent to Wallowa Fish Hatchery at the same time so there is potential for fish to accidently get mixed in the holding ponds prior to distribution, leading to discrepancies in the number of fish transferred into and out of this facility. On occasion, as occurred in 2010, but not 2012, excess hatchery fish are also held on a temporary basis at Lookingglass Fish Hatchery before they are either distributed to Oregon/tribal food banks.

One unique challenge with counting returns to Lookingglass Creek in 2012 was the release of 116 hatchery salmon collected from the Catherine Creek weir and outplanted into Lookingglass Creek below the weir to supplement fisheries. All of these Catherine Creek outplants were marked with a left OP, but this mark can sometimes be lost or missed during fish handling (e.g., carcasses recovered on the spawning ground), which results in an overestimate of the number of stray Catherine Creek fish recovered in Lookingglass Creek. Also, because there was no biological information collected from any fish harvested in the tribal fisheries, and the OP mark was not recorded by the ODFW sport creeler, we do not have a reliable way of estimating the number of outplanted fish that were harvested. In years where fish are collected at the Catherine Creek weir and outplanted into Lookingglass Creek, recording the presence or absence and type of OP mark (e.g., 1LOP, 1ROP) on all harvested fish would reduce the chances that outplanted fish were incorrectly identified as strays. This would also provide data that could be used to determine the proportion of outplanted fish that were harvested.

Although the number of fish that enter and leave each facility is documented, there are usually discrepancies between weir records and hatchery records concerning the numbers of males and females kept, spawned, and distributed to foodbanks. The most common factors that contribute to discrepancies between weir and hatchery records are incorrect sex identification at time of capture, error in classifying fish into “jack” and “adult” age categories based on size at time of collection, and incorrectly identifying the presence of a CWT in unclipped hatchery returns. Incorrectly classifying unclipped returns is one reason why the number of hatchery and natural fish collected at the weir disagree with hatchery spawning records. Marking all hatchery releases with an ad clip would help reduce errors associated with differentiating hatchery and natural returns.

2012 Brood Year Hatchery Spawning

Imnaha River

For the 2012 brood year, we spawned 71 hatchery and 38 natural females with 106 unique hatchery and 27 unique natural male parents. Jacks were counted as males (six jacks were counted as one male) and some males were spawned multiple times. Counting six jacks as one male is unique to the Imnaha production. We collected 489,198 green eggs which were incubated at Lookingglass Fish Hatchery where mortality rate to shocking was 20.3%, resulting in 389,802 eyed eggs (Table 6).

Catherine Creek

Adults used as broodstock to create the Catherine Creek 2012 brood year were from both natural and hatchery origin (CHP progeny only – returning CBS progeny are allowed to spawn naturally or are removed but are not collected for CHP due to domestication concerns). For the 2012 brood year, we spawned 22 hatchery and 23 natural females with 19 unique hatchery and 23 unique natural male parents. Jacks were counted as males and some males were spawned more than once. We collected 170,686 green eggs and mortality rate to shocking was 13.0%, resulting in 148,514 eyed eggs (Table 6).

Upper Grande Ronde River

Adults used as broodstock to create the Upper Grande Ronde River 2012 brood year were from both natural and CHP origin (returning CBS progeny are allowed to spawn naturally or are removed but are not collected for CHP broodstock due to domestication concerns). We spawned 45 hatchery and 29 natural females with 34 unique hatchery and 41 unique natural male parents. Jacks were counted as males and some males were spawned more than once. We collected 267,394 green eggs and mortality rate to shocking was 8.3%, resulting in 245,116 eyed eggs (Table 6).

Lookingglass Creek

For the 2012 brood year, we spawned 57 hatchery and 24 natural females with 52 unique hatchery and 21 unique natural origin male parents. Jacks were counted as males and some males were spawned more than once. We collected 297,475 green eggs and morality rate to shocking was 6.0%, resulting in 279,533 eyed eggs (Table 6).

Lostine River

For the 2012 brood year, we spawned 47 hatchery and 15 natural females with 42 unique hatchery and 21 unique natural male parents. Jacks were counted as males and some males were spawned more than once. We collected 270,211 green eggs and morality rate to shocking was 10.2%, resulting in 242,616 eyed eggs (Table 6).

Egg Weight

For all stocks, a greater number of eggs were collected from age 4 salmon than age 5 salmon (Table 7). Mean egg weight was greater for age 5 than age 4 females ($P < 0.001$). In all stocks, mean egg weight for natural origin salmon was larger than hatchery salmon and this difference was significant for Imnaha River salmon ($P = 0.037$) but not for the other stocks ($P \geq 0.080$).

Coded-Wire Tag Recoveries

Methods

Hatchery salmon from most production raceways were marked with a coded-wire tag to provide basic information on survival, harvest, escapement, straying, and specific information on experimental groups, if any. Recovery information for each CWT code group was obtained from the Regional Mark Information System (RMIS) CWT recovery database maintained by the Pacific States Marine Fisheries Commission.

The observed and estimated numbers of hatchery salmon from each CWT code group recovered in ocean and main stem river fisheries, as well as strays collected in and out of the Snake River Basin, were summarized. Estimated CWT recoveries in the RMIS database were expanded from observed recoveries based on sampling efficiencies at some recovery locations, but not for recoveries observed in the Imnaha and Grande Ronde river basins. Therefore, we estimated total CWT marked hatchery adults from each code group (observed from weir collections and spawning ground recoveries) returning to the Imnaha River, Upper Grande Ronde River, Lookingglass Creek, Catherine Creeks, and Lostine River based on total escapement to each stream, sampling rate, and the proportion of each cohort marked with CWTs.

The methodology for estimating hatchery and natural escapement to the Imnaha River was modified for the 2008 return year and this modification has been used since then (Feldhaus et al. 2011). In the Grande Ronde Basin, CWTs from the CBS and CHP were recovered at different sampling efficiencies. Recovery rates for CHP progeny are usually higher because CWTs are recovered from CHP progeny retained for broodstock, as well as from spawning grounds surveys, whereas CBS recoveries are typically recovered only on spawning ground surveys, since none are retained for broodstock. This necessitated expanding CWT recoveries for CBS and CHP hatchery returns separately.

The methodology for estimating hatchery and natural escapement to the Lostine River for the 2012 return year was the same as the 2011 return year and is described in Feldhaus et al. (2011). To estimate CBS and CHP returns to the Lostine River, we utilized the same methods described above for Catherine Creek and the Upper Grande Ronde River (i.e., separate CWT expansions for CBS and CHP returns).

In both the Imnaha and Grande Ronde basins, the exception to the CWT expansion method is when we did not have any CWT recoveries for a particular brood year, but weir data indicated adults from that brood year had returned. In these cases, we estimated the total number of returning adults by age class. If the returning adults from the brood year were potentially comprised of more than one tag group, we partitioned the estimated CWT returns into individual code groups based on the relative proportion of tag group recoveries from the previous year's return.

For some stocks, excess adult hatchery returns were outplanted to nearby streams. CWTs from these stocks that were recovered in outplant streams were not considered strays but rather were included in escapement calculations for the stream to which they returned. For all streams, the escapement estimate was the sum of untrapped Chinook above and below the weir added to the number trapped at the weir (released above or below the weir, kept for broodstock, outplanted, trap mortalities, sacrificed, and harvested).

Results

Imnaha River

In 2012, 441 hatchery-reared Imnaha River Chinook salmon from the 2007-2009 brood years with a CWT were recovered, nearly all in the Snake River Basin (Table 8). Seventy-five CWT recoveries were from the 2009 brood year (age 3), 341 were from the 2008 brood year (age 4), and 25 were recovered from the 2007 brood year (age 5). Catch distribution was comprised of two CWT-marked Imnaha River salmon harvested in ocean fisheries, 58 salmon with a CWT were harvested in the Columbia River, and no CWT recoveries were reported from sport or tribal fisheries in the Snake River. The CWT recoveries in the Columbia and Snake rivers were comprised of 32 CWTs in treaty net fisheries, four in non-tribal net fisheries, and 22 in sport fisheries. Below LGD, six stray CWT-marked salmon were recovered in the Deschutes River. Above LGD, one CWT was recovered from the Wenaha River and one CWT was recovered from the Rapid River rack.

Within the Imnaha River Basin, 13 CWTs were recovered from the Imnaha River sport fishery, no CWTs were collected from the tribal fishers, 107 CWTs were recovered on the spawning grounds, and 253 were recovered from salmon collected at the Imnaha River adult trap.

Catherine Creek

We recovered 178 hatchery-reared Catherine Creek Chinook salmon with a CWT from the 2007-2009 brood years (Table 9). Sixteen CWT recoveries were from the 2009 brood year (age 3), 155 were from the 2008 brood year (age 4), and seven CWTs were recovered from the 2007 brood year (age 5). Catherine Creek Chinook salmon were not recovered in ocean fisheries, 34 CWTs were recovered in the Columbia River, and eight were from the Snake River sport fishery. Of the Columbia River CWT recoveries, three were recovered in tribal net fisheries, ten in non-tribal net fisheries, and 21 in sport fisheries. Below LGD, we recovered one CWT from a stray salmon at the Pelton Dam fish trap in the Deschutes River. Above LGD, zero CWTs were recovered outside the Grande Ronde Basin.

Within the Grande Ronde Basin, one salmon released into Catherine Creek was recovered on the Lostine River spawning ground surveys, three were recovered from the Upper Grande Ronde River (two on the spawning ground and one from the adult trap), and 17 were recovered in Lookingglass Creek (eight on the spawning ground, eight in the fish trap, and one in the sport fishery). Within Catherine Creek, one CWT was recovered in the first sport fishery since 1978, zero CWTs were recovered from tribal fishers, 50 CWTs were recovered on the spawning grounds, and 63 CWTs were recovered from salmon collected at the Catherine Creek adult trap.

Upper Grande Ronde River

We recovered 205 hatchery-reared Upper Grande Ronde River Chinook salmon with a CWT from the 2007-2009 brood years (Table 10). Fourteen CWT recoveries were from the 2009 brood year (age 3), 181 were from the 2008 brood year (age 4), and ten were from the 2007 brood year (age 5). No Upper Grande Ronde River CWT-marked salmon were recovered in ocean fisheries, 38 CWTs were recovered in the Columbia River, and three CWT-marked salmon were recovered in the Snake River. Below Lower Granite Dam, three CWT-marked salmon were recovered on the North Fork of the John Day River. Above LGD, no CWT-marked salmon were recovered outside the Grande Ronde Basin. Within the Grande Ronde Basin, 13

CWT-marked salmon were recovered as in-basin strays in Lookingglass Creek (four from the spawning ground and nine from the adult trap). A total of 55 CWTs were recovered from carcasses collected on spawning ground surveys in the Upper Grande Ronde River and 93 were collected from salmon collected at the Upper Grande Ronder River adult trap.

The limited number of recoveries outside the Upper Grande Ronde River is probably because only 21.1% of the 2009 brood year, 76.6% of the 2008 brood year, and 34.6% of the 2007 brood year were marked with both a CWT and an adipose fin clip. Nearly all of the remainder were marked with only a CWT and no adipose fin clip. Therefore, unless a snout is collected for fish with an intact adipose fin or a CWT wand is used to check for the presence or absence of a CWT for all fish handled, it is likely that Upper Grande Ronde River hatchery Chinook salmon were mistakenly identified as natural returns. Furthermore, most sport fisheries prohibit harvesting Chinook salmon with an intact adipose fin and tribal fishers rarely check non-adipose clipped salmon for tags, further diminishing the chances of recovering a CWT from Upper Grande Ronde River hatchery salmon. This decreases the total survival (SAS) and stray rate for the Upper Grande Ronde River hatchery salmon and inflates the natural return numbers from streams in which they were captured.

Lookingglass Creek

We recovered 355 hatchery-reared Chinook salmon released into Lookingglass Creek with a CWT from the 2007-2009 brood years (Table 11). A total of 35 CWT recoveries were from the 2009 brood year (age 3), 310 CWTs from the 2008 brood year (age 4), and ten CWT-marked salmon from the 2007 brood year (age 5). Four Lookingglass Creek salmon marked with a CWT were recovered in ocean fisheries. Sixty-nine CWT-marked salmon were recovered in the Columbia River, nine in treaty net fisheries, 24 in non-tribal net fisheries, and 36 in sport fisheries. Six CWT-marked salmon were recovered in Snake River sport fisheries and none were recovered in Snake River tribal fisheries. Below LGD, six CWT-marked salmon were recovered; three in the Deschutes River, two in the John Day River, and one in the Klickitat River. Above LGD, three CWT marked salmon were recovered in the Wenaha River. Within Lookingglass Creek, 41 CWTs were recovered from the Lookingglass Creek sport fishery, no CWTs were recovered from tribal fishers, 128 CWTs were recovered from carcasses collected on spawning ground surveys in Lookingglass Creek, and 96 were recovered from salmon collected at the Lookingglass Creek adult trap.

Lostine River

We recovered 485 hatchery-reared Chinook salmon released into the Lostine River with a CWT from the 2007-2009 brood years (Table 12). Four CWT recoveries were from the 2009 brood year (age 3), 420 were from the 2008 brood year (age 4), and 61 CWTs were from the 2007 brood year (age 5). Four CWT-marked Lostine River Chinook salmon were recovered in ocean fisheries and 46 CWTs were recovered in the Columbia River, of which 31 were recovered in tribal net fisheries, five in non-tribal net fisheries, and ten in sport fisheries. Below LGD, eighty CWT-marked salmon were recovered in the Deschutes River. Within the Snake River, no CWT-marked salmon were recovered from either sport or tribal fisheries. Above LGD, two CWTs were recovered outside the Grande Ronde Basin: one from the Salmon River and one from the Dworshak Fish Hatchery. Within the Grande Ronde Basin, two CWT-marked Lostine River salmon were recovered in the Minam River, two in the Wallowa River and one was

recovered in each of the Wenaha River, Bear Creek, and Hurricane Creek. No CWTs were recovered from tribal fishers.

Compensation Goals

To assess LSRCP success at achieving mitigation goals and management objectives, we estimated the total number of hatchery-produced salmon for each stock that were caught in fisheries, escaped to the stream of release, or strayed within or outside the Snake River Basin. The numbers of hatchery-produced salmon that were caught in fisheries or strayed was based on CWT recoveries from the RMIS database. Because not all of a cohort within a stock were CWT-marked (i.e., ad only or failed CWT application), the estimated number recovered in each recovery location was further expanded by dividing it by the proportion of the cohort with CWT marks. The number of hatchery-produced salmon that escaped to the stream of release was determined using the method described in Monzyk et al. (2006a) and modified by Feldhaus et al. (2011). To determine the return to the LSRCP Compensation Area, defined as the Snake River Basin above LGD, we summed all estimated escapement for the 2012 return year above LGD.

Imnaha River

Return to Compensation Area

The annual compensation goal for the Imnaha Basin is 3,210 hatchery adults (age 3-5). We estimated that 2,903 Imnaha River hatchery adults returned to the compensation area in 2012, 90.4% of the hatchery adult goal for the Imnaha River stock (Table 8). Of the total escapement above Lower Granite Dam, we estimate that 630 hatchery salmon were harvested in fisheries, 19.6% of the compensation area mitigation goal.

The annual total production goal for Imnaha River hatchery Chinook salmon is 16,050 (Corps of Engineers 1974). There is a catch to escapement ratio goal of 4:1, resulting in a harvest mitigation goal of 12,840 hatchery Chinook salmon. We estimate 713 Imnaha River hatchery Chinook salmon were harvested in fisheries below Lower Granite Dam, 5.5% of the downstream harvest mitigation goal.

Return to the River

We estimate that 2,880 hatchery and 886 natural origin salmon returned to the Imnaha River in 2012. The estimated total return to the river of hatchery salmon was comprised of 328 age 3, 2,232 age 4, and 320 age 5 returns. For natural salmon, we estimate that 65 age 3, 589 age 4, and 232 age 5 returned. The estimated total return to the river includes an estimate of 19 hatchery jacks and 203 hatchery adults harvested by sport anglers. Estimated incidental mortality of hooked and released Chinook (estimated at 10% mortality) was 1 unmarked jack and 6 unmarked adults. The area open to recreational anglers on the Imnaha River extended from the mouth of the Imnaha River upstream to Summit Creek bridge, and the fishery was open from 9 June-27 June 2012 (Yanke 2012). Additionally, NPT reported an estimate of two hatchery jacks, 369 hatchery adults, zero natural jacks, and 42 natural adults. The CTUIR reported harvest of 20 hatchery jacks, 17 hatchery adults, five natural jacks, and six natural adults. In total, 630 hatchery salmon were harvested, representing 21.9% of the estimated total return to the river mouth.

Recruits:Spawner (R:S) and Smolt-to-Adult Return Rates (SAR)

The recruits-per-spawner (R:S) ratios reported here include jacks and were adjusted for estimates of pre-spawn mortality in the parent population. The R:S ratio for the 2007 brood year was 1.3 for naturally spawning (any origin) Imnaha River salmon and 10.1 for the hatchery component. The 2007 brood year smolt-to-adult return rate (SAR) for hatchery salmon above LGD was 1.217 (Table 13).

Grande Ronde Basin

Return to Compensation Area

In the Grande Ronde Basin, the annual compensation goal for all stocks combined was set at 5,860 hatchery adults (Herrig 1990). We estimated that 829 Catherine Creek, 702 Upper Grande Ronde River, 2,208 Lookingglass Creek and 1,249 Lostine River hatchery Chinook returned to the compensation area, a combined return of 4,988, 85.1% of the compensation goal (Tables 9-12). Of the total escapement above Lower Granite Dam, we estimate that 1,015 hatchery salmon were harvested in fisheries, 17.3% of the compensation area return. There were 28 hatchery salmon harvested in Catherine Creek, zero in the Upper Grande Ronde River, 951 in Lookingglass Creek, and 36 in the Wallowa and Lostine rivers.

The annual total production goal for Grande Ronde Basin hatchery Chinook salmon is 29,300 (Corps of Engineers 1975). For the Columbia River Basin below Lower Granite Dam there is a catch to escapement ratio goal of 4:1, resulting in a harvest mitigation goal of 23,440 hatchery Chinook salmon. We estimate 977 Grande Ronde Basin hatchery salmon were harvested in fisheries below Lower Granite Dam, 4.2% of the downstream mitigation goal (Table 9-12). Harvest below Lower Granite Dam was comprised of 132 Catherine Creek, 136 Upper Grande Ronde River, 457 Lookingglass Creek and 252 Lostine River hatchery Chinook salmon.

Returns of Grande Ronde Basin hatchery Chinook salmon in 2012 did not meet the mitigation goals for either returns to the compensation area or harvest mitigation. Harvest of hatchery salmon in the Grande Ronde Basin is hindered by the paucity of natural salmon and the threat of endangering them further from incidental mortality, lack of fishing access in some streams and seasonally poor river conditions (high discharge and turbid water) for angling. Factors that have previously contributed to low hatchery returns of Grande Ronde Basin hatchery salmon included low numbers of CHP broodstock collections, limited rearing space at Lookingglass Fish Hatchery, and a CBS program that was beleaguered with low broodstock survival due to bacterial kidney disease and low fecundity due to slow broodstock growth rates (Hoffnagle et al. 2003; Carmichael et al. 2007). Consistently poor survival (<50%) of Catherine Creek and Upper Grande Ronde River hatchery smolts from the acclimation sites to LGD is another factor that has also been identified as contributing to reduced hatchery returns (Monzyk et al. 2009).

Return to the River

We estimate that 37 age 3, 601 age 4, and 34 age 5 hatchery salmon returned to Catherine Creek in 2012 (Table 9). We also estimate that 14 age 3, 356 age 4, and 47 age 5 natural origin salmon returned. The first sport fishery in Catherine Creek since 1978 was opened from 26 May – 30 June 2012. The area open to recreational anglers extended from the Miller Lane Bridge downstream of Union, OR, upstream 21.7 kilometers to the Highway 203 Bridge immediately upstream of the Catherine Creek State Park (Bailey 2012a). ODFW estimates that salmon harvest in Catherine Creek consisted of zero hatchery jacks and 24 hatchery adults.

Additionally, zero unmarked jacks and 71 unmarked adults were released for an estimated incidental hooking mortality of seven natural adults. CTUIR reported zero hatchery jacks, four hatchery adults, zero natural jacks, and five natural adult salmon were harvested in the tribal fishery.

We estimate that 14 age 3, 604 age 4, and 23 age 5 hatchery salmon returned to the Upper Grande Ronde River in 2012 (Table 10). We also estimate that nine age 3, 223 age 4, and eight age 5 natural origin salmon returned. There were no sport or tribal fishing reported on the Upper Grande Ronde River in 2012.

We estimate that 82 age 3, 1,934 age 4, and 73 age 5 hatchery salmon released as smolts into Lookingglass Creek returned to Lookingglass Creek in 2012 (Table 11). We estimate that five age 3, 230 age 4, and 18 age 5 natural origin salmon returned. CTUIR tribal harvest estimates were one hatchery jack, 77 hatchery adults, zero natural origin jacks, and 10 natural origin adults (Preston Bronson, CTUIR, personal communication, 2 July 2012). NPT tribal harvest estimates were 66 hatchery jacks, 332 hatchery adults, zero natural jacks, and 18 natural adults (Joe Oatman, NPT, personal communication, 26 Nov 2012). The ODFW sport fishery was open from 26 May -12 June and 22 June – 25 June and the area open to anglers extended from the confluence of Lookingglass Creek and the Grande Ronde River upstream 3.2 kilometers to the confluence of Jarboe Creek (Bailey 2012b). The sport fishery harvest estimates were 11 hatchery jacks and 464 hatchery adults. Additionally, ODFW estimated that zero natural origin jacks and 26 natural origin adults were released by sport anglers for an estimated (7.5% hooking mortality) of 4 natural origin adults. Both sport and tribal fishery numbers include salmon that were originally captured at the Catherine Creek weir and released into Lookingglass Creek. We estimate the sport harvest includes an estimated two age 3, 47 age 4, and two age 5 salmon that were outplants from Catherine Creek. We estimated that tribal harvest of hatchery Chinook outplants from Catherine Creek included 66 age 3, 41 age 4, and one age 5 salmon.

We estimate that 35 age 3, 1,020 age 4, and 115 age 5 hatchery salmon returned to the Lostine River in 2012 (Table 12). We also estimate that 41 age 3, 641 age 4, and 86 age 5 natural origin salmon returned. A recreational sport harvest was open on the Wallowa River from 9 June 15 July 2012, targeting Lostine River hatchery salmon. The fishery extended from Minam State Park upstream to the mouth of the Lostine River. On the Wallowa River, it was estimated that sport anglers harvested zero hatchery jacks and zero hatchery adults, and five unmarked jacks and 62 unmarked adults were caught and released (Yanke 2012). In the tribal Chinook fishery, NPT reported four hatchery jacks, 32 hatchery adults, two natural origin jacks, and 36 natural origin adults were harvested (Joe Oatman, NPT, personal communication, 26 Nov. 2012). CTUIR tribal fishers reported zero salmon were harvested (Preston Bronson, CTUIR, personal communication, 2 July 2012).

Recruits:Spawner (R:S) and Smolt-to-Adult Return Rates (SAR)

The R:S ratio for the hatchery component was calculated by dividing the number of offspring that return to the river mouth (ages 3-5) by the number of parents (ages 3-5) spawned at Lookingglass Fish Hatchery. The R:S ratio for salmon that spawn in nature was calculated by dividing the number of returns to the river mouth (ages 3-5) by the estimated number of hatchery and natural origin salmon, ages 3-5, that spawned naturally in the river, adjusted for pre-spawn mortality in parents.

In Catherine Creek, the R:S ratio for brood year 2007 was 11.7 for the hatchery CHP component and 3.2 for the natural component. The SAR over LGD for the 2007 brood year was

0.702% (Table 14). No CBS smolts were released into Catherine Creek from the 2007 brood year.

In the Upper Grande Ronde River, the R:S ratios for the hatchery CHP and natural components from the 2007 brood year were 9.7 and 4.3, respectively. The 2007 brood year SAR rates over LGD were 0.805% and 0.645% for CBS and CHP programs, respectively (Table 15).

In Lookingglass Creek, the R:S ratio for the hatchery and natural component from the 2007 brood year was 23.9 and 1.9, respectively (Table 16). The SAR over LGD for the 2007 brood year returns of Catherine Creek CBS smolts released into Lookingglass Creek was 1.162% (Table 16). No CHP smolts were released into Lookingglass Creek from the 2007 brood year.

In the Lostine River, the R:S ratios for brood years 2007 were 25.3 and 1.8 for hatchery CHP and natural returns, respectively. The SAR rates over LGD for the 2007 brood year smolts released into the Lostine River were 2.122% and 1.528% for CBS and CHP returns, respectively (Table 17). This is the highest SAR rate over LGD for the CBS program and the third largest for the CHP program.

Natural Escapement Monitoring

We surveyed three streams in the Imnaha Basin and 12 in the Grande Ronde Basin. Stream surveys to count Chinook salmon redds and sample salmon carcasses were conducted as in previous years (see Monzyk et al. 2006a).

In 2012, we counted 774 redds and recovered 457 carcasses in the Imnaha Basin (Table 18). The number of redds/river kilometer (rkm) in 2012 (9.6 redds/rkm) was lower than 2011 when 10.5 redds/rkm were observed (Figure 2). We did not recovery any out-of-basin stray hatchery salmon (Table 19). With 886 natural salmon returning to the Imnaha basin, 2012 is the 12th year since the first year of hatchery returns (1984) with >500 natural origin salmon returning to the Imnaha River (Figure 3). Hatchery salmon comprised the majority (55.2%) of the carcasses recovered on the spawning grounds. Adult (age 4-5) hatchery salmon returns to the Imnaha River have exceeded natural adult returns for the last nine consecutive years and 13 of the 28 years that adult hatchery salmon have returned to the Imnaha River. On two tributary streams to the Imnaha River, Big Sheep Creek and Lick Creek, 37.0% and 0%, respectively, of salmon carcasses recovered were hatchery origin, which were most likely the result of outplants from the Imnaha River. For the entire Imnaha Basin, hatchery salmon represented 54.9% of carcasses recovered.

In the Grande Ronde Basin, we observed 7.9 redds/rkm and counted 1,781 redds, the third largest number of redds recorded between 1996 and 2012 (Figure 2). Hatchery salmon comprised the majority (66.0%) of the 1,267 carcasses recovered on spawning ground surveys in the Grande Ronde Basin (Table 18). Adult hatchery salmon have comprised the majority of adult returns in 11 of the last 12 return years in Catherine Creek, eight of the last 11 return years in the Upper Grande Ronde River, ten of the last 12 return years in the Lostine River, and six of the last nine years in Lookingglass Creek.

In the Grande Ronde Basin, we recovered 32 in-basin strays: one Lostine River salmon in Bear Creek; one Lostine River salmon in Hurricane Creek; four Upper Grande Ronde River, and 16 Catherine Creek salmon in Lookingglass Creek; one Catherine Creek salmon in the Lostine River; two Lostine River salmon in the Minam River; two Lostine River salmon in the

Wallowa River; and three Lookingglass Creek salmon, one Lostine River salmon, and one Imnaha River salmon in the Wenaha River (Table 19).

In 2012, 116 hatchery salmon collected at the Catherine Creek weir were released into Lookingglass Creek below the adult weir. On spawning ground surveys, CTUIR staff collected 13 CWT-marked carcasses in Lookingglass Creek for salmon that were released into Catherine Creek. Eight of these carcasses were marked with a left opercle (OP) mark indicating that they were outplants from the Catherine Creek weir. There were also 29 hatchery salmon collected at the Lostine River weir that were released in the Wallowa River at the Sunset Road Bridge below the town of Enterprise, OR. Three salmon recovered in the Wallowa River and one salmon recovered in Hurricane Creek were marked with an OP mark (one ROP-marked and two LOP-marked salmon) indicating that these salmon were outplants from the Lostine River.

In streams with hatchery supplementation programs, returns over the last seven years have been largely comprised of hatchery salmon (Figure 4). The percentage of hatchery salmon recovered on the spawning grounds was 67.4%, 93.2% , 87.1%, and 62.0%, for Catherine Creek, the Upper Grande Ronde River, Lookingglass Creek and Lostine River, respectively (Table 18, Figures 6-8).

Bacterial Kidney Disease Monitoring

We collected 188 kidney samples from Imnaha River Chinook salmon in 2012 (Table 20). Of those, 110 came from hatchery-reared salmon and 78 from natural salmon; 109 samples were collected at Lookingglass Fish Hatchery and 79 from carcasses recovered on spawning ground surveys. ELISA OD levels were <0.2 for 100% of hatchery salmon and 98.7% of natural origin salmon.

We collected 451 kidney samples from Grande Ronde Basin salmon in 2012: 292 from hatchery-reared salmon and 159 from natural salmon; 262 from salmon spawned at Lookingglass Fish Hatchery and 189 recovered during spawning ground surveys (Table 20). ELISA OD levels were <0.2 for 98.3% of hatchery salmon and 97.5% of natural origin salmon.

The highest ELISA OD level was measured from a natural origin salmon collected in the Lostine River (1.673). In the Minam River, ELISA OD levels were <0.2 for all seven natural origin salmon and no hatchery origin salmon were sampled. From the other wilderness stream, the Wenaha River, the one hatchery and 12 of the 13 natural origin salmon recovered had ELISA OD levels <0.2.

We found no evidence that the release of hatchery salmon is causing an increase in BKD prevalence in the monitored streams, despite the fact that CBS has released offspring of females with ELISA OD levels >1.0, particularly into the Upper Grande Ronde River. Both natural and CHP females returning to Grande Ronde Basin streams tend to have low ELISA OD levels and those >0.2 are culled if they are spawned at Lookingglass Fish Hatchery. Therefore, smolts released from the CHP are always from females with ELISA OD levels <0.2. It seems likely that any sick salmon that may have been released were either unable to survive in nature or they were able to fight off the infection, leaving only healthy fish to survive to maturation and return to spawn.

Acknowledgments

Roger Elmore, Lookingglass Fish Hatchery Manager, Diane Deal, Assistant Hatchery Manager, and many other hatchery personnel exhibited great dedication and provided essential assistance. Numerous personnel from ODFW, U.S. Fish and Wildlife Service, U.S. Forest Service, Nez Perce Tribe, Confederated Tribes of the Umatilla Indian Reservation, and Grande Ronde Model Watershed were supportive during spawning ground surveys and spawning at Lookingglass Fish Hatchery. In addition, the Nez Perce Tribe provided Lostine River weir data and the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) provided weir data from Catherine Creek and the Upper Grande Ronde River. Additionally, CTUIR provided all the spawning ground survey data summarized from Lookingglass Creek and Indian Creek. This project was funded by the U.S. Fish and Wildlife Service under the Lower Snake River Compensation Plan, contract number F13AC00034, a cooperative agreement with the Oregon Department of Fish and Wildlife.

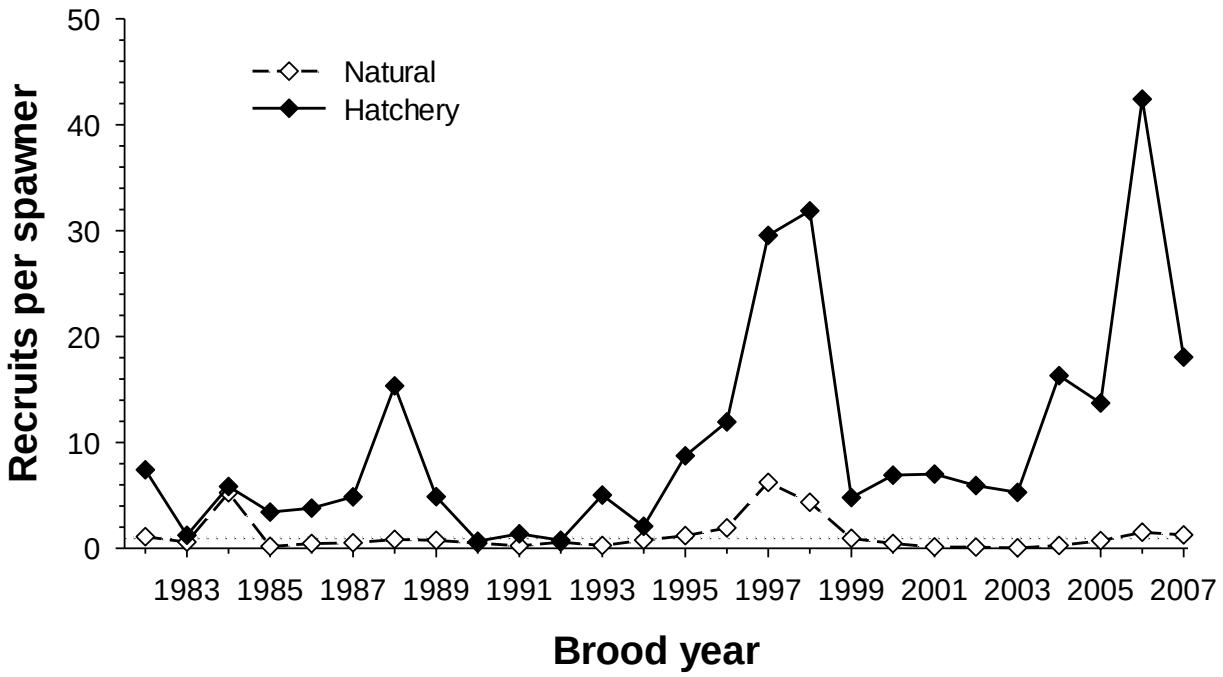

Figure 1. Total recruits-per-spawner ratios (including jacks) for completed brood years (1982-2007) of Imnaha River Chinook salmon. Note: dotted line indicates recruits-per-spawner ratio=1.

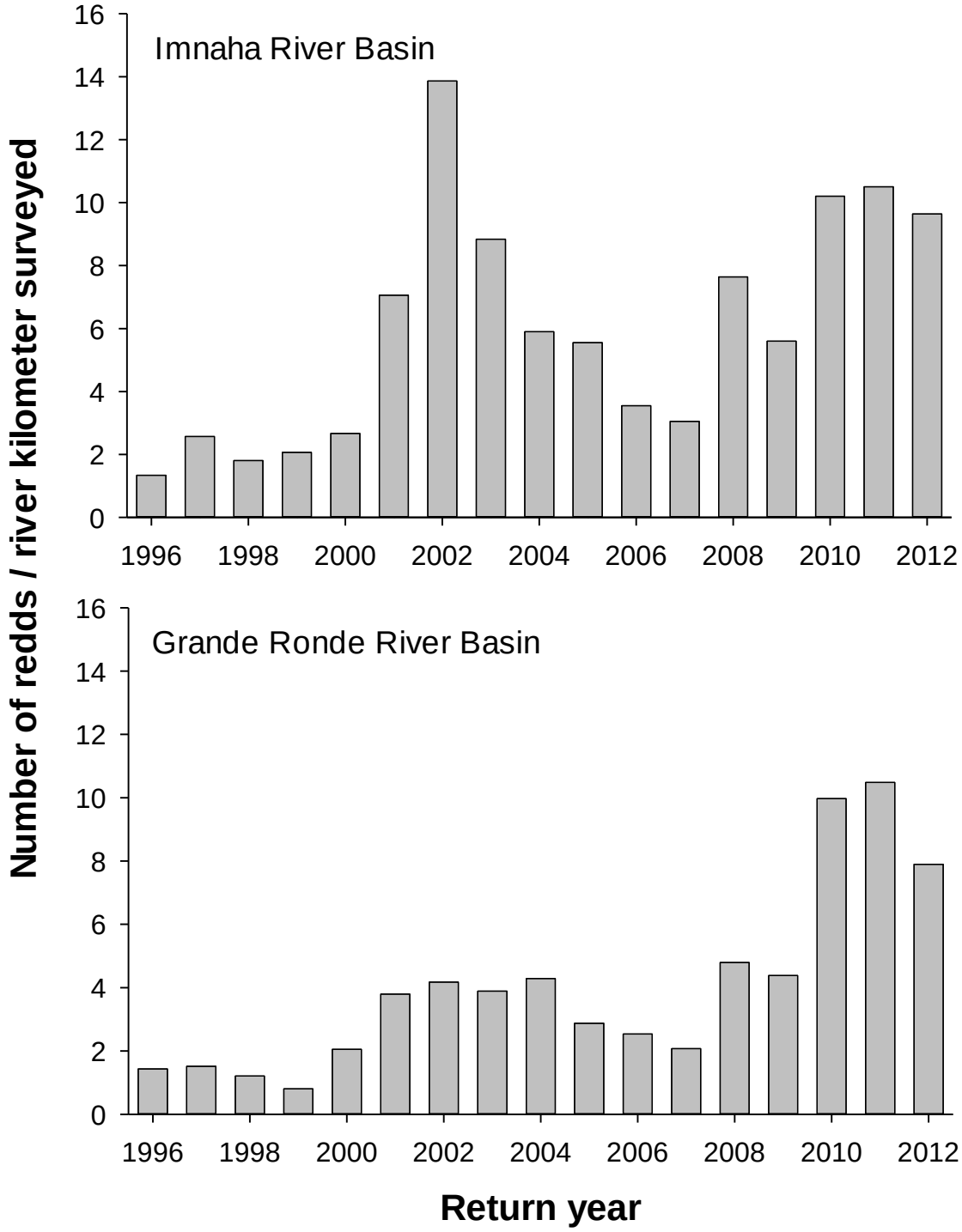

Figure 2. Total redds/river kilometer surveyed in the Imnaha and Grande Ronde river basins, 1996-2012.

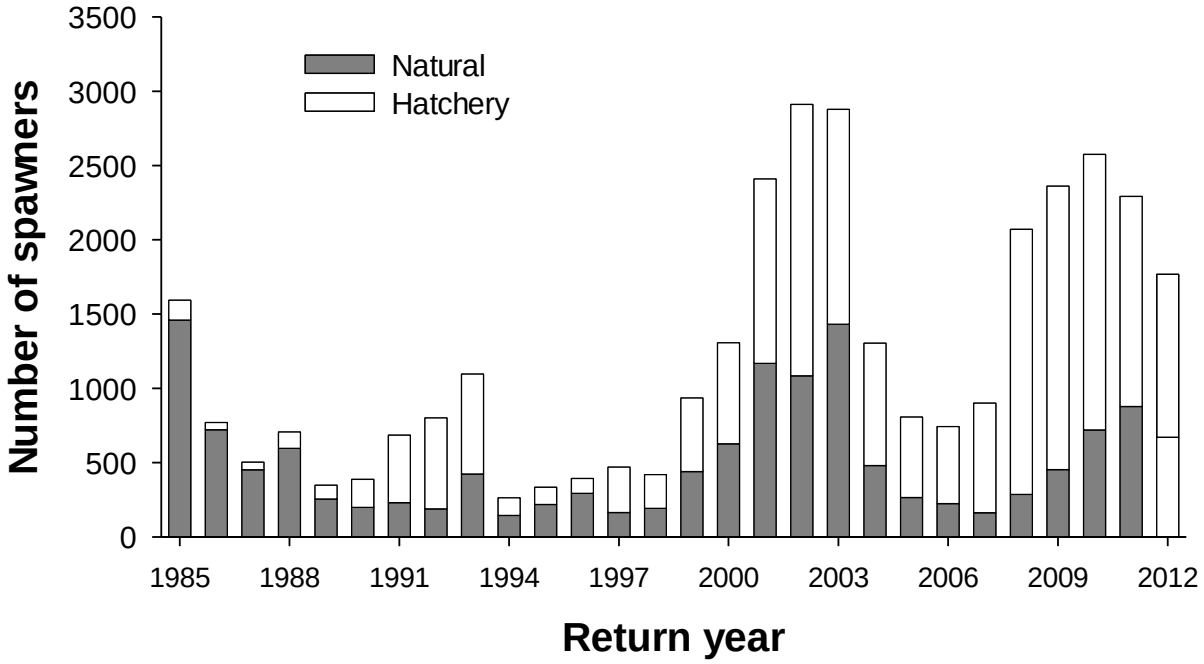

Figure 3. Estimated numbers of natural- and hatchery-origin spring/summer Chinook salmon (including jacks) that spawned naturally in the Imnaha River, 1985-2012.

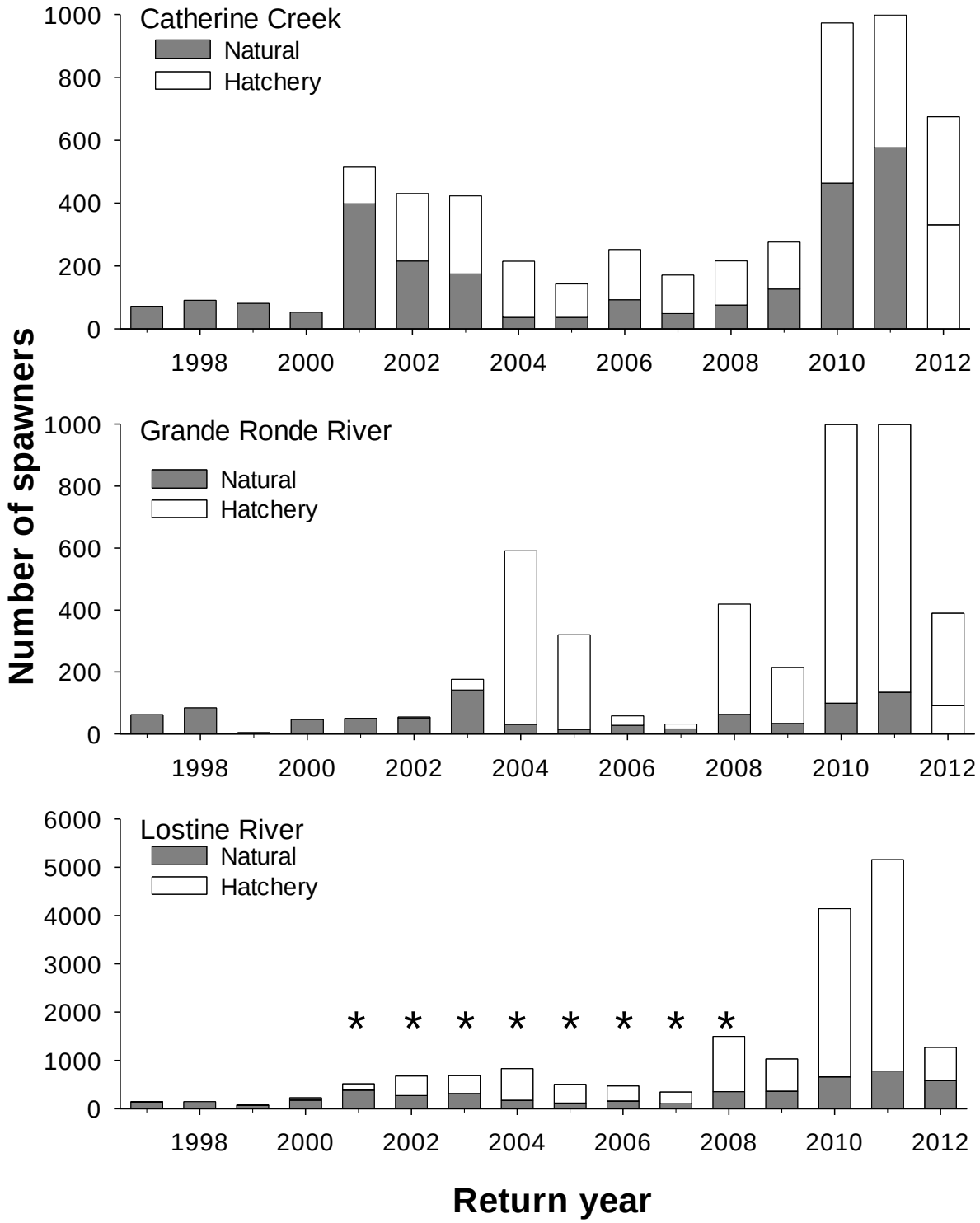

Figure 4. Estimated numbers of natural- and hatchery-origin Chinook salmon (including jacks) that spawned naturally in Catherine Creek, the Upper Grande Ronde River, and Lostine River, 1997-2012. Asterisks indicate years (2001-2008) where the Nez Perce Tribe reported that some members of the hatchery production staff falsified weir data. Therefore, data for the Lostine River between 2001 and 2008 may not be reliable.

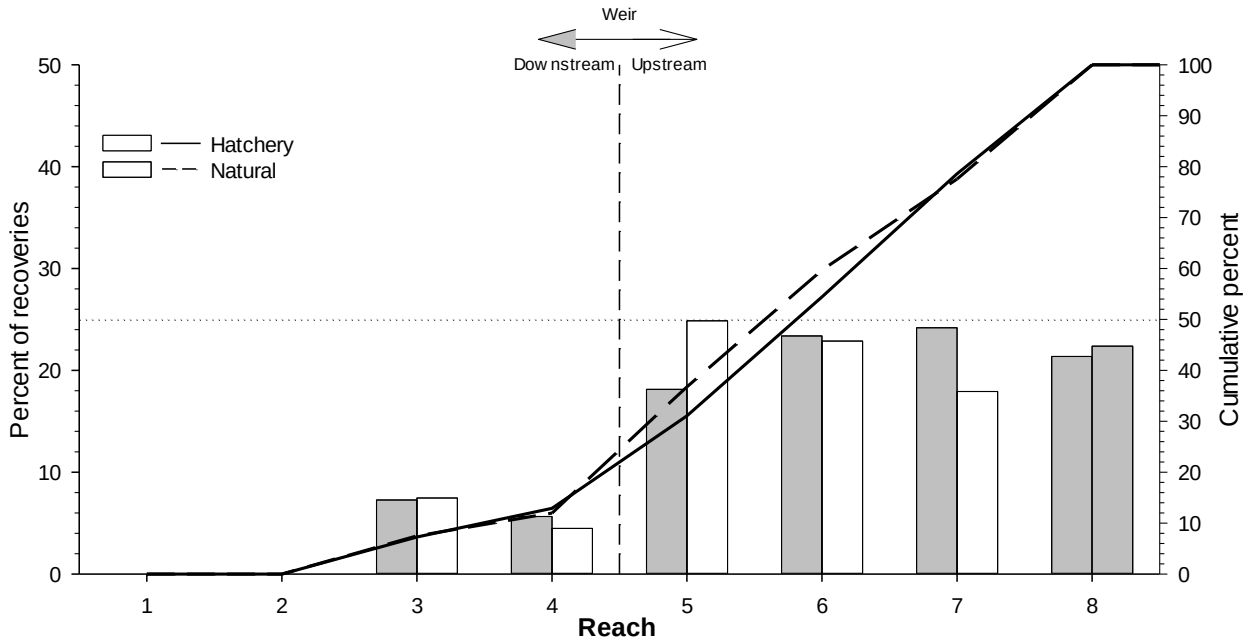

Figure 5. Percent of natural-and hatchery-origin Chinook salmon carcasses recovered during spawning ground surveys on the Imnaha River, 2012. Reach 1- Gorge to Freezeout Creek, Reach 2-Grouse Creek to the Gorge, Reach 3-Crazyman Creek to Grouse Creek, Reach 4-Weir to Crazyman Creek, Reach 5-Macs Mine to the weir, Reach 6-Log to Macs Mine, Reach 7-Indian Crossing to Log, Reach 8-Blue Hole to Indian Crossing.

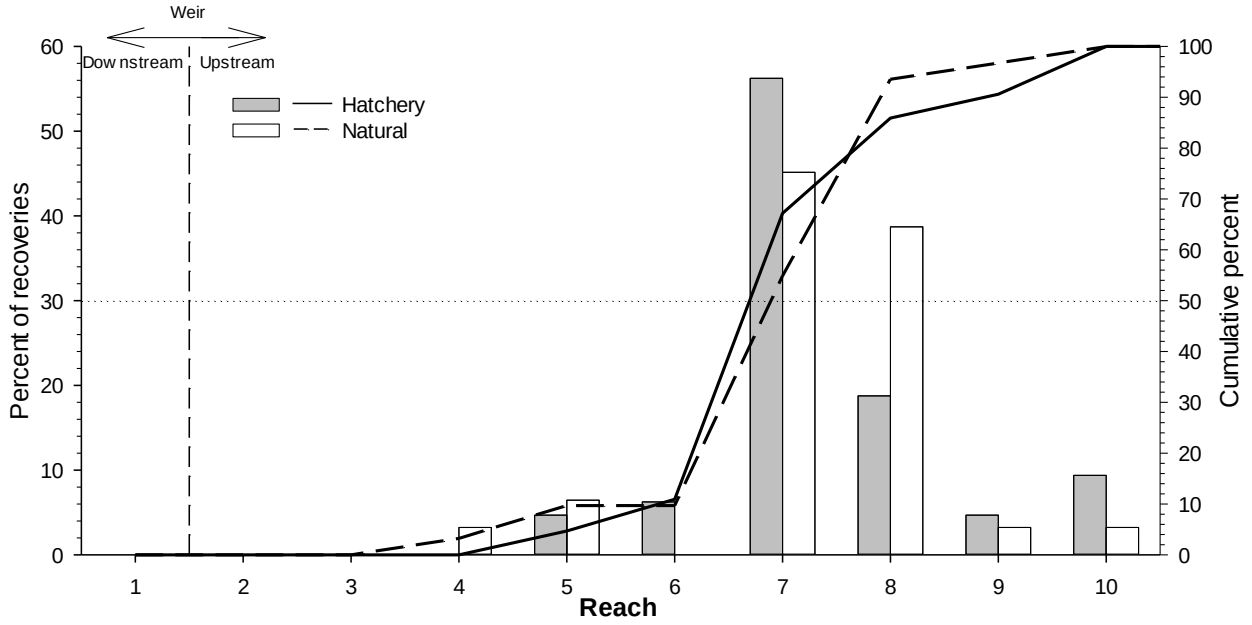

Figure 6. Percent of natural-and hatchery-origin Chinook salmon carcasses recovered during the spawning ground surveys on Catherine Creek, 2012. Reach 1-Weir to 2nd Union Bridge, Reach 2-Bottom of Southern Cross Ranch to the Weir, Reach 3-Mile Post 5 to top of Southern Cross Ranch, Reach 4-Badger Flat to Mile Post 5, Reach 5- Highway Bridge to Badger Flat, Reach 6-7735 Bridge to Highway Bridge, Reach 7-Forks to 7735 Bridge, Reach 8-South Fork Catherine Creek, Reach 9-North Fork Catherine Creek.

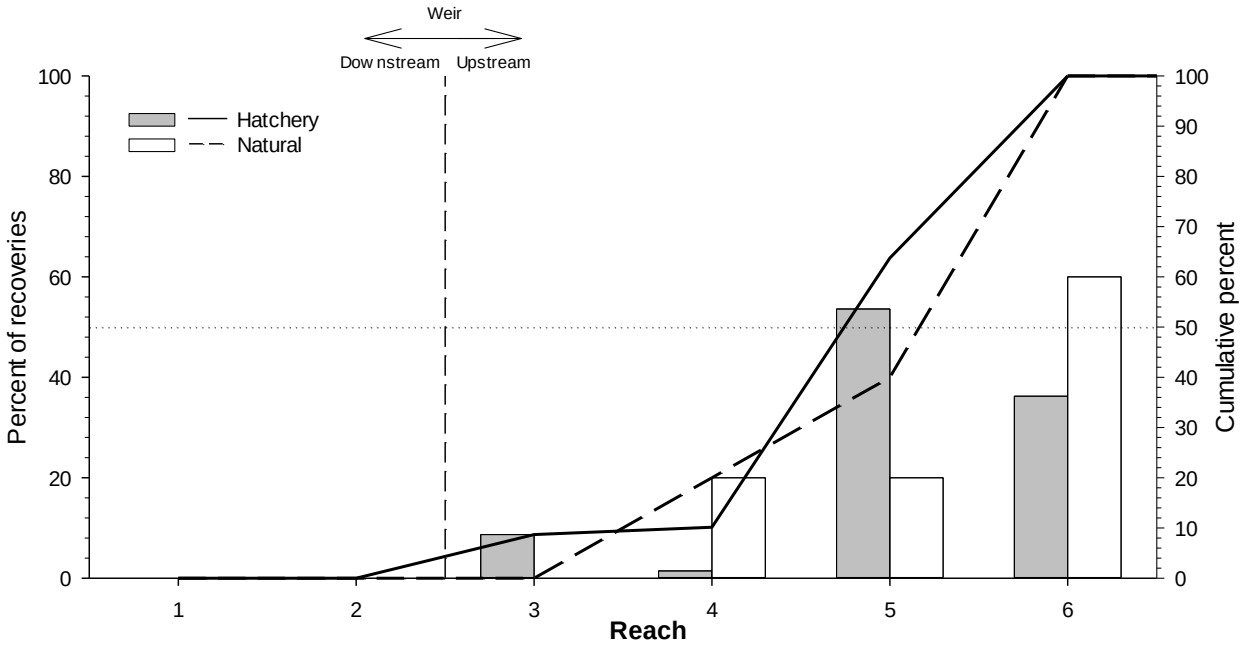

Figure 7. Percent of natural-and hatchery-origin Chinook salmon carcasses recovered during spawning ground surveys on the Upper Grande Ronde River, 2012. Reach 1-Weir to Starkey Store, Reach 2-Spoolcart Campground to the Weir, Reach 3-Time and a Half Campground to Spoolcart Campground, Reach 4-Forest Service Boundary below Vey Meadows to Time and a Half Campground, Reach 5-Carson Campground Bridge to Forest Service Boundary below acclimation facility, Reach 6- Three Penny Claim to Carson Campground Bridge.

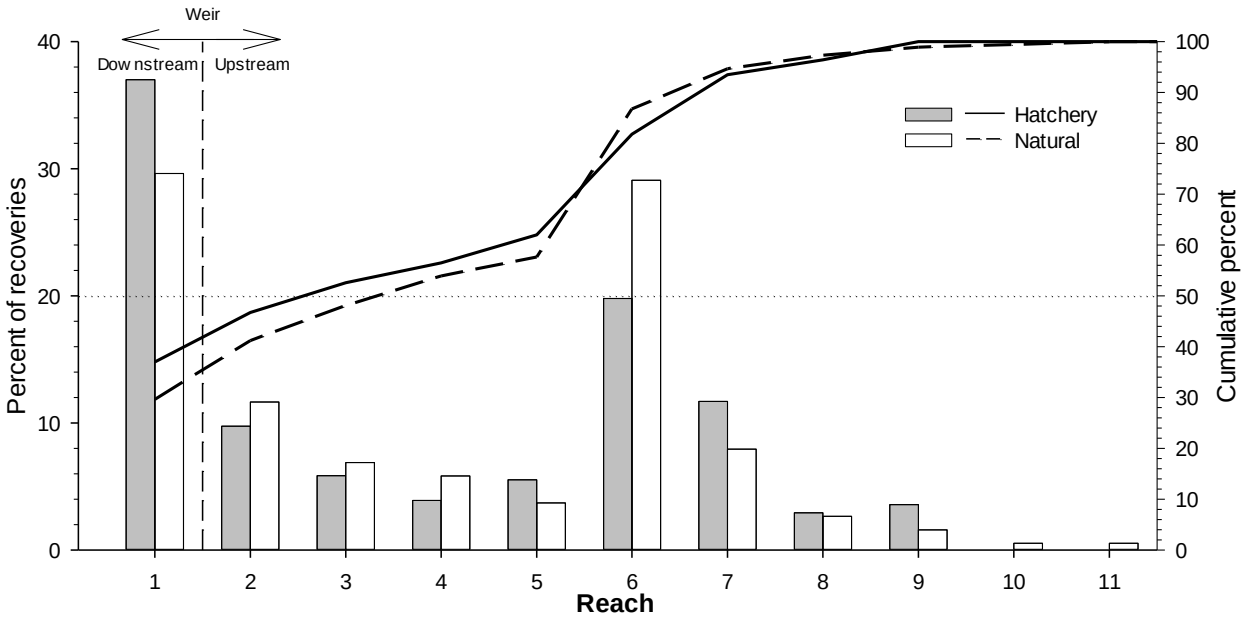

Figure 8. Percent of natural-and hatchery-origin Chinook salmon carcasses recovered during spawning ground surveys on the Lostine River, 2012. Reach 1-Weir to the Mouth, Reach 2-McLain's Ranch to the Weir, Reach 3-Highway 82 Bridge in Lostine to McLain's Ranch, Reach 4-Westside Ditch to the trout farm, Reach 5-Lostine River Ranch Bridge to Westside Ditch, Reach 6-Acclimation Facility to Lostine River Ranch Bridge, Reach 7-Six Mile Bridge to Acclimation Facility, Reach 8-Pole Bridge to Six Mile Bridge, Reach 9-Above Walla Walla Campground to Williamson Campground, Reach 10-Lapover Meadows to Bowman Trailhead, Reach 11-Turkey Flat to Lapover Meadows.

Table 1. Rearing summaries for the 2010 brood year of juvenile spring Chinook salmon from the Captive Broodstock (CBS) and Conventional Hatchery Program (CHP) released into the Imnaha and Grande Ronde river basins, 2012.

Stock	Program	Number of Females	Number of green eggs taken	Eyed eggs	Number culled[a]	Number released as eyed eggs	Percent Survival: Green egg -to-eyed egg	Percent Survival: Eyed egg -to-smolt[b]	Percent Survival: Green egg -to-smolt[b]	Total smolts released
Imnaha River	CHP	110	518,403	475,232	0	0	91.7	98.9	90.6	469,807
Catherine Creek	CHP	42	176,409	161,562	0	0	91.6	99.9	91.5	161,373
Upper Grande	CHP	82	318,955	297,738	0	0	93.3	96.0	89.6	285,738
Ronde River	CBS	138	279,515	251,107	0	251,107[c]	89.8	NA	NA	NA
Lookingglass Creek	CHP	75	300,180	260,562	0	0	86.8	87.7	76.1	228,565
Lostine River	CHP	76	331,956	309,266	0	0	93.2	86.4	80.5	267,352

[a] *Eggs were culled if enzyme-linked immunosorbent assay (ELISA) levels of female broodstock were > 0.2 for CHP production. No eggs were culled from the Upper Grand Ronde River CBS.*

[b] *Embryos culled from production or released as eyed eggs were subtracted from the calculation of green egg-to-smolt and eyed egg-to-smolt survival.*

[c] *All eggs were released into Meadow Creek, a tributary to the Upper Grande Ronde River near Starkey, OR, in small batches as they eyed up. Release dates were: 26 October, 2 November, 9 November, 16 November, and 29 November, 2012.*

Table 2. Estimates of percent adipose fin (Ad) clip and coded-wire tag application success for the 2010 brood year spring Chinook salmon smolts produced from the Captive Broodstock (CBS) and Conventional Hatchery (CHP) programs reared at Lookingglass Fish Hatchery and released in 2012.

Stock, CWT code	Raceway	Program	Number checked	Ad clip, with CWT	Ad clip, no CWT	No Ad clip, with CWT	No Ad clip, no CWT	Total released
Imnaha River								
090416	12	CHP	497	90.2	4.8	4.0	1.0	67,265
090417	13	CHP	513	92.8	1.5	5.1	0.6	69,667
090418	14	CHP	501	93.2	5.6	0.8	0.4	65,438
090419	15	CHP	511	88.1	2.0	1.7	8.1	67,466
Total/mean			2,022	91.0	3.5	2.9	2.6	269,836
Ad-only	16-18	CHP	1,643	n/a	95.1	n/a	4.9	199,971
Catherine Creek								
090380	1	CHP	518	90.7	5.8	3.3	0.2	54,098
090381	2	CHP	503	95.4	1.0	3.2	0.4	52,783
Total/mean			1,021	93.1	3.4	3.2	0.3	106,881
Ad-only	3	CHP	508	n/a	96.5	n/a	3.5	54,492
Upper Grande Ronde River								
090396	4	CHP	503	95.6	1.8	2.6	0.0	70,286
090397	5	CHP	507	96.8	0.8	2.4	0.0	66,956
Total/mean			1,010	96.2	1.3	2.5	0.0	137,242
090398	6	CHP	507	n/a	n/a	99.0	1.0	72,192
090399	7	CHP	500	n/a	n/a	97.8	2.2	76,304
Total/mean			1,007	n/a	n/a	98.4	1.6	148,496

Table 2 continued.

Stock, CWT code	Raceway	Program	Number checked	Ad clip, with CWT	Ad clip, no CWT	No Ad clip, with CWT	No Ad clip, no CWT	Total released
Lookingglass Creek								
090394	AHPA	CHP	504	97.2	1.8	1.0	0.0	60,985
090361	AHPB	CHP	517	94.8	1.7	3.5	0.0	61,023
Total/mean			1,021	96.0	1.8	2.2	0.0	122,008
Ad-only	AHPC,D	CHP	1,007	n/a	97.5	n/a	2.5	106,557
Lostine River								
090282	8	CHP	497	98.6	0.8	0.6	0.0	72,049
090283	9	CHP	502	97.4	1.8	0.8	0.0	70,987
Total/mean			999	98.0	1.3	0.7	0.0	143,036
Ad-only	10-11	CHP	1,001	n/a	99.3	n/a	0.7	124,316

Table 3. Mean size, total number released into the Imnaha and Grande Ronde river basins, number PIT-tagged, and survival probability to Lower Granite Dam of the 2010 brood year spring Chinook salmon smolts produced from the Captive Broodstock (CBS) and Conventional Hatchery Programs (CHP) and released in 2012. Length and weight data were collected at Lookingglass Fish Hatchery, 6-9 February 2012.

Stock, CWT code	Raceway	Program	Release date	Fork Length (mm)		Weight (g)		Condition factor (K)		Total released	Number PIT-tagged	Survival probability to Lower Granite Dam
				Mean	SD	Mean	SD	Mean	SD			
Imnaha River												
090416	12	CHP	30 MAR[a]	118.3	8.5	21.7	5.7	1.3	0.1	67,265	2,977	0.65
090417	13	CHP	30 MAR[a]	115.6	6.4	18.9	3.7	1.2	0.1	69,667	2,961	0.71
090418	14	CHP	30 MAR – 6 APR	120.2	9.6	21.9	5.8	1.2	0.1	65,438	2,963	0.67
090419	15	CHP	30 MAR – 6 APR	115.9	6.5	20.0	3.0	1.3	0.1	67,466	2,976	0.71
Ad-only	16	CHP	30 MAR – 6 APR	117.7	8.2	21.5	4.8	1.3	0.1	64,199	2,984	0.67
Ad-only	17	CHP	30 MAR – 6 APR	116.7	7.3	22.7	4.5	1.4	0.2	62,431	2,972	0.72
Ad-only	18	CHP	30 MAR – 6 APR	113.5	7.5	19.8	4.6	1.4	0.1	73,341	2,986	0.70
Total/mean										469,807	20,819	0.69
Catherine Creek												
090380	1	CHP	22 MAR-14 APR	118.9	9.2	22.0	5.2	1.3	0.1	54,098	6,903	0.38
090381	2	CHP	22 MAR-14 APR	116.8	6.8	22.9	4.9	1.5	0.2	52,783	6,957	0.38
Ad-only	3	CHP	16 APR[b]	113.1	9.3	19.3	4.1	1.3	0.1	54,492	6,781	0.28
Total/mean										161,373	20,641	0.35
Upper Grande Ronde River												
090396	4[c]	CHP	21 MAR-2 or 14 APR	115.9	7.5	20.1	3.7	1.3	0.1	70,286	770	0.42
090397	5	CHP	16 APR[d]	114.3	7.2	19.0	3.3	1.3	0.1	66,956	662	0.50
090398	6	CHP	9 APR-14 APR	116.7	6.7	21.6	4.0	1.4	0.2	72,192	785	0.54
090399	7[c]	CHP	21 MAR-2 or 14 APR	115.3	6.7	21.8	4.5	1.4	0.2	76,304	693	0.36
Total/mean										285,738	2,910	0.46

Table 3 continued.

Stock, CWT code	Raceway	Program	Release Date	Fork Length (mm) Mean	Fork Length (mm) SD	Weight (g) Mean	Weight (g) SD	Condition Factor (K) Mean	Condition Factor (K) SD	Total released	Number PIT-tagged	Survival probability to Lower Granite Dam
Lookingglass Creek[e]												
090394	AHPA	CHP	30 MAR – 13 APR	114.3	7.1	18.9	3.4	1.2	0.1	60,985	500	0.77
090395	AHPB	CHP	30 MAR – 13 APR	114.7	7.4	20.1	3.5	1.3	0.1	61,023	499	0.69
Ad-only	AHPC	CHP	30 MAR – 13 APR	115.3	9.2	20.1	6.2	1.2	0.2	53,269	495	0.82
Ad-only	AHPD	CHP	30 MAR – 13 APR	115.0	7.6	18.3	3.8	1.2	0.1	53,288	499	0.80
Total/mean										228,565	1,993	0.77
Lostine River												
090282	8	CHP	22 MAR - 26 MAR	117.2	7.3	19.6	3.7	1.2	0.1	72,049	1,484	0.69
090283	9	CHP	13 APR - 19 APR	114.6	8.8	18.6	4.0	1.2	0.1	70,987	1,482	0.64
Ad-only	10	CHP	22 MAR - 26 MAR	113.0	6.8	18.9	4.3	1.3	0.2	62,370	1,487	0.61
Ad-only	11	CHP	13 APR - 19 APR	113.5	5.8	18.9	3.1	1.3	0.2	61,946	1,479	0.69
Total/mean										267,352	2,966	0.66

[a] *Direct stream release at the Imnaha River weir.*

[b] *Direct stream release from the bridge at the Catherine Creek Acclimation Facility.*

[c] *Raceways 4 and 7: half of these smolts were released early (forced out 2 April 2012) and half were forced out 14 April 2012.*

[d] *Direct stream release into the Grande Ronde River.*

[e] *Reared and coded-wire tagged in raceways 19-21 at Irrigon Fish Hatchery; transferred to adult holding ponds at Lookingglass Fish Hatchery on 23 September 2011.*

Table 4. Number of adult spring Chinook salmon handled each week at northeast Oregon LSRCP trapping facilities in 2012. The total for each stream excludes recaptured salmon. The total for Lookingglass Creek includes stray hatchery fish from Catherine Creek and Upper Grande Ronde River stock, and excludes outplants from Catherine Creek. These numbers were not adjusted to account for unmarked hatchery returns.

Period	Week of year	Imnaha River[a]		Catherine Creek[b]		Upper Grande Ronde River[b]		Lookingglass Creek[a]		Lostine River[c]	
		Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural	Hatchery	Natural
Dates of trap operation:		22 JUN – 18 SEP		1 MAR – 15 AUG		1 MAR – 22 JUN		1 MAR – 18 SEP		15 FEB – 29 SEP	
13-19 MAY	20	-	-	-	-	-	-	0	0	-	-
20-26 MAY	21	-	-	1	0	-	-	7	0	-	-
27 MAY-2 JUN	22	-	-	20	36	1	-	92	28	-	-
3-9 JUN	23	-	-	180	143	212	72	199	33	-	-
10-16 JUN	24	-	-	207	111	187	76	386	37	-	-
17-23 JUN	25	0	0	111	43	87	39	36	4	8	18
24 JUN – 30 JUN	26	47	22	55	22	-	-	79	9	2	4
1-7 JUL	27	83	29	18	12	-	-	39	5	10	10
8-14 JUL	28	227	49	9	7	-	-	30	7	104	100
15-21 JUL	29	405	76	2	2	-	-	8	3	179	100
22-28 JUL	30	233	53	0	1	-	-	4	1	305	118
29 JUL – 4 AUG	31	106	38	0	2	-	-	2	0	50	23
5-11 AUG	32	49	23	-	-	-	-	2	1	39	21
12-18 AUG	33	52	31	-	-	-	-	15	2	6	0
19-25 AUG	34	102	72	-	-	-	-	61	11	6	1
26 AUG – 1 SEP	35	143	73	-	-	-	-	47	4	35	24
2-8 SEP	36	21	12	-	-	-	-	20	0	45	50
9-15 SEP	37	4	3	-	-	-	-	1	0	10	17
16-22 SEP	38	-	-	-	-	-	-	-	-	2	2
23-29 SEP	39	-	-	-	-	-	-	-	-	-	-
Total		1,472	481	603	379[d]	487	187	1,028	145	801	488

[a] *Operated by Oregon Department of Fish and Wildlife*
[b] *Operated by Confederated Tribes of the Umatilla Indian Reservation (CTUIR). Data provided by Mike McLean (CTUIR).*
[c] *Operated by Nez Perce Tribe (NPT). Data provided by Peter Cleary (NPT).*
[d] *Excludes one natural origin male weir mort recovered on 16 April 2012 (Week of the year 16)*

Table 5. Number and disposition, by origin, age, and sex of adult spring Chinook salmon returning to northeast Oregon LSRCP trapping facilities in 2012. The numbers of Chinook trapped/passed above the weir were adjusted to account for the estimated number of returning unclipped hatchery salmon without a coded wire tag. Note: Because of errors identifying salmon sex at time of capture, the numbers of male and female salmon collected within each age class may not match the numbers spawned at Lookingglass Fish Hatchery (LFH).

	Hatchery							Natural							
	Age 3		Age 4		Age 5			Age 3		Age 4		Age 5			Grand
Stock, Disposition	M	F	M	F	M	F	Total	M	F	M	F	M	F	Total	total
Imnaha River															
Trapped[a]	107	5	444	757	41	124	1,478	22	3	186	134	38	92	475	1,953
Passed above the weir	2	2	124	154	10	53	345	22	3	161	106	33	80	405	750
Passed below the weir	2	0	6	109	0	6	123	0	0	0	0	0	0	0	0
Outplanted	16	3	78	78	9	7	191	0	0	0	0	0	0	0	191
Foodbank/tribal distribution	26	0	161	344	18	46	595	0	0	0	0	0	0	0	595
Trap Morts	2	0	1	3	0	0	6	0	0	1	1	0	0	2	8
Kept for broodstock	59	0	74	69	4	12	218	0	0	24	27	5	12	68	286
Spawned	28	0	72	61	4	10	175	0	0	23	26	5	12	66	241
Killed, not spawned	20	0	0	1	0	0	21	0	0	0	0	0	0	0	21
Pre-spawn mortality	11	0	2	7	0	2	22	0	0	1	0	0	0	2	24
Weir age composition (%)	7.2	0.3	30.0	51.2	3.0	8.3	100	4.6	0.6	39.2	28.2	8.0	19.4	100	
Catherine Creek[b]															
Trapped[a]	37	0	243	291	19	13	603	14	0	156	165	19	25	379	982
Passed above the weir	11	0	133	157	17	10	328	13	0	136	146	15	19	329	657
Outplanted	14	0	94	113	0	1	222	0	0	0	0	0	0	0	222
Foodbank/tribal distribution	10	0	0	0	0	0	10	0	0	0	0	0	0	0	10
Trap Morts	0	0	1	2	0	0	3	0	0	0	0	0	0	0	3
Kept for broodstock[c]	2	0	15	19	2	2	40	1	0	20	19	4	6	50	90
Spawned[d]	2	0	15	20	2	2	41	1	0	18	19	4	4	46	87
Killed, not spawned	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pre-spawn mortality	0	0	1	2	0	0	3	0	0	2	0	0	2	4	7
Weir Age composition (%)	6.1	0	40.3	48.3	3.2	2.1	100	3.7	0.0	41.2	43.5	5.0	6.6	100	

Table 5 continued.

Stock, Disposition	Hatchery							Natural							Grand total
	Age 3		Age 4		Age 5			Age 3		Age 4		Age 5			
	M	F	M	F	M	F	Total	M	F	M	F	M	F	Total	
Upper Grande Ronde River (UGR)[b]															
Trapped	13	0	144	309	6	12	484	9	0	86	89	5	1	190	674
Passed above the weir	3	0	112	265	4	7	391	8	0	42	56	0	0	106	497
Foodbank/tribal distribution	6	0	2	1	0	0	9	0	0	0	0	0	0	0	9
Kept for broodstock[d]	5	0	30	43	2	5	85	1	0	44	33	5	1	84	169
Spawned	4	0	28	40	2	5	79	1	0	36	28	5	1	70	149
Killed, not spawned	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
Pre-spawn mortality	1	0	2	3	0	0	6	1	0	7	5	0	0	13	19
Weir Age composition (%)	43.1	0	20.1	34.0	1.4	1.4	100	4.8	0	45.3	46.8	2.6	0.5	100	
Lookingglass Creek															
All trapped Chinook[e]	59	0	392	543	24	10	1,028	4	0	64	65	10	2	145	1,173
Stray from UGR[f]	3	0	13	6	1	1	24	0	0	0	0	0	0	0	24
Stray from Catherine Creek[g]	0	0	1	2	0	0	3	0	0	0	0	0	0	0	3
Lookingglass Creek return	56	0	378	535	23	9	1,001	4	0	64	65	10	2	145	1,146
Passed above weir	2	0	325	481	15	8	831	1	0	43	41	8	2	95	926
Passed below weir	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Removed/foodbank	45	0	2	0	0	0	47	0	0	0	0	0	0	0	47
Kept for broodstock[c]	8	0	51	54	8	1	122	3	0	21	24	2	0	50	172
Actual fish at LFH[d]	14	0	52	58	4	1	129	3	0	21	25	2	0	51	180
Spawned	5	0	44	56	3	1	109	2	0	17	24	2	0	45	154
Killed, not spawned	9	0	5	0	0	0	14	1	0	0	0	0	0	1	15
Pre-spawn mortality	0	0	3	2	0	0	6	0	0	4	1	0	0	5	11
Age composition (%)	5.7	0	38.2	52.8	2.3	1.0	100	2.8	0.0	44.1	44.8	6.9	1.4	100	

Table 5 continued.

Stock, Disposition	Hatchery							Natural							Grand total
	Age 3		Age 4		Age 5			Age 3		Age 4		Age 5			
	M	F	M	F	M	F	Total	M	F	M	F	M	F	Total	
Lostine River[h]															
Trapped	15	3	281	417	27	60	803	27	0	229	187	22	21	486	1,289
Passed above the weir	8	3	160	266	17	39	493	27	0	212	168	17	18	442	935
Tribal distribution/foodbank	5	0	76	87	4	9	181	0	0	1	1	0	0	2	183
Outplanted	2	0	5	21	0	1	29	0	0	0	0	0	0	0	29
Kept for broodstock[c,i]	0	0	40	43	6	11	100	0	0	16	18	5	3	42	142
Actual fish at LFH[d]	0	0	40	43	6	11	100	0	0	16	18	5	3	42	142
Spawned	0	0	36	38	6	9	89	0	0	16	12	5	3	36	125
Killed, not spawned	0	0	0	0	0	1	1	0	0	0	1	0	0	1	2
Pre-spawn mortality	0	0	4	5	0	1	10	0	0	0	5	0	0	5	15
Age composition (%)	1.9	0.4	35.0	51.9	3.3	7.5	100	5.6	0.0	47.1	38.5	4.4	4.3	100	

[a] *The total number trapped was adjusted to account for unmarked hatchery returns.*
[b] *Operated by Confederated Tribes of the Umatilla Indian Reservation (CTUIR). Data provided by Mike McLean (CTUIR).*
[c] *The numbers kept for broodstock are based on weir record.*
[d] *The numbers spawned are based on records collected at Lookingglass Fish Hatchery.*
[e] *Totals exclude eight salmon with an LOP mark which were assumed to be outplants from Catherine Creek. Three jacks were killed at the weir, one jack was passed below the weir, one age 4 female was kept for Catherine Creek broodstock, one age 4 male was killed, and two age 4 females were passed below the weir.*
[f] *One jack kept for broodstock; 23 held in adult ponds and the passed above the weir.*
[g] *One age 4 females kept for Catherine Creek Broodstock; one age 4 male and one age 4 female sent to a foodbank.*
[h] *Operated by Nez Perce Tribe (NPT). Data provided by Peter Cleary (NPT).*
[i] *Adjusted the broodstock collection records at the weir by removing two natural origin salmon and adding two hatchery origin salmon.*

Table 6. Spawning summaries of spring Chinook salmon from the Imnaha and Grande Ronde basins Conventional Hatchery Programs at Lookingglass Fish Hatchery, 2012.

	Number of parents									
	Hatchery			Natural						
		Males[a]			Males[a]					
Stock	F	Unique	Multiple[b]	F	Unique	Multiple[b]	Number of green eggs collected	Mean fecundity	Number of eyed eggs	Percent mortality to shocking
Imnaha River	71	106[c]	115	38	27	27[c]	489,198	4,488	389,802	20.3
Catherine Creek	22	19	20	23	23	26	170,686	3,793	148,514	13.0
Upper Grande Ronde River	45	34	34	29	41	44	267,394	3,613	245,116	8.3
Lookingglass Creek	57	52	57	24	21	30	297,475	3,673	279,533	6.0
Lostine River	47	42	45	15	21	23	270,211	4,358	242,616	10.2

[a] *Male counts include jacks.*

b The numbers of male parents is greater than the number of males that were spawned and the number of males kept because some males were spawned more than once and multiple males were usually spawned with one female in a 2x2 matrix.

[c] *Six jacks were spawned as one male.*

Table 7. Number of female spring/summer Chinook salmon and mean egg weight (g) by stock, origin (hatchery or natural), and age collected for spawn year 2012. P-value is for a t-test comparing hatchery vs. natural salmon mean egg weights.

		Hatchery			Natural			
Stock		Age 4	Age 5	Total/ mean	Age 4	Age 5	Total/ mean	P-value
Imnaha River	Females	60	10	70	26	12	38	
	Mean egg wt.	0.239	0.281	0.245	0.240	0.301	0.259	0.037
Catherine Creek	Females	20	2	22	19	4	23	
	Mean egg wt.	0.222	0.271	0.226	0.216	0.254	0.223	0.680
Upper Grande Ronde River	Females	39	5	44	28	1	29	
	Mean egg wt.	0.211	0.245	0.215	0.215	0.258	0.217	0.766
Lookingglass Creek	Females	52	1	53	20	0	20	
	Mean egg wt.	0.229	0.299	0.230	0.218	—	0.218	0.080
Lostine River	Females	38	9	47	12	3	15	
	Mean egg wt.	0.237	0.273	0.244	0.219	0.258	0.227	0.094

Table 8. Catch and escapement summary for the 2012 return year of smolts released into the Imnaha River from brood years 2007-2009. Estimated coded-wire tag (CWT) recoveries were summarized through 3 March 2014 from the PSMFC database and expanded to account for recoveries of adipose-clipped Chinook salmon without a CWT. Recruitment to the river incorporates weir records in addition to CWT data.

	Age 3 (BY 2009)			Age 4 (BY 2008)			Age 5 (BY 2007)			
Total Smolts Released	252,588			390,062			293,801			
% Ad + CWT	69.9%			49.2%			59.6%			
Location, recovery type	CWT recoveries	Est. CWT	Expanded Return	CWT recoveries	Est. CWT	Expanded Return	CWT recoveries	Est. CWT	Expanded Return	Total
Ocean catch	0	0	0	2	37	74	0	0	0	74
Columbia River										
Tribal	1	4	5	29	160	322	2	8	13	340
Non-tribal net	0	0	0	4	14	27	0	0	0	27
Sport	4	30	43	18	114	229	0	0	0	272
Stray	1	1	1	2	2	4	3	3	5	10
Snake River										
Sport[a]	0	0	0	0	0	0	0	0	0	0
Tribal[a]	0	0	0	0	0	0	0	0	0	0
Stray below LGD[b]	0	0	0	0	0	0	0	0	0	0
Stray above LGD[a,b]	0	0	0	2	23	23	0	0	0	23
Recruitment to river[a]										
Sport Fisheries[d]	1	--	19	11	--	178	1	--	25	222
Tribal Fisheries[d]	0	--	22	0	--	341	0	--	45	408
Above weir estimate[c]	9	--	142	81	--	655	4	--	117	914
Below weir estimate[c]	0	--	39	10	--	250	3	--	37	326
Removed at weir[c]	59	--	106	182	--	808	12	--	96	1,010
Compensation area return	69	--	328	286	--	2,255	20	--	320	2,903
Total/Total estimated return	75	--	377	341	--	2,911	25	--	338	3,626

[a] *Indicates areas within LSRCP compensation area.*

[b] *Estimated number of total CWT fish recovered from PSMFC and ODFW databases.*

[c] *Expansion factor based on estimated total return to natal stream of Imnaha River hatchery adults (ages 3-5).*

[d] *CWT samples were not collected from the fishery.*

Table 9. Catch and escapement summary for the 2012 return year of Captive Broodstock (CBS) and Conventional Hatchery (CHP) program smolts released into Catherine Creek from brood years 2007-2009. Estimated coded-wire tag (CWT) recoveries were summarized through 3 March 2014 from the PSMFC database and expanded to account for recoveries of adipose-clipped Chinook salmon without a CWT. Recruitment to the river incorporates weir records in addition to CWT data.

	Age 3 (BY 2009)			Age 4 (BY 2008)			Age 5 (BY 2007)			
Total Smolts Released	155,475			144,353			138,844			
% Ad + CWT	96.3%			93.8%			59.7%			
Location, recovery type	CWT recoveries	Est. CWT	Expanded Return	CWT recoveries	Est. CWT	Expanded Return	CWT recoveries	Est. CWT	Expanded Return	Total
Ocean catch	0	0	0	0	0	0	0	0	0	0
Columbia River										
Tribal	0	0	0	3	12	13	0	0	0	13
Non-tribal net	1	3	3	8	15	16	1	2	3	22
Sport	0	0	0	20	89	90	1	4	7	97
Stray	1	1	1	0	0	0	0	0	0	1
Snake River										
Sport[a]	0	0	0	8	56	57	0	0	0	57
Tribal[a]	0	0	0	0	0	0	0	0	0	0
Stray below LGD[b]	0	0	0	0	0	0	0	0	0	0
Stray above LGD[a,b]										
Outside GR Basin	0	0	0	0	0	0	0	0	0	0
GR Basin[c]	4	--	8	16	--	91	1	--	1	100
Recruitment to river[a]										
Sport Fisheries	0	--	0	1	--	28	0	--	0	28
Tribal Fisheries	0	--	0	0	--	0	0	--	0	0
Above weir estimate[c]	0	--	11	49	--	327	1	--	29	367
Below weir estimate[c]	0	--	0	0	--	2	0	--	0	2
Removed at weir[c]	10	--	26	49	--	244	3	--	5	275
Compensation area return	14	--	45	124	--	749	5	--	35	829
Total/Total estimated return	16	--	49	155	--	868	7	--	45	962

[a] *Indicates areas within LSRCP compensation area.*

[b] *Estimated number of total CWT fish recovered from PSMFC and ODFW databases.*

[c] *Expansion factor based on estimated total return to natal stream of Catherine Creek hatchery adults (ages 3-5).*

Table 10. Catch and escapement summary for the 2012 return year of Captive Broodstock (CBS) and Conventional Hatchery (CHP) program smolts released into the Upper Grande Ronde River from brood years 2007-2009. Estimated coded-wire tag (CWT) recoveries were summarized through 3 March 2014 from the PSMFC database and expanded to account for recoveries of adipose-clipped Chinook salmon without a CWT. Recruitment to the river incorporates weir records in addition to CWT data.

	Age 3 (BY 2009)			Age 4 (BY 2008)			Age 5 (BY 2007)			
Total Smolts Released	242,385			232,349			146,552			
% Ad + CWT	21.1%			76.6%			34.6%			
Location, recovery type	CWT recoveries	Est. CWT	Expanded Return	CWT recoveries	Est. CWT	Expanded Return	CWT recoveries	Est. CWT	Expanded Return	Total
Ocean catch	0	0	0	0	0	0	0	0	0	0
Columbia River										
Tribal	0	0	0	4	13	14	0	0	0	14
Non-tribal net	0	0	0	14	31	32	0	0	0	32
Sport	0	0	0	20	87	90	0	0	0	90
Stray	0	0	0	0	0	0	0	0	0	0
Snake River										
Sport[a]	0	0	0	3	18	18	0	0	0	18
Tribal[a]	0	0	0	0	0	0	0	0	0	0
Stray below LGD[b]	0	0	0	3	3	3	0	0	0	3
Stray above LGD[a,b]										
Outside GR Basin	0	0	0	0	0	0	0	0	0	0
GR Basin[c]	3	--	3	10	--	40	0	--	0	43
Recruitment to river[a]										
Sport Fisheries	0	--	0	0	--	0	0	--	0	0
Tribal Fisheries	0	--	0	0	--	0	0	--	0	0
Above weir estimate[c]	0	--	3	52	--	524	3	--	16	543
Below weir estimate[c]	0	--	0	0	--	4	0	--	0	4
Removed at weir[c]	11	--	11	75	--	76	7	--	7	94
Compensation area return	14	--	17	140	--	662	10	--	23	702
Total/Total estimated return	14	--	17	181	--	801	10	--	23	841

[a] *Indicates areas within LSRCP compensation area.*

[b] *Estimated number of total CWT fish recovered from PSMFC and ODFW databases.*

[c] *Expansion factor based on estimated total return to natal stream of Upper Grande Ronde River hatchery adults (ages 3-5).*

Table 11. Catch and escapement summary for the 2012 return year of smolts released into Lookingglass Creek from brood years (BY) 2007-2009. Estimated coded-wire tag (CWT) recoveries were summarized through 3 March 2014 from the PSMFC database and expanded to account for recoveries of adipose-clipped Chinook salmon without a CWT. Recruitment to the river incorporates weir records in addition to CWT data.

	Age 3 (BY 2009)			Age 4 (BY 2008)			Age 5 (BY 2007)			
Total Smolts Released	100,759			262,910			150,478			
% Ad + CWT	98.7%			53.6%			97.8%			
Location, recovery type	CWT recoveries	Est. CWT	Expanded Return	CWT recoveries	Est. CWT	Expanded Return	CWT recoveries	Est. CWT	Expanded Return	Total
Ocean catch	0	0	0	4	10	18	0	0	0	18
Columbia River										
Tribal	0	0	0	9	45	79	0	0	0	79
Non-tribal net	1	1	1	20	43	76	3	7	7	84
Sport	0	0	0	35	155	273	1	3	3	276
Stray	0	0	0	6	17	30	0	0	0	30
Snake River										
Sport[a]	0	0	0	6	39	69	0	0	0	69
Tribal[a]	0	0	0	0	0	0	0	0	0	0
Stray below LGD[b]	0	0	0	0	0	0	0	0	0	0
Stray above LGD[a,b]										
Outside GR Basin	0	0	0	0	0	0	0	0	0	0
GR Basin[c]	1	--	5	2	--	2	2	--	43	50
Recruitment to river[a]										
Sport Fisheries[d]	0	--	9	40	--	401	1	--	14	424
Tribal Fisheries[e]	0	--	1	0	--	353	0	--	13	367
Above weir estimate[c]	0	--	2	90	--	793	0	--	29	824
Below weir estimate[c]	2	--	11	36	--	275	0	--	12	298
Removed at weir[c]	31	--	59	62	--	112	3	--	5	176
Compensation area return	34	--	87	236	--	2,005	6	--	116	2,208
Total/Total estimated return	35	--	88	310	--	2,481	10	--	126	2,695

[a] *Indicates areas within LSRCP compensation area.*

[b] *Estimated number of total CWT fish recovered from PSMFC and ODFW databases.*

[c] *Expansion factor based on estimated total return to natal stream of Grande Ronde River (GR) basin hatchery adults (ages 3-5).*

[d] *Harvest excludes two age 3, 47 age 4, and two age 5 hatchery Chinook that were captured at the Catherine Creek weir and released in Lookingglass Creek.*

[e] *Harvest excludes 66 age 3, 41 age 4, and one age 5 hatchery Chinook salmon captured at the Catherine Creek weir and released in Lookingglass Creek.*

Table 12. Catch and summary distribution for the 2012 return year of Captive Broodstock (CBS) and Conventional Hatchery (CHP) program smolts released into the Lostine River from brood years (BY) 2007-2009. Estimated coded-wire tag (CWT) recoveries were summarized through 3 March 2014 from the PSMFC database and expanded to account for recoveries of adipose-clipped Chinook salmon without a CWT. Recruitment to the river incorporates weir records in addition to CWT data.

	Age 3 (BY 2009)			Age 4 (BY 2008)			Age 5 (BY 2007)			
Total Smolts Released	62,836			243,663			247,692			
% Ad + CWT	0.0%			72.5%			74.6%			
Location, recovery type	CWT recoveries	Est. CWT	Expanded Return	CWT recoveries	Est. CWT	Expanded Return	CWT recoveries	Est. CWT	Expanded Return	Total
Ocean catch	0	0	0	4	12	12	0	0	0	12
Columbia River										
Tribal	0	0	0	26	129	131	5	24	24	155
Non-tribal net	0	0	0	4	12	12	1	2	2	14
Sport	0	0	0	9	63	64	1	7	7	71
Stray	0	0	0	6	6	6	2	2	2	8
Snake River										
Sport[a]	0	0	0	0	0	0	0	0	0	0
Tribal[a]	0	0	0	0	0	0	0	0	0	0
Stray below LGD[b]	0	0	0	0	0	0	0	0	0	0
Stray above LGD[a,b]										
Outside GR Basin	0	0	0	2	2	2	0	0	0	2
GR Basin[c]	0	--	0	6	--	55	1	--	22	77
Recruitment to river[a]										
Sport Fisheries	0	--	0	0	--	0	0	--	0	0
Tribal Fisheries	0	--	4	0	--	29	0	--	3	36
Above weir estimate[c]	0	--	11	138	--	446	25	--	50	507
Below weir estimate[c]	0	--	13	78	--	273	7	--	31	317
Removed at weir[c]	4	--	7	147	--	272	19	--	31	310
Compensation area return	4	--	35	371	--	1,077	52	--	137	1,249
Total/Total estimated return	4	--	35	420	--	1,302	61	--	172	1,509

[a] *Indicates areas within LSRCP compensation area.*

[b] *Estimated number of total CWT fish recovered from PSMFC and ODFW databases.*

[c] *Expansion factor based on estimated total return to natal stream of Lostine River basin hatchery adults (ages 3-5).*

Table 13. Total smolts released, total returns (age 3-5) and smolt-to-adult return rates (SAR) to Lower Granite Dam (LGD) and total returns to the Imnaha River for spring Chinook salmon released into the Imnaha River, complete brood years 1982-2006. SAR data were updated on 19 March 2014.

Brood Year	Total smolts released	To Lower Granite Dam		To river mouth	
		Total	SAR	Total	SAR
1982	29,184	208	0.713	208	0.713
1983	59,595	80	0.134	80	0.134
1984	35,782	112	0.313	111	0.310
1985	123,533	207	0.168	206	0.167
1986	199,506	499	0.250	499	0.250
1987	142,320	384	0.270	384	0.270
1988	253,869	1,878	0.740	1,878	0.740
1989	267,670	630	0.235	630	0.235
1990	262,500	103	0.039	103	0.039
1991	157,659	76	0.048	76	0.048
1992	438,617	207	0.047	207	0.047
1993	590,118	1,046	0.177	1,046	0.177
1994	91,240	99	0.109	99	0.109
1995	50,903	519	1.020	519	1.020
1996	93,112	920	0.988	920	0.988
1997	194,958	3,520	1.806	3,518	1.804
1998	179,972	4,631	2.573	4,623	2.569
1999	123,009	1,216	0.989	1,210	0.984
2000	303,717	2,315	0.762	2,286	0.753
2001	268,420	1,806	0.673	1,801	0.671
2002	398,178	1,459	0.366	1,351	0.339
2003	435,187	1,304	0.299	1,301	0.299
2004	441,680	3,462	0.784	3,458	0.783
2005	432,530	3,395	0.785	3,395	0.785
2006	348,909	8,958	2.567	8,910	2.554
2007	293,801	3,581	1.219	3,581	1.219
Mean	239,076	1,639	0.695	1,631	0.693

Table 14. Total smolts released, total returns (ages 3-5) and smolt-to-adult return rates (SAR) to Lower Granite Dam (LGD) and Catherine Creek for smolts produced from the Captive Broodstock (CBS) and Conventional Hatchery (CHP) programs released into Catherine Creek, complete brood years 1998-2006. SAR data were updated on 19 March 2014.

Brood Year	Program	Total smolts released	To Lower Granite Dam		To river mouth	
			Total	SAR	Total	SAR
1998	CBS	38,144	425	1.114	419	1.098
1999	CBS	136,820	267	0.195	242	0.177
2000	CBS	180,340	695	0.385	673	0.373
2001	CBS	105,292	129	0.123	112	0.106
2001	CHP	24,392	79	0.324	77	0.316
2002	CBS	91,797	74	0.081	69	0.075
2002	CHP	70,072	210	0.300	200	0.285
2003	CBS	68,827	47	0.068	41	0.060
2003	CHP	120,754	132	0.109	121	0.100
2004	CBS	45,604	113	0.248	109	0.239
2004	CHP	23,216	87	0.375	83	0.358
2005	CBS	21,574	41	0.190	36	0.167
2005	CHP	49,696	244	0.491	225	0.453
2006	CHP	116,882	1,473	1.260	1,401	0.457
2007	CHP	138,843	975	0.702	878	0.632
Mean	CBS/CHP	82,151	333	0.398	312	0.326

Table 15. Total smolts released, total returns (ages 3-5) and smolt-to-adult return rates (SAR) to Lower Granite Dam (LGD) and the Upper Grande Ronde River for smolts produced from the Captive Broodstock (CBS) and Conventional Hatchery (CHP) programs released into the Upper Grande Ronde River, complete brood years 1998-2006. SAR data were updated on 19 March 2014.

Brood Year	Program	Total smolts released	To Lower Granite Dam		To river mouth	
			Total	SAR	Total	SAR
1998	CBS	1,508	7	0.464	7	0.464
1999	CBS	2,559	12	0.469	12	0.469
2000	CBS	151,443	659	0.435	630	0.416
2001	CBS	210,113	327	0.156	312	0.148
2001	CHP	26,923	164	0.609	151	0.561
2002	CBS	75,063	3	0.004	3	0.004
2002	CHP	69,856	178	0.255	166	0.238
2003	CBS	1,019	0	0.000	0	0.000
2003	CHP	104,350	44	0.042	41	0.039
2004	CBS	76	0	0.000	0	0.000
2004	CHP	18,901	124	0.656	114	0.603
2005	CBS	20,620	132	0.640	126	0.611
2005	CHP	118,803	901	0.758	883	0.743
2006	CHP	259,932	2,988	1.150	2,830	1.089
2007	CBS	52,404	422	0.805	402	0.767
2007	CHP	94,148	607	0.645	583	0.619
Mean	CBS/CHP	78,482	411	0.443	391	0.423

Table 16. Total smolts released, total returns (ages 3-5) and smolt-to-adult return rates (SAR) to Lower Granite Dam (LGD) and Lookingglass Creek for smolts released into Lookingglass Creek from either the Catherine Creek Captive Broodstock (CBS) or Lookingglass Creek Conventional Hatchery (CHP) programs, complete brood years 2000-2006. SAR data were updated on 19 March 2014.

Brood Year	Program	Total smolts released	To Lower Granite Dam		To river mouth	
			Total	SAR	Total	SAR
2000	CBS	51,864[a]	79	0.152	66	0.127
2001	CBS	17,880[a]	53	0.296	53	0.295
2002	CBS	53,195	108	0.203	107	0.201
2003	CBS	98,023	167	0.170	164	0.167
2004	CHP	125,023	506	0.405	446	0.357
2005	CHP	0	NA	NA	NA	NA
2006	CHP	43,219	776	1.796	717	1.659
2007	CBS/CHP[b]	150,478	1,746	1.160	1,455	0.967
Mean	CBS/CHP	77,096	491	0.597	430	0.539

[a] *Parr releases, not smolts.*

[b] *Released 104,450 Catherine Creek CBS smolts and 50,027 Lookingglass Creek CHP smolts. All smolts were marked with an adipose fin clip and a CWT.*

Table 17. Total smolts released, total returns (ages 3-5) and smolt-to-adult return rates (SAR) to Lower Granite Dam (LGD) and the Lostine River for smolts produced from the Captive Broodstock (CBS) and Conventional Hatchery (CHP) programs released into the Lostine River, complete brood years 1998-2006. SAR data were updated on 19 March 2014.

Brood Year	Program	Total smolts released	To Lower Granite Dam		To river mouth	
			Total	SAR	Total	SAR
1997	CHP	11,870	237	1.997	233	1.963
1998	CBS	35,100	589	1.678	576	1.641
1999	CBS	133,880	341	0.255	320	0.239
2000	CBS	77,312	657	0.850	628	0.812
2000	CHP	31,464	432	1.373	425	1.351
2001	CBS	141,867	433	0.305	427	0.301
2001	CHP	100,882	657	0.651	637	0.631
2002	CBS	133,729	189	0.141	181	0.135
2002	CHP	116,370	321	0.276	308	0.265
2003	CBS	62,149	113	0.182	112	0.180
2003	CHP	102,556	272	0.265	256	0.250
2004	CBS	40,982	115	0.281	106	0.259
2004	CHP	197,950	1,315	0.664	1,201	0.607
2005	CBS	24,604	216	0.878	204	0.829
2005	CHP	205,407	1,891	0.921	1,868	0.909
2006	CBS	10,470	212	2.025	212	2.025
2006	CHP	194,594	5,583	2.869	5,352	2.750
2007	CBS	61,927	1,314	2.122	1,308	2.112
2007	CHP	185,765	2,838	1.528	2,757	1.484
Mean	CBS/CHP	98,362	901	1.014	901	0.987

Table 18. Summary of hatchery and natural spring Chinook salmon carcasses recovered and number of redds observed by stream during spawning ground surveys in the Imnaha River and Grande Ronde River basins, 2012.

Basin, stream	Hatchery	Natural	Unknown origin	Percent hatchery	Number of redds
Imnaha River Basin					
Big Sheep Creek	3	5	0	37.5	34
Imnaha River	248	201	6	55.2	738
Lick Creek	0	0	0	0.0	2
Total	251	206	6	54.9	774
Grande Ronde River Basin					
Bear Creek	1	15	0	6.3	48
Catherine Creek	64	31	4	67.4	237
Upper Grande Ronde River	69	5	5	93.2	97
Hurricane Creek	2	26	0	7.1	38
Limber Jim Creek	0	0	0	0.0	0
Lookingglass Creek[a,b]	377	56	2	87.1	447
Lostine River	309	189[c]	19	62.0	421
Meadow Creek	0	0	1	0	0
Minam River[d]	4	44	1	8.3	174
Sheep Creek	0	0	0	0.0	0
Wallowa River	5	29	0	14.7	93
Wenaha River	5	35	3	12.5	226
Total	836	431	35	66.0	1,781

[a] Data provided by CTUIR.
[b] Includes Little Lookingglass Creek.
[c] Unclipped recoveries that did not have a CWT.
[d] Includes Little Minam River.

Table 19. Summary of hatchery Chinook salmon carcasses with coded-wire tags recovered during spawning ground surveys in the Imnaha River and Grande Ronde River basins, 2012.

Recovery location	Brood year	CWT code	Number recovered	Release site
Imnaha River Basin				
Imnaha River	2007	094571	1	Imnaha River
		094577	2	Imnaha River
		094578	4	Imnaha River
	2008	094667	30	Imnaha River
		094668	30	Imnaha River
		094669	31	Imnaha River
	2009	090290	2	Imnaha River
		090291	3	Imnaha River
		090292	4	Imnaha River
Grande Ronde River Basin				
Bear Creek	2008	094665	1	Lostine River
Catherine Creek	2007	094565	1	Catherine Creek
	2008	094590	29	Catherine Creek
		094591	10	Catherine Creek
		094592	10	Catherine Creek
Hurricane Creek[a]	2008	094665	1	Lostine River
Upper Grande Ronde	2007	094570	2	Upper Grande Ronde River
		094576	1	Grande Ronde River
	2008	094595	17	Grande Ronde River
		094596	15	Grande Ronde River
		094597	9	Grande Ronde River
		094598	11	Grande Ronde River
Lookingglass Creek[b]	2008	094590	6	Catherine Creek
		094591	7	Catherine Creek
		094592	2	Catherine Creek
		094593	68	Lookingglass Creek
		094594	58	Lookingglass Creek
		094596	3	Grande Ronde River
		094597	1	Grande Ronde River
	2009	090361	2	Lookingglass Creek
		090378	1	Catherine Creek
Lostine River	2007	094572	3	Lostine River
		094573	7	Lostine River
		094574	9	Lostine River
		094575	13	Lostine River

Table 19 continued.

Recovery location	Brood year	CWT code	Number recovered	Release site
Lostine River	2008	094590	1	Catherine Creek
		094599	50	Lostine River
		094664	64	Lostine River
		094665	33	Lostine River
		094666	69	Lostine River
Minam River[c]	2008	094665	1	Lostine River
		094666	1	Lostine River
Wallowa River[a]	2008	094599	1	Lostine River
		094664	1	Lostine River
Wenaha River	2007	094566	1	Lookingglass Creek
		094568	1	Lookingglass Creek
		094573	1	Lostine River
	2008	094669	1	Imnaha River
	2009	090361	1	Lookingglass Creek

[a] *Recoveries may include outplants from the Lostine River.*
[b] *Data provided by CTUIR. Includes Little Lookingglass Creek.*
[c] *Includes the Little Minam River.*

Table 20. Number and percent of natural- and hatchery-reared adult Chinook salmon from streams in the Grande Ronde River and Imnaha River basins sampled for BKD at Lookingglass Fish Hatchery (LFH) or on spawning grounds surveys (SGS) with ELISA OD levels in each category, 2012.

Population, origin	Sample Location	ELISA category: Low (< 0.2) N	Low (< 0.2) %	Moderate (0.2-0.799) N	Moderate (0.2-0.799) %	High (≥ 0.8) N	High (≥ 0.8) %	Total N	Mean ELISA OD level
Imnaha River									
Hatchery	LFH	71	100	0	0.0	0	0.0	71	0.087
	SGS	39	100	0	0.0	0	0.0	39	0.108
Natural	LFH	38	100	0	0.0	0	0.0	38	0.084
	SGS	39	97.5	1	2.5	0	0.0	40	0.119
Catherine Creek									
Hatchery	LFH	22	100	0	0.0	0	0.0	22	0.069
	SGS	33	100	0	0.0	0	0.0	33	0.114
Natural	LFH	23	100	0	0.0	0	0.0	23	0.071
	SGS	12	80.0	0	20.0	0	0.0	12	0.119
Upper Grande Ronde River									
Hatchery	LFH	45	100	0	0.0	0	0.0	45	0.078
	SGS	28	93.4	1	3.3	1	3.3	30	0.142
Natural	LFH	29	100	0	0.0	0	0.0	29	0.076
	SGS	4	100	0	0.0	0	0.0	4	0.109
Lookingglass Creek									
Hatchery	LFH	57	100	0	0.0	0	0.0	57	0.074
	SGS	24	96.0	1	4.0	0	0.0	25	0.102
Natural	LFH	24	100	0	0.0	0	0.0	24	0.075
	SGS	1	100.0	0	0.0	1	50.0	1	0.081
Lostine River									
Hatchery	LFH	47	100	0	0.0	0	0.0	47	0.078
	SGS	30	93.8	2	6.3	0	0.0	32	0.118
Natural	LFH	15	100	0	0.0	0	0.0	15	0.086
	SGS	28	90.3	2	6.5	1	3.2	31	0.174
Minam River									
Hatchery	SGS	0	0.0	0	0.0	0	0.0	0	---
Natural	SGS	7	100	0	0.0	0	0.0	6	0.107
Wenaha River									
Hatchery	SGS	1	100	0	0.0	0	0.0	1	0.107
Natural	SGS	12	92.3	1	7.7	0	0.0	13	0.129
Total		629	98.4	8	1.3	2	0.3	639	0.100

References

Bailey, Timothy. 2012a. 2012 Catherine Creek spring Chinook sport fishery report. Oregon Department of Fish and Wildlife, La Grande.

Bailey, Timothy. 2012b. 2012 Lookingglass Creek spring Chinook sport fishery report. Oregon Department of Fish and Wildlife, La Grande.

Carmichael, R.W. and E.J. Wagner. 1983. Evaluation of Lower Snake River Compensation Plan facilities in Oregon, Fish Research Project 14-16-0001-83269, 1983 Annual Progress Report. Oregon Department of Fish and Wildlife, Portland.

Carmichael, R.W. and R.T. Messmer. 1985. Evaluation of Lower Snake River Compensation Plan facilities in Oregon, Fish Research Project FRI/LSR-86-35, 1985 Annual Progress Report. Oregon Department of Fish and Wildlife, Portland.

Carmichael, R.W., B.A. Miller and R.T. Messmer. 1986a. Lower Snake River Compensation Plan - Oregon evaluation studies, Fish Research Project FRI/LSR-86-35, 1986 Annual Progress Report. Oregon Department of Fish and Wildlife Portland.

Carmichael, R.W., R. Boyce and J. Johnson. 1986b. Grande Ronde River spring Chinook production report (U.S. v. Oregon). Oregon Department of Fish and Wildlife, Portland.

Carmichael, R.W., R.T. Messmer and B.A. Miller. 1987. Lower Snake River Compensation Plan--Oregon evaluation studies, Fish Research Project FRI/LSR-88-16, 1987 Annual Progress Report. Oregon Department of Fish and Wildlife, Portland.

Carmichael, R.W., R.T. Messmer and B.A. Miller. 1988. Lower Snake River Compensation Plan--Oregon evaluation studies, Fish Research Project AFFI/LSR-90-17, 1988 Annual Progress Report. Oregon Department of Fish and Wildlife, Portland.

Carmichael, R.W., D.L. Eddy, M.W. Flesher, M. Keefe, P.J. Keniry, S.J. Parker and T.A. Whitesel. 1999. Lower Snake River Compensation Plan: Oregon evaluation studies. Oregon Department of Fish and Wildlife, 1994 Annual Progress Report, Portland.

Carmichael, R.W., D.L. Eddy, M.W. Flesher, T.L. Hoffnagle, P.J. Keniry and J.R. Ruzycki. 2004. Lower Snake River Compensation Plan: Oregon evaluation studies. Oregon Department of Fish and Wildlife, 1995 and 1996 Bi-Annual Progress Report, Salem.

Carmichael, R.W., T.L. Hoffnagle and G. C. Grant. 2007. Lower Snake River Compensation Plan: Oregon evaluation studies. Work statement submitted to the U. S. Fish and Wildlife Service, Lower Snake River Compensation Plan office, Boise, ID. Contract Number 14-11-07-J009. Oregon Department of Fish and Wildlife, La Grande.

Carmichael, R.W. and T.L. Hoffnagle. 2011. Lower Snake River Compensation Plan: Oregon evaluation studies. Work statement submitted to the U. S. Fish and Wildlife Service, Lower Snake River Compensation Plan office, Boise, ID. Contract Number 14110-B-J010. Oregon Department of Fish and Wildlife, La Grande.

Corps of Engineers. 1975. Special Report, Lower Snake River Fish and Wildlife Compensation Plan, Lower Snake River, Washington and Idaho. U.S. Army Engineer District, Walla Walla, Washington. http://www.fws.gov/lsnakecomplan/Reports/LSRCPreports.html

Cleary, P.J. and M. Edwards. 2011. Evaluation of Spring Chinook salmon *Oncorhynchus tshawytscha* supplementation in the Lostine River, Oregon, 2010 Annual Report (January 2010 to December 2010). BPA Project Number 1998-007-02, Contract Number 00044925. Bonneville Power Administration. Portland, Oregon.

Feldhaus, J.W., T.L. Hoffnagle, D.L. Eddy, S.M. Warren, N.C. Albrecht, and R.W. Carmichael. 2010. Lower Snake River Compensation Plan: Oregon spring Chinook salmon evaluation studies, 2007 Annual Progress Report. Oregon Department of Fish and Wildlife, Salem.

Feldhaus, J.W., T.L. Hoffnagle, N.C. Albrecht, and R.W. Carmichael. 2011. Lower Snake River Compensation Plan: Oregon spring Chinook salmon evaluation studies, 2008 Annual Progress Report. Oregon Department of Fish and Wildlife, Salem.

Feldhaus, J.W., T.L. Hoffnagle, and R.W. Carmichael. 2012a. Lower Snake River Compensation Plan: Oregon spring Chinook salmon evaluation studies, 2009 Annual Progress Report. Oregon Department of Fish and Wildlife, Salem.

Feldhaus, J.W., T.L. Hoffnagle, and R.W. Carmichael. 2012b. Lower Snake River Compensation Plan: Oregon spring Chinook salmon evaluation studies, 2010. Annual Progress Report. Oregon Department of Fish and Wildlife, Salem.

Feldhaus, J.W., T.L. Hoffnagle, E.L. Eddy, and R.W. Carmichael. 2014. Lower Snake River Compensation Plan: Oregon spring Chinook salmon evaluation studies, 2011. Annual Progress Report. Oregon Department of Fish and Wildlife, Salem.

Gee, Sally A, T.L. Hoffnagle, and R.W. Carmichael. 2010. Grande Ronde Basin Spring Chinook Salmon Captive Broodstock Program. 2009 Annual Report. Submitted to Bonneville Power Administration, Portland, Oregon. Northeast Region Fish Research and Development, Oregon Department of Fish and Wildlife, La Grande.

Gee, Sally A, T.L. Hoffnagle, and S.T. Onjukka. 2011. Grande Ronde Basin Spring Chinook Salmon Captive Broodstock Program. 2010 Annual Report. Submitted to Bonneville Power Administration, Portland, Oregon. Northeast Region Fish Research and Development, Oregon Department of Fish and Wildlife, La Grande.

Gee, S.A, T.L. Hoffnagle, and S.T. Onjukka. 2012. Grande Ronde Basin Spring Chinook Salmon Captive Broodstock Program. 2011 Annual Report. Submitted to Bonneville Power Administration, Portland, Oregon. Northeast Region Fish Research and Development, Oregon Department of Fish and Wildlife, La Grande.

Herrig, Daniel M. A Review of the Lower Snake River Compensation Plan Hatchery Program. 1990. Lower Snake River Compensation Plan Office, Boise, Idaho. http://www.fws.gov/lsnakecomplan/Reports/LSRCPreports.html

Hoffnagle, T. L., R. W. Carmichael and W. T. Noll. 2003. Grande Ronde Basin Chinook salmon captive broodstock program. 1995-2002 status report. Submitted to Bonneville Power Administration, Portland, Oregon. Northeast Region Fish Research and Development, Oregon Department of Fish and Wildlife, La Grande.

Hoffnagle, T.L., R. W. Carmichael, D.L. Eddy, P.J. Keniry, F. M. Monzyk and G. Vonderohe. 2005. Lower Snake River Compensation Plan: Oregon evaluation studies. Oregon Department of Fish and Wildlife, 1997 and 1998 Bi-Annual Progress Report, Salem.

Messmer, R.T., R.W. Carmichael and M.W. Flesher. 1989. Evaluation of Lower Snake River Compensation Plan facilities in Oregon, Fish Research Project, 1989 Annual Progress Report. Oregon Department of Fish and Wildlife, Portland.

Messmer, R.T., R.W. Carmichael and M.W. Flesher. 1990. Evaluation of Lower Snake River Compensation Plan facilities in Oregon, Fish Research Project, 1990 Annual Progress Report. Oregon Department of Fish and Wildlife, Portland.

Messmer, R.T., R.W. Carmichael, M.W. Flesher and T.A. Whitesel. 1991. Evaluation of Lower Snake River Compensation Plan facilities in Oregon, Fish Research Project, 1991 Annual Progress Report. Oregon Department of Fish and Wildlife, Portland.

Messmer, R.T., R.W. Carmichael, M.W. Flesher and T.A. Whitesel. 1992. Evaluation of Lower Snake River Compensation Plan facilities in Oregon, Fish Research Project, 1992 Annual Progress Report. Oregon Department of Fish and Wildlife, Portland.

Messmer, R.T., R.W. Carmichael, M.W. Flesher and T.A. Whitesel. 1993. Evaluation of Lower Snake River Compensation Plan facilities in Oregon, Fish Research Project, 1993 Annual Progress Report. Oregon Department of Fish and Wildlife, Portland.

Monzyk, F. R., G. Vonderohe, T. L. Hoffnagle, R. W. Carmichael, D.L. Eddy and P.J. Keniry. 2006a. Lower Snake River Compensation Plan: Oregon spring Chinook salmon evaluation studies, 1999 Annual Progress Report. Oregon Department of Fish and Wildlife, Salem.

Monzyk, F. R., G. Vonderohe, T. L. Hoffnagle, R. W. Carmichael, D.L. Eddy and P.J. Keniry. 2006b. Lower Snake River Compensation Plan: Oregon spring Chinook salmon evaluation studies, 2000 Annual Progress Report. Oregon Department of Fish and Wildlife, Salem.

Monzyk, F. R., G. Vonderohe, T. L. Hoffnagle, R. W. Carmichael, D.L. Eddy and P.J. Keniry. 2006c. Lower Snake River Compensation Plan: Oregon spring Chinook salmon evaluation studies, 2001 Annual Progress Report. Oregon Department of Fish and Wildlife, Salem.

Monzyk, F. R., G. Vonderohe, T. L. Hoffnagle, R. W. Carmichael, D.L. Eddy and P.J. Keniry. 2006d. Lower Snake River Compensation Plan: Oregon spring Chinook salmon evaluation studies, 2002 Annual Progress Report. Oregon Department of Fish and Wildlife, Salem.

Monzyk, F. R, M., G. Vonderohe, T. L. Hoffnagle, R. W. Carmichael, D.L. Eddy and P.J. Keniry. 2006e. Lower Snake River Compensation Plan: Oregon spring Chinook salmon evaluation studies, 2003 Annual Progress Report. Oregon Department of Fish and Wildlife, Salem.

Monzyk, F. R., T. L. Hoffnagle, R. W. Carmichael, D.L. Eddy and P. J. Keniry. 2007. Lower Snake River Compensation Plan: Oregon spring Chinook salmon evaluation studies, 2004 Annual Progress Report. Oregon Department of Fish and Wildlife, Salem.

Monzyk, F. R., T. L. Hoffnagle, R. W. Carmichael, D.L. Eddy and P. J. Keniry. 2008a. Lower Snake River Compensation Plan: Oregon spring Chinook salmon evaluation studies, 2005 Annual Progress Report. Oregon Department of Fish and Wildlife, Salem.

Monzyk, F. R., T. L. Hoffnagle, R. W. Carmichael, and D.L. Eddy. 2008b. Lower Snake River Compensation Plan: Oregon spring Chinook salmon evaluation studies, 2006 Annual Progress Report. Oregon Department of Fish and Wildlife, Salem.

Monzyk, F.R., B.C. Jonasson, T.L. Hoffnagle, P.J. Keniry, R.W. Carmichael, and P.J. Cleary. 2009. Migration Characteristics of Hatchery and Natural Spring Chinook Salmon Smolts from the Grande Ronde River Basin, Oregon, to Lower Granite Dam on the Snake River. Transactions of the American Fisheries Society. 138: 1093-1108.

Robson, D.S., H.A. Regier. 1964. Sample size in Petersen mark-recapture experiments. Transactions of the American Fisheries Society. 93(2) 215-226.

Westhagen and Skalski. 2007. Program PITPro 4: PIT-Tag Processor. School of Aquatic and Fishery Sciences, University of Washington, Seattle, WA. http://www.cbr.washington.edu/paramest/pitpro/

Yanke, Jeff. 2012. 2012 Imnaha and Wallowa Rivers Spring Chinook Sport Fishery Report. Oregon Department of Fish and Wildlife, Enterprise.

Appendix A

Methods for Individual Age Assignment

We attempt to assign age to all mature salmon returning to the Grande Ronde and Imnaha basins of Northeast Oregon in order to determine the contribution to the population (e.g., smolt-to-adult return rate) of each brood year. Although nearly all handled salmon are measured for length, unfortunately, the samples necessary to determine age are not / cannot be collected (e.g., due to logistical constraints or we may not wish to conduct lethal sampling). To determine age we generally use scales for natural salmon and coded-wire tags (CWT) for hatchery salmon. Additionally, a variable (usually small) portion of both hatchery and natural returns are implanted, as juveniles, with a passive integrated transponder (PIT) tag, from which we determine a known age.

In the Grande Ronde and Imnaha basins, mature Chinook salmon are sampled in a variety of ways and at a variety of locations: weirs, on spawning grounds, at Lookingglass Hatchery or during distribution to food banks/tribal subsistence. All salmon captured at weirs are measured for length but samples for determining age are not necessarily collected. Salmon captured at weirs will have one of six dispositions:

- released above the weir to spawn in nature (all are given an opercle punch to show that they were handled at the weir and for use in a mark/recapture population estimate)
- released below the weir for tribal and sport fisheries (also differentially marked)
- outplanted into nearby streams for supplementation (also differentially marked)
- taken to Lookingglass Hatchery for use as broodstock
- killed for food banks/tribal subsistence
- accidental mortality at the weir

All weir mortalities and salmon spawned at Lookingglass Hatchery, and nearly all of those taken for food banks/tribal subsistence have lengths measured and samples collected for ageing. Nearly all salmon recovered on spawning ground surveys also have length measured and scales/snouts collected. However, logistical constraints may preclude scale or snout collection, some scale samples are found to be unreadable, and not all salmon with a clipped adipose fin has a CWT (by intention or accident).

For a variety of reasons, the salmon are not sampled in proportion to their abundance based on age and origin. Hatchery salmon (all ages) are well-sampled, since we capture more of them than we can use for broodstock or are allowed to release above the weir or outplant. All natural salmon captured at the weir are either kept for hatchery broodstock or released to spawn in nature. We are able to collect snouts from most of the salmon retained for food banks/tribal subsistence, all of which are hatchery-origin and most are jacks. We recover only ~20% of the carcasses on spawning ground surveys and jacks are recovered as carcasses at approximately half of the rate at which adults are recovered. So natural jacks are the least sampled group and hatchery jacks are frequently the most sampled group. We believe that the sample of the entire population (aged + unaged) is representative of the entire population but know that the sampling rate of hatchery jacks is often higher than that of ages 4 and 5 salmon.

When the spawning season is over, we are left with a sample of the entire population comprised of two groups of Chinook salmon: one group with lengths only (unaged) and the other group with both lengths and ages (aged). We now need to assign ages to those unaged salmon when we know that the assumption of equal sampling among age/size classes has been

violated. Because of sample size limitations (for natural salmon, especially jacks) and previous analysis showing little difference in size-at-age of natural vs. hatchery salmon, we pool both origins for these analyses.

To assign ages to the unaged salmon, we first compile two data sets: 1) all of the available unique records that contain both length and age and 2) all unique records containing only length. However, some of these fish are duplicates, since some salmon are measured for length at the weir and then measured again, this time (usually) with age, at Lookingglass Hatchery, on the spawning grounds or during foodbank/tribal subsistence distribution. To remove these duplicates, we first remove all salmon from the weir database for which the disposition indicated that the salmon was kept and sampled later in captivity, which solves the problem for salmon sampled at the hatchery and at foodbank/tribal distribution. However, the salmon that are released into nature and later recovered as carcasses are problematic - we only recover approximately 25% (half of that for jacks) of those carcasses and don't know which length recorded during weir sampling corresponds with the length and age of the recovered carcass. To remove these recovered salmon from the weir data set, we pool the data for salmon released above the weir by 20 mm length intervals (bins). We use 20 mm bins to account for measuring differences between the weir and spawning grounds. Carcasses without a fork length or that have an unknown OP-mark are excluded from all analyses. For each opercle-punched (OP - i.e., released into nature after being captured at the weir) salmon recovered in nature, we randomly remove one salmon from the appropriate length bin of the data set of the released salmon. E.g., for an OP-marked salmon recovered in nature with a length of 755 mm, we randomly remove one salmon from the 740-759 mm bin of the data set of those released into nature. After removing all duplicate salmon from the weir data, we expand the salmon carcasses remaining in the spawning ground data set by the carcass recovery rate which is calculated by dividing the number of salmon without an OP-mark by the sum of OP-marked and non-OP-marked salmon. We now have two data sets, both with lengths but one without ages, and there are no duplicates.

For the data set containing ages, we calculate the initial mean and standard deviation (SD) of lengths for each age class and the sample size (N) of all of the aged fish for in each age class, providing us with a normal distribution for each age class. We use those distributions to construct population-specific age keys for assigning final ages to the unaged salmon in the overlap zones (the ranges of bins that contain salmon of more than one age class) based on their bin.

Before assigning any ages to unaged salmon in the overlap zones, we assign ages to salmon with lengths in 'uncontested' length ranges based on known maxima and minima for each age class in each population. E.g., for the Imnaha River, we have never had a salmon with a fork length <496 mm and a known age that was older than 3 years or fork length >1000 mm that was younger than 5 years. So, all unaged salmon with lengths <496 mm and those >1000 mm are automatically assigned ages of 3 and 5, respectively. These limits could change in the future, if scales, tags or marks showed salmon that exceeded these limits.

Finally, we construct the age keys used to assign final ages to unaged salmon within the overlap zones using the mean and SD for each age class to calculate the percentage of the total distribution of each age class that comprises each 10 mm length bin (p; for each age class $\Sigma p=1$). E.g., for the 890-899 mm length bin, $p_3=0.00000002$, $p_4=0.003$ and $p_5=0.073$ for ages 3, 4 and 5, respectively, which means that 0.000002% (essentially zero) of all age 3, 0.3% of all age 4, and 7.3% of all age 5 salmon are found in the 890-899 mm bin. We then weight each age class by the sample size (N) to estimate the number of salmon (n) that should be found in each bin for

each age class by (for age 3, $n_3=N_3*p_3$). E.g., if $N_3=100$, $N_4=500$ and $N_5=50$ for ages 3, 4 and 5, respectively, then $n_3=0.000002$, $n_4=1.598$ and $n_5=3.669$ for ages 3, 4 and 5. Lastly, we calculated the proportion of each length bin (P) that is comprised of individuals from each age class ($P=n/\Sigma n$; for each bin $\Sigma P=1$) - e.g., $P_3=0.0000003$, $P_4=0.303$ and $P_5=0.697$ for ages 3, 4 and 5, respectively, meaning that the 890-899 mm bin is comprised of 0.00003%, 30.3% and 69.7% ages 3, 4 and 5. To assign ages to individual salmon, we use a semi-random method for age assignment where the unaged salmon within a given length bin are randomly assigned ages in proportion to the ages present in the key (Isermann and Knight 2005; Ogle 2014). E.g., the 890-899 mm bin is in the overlap zone for ages 4 and 5, and if there are 7 unaged salmon in the this bin, then 1.52 (rounded to 2) salmon are randomly assigned to age 4 and 5.49 (rounded to 5) salmon are assigned to age 5. Since the proportion of age 3 is essentially zero (0.000002%) in this bin (there were no bins where ages 3 and 5 overlapped with known age salmon) and 890 mm is above the maximum size of any known age 3 salmon (765 mm), we ignore the age 3 component and no salmon are assigned to this age class.

This method solves two common problems with this type of data: 1) length intervals for which there are no salmon of known age in that interval and 2) length intervals in overlap zones for which 100% of the aged salmon were of only one age class. Using this method prevents us from having to pool across wide length intervals, which diminishes precision.

References

Isermann, D.A. and C.T. Knight. 2005. A computer program for age-length keys incorporating age assignment to individual fish. North American Journal of Fisheries Management 25:1153-1160.

Ogle, D.H. 2014. FSA: fisheries stock analysis. R package, Version 0.4.1. http://www.rforge.net/doc/packages/FSA/FSA.html.