LOWER SNAKE RIVER COMPENSATION PLAN:
Oregon Evaluation Studies
1997 and 1998 Bi-Annual Progress Report

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LOWER SNAKE RIVER
COMPENSATION PLAN

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Preface

The purpose of this progress report is to provide summary information for spring Chinook salmon Lower Snake River Compensation Plan (LSRCP) programs operated by ODFW in the Grande Ronde and Imnaha river basins during 1997 and 1998. These ongoing monitoring programs provide technical, logistical and biological information to managers charged with maintaining viable salmon populations and associated fisheries in northeast Oregon.

The data in this report serve as the basis for the analysis of trends in culture performance and were derived from hatchery inventories and standard databases (i.e., PSMFC, coded-wire tag) or through standard measuring techniques. As such, specific protocols are usually not described. In cases where expansions of data or unique methodologies were used, protocols are described in more detail. Additional descriptions of protocols can be found in the 1997 and 1998 work statements (Carmichael 1989; Carmichael et al 1997; 1998). Coded-wire tag (CWT) data collected from 1997-1998 adult returns are used to evaluate smolt-to-adult survival rates in experimental rearing and release groups. In 1997-1998, experimental treatments from which salmon returned included acclimated vs. direct stream release, size at release and rearing density. In 1997-1998, experimental treatments for which salmon were released included size at release, presmolt exercise and rearing density treatments. Analysis of specific survival studies will be completed once all brood years have returned and CWT data are complete for a given experiment. In addition, much of the data that we discuss in this report will be used in separate and specific evaluations of ongoing supplementation programs for Chinook salmon in the Imnaha River Basin. We began culture evaluations in 1983 and have dramatically 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, 1988a, 1988b, 1989, 1990, 1999 and 2004; Messmer et al 1989, 1990, 1991, 1992 and 1993; Jonasson et al 1994, 1995 and 1996) and United States v. Oregon production report (Carmichael et al 1986b).

Within each section of this report, data are organized into salmon culture monitoring for juveniles, adults, CWT recoveries, compensation goals and estimates for total escapement. During the period covered in this report, Chinook salmon from the 1991-1995 brood years returned to spawn, Chinook salmon from the 1995-1996 brood year were released as smolts and adult Chinook salmon that returned to spawn were used to create the 1997 and 1998 cohorts.

Acknowledgments

We would like to thank Tim Whitesel for overseeing the collection of the data presented in this report as well as coordinating many of the experiments. Mike Gribble, Bob Lund and many other hatchery personnel exhibited great dedication and provided essential assistance. Numerous personnel from the U.S. Fish and Wildlife Service, U.S. Forest Service, the Nez Perce Tribe and the Confederated Tribes of the Umatilla Indian Reservation were enthusiastically supportive during spawning ground surveys and spawning at Lookingglass Fish Hatchery. This project was funded by the U.S. Fish and Wildlife Service under the Lower Snake River Compensation Plan, contract numbers 14-48-0001-95560 and 96540, a cooperative agreement with the Oregon Department of Fish and Wildlife.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

In 1997 and 1998 we released 50,911 smolts from the 1995 cohort and 93,127 smolts from the 1996 cohort into the Imnaha River. The 1995 and 1996 cohorts of Imnaha River Chinook salmon released included groups for evaluation of rearing density and size-at-release. In 1997, 99.3% of the releases were recognizably marked with ad-clips and in 1998, 95.9% were recognizably marked. In the Grande Ronde Basin we released 153,478 Rapid River stock smolts in 1997 and 302,145 smolts in 1998. The 1995 cohort releases include groups for evaluation of exercise of parr. In 1997, 98.0% were recognizably marked and in 1998, 97.6% were ad-clipped.

In 1997, we trapped 204 hatchery- and 84 naturally-produced Chinook salmon on the Imnaha River and in 1998 we trapped 115 hatchery- and 150 naturally-produced salmon. In 1995, we began trapping Rapid River stock adults destined for Lookingglass Fish Hatchery at Lower Granite Dam in order to reduce the number of these hatchery salmon straying to the spawning grounds in the Grande Ronde Basin. In 1997, we trapped 741 Rapid River stock Chinook salmon at Lower Granite Dam and 26 at Lookingglass Fish Hatchery. In addition, 94 natural salmon were trapped at Lookingglass Fish Hatchery. In 1998, we trapped 212 Rapid River stock salmon at Lower Granite Dam and 7 at Lookingglass Fish Hatchery. We also trapped 276 natural salmon at Lookingglass Fish Hatchery.

We estimated that 378 and 362 hatchery Chinook salmon returned to the LSRCP compensation area in 1997 as a result of hatchery releases in the Grande Ronde and Imnaha basins. These returns achieved only 16.4% and 11.3% of the adult compensation goals, respectively. In 1998, we estimated that LSRCP hatchery releases in the Imnaha River Basin produced a return of 209 Chinook salmon to the compensation area (6.5% of the goal). The return of Grande Ronde River hatchery Chinook salmon was also 209, achieving 9.1% of the goal. In 1997, we recovered 166 carcasses and found 286 redds during spawning ground surveys in the Imnaha River Basin. In the Grande Ronde Basin, we recovered 233 carcasses and found 301 redds. There were four strays recovered in 1997, two each in the Minam and Wenaha rivers, and all from Lookingglass Fish Hatchery releases. In 1998, we recovered 93 Imnaha River carcasses and found 157 redds. In the Grande Ronde Basin, we found 194 carcasses and 253 redds. We recovered only two carcasses of stray Chinook salmon: one in the Wenaha River, from Lookingglass Fish Hatchery, and one in the Wallowa River, from Trinity River Fish Hatchery in California.

INTRODUCTION

The main objective of this report is to document and evaluate salmon culture performance for spring Chinook salmon at Lookingglass Fish Hatchery (LFH), the Lower Snake River Compensation Plan (LSRCP) facility rearing spring Chinook salmon for the Grande Ronde and Imnaha river basins. These data are used to design culture practices to optimize egg-to-smolt survival rate, smolt quality and smolt-to-adult survival rate. This report provides information on rearing and release operations for the 1995 and 1996 cohorts of juvenile Chinook salmon; the collection, spawning and adult characteristics for the 1997 and 1998 returns of adult Chinook salmon and the collection of eggs for the 1997 and 1998 cohorts.

Program Objectives

1. Document spring Chinook salmon rearing and release activities at all Lower snake River Compensation Plan (LSRCP) facilities.
2. Determine optimum rearing and release strategies that will produce maximum survival to adulthood for hatchery-produced spring Chinook salmon smolts.
3. Document Chinook salmon adult returns by stock to each LSRCP broodstock collection facility.
4. Determine if the total production of spring Chinook salmon adults meet mitigation goals and index annual smolt survival and adult returns to Lower Granite Dam for production groups.
5. Coordinate spring Chinook salmon broodstock marking programs for Lookingglass Fish Hatchery.
6. Participate in planning activities associated with anadromous salmon production and management in the Grande Ronde and Imnaha river basins and participate in ESA permitting, consultation and rearing activities.
7. Conduct index, extensive and supplemental spring Chinook salmon spawning ground surveys in selected streams in northeast Oregon.
8. Identify hatchery and wild origin for carcasses collected on spawning ground surveys in the Grande Ronde Basin.

RESULTS and DISCUSSION

This report summarizes spring Chinook salmon culture monitoring data for LSRCP facilities in 1997 and 1998. During the period covered in this report, Chinook salmon from the 1995-1996 brood year were released as smolts and adult Chinook salmon from the 1991-1995 brood years returned to spawn and were used to create the 1997 and 1998 cohorts. Experimental treatments from which adult salmon returned included acclimated vs. direct stream release, size at release and rearing density. Experimental treatments for which salmon smolts were released included size at release, pre-smolt exercise and rearing density treatments. Analysis of specific survival studies will be completed once all brood years have returned and coded-wire tag (CWT) data are complete for a given experiment. These data will be presented in separate and specific reports for these experiments. 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 River Basin.

Juveniles

1997

Egg-to-smolt survival rates for 1995 cohort Imnaha River and Rapid River stock Chinook salmon were within the normal range observed in past years (Table 1). The smolt production goal for 1995 cohort Rapid River stock was set at 490,000, below the mitigation goal of 900,000. This provided rearing space for Imnaha Chinook salmon, one of the actions taken in the transition from the non-local origin Rapid River stock to local origin broodstocks. The release of 153,478 smolts was well below the modified goal. An additional 30,880 1996 cohort parr were released, as well. The release of 50,911 1995 cohort Imnaha River smolts was well below the mitigation goal of 490,000. Production levels of the 1995 cohort of both Rapid River and Imnaha River stocks were a result of a low number of hatchery and natural returns in 1995.

We implemented a complex marking program for 1995 cohort Chinook salmon (Table 2). We attempted to mark 100% of the 1995 cohort Imnaha River Chinook salmon with an adipose clip and CWT and 100% of the 1995 cohort Rapid River stock smolts with Ad-RV and CWT. This mark was applied to allow for trapping, identification and removal of Lookingglass produced Rapid River stock adults at Lower Granite Dam. We achieved a mark rate of 96%.

The 1995 cohort Imnaha River juveniles were reared in four raceways at Lookingglass Fish Hatchery with an evaluation of size at release (18.2 vs. 30.3 g target weight at release) and rearing density (1.9 vs. 3.7 g/L). Actual mean weight of released smolts was 20.9 and 31.8 g for the small and large smolts, respectively. Rapid River stock Chinook salmon juveniles were reared in seven raceways. To evaluate exercise during pre-smolt rearing on post-smolt performance, we marked four Rapid River raceways with unique CWT codes (Table 3). The release size target for all smolts was 22.7 g and mean size at release ranged from 20.4-23.3 g. All smolts were released directly into Lookingglass Creek on 7 April 1997.

We monitored smolt migration performance by measuring the percentage of each PIT-tagged group detected at mainstem dams on the Columbia and Snake rivers (Table 3). Detection rates for the Rapid River salmon (26.0%) were similar to rates for the Imnaha salmon (26.4%).

1998

Egg-to-smolt survival rate for 1996 cohort of Imnaha River Chinook salmon parr was high (84.5%) but low (65.4%) for the Rapid River salmon (Table 4). The smolt production goal for the 1996 brood Rapid River Chinook salmon was set at 490,000. The release of 302,145 1996 cohort smolts was below the modified production goal and was a result of poor returns of Rapid River stock adults in 1996. The release of 93,127 smolts from the 1996 Imnaha River cohort was far below the mitigation goal of 490,000, also the result of a poor 1996 return, as well as broodstock collection strategies that placed a significant proportion of trapped hatchery and natural salmon above the weir to spawn naturally. We attempted to mark 100% of the 1996 cohort Imnaha and River Rapid River stock smolts with Ad-RV+CWT. We had a poor mark rate with the RV clip, as we achieved clip rates of only 93.3% and 88.0%, respectively (Table 5).

The 1996 cohort Imnaha Chinook salmon were reared in seven raceways at Lookingglass Fish Hatchery. To evaluate the influence of rearing density and size at release on smolt-to-adult survival, we marked all seven raceways with unique CWT codes. All Imnaha River Chinook

salmon smolts were acclimated at the Imnaha Facility and released on 6 April 1998 (Table 6). Rapid River Chinook salmon were reared in ten raceways at rearing densities of about 50% of normal past practices. All Rapid River stock smolts were released from Lookingglass Fish Hatchery on 6 April 1998. Smolt migration success was monitored based on PIT-tag observations at mainstem dams. We observed higher migration rates for the 1996 cohort than we observed for the 1995 cohort (Table 6).

Adults

1997

The Imnaha weir was installed on 3 July 1997, later than the target date of 15 June, and fished until 10 September (Table 7). We retained 60% of the trapped adults (149 hatchery and 23 natural) for hatchery broodstock and released 40% (55 hatchery and 61 natural) above the weir to spawn naturally (Table 8).

We determined age structure of the Imnaha returns based on CWT age, scale age and length-at-age relationships (Figure 1; Table 8). Both hatchery and natural origin salmon had a low proportion of age 3 males recovered. Prespawn mortality for Imnaha Chinook salmon held at Lookingglass Fish Hatchery was 30%. We spawned a total of 57 females (50 hatchery and 7 natural) with 54 hatchery and 8 natural males. We collected 282,823 eggs, which was well below the egg-taking goal of 494,000 green eggs (Table 9). Eggs collected in 1997 were incubated at LFH.

In 1997, we continued trapping Lookingglass-produced Rapid River Chinook salmon at Lower Granite Dam to reduce straying in the Grande Ronde Basin. A total of 741 Ad-RV+CWT Chinook salmon were collected at Lower Granite Dam and transported to Lookingglass Fish Hatchery (Table 8). In addition, we trapped 26 Rapid River and 94 natural Chinook salmon at Lookingglass Fish Hatchery and released 76 salmon (all naturally-produced) above the hatchery to spawn. Prespawning mortality for marked salmon at LFH was 18% and we spawned 102 females. We transferred 282 marked adults to Idaho and 202 adults were killed-but-not-spawned. Only hatchery salmon were spawned and we collected a total of 412,355 eggs from the Rapid River stock, all of which were incubated at Lookingglass Fish Hatchery. Mean egg mortality rate to shocking was 19% (Table 9). We determined age structure of Rapid River returns based on CWT age, scale age and length-at-age. Only 0.8% and 0% of the hatchery and natural adults, respectively, were age 3. (Figure 2).

1998

The Imnaha River weir was installed on 6 July in 1998, well after the target date of 15 June, and operated until 16 September (Table 10). We trapped a total of 115 hatchery and 150 naturally-produced salmon and retained 51% for broodstock: 57 hatchery and 77 natural (Table 11). The remaining 131 adults were released above the weir to spawn naturally. Age structure was determined from CWT age, scale age and length-at-age relationships (Figure 3). Age 3 hatchery males were the dominant age group, comprising 26.0% of the total return and 42% of the total males that returned. Prespawn mortality of combined hatchery and natural Imnaha River Chinook salmon held at LFH was 20%. We spawned 15 hatchery and 27 natural females with 39 hatchery and 31 natural males. We collected 308,472 eggs, which was well below our goal of 576,500 green eggs (Table 12). The mortality to shocking was very high (74.8%). Imnaha eggs collected in 1998 were incubated at Lookingglass Fish Hatchery.

In 1998 we trapped Rapid River stock Chinook salmon at Lower Granite Dam and at Lookingglass Fish Hatchery. A total of 212 Ad-RV+CWT marked Chinook salmon were collected at Lower Granite Dam and transported to Lookingglass and Wallowa fish hatcheries and 7 Rapid River and 57 natural salmon were trapped at Lookingglass Hatchery (Table 11). We kept 276 salmon for broodstock and prespawn mortality was 22%. We spawned 17 natural females and 95 hatchery females with 12 natural and 81 hatchery males. We collected a total of 74,740 eggs; 8,138 from hatchery x natural crosses and 66,602 eggs from natural x natural crosses and survival to the eyed stage was high, 90.2% (Table 12). Eggs from hatchery parents were transported to Irrigon Fish Hatchery for incubation and early rearing and eggs from natural parents were incubated at Lookingglass Fish Hatchery.

At the Catherine Creek weir, 28 natural Chinook salmon were captured, 13 females and 15 males, and all were released above the weir to spawn naturally (Table 11). At the Grande Ronde River weir, 33 salmon were captured, 20 females and 13 males. All were released above the weir, except for four, which died prior to release. The Lostine River weir captured 23 adult Chinook salmon, 11 females and 12 males. There was 1 mortality and the remaining 22 were released above the weir to spawn naturally. No stray hatchery Chinook salmon were captured at these weirs.

Coded-Wire Tag Recoveries

Adult returns and fisheries recoveries from experimental groups of each stock of Chinook salmon are used to evaluate hatchery treatments and to assess the success of achieving mitigation goals and management objectives. We mark all experimental and most production groups with coded-wire tags to provide basic information on survival, harvest, escapement and straying and specific information on experimental results. We summarized the number of recoveries of each CWT code from the Regional Mark Information system (RMIS) CWT recovery database maintained by the Pacific States Marine Fisheries Commission. To account for hatchery salmon that spawn in nature, we develop expansion factors as described in Carmichael et al (1994).

1997

We estimate that 189 Imnaha River CWT salmon were recovered in 1997 (Table 13). A total of 167 adults were recovered at the Imnaha River weir, most of which (163) came from the 1993 cohort, in which we are evaluating the effect of acclimation vs. direct stream release and size at release. No marked Imnaha River adults were captured elsewhere in the Snake River Basin and only 22 adults were captured outside the Snake River Basin, two in the Columbia River and 20 in the Deschutes River.

We estimate that 492 Rapid River Chinook salmon released from Lookingglass Fish Hatchery were captured in 1997 (Table 14). Most (446) were captured at Lower Granite Dam and transported to Lookingglass Fish Hatchery. The 1992 cohort was largely production but was also used to evaluate rearing density – we captured 60 of those salmon at Lower Granite Dam and eight were recovered outside of the Snake River Basin. A total of 422 adults from the 1993 cohort of Rapid River salmon were captured, which was all production, 384 at Lower Granite Dam, five elsewhere in the Snake River Basin (all in the Grande Ronde River Basin) and 32 outside of the basin. The 1996 cohort was used to evaluate presmolt exercise and two were captured, both at Lower Granite Dam. A total of 39 adults were captured outside the Snake

River Basin, including 20 in the Deschutes River, eight in ocean fisheries and six in the lower Columbia River.

1998

We estimate that we captured 118 of the 1993-1995 cohorts of hatchery-reared Imnaha River Chinook salmon in 1998 (Table 15). We trapped 104 at the Imnaha River weir, 54 from the 1993 cohort (acclimated vs. direct stream release and size at release evaluations), 13 from the 1994 cohort (size at release) and 37 from the 1995 cohort (size at release). Fourteen marked Imnaha River salmon were captured outside of the Snake River Basin in 1998, 13 in the Deschutes River (all 1993 cohort) and one at Carson National Fish Hatchery (1995 cohort).

In 1998, we recovered 216 of the 1993-1995 cohorts of Rapid River Chinook salmon released from Lookingglass Fish Hatchery. Of those, 188 were captured at Lower Granite Dam and transported to Lookingglass Fish Hatchery, 21 were captured at the LFH weir, one was captured elsewhere in the Snake River Basin (Wenaha River in the Grande Ronde Basin) and six outside of the Snake River Basin (all in the Bonneville Pool). The 1993 cohort (production) contributed 150 of the 1998 recoveries, 42 came from the 1994 cohort (presmolt exercise) and 24 from the 1995 cohort (presmolt exercise).

Compensation Goals

Nearly all of the CWT recoveries for hatchery Chinook salmon that were released in the Grande Ronde and Imnaha basins occurred in the Snake River basin (Table 17). The total number of hatchery produced salmon for each stock that are recovered in fisheries, escape to the stream of release or stray within or outside the Snake River basin can be estimated based on recoveries of CWT fish and expansions for non-CWT salmon. To calculate the return to the LSRCP Compensation Area, which is defined as the Snake River basin above Ice Harbor Dam, we summed all expanded recoveries for the 1997 return year that occurred above Ice Harbor Dam.

1997

We did not reach the compensation goal for either the Imnaha or Grande Ronde basins in 1997 (Table 17). We estimated that we only achieved 11.3% of our goal for the Imnaha Basin and 16.4% for the Grande Ronde Basin. Two factors contributed to the poor returns in 1997. Smolt production for the 1992 and 1993 cohorts of Imnaha River Chinook salmon were at or below 30% of the production goal. However, poor smolt-to-adult survival was the primary factor causing the poor returns for both stocks and particularly the 1994 cohort.

The Imnaha supplementation evaluation program provides information to evaluate the replacement rates (progeny-to-parent ratios) of the hatchery and natural populations. The hatchery component progeny-to-parent ratio for the 1992 cohort was very low (0.64). The ratio for the 1992 cohort natural spawning population was also low (0.48) and represented the ninth consecutive year that the naturally spawning salmon did not replace themselves (Figure 5). One of the primary objectives of the Imnaha hatchery program is to enhance natural production. However, because replacement rates have been below 1.0 for nine consecutive years, we have seen a steady decline in the number of naturally produced salmon that return to the basin (Figure 6).

1998

We did not reach the compensation goal in 1998 for either the Imnaha or Grande Ronde basins (Table 18). We estimated that we reached 6.5% of the goal for the Imnaha Basin and 9.1% of the goal for the Grande Ronde Basin (Table 18). Similar to 1997 the two primary factors causing low returns were poor smolt-to-adult survival and smolt releases that were below the goal.

The progeny-to-parent ratio for the salmon that spawned naturally in 1993 was 0.25, below the mean value since the 1982 and well below replacement (Figure 5). This represented the tenth year in a row that productivity has been well below replacement. The parent-to-progeny ratio for the hatchery component was 2.55, much better than for naturally spawning salmon and above replacement. The number of natural salmon that returned to the basin was slightly higher than 1997, but was well below levels observed in the early 1990s (Figure 6).

Natural Escapement Monitoring

Stream surveys to enumerate Chinook salmon redds and to sample salmon carcasses were conducted as in previous years (see Keefe et al 1994). We surveyed four streams in the Imnaha River Basin and nine in the Grande Ronde Basin.

1997

During the 1997 surveys, we counted a total of 286 redds and recovered 166 carcasses in the Imnaha Basin (Table 19). All marked hatchery salmon recovered were Imnaha hatchery fish, thus no out-of-basin strays were observed. Marked salmon comprised 65.1% of the recovered carcasses. In the Grande Ronde River Basin, we observed 301 redds and recovered 233 carcasses. We recovered four stray hatchery salmon on the spawning grounds: two in each of the Minam and Wenaha rivers and all had been released from Lookingglass Hatchery in 1993 (Table 20). Marked hatchery strays comprised 1.7% of the carcasses recovered on spawning grounds in the Grande Ronde Basin. We continue to observe fewer marked hatchery salmon in the Grande Ronde Basin, which is a result of trapping Lookingglass destined hatchery salmon at Lower Granite Dam. Age composition of the carcass recoveries was similar between basins, with each having 83% age 4 salmon and a low percentage of age 3 salmon (Table 21).

1998

In 1998, we counted a total of 157 redds and recovered 93 carcasses in the Imnaha Basin (Table 22). All marked hatchery salmon recovered were Imnaha hatchery fish, thus no out-of-basin strays were observed but we did recover one tagged adult in Lick Creek that was released from the Imnaha River Acclimation Site (Table 23). Marked salmon comprised 51.6% of the recovered carcasses. In the Grande Ronde Basin in 1998, we observed a total of 253 redds and recovered 184 carcasses on the spawning grounds. We recovered two marked hatchery strays in the Grande Ronde Basin in 1998. There was one stray in the Wenaha River that came from Lookingglass Fish hatchery and one stray in the Wallowa River that came from Trinity River Fish Hatchery, California. Hatchery strays comprised 1.1% of the total carcasses recovered. Age composition of the carcass recoveries was similar between basins (Table 24). The 1993 cohort appears to have been a strong one, with the majority of the recovered carcasses (67.1% in the Grande Ronde Basin and 70.6% in the Imnaha Basin) being age 5. Approximately 30% of the carcasses recovered in each basin were age 4 salmon and 2% age 3.

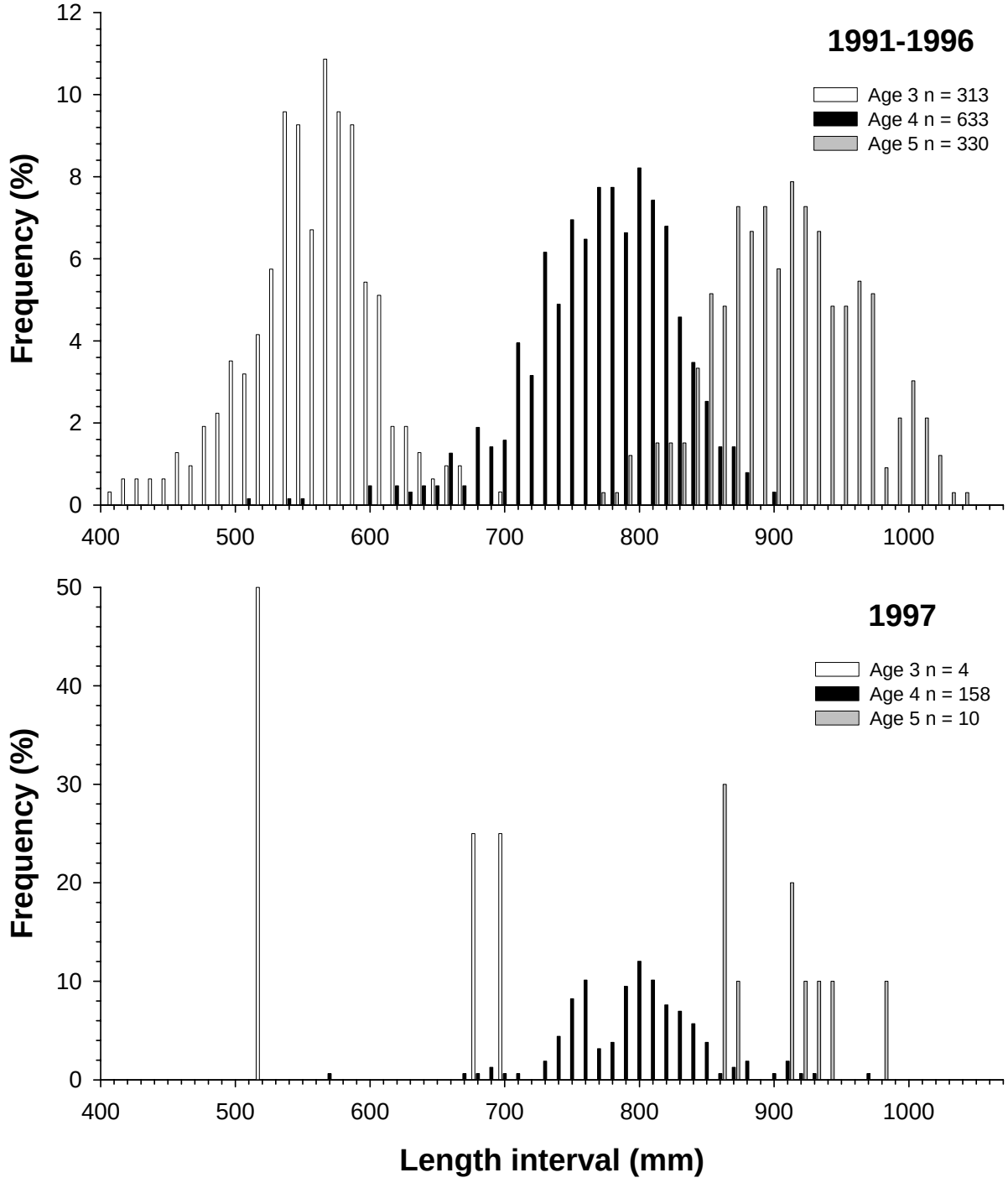

Figure 1. Length frequency-at-age relationship for Imnaha River Chinook salmon adults (hatchery and natural) used as hatchery broodstock in 1991-1996 (top) and in 1997 (bottom).

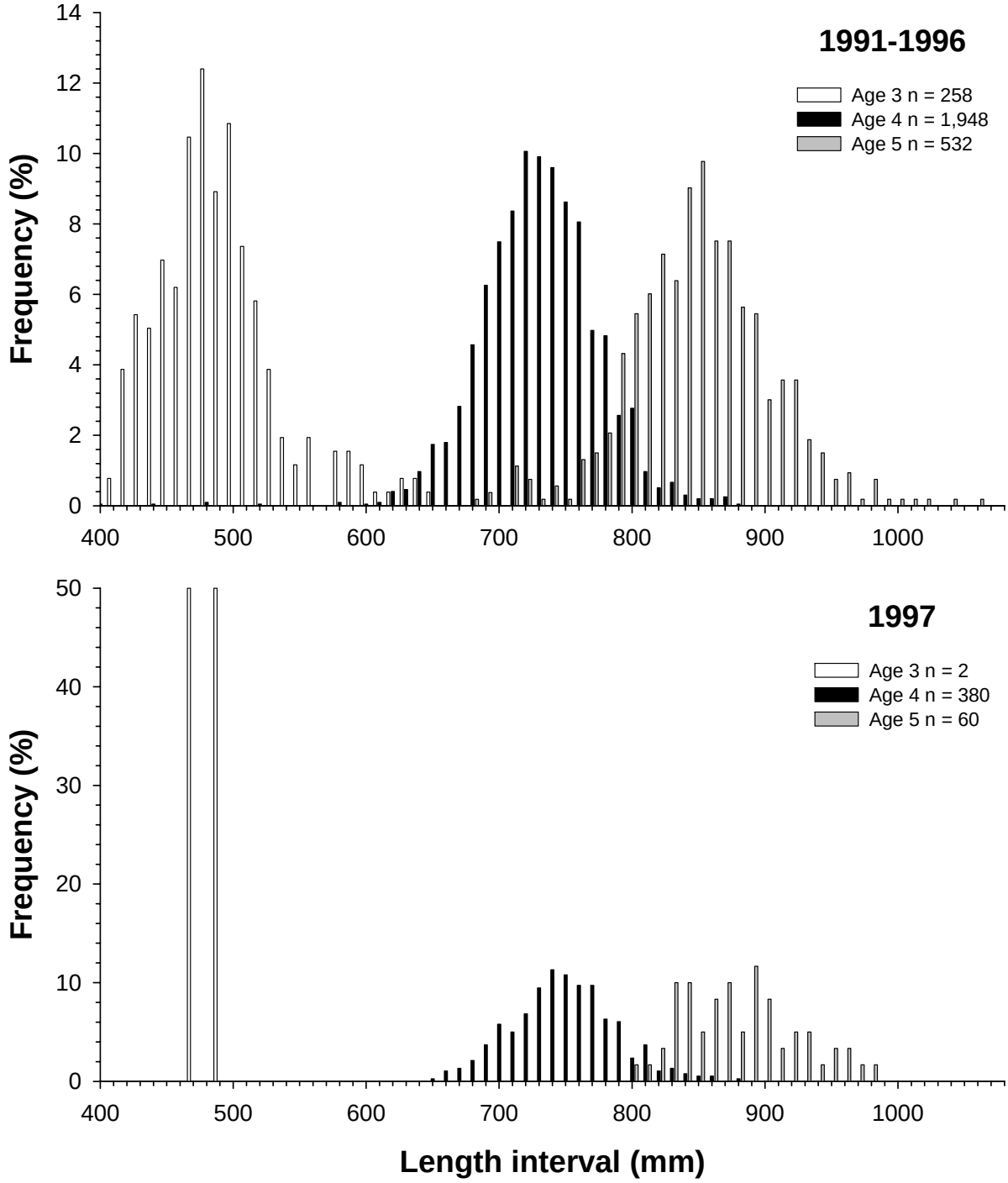

Figure 2. Length frequency-at-age relationship for Rapid River stock Chinook salmon adults used as hatchery broodstock in 1991-1996 (top) and in 1997 (bottom).

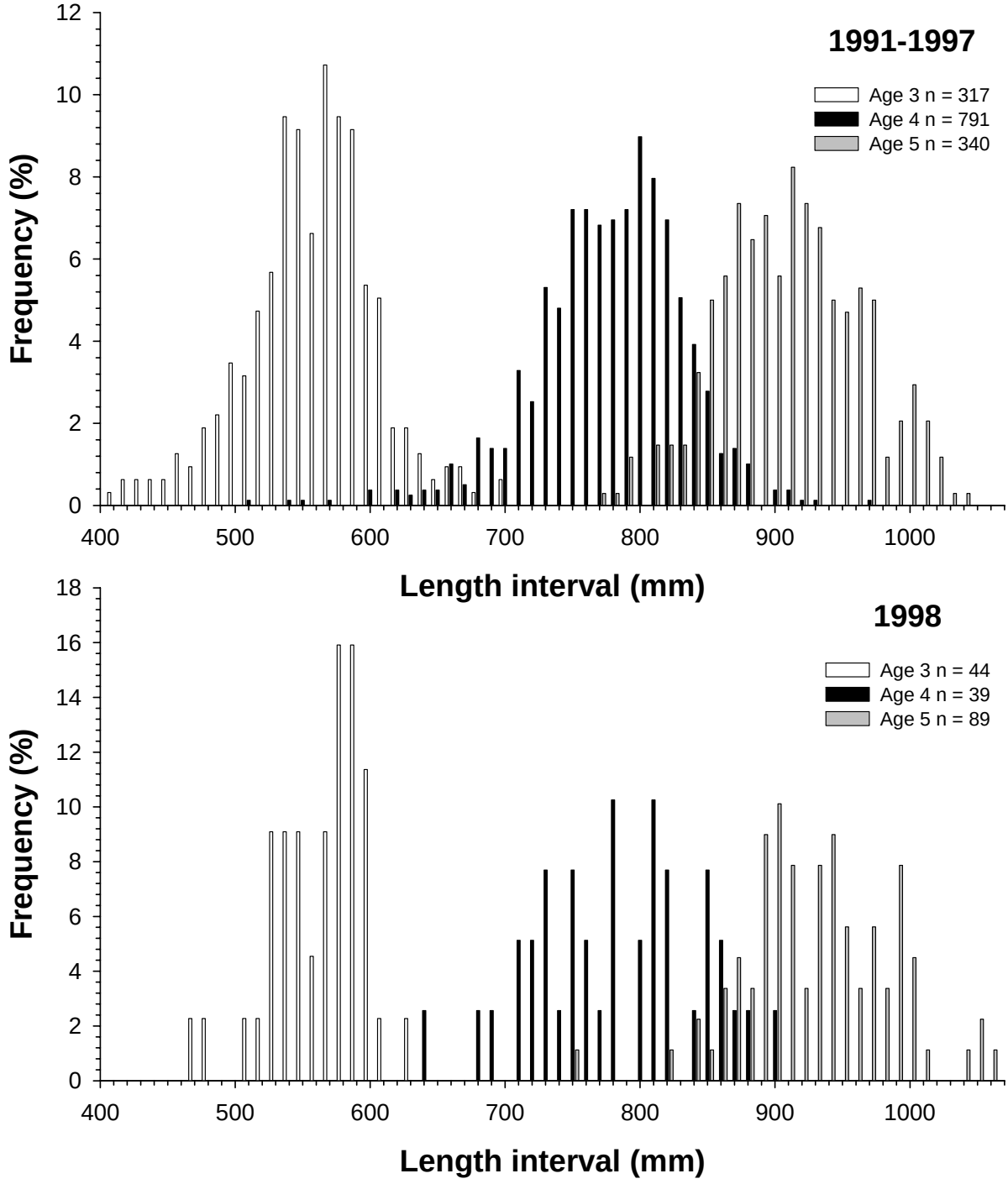

Figure 3. Length frequency-at-age relationship for Imnaha River Chinook salmon adults (hatchery and natural) used as hatchery broodstock in 1991-1997 (top) and in 1998 (bottom).

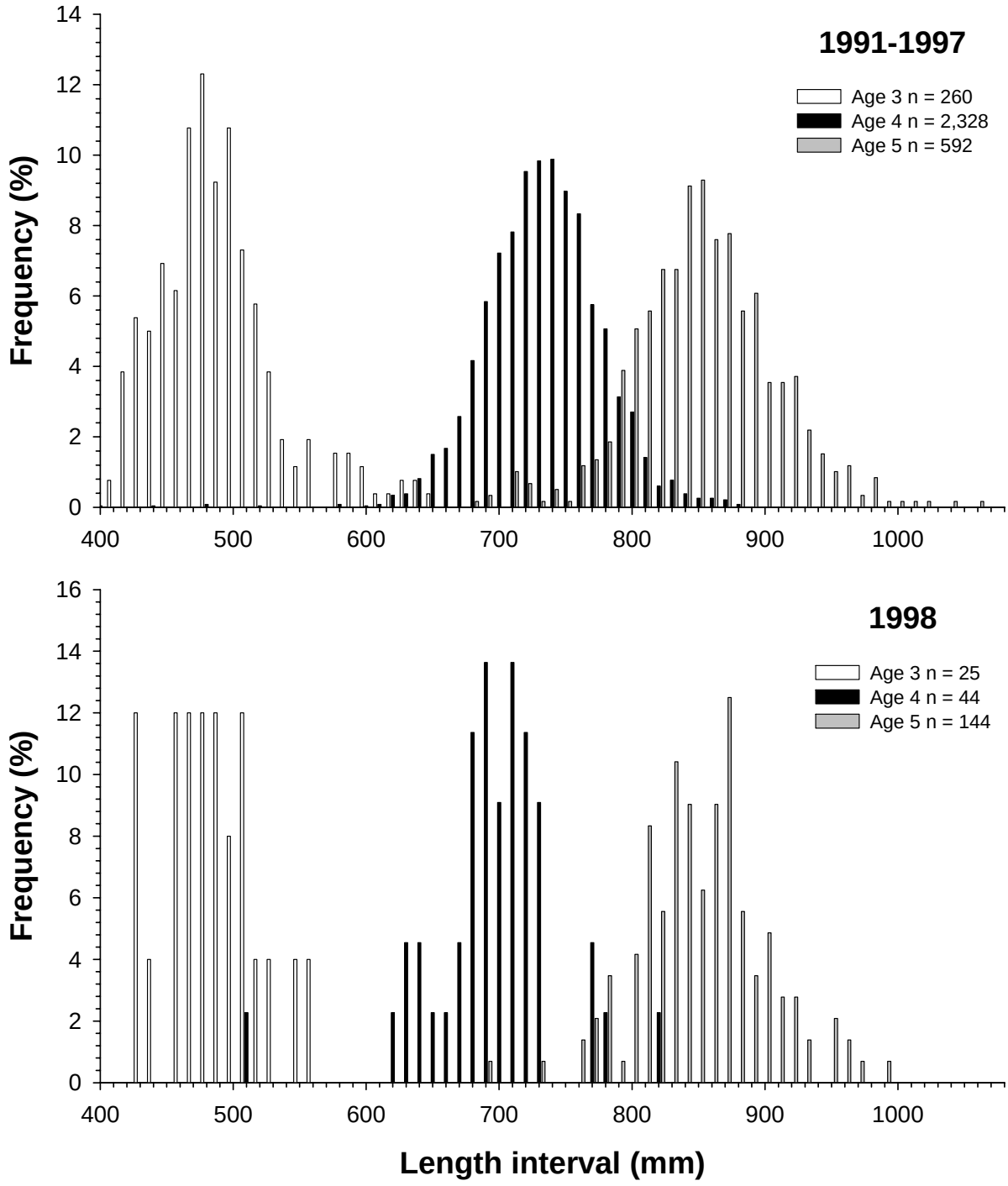

Figure 4. Length frequency-at-age relationship for Rapid River stock Chinook salmon adults used as hatchery broodstock in 1991-1997 (top) and in 1998 (bottom).

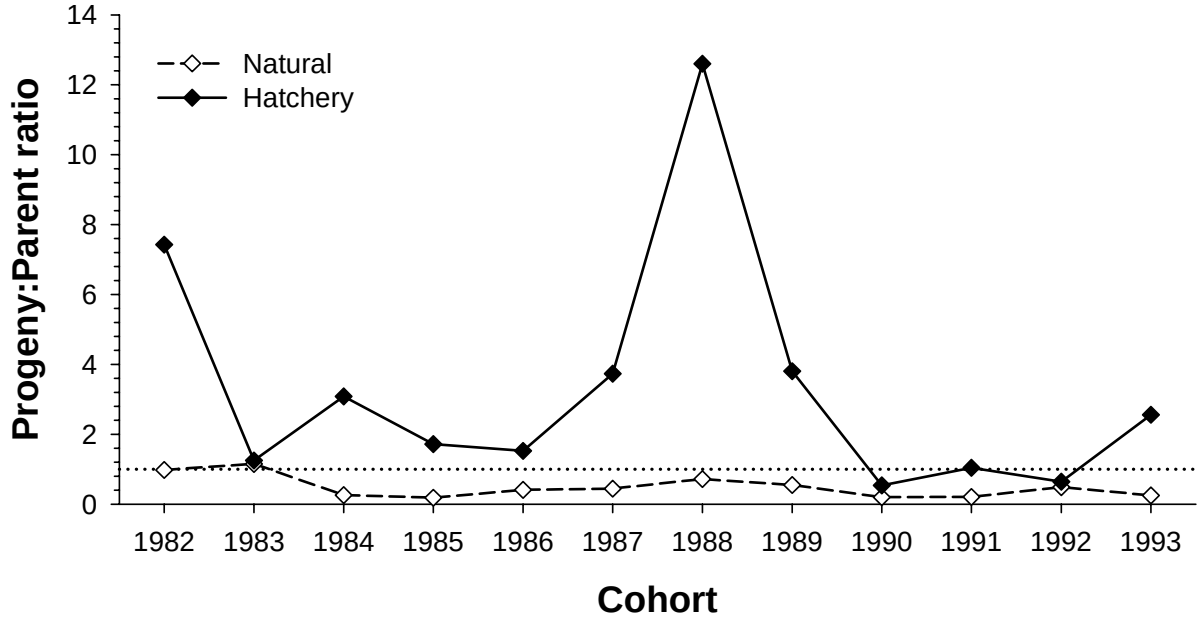

Figure 5. Progeny-to-parent ratios for completed brood years (1982-1993) of Imnaha River Chinook salmon.

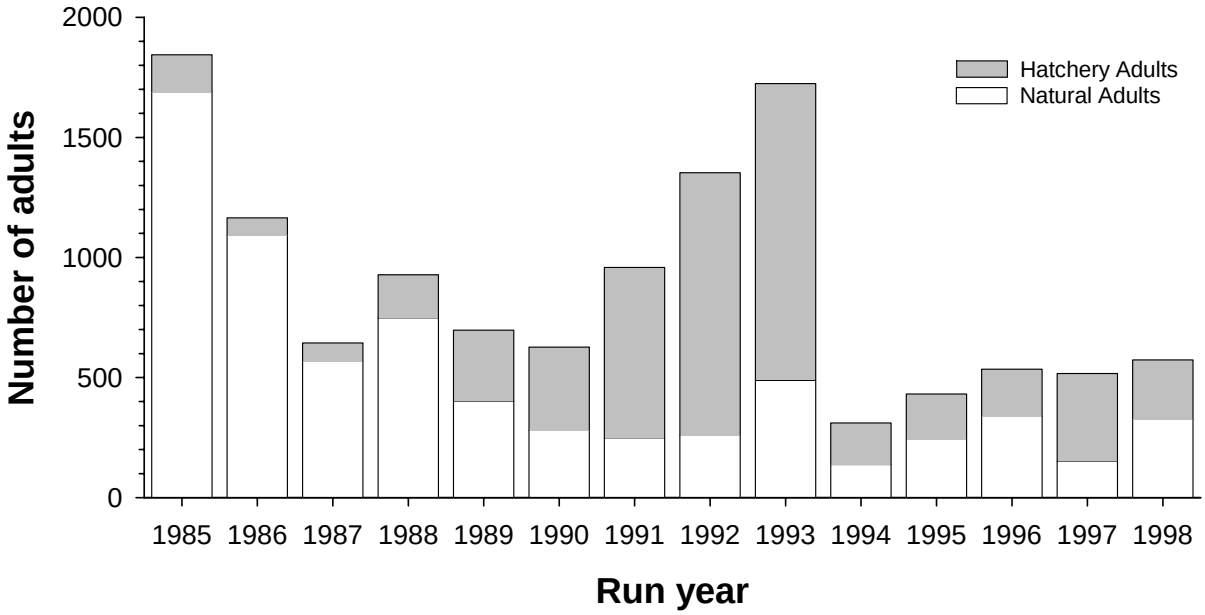

Figure 6. Estimated numbers of natural- and hatchery-origin Chinook salmon that returned to the Imnaha River, 1985-1998.

Table 1. Rearing summaries for juvenile spring Chinook salmon from the 1995 cohort released in the Grande Ronde and Imnaha river basins in 1997.

Stock	Green eggs	Eyed eggs	Estimated Survival Rate (%)		Total fish released [a]
			Egg to embryo	Embryo to smolt	
Imnaha River	68,121	57,070	83.8%	89.2%	50,911
Rapid River	209,357	198,924	95.0%	91.3% [b]	153,478[b]

[a] *Includes all salmon released (adipose clipped and coded-wire tagged plus unrecognizable marks, target 100% marked, see Table 2).*

[b] *Does not include 30,880 salmon released as pre-smolts on 25 July 1996.*

Table 2. Estimates of percent fin clip and coded-wire tag application success for 1995 cohort spring Chinook salmon reared at Lookingglass Fish Hatchery and released in 1997. Release group indicates rearing density, experimental treatment and raceway number. Imnaha River target was 100% AD with CWT, Rapid River stock target was 100% ADRV with CWT.

Release group, raceway	Number checked	Ad clip with CWT	Ad clip, no CWT	No Ad clip with CWT	No Ad clip, no CWT	RV clip	No RV clip
			Imnaha River				
Acclimated, 7	297	96.6	2.7	0.7	0	-	-
Acclimated, 6	322	98.4	1.6	0	0	-	-
Acclimated, 3	301	99.3	0.3	0.3	0	-	-
Acclimated, 4	318	95.6	2.5	1.6	0.3	-	-
Acclimated, 4	357	98.9	0.6	0.6	0	-	-
Total / mean	1,595	97.8	1.5	0.6	0.1	-	-
			Rapid River				
Pre-smolt, 8, 9, 10	449	94.9	2.2	2.2	0.7	-	-
Control, 17	301	96.3	2.3	1.3	0	88.4	11.6
Control, 16	333	96.1	3.6	0.3	0	82.9	17.1
Exercise, 14	337	95.3	2.4	2.4	0	77.4	22.6
Exercise, 15	302	95.4	1.7	3	0	83.8	16.2
Total / mean	1,722	95.6	2.4	1.8	0.1	83.1	16.9

Table 3. Details of experimental groups of 1995 cohort spring Chinook salmon released in the Grande Ronde and Imnaha river basins in 1997. Experimental group indicates rearing density, experimental treatment and rearing raceway number.

Stock, experimental group	Mean weight (g)	Release date	Release location	CWT code	Fork length (mm)		Weight (g)		Condition factor		Total released [a]	Number PIT-tagged	Percent of PIT tags detected [b]
					Mean	SD	Mean	SD	Mean	SD			
Imnaha River													
2.6 g/L, 18 g	21.9	7 APR 97	Imnaha weir	91722	123	7	22.6	3.8	1.2	0.06	12,749	3489	27.2
3.7 g/L, 18 g	19.7	7 APR 97	Imnaha weir	91723	118	6	20.1	2.8	1.17	0.11	15,858	5,385	25
				91719[c]							4,925		
2.7 g/L, 30 g	29.9	7 APR 97	Imnaha weir	91721	133	7	30.7	5.1	1.26	0.06	9,742	2,771	28
1.9 g/L, 30 g	32.2	7 APR 97	Imnaha weir	91720	136	9	32.9	5	1.29	0.07	6,390	1,772	26.8
Unrecognizable marks											1,248		
Total smolts released											50,911	13,417	
Rapid River													
Exercise	20.2	7 APR 97	LFH	91726	125	8	21.3	4.3	1.08	0.08	36,172	9,758	25.7
Control	21.8	7 APR 97	LFH	91727	122	8	22.5	4.1	1.19	0.09	37,156	9,883	25.4
Exercise	21.9	7 APR 97	LFH	91725	125	9.0	23.2	5.5	1.12	0.1	36310.0	10,020	26.5
Control	22.7	7 APR 97	LFH	91724	127	7	23.3	3.9	1.15	0.08	37,340	10,138	26.2
Unrecognizable marks											6,500		
Total smolts released											153,478	39,799	
Parr released		25 JUL 96										30,880	

[a] *Equals total number released in Table 1 by stock. Total released includes all salmon with adipose clip and CWT (target 100%) plus an additional 6,500 Rapid River stock and 1,248 Imnaha River salmon were released without recognizable marks.*

[b] *Includes unique detections at all dams in the Snake and Columbia rivers.*

[c] *Two coded wire tag codes were ponded together.*

Table 4. Rearing summaries for juvenile spring Chinook salmon from the 1996 cohort released in the Grande Ronde and Imnaha river basins in 1998.

			Percent Survival		
Stock	Green eggs	Eyed eggs	Egg to embryo	Embryo to smolt	Total salmon released
Imnaha River	110,146	103,125	93.6	90.3	93,127
Rapid River	686,204 [a]	635,124	92.6 [b]	65.4	302,145

[a] *Does not include 20,000 eggs destroyed due to high BKD.*

[b] *Includes 173,183 eyed eggs that were shipped to Idaho Fish and Game.*

Table 5. Estimates of percent fin clip and coded-wire tag application success for 1996 brood year spring Chinook salmon reared at Lookingglass Fish Hatchery and released in 1998. Release group indicates rearing density, experimental treatment and raceway number. Imnaha River target was 100% AD with CWT and Rapid River stock target was 100% ADRV with CWT.

Stock, raceway	Number checked	Ad Clip with CWT	Ad clip, no wire	No Ad clip with CWT	No Ad clip, no CWT	RV Clip	No RV Clip
Imnaha River							
1	315	94.6	1.6	3.5	0.3		
2	394	90.4	2.0	6.3	1.5		
3	336	94.0	3.3	2.1	0.6		
4	327	94.8	2.8	1.8	0.6		
5	315	94.6	1.6	3.5	0.3		
6	394	90.4	2.0	6.3	1.3		
7	336	94.0	3.3	2.1	0.6		
Total / mean	2,417	93.3	2.4	3.7	0.7		
Rapid River							
9	301	95.0	1.7	2.3	1.0		
10	389	94.1	5.1	0.8	0.0		
11	308	97.7	0.6	1.6	0.0	86.4	13.6
12	308	91.2	6.5	1.9	0.3	92.5	7.5
13	325	84.3	14.5	0.9	0.3	96	4
14	357	90.2	3.9	3.9	2.0	81.5	18.5
15	326	92.0	5.5	2.1	0.3	NA	NA
16	325	96.0	1.2	2.8	0.0	85.8	14.2
17	301	97.7	0	2.3	0.0	90.7	9.3
18	358	88.0	10.9	0.8	0.3	92.7	7.3
Total / mean	3,298	92.6	5.0	1.9	0.4	89.4	10.6

Table 6. Details of experimental groups of 1996 cohort spring Chinook salmon released in the Grande Ronde and Imnaha river basins in 1998.

Stock, raceway	Mean weight (g)	Release date	Release location	CWT code	Fork length (mm)		Weight (g)		Condition factor		Total salmon released [a]	Number PIT-tagged	Percent PIT tags detected [b]
					Mean	SD	Mean	SD	Mean	SD			
Imnaha River													
1	27.7	6 Apr 98	Imnaha Weir	92163	135	9	29.3	6.1	1.18		6,997	1,504	92.8
2	29.5	6 Apr 98	Imnaha Weir	92203	133	8	30.2	6.2	1.21		14,022	3,012	60.7
3	31.3	6 Apr 98	Imnaha Weir	92204	132	7	31.7	4.1	1.31		12,366	3,039	60.5
4	31.3	6 Apr 98	Imnaha Weir	92124	132	7	31.7	4.1	1.31		1,805		
5	19.6	6 Apr 98	Imnaha Weir	92201	121	5	19.9	2.5	1.1		9,494	2,029	58
6	19.6	6 Apr 98	Imnaha Weir	92205	120	6	20	2.7	1.1		19,056	3,973	57.8
7	19.1	6 Apr 98	Imnaha Weir	92202	121	6	19.6	3.2	1.12		9,513	2,047	57.5
8	19.4	6 Apr 98	Imnaha Weir	92206	118	6	19.9	3	1.13		19,874	4,223	56.4
Total released											93,127	19,827	
Rapid River													
9	10.8	6 Apr 98	LFH	92207	99	8	11.3	2.3	1.13	0.08	51,131	534	49.1
10	23.5	6 Apr 98	LFH	92208	127	7	24.1	4	1.16	0.05	17,893	538	53.3
11	25.8	6 Apr 98	LFH	90009	132	13	28.4	9	1.19	0.13	12,760	507	64.7
12	26.2	6 Apr 98	LFH	92210	132	12	28.3	8.8	1.14	0.06	28,163	0	
13	26.7	6 Apr 98	LFH	92212	130	8	27.6	5.3	1.18	0.07	27,919	0	
14	23.4	6 Apr 98	LFH	75309	127	11	24.8	6.2	1.18	0.08	31,880	0	
15	24.9	6 Apr 98	LFH	75310							34,747	33,905	61.2
16	24.9	6 Apr 98	LFH	75311	128	10	26.3	6.8	1.13	0.05	33,216	8,749	54.4
17	23.2	6 Apr 98	LFH	75850	127	8	23.9	4.2	1.13	0.06	33,430	0	
18	25.2	6 Apr 98	LFH	92211	129	11	26.6	6.3	1.2	0.08	31,006	0	
Total released											302,145	44,233	

[a] *Equals total number released in Table 1 by stock. Total released includes all salmon with adipose clip and CWT (target 100%).*

[b] *Percent PIT tag detections are unique detections at all dams in the Snake and Columbia Rivers.*

Table 7. Number of adult Imnaha River, Rapid River, Lostine River, Catherine Creek and Grande Ronde River spring Chinook salmon trapped at LSRCP trapping facilities during each week of operation in 1997. Note: The Imnaha River weir was operational from 3 July through 10 September and the Lookingglass Creek weir was operational from 22 May through 15 September.

					Rapid River Stock						
		Imnaha River			Lookingglass Weir		Lower Granite Dam [a]	Lostine River		Catherine Creek	Grande Ronde River
Period	Week of year	Marked	Marked H x H [b]	Un-marked [c]	Marked [d]	Un-marked	Ad RV	Marked	Un-marked	Un-marked	Un-marked
9-15 Apr	15				0	0	1				
16-22 Apr	16				0	0	1				
23-29 Apr	17				0	0	3				
30 Apr – 6 May	18				0	0	30				
7-13 May	19				0	0	161				
14-20 May	20				0	0	60				
21-27 May	21				0	0	126				
28 May – 3 Jun	22				0	0	153				
4-10 Jun	23				1	2	74				
11-17 Jun	24				13	41	59				
18-24 Jun	25				0	9	53				4
25 Jun – 1 Jul	26				10	20	12				4
2-8 Jul	27	18	4	6	2	1	5				1
9-15 Jul	28	7	39	3	2	6	2			0	0
16-22 Jul	29	28	66	23	0	5	1	0	2	1	0
23-29 Jul	30	39	20	10	0	0	0	0	0	1	0
30 Jul –5 Aug	31	30	12	5	0	2	0	1	4	0	0
6- 12 Aug	32	26	23	13	0	0		0	3	0	0
13-19 Aug	33	26	15	9	0	0		0	4	0	0
20-26 Aug	34	24	15	11	0	0		0	1	0	0
27 Aug – 2	35	3	4	1	0	0		0	5	0	0

Sep											
3-9 Sep	36	3		0	0	2		1	3	0	0
10-16 Sep	37			0	0	1		0	1		
17-23 Sep	38							0	2		
24-30 Sep	39							0	0		
31 Sep- 7 Oct	40							0	0		
Total		204	198	81	28	89	741	2	25	2	9

[a] *Fish trapped at Lower Granite Dam were Rapid River stock chinook salmon released in Lookingglass Creek and identified at Lower Granite Dam by AdRV fin-clips. Fish trapped at Lookingglass Fish Hatchery were Rapid River stock salmon that were either unmarked, mismarked with an adipose clip only or were missed at the Lower Granite Dam trap.*

[b] *H x H = hatchery x hatchery crosses.*

[c] *Unmarked includes unmarked Hatchery fish.*

[d] *Two Rapid River stock salmon collected at the Lookingglass weir were called marked at collection and unmarked at spawning. They are included here as marked and in Table 8 as unmarked.*

Table 8. Numbers of adult spring Chinook salmon that returned to LSRCP facilities in northeast Oregon, by origin, age and sex, 1997.

	Hatchery							Natural							
	3		4		5			3		4		5			Grand
Stream, disposition	F	M	F	M	F	M	Total	F	M	F	M	F	M	Total	total
Imnaha River															
Trapped	0	4	89	107	4	0	204	0	3	26	33	15	7	84	288
Passed	0	0	24	30	1	0	55	0	2 [a]	19	24 [a]	11	5	61	119
Outplanted [b]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kept	0	4	65	77	3	0	149	0	1	7	9	4	2	23	172
Actual spawned	0	2	49	52	1	0	104	0	1	4	6	3	1	15	119
Killed, not spawned	0	1	0	0	0	0	1	0	0	0	0	0	0	0	1
Pre-spawn mortality	0	1	16	25	2	0	44	0	0	3	3	1	1	8	52
Mean length (mm) [c]	-	570	791	788	858	-		-	700	828	824	903	956		
Standard deviation (mm)	-	92	33	50	3	-		-	-	63	78	25	35		
Age composition (%)	0	2.0	43.6	52.5	2.0	0	70.8	0	3.6	31	39.3	17.9	8.3	29.2	
Rapid River															
Total trapped	0	6	343	337	40	41	767	0	0	38	28	6	22	94	861
Trapped at LG Dam	0	6	331	325	39	40	741	0	0	0	0	0	0	0	741
Trapped at LFH	0	0	12	12	1	1	26	0	0	38	28	6	22	94	120
Passed	0	0	0	0	0	0	0	0	0	27	26	4	19	76	76
Outplanted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Transferred to Idaho	0	4	135	127	6	10	282	0	0	0	0	0	0	0	282
Kept	0	2	208	210	34	31	485	0	0	11	2	2	3	18	503
Actual spawned	0	1	86	91	16	11	205	0	0	0	0	0	0	0	205
Killed-not spawned [d]	0	0	91	87	7	17	202	0	0	2	1	0	1	4	206
Pre-spawn mortality	0	1	31	32	11	3	78	0	0	9	1	2	2	14	92
Mean length (mm) [c]	-	449	736	751	865	893		-	-	746	782	844	891		
Standard deviation (mm)	-	42	42	44	42	50		-	-	43	70	56	43		

Age composition (%)	0	0.8	44.7	43.9	5.2	5.3	89.1	0	0	40.4	29.8	6.4	23.4	10.9

[a] *One natural 3 year old and six natural four year old males that were passed above the Imnaha weir had sperm samples taken that were used to fertilize eggs at Lookingglass Fish Hatchery. They are included here as passed fish.*

[b] *AdLV, LV or Ad no CWT four year old salmon trapped at the Imnaha weir in 1997 were progeny of hatchery x hatchery crosses that were kept separate from the normal LSRCP production during early rearing and release. Five of these salmon were collected and spawned and one was passed above the weir. These five salmon are reported in this table. An additional 187 were collected and outplanted to Big Sheep and Lick Creeks, one was killed – not spawned and four were mortalities before they could be outplanted. These 192 salmon are not included in this table.*

[c] *Mean length per age class determined from known age salmon based on either CWT or scale data.*

[d] *Includes 127 salmon killed and distributed to tribal members for consumption, 34 salmon killed for research purposes as well as 45 salmon "killed-not spawned."*

Table 9. Timing of spawning and spawning summaries for spring Chinook salmon at Lookingglass Fish Hatchery, 1997.

Stock, date	Hatchery spawn code	Origin of parents	Number of parents		Number of eggs taken	Percent mortality to shocking [b]
			Female	Male [a]		
Imnaha River						
15 August	194	Both	4	4	19,357	24
22 August	195	Hatchery	4	4	98,141	24
		Both	16	14		
29 August	196	Hatchery	9	26	127,678	33
		Both	17	14		
3 September	197	Hatchery	1	1	3,486	8
5 September	198	Hatchery	4	7	27,185	15
		Both	2	2		
12 September	199	Both	1	3	6,976	3
Total			58	75	282,823	
Rapid River						
28 August	120	Hatchery	1	1	5,112	18
4 September	121	Hatchery	31	31	126,524	14
11 September	122	Hatchery	68	69	270,630	22
16 September	123	Hatchery	1	1	5,527	2
23 September	124	Hatchery	1	1	4,562	1
Total			102	103	412,355	

[a] *Some parent groups include males that were spawned more than once so there are more individual males reported here than the total number actually spawned.*
[b] *Imnaha embryos were shocked on 22 October 1997 and Rapid River embryos were shocked on 4 November 1997.*
[c] *Rapid River stock were usually spawned in a 2X2 matrix.*

Table 10. Number of adult Imnaha River, Rapid River, Lostine River, Catherine Creek and Grande Ronde River spring Chinook salmon trapped at LSRCP trapping facilities during each week of operation in 1998. Note: The Imnaha River weir was operational from 6 July through 16 September. The Lookingglass Creek weir was operational from 1 April through 30 September. The Lostine River weir was operational from 10 May through 1 October. The Catherine Creek weir was operational from 10 June through 24 July. The Grande Ronde River weir was operational from 9 June through 24 July. M=marked and U=unmarked.

				Rapid River stock					
				Lower Granite Dam [b]	Lookingglass Fish Hatchery [b]		Lostine River	Cath-erine Creek	Grande Ronde River
	Week of the	Imnaha River							
Period	year	M [a]	U	M	M	U	U	U	U
9-15 Apr	15			-					
16-22 Apr	16			1					
23-29 Apr	17			15					
30 Apr - 6 May	18			52					
7-13 May	19			39					
14-20 May	20			37					
21-27 May	21			5					
28 May - 3 Jun	22			10	0	3			
4-10 Jun	23			31	0	3			4
11-17 Jun	24			12	0	4		5	8
18-24 Jun	25			8	0	3	2	10	10
25 Jun - 1 Jul	26			2	0	3	5	4	5
2-8 Jul	27				4	6	1	8	1
9-15 Jul	28	17	30		1	0	7	0	4
16-22 Jul	29	28	36		0	0	1	0	
23-29 Jul	30	32	26		0	4	0	0	
30 Jul - 5 Aug	31	10	12		0	9	4	0	
6-12 Aug	32	8	9		0	2	0	0	
13-19 Aug	33	4	8		0	1	0	0	
20-26 Aug	34	9	19		1	10	0	0	
27 Aug - 2 Sep	35	6	7		1	4	0	0	
3-9 Sep	36	2	3		0	3	0	1	
10-16 Sep	37				0	2	2		

[a] *Marked salmon does not include Hatchery x Hatchery crosses.*

[b] *Fish trapped at Lower Granite Dam were Rapid River stock Chinook salmon released from Lookingglass Fish Hatchery into Lookingglass Creek and identified at Lower Granite Dam by AdRV fin-clips. Fish trapped at Lookingglass Fish Hatchery were Rapid River stock salmon that were either unmarked, mismarked with an adipose clip only or were missed at the Lower Granite Dam trap.*

Table 11. Numbers of adult spring Chinook salmon that returned to LSRCP facilities in northeast Oregon, by origin, age and sex, 1998. Hatchery salmon are program salmon and not hatchery x hatchery crosses.

	Hatchery							Natural							
	3		4		5			3		4		5			Grand
Stream, disposition	F	M	F	M	F	M	Total	F	M	F	M	F	M	Total	total
Imnaha River															
Trapped	0	69	8	10	24	4	115	0	14	19	28	48	41	150	265
Passed	0	34	4	5	13	2	58	0	5	9	13	26	20	73	131
Outplanted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kept	0	35	4	5	11	2	57	0	9	10	15	22	21	77	134
Actual spawned	0	33	4	4	11	2	54	0	4	8	12	19	15	58	112
Killed, not spawned	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pre-spawn mortality	0	2	0	1	0	0	3	0	5	2	3	3	6	19	22
Mean length (mm) [a]	0	562	788	770	903	941	-	0	554	807	753	915	956	-	-
Standard deviation (mm)	0	28.5	39.6	54.2	41.6	29.8	-	0	55.9	23.2	52.3	34.4	62.5	-	-
Age composition (%)	0	60	6.9	8.7	20.9	3.5	43.4	0	9.3	12.7	18.7	32.0	27.3	56.6	
Rapid River															
Total trapped	1	26	35	21	82	54	219	0	0	16	14	10	17	57	276
Trapped at LG Dam	1	23	35	20	81	52	212	0	0	0	0	0	0	0	212
Trapped at LFH	0	3	0	1	1	2	7	0	0	16	14	10	17	57	64
Passed	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Outplanted	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Kept	1	26	35	21	82	54	219	0	0	16	14	10	17	57	276
Actual spawned	1	19	31	16	63	46	176	0	0	13	5	4	7	29	205
Killed-not spawned	0	1	2	0	2	2	7	0	0	0	4	0	0	4	11
Pre-spawn mortality	0	6	2	5	17	6	36	0	0	3	5	6	10	24	60
Mean length (mm) [a]	480	510	697	720	879	842		0	0	749	742	890	860		
Standard deviation (mm)	34	NA	43.3	33.8	39.2	31.7		0	0	35.5	37.8	60.6	40.7		
Age composition (%)	0.5	12.3	16.0	9.6	37.4	24.7	79.3	0	0	28.1	24.6	17.5	29.8	20.7	

	Hatchery							Natural							
	3		4		5			3		4		5			
Stream, disposition	F	M	F	M	F	M	Total	F	M	F	M	F	M	Total	Grand total
Catherine Creek															
Trapped	0	0	0	0	0	0	0	0	0	2	4	11	11	28	28
Passed [b]	0	0	0	0	0	0	0	0	0	2	4	11	11	28	28
Kept	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mortality	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mean length (mm) [a]	0	0	0	0	0					740	739	837	875		
Standard deviation (mm)	0	0	0	0	0					70.7	36.7	21.9	33.3		
Age composition (%)	0	0	0	0	0	0	0	0	0	7.1	14.3	39.3	39.3	100	
Grande Ronde River															
Trapped	0	0	0	0	0	0	0	0	0	3	2	17	11	33	33
Passed [c]	0	0	0	0	0	0	0	0	0	2	2	15	10	29	29
Kept	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mortality	0	0	0	0	0	0	0	0	0	1	0	2	1	4	4
Mean length (mm) [a]	0	0	0	0	0					770	745	870	898		
Standard deviation (mm)	0	0	0	0	0					26	49.5	40.5	55.4		
Age composition (%)	0	0	0	0	0	0	0	0	0	9.1	6.1	51.5	33.3	100	
Lostine River															
Trapped	0	0	0	0	0	0	0	0	1	3	3	8	8	23	23
Passed [d]	0	0	0	0	0	0	0	0	1	3	3	7	8	22	22
Kept	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mortality	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1
Mean length (mm) [a]	0	0	0	0	0				556	773	751	870	915		
Standard deviation (mm)	0	0	0	0	0				-	24.7	57.8	34.4	69.8		
Age composition (%)	0	0	0	0	0	0	0	0	4.4	13	13	34.8	34.8	100	

[a] *Mean length per age class determined from known age salmon based on either CWT or scale data.*

[b] *Two age 4 females, two age 5 females and four age 5 males were kept then released back to Catherine Creek.*

[c] *One age 4 female, three age 5 females and 2 age 5 males were kept then released back to upper Grande Ronde.*

[d] *One age 4 male and one age 4 female were kept and then released back to Lostine River.*

Table 12. Timing of spawning and spawning summaries for spring Chinook salmon at Lookingglass Fish Hatchery, 1998.

Stock, date	Origin of parents	Number of parents [a]		Number of eggs collected	Percent mortality to shocking
		Females	Males		
Imnaha River					
5 August 1998	Mixed	2	1	10,036	98.8
11 August 1998	Mixed	2	3	11,377	0
14 August 1998	Mixed	6	5	29,597	0
19 August 1998	Mixed	4	4	15,463	0
26 August 1998	Mixed	20	30	101,069	25.7
2 September1998	Mixed	20	30	104,302	30.7
7 September 1998	Mixed	1	1	4,000	100
9 September 1998	Mixed	7	14	30,208	17.1
14 September 1998	Mixed	1	2	2,420	25.1
Rapid River stock [b]					
18 August 1998	Mixed	2	2	8,138	18.3
25 August 1998	Wild	6	6	28,433	7.1
1 September 1998	Wild	5	5	19,589	2.8
8 September 1998	Wild	3	3	11,380	8.7
15 September 1998	Wild	2	2	7,200	31.3

[a] *The number of males in table is greater than the number kept because 12 were recycled for Imnaha River and 5 were recycled for Rapid River stock.*

[b] *Eggs from matrices of hatchery parents were transferred to the Umatilla tribe.*

Table 13. Expanded adult recoveries of coded-wire tagged Imnaha River stock spring Chinook salmon from the PSMFC RMIS database, 1997.

Cohort	Experimental group (acclimated vs. direct release, target weight at release, density)	CWT code	Recovery location			Total
			Weir [a]	Other Snake River Basin [b]	Out of basin [c]	
1992						
	Acclimated, 30.3 g	070118	0	0	0	0
	Acclimated, 30.3 g	070119	0	0	0	0
	Acclimated, 18.2 g	076362	3	0	1	4
	Acclimated, 18.2 g	076363	0	0	0	0
	Direct, 18.2 g	070116	0	0	0	0
	Direct, 18.2 g	070117	0	0	0	0
	Total		3	0	1	4
1993						
	Acclimated, 18.2 g	070745	29	0	6	35
	Acclimated., 18.2 g	070746	15	0	1	16
	Direct, 18.2 g	070747	26	0	0	26
	Direct, 18.2 g	070748	36	0	6	42
	Acclimated., 30.3 g	070750	22	0	2	24
	Acclimated., 30.3 g	070751	35	0	6	41
	Total		163	0	21	184
1994						
	4.0 g/L, 30.3 g	071225	1	0	0	1
	4.0 g/L, 30.3 g	071226	0	0	0	0
	2.0 g/L, 30.3 g	071227	0	0	0	0
	4.0 g/L, 18.2 g	071228	0	0	0	0
	4.0 g/L, 18.2 g	071229	0	0	0	0
	2.0 g/L, 18.2 g	071230	0	0	0	0
	Total		1	0	0	1
Grand total			167	0	22	189

[a] *Actual numbers of CWT salmon recovered at the Imnaha River weir. Fish were collected for broodstock and sampled in the hatchery.*

[b] *Estimated number (the estimated spawning population above the weir, the number of redds above the weir, the fish/redd estimate from above the weir, the number of redds below the weir and the proportion of salmon sampled from the hatchery with these tag codes) of total CWT salmon that spawned naturally in the Imnaha River. We passed 51 CWT salmon above the weir and estimate that 103 CWT salmon escaped before weir installation and 73 CWT salmon spawned below the weir.*

[c] *Estimated number recovered in the ocean, mainstem Columbia River or Deschutes River.*

Table 14. Expanded adult recoveries of coded-wire tagged Rapid River Chinook salmon, released from Lookingglass Fish Hatchery, from the PSMFC RMIS database, 1997.

Cohort	Experimental group (density, target size at release and exercise vs. control)	CWT code	Recovery location: LFH weir	Lower Granite Dam	Other Snake River Basin	Out of basin [a]	Total
1992							
	16 g/L, 22.7 g	070441	0	7	0	1	8
	16 g/L, 22.7 g	070440	0	1	0	0	1
	16 g/L, 22.7 g	070439	0	6	0	0	6
	16 g/L, 22.7 g	070438	0	1	0	0	1
	16 g/L, 22.7 g	070437	0	11	0	0	11
	16 g/L, 22.7 g	070436	0	5	0	1	6
	16 g/L, 22.7 g	070435 [b]	0	0	0	0	0
	16 g/L, 22.7 g	070434	0	4	0	1	5
	16 g/L, 22.7 g	075308	0	6	0	2	8
	16 g/L, 22.7 g	075307	0	8	0	1	9
	8 g/L, 22.7 g	070448	0	3	0	2	5
	8 g/L, 22.7 g	070447	0	8	0	0	8
	Total		0	60	0	8	68
1993							
	16 g/L, 22.7 g	070829	0	42	0	1	43
	16 g/L, 22.7 g	070828	1	61	3	9	74
	16 g/L, 22.7 g	070827	0	80	1	5	86
	16 g/L, 22.7 g	070826	0	55	0	4	59
	16 g/L, 22.7 g	070825	0	45	0	3	48
	16 g/L, 22.7 g	070824	0	40	1	1	42
	16 g/L, 22.7 g	070823	0	31	0	4	35
	16 g/L, 22.7 g	070822	0	30	0	5	35
	Total		1	384	5	32	422
1994							
	16 g/L, Exercise, 22.7g	071231	0	1	0	0	1
	16 g/L, Control, 22.7g	071232	0	0	0	0	0
	16 g/L, Exercise, 22.7g	071233	0	1	0	0	1
	16 g/L, Control, 22.7g	071234	0	0	0	0	0
	Total		0	2	0	0	2
Grand total			1	446	5	39	492

[a] *Estimated number recovered in the ocean, mainstem Columbia River or Deschutes River.*

[b] *Fish from brood year 1992 CWT code 070435 were released in Hells Canyon not Lookingglass Creek.*

Table 15. Expanded adult recoveries of coded-wire tagged Imnaha River stock spring Chinook salmon from the PSMFC RMIS database, 1998.

Cohort	Experimental group (target size at release, density and acclimated vs. direct release)	CWT code	Recovery location: Imnaha River weir	Recovery location: Other Snake River Basin	Recovery location: Out of basin [a]	Total
1993						
	18 g, Acclimated	070745	18	0	1	19
	18 g, Acclimated	070746	8	0	6	14
	18 g, Direct Stream	070747	7	0	0	7
	18 g, Direct Stream	070748	7	0	1	8
	30 g, Acclimated	070750	3	0	5	8
	30 g, Acclimated	070751	11	0	0	11
	Total		54	0	13	67
1994						
	30 g	071225	7	0	0	7
	30 g	071226	2	0	0	2
	18 g	071228	2	0	0	2
	18 g	071229	1	0	0	1
	18 g	071230	1	0	0	1
	Total		13	0	0	13
1995						
	18 g	091719	7	0	0	7
	30 g	091720	1	0	0	1
	30 g	091721	7	0	1	8
	18 g	091722	13	0	0	13
	18 g	091723	9	0	0	9
	Total		37	0	1	38
Grand total			104	0	14	118

[a] *Estimated number recovered in the ocean, mainstem Columbia River or Deschutes River.*

Table 16. Expanded adult recoveries of coded-wire tagged Rapid River Chinook salmon, released from Lookingglass Fish Hatchery, from the PSMFC RMIS database, 1998.

			Recovery location				
Cohort	Experimental group	CWT code	LFH weir	Lower Granite Dam	Other Snake River basin	Out of basin [a]	Total
1993							
	Production	070822	0	10	0	0	10
	Production	070823	0	8	0	1	9
	Production	070824	1	20	0	2	23
	Production	070825	0	13	0	1	14
	Production	070826	0	16	0	0	16
	Production	070827	1	31	0	1	33
	Production	070828	0	25	0	1	26
	Production	070829	1	16	1	0	18
	Total		3	139	1	6	149
1994							
	Exercise	071231	0	9	0	0	9
	Control	071232	0	14	0	0	14
	Exercise	071233	0	5	0	0	5
	Control	071234	1	13	0	0	14
	Total		1	41	0	0	42
1995							
	Control	091724	0	6	0	0	6
	Control	091725	1	1	0	0	2
	Exercise	091726	0	8	0	0	8
	Exercise	091727	0	7	0	0	7
	Total		1	22	0	0	23
Grand total			5	202	1	6	214

[a] *Estimated number recovered in the ocean, mainstem Columbia River or Deschutes River.*

Table 17. Catch and escapement distribution of hatchery adult spring Chinook salmon by recovery location in 1997. Data are summarized through November 2004 from the PSMFC and ODFW CWT recovery databases.

	Imnaha River		Rapid River Stock	
Location, recovery type	Expanded adults	Percent of total	Expanded adults	Percent of total
Ocean catch	2	0.5	8	1.9
Columbia River				
Treaty net	0		5	1.2
Non-treaty net	0		2	0.5
Sport	0		0	
Deschutes River				
Traps	18	4.7	18	4.3
Sport	0		0	
Ceremonial and subsistence	0		0	
Strays				
Outside Snake River Basin	2	0.5	7	1.7
Within Snake River Basin [a]	0		4	1.0
Recruitment to river [a]	362	94.3	374	89.5
Total estimated return	384		418	
Return to compensation area	362		378	
Percent of compensation goal		11.3		16.4

[a] *Indicates areas defining the compensation area. The compensation goal for Rapid River stock is 2,300 adults and the goal for Imnaha River is 3,210 adults. Expanded adults returning for each stock in 1997 is calculated in Tables 13 and 14.*

Table 18. Catch and escapement distribution of hatchery adult spring Chinook salmon by recovery location in 1998. Data are summarized through November 2004 from the PSMFC and ODFW CWT recovery databases.

	Imnaha River		Rapid River stock	
Location, recovery type	Expanded adults	Percent of total	Expanded adults	Percent of total
Ocean Catch	0	0	0	0
Columbia River				
Treaty net	0	0	6	2.7
Non-treaty net	0	0	0	0
Sport	0	0	0	0
Deschutes River	0	0	0	0
Traps	13	5.8		
Sport	0	0	0	0
Ceremonial and subsistence	0	0	0	0
Strays			0	0
Outside Snake R. Basin	1	0.4	0	0
Within Snake R. Basin [a]	1	0.4	1	0.5
Lower Granite Dam [b]	0	0	188	0
Recruitment to river [a]	209	93.4	21	96.8
Total Estimated Return	224		216	
Return to compensation area	209		209	
Percent of compensation goal	6.5		9.1	

[a] *indicates areas defining the compensation area. The compensation goal for Rapid River stock is 2,300 adults and the goal for Imnaha River is 3,210 adults.*

[b] *ADRV fin clipped salmon were trapped at Lower Granite dam and trucked to Lookingglass Fish Hatchery.*

Table 19. Summary of marked and unmarked spring Chinook salmon carcasses recovered during spawning ground surveys in the Grande Ronde and Imnaha river basins, 1997. These recoveries do not distinguish between natural salmon and unmarked hatchery salmon recovered on the spawning grounds.

Basin, stream	Marked	Unmarked	Percent marked	Number of redds
Grande Ronde River Basin				
Bear Creek	0	0	0	0
Hurricane Creek	0	4	0	9
Lostine River	0	53	1.9	49
Wallowa River	0	1	0	12
Grande Ronde River	0	10	11.1	19
Catherine Creek	0	40	5.0	46
Lookingglass Creek	3	7	30.0	28
Minam River	2	54	7.1	58
Wenaha River	2	58	5.0	80
Total	7	227	6.0	301
Imnaha River Basin				
Little Sheep Creek	0	0	0	0
Big Sheep Creek	3	1	100	19
Imnaha River	39	74	46	216
Lick Creek	55	0	100	51
Total	99	75	65.1	286

Table 20. Summary of adipose-clipped Chinook salmon carcass recoveries during spawning ground surveys, 1997.

Recovery location	Number recovered	CWT code	Release site
Big Sheep Creek	1	No tag	Likely Imnaha River 1993 cohort hatchery x hatchery crosses
Big Sheep Creek	3	No snout	Likely Imnaha River 1993 cohort hatchery x hatchery crosses
Imnaha River	8	70745	Imnaha Acclimation Pond (1993 cohort)
Imnaha River	1	70746	Imnaha Acclimation Pond (1993 cohort)
Imnaha River	5	70747	Imnaha Acclimation Pond (1993 cohort)
Imnaha River	10	70748	Imnaha Acclimation Pond (1993 cohort)
Imnaha River	3	70750	Imnaha Acclimation Pond (1993 cohort)
Imnaha River	5	70751	Imnaha Acclimation Pond (1993 cohort)
Imnaha River	14	No Tag	Likely Imnaha River 1993 cohort hatchery x hatchery crosses
Imnaha River	9	No Snout	Likely Imnaha River 1993 cohort hatchery x hatchery crosses
Lick Creek	48	No Snout	Outplanted Imnaha River 1993 cohort hatchery x hatchery crosses
Lick Creek	7	No snout	
Lookingglass Creek	3	No snout	
Minam River	2	70828	Lookingglass Fish Hatchery (1993 cohort)
Wenaha River	1	70824	Lookingglass Fish Hatchery (1993 cohort)
Wenaha River	1	70827	Lookingglass Fish Hatchery (1993 cohort)

Table 21. Age composition of Chinook salmon carcasses recovered in 1997 during surveys in the Imnaha and Grande Ronde river basins.

	Age 3		Age 4		Age 5	
Basin, parameter	Female	Male	Female	Male	Female	Male
Grande Ronde River						
Number [a]	4	5	107	70	12	15
Percent of total	2	2	50	33	6	7
Mean length (mm)	658	673	751	780	843	946
Standard deviation	39	103	59	83	93	42
Imnaha River						
Number [b]	0	1	52	64	20	3
Percent of total	0	1	37	46	14	2
Mean length (mm)	-	540	783	800	936	988
Standard deviation	-	-	46	64	46	55

[a] *Age could not be determined for an additional 1 female and 6 males.*
[b] *Age could not be determined for an additional 12 female and 7 males and gender could not be determined for an additional 4 four year olds and 1 five year old.*

Table 22. Summary of marked and unmarked spring Chinook salmon carcasses recovered during spawning ground surveys in the Grande Ronde and Imnaha river basins, 1998. These recoveries do not distinguish between natural salmon and unmarked hatchery salmon recovered on the spawning grounds.

Basin, stream	Marked	Unmarked	Percent marked	Number of redds
Grande Ronde River Basin				
Bear Creek	0	0	0	1
Hurricane Creek	0	0	0	0
Lostine River	0	36	0	35
Wallowa River	0	5	0	12
Grande Ronde River	0	30	0	25
Catherine Creek	0	21	0	34
Lookingglass Creek	0	0	0	5
Minam River	0	32	0	65
Wenaha River	1	59	1.7	76
Total	1	183	0.5	253
Imnaha River Basin				
Lick Creek	4	0	100	11
Big Sheep Creek	0	0		0
Imnaha River	39	51	49.4	146
Total	43	51	51.6	157

Table 23. Summary of adipose-clipped Chinook salmon carcasses recovered during spawning ground surveys in 1998.

Recovery location	Number recovered	CWT code	Release site
Imnaha River	9	070745	Imnaha Acclimation Pond (1993 cohort)
Imnaha River	3	070746	Imnaha Acclimation Pond (1993 cohort)
Imnaha River	1	070747	Imnaha Acclimation Pond (1993 cohort)
Imnaha River	2	070748	Imnaha Acclimation Pond (1993 cohort)
Imnaha River	3	070750	Imnaha Acclimation Pond (1993 cohort)
Imnaha River	3	070751	Imnaha Acclimation Pond (1993 cohort)
Imnaha River	1	071225	Imnaha Acclimation Pond (1994 cohort)
Imnaha River	1	071230	Imnaha Acclimation Pond (1994 cohort)
Imnaha River	1	091723	Imnaha Acclimation Pond (1993 cohort)
Imnaha River	1	104915	Snake River at Hells Canyon Dam (1993 cohort)
Imnaha River	2	No tag	1994 cohort
Imnaha River	9	No tag	1993 cohort
Lick Creek	1	070751	Imnaha Acclimation Pond (1993 cohort)
Wallowa River	1	065221	Trinity River Hatchery, CA (1994 cohort)
Wenaha River	1	070829	1995 cohort, Lookingglass Fish Hatchery

Table 24. Age composition of Chinook salmon carcasses recovered during spawning ground surveys in the Imnaha and Grande Ronde river basins, 1998.

	Age 3		Age 4		Age 5	
Basin / parameter	F	M	F	M	F	M
Grande Ronde River						
Number [a]	0	3	29	20	71	35
Percent of total	0	100	59.2	40.8	67	33
Mean length (mm)	NA	518	768	831	860	945
Standard deviation	NA	67.8	58.4	85	50	53
Imnaha River						
Number [b]	0	2	10	13	37	23
Percent of total	0	100	43.5	56.5	61.7	38
Mean length (mm)	NA	566	823	820	902	985
Standard deviation	NA	10.6	50.5	93.4	46.3	78

[a] *These numbers do not reflect 17 additional salmon whose age could not be determined, nor one age 3 and two age 5 salmon whose sex is unknown.*

[b] *These numbers do not reflect one age 3 salmon and three age 5 salmon whose sex is unknown.*

REFERENCES

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

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

Carmichael, R.W., B.A. Miller and R.T. Messmer. 1986a. Lower Snake River Compensation Plan--Oregon evaluation studies. Oregon Department of Fish and Wildlife, Fish Research Project FRI/LSR-86-35, Annual Progress Report, 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. Oregon Department of Fish and Wildlife, Fish Research Project FRI/LSR-88-16, Annual Progress Report, Portland.

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

Carmichael, R.W., B.A. Miller and R.T. Messmer. 1988b. Summer steelhead creel surveys in the Grande Ronde, Wallowa, and Imnaha rivers for the 1987-1988 run year. Oregon Department of Fish and Wildlife, Fish Research Project AFFI-LSR-89-02, Annual Progress Report, Portland.

Carmichael, R.W., M.W. Flesher and R.T. Messmer. 1989. Summer steelhead creel surveys in the Grande Ronde, Wallowa, and Imnaha rivers for the 1988-1989 run year. Oregon Department of Fish and Wildlife, Fish Research Project AFFI-LSR-90-12, Annual Progress Report, Portland.

Carmichael, R.W. 1989. Lower Snake River Compensation Plan--Oregon evaluation studies, five-year study plan. Oregon Department of Fish and Wildlife, Fish Research Project, Portland.

Carmichael, R.W., M.W. Flesher and R.T. Messmer. 1990. Summer steelhead creel surveys in the Grande Ronde, Wallowa, and Imnaha rivers for the 1989-1990 run year. Oregon Department of Fish and Wildlife, Fish Research Project AFFI-LSR-91-12, Annual Progress Report, Portland.

Carmichael, R.W., T.A. Whitesel and M. Keefe. 1997. 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 14-48-0001-93538.

Carmichael, R.W., T.A. Whitesel and M. Keefe. 1998. 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 14-48-0001-93538.

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, Portland.

Jonasson, B.C., R.W. Carmichael and T.A. Whitesel. 1994. Residual hatchery steelhead: Characteristics and potential interactions with spring Chinook salmon in northeast Oregon. Oregon Department of Fish and Wildlife, Fish Research Project. Annual Progress Report, Portland.

Jonasson, B.C., R.W. Carmichael and T.A. Whitesel. 1995. Residual hatchery steelhead: Characteristics and potential interactions with spring Chinook salmon in northeast Oregon. Oregon Department of Fish and Wildlife, Fish Research Project. Annual Progress Report, Portland.

Jonasson, B.C., R.W. Carmichael and T.A. Whitesel. 1996. Residual hatchery steelhead: Characteristics and potential interactions with spring Chinook salmon in northeast Oregon. Oregon Department of Fish and Wildlife, Fish Research Project. Annual Progress Report, Portland.

Keefe, M., R.W Carmichael, B.C. Jonasson, R.T. Messmer and T.A. Whitesel. 1994. Investigations into the life history of spring chinook salmon in the Grande Ronde River Basin. Annual Report 1994. Project Number 92-026-01. U.S. Department of Energy, Bonneville Power Administration, P.O. Box 3621, Portland, OR.

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

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