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ANNUAL PROGRESS REPORT

FISH RESEARCH PROJECT
OREGON

PROJECT TITLE: Evaluation of Lower Snake River Compensation Plan Facilities in Oregon

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CONTENTS

PREFACE

The background of the Lower Snake River Compensation Plan (LSRCP) is given in the LSRCP five-year study plan (Carmichael 1989). Oregon's compensation goals for adult salmonids are 5,820 spring chinook salmon and 9,184 summer steelhead for the Grande Ronde Basin and 3,210 spring chinook salmon and 2,000 summer steelhead for the Imnaha River Basin (U.S. Army Corps of Engineers 1975). The means of compensation for

Oregon's LSRCP is through the production and release of hatchery smolts. A complex of hatcheries and satellite facilities exists to produce spring chinook salmon and summer steelhead for release in the Grande Ronde and Imnaha river basins. A description of these facilities is given by Carmichael (1989). In this report we present a review of our activities under all projects for the period 1 January 1993 to 31 December 1993. Many of the projects were report on are ongoing. Previous annual progress reports include Carmichael and Wagner (1983), Carmichael and Messmer (1985), and Carmichael et al. (1986a, 1987, 1988a 1988b, 1989, 1990), Messmer et al. (1989, 1990, 1991, 1992), Flesher et al. (1991, 1992, 1993), Whitesel et al. (1993), and Jonasson et al (1994).

FIGURES

FIGURES (continued)

Number Page

TABLES

Number Page

TABLES (continued)

Number Page

TABLES (continued)

Number Page

TABLES (continued)

Number Page

SUMMARY

Objectives

1. Document egg take, egg-to-smolt survival, and growth of spring chinook salmon and summer steelhead reared and released at Lower Snake River Compensation Plan (LSRCP) facilities in Oregon.

2. Document number, size, time, and location of releases for spring chinook salmon and summer steelhead juveniles produced at Lower Snake River Compensation Plan facilities in Oregon.

3. Determine sex ratio, run timing, and spawning timing for spring chinook salmon adults that return to Lookingglass Hatchery, the Big Canyon facility and the Imnaha River weir and for adult summer steelhead that return to the Big Canyon facility, Wallowa Hatchery, and the Little Sheep Creek facility.

4. Collect and analyze scales from spring chinook salmon and summer steelhead adults to determine age composition and length-age relationships.

5. Tag the following groups of 1991 brood chinook salmon with Passive Integrated Transponders (PIT): Rapid River stock for rearing density comparisons and production survival estimates; Imnaha stock for size-at-release comparisons and production survival estimates.

6. Release 1991 brood Rapid River and Imnaha stock spring chinook salmon that were marked (Ad+CWT), cold-branded, and PIT-tagged for rearing density comparisons, size-at-release comparisons, and production survival estimates.

7. Mark (Ad+CWT) and cold-brand the following groups of 1992 brood chinook salmon: Rapid River stock for rearing density comparisons and production survival estimates; Imnaha stock for size-at-release comparisons, production survival estimates, and acclimation evaluation.

8. Mark (Ad-LV+CWT), cold-brand (Wallowa Hatchery and Little Sheep Creek releases only), PIT-tag, and release the following groups of 1992 brood summer steelhead: Wallowa stock for production survival estimates

(at Wallowa Hatchery and Big Canyon facility), and acclimation evaluation (at Big Canyon facility); Imnaha stock for production survival estimates and acclimation evaluation.

9. Collect and decode coded-wire tags from marked spring chinook salmon and summer steelhead adults that return to adult collection facilities.

10. Summarize catch and escapement information for groups of coded-wire-tagged spring chinook salmon and summer steelhead adults as information becomes available.

11. Summarize information from cold-branded and PIT-tagged spring chinook salmon and summer steelhead smolts recovered at Snake River collection sites.

12. Conduct spring chinook salmon spawning ground surveys on northeast Oregon streams in cooperation with Oregon Department of Fish and Wildlife (ODFW) management personnel and recover carcasses of marked hatchery strays.

13. Participate in planning activities associated with anadromous fish production, management, and research in the Grande Ronde and Imnaha river basins.

14. Determine the success of maintaining genetic and life history characteristics of endemic summer steelhead and spring chinook salmon in the Imnaha River basin while pursuing mitigation and management goals.

15. Determine the effectiveness of the summer steelhead and spring chinook salmon supplementation programs in the Imnaha River basin by comparing life history characteristics of natural and hatchery produced fish.

16. Determine and compare adult progeny-to-parent ratios for natural and hatchery fish to assess the effectiveness of Imnaha River basin summer steelhead and spring chinook salmon hatchery supplementation programs.

Accomplishments and Findings

Fish Culture Monitoring, spring chinook salmon

Rapid River stock (1991 brood) spring chinook salmon released in 1993 were 100% Ad-RV+CWT marked and Imnaha stock (1991 brood) chinook salmon released in 1993 were 100% Ad+CWT marked for broodstock management and identification on spawning grounds.

Imnaha stock chinook salmon (1991 brood year) targeted for release at 15 fish/lb developed a bimodal and skewed length-frequency distribution in the fall of their first year of rearing. Also, fish in the upper modal group exhibited a lower mean condition factor and lower mean hepatosomatic index than did the fish in the lower modal group.

An estimated 217 spring chinook adults passed above the Lookingglass Creek weir untrapped, with the majority passing before the weir was installed on 28 May. An additional 3 jack, 46 male, and 50 female spring chinook salmon were passed above the Lookingglass Hatchery weir in 1993 as part of the Lookingglass Creek Reintroduction Study. A total of 151 redds were observed in the Lookingglass Creek Drainage (131 above the weir and 20 below the weir). The total estimated spring chinook salmon spawning population in Lookingglass Creek was 364 fish.

In 1993, a total of 107 Carson stock and 1,020 Rapid River stock spring chinook salmon returned to Lookingglass Hatchery. An estimated 60 fish were harvested from Lookingglass Creek by Nez Perce and Umatilla tribal members. No spring chinook salmon adults were trapped at the Big Canyon facility in 1993.

The Imnaha River weir was installed on 2 July, the latest installation date since 1985. We estimated that 12.4% of the Imnaha chinook salmon run above the weir passed before the weir was installed. We trapped 1,243 chinook salmon at the Imnaha River weir of which 593 were marked hatchery fish. We estimated that 302 of the 650 unmarked adult returns were of hatchery origin. Unmarked hatchery origin fish were age 52 and age 42 adult returns from releases of 1988 brood (59% marked) and 1989 brood (76% marked). Jack (age 32) returns to the Imnaha weir totalled 20 fish of which 16 were marked hatchery fish and 4 were unmarked natural origin fish. Prespawning mortality of 1993 brood Imnaha stock chinook salmon held for hatchery broodstock was 1.4% and 12.6% for natural (unmarked fish) and hatchery (marked fish) origin females respectively.

A total of 543 unmarked and 248 marked hatchery fish were released above the Imnaha River weir to spawn naturally. We estimated that 252 of the 543 unmarked fish were of hatchery origin. The hatchery-natural composition of fish released above the weir was estimated at 63% hatchery and 37% natural origin. One-hundred (27 males and 73 females) of the 791 fish released above the Imnaha River weir were released late in the spawning season, on 28 August. Redd counts for the area immediately above the weir (weir upstream to Mac's, Mine, 7.2 km) increased 54% (54 to 82 redds) after these fish were released. Redd superimposition was observed but not quantified in this section of the Imnaha River. Ninety-four percent of the carcass recoveries (48 out of 51) from this group were recovered in the 7.2 km area above the weir. Only 3 of the 51 carcasses recovered were in areas above Mac's Mine (km 7.2).

A total of 16 male and 33 female Imnaha stock spring chinook salmon (adults trapped at the Imnaha weir) were released into Lick Creek near km 4.8 (meadow area below Lick Creek Campground) on 28 and 31 August. Twenty-four chinook salmon redds were observed on 8 September in Lick Creek following this release. A total of 8 male and 23 female carcasses were recovered on the survey (all fish released were adipose and operculum marked hatchery fish). Of the 23 female carcasses recovered and examined, 26% (6 females) died before spawning (100% egg retention), 48% appeared to have spawned successfully (less than 20% egg retention), and 26% appeared to have spawned partially (50-80% egg retention).

For Imnaha stock chinook salmon, 54 unmarked females and 139 marked hatchery females were spawned resulting in a total egg take of 1,047,064 green eggs. All unmarked females not released above the Imnaha River weir or outplanted into Lick Creek were retained for broodstock and spawned. This egg take represents 179% of the egg take needed to achieve the LSRCP smolt production goal for the Imnaha chinook program.

Fish Culture Monitoring, summer steelhead

A total of 1,353 summer steelhead adults (801 males and 552 females) returned to Wallowa Hatchery in 1993. Adult female prespawning mortality was only 0.6%, the lowest since the Wallowa Hatchery adult holding facilities were completed. We outplanted 400 surplus Wallowa Hatchery steelhead adults to local fishing ponds.

The Big Canyon facility weir was opened on 16 April, after closure of the steelhead sport fishery. Twenty-eight natural and 342 hatchery origin steelhead adults were trapped. All naturally-produced summer steelhead adults (17 male and 11 female) and 28 hatchery (11 male and 17 female) origin steelhead adults were released above the weir to spawn naturally.

A total of 514 Wallowa stock, female summer steelhead were spawned in 1993 (19 from Big Canyon returns and 495 from Wallowa Hatchery returns) for an egg take of 2,258,846 green eggs. Egg loss was 26.2% and egg-to-fry survival was 68.6%.

We trapped 99 natural and 1,773 hatchery origin steelhead adults at the Little Sheep Creek facility in 1993. We released 77 natural origin (17 male and 60 female) and 77 hatchery origin (60 male and 17 female) steelhead adults above the Little Sheep Creek weir. These release numbers resulted in a 1:1 hatchery-to-natural and male-to-female sex ratio. A total of 1,416 surplus Imnaha stock summer steelhead were killed and buried, (80% of the total 1993 Little Sheep Creek hatchery origin returns).

A total of 134 (18 natural and 116 hatchery origin) females and 158 (4 natural and 154 hatchery origin) male summer steelhead were spawned for hatchery broodstock in 1993 resulting in an egg take of 647,272 green eggs. Natural origin steelhead comprised only 7.5% of the total summer steelhead used for hatchery broodstock.

Survival Studies, spring chinook salmon

Rapid River stock (1988 brood) spring chinook salmon released from Lookingglass Hatchery in April of 1990 at a mean weight of 22.8 grams and 40.7 grams survived at 0.35% and 0.44% respectively. The 1988 brood of Rapid River stock chinook salmon returned predominantly as age 52 adults. Age-at-return for the 1988 brood released at 22.8 grams (20 fish/lb release group) averaged 4.3% age 32, 41.9% age 42, and 53.8% age 52. The age-at-return for 1988 brood Rapid River stock released at a mean weight

of 40.7 grams (12 fish/lb release group) averaged 13.3% age 32, 56.0% age 42, and 30.7% age 52.

The survival rate for 1988 brood Imnaha chinook salmon acclimated and released in March 1990 at the Imnaha River facility averaged 0.38% and 0.34% for fish released at 24.7 grams and 28.9 grams respectively. Age at return for 1988 brood Imnaha stock chinook salmon adults produced from smolts averaging 24.7 grams at release was 21.9% age 32, 41.8% age 42, and 36.3% age 52, and males comprised 58.2% of the returns. Age at return for 1988 brood Imnaha stock chinook salmon adults produced from smolts averaging 28.9 grams at release was 13.2% age 32, 46.3% age 42, and 40.5% age 52, and males comprised 37.9% of the returns.

For the 1988 brood year of Imnaha stock chinook salmon, the hatchery progeny-to-parent ratio was 9.45, which is 12 times greater than the estimated ratio for natural origin fish (0.79). Estimates of the 1988 brood progeny-to-parent ratios are preliminary, pending classification (using discriminant scale analysis) of the unmarked adult returns. The progeny-to-parent ratio for naturally-produced fish was below 1.0 for the 1984-1988 brood years.

Smolt passage indices for cold-branded, 1991 brood Rapid River stock spring chinook salmon reared at standard density (1.00 lbs/ft3 and 6.0 lbs/gal/min) and one-half standard density (0.5 lbs/ft3 and 3.0 lbs/gal/min) and released at Lookingglass Hatchery in the spring of 1993 were 27.4% and 34.9% respectively. Passage indices for PIT-tagged releases averaged 36.5% and 30.0% for fish reared at standard density and one-half standard density respectively. Migration timing at Lower Granite Dam was similar for cold-branded and PIT-tagged release groups.

The smolt passage indices for cold-branded, 1991 brood Imnaha chinook salmon released in the spring of 1993 at a mean weight of 37.6 and 21.2 grams were 24.9% and 32.0%, respectively. The smolt passage indices for PIT-tagged 1991 brood Imnaha chinook salmon juveniles released in the spring of 1993 at a mean weight of 37.6 and 21.2 grams were 31.7% and 28.7%, respectively. Migration timing at Lower Granite Dam was similar for cold-branded and PIT-tagged release groups.

Survival Studies, summer steelhead

Smolt-to-adult survival rate (catch plus escapement) for 1989 Wallowa stock summer steelhead smolts that were acclimated and released at Wallowa Hatchery at a mean weight of 108.1 grams (4 fish/lb release group) and 87.2 grams (5 fish/lb release group) was 1.60% and 1.10%, respectively for an average of 1.35%. The smolt-to-adult survival rate for 1989 brood Wallowa stock steelhead released directly into Spring Creek at Wallowa Hatchery at a mean weight of 96.3 grams was 0.85%. The 1989 brood represents the last Wallowa Hatchery releases in the acclimation evaluation. The age-at-return (includes catch and escapement) for adults produced from the 4 fish/lb release was 73.9% age 3 and 26.1% age 4. The 5 fish/lb release group produced adults which returned at 70.1% age 3 and 29.9% age 4. Direct stream releases returned 66.7% age 3 adults and 33.3% age 4 adults.

The smolt-to-adult survival rate for 1989 brood Imnaha stock summer steelhead acclimated and released at the Little Sheep Creek Facility (mean weight 77.7 grams) was 1.08% with a hatchery return rate of 0.44%. The age-at-return (includes catch and escapement) averaged 58.1% age 3 and 41.9% age 4 adults.

The progeny-to-parent ratio (progeny are represented by adult returns to the Little Sheep Creek weir and do not include fish that were harvested) for 1989 brood hatchery releases was 5.86 which was 17.2 times greater than the estimated ratio (0.34) for 1988 brood of naturally-produced fish.

In the 1992-1993 run year, a total of 5,830 Wallowa stock summer steelhead were estimated to have escaped above Lower Granite Dam. This escapement achieved 63.5% the LSRCP adult summer steelhead compensation goals for the Grande Ronde River basin.

In the 1992-1993 run year, a total of 2,427 Imnaha stock summer steelhead were estimated to have escaped above Lower Granite Dam. This escapement achieved the LSRCP adult compensation goals (2,000 adults to Lower Granite Dam) for the Imnaha River basin summer steelhead program.

The smolt passage index for cold-branded 1992 brood Wallowa stock summer steelhead acclimated and released at Wallowa Hatchery (mean weight 98.5 grams) in 1993 was 50.1%, 28% lower than the smolt passage index of 64.1% for PIT-tagged fish. Migration timing at Lower Granite Dam was similar for cold-branded and PIT-tagged release groups.

The smolt passage index for PIT-tagged, 1992 brood Wallowa stock summer steelhead released directly into Deer Creek at the Big Canyon Facility (mean weight 91.0 grams) was 75.3% and the passage index for groups of Wallowa stock summer steelhead acclimated at the Big Canyon Facility (mean weight 96.1 grams) was 76.5%.

The smolt passage index for cold branded, 1992 brood Imnaha stock summer steelhead released in the spring of 1993 was 40.1% for fish released directly into Little Sheep Creek and 28.6% for acclimated fish. The PIT-tag smolt passage index for the direct stream release group of 1992 brood Imnaha stock steelhead released in the spring of 1993 was 72.2%, 80% greater than the cold-branded group. The average smolt passage index for the acclimated PIT-tagged group was 69.2% which is 142% greater than the cold-branded group. Based on the cold-branded smolt passage index, the direct stream release group of Imnaha stock summer steelhead was detected at a 40% higher rate than the acclimated release group, but the PIT-tagged smolt passage indices for acclimated and direct stream release groups were similar.

Natural Escapement Monitoring

In 1993 there were 4 coded-wire-tagged spring chinook salmon carcasses (2 from 1988 brood, tag codes 07-47-39 and 07 50-53, and 2 from 1989 brood, tag code 07-50-53, all released from Lookingglass Hatchery)

and 3 ventral fin marked (1989 brood Carson stock spring chinook salmon released from Lookingglass Hatchery) spring chinook salmon carcasses recovered on the Minam River spawning ground surveys. Marked hatchery spring chinook salmon were estimated to comprise 15.9% of the carcasses sampled on the Minam River in 1993. We sampled 44 adult salmon carcasses which was an estimated 16.7% of the total spawning population in the Minam River.

On Lostine River spawning ground surveys in 1993, we recovered 2 coded-wire-tagged spring chinook salmon carcasses (1988 brood, tag codes 07-47-39 and 07-47-40, Lookingglass Hatchery releases), which comprised 2.7% of the carcasses sampled.

We recovered one coded-wire-tagged spring chinook salmon carcass (1989 brood, tag code 07-50-54, Lookingglass Hatchery release), and 2 ventral fin-marked spring chinook salmon carcasses (1989 brood Carson stock released from Lookingglass Hatchery) on the Wenaha River which comprised 10.3% of the carcasses sampled.

There were no marked hatchery fish recovered on spawning ground surveys on the Grande Ronde River, Wallowa River, Bear Creek, Hurricane Creek, and Catherine Creek.

Management Recommendations

1. Continue to monitor the growth patterns and smolt physiology of hatchery-reared salmon because of potential affects growth patterns may have on smolt quality and survival.

2. Continue to mark (Ad-RV+CWT) Lookingglass Hatchery releases of Rapid River stock spring chinook salmon so returning adults can be trapped at Lower Granite Dam and hauled to Lookingglass Hatchery. Evaluate the effectiveness of this strategy in reducing hatchery strays starting with 1995 adult returns.

3. Install the Lookingglass Hatchery weir in early March (prior to spring run-off), before spring chinook salmon start returning to Lookingglass Creek so escapement above Lookingglass Hatchery can be regulated. Operate the Lookingglass Hatchery fish ladder to trap and pass bull trout and summer steelhead adults above the Lookingglass weir to ensure that their migration is not impeded.

4. Mark individual Imnaha stock spring chinook salmon adults which are retained for hatchery broodstock in order track individual fish throughout holding and spawning. This will assist in record keeping required under our ESA section 10 permit and spawning activities.

5. Chinook salmon that are going to be released above the Imnaha River weir should be released the day they are processed from the trap. This should minimize disruption of adult migration patterns, and allow fish to select spawning locations and times naturally. Avoid late season releases of large numbers of surplus fish to allow for natural mate

selection and spawning distribution and prevent disruption of established redds and spawning fish.

6. Develop a cooperative management plan for the Imnaha chinook salmon supplementation program which will detail strategies to cope with possible large numbers of hatchery fish that will return from the 1993 brood year.

7. Broodstock collection guidelines for the Little Sheep Creek supplementation program should be adjusted to compensate for differences in run-timing possibly caused by variation in stream flows. Run-timing curves for summer steelhead at the Little Sheep Creek facility should be developed for high and low water years to ensure adults are collected proportionally from a cross section of the run.

8. Increase the contribution of naturally-produced summer steelhead to the Imnaha stock summer steelhead hatchery broodstock using such methods as sperm cryopreservation, spawn and release wild males, obtaining natural broodstock from other steelhead populations in the Imnaha basin, or by possibly reducing smolt production.

9. Develop alternative methods to more effectively utilize surplus adult summer steelhead at LSRCP facilities.

10. Continue to acclimate and release all Wallowa stock from Wallowa Hatchery or the Big Canyon facility facilities in order to take advantage of increased smolt-to-adult survival rates and adult trapping abilities.

11. Determine the accuracy of the discriminant scale model used to differentiate between natural and hatchery origin spring chinook salmon recovered on spawning ground surveys by comparing current growth rates of naturally-produced fish to the historical growth rates used in the scale model. Scale samples from known naturally-produced spring chinook salmon carcasses should be collected on spawning ground surveys in the Grande Ronde River Basin starting with the 1995 returns because 100% of the hatchery produced spring chinook salmon adults will be fin-marked. If growth rates of naturally-produced spring chinook salmon have changed since the time scale samples were collected for the historical scale model, then a new discriminant scale model can be developed and used to determine the origin of unmarked spring chinook salmon carcasses collected on previous surveys.

INTRODUCTION

The evaluation of LSRCP facilities in Oregon began in the fall of 1983. Work conducted during this report period (1 January 1993 to 31 December 1993) encompassed four areas of study: fish culture monitoring; survival studies; natural escapement monitoring; and planning. The specific objectives and tasks for this report period are reviewed in the five-year study plan (Carmichael 1989) and in the summary section of this report. Work conducted under fish culture monitoring, and survival studies was a continuation of ongoing studies. We began comprehensive spring chinook spawning ground surveys in 1986 because of the Pacific

Salmon Treaty's need for better escapement information. These surveys were funded in part with LSRCP and National Marine Fisheries Service funds. Results pertinent to straying of hatchery chinook salmon into northeast Oregon streams are presented in this report.

METHODS

Fish Culture Monitoring

Methods are generally described in the 1985-1991 annual reports (Carmichael and Messmer 1985; Carmichael et al. 1986a, 1987, 1988a; Messmer et al. 1989, 1990, 1991, 1992) and in the five-year study plan (Carmichael 1989).

Survival Studies

Methods are described in the 1985-1992 annual reports (Carmichael and Messmer 1985; Carmichael et al. 1986a, 1987, 1988a; Messmer et al. 1989, 1990, 1991, 1992). Statistical comparisons of cold-branded and Pit-tagged juvenile spring chinook salmon and summer steelhead median passage timing and survival at Lower Granite Dam were made using paired comparisons (Snedecor and Cochran 1967) at the 95% level of significance.

Natural Escapement Monitoring

Methods are described in the 1985-1992 annual reports (Carmichael and Messmer 1985; Carmichael et al. 1986a, 1987, 1988a, Messmer et al. 1989, 1990, 1991,1992). Estimates of straying levels for hatchery chinook salmon were made using methods described in Messmer et al. (1989, 1990, 1991).

We conducted spawning ground surveys cooperatively with ODFW management personnel on the Minam River from 24-25 August and 4, 13 September 1993, on the Wenaha River from 7-9 and 16 September 1993, and on the Lostine River on 28 August and 4, 13 September 1993. We examined all carcasses for fin marks and collected snouts from all adipose fin marked fish. Spawning population size was estimated as described in Carmichael et al. (1986b). Specifically, the estimated spawning populations in northeast Oregon streams (Table 38) were estimated by multiplying total redds observed on spawning ground surveys (index, extensive, and supplemental surveys) by 2.4 fish/redd. The number of coded-wire-tagged Rapid River stock spring chinook salmon that returned to the Grande Ronde River Basin was estimated by totalling Lookingglass Hatchery recoveries, Lookingglass Creek Tribal harvest, and expanded spawning ground survey recoveries. We expanded spawning ground survey recoveries for each stream by multiplying the proportion of coded-wire-tagged fish in the carcass sample by the estimated spawning population size.

RESULTS

Fish Culture Monitoring

Results of fish culture monitoring for spring chinook salmon are presented in Tables 1-13 and Figures 1-3, and for summer steelhead in Tables 14-22 and Figures 4 and 5.

Survival Studies

Results related to survival studies of spring chinook salmon and summer steelhead appear in Tables 23-37 and Figures 6-18.

Natural Escapement Monitoring

Results of natural escapement monitoring for spring chinook salmon are presented in Table 38 and Figure 19.

Planning

We completed annual reports for all scientific research and propagation conducted by ODFW in the Grande Ronde and Imnaha river basins under ESA Section 10 permits. Project personnel participated in the development and review of ESA section 7 biological assessments and attended consultation meetings with the United States Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS). We provided technical presentations to the Snake River Salmon Recovery Team. Project personnel assisted in the planning and writing of annual operation plans for all of Oregon's LSRCP facilities.

Table 1. Egg take and survival of spring chinook salmon at Lookingglass, Irrigon, and Umatilla hatcheries, 1991, 1992 and 1993 broods.

Stock, brood year	Number of eggs taken or received	Egg loss (%)	Egg-to-fry survival (%)	Egg-to-smolt survival (%)
Imnaha,				
1991	193,206	14.4	84.1	81.6
1992	542,005	13.5	85.8	(a)
1993	1,047,064	3.4	96.5	(b)
Rapid River,				
1991	515,951	3.2	96.2c	91.8

1992	1,352,799	3.2d	96.6e	(a)
1993	1,071,616f	9.0	90.2g	(b)

a 1992 brood smolts will be released in the spring of 1994.
b 1993 brood smolts will be released in the spring of 1995.
c Estimate does not include 26,694 eyed eggs shipped to Rapid River Hatchery.
d Estimate does not include 308,008 viable eggs shipped to Rapid River Hatchery.
e Estimate does not include 109,950 eyed eggs shipped to Rapid River Hatchery.
f Does not include 956,000 viable eggs shipped to the Nez Perce Tribe.
g Does not include 255,071 eyed eggs destroyed because of excess program needs.

Table 2. Results of fecundity sampling of Imnaha stock chinook salmon, 1988 and 1991-1993 brood years. Standard deviation is shown in parentheses.

Brood year, origin	Age 42			Age 52		
	n	Mean	Range	n	Mean	Range
1988,						
Natural	3	3,894(286)	3,567-4,101	25	6,432(889)	5,017-8,434
Hatchery	4	4,710(768)	4,034-5,696	2	6,422(950)	5,750-7,093
Combined	7	4,361(716)	3,567-5,696	27	6,432(874)	5,017-8,434
1991,						
Natural	2	4,336(483)	3,995-4,678	13	4,924(667)	3,703-6,183
Hatchery	13	4,667(864)	3,333-6,180	11	5,443(904)	4,081-7,065
Combined	15	4,624(818)	3,333-6,180	24	5,162(810)	3,703-7,065
1992,						
Natural	13a	4,867(476)	3,964-5,661	5	5,295(267)	4,935-5,686
Hatchery	37	4,897(845)	3,028-7,152	8	5,071(636)	4,055-5,784
Combined	51	4,889(757)	3,028-7,152	13	5,157(522)	4,055-5,784
1993,						
Natural	10a	4,689(635)	3,717-5,859	21a	5,887(766)	4,328-7,474
Hatchery	13	5,017(629)	3,730-6,010	12	6,065(714)	4,445-7,132
Combined	23	4,874(639)	3,717-6,010	33	5,953(743)	4,328-7,474

a Includes unmarked hatchery fish.

Table 3. Vital statistics for juvenile spring chinook salmon released in the Grande Ronde and Imnaha river basins, 1991 brood. Standard deviation is shown in parentheses.

Release dates	Number released	Size (fish/lb)	Location released	N	Mean fork length (mm)
RAPID RIVER STOCKa					
07 Apr 1993	305,643	19.3b	Lookingglass Creek	600	123(7.6)
07 Apr 1993	142,576	19.6c	Lookingglass Creek	601	124(7.4)
IMNAHA STOCKd					
12 Apr 1993	98,935	21.4	Imnaha River Facility	380	120(6.8)
12 Apr 1993	58,724	12.1	Imnaha River Facility	946	142(17.4)

a 100% AdRV+CWT marked.
b Standard density release group.
c One-half standard density release group.
d 100% Ad+CWT marked.

Table 4. Vital statistics for spring chinook salmon that returned to Lookingglass Hatchery, the Imnaha River facility, or were harvested in Lookingglass Creek, 1993. J = jacks, M = males, F = females. No spring chinook salmon returned to the Big Canyon facility in 1993.

Stock, origin	Total Number	Number of J	M	F	Number females spawned	Prespawning mortality (%) J	M	F
LOOKINGGLASS HATCHERY								
Carson,								

Hatchery	107	0	42	65	--	--	--
--							
Rapid River,							
Hatchery	1,020	22	457	541	422a	11.8b	3.6b
3.2b							
IMNAHA RIVER FACILITY							
Imnaha,							
Natural	650	4	286c	360d	54e	0.0	2.8
1.4							
Hatchery	593	16	227	350	139	6.3	10.6
12.6							
LOOKINGGLASS CREEK FISHERY							
Rapid River,							
Hatchery	70	0	24	46f	--	--	--
--							

a Includes 278 females spawned at Lookingglass Hatchery and 144 females spawned at Wallowa Hatchery.
b Lookingglass Hatchery prespawning mortality only, Wallowa Hatchery mortality not included.
c Includes an estimated 111 unmarked hatchery males.
d Includes an estimated 191 unmarked hatchery females.
e Includes an estimated 25 unmarked hatchery females.
f Includes 2 disk tagged fish released above the Lookingglass Hatchery Weir.

Table 5. Run timing for spring chinook salmon that returned to Lookingglass Hatchery (Rapid River stock) and the Imnaha River facility, 1993.

			Imnaha River facilitya			
	Lookingglass Hatcheryb		Natural fishc		Hatchery fish	
Time interval	Number	% of total	Number	% of total	Number	% of total
28 May-03 Jun	(d)	(d)	--	--	--	--
04-10 Jun	498	48.8	--	--	--	--
11-17 Jun	85	8.3	--	--	--	--
18-24 Jun	257	25.2	--	--	--	--

25 Jun-01 Jul	66	6.4	--	--	--	--	
02-08 Jul	18	1.7	34	5.2	23	3.9	
09-15 Jul	13	1.3	76	11.7	54	9.1	
16-22 Jul	(d)	(d)	144	22.2	113	19.1	
23-29 Jul	(d)	(d)	149	22.9	140	23.6	
30 Jul-05 Aug	22	2.2	35	5.4	49	8.3	
06-12 Aug	10	1.0	117	18.0	115	19.4	
13-19 Aug	10	1.0	45	6.9	47	7.9	
20-26 Aug	23	2.3	29	4.5	37	6.2	
27 Aug-02 Sep	8	0.8	18	2.8	8	1.3	
03-09 Sep	6	0.6	3	0.4	3	0.5	
10-16 Sep	4	0.4	0	0.0	4	0.7	

a Imnaha River facility trap operated from 2 July to 16 September.
b Lookingglass Hatchery trap operated from 28 May to 15 September.
c Includes some unmarked age 4 and age 5 hatchery fish.
d Fish were not taken from the trap and put into the adult holding ponds during this time period.

Table 6. Spawning timing of female spring chinook salmon that returned to Lookingglass Hatchery (spawned at Lookingglass Hatchery and Wallowa Hatchery) and the Imnaha River facility, 1993.

Time fish interval	Rapid River Stock				Imnaha stock			
	Lookingglass		Wallowa		Natural fish[a]		Hatchery	
	N	%	N	%	N	%	N	%
12 Aug	0	0.0	0	0.0	5	9.3	2	1.4
13-19 Aug	0	0.0	0	0.0	5	9.3	13	9.4
20-26 Aug	120	43.2	0	0.0	23	42.6	25	18.0
27 Aug-02 Sep	136	48.9	31	21.5	14	25.9	88	63.3
03-09 Sep	0	0.0	102	70.9	0	0.0	0	0.0
10-16 Sep	22	7.9	11	7.6	7	12.9	11	7.9

a Includes some unmarked age 4 and age 5 hatchery fish.

Table 7. Mating combinations for Imnaha stock chinook salmon spawned in 1993.
Fish were spawned in 2x2 matrixes. U = unmarked fish, H = marked hatchery fish, M = males, F = females, J = jacks. Unmarked fish include some age 4 and age 5 hatchery fish. Hatchery fish spawned as part of the chlorine egg disinfection study are not included (12 females and 8 males) because they were not matrix spawned.

Spawn date	Matrix composition M F H H H H	M F H H H U	M F H H U H	M F H H U U	M F U H U H	M F H U U H	M F U H U U	M F U U H U	M F U U U U
12 Aug	0	0	0	0	1	0	1	0	1
18 Aug	0	0	0	0	0	0	1	0	2
26 Aug	7	0	0	0	5	0	1	1	10
02 Sep	1	1	1	3	0	3	1	3	0
10 Sep	3	1	0	0	0	3	0	0	0
Totals	11	2	1	3	6	6	4	4	13

Table 8. Age composition of Imnaha stock chinook salmon spawned in 1993. Unmarked fish include some age 4 and age 5 hatchery fish. Hatchery fish spawned as part of the chlorine egg disinfection study are not included (12 females and 8 males) because they were not matrix spawned.

Spawn date	Unmarked fish Age 3 M	Age 3 F	Age 4 M	Age 4 F	Age 5 M	Age 5 F	Hatchery fish Age 3 M	Age 3 F	Age 4 M	Age 4 F	Age 5 M	Age 5 F
12 Aug	0	0	2	0	5	6	0	0	0	0	0	1
18 Aug	0	0	1	0	5	5	0	0	2	2	10	11
26 Aug	1	0	13	5	19	18	0	0	3	6	12	19
02 Sep	0	0	7	4	5	10	2	0	5	7	7	5
10 Sep	0	0	0	1	0	6	1	0	13	6	0	1
Totals	1	0	23	10	34	45	3	0	23	21	29	37

Table 9. Number of spring chinook salmon that were trapped and then released above the Imnaha River weir, 1993. The Imnaha River weir was operated from 2 July to 16 September. Unmarked fish include some age 4

and age 5 hatchery fish. An additional 16 males and 33 females were released in Lick Creek from 28 Jul-08 Sep, 1993.

Time interval		Number of fish released: Natural fish Jack	Natural fish Male	Natural fish Female	Hatchery fish Jack	Hatchery fish Male	Hatchery fish Female
02-08 Jul	0	9	16	0	5	2	
09-15 Jul	0	22	36	0	11	8	
16-22 Jul	1	49	71	0	25	17	
23-29 Jul	2	65	63	0	33	17	
30 Jul-05 Aug		0	43	44	0	12	17
06-12 Aug	0	20	24	0	1	0	
13-19 Aug	0	19	20	0	0	0	
20-26 Aug	0	8	16	0	0	0	
27 Aug-02 Sep		0	4	10	2	25	73
03-09 Sep	0	0	1	0	0	0	
10-16 Sep	0	0	0	0	0	0	
Totals	3	239	301	2	112	134	

Table 10. Number of spring chinook salmon that were trapped and then released above the Lookingglass Hatchery weir, 1993. The Lookingglass Hatchery trap was operated from 28 May to 15 September.

Time Interval		Jack	Male	Female
11-17 Jun	1	19	19	
18-24 Jun	0	9	10	
25 Jun-01 Jul		2	10	10
02-08 Jul	0	3	4	
09-15 Jul	0	2	2	
16-22 Jul	0	0	0	
23-29 Jul	0	0	0	
30 Jul-05 Aug		0	1	2
06-12 Aug	0	1	2	
13-19 Aug	0	1	1	
20-26 Aug	0	0	0	
27 Aug-02 Sep		0	0	0
03-09 Sep	0	0	0	
10-16 Sep	0	0	0	
Total released	3	46	50	

Table 11. Percent age composition of spring chinook salmon that returned to Lookingglass Hatchery (Rapid River stock) and the Imnaha River facility, 1993. Age nomenclature is that of Gilbert and Rich (1927). Percentages are based on total returns (male and female). For example, the percent age 42 males that returned to Lookingglass Hatchery is calculated by dividing the total number of age 42 males by the total returns (173/(479+541))*100 = 17.0%.

Age group, number	Lookingglass Hatchery		Imnaha River facility			
			Unmarked fish[a]		Hatchery fish	
	Male	Female	Male	Female	Male	Female
32	2.2	0.0	0.6	0.0	2.9	0.0
42	17.0	14.9	15.2	12.0	20.8	23.1
52	27.7	38.1	28.8	43.4	17.5	35.9
62	0.1	0.0	0.0	0.0	0.0	0.0
Number of fish	479	541	290	360	243	350

a Unmarked fish include some age 4 and age 5 hatchery fish.

Table 12. Mean fork length (mm) for age-specific groups of adult spring chinook salmon, 1993. Age nomenclature is that of Gilbert and Rich (1927). Standard deviation is shown in parentheses.

Stock, origin	Age 32				Age 42			
	Male		Female		Male		Female	
	N	Length	N	Length	N	Length	N	Length
LOOKINGGLASS HATCHERY								
Rapid River, Hatchery	19	478(44)	0	--	151	740(49)	138	717(40)
IMNAHA RIVER FACILITY								
Imnaha,								

Unmarkeda	1	545	0	--	16	753(52)	12	777(36)
Hatchery	14	547(43)	0	--	55	758(54)	71	790(35)

Stock, origin	Age 52 Male N	Length	Female N	Length	Age 62 Male N	Length	Female N	Length
LOOKINGGLASS HATCHERY								
Rapid River, Hatchery	234	895(47)	312	845(37)	1	950	0	--
IMNAHA RIVER FACILITY								
Imnaha, Unmarkeda	29	956(61)	44	906(43)	0	--	0	--
Imnaha, Hatchery	39	965(56)	110	902(46)	0	--	0	--

a Unmarked age 4 and age 5 fish include some hatchery fish.

Table 13. Results of condition factor hepatosomatic index, and hematocrit sampling in 1991 brood, Imnaha stock, spring chinook salmon juveniles which exhibited bimodal length frequency distributions. Standard deviation is shown in parentheses and standard error is shown in brackets. * indicates a significant difference and NS indicates no difference between the upper and lower modal groups.

Date, characteristic	Lower modal group N	Mean	(SD)	[SE]	Upper modal group N	Mean	(SD)	[SE]	Signif-icance
21 Jan 1993, Condition factora	10	1.21	0.04	0.01	10	1.20	0.06	0.02	NS
Hepatosomatic									

indexb	10	1.85	0.24	0.08	10	1.69	0.16	0.05	NS
26 Feb 1993,									
Condition factora	10	1.22	0.06	0.02	10	1.16	0.06	0.02	*
Hepatosomatic indexb	10	1.70	0.19	0.06	10	1.50	0.13	0.04	*
Hematocritc	10	41.0	3.48	1.10	12	39.5	3.19	1.01	NS

a Expressed as 100*liver weight(g)/body weight(g).
b Expressed as the percent of whole blood that was accounted for by red blood cells.
c Expressed as 100,000*weight(g)/fork length(mm)3.

Table 14. Egg take and egg survival of Wallowa and Imnaha stocks of summer steelhead, 1992 and 1993 broods.

Stock, brood year	Eggs taken	Egg loss (%)	Egg-to-fry survival (%)	Egg-to-smolt survival (%)
Wallowa,				
1992	2,531,788	16.2	80.4a	59.2
1993	2,258,846	26.2	68.6b	(c)
Imnaha,				
1992	749,330	20.0d	76.9e	57.5
1993	647,272	19.2	79.0f	(c)

a Does not include 225,000 eyed eggs shipped to Lyons Ferry Hatchery.
b Does not include 272,000 eyed eggs shipped to Lyons Ferry Hatchery.
c 1993 brood smolts will be released in the spring of 1994.
d Does not include 121,500 viable eggs dumped because of excess program needs.
e Does not include 20,000 fry lost to water flow interruption and 6,000 fry dumped because of excess program needs.
f Does not include 40,200 eyed eggs and 33,000 fry dumped because of excess program needs.

Table 15. Vital statistics for juvenile summer steelhead released in the Grande Ronde and Imnaha river basins, 1992 brood year. All fish were adipose fin marked. Standard deviation is shown in parentheses.

	Mean

Stock, date released	Number released	Size (fish/lb)	Location of release	N	fork length (mm)
Wallowa,					
04/19/93	495,164	4.6	Wallowa Hatchery	442	205(18.7)
05/05/93	161,063	5.1	Wallowa Hatchery	221	203(20.9)
04/12-15/93	200,111	5.1	Upper Grande Ronde River	289	194(16.1)
04/15-16/93	62,563	5.7	Catherine Creek	990	199(17.1)
04/23/93	223,943	4.9	Big Canyon facility	412	203(18.2)
05/07/93	157,460	5.4	Big Canyon facility	313	199(17.7)
04/23/93	51,574	5.0	Deer Creek	208	203(17.6)
04/26-27/93	50,188a	4.9	Lower Grande Ronde River	--	--
Imnaha,					
04/28/93	237,969	5.4	Little Sheep Creek facility	209	196(20.7)
04/28/93	48,725	6.4	Little Sheep Creek	257	188(18.7)
04/29/93	53,692	6.1	Imnaha River	274	192(22.0)

a Reared at Lyon's Ferry Hatchery.

Table 16. Vital statistics for adult summer steelhead that returned to the Big Canyon facility, Wallowa Hatchery, and Little Sheep Creek facility, 1993.

Location, origin	Total	Male	Female	Number of females spawned	Prespawning mortality (%) Male	Female
Big Canyon facility,						
Natural	28	17	11	0	--	--
Hatchery	342	176	166	19	0	0.6

Wallowa Hatchery, Hatchery	1,353	801	552	495	3.2	0.5
Little Sheep Creek facility,						
Natural	99	21	78	18	0.0	0.0
Hatchery	1,773	756	1,017	116	1.0	0.3

Table 17. Run timing for adult summer steelhead that returned to the Big Canyon facility, Wallowa Hatchery, and Little Sheep Creek facility, 1993.

Time interval	Big Canyon facilitya Natural fish Number	Big Canyon facilitya Natural fish % of Total	Big Canyon facilitya Hatchery fish Number	Big Canyon facilitya Hatchery fish % of Total	Wallowa Hatcheryb Number	Wallowa Hatcheryb % of Total
01-04 Mar	--	--	--	--	0	0.0
05-11 Mar	--	--	--	--	0	0.0
12-18 Mar	--	--	--	--	0	0.0
19-25 Mar	--	--	--	--	47	3.5
26 Mar-01 Apr	--	--	--	--	245	18.1
02-08 Apr	--	--	--	--	130	9.6
09-15 Apr	--	--	--	--	486	35.9
16-22 Apr	7	25.0	169	49.4	169	12.5
23-29 Apr	7	25.0	86	25.2	121	8.9
30 Apr-06 May	5	17.9	41	12.0	71	5.3
07-13 May	5	17.9	26	7.6	37	2.7
14-20 May	2	7.1	9	2.6	45	3.3
21-27 May	2	7.1	10	2.9	2	0.2
28 May-03 Jun	0	0.0	1	0.3	--	--

Time interval	Little Sheep Creek facilityc Natural fish Number	Little Sheep Creek facilityc Natural fish % of Total	Little Sheep Creek facilityc Hatchery fish Number	Little Sheep Creek facilityc Hatchery fish % of Total
01-04 Mar	0	0.0	0	0.0
05-11 Mar	0	0.0	0	0.0
12-18 Mar	0	0.0	1	0.1
19-25 Mar	6	6.1	75	4.2
26 Mar-01 Apr	11	11.1	186	10.5
02-08 Apr	14	14.1	282	15.9
09-15 Apr	11	11.1	338	19.1

16-22 Apr	20	20.2	317	17.9
23-29 Apr	22	22.3	350	19.7
30 Apr-06 May	8	8.1	111	6.3
07-13 May	2	2.0	82	4.6
14-20 May	1	1.0	13	0.7
21-27 May	2	2.0	11	0.6
28 May-03 Jun	2	2.0	7	0.4

a Big Canyon facility trap operated from 16 April to 1 June 1993.
b Wallowa Hatchery trap operated from 1 March to 25 June 1993.
c Little Sheep Creek trap operated from 1 March to 6 June 1993.

Table 18. Time of spawning for adult summer steelhead that returned to Wallowa Hatchery, the Big Canyon facility, and the Little Sheep Creek facility, 1993.

	Wallowa Hatchery		Big Canyona Facility		Little Sheep Creek facility			
					Natural fish		Hatchery fish	
Time interval	Number	% of total	Number	% of total	Number	% of total	Number	% of total
12-18 Mar	0	0.0	--	--	0	0.0	0	0.0
19-25 Mar	0	0.0	--	--	0	0.0	0	0.0
26 Mar-01 Apr	60	12.1	--	--	1	5.6	11	9.5
02-08 Apr	67	13.5	--	--	2	11.1	22	19.0
09-15 Apr	199	40.2	--	--	0	0.0	36	31.0
16-22 Apr	60	12.1	0	0.0	2	11.1	22	19.0
23-29 Apr	46	9.3	0	0.0	2	11.1	11	9.5
30 Apr-06 May	31	6.3	0	0.0	4	22.2	5	4.3
07-13 May	22	4 5	9	47.4	6	33.3	6	5.1
14-20 May	10	2.0	5	26.3	0	0.0	3	2.6
21-27 May	0	0.0	5	26.3	1	5.6	0	0.0

a The Big Canyon facility trap was operated from 16 April to 1 June 1993.

Table 19. Percent age composition for adult summer steelhead that returned to the Big Canyon facility, Wallowa Hatchery, and the Little Sheep Creek facility, 1993. Age is expressed as years spent in freshwater prior to ocean migration:years spent in ocean prior to spawning migration. Percentages are based on total returns (male and female). For example, the percent age 1:1 males that returned to Wallowa Hatchery is calculated by dividing the total number of age 1:1 males by the total returns (713/(801+552))*100 = 53.9%.

Age group, number	Big Canyon facility				Wallowa Hatchery	
	Natural fish		Hatchery fish			
	Male	Female	Male	Female	Male	Female
1:1	0.0	0.0	44.8	30.1	53.9	21.1
1:2	0.0	0.0	6.7	18.4	5.3	19.6
2:1	35.7	21.4	0.0	0.0	0.0	0.0
2:2	25.0	17.9	0.0	0.0	0.0	0.1
Number of fish	17	11	176	166	801	552

Age group, number	Little Sheep Creek facility			
	Natural fish		Hatchery fish	
	Male	Female	Male	Female
1:1	0.0	0.0	37.3	35.7
1:2	0.0	0.0	5.3	21.7
2:1	15.2	53.5	0.0	0.0
2:2	6.1	25.2	0.0	0.0
Number of fish	21	78	756	1,017

Table 20. Mean fork length (mm) by age group for adult summer steelhead that returned to the Big Canyon facility, Wallowa Hatchery, and the Little Sheep Creek facility, 1993. Standard deviation is shown in parentheses.

Age group	Big Canyon Facilitya				Wallowa Hatchery			
	Male		Female		Male		Female	
	N	Length	N	Length	N	Length	N	Length
1:1	62	570(26)	36	558(21)	250	581(25)	132	571(27)
1:2	2	705(49)	12	656(36)	33	702(40)	150	680(34)
2:1	0	--	0	--	0	--		
2:2	0	--	0	--	1	710		

		Little Sheep Creek facility							
		Natural fish				Hatchery fish			
Age		Male		Female		Male		Female	
group	N	Length	N	Length		N	Length	N	Length
1:1	0	--	0	--	304	569(25)	271	557(21)	
1:2	0	--	0	--	52	705(34)	143	676(28)	
2:1	1	595	7	556(37)	0	--	0	--	
2:2	3	721(77)	12	650(29)	0	--	0	--	

a Hatchery fish only, no lengths were taken off wild fish released above the
Big Canyon Facility weir.

Table 21. Number of adult summer steelhead trapped then released above the Big Canyon facility, 1993. The Big Canyon facility trap was operated from 16 April to 1 June 1993.

Trapping and release time period		Natural fish		Hatchery fish	
		Male	Female	Male	Female
16-22 Apr	4	3	3	4	
23-29 Apr	6	1	1	6	
30 Apr-06 May	3	2	2	3	
07-13 May	2	3	3	2	
14-20 May	2	0	0	2	
20-27 May	0	2	2	0	
Total released	17	11	11	17	

Table 22. Number of adult summer steelhead trapped then released above the Little Sheep Creek facility, 1993. The Little Sheep Creek trap was operated from 1 March to 6 June 1993.

Trapping and release time period	Natural fish		Hatchery fish	
	Male	Female	Male	Female

12-18 March	0	0	0	
19-25 March	2	2	2	
26 March-01 Apr	4	6	5	3
02-08 Apr	1	9	10	3
09-15 Apr	1	6	6	0
16-22 Apr	4	12	12	4
23-29 Apr	2	15	15	2
30 Apr-06 May	1	6	3	1
07-13 May	1	1	4	1
14-20 May	0	1	1	0
21-27 May	0	1	1	0
28 May-03 Jun	1	1	1	1
Total released	17	60	60	17

Table 23. Release information for Ad+CWT marked spring chinook salmon juveniles released in the Grande Ronde and Imnaha river basins, 1991 brood. Rapid River stock spring chinook salmon were released at Lookingglass Hatchery and Imnaha stock chinook at the Imnaha River Facility. 0.5 STD = experimental release group reared at one-half standard density, 1.0 STD = experimental release group reared at standard density, 20/lb PRD = 20 fish/lb production release groups, 25/lb ACC = 25 fish/lb experimental acclimated release group, and 15/lb ACC = 15 fish/lb experimental acclimated release group. Standard deviation is shown in parentheses.

Location of release, Mean release group	CWT code	Date	Number released	N	Mean fork length (mm)	Mean weight (g)	Mean condition factor
	replicates						
RAPID RIVER STOCK							
Lookingglass Hatchery,							
0.5 STD	07 15 48	04/07/93	35,011	296a	123(7.0)	22.2(4.1)	1.20(0.06)
0.5 STD	07 15 49	04/07/93	35,002	305a	126(7.5)	24.0(4.2)	1.19(0.07)
1.0 STD	07 15 46	04/07/93	35,580	300a	123(8.2)	24.0(4.2)	1.26(0.07)
1.0 STD	07 15 47	04/07/93	35,583	(b)	(b)	(b)	(b)

1.0 STD	07 15 50	04/07/93	35,351	300a	122(6.9)	23.0(4.1) 1.25(0.10)
1.0 STD	07 15 51	04/07/93	35,460	(b)	(b)	(b) (b)
20/lb PRD	07 15 52	04/07/93	36,445	271a	124(7.5)	23.5(7.5) 1.24(0.09)
20/lb PRD	07 15 53	04/07/93	34,812	300a	124(6.6)	25.0(6.6) 1.27(0.08)
20/lb PRD	07 15 54	04/07/93	35,190	305a	124(6.8)	23.7(3.7) 1.22(0.07)
20/lb PRD	07 15 55	04/07/93	34,822	300a	124(6.0)	23.8(3.3) 1.24(0.09)
20/lb PRD	07 15 56	04/07/93	35,176	311a	125(6.9)	22.5(3.7) 1.14(0.06)
20/lb PRD	07 15 57	04/07/93	34,753	304a	123(6.5)	23.8(3.5) 1.21(0.09)
20/lb PRD	07 15 58	04/07/93	20,063	333a	125(6.3)	23.1(3.6) 1.15(0.07)
IMNAHA STOCK						
Imnaha River facility,						
25/lb ACC	07 15 40	04/12/93	49,077	185c	120(6.1)	21.2(3.5) 1.21(0.07)
25/lb ACC	07 15 41	04/12/93	49,365	195d	119(7.4)	21.1(5.5) 1.23(0.07)
15/lb ACC	07 15 38	04/12/93	29,330	507e	143(16.8)	38.6(15.7) 1.21(0.07)
15/lb ACC	07 15 39	04/12/93	29,114	439f	141(16.8)	36.5(16.1) 1.21(0.07)

a N = 100 for mean weight and mean condition factor.
b Sample size, mean length, mean weight, and mean condition factor are the same as the replicate release group.
c N = 134 for mean weight and mean condition factor.
d N = 138 for mean weight and mean condition factor.
e N = 187 for mean weight and mean condition factor.
f N = 157 for mean weight and mean condition factor.

Table 24. Recovery information for Ad+CWT marked spring chinook salmon that returned to Lookingglass Hatchery, the Imnaha River weir, that were recovered on Northeast Oregon spawning ground surveys, or were harvested in Lookingglass Creek, in 1993. Standard deviation is shown in parentheses.

	Number	Mean fork

Brood year, CWT code	recovered Male	recovered Female	length (mm) Male	length (mm) Female	Mean weight (kg) Male	Mean weight (kg) Female
LOOKINGGLASS HATCHERY						
1987,						
07 45 33 1	0	950	--	8.2	--	
1988,						
07 47 39 27	25	903(39)	845(52)	7.1(0.9)	6.0(1.0)	
07 47 40 19	19	912(39)	848(47)	7.2(1.0)	6.4(0.9)	
07 47 43 17	27	874(49)	827(30)	6.0(1.2)	5.8(0.7)	
07 47 45 14	17	890(41)	836(28)	6.5(0.8)	6.0(0.7)	
07 47 30a 0	2	--	868(60)	--	7.6(1.6)	
07 51 09b 1	0	920	--	--	--	
23 24 35c 0	1	--	884	--	8.2	
1989,						
07 50 51 14	18	701(57)	710(30)	3.0(0.7)	3.6(0.5)	
07 50 48 10	18	741(40)	688(49)	3.7(0.5)	3.3(0.6)	
07 50 53 27	15	739(51)	721(31)	3.8(0.8)	3.9(0.5)	
07 50 54 21	14	740(39)	724(52)	4.0(1.1)	3.9(0.5)	
07 50 45a 2	0	745(42)	--	4.2(1.1)	--	
1990,						
07 47 46 1	0	510	--	1.3	--	
07 50 55 2	0	490(7)	--	0.8	--	
IMNAHA RIVER WEIRd						
1988,						
07 47 29 12[14]	35[43]	962(47)	907(42)	8.5(1.0)	8.0(1.3)	
07 47 30 14[19]	39[51]	963(60)	907(42)	8.5(1.2)	8.0(1.3)	
07 47 33 15[19]	41[52]	978(68)	915(30)	7.8(1.7)	8.6(0.9)	
07 47 39 14[21]	36[51]	986(40)	905(43)	9.2(2.0)	7.9(1.3)	
23 24 32c 0	1[1]	--	910	--	--	
1989,						
07 50 40 15[21]	9[14]	749(51)	803(29)	4.3(0.3)	5.8(0.8)	
07 50 43 15[22]	11[15]	782(53)	787(50)	5.1(0.8)	4.7(0.1)	
07 50 45 10[16]	5[8]	743(63)	812(21)	4.5(1.1)	6.0(0.6)	
07 50 46 12[16]	12[21]	781(45)	802(49)	4.5(0.9)	5.9(0.6)	

Table 24. Continued.

Brood year, CWT code	Number recovered Male	Female	Mean fork length (mm) Male	Female	Mean weight (kg) Male	Female
IMNAHA RIVER WEIRdcont.						
1990,						
07 58 44 2[2]	0		535(21)	--	1.4	--
07 58 45 1[1]	0		535 --	--	--	
07 58 46 5[6]	0		559(40)	--	2.0(0.2)	--
07 58 47 5[6]	0		564(20)	--	1.9(0.3)	--
07 58 49 1[1]	0		435 --	0.8	--	
SPAWNING GROUND SURVEYS						
Imnaha River:						
1988,						
07 47 29 3	6		1,015(22)	873(29)	--	--
07 47 30 1	5		1,005	918(23)	--	--
07 47 33 2	2		930(0)	940(0)	--	--
07 47 34 1	3		950	903(43)	--	--
1989,						
07 50 40 0	1		--	850	--	--
07 50 43 1	0		780	--	--	--
07 50 45 2	1		780(42)	800	--	--
Lostine River:						
1988,						
07 47 39 0	1		--	810	--	--
07 47 40 0	1		--	820	--	--
Minam River:						
1988,						
07 47 39 0	1		--	830	--	--
23 24 29c 1	0		870	--	--	--
1989,						
07 50 53 1	1		720	750	--	--
07 50 54 0	1		--	670	--	--
Wenaha River:						
1989,						
07 50 54 0	1		--	660	--	--
1990,						
07 58 47 1	0		530	--	--	--
07 58 48 1	0		510	--	--	--

Table 24. Continued.

Brood year, CWT code	Number recovered Male	Number recovered Female	Mean fork length (mm) Male	Mean fork length (mm) Female	Mean weight (kg) Male	Mean weight (kg) Female
SPAWNING GROUND SURVEYS cont.						
Lookingglass Creek:						
1988,						
07 47 39 1	5	880	851(46)	--	--	
07 47 40 2	2	890(42)	800(71)	--	--	
07 47 43 0	1	--	870	--	--	
1989,						
07 50 48 0	2	--	693(11)	--	--	
07 50 51 0	2	--	685(35)	--	--	
07 50 53 0	1	--	700	--	--	
07 50 54 2	0	773(46)	--	--	--	
1990,						
07 53 05 1	0	490	--	--	--	
LOOKINGGLASS CREEK TRIBAL FISHERY						
1988,						
07 47 39 1	1	890	865	--	--	
07 47 40 3	3	888(13)	840(41)	--	--	
07 47 43 0	2	--	850(14)	--	--	
07 47 45 0	2	--	870(28)	--	--	
1989,						
07 50 48 1	0	0	720	--	--	

a Imnaha stock recovered at Lookingglass Hatchery.
b Umatilla River release recovered at Lookingglass Hatchery.
c Hatchery fish of unknown origin tagged by NMFS at Lower Granite Dam.
d Imnaha River weir recoveries include adipose marked fish released above the weir. Observed recoveries (hatchery plus spawning ground survey recoveries of trapped and released fish) are shown under the number recovered column and expanded numbers (expanded for fish released and not recovered on spawning ground surveys) are shown in brackets.

Table 25. Release information for Ad-LV+CWT marked summer steelhead released in the Grande Ronde and Imnaha river basins, 1992 brood year. 5/lb = releases of fish targeted for 5 fish/lb, PRD = production monitoring releases, ACC = acclimated experimental releases, and DSR = direct stream experimental releases. Standard deviation is shown in parentheses.

Location of release, release group	CWT code replicates released	Date released	Number released	N	Mean fork length (mm)	Mean weight (g)	Mean condition factor
WALLOWA STOCK							
Wallowa Hatchery, 5/lb PRD	07 61 06	04/19/93	26,088	141	213(16.6)	103.4(25.8)	1.07(0.06)
5/lb PRD	07 61 07	04/19/93	25,413	129	204(17.7)	93.3(25.1)	1.07(0.06)
Big Canyon Facility, 5/lb ACC	07 61 02	04/23/93	25,890	203a	204(20.3)	96.1(29.3)	1.08(0.06)
5/lb ACC	07 61 03	04/23/93	25,222	(b)	(b)	(b)	(b)
5/lb DSR	07 61 04	04/23/93	23,274	208c	203(17.6)	91.0(21.6)	1.06(0.06)
5/lb DSR	07 61 05	04/23/93	24,818	(b)	(b)	(b)	(b)
IMNAHA STOCK							
Little Sheep Creek facility, 5/lb ACC	07 60 61	04/28/93	24,357	104	198(16.5)	84.8(20.1)	1.07(0.07)
5/lb ACC	07 60 62	04/28/93	24,806	139	190(17.6)	74.7(20.1)	1.06(0.07)
5/lb DSR	07 61 01	04/28/93	23,382	257	188(18.7)	70.6(19.3)	1.04(0.06)
5/lb DSR	07 60 63	04/28/93	22,560	(b)	(b)	(b)	(b)

a N = 50 for mean weight and mean condition factor.

b Sample size, mean length, mean weight, and mean condition factor are the
same as the replicate release group.
c N = 100 for mean weight and mean condition factor.

Table 26. Recovery information for Ad-LV+CWT marked summer steelhead that returned to Wallowa Hatchery, the Big Canyon Facility, and the Little Sheep Creek facility in 1993. Standard deviation is shown in parentheses.

Brood year, CWT Code	Number recovered Male	Number recovered Female	Mean fork length(mm) Male	Mean fork length(mm) Female	Mean weight (kg) Male	Mean weight (kg) Female
WALLOWA HATCHERY						
1989,						
07 51 18 2	6		699(21)	655(28)	2.7(0.2)	2.6(0.5)
07 51 19 3	10		690(64)	681(47)	3.1(0.6)	3.0(0.7)
07 51 20 3	4		706(77)	667(23)	3.0(1.3)	2.7(0.4)
07 51 21 6	12		724(37)	671(38)	3.3(0.4)	2.6(0.5)
07 51 22 1	3		699	680(44)	2.8	2.9(0.4)
07 51 23 2	10		653(11)	675(34)	2.7	2.7(0.7)
1990,						
07 54 43 30	6		582(31)	560(5)	1.7(0.3)	1.6(0.1)
07 54 44 27	10		578(25)	582(18)	1.6(0.3)	1.8(0.2)
07 53 59 26	8		581(17)	580(16)	1.6(0.2)	1.7(0.2)
07 53 60 51	13		579(28)	557(25)	1.6(0.2)	1.5(0.3)
BIG CANYON FACILITY						
1990,						
07 53 51 13	8		572(24)	552(23)	1.6(0.2)	1.5(0.2)
07 53 52 12	7		579(26)	566(12)	1.8(0.3)	1.7(0.2)
07 53 53 7	2		568(20)	567(20)	1.6(0.2)	1.4b
07 53 54 8	4		561(38)	541(27)	1.6(0.3)	1.5(0.2)
LITTLE SHEEP CREEK FACILITY						
1989,						
07 51 24 11	41		707(39)	664(28)	3.0(0.4)	2.6(0.4)
07 51 25 8	36		706(29)	681(25)	2.9(0.6)	2.8(0.4)
1990,						
07 53 57 66	82		567(34)	559(19)	1.5(0.3)	1.6(0.2)
07 53 58 103	71		568(25)	559(20)	1.6(0.2)	1.6(0.2)
07 53 55 28	25		558(22)	543(22)	1.5(0.3)	1.6(0.2)
07 53 56 24	20		565(30)	556(18)	1.6(0.3)	1.6(0.1)

07 54 44a	1	0	555	--	1.6	--	

a Wallowa Hatchery release.
b N = 1 for mean weight.

Table 27. Release information for cold-branded spring chinook salmon juveniles released in the Grande Ronde and Imnaha river basins, 1991 brood. 0.5 STD = experimental release group reared at one-half standard density, 1.0 STD = experimental release group reared at standard density, 25/lb ACC = 25 fish/lb experimental acclimated release group, and 15/lb ACC = 15 fish/lb experimental acclimated release group. Standard deviation is shown in parentheses.

Location of release, release group	Brand rep-licates	Date released	Number released	N	Mean fork length (mm)	Mean weight (g)	Mean condition factor
RAPID RIVER STOCK							
Lookingglass Hatchery,							
0.5 STD	RA-A-1	04/07/93	20,537	296a	123(7.0)	22.2(4.1)	1.20(0.06)
0.5 STD	LA-A-1	04/07/93	20,695	305a	126(7.5)	24.0(4.2)	1.19(0.07)
1.0 STD	LA-A-3	04/07/93	20,541	300a	123(8.2)	24.0(4.2)	1.26(0.07)
1.0 STD	RA-A-3	04/07/93	20,047	300a	122(6.9)	23.0(4.1)	1.25(0.10)
Imnaha River facility,							
25/lb ACC	LA-A-2	04/12/93	20,271	185b	120(6.1)	21.2(3.5)	1.21(0.07)
25/lb ACC	RA-A-2	04/12/93	20,384	195c	119(7.4)	21.1(5.5)	1.23(0.07)
15/lb ACC	RA-A-4	04/12/93	20,094	507d	143(16.8)	38.6(15.7)	1.21(0.07)
15/lb ACC	LA-A-4	04/12/93	20,385	439e	141(16.8)	36.5(16.1)	1.21(0.07)

a N = 100 for mean weight and mean condition factor.
b N = 134 for mean weight and mean condition factor.
c N = 138 for mean weight and mean condition factor.
d N = 187 for mean weight and mean condition factor.
e N = 157 for mean weight and mean condition factor.

Table 28. Recovery information for cold-branded, downstream migrant, Rapid River, and Imnaha stock spring chinook salmon smolts recaptured at Lower Granite Dam in 1993, 1991 brood year. Cumulative recoveries by week are expanded for spillway efficiency. 0.5 STD = experimental release group reared at one-half standard density, 1.0 STD = experimental release group reared at standard density, 25/lb ACC = 25 fish/lb experimental acclimated release group, and 15/lb = 15 fish/lb experimental acclimated release group.

Stock, release group	Brand rep-licates	Date released	Estimated number releaseda	Number observed	Estimated number recovered	Percent of number released
Rapid River,						
0.5 STD	RA-A-1	04/07/93	20,537	197	7,233	35.7
0.5 STD	LA-A-1	04/07/93	20,695	169	7,168	34.6
1.0 STD	LA-A-3	04/07/93	20,541	187	5,711	27.8
1.0 STD	RA-A-3	04/07/93	20,047	176	5,390	26.9
Imnaha,						
25/lb ACC	LA-A-2	04/12/93	20,271	69	5,505	27.2
25/lb ACC	RA-A-2	04/12/93	20,384	89	7,490	36.7
15/lb ACC	RA-A-4	04/12/93	20,094	61	4,289	21.7
15/lb ACC	LA-A-4	04/12/93	20,385	68	5,793	28.4

Stock,	Cumulative percent of recoveries by week of the yearb									
brand code	14	15	16	17	18	19	20	21	22	23 24
Rapid River,										
RA-A-1	0.0	0.4	16.8	57.7	90.4	97.2	100	--	--	-- --

LA-A-1	0.0	0.1	13.7	52.8	87.7	98.2	99.5	100	--	--
LA-A-3	0.0	1.1	22.8	68.3	96.3	98.8	98.8	98.8	98.8	100
RA-A-3	0.0	0.7	24.8	65.6	97.1	100	--	--	--	--
Imnaha,										
LA-A-2	--	0.2	0.2	15.6	64.6	91.0	100	--	--	--
RA-A-2	--	0.0	0.0	15.0	56.4	87.2	99.5	100	--	--
RA-A-4	--	0.0	5.6	23.8	62.7	92.6	100	--	--	--
LA-A-4	--	0.0	1.7	12.3	57.2	90.1	99.3	100	--	--

b Rapid River stock released at Lookingglass Hatchery and Imnaha stock at the Imnaha River facility.

a Week 1 of the year is 1-7 January and week 52 of the year is 24-31 December. Weeks 2-51 are 7 day intervals except in leap years when week 9 is 8 days.

Table 29. Release information for cold-branded summer steelhead juveniles released in the Grande Ronde and Imnaha river basins, 1992 brood year. 5/lb = releases of fish targeted for 5 fish/lb, PRD = production monitoring releases, ACC = acclimated experimental releases, and DSR = direct stream experimental releases. Standard deviation is shown in parentheses.

Location of release group	Brand rep-licates	Date released	Number released	N	Mean fork length (mm)	Mean weight (g)	Mean condition factor
WALLOWA STOCK							
Wallowa Hatchery,							
5/lb PRD	LA-J-2	04/19/93	20,510	141	213(16.6)	103.4(25.8)	1.07(0.06)
5/lb PRD	RA-J-2	04/19/93	20,735	129	204(17.7)	93.3(25.1)	1.07(0.06)

IMNAHA STOCK
Little Sheep Creek facility,

5/lb ACC	RA-J-1	04/28/93	20,198	104	198(16.5)	84.8(20.1)	1.07(0.07)
5/lb ACC	LA-J-1	04/28/93	20,126	139	190(17.6)	74.7(20.1)	1.06(0.07)
5/lb DSR	RA-J-3	04/28/93	20,314	126	189(17.2)	71.0(18.4)	1.03(0.05)
5/lb DSR	LA-J-3	04/28/93	20,771	131	187(20.1)	70.2(20.1)	1.04(0.06)

Table 30. Recovery information for cold-branded downstream migrant Wallowa and Imnaha stock summer steelhead smolts recaptured at Lower Granite Dam in 1993, 1992 brood year. Cumulative recoveries by week are expanded for spillway efficiency. Recoveries are from time of release through 15 July. 5/lb = releases of fish targeted for 5 fish/lb, PRD = production monitoring releases, ACC = acclimated experimental releases, and DSR = direct stream experimental releases.

Stock, release group	Brand rep-licates	Date released	Number released	Number observed	Estimated number recovered	Percent of number released
Wallowa,						
5/lb PRD	LA-J-2	04/19/93	20,510	152	10,924	53.3
5/lb PRD	RA-J-2	04/19/93	20,735	145	9,732	46.9
Imnaha,						
5/lb PRD	RA-J-1	04/28/93	20,198	94	6,403	31.7
5/lb PRD	LA-J-1	04/28/93	20,126	88	5,137	25.5
5/lb DSR	RA-J-3	04/28/93	20,314	129	9,540	47.0
5/lb DSR	LA-J-3	04/28/93	20,771	106	6,926	33.3

Stock,	Cumulative percent of recoveries by week of the yeara□

brand code	16	17	18	19	20	21	22	23	24	25	26	27	28
Wallowa,													
LA-A-2	0.0	11.4	30.0	70.2	93.0	97.8	98.8	99.1	99.3	99.6	99.9	100	--
RA-A-2	0.0	12.4	25.8	64.9	91.6	96.1	98.0	98.7	99.3	99.5	99.9	100	--
Imnaha,													
RA-J-1	--	0.9	40.0	79.1	89.4	94.7	98.3	98.8	99.3	99.9	100	--	--
LA-J-1	--	0.0	29.2	55.6	88.1	94.3	96.0	96.6	98.3	98.8	99.8	99.9	100
RA-J-3	--	0.0	47.2	81.9	96.0	97.2	98.4	98.8	99.4	99.7	99.8	100	--
LA-J-3	--	0.0	46.2	83.1	90.5	93.8	97.2	98.1	99.0	99.5	99.8	99.9	100

a Week 1 of the year is 1-7 January and week 52 of the year is 24-31 December.

Weeks 2-51 are 7 day intervals except in leap years when week 9 is 8 days.

Table 31. Release information for PIT-tagged spring chinook salmon juveniles released in the Grande Ronde and Imnaha river basins, 1991 brood. 0.5 STD = experimental release group reared at one-half standard density, 1.0 STD = experimental release group reared at standard density, 25/lb ACC = 25 fish/lb experimental acclimated release group, and 15/lb ACC = 15 fish/lb experimental acclimated release group. Mean fork length, weight, and condition factor are at time of release and sample sizes are shown in Table 22. Standard deviation is shown in parentheses.

Location of release group	Representative experimental marks: CWT code(s)	Brand code	Date released	Number released	Mean fork length (mm)	Mean weight (g)	Mean condition factor
RAPID RIVER STOCK							
Lookingglass Hatchery,							

0.5 STD	07 15 48	RA-A-1	04/07/93	500	123(7.0)	22.2(4.1)	1.20(0.06)
0.5 STD	07 15 49	LA-A-1	04/07/93	498	126(7.5)	24.0(4.2)	1.19(0.07)
1.0 STD	07 15 50	RA-A-3	04/07/93	499	122(6.9)	23.0(4.1)	1.25(0.10)
1.0 STD	07 15 51						
1.0 STD	07 15 46	LA-A-3	04/07/93	500	123(8.2)	24.0(4.2)	1.26(0.07)
1.0 STD	07 15 47						
IMNAHA STOCK							
Imnaha River facility,							
25/lb ACC	07 15 40	LA-A-2	04/12/93	496	120(6.1)	21.2(3.5)	1.21(0.07)
25/lb ACC	07 15 41	RA-A-2	04/12/93	499	119(7.4)	21.1(5.5)	1.23(0.07)
12/lb ACC	07 15 38	RA-A-4	04/12/93	498	143(16.8)	38.6(15.7)	1.21(0.07)
12/lb ACC	07 15 39	LA-A-4	04/12/93	498	141(16.8)	36.5(16.1)	1.21(0.07)

Table 32. Recovery information for PIT-tagged Rapid River, and Imnaha stock spring chinook salmon smolts detected at Lower Granite Dam in 1993, 1991 brood year. Cumulative detections by week are expanded for spillway efficiency. 0.5 STD = experimental release group reared at one-half standard density, 1.0 STD = experimental release group reared at standard density, 25/lb ACC = 25 fish/lb experimental acclimated release group, and 15/lb ACC = 15 fish/lb experimental acclimated release group.

Stock,	Representative experimental marks				Estimated	Percent
release group	CWT code(s)	Brand code	Date released	Number detected	number detected	of number released
Rapid River,						
0.5 STD	07 15 48	RA-A-1	04/07/93	175	175	35.0
0.5 STD	07 15 49	LA-A-1	04/07/93	188	189	38.0

1.0 STD	07 15 50 07 15 51	RA-A-3	04/07/93	154	154	30.9
1.0 STD	07 15 46 07 15 47	LA-A-3	04/07/93	176	176	35.2
Imnaha,						
25/lb ACC	07 15 40	LA-A-2	04/12/93	131	137	27.6
25/lb ACC	07 15 41	RA-A-2	04/12/93	142	149	30.0
15/lb ACC	07 15 38	RA-A-4	04/12/93	145	151	30.3
15/lb ACC	07 15 39	LA-A-4	04/12/93	157	165	33.1

Stock, release group	Cumulative percent of recoveries by week of the year[a]									
	14	15	16	17	18	19	20	21	22	23 24
Rapid River,										
0.5 STD	0.0	2.3	14.9	62.3	93.4	100	--	--	--	-- --
0.5 STD	0.0	1.6	15.9	58.7	94.2	98.4	100	--	--	-- --
1.0 STD	0.0	2.6	20.8	64.9	94.2	100	--	--	--	-- --
1.0 STD	0.0	4.0	30.7	71.6	95.5	100	--	--	--	-- --
Imnaha,										
25/lb ACC	--	0.0	0.7	13.1	63.5	90.5	97.8	100	--	-- --
25/lb ACC	--	0.0	0.0	17.5	63.1	86.6	99.3	100	--	-- --
15/lb ACC	--	0.0	0.7	18.5	68.2	88.7	100	--	--	-- --
15/lb ACC	--	0.0	0.0	18.8	61.8	90.3	100	--	--	-- --

a Week 1 of the year is 1-7 January and week 52 of the year is 24-31 December.

Weeks 2-51 are 7 day intervals except in leap years when week 9 is 8 days.

Table 33. Release information for PIT-tagged summer steelhead juveniles released in the Grande Ronde and Imnaha river basins, 1992 brood. 5/lb = releases of fish targeted for 5 fish/lb, PRD = production monitoring

releases, ACC = acclimated experimental releases, and DSR = direct stream experimental releases. Mean fork length, weight, and condition factor are at time of release and sample sizes are shown in Table 25. Standard deviation is shown in parentheses.

Location of release group	Representative experimental marks CWT code(s)	Brand code	Date released	Number released	Mean fork length (mm)	Mean weight (g)	Mean condition factor
WALLOWA STOCK							
Wallowa Hatchery,							
5/lb PRD	07 61 06	LA-J-2	04/19/93	241	213(16.6)	103.4(25.8)	1.07(0.06)
5/lb PRD	07 61 07	RA-J-2	04/19/93	252	204(17.7)	93.3(25.1)	1.07(0.06)
Big Canyon facility,							
5/lb ACC	07 61 02	None	04/23/93	240	204(20.3)	96.1(29.3)	1.08(0.06)
5/lb ACC	07 61 03	None	04/23/93	224	(a)	(a)	(a)
5/lb DSR	07 61 04	None	04/23/93	438	203(17.6)	91.0(21.6)	1.06(0.06)
	07 61 05						
IMNAHA STOCK							
Little Sheep Creek facility,							
5/lb ACC	07 60 61	RA-J-1	04/28/93	493	198(16.5)	84.8(20.1)	1.07(0.07)
5/lb ACC	07 60 62	LA-J-1	04/28/93	501	190(17.6)	74.7(20.1)	1.06(0.07)
5/lb DSR	07 61 01	RA-J-3	04/28/93	493	188(18.7)	70.6(19.3)	1.04(0.06)
	07 60 62	LA-J-3					

a Sample size, mean length, mean weight, and mean condition factor are the same as the replicate release group.

Table 34. Recovery information for PIT-tagged downstream migrant Wallowa and Imnaha stock summer steelhead smolts detected at Lower Granite Dam in 1993, 1992 brood year. Cumulative detections by week are expanded for spillway efficiency. Recoveries are from time of release through 15 July. 5/lb = releases of fish targeted for 5 fish/lb, PRD = production monitoring releases, ACC = acclimated experimental releases, and DSR = direct stream experimental releases. Mean fork length, weight, and condition factor are at time of release and sample sizes are shown in Table 25. Standard deviation is shown in parentheses.

Stock, release group	Representative experimental marks: CWT code(s)	Brand code	Date released	Number detected	Estimated number detected	Percent of number released
Wallowa,						
5/lb PRD	07 61 06	LA-J-2	04/19/93	136	155	64.7
5/lb PRD	07 60 07	RA-J-2	04/19/93	140	161	63.9
5/lb ACC	07 61 02	None	04/23/93	164	194	80.0
5/lb ACC	07 61 03	None	04/23/93	137	161	72.3
5/lb DSR	07 61 04 07 61 05	None	04/23/93	317	330	75.3
Imnaha,						
5/lb ACC	07 60 61	RA-J-1	04/28/93	268	328	66.5
5/lb ACC	07 60 62	LA-J-1	04/28/93	302	360	72.3
5/lb DSR	07 61 01 07 60 63	RA-J-3 LA-J-3	04/28/93	314	356	72.2

Stock, release group	Cumulative percent of recoveries by week of the year[a] 16	17	18	19	20	21	22	23	24	25	26	27	28
Wallowa,													
5/lb PRD	0.0	8.5	30.4	65.2	93.0	96.2	96.8	98.1	98.1	99.4	100	--	--
5/lb PRD	0.0	11.2	31.7	60.3	99.7	93.8	96.9	96.9	97.5	99.4	100	--	--

5/lb ACC	--	0.0	5.7	37.7	57.8	89.2	99.0	100	--	--	--	--
5/lb ACC	--	0.0	3.7	31.7	54.1	83.9	94.4	96.3	98.2	98.2	98.8	100
5/lb DSR	--	0.0	23.0	71.2	89.4	97.3	98.8	99.4	99.7	99.7	100	--
Imnaha,												
5/lb ACC	--	0.0	18.6	39.0	67.4	92.1	98.5	99.4	99.7	100	--	--
5/lb ACC	--	0.0	18.9	37.2	61.4	85.6	93.7	96.5	98.1	99.7	99.7	99.7
100												
5/lb DSR	--	0.0	44.1	64.9	85.1	96.9	98.9	99.5	100	--	--	--

a Week 1 of the year is 1-7 January and week 52 of the year is 24-31 December.

Weeks 2-51 are 7 day intervals except in leap years when week 9 is 8 days.

Table 35. Total catch, escapement and survival of coded-wire-tagged, spring chinook salmon released in the Grande Ronde and Imnaha river basins, 1988-1989 brood years. Recoveries are complete for the 1988 (age 3-5). Total strays includes Deschutes River catch and trap recoveries, and catch and trap recoveries from areas other than river-of-release (excluding the mainstem Columbia River). Col. River = Columbia River. One 1987 brood Rapid River stock (CWT 07-45-33) was recovered at Lookingglass Hatchery.

Stock, CWT code	Month of release	Catch		Spawning escapement[b]	Total strays	Return rate (% of release)[c]	Total survival rate (% of release)[d]
		Ocean	Col. River[a]				
1988 BROOD YEAR							
Rapid River,							
07 47 39	Apr	0	30	110	10	0.26	0.36
07 47 40	Apr	0	29	110	7	0.26	0.35
07 47 43	Apr	0	33	128	5	0.29	0.38
07 47 45	Apr	0	43	159	12	0.37	0.49
Imnaha,							
07 47 33	Mar	3	1	190	8	0.35	0.36
07 47 34	Mar	3	1	221	3	0.39	0.40
07 47 29	Mar	3	0	172	2	0.35	0.36

07 47 30	Mar	0	0	166	4	0.32	0.33
1989 BROOD YEAR							
Rapid River,							
07 50 53	Apr	0	2	43	2	0.10	0.11
07 50 54	Apr	0	2	37	2	0.09	0.09
07 50 51	Apr	0	5	36	0	0.08	0.10
07 50 48	Apr	0	5	30	0	0.08	0.09
Imnaha,							
07 50 45	Mar	0	0	29	2	0.07	0.07
07 50 46	Mar	0	0	40	0	0.09	0.09
07 50 43	Mar	0	0	45	0	0.11	0.11
07 50 40	Mar	0	0	50	1	0.12	0.12

a Includes winter gill net, Columbia River test fisheries, and ceremonial and subsistence fisheries, and sport fisheries.
b Spawning escapement includes tribal harvest in Lookingglass Creek in 1992 and 1993.
c Equal to spawning escapement (hatchery returns, and spawning ground recoveries from river of release) divided by total recoveries.
d Equal to total recoveries divided by total releases

Table 36. Total catch, escapement and survival of coded-wire-tagged, Wallowa and Imnaha stock summer steelhead released in the Grande Ronde and Imnaha River basins, 1989 and 1990 brood years. Recoveries are complete for the 1989 brood year, but only include age 3 recoveries for the 1990 brood year. Exploitation rate does not include Warm Springs or Round Butte Hatchery trap recoveries or stray recoveries. 5/lb = releases of fish targeted for 5 fish/lb, 4/lb = releases of fish targeted for 4 fish/lb, ACC = acclimated experimental releases, DSR = direct stream experimental, and PRD = production monitoring releases, releases.

Stock, CWT Code	Release group	N	Total exploitation rate(%)a	Hatchery return rate (% of of release)b	Total survival rate (% of release)c
1989 BROOD YEAR					
Wallowa,					
07-51-22	5/lb ACC	251	81.3	0.13	0.94
07-51-23	5/lb ACC	335	81.2	0.18	1.27
07-51-20	4/lb ACC	383	82.5	0.20	1.45
07-51-21	4/lb ACC	463	81.0	0.25	1.75
07-51-18	5/lb DSR	213	77.5	0.11	0.82
07-51-19	5/lb DSR	231	71.9	0.18	0.88

Imnaha,					
07-51-24	5/lb PRD	259	54.1	0.45	0.98
07-51-25	5/lb PRD	310	64.2	0.42	1.19
1990 BROOD YEAR					
Wallowa,					
07 54 43	5/lb ACC	152	75.0	0.13	0.53
07 54 44	5/lb ACC	173	74.5	0.13	0.60
07 53 59	4/lb ACC	142	75.4	0.13	0.55
07 53 60	4/lb ACC	268	73.5	0.23	0.96
07 53 51d	5/lb ACC	133	84.2	0.08	0.51
07 53 52d	5/lb ACC	127	85.0	0.07	0.41
07 53 53d	5/lb DSR	107	89.7	0.04	0.40
07 53 54d	5/lb DSR	95	84.2	0.05	0.38
Imnaha,					
07 53 57	5/lb ACC	298	50.0	0.61	1.23
07 53 58	5/lb ACC	313	44.1	0.65	1.18
07 53 55	5/lb DSR	93	43.0	0.22	0.39
07 53 56	5/lb DSR	81	44.4	0.23	0.42

Table 36. cont.

		Number of fish observed							
		Columbia River		Deschutes River			Snake River	Trib-utary	
Stock, CWT code	Ocean Sport	Treaty net	Sport	Sporte	Trapf		Sport	Sportg	Hatchery returns
Strays									
1989 BROOD YEAR									
Wallowa,									
07-51-22	0	81	23	16	13		62	22	34
0									
07-51-23	0	93	59	16	16		94	10	47
0									
07-51-20	0	113	40	15	15		135	13	52
0									
07-51-21	3	141	44	48	19		129	13	65
1									
07-51-18	4	58	25	14	19		55	9	29
0									

07-51-19	0	103	13	16	19	21	13	46
0								
Imnaha,								
07-51-24	0	77	23	7	1	19	14	118
0								
07-51-25	0	134	43	9	0	11	2	111
0								
1990 BROOD YEAR								
Wallowa,								
07 54 43	0	66	9	9	2	20	10	36
0								
07 54 44	1	45	28	12	6	35	8	37
1								
07 53 59	2	57	5	4	1	23	16	34
0								
07 53 60	2	112	10	13	6	34	26	64
1								
07 53 51a	1	42	10	3	0	27	29	21
0								
07 53 52a	3	50	0	19	0	19	17	19
0								
07 53 53a	0	47	17	3	2	7	22	9
0								
07 53 54a	0	24	23	3	3	13	17	12
0								
Imnaha,								
07 53 57	0	47	39	3	1	55	5	148
0								
07 53 58	0	54	33	14	0	26	11	174
1								
07 53 55	0	33	7	0	0	0	0	53
0								
07 53 56	0	17	14	0	1	0	5	44
0								

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a Equal to total harvest divided by total recoveries.
b Equal to total hatchery returns divided by total recoveries.
c Equal to total recoveries divided by total release.
d Big Canyon facility releases (Deer Creek).
e Includes Deschutes tribal fishery recoveries.
f Round Butte Hatchery and Warm Springs Hatchery recoveries.
g Includes Grande Ronde and Wallowa Rivers for Wallowa stock and Imnaha River for Imnaha stock.

Table 37. Number of adult (age 3 and 4) summer steelhead in the 1992-93 run year and adult (age 4 and 5) spring chinook salmon in the 1993 run year produced by releases from Lower Snake River Compensation Plan facilities in Oregon.

Stock, brood year, totals	Ocean catch	Columbia River Net[a]	Columbia River Sport	Deschutes River[b]	Tributary sport[c]	Spawning escapement[d]	Total recoveries
SUMMER STEELHEAD							
Wallowa,							
1989	0	1,936	606	308	1,566	577	4,993
1990	58	2,942	650	567	2,075	1,612	7,904
Stock total	58	4,878	1,256	875	3,641	2,189	12,897
Imnaha,							
1989	0	529	140	27	65	519	1,280
1989e	0	25	18	4	20	8	65
1990	0	566	330	71	325	1,490	2,782
Stock total	0	1,120	478	102	410	2,017	4,127
Species total	58	5,998	1,734	977	4,051	4,206	17,024
SPRING CHINOOK							
Carson,							
1989	0	6	4	0	0	110	120
Rapid River,							
1988	0	135	87	6	61	986	1,275
1989	0	29	16	0	7	483	535
Stock total	0	164	103	6	68	1,469	1,810
Imnaha,							
1988	0	0	0	0	--	634	642
1989	8	0	0	0	--	339	339
Stock total	8	0	0	0	--	973	981
Species total	8	170	107	6	68	2,552	2,911

a Includes zone 6 tribal harvest for summer steelhead and winter gill net,
Columbia River test fisheries, and ceremonial and subsistence fisheries for spring chinook salmon.
b Includes sport and tribal harvest and trap recoveries.
c Includes Snake, Grande Ronde, and Wallowa rivers for Wallowa stock summer
steelhead and Snake and Imnaha rivers for Imnaha stock summer steelhead and
Lookingglass Creek tribal harvest for spring chinook salmon.
d Includes strays.

e Grande Ronde Basin returns from direct stream smolt releases in the Grande Ronde River Basin.

Table 38. Results of N.E. Oregon spring chinook salmon carcass surveys, 1992 and 1993 return years. Estimated spring chinook salmon spawning population is equal to total redds observed (index, extensive, and supplemental counts) multiplied by 2.4 fish/redd.

Return year, Location	Marked hatchery carcasses recovered Ad+CWT	LV or RV	Total carcasses recovered	Estimated spawning population	Percent of spawning population in carcass sampled	Percent marked hatchery fish in carcass sample
1992,						
Minam River	12	1	46	266	17.3	28.3
Wenaha River	13	0	56	461	12.1	23.2
Lostine River	1	0	30	86	34.9	3.3
Grande Ronde River	0	0	83	278	29.9	0.0
Catherine Creek	0	1	9	118	7.6	11.1
Bear Creek	0	0	3	0a	--	0.0
Hurricane Creek	0	0	2	36	5.6	0.0
1993,						
Minam River	4	3	44	264	16.7	15.9
Wenaha River	1	2	29	250	11.8	10.3
Lostine River	2	0	74	245	30.2	2.7
Grande Ronde River	0	0	46	247	18.6	0.0
Catherine Creek	0	0	28	202	13.9	0.0
Bear Creek	0	0	5	46	10.9	0.0
Hurricane Creek	0	0	10	77	13.0	0.0

DISCUSSION AND MANAGEMENT IMPLICATIONS

Fish Culture Monitoring
Spring chinook salmon

In order to reduce the in-basin stray rates of adult Rapid River stock spring chinook salmon that were produced from smolts released at Lookingglass Hatchery, all 1991 brood spring chinook salmon released in 1993 were 100% marked Ad-RV+CWT. Adults that return will be trapped at Lower Granite Dam and hauled to Lookingglass Hatchery. This strategy will reduce the number of hatchery origin spring chinook salmon adults on spawning grounds in the Grande Ronde River basin and at the same time provide adults for experimental and compensation purposes.

Growth patterns at Lookingglass Hatchery are controlled to achieve specific release size and also influence smolt quality. Imnaha stock, chinook salmon (1991 brood year) which were targeted for release at 15 fish/lb developed a bimodal and skewed length-frequency distribution. Their distribution was skewed by August and became bimodal in September. Furthermore, fish in the upper modal group exhibited a lower mean condition factor and lower mean hepatosomatic index than fish in the lower modal group. This is in contrast to chinook targeted for 25 fish/lb which had a normal length-frequency distribution throughout their rearing cycle. Thus, when chinook salmon develop two modes of growth, those in the upper modal group are more smolt-like than those in the lower modal group. This is consistent with literature on other species (for example, see Thorpe et al. 1980). Given this information, it would be prudent to continue monitoring growth patterns and smolt physiology of hatchery reared salmon. Fish from a lower mode of growth may represent a reduced production of actual smolts from a release group.

The Lookingglass Hatchery weir was not installed until 28 May because of delays in getting the NMFS Section 10 permit for the Lookingglass Hatchery program. In the week following weir installation, 498 adults were trapped (nearly 50% of the total run trapped). The number of adults estimated to have escaped above the hatchery was 217 adults and most of adults escaped above the hatchery before the weir was installed (Lofy and McClean 1995). An additional 99 fish were passed above the Lookingglass Creek weir. A total of 151 redds were observed on spawning ground surveys conducted on Lookingglass Creek (131 redds above the Lookingglass Hatchery weir and 20 redds below the weir). The fish/redd ratio for Lookingglass Creek was estimated to be 2.39 (Lofy and McClean 1995) and the estimated spawning population estimate was 364 adults. This is the highest spring chinook natural spawning escapement in Lookingglass Creek since the early 1970's (114 redds observed in the index area in 1974).

Higher than average flows in the Imnaha River in the spring of 1993 (Hubbard et al. 1993) delayed installation of the Imnaha River weir until 2 July, the latest date since 1985 (9 July). It may have been a physical impossibility to install the weir earlier in June because of high flows (at rkm 31.3 gauge, June flow averaged 42.7 m3/sec, 25.1 m3/sec is the highest flow the weir has been installed, 19 June 1989). In order to collect broodstock from a cross-section of the run, it is important that every effort be made to install the weir before returning adults pass the weir site. This will help maintain genetic similarity between the

hatchery- and naturally-produced populations (Allendorf and Ryman 1987). Mark-recapture techniques (Ricker 1975) were used to determine that 12.4% of the Imnaha chinook salmon run that returned to or past the weir had passed the weir before it was installed. Thus, we were able to collect Imnaha hatchery broodstock from all segments of the run except the very earliest returning fish.

The run-timing of Imnaha chinook salmon at the Imnaha River weir in 1993 was later than observed in other years (Figure 1). The delay in timing may have resulted from higher than average spring flows. The run-timing curve for 1993 showed an increasing trend in adult returns through time with a peak in early July and again in early August. In the 1990 and 1992 run-years (below average spring flows), we did not observe the large increase in adult returns early in the run, but did observe a small peak in late July and early August. The run-timing of marked hatchery and unmarked fish were similar to each other in 1993 (Figure 1). The high abundance of unmarked age 42 and 52 hatchery origin adult returns in 1993 may have contributed to this similarity. Unless we mark individual fish at time of trapping, and subsequently determine the origin of that fish by scale analysis, we cannot accurately determine run timing of naturally-produced fish when there are unmarked hatchery origin fish returning.

Extensive monitoring of the 1993 Imnaha chinook salmon run was necessary in order to comply with NMFS's ESA Section 10 Fish Propagation Permit requirements and ODFW Wild Fish Policy guidelines. A spreadsheet was developed to track disposition of all fish handled and formulate weekly broodstock collection and adult release plans. Individual adults were not marked in 1993, so we could not adjust for any incorrect determinations of sex on individual fish. The higher than anticipated number of hatchery fish that returned in 1993 resulted in modifications of the ESA Permit so that additional hatchery fish could be released above the Imnaha weir. Extensive debate occurred dealing with whether or not to release additional hatchery fish above the weir in excess of 50% of the total natural spawners.

The late season (28 August) release of 27 males and 73 female chinook salmon adults above the Imnaha River weir was associated with a redd increase of 54% (54 to 82 redds) in the 7.2 km area above the weir (weir upstream to Mac's Mine). Redd superimposition (redds constructed on existing redds) was observed in this area after the late season release. Redd superimposition can result in egg displacement of earlier deposited eggs by these later spawning fish and, therefore, has the potential to reduce the reproduction success of the early spawning fish (McNeil 1964, Deverall et al. 1993). This superimposition may have resulted from high abundance of spawners in this section, releasing ripe females during or after peak spawning, and the lack of adequate spawning habitat in this section. Based on the area where marked salmon carcasses were recovered, the majority of these 100 adults appeared to have spawned in the 7.2 km area above the weir. The sexually mature females released late in the spawning season appeared to have selected the nearest spawning habitat.

Juvenile chinook salmon production resulting from an egg take of 1,055,064 green eggs will be well above the Imnaha River LSRCP smolt production goal (490,000 smolts). The large egg take of Imnaha stock was a result of the high number of hatchery fish that returned to the Imnaha weir, limits set on the percentage of hatchery fish which could be released above

Figure 1. Run timing of natural and hatchery origin Imnaha stock chinook salmon trapped at the Imnaha River weir, 1990-1993 run years.

the weir (a 50% limit was set in the NMFS ESA Section 10 Fish Propagation Permit), and from the final co-manager's consensus to spawn or release all hatchery fish. Some of the 1993 brood are scheduled to be released as presmolts in the Imnaha River basin in 1994, and the remainder will be reared to yearling smolts. We will be conducting size-at-release (15 and 25 fish/lb release groups) and acclimation studies with the 1993 brood year.

The 1988 brood year of Imnaha chinook salmon returned a higher proportion of age 52 adults compared to the 1982-1987 brood year average (Figures 2 and 3). Hatchery origin fish produced above average proportion of age 52 adult returns, with 23.6% of the hatchery males and 55.5% of the hatchery females returning at age 52. Previously, 8.2% of the hatchery males and 30.9% of the hatchery females returned at age 52. We do not know if the higher proportion of age 52 fish resulted from high smolt-to-adult survival which was mainly attributable to favorable environmental conditions rather than size-at-release because both Imnaha size-at-release groups (12 and 20 fish/lb) produced above average proportion of age 52 adult returns. We also observed an above average proportion of age 52 adults produced from the 1988 brood Rapid River stock spring chinook salmon at Lookingglass Hatchery. Further investigation is needed to determine and document factors (hatchery rearing, environmental conditions such as juvenile and adult migration conditions and ocean conditions) which may have contributed to the high survival of the 1988 brood year.

Since a portion of the 1988 and 1989 brood year releases of Imnaha chinook were unmarked, we plan to use discriminant scale analysis to classify all unmarked returns. This will allow us to calculate progeny-to-parent ratios for hatchery- and naturally-produced fish more precisely and determine age composition for the 1988 and 1989 brood years. Starting with the 1990 brood year, all Imnaha chinook releases will be 100% fin marked so we can determine the origin of fish when they are trapped and processed at the weir and recovered on spawning ground surveys.

A low prespawning mortality rate (as indicated by a low fish/redd ratio) was observed for chinook salmon in the Imnaha River in 1993. The fish/redd ratio for the area above the Imnaha River weir in 1993 was 2.8, which was lower than the ratio in 1992 (4.3) and similar to the ratios in 1990 and 1991 (3.2 and 2.9 respectively). The total spawning population for the Imnaha River was estimated to be 1,280 adults, which is one of the highest spawning escapements since 1978 (in 1978, 415 redds observed in Imnaha River index area). Higher than average flows along with a decrease in the frequency and severity of flash-flooding and high siltation in the Imnaha River in 1993 may have contributed to the lower prespawning mortality rate than was observed in 1992.

The return of natural and hatchery origin adults from the 1993 brood year (age 42 returns in 1997) could be one of the largest returns of chinook salmon to the Imnaha River since the LSRCP program was initiated in 1982. It is essential that adequate and functional operation plans are developed cooperatively, with input from all co-managers, and that the plans are ready to implement when the 1993 brood adults return.

Figure 2. Age composition of natural and hatchery origin chinook salmon that returned to the Imnaha River, 1988 brood year.

Figure 3. Mean percent age-composition of natural and hatchery origin chinook salmon that returned to the Imnaha River, 1982-1987 brood years.

LSRCP spring chinook salmon smolt production goals were not achieved in 1993. Lookingglass Hatchery produced a total of 31,388 pounds of 1991 brood
Rapid River and Imnaha stock salmon smolts which was 45% of the production goal for Grande Ronde and Imnaha basin smolt releases. Only 9,016 lbs of Imnaha stock chinook salmon were produced for the Imnaha Basin which was 36.8% of the production goal of 24,500 lbs. A total of 22,372 lbs of 1991 brood Rapid River stock smolts were produced for the Grande Ronde Basin which was 49.7% of the production goal of 45,000 lbs. Therefore, it is improbable (given the current low smolt-to-adult survival rates) that adult returns from this brood year will contribute substantially to achievement of LSRCP compensation goals.

Summer steelhead

Low natural spawning escapement in Deer Creek continues to impose limits on the numbers of hatchery fish which can be released above the Big Canyon Facility weir to spawn naturally. Only 28 natural origin summer steelhead adults were trapped at the Big Canyon facility in 1993. In order to keep within ODFW Wild Fish Management Policy guidelines for supplementing natural fish populations with hatchery origin fish (maximum of 50% hatchery origin spawners in the natural spawning population), only 28 additional hatchery origin steelhead could be released above the Big Canyon facility weir (28 total females). It is not known how many adults are required to fully seed Deer Creek, but 28 females is most likely short of that number based on the miles of available habitat. Summer steelhead redd counts conducted on 3 of the 12 miles of steelhead spawning habitat in 1985 showed a spawning density of 13 redds/mile (personnel communication, Bill Knox, ODFW assistant district fish biologist, Wallowa fish district). It is imperative to maximize natural production in hatchery supplemented streams in order to fully implement supplementation programs.

Natural- and hatchery-produced summer steelhead that returned to Little Sheep Creek in 1993 had similar run timing (Figure 4). Peak returns of steelhead at the Little Sheep Creek facility occurred in the last week of April which was about two weeks later than observed in 1992, a year with below average spring flows (Hubbard et al. 1992). Higher than average flows in the Imnaha River basin and Little Sheep Creek may have delayed returns of summer steelhead. If this is the case, broodstock collection guidelines for Imnaha stock summer steelhead may have to be adjusted to compensate for differences in run timing caused by flow variation. The average age-at-return for hatchery and naturally-produced Imnaha stock summer steelhead are nearly identical (Figure 5).

Similarity in age-at-return and run-timing are indications that important life-history characteristics of the native population are being retained in the hatchery population.

Trapping and release guidelines for Little Sheep Creek in 1993 resulted in retention of 25% of the naturally-produced run for hatchery broodstock. Naturally-produced fish kept and spawned for broodstock only comprised 7.5% of the adults spawned. Oregon's Wild Fish Management Policy standard for the percentage of naturally-produced fish in hatchery broodstock is 30% if the natural spawning population is supplemented with up to 50% hatchery fish, which is the case with the Little Sheep Creek supplementation program. Since

Figure 4. Run timing of natural and hatchery origin Imnaha stock summer steelhead at the Little Sheep Creek facility, 1992 and 1993 returns.

the number of naturally-produced summer steelhead adults is consistently lower than needed to achieve 30% of hatchery broodstock, thought needs to be given to ways to increase naturally-produced fish contribution to hatchery broodstock such as sperm cryopreservation, obtaining broodstock from some other segments (but within the same gene conservation group) of the Imnaha River summer steelhead population, or possibly reducing smolt release numbers and, therefore, broodstock needs.

High hatchery return rates for 1989 and 1990 broods of Imnaha stock summer steelhead resulted in surplus fish at the Little Sheep Creek Facility in 1993. A total of 1,416 hatchery adults (80% of the 1993 Little Sheep Creek hatchery origin returns) were excess to broodstock and spawning escapement needs. Surpluses of summer steelhead at LSRCP facilities will most likely result when total smolt-to-adult survival rates are high (above 1.0%). The high survival rates are necessary in order to ensure tribal and sport harvest, sufficient adult broodstock, and adequate spawning escapement. It would be beneficial to develop alternative ways to handle surplus fish to increase benefits from these fish.

We exceeded the program goal of 1.35 million smolts (1992 brood year) for the Wallowa stock steelhead program. We released a total of 1,351,878 smolts of Wallowa stock into the Grande Ronde River Basin in 1993. An additional 50,188 Wallowa stock summer steelhead smolts which were reared at Lyon's Ferry Hatchery (WDFW) were released in the Lower Grande Ronde River. Since results from our acclimation studies at Wallowa Hatchery have suggested that acclimated fish have higher smolt-to-adult survival rates than direct stream releases, direct stream releases of smolts in the Grande Ronde basin were limited to Catherine Creek, Grande Ronde River, and experimental releases in Deer Creek. We also moved direct stream releases to lower reaches in the streams to increase tributary sport harvest, reduce the potential of summer steelhead adults returning to spawn in upper tributaries, and reduce potential negative impacts (predation, competition) to endemic summer steelhead populations and ESA listed Snake River stock spring chinook salmon. Direct stream releases were reallocated to Wallowa Hatchery and the Big Canyon facility. We exceeded the smolt production goal of 330,000 smolts of 1992 brood Imnaha stock steelhead. We released 340,386 summer steelhead smolts into the Imnaha Basin in 1993. Smolts were released directly into the lower Imnaha River (at Cow Creek, RM 4) to increase sport harvest opportunities. Since nearly 77% of the LSRCP production goal of 1.35 million summer steelhead smolts are now scheduled to be released from acclimation facilities, it is possible that there

will be large numbers of surplus adults returning to the Big Canyon Facility and Wallowa Hatchery in future years.

Survival Studies

Spring chinook salmon

The smolt-passage indices at Lower Granite Dam for cold-branded and PIT-tagged yearling Rapid River stock spring chinook salmon smolts reared at standard density were both significantly less ($P = 0.03$) than the passage indices for yearling smolts reared at 1/2 standard density. The detection rates of PIT-tagged release groups tended to be higher than the cold-branded releases (Figure 6) but were not significantly different ($P = 0.12$). The

Figure 5. Percent of natural and hatchery origin summer steelhead that returned to the Little Sheep Creek facility after 1 or 2 years in the ocean, 1981-1989 brood years. Means of age composition of ocean residence are for the 1981-1988 brood years for natural fish and 1982-1989 brood years for hatchery fish. These years represent similar out-migration and ocean rearing conditions.

Figure 6. Recovery rates for cold-branded and PIT-tagged, downstream migrant Rapid River and Imnaha stock spring chinook salmon smolts at Lower Granite Dam in 1993, 1991 brood year. O.5 STD = fish reared at one-half standard density, 1.0 STD = fish reared at standard density, 15/lb = fish targeted for 15 fish/lb at release, and 25/lb = fish targeted for 25 fish/lb at release.

differences between the standard density and 1/2 standard density releases were less for PIT-tagged release groups when compared to cold-branded releases. The differences in smolt passage indices between cold-branded and PIT-tagged release groups were probably not attributable to passage timing. Both cold-branded and PIT-tagged Rapid River stock salmon smolts had similar migration timing to Lower Granite Dam. The first fish was observed at Lower Granite Dam 1 week after release (9-15 April), and over 90% of the recoveries occurred by the first week in May (Figure 7). The smolt passage indices for cold-branded and PIT-tagged Imnaha stock juvenile chinook salmon releases were not significantly different (P = 0.64). Cold-branded and PIT-tagged Imnaha stock smolts also had similar passage timing. The first fish arrived at Lower Granite Dam about 1 week after release and 90% of recoveries were recorded 4 weeks after release, the 2nd week in May (Figure 8).

Comparisons between cold-branded and PIT-tagged smolt releases of spring chinook salmon will be repeated with the 1994 releases (1992 brood year spring chinook salmon). Because of the advantages of associated with PIT tags (Prentice et al. 1986), we anticipate using only PIT tags in the future for spring chinook salmon evaluations.

Returns are complete for 1988 brood Rapid River stock spring chinook salmon released from Lookingglass Hatchery for size-at-release comparisons (Table 34). The survival rate for fish released at 12 fish/lb was 0.44% and was 26% greater than the survival rate for fish released at 20 fish/lb (0.35%). We observed a similar pattern for the 1987 brood year when the 12 fish/lb release group survived at twice the rate as the 20 fish/lb release group, but opposite to the 1986 brood year when the 20/lb releases survived at nearly twice the rate of 12 fish/lb releases (Figure 9). This annual variation in smolt-to-adult survival rates will complicate interpretation of Rapid River stock release strategies.

The 12 fish/lb release group of 1988 brood of Rapid River stock produced a higher proportion of age 32 and 42 adults than the 20 fish/lb release group. This trend was also observed with 1986 brood Rapid River stock released from Lookingglass Hatchery. Several studies have shown that larger or faster growing salmonid juveniles tend to produce adults

that return at a younger age (Bilton 1980, Hankin et al. 1993, Smith and Zakel 1980).

Rapid River stock spring chinook salmon released at 12 fish/lb survived at the highest rate of any group to date. However, the survival rate was still below that needed to achieve adult compensation goals (0.65% smolt-to-adult survival rate to Lower Granite Dam to produce a return of 5,820 adults). At a survival rate of 0.44%, a total of 1,323,000 smolts would have to be released from Lookingglass Hatchery (a 47% smolt production increase) to meet adult LSRCP compensation goals for Grande Ronde Basin spring chinook salmon. It is very unlikely that this release number can be achieved given current NMFS imposed restrictions on release numbers as well as broodstock availability and hatchery rearing capacity limitations. Therefore, it is doubtful that LSRCP Grande Ronde Basin spring chinook salmon compensation goals will be achieved under the current production program.

Returns are complete for the 1988 brood Imnaha stock chinook salmon (Table 34). The smolt-to-adult survival rate for the 15/lb release group averaged 0.34% and the 25/lb release group averaged 0.38%. These are the

Figure 7. Migration timing of cold-branded and PIT-tagged, Rapid River stock spring chinook salmon smolts at Lower Granite Dam in 1993, 1991 brood year. 0.5 STD = fish reared at one-half standard density and 1.0 STD = fish reared at standard density.

Figure 8. Migration timing of cold-branded and PIT-tagged, Imnaha stock spring chinook salmon smolts at Lower Granite Dam in 1993, 1991 brood year. 15/lb = fish released at a mean weight of 37.6 grams/fish, and 25/lb = fish released at a mean weight of 21.2 grams/fish.

Figure 9. Survival rates of coded-wire-tagged, Rapid River stock spring chinook salmon released at Lookingglass Hatchery, 1985-1988 brood years. Size-at-release is presented as fish/lb (for example, 9.6/lb = 9.6 fish/lb releases for the 1985 brood year).

Figure 10. Survival rates of coded-wire-tagged, Imnaha stock chinook salmon released at the Imnaha River weir and Lookingglass Creek, 1982-1988 brood years. Size-at-release was 32.0, 15.4, 13.2, 8.4, 9.7, 16.0 fish/lb for the 1982-1987 brood years respectively and the 1988 brood release groups averaged 18.4 (1988a) and 12.5 fish/lb (1988b).

highest survival rates observed to date (Figure 10) for Imnaha stock chinook salmon but still only represent 58% of the survival rate needed to meet compensation plan goals (0.65% smolt-to-adult survival rate at Lower Granite Dam to return 3,210 adults to compensation area). At a smolt-to-adult survival rate of 0.34% smolt production would have to increase by 93% (release 944,000 smolts) to return 3,210 adults. The additional smolt releases would require nearly doubling the number of Imnaha stock adults collected for broodstock.

The progeny-to-parent ratios for the 1988 brood year of Imnaha chinook salmon was 0.78 for naturally-produced fish and 9.45 for hatchery-produced fish (Figure 11). Adult progeny-to-parent ratios for hatchery-reared fish were equal to or greater than ratios of the naturally-produced population for the 1984-1988 brood years. Estimates of the 1988 brood progeny-to-parent ratios are preliminary and were based on marked adult returns and marked-to-unmarked smolt release ratios. We will use discriminant scale analysis to verify the origin of unmarked adult returns from the 1988 brood year. We will then recalculate the progeny-to-parent ratios for this brood year.

We did not achieve LSRCP compensation goals for spring chinook in 1993. Spring chinook adult returns to the LSRCP compensation area in 1993 were only 26.4% of the compensation goal of 5,820 adults for the Grande Ronde Basin (Table 36). We were able to release 101.6% and 92.9% of the production goal of 900,000 smolts for the 1988 and 1989 brood years respectively in the Grande Ronde Basin. The future of Rapid River stock at Lookingglass Hatchery is uncertain because it is not considered a component of the Snake River ESU (Evolutionary Significant Unit). Therefore, any production of this stock at Lookingglass Hatchery will be regulated closely to make sure it does not jeopardize the recovery of Grande Ronde Basin natural spring chinook salmon.

We estimated that only 973 hatchery Imnaha chinook salmon adults returned to the LSRCP area in 1993, which represented only 30.3% of Oregon's compensation goal of 3,210 chinook for the Imnaha Basin (Table 36). Adults that returned in the 1993 run year were from releases of the 1988 and 1989 broods. These releases were only 91.4% (1988 brood) and 81.4% (1989 brood) and of the yearly production goal of 490,000 smolts. Our analysis of the Imnaha chinook salmon program has shown that hatchery supplementation helped to maintain the Imnaha chinook salmon population, and has resulted in a higher number of adults in the Imnaha River than if the program had not been initiated (Carmichael and Messmer 1993).

Summer Steelhead

PIT-tagged groups of Wallowa and Imnaha stock summer steelhead juveniles had significantly higher ($P = 0.01$ for Wallowa and Imnaha stocks combined) smolt passage indices than did cold-branded release groups (Figure 12). The differences in detection rates were highest for Imnaha stock summer steelhead. The passage indices for groups of 1992 brood Imnaha stock summer steelhead released at the Little Sheep Creek Facility were 28.7% for cold-branded acclimated fish, and 31.7% for cold-branded direct stream releases, but PIT-tagged release groups survived at an average of 69.2% for acclimated fish, and 72.2% for direct stream releases (Figure 12). Passage timing at Lower Granite

Figure 11. Adult progeny-to-parent ratios for natural and hatchery origin Imnaha River chinook salmon, 1982-1988 brood years. For the 1988 brood year, the number of unmarked hatchery origin fish was estimated using marked to unmarked smolt release ratios. The 1988 ratios will be recalculated when the origin of unmarked adults has been determined by discriminant scale analysis.

Figure 12. Recovery rates for cold-branded and PIT-tagged, downstream migrant Wallowa and Imnaha stock summer steelhead smolts at Lower Granite Dam in 1993, 1992 brood year. WH 5/lb = 5 fish/lb Wallowa stock summer steelhead acclimated and released at Wallowa Hatchery, LSC ACC = 5 fish/lb Imnaha stock summer steelhead acclimated and released at the Little Sheep Creek facility, and LSC DSR = 5 fish/lb Imnaha stock summer steelhead direct stream release at the Little Sheep Creek facility.

Figure 13. Migration timing of the 5 fish/lb release of cold-branded and PIT-tagged, 1992 brood Wallowa stock summer steelhead smolts at Lower Granite Dam in 1993.

Figure 14. Migration timing of cold-branded and PIT-tagged, 1992 brood Imnaha stock summer steelhead smolts at Lower Granite Dam in 1993. ACC = acclimated fish released at a mean weight of 79.0 grams/fish and DSR = direct stream release group released at a mean weight of 70.6 grams/fish.

Dam was similar (P = 0.20) for cold-branded and PIT-tagged Wallowa stock summer steelhead juveniles released from Wallowa Hatchery (Figure 13), but there were some differences observed in the migration timing of cold-branded and PIT-tagged Imnaha stock summer steelhead (Figure 14).

The slight differences (one week) in migration timing of Imnaha stock summer steelhead at Lower Granite Dam may account for some of the differences observed in smolt passage indices. The differences in smolt-passage indices are probably not attributable to differential post-tagging mortality rates (Prentice et al. 1990a) but result from sources of error associated with reading brands and the subsampling process in the juvenile by-pass facilities (McCutcheon and Giorgi 1989, Prentice et al 1990b). It is possible that the cold-brands on summer steelhead loose recognizability with time and can not be identified at Snake River dam juvenile collection facilities (McCutcheon and Giorgi 1989), whereas PIT-tagged fish entering the Snake River dam juvenile by-pass facilities are detected at over a 95% detection efficiency with less than a 1.0% reading error (Prentice et al. 1990b). Comparisons between cold-branded and PIT-tagged smolt releases of summer steelhead will be repeated with the 1994 releases (1993 brood year). Even though we may switch to PIT tags for research evaluations, we plan to continue cold-branding representative groups of Wallowa and Imnaha stock summer steelhead releases in order to obtain smolt-to-adult survival estimates to use for in-season adult run projections to LSRCP facilities.

Returns are complete for the 1989 brood Wallowa stock summer steelhead released for size-at-release comparisons. Smolts released at 108.1 grams (4 fish/lb release group) and 87.2 grams (5 fish/lb release

group) survived at 1.60% and 1.10% respectively. The differences between 1989 brood size-at-release group survival rates were not significant (P = 0.16), but were similar to the 1985 and 1988 brood years when the 4 fish/lb group tended to survive at a higher rate (Figure 15). The smolt-to-adult survival rates for the 1989 brood are among the highest observed for Wallowa stock summer steelhead. Returns will be complete for all size-at-release comparisons in 1994.

The 1989 brood Wallowa stock direct stream release group survived at 0.85% which was 29% lower than the acclimated release group (1.10%). We have observed consistently better smolt-to-adult survival for smolts that have been acclimated at Wallowa Hatchery (Figure 15).

The 1989 brood of Wallowa stock summer steelhead released from Wallowa Hatchery had an average smolt-to-adult survival rate of 0.64% to Lower Granite Dam (1.35% total survival), which is just 94% of the LSRCP goal of 0.68%. Because the 1989 brood returned in two different run years (age 3 in 1991-92 and age 4 in 1992-93) and the 1988 (age 4 returns in the 1991-92 run year) and 1990 (age 3 returns in the 1992-93 run year) brood years did not have as high of survival rates as the 1989 brood, the LSRCP goal of 9,184 adults above Lower Granite Dam was not achieved in the 1991-92 or 1992-93 run years. If two consecutive brood years of Wallowa stock summer steelhead releases have high smolt-to-adult survival rates (above 1.35% total smolt-to-adult survival), LSRCP adult compensation goals could be achieved for the Grande Ronde River Basin.

Returns are complete for the 1989 brood Imnaha summer steelhead. Total survival (catch and escapement) was 1.08%, the highest survival rate observed to date for Imnaha stock summer steelhead released at Little Sheep Creek (Figure 16). The smolt-to-adult survival rate to Lower Granite for this brood year was 0.52%, which is only 85% of smolt-to-adult survival rate (0.61%) needed to achieve compensation goals for the LSRCP Imnaha River Basin summer steelhead program (2,000 adults to Lower Granite Dam). At a total survival rate of 1.08%, summer steelhead smolt releases would have to increase 17% to a total release of 385,000 smolts. It is possible, as was the case in the 1992-93 run year, to achieve LSRCP adult summer steelhead compensation goals in the Imnaha River Basin if two consecutive broods of Imnaha stock summer steelhead have high (above 1.0%) smolt-to-adult survival rates.

The progeny-to-parent ratio (escapement only) for hatchery origin 1988 brood Imnaha stock summer steelhead was 5.86, but the progeny-to-parent ratio for naturally-produced summer steelhead in Little Sheep Creek continues to be below 1.0. This indicates that the hatchery and natural fish spawning in Little Sheep Creek are not replacing themselves (Figure 17). The Little Sheep Creek summer steelhead program relies on naturally-produced fish for hatchery broodstock and since only up to 50% of the population can be hatchery origin, spawning escapement is regulated by the numbers naturally-produced fish. Thus, it is imperative that habitat protection and restoration efforts continue and other natural production problems are identified and solved in order to increase summer steelhead production in Little Sheep Creek through the supplementation program.

The LSRCP compensation goal for summer steelhead in the Grande Ronde basin was not achieved during the 1992-93 return year, but adult returns to the LSRCP area were the third highest since the program began. We estimated that 5,830 Wallowa stock summer steelhead returned to the LSRCP area (above Lower Granite Dam) in the 1992-93 run year, which was 63.5% of the compensation goal of 9,184 adults for the Grande Ronde Basin (Table 37). Smolt releases that produced the 1992-93 run were 97.4% of the production goal (1.35 million smolts) for the 1989 brood year and 99.2% for the 1990 brood year. The exploitation rates (not corrected for unaccounted inter-dam losses) of 1989 and 1990 brood Wallowa stock summer steelhead that returned in the 1992-93 run year, averaged 83% (Table 37). Of the total fish we could account for in the 1992-93 run year, 54% were harvested below Lower Granite Dam. A total of 70% of this harvest occurred in the Columbia River Net fishery and 12% occurred in the Deschutes River. The tributary sport fishery accounted for 28% of all recoveries, which is similar to tributary sport harvest of the 1991-92 run year, but higher than earlier years (Figure 18).

The LSRCP summer steelhead adult compensation goal was achieved for summer steelhead in the Imnaha River basin in the 1992-93 run year. A total of 2,427 hatchery stock Imnaha summer steelhead returned to the LSRCP compensation area (Table 37). Smolt releases that produced adults in the 1992-93 run year were 100% of the production goal of 330,000 smolts for the Imnaha Basin for the 1989 and 1990 brood years. The exploitation rate (not

Figure 15. Total smolt-to-adult survival rates of coded-wire-tagged, Wallowa stock summer steelhead released at Wallowa Hatchery 1985-1989 brood years. 4 lb = 4 fish/lb acclimated releases, 5 lb = 5 fish/lb acclimated releases, and DSR = 5 fish/lb, direct stream releases.

Figure 16. Total smolt-to-adult survival rates of coded-wire-tagged, Imnaha stock summer steelhead released at the Little Sheep Creek facility, 1985-1989 brood years.

corrected for unaccounted inter-dam losses) of 1989 and 1990 brood Imnaha stock summer steelhead that returned in the 1992-93 run year averaged 49% (Table 37). Of the total fish we could account for in the 1992-93 run year, 41% were harvested below Lower Granite Dam. A total of 66% of this harvest occurred in the Columbia River Net fishery, 28% in the Columbia River sport fishery, and 6% in the Deschutes River (Figure 18). Of the estimated 2,188 steelhead adults entering the Imnaha River (Imnaha River sport catch plus Little Sheep Creek facility recoveries), only 171 were harvested in the spring sport fishery (Flesher et al. 1993).

Figure 17. Adult progeny-to-parent ratios for natural and hatchery origin summer steelhead that returned to the Little Sheep Creek facility, 1982-1989 brood years. Progeny returns are equal to the number of fish trapped at the Little Sheep Creek weir and do not include harvest, ND = no data available for natural fish prior to the 1987 brood year. The 1988 brood year is incomplete for natural fish.

Figure 18. Numbers of Wallowa and Imnaha stock summer steelhead harvested in mainstem Columbia River and tributary fisheries, 1987-88 to 1991-93 run years.

Natural Escapement Monitoring

The number and percentage (percentage of carcasses recovered) of coded-wire-tagged, Lookingglass Hatchery origin, Rapid River stock spring chinook salmon recovered on spawning ground surveys in the Minam, Lostine and Wenaha rivers was lower in 1993 than in 1992 (Table 37). The proportion of the total return of coded-wire-tagged Rapid River stock spring chinook salmon that were recovered on spawning ground surveys was also much lower in 1993 than in 1992 (Figure 19). In 1993, we estimated that 8.6% (39 of the 541 total estimated returns) of the coded-wire-tagged Rapid River stock spring chinook salmon that returned to the Grande Ronde River basin strayed onto spawning grounds in the Minam, Lostine and Wenaha rivers, but in 1992 the estimate was 39.2% (188 of the 479 total estimated coded-wire-tag recoveries).

Flow patterns in the Grande Ronde River during 1992 and 1993 were dramatically different and may have had an effect on hatchery stray rates. In 1993, flows in the lower Grande Ronde River were above average for the months of April and May and were near average (1991 flows were similar to the 1945-1991 average and therefore were used to represent average flows) in June. The peak flows in 1993 occurred in mid May (Figure 20). In 1992, peak flows occurred in mid April in the lower Grande Ronde River and by the end of May, flows were near July averages (61.4 m3/sec). At such low flows, it is probable that thermal barriers begin to develop in the Grande Ronde River at the confluence of

the Grande Ronde and Wallowa Rivers (Rondowa). This is especially true during the irrigation season when a significant amount of water is removed from the Grande Ronde River. Because the flows in the Wallowa River are supplemented by releases of irrigation water from Wallowa and Kenny lakes, the Minam and Lostine rivers remain accessible for spring chinook salmon until thermal barriers develop (in lower Minam River) or irrigation diversion dams are put in place (on the Lostine River). If returning spring chinook salmon adults can't get to Lookingglass Hatchery because of low flows and high temperatures in the Grande Ronde River at Rondowa, the most accessible spawning tributaries would be the Minam River 16 km upstream, or the Wenaha river 59 km downstream. Both of these rivers originate in wilderness areas containing nearly pristine adult spring chinook salmon holding and spawning habitat. Flows in the Minam River also peak at a latter date than in Lookingglass Creek (Figure 21) and, therefore, may attract stray spring chinook salmon adults during low flow years. It is unlikely that flow or temperature problems existed in the lower Grande Ronde River at Rondowa during 1993 because of above average flows during the spring chinook adult migration time period (April-June). In 1992, the first returns of Rapid River stock spring chinook salmon adults to Lookingglass Hatchery occurred the week of 7-13 May, with peak returns during the week of 21-27 May. Peak flows in the lower Grande Ronde River and Lookingglass Creek in 1992 occurred in mid April, one month before peak returns to Lookingglass Hatchery. It is likely that low flows and possible thermal barriers in the Grande Ronde River at Rondowa prevented some Rapid River stock spring chinook salmon adults from returning to Lookingglass Hatchery in 1992, especially adults late in the run.

Figure 19. Area of recovery (percent of total estimated returns to the Grande Ronde Basin) for coded-wire-tagged, Rapid River stock spring chinook salmon adults (age 42 and 52, does not include age 32 jacks)

produced from Lookingglass Hatchery releases, 1992 and 1993 run years. LGH+LGC = Lookingglass Hatchery and Lookingglass Creek recoveries.

Figure 20. Flow rates (discharge in m3/sec, mean of 5 day averages) in the Grande Ronde River, 1991-1993 water years (from Hubbard et al. 1991, 1992 and 1993).

Figure 21. Flow rates (discharge in m3/sec, mean of 5 day averages) in the Minam River and Lookingglass Creek, 1992 and 1993 water years (from Hubbard et al. 1992 and 1993).

With the ever increasing attention being drawn to the status of stocks of Snake River chinook salmon, the importance of natural escapement monitoring is becoming extremely important. Spawning ground surveys are one of the best methods to enumerate spawning populations of Snake River stock spring chinook salmon, and determine the distribution and abundance of hatchery spring chinook salmon strays. Increased effort (expanded survey area, multiple surveys) will be needed in the future to increase the accuracy of estimates of natural spawner distribution and abundance, especially with decreasing populations of salmon in N.E Oregon. Increased accuracy of estimates help to assist managers in making critical decisions regarding recovery efforts for Snake River stocks of spring chinook salmon. Starting with the 1991 brood year, all hatchery releases of spring chinook salmon were fin-marked so adult returns (and juvenile residuals) can be identified on surveys. This is an important step in accurately determining the distribution and number of hatchery strays as well as natural spring chinook salmon escapement. With returns of all hatchery fish being 100% fin-marked starting in 1995, we will be able to collect scale samples from known natural origin spring chinook salmon adults in order to determine current growth patterns and rates. Growth patterns and rates of these naturally-produced adults can then be compared to historical scale collections used to develop discriminant scale models. It is possible that some naturally-produced spring chinook salmon populations may have scale patterns which are similar to hatchery fish because of increased growth rates at low rearing

densities and, therefore, would be classified as hatchery fish using models developed from historical scale collections. If growth rates of naturally-produced spring chinook salmon have changed since the time scale samples were collected for the historical scale model, then a new discriminant scale model can be developed and used to determine the origin of unmarked spring chinook salmon carcasses collected on previous and future surveys.

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