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IDAHO NATURAL PRODUCTION MONITORING AND EVALUATION

Annual Progress Report
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Project Progress Report

2006 Annual Report

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Part 5—Monitoring trends in abundance of anadromous salmonids parr in Idaho

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PART 1—PROJECT OVERVIEW

Populations of anadromous salmonids in the Snake River basin declined precipitously following the construction of hydroelectric dams in the Snake and Columbia rivers. Raymond (1988) documented a decrease in survival of emigrating steelhead trout *Oncorhynchus mykiss* and Chinook salmon *O. tshawytscha* from the Snake River following the construction of dams on the lower Snake River during the late 1960s and early 1970s. Although Raymond documented some improvements in survival through the early 1980s, anadromous populations remained depressed and declined even further during the 1990s (Petrosky et al. 2001; Good et al. 2005). The effect was disastrous for all anadromous salmonid species in the Snake River basin. Coho salmon *O. kisutch* were extirpated from the Snake River by 1986. Sockeye salmon *O. nerka* almost disappeared from the system and were declared under extreme risk of extinction by authority of the Endangered Species Act (ESA) in 1991. Chinook salmon were classified as threatened with extinction in 1992. Steelhead trout were also classified as threatened in 1997.

Federal management agencies in the basin are required to mitigate for hydroelectric impacts and provide for recovery of all ESA-listed populations. In addition, the Idaho Department of Fish and Game (IDFG) has the long-term goal of preserving naturally reproducing salmon and steelhead populations and recovering them to levels that will provide a sustainable harvest (IDFG 2007). Management to achieve these goals requires an understanding of how salmonid populations function (McElhany et al. 2000) as well as regular status assessments. Key demographic parameters, such as population density, age composition, recruits per spawner, and survival rates must be estimated annually to make such assessments. These data will guide efforts to meet mitigation and recovery goals.

The Idaho Natural Production Monitoring and Evaluation Project (INPMEP) was developed to provide this information to managers. The Snake River stocks of steelhead and spring/summer Chinook salmon still have significant natural reproduction and thus are the focal species for this project's investigations. The overall goal is to monitor the abundance, productivity, distribution, and stock-specific life history characteristics of naturally produced steelhead and Chinook in Idaho (IDFG 2007).

Project Objectives

We have grouped project tasks into four objectives, as defined in our latest project proposal and most recent statement of work. The purpose of each objective involves enumerating or describing individuals within the various life stages of Snake River anadromous salmonids. By understanding the transitions between life stages and associated controlling factors, we hope to achieve a mechanistic understanding of stock-specific population dynamics. This understanding will improve mitigation and recovery efforts.

Objective 1. Measure 2006 adult escapement and describe the age structure of the spawning run of naturally produced spring/summer Chinook salmon passing Lower Granite Dam.

Objective 2. Investigate basinwide aggregate life cycle survival rates for wild and naturally produced spring/summer Chinook salmon populations above Lower Granite Dam from 1990 to the present.

Objective 3. Increase the precision of estimates of aggregate smolt-to-adult return (SAR) rate of naturally produced steelhead that spawn above Lower Granite Dam by placing PIT tags in juveniles at remote locations.

Objective 4. Correlate parr density of spring/summer Chinook salmon to counts of the parental generation and the subsequent smolt migration.

Report Topics

In this annual progress report, we present results for work done during 2006. Part 2 contains detailed results of INPMEP aging research and estimation of SAR rates for wild and naturally produced Chinook salmon (Objectives 1 and 2). Part 3 is a report on the ongoing development of a stock-recruit model for the freshwater phase of spring/summer Chinook salmon in the Snake River basin (Objective 2). Part 4 is a summary of work done toward evaluating the emigration of wild juvenile steelhead (Objective 3). Part 5 is a summary of the parr density data (Objective 4) gathered since the last summary report on this work (Hall-Griswold and Petrosky 2002) and covers the period 2000-2006. Data are maintained in computer databases housed at the IDFG Nampa Fisheries Research office and are available from the first author.

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PART 2—MONITORING AGE COMPOSITION OF WILD ADULT SPRING/SUMMER CHINOOK SALMON IN THE SNAKE RIVER BASIN IN 2006 TO ESTIMATE SMOLT-TO-ADULT RETURN RATES

ABSTRACT

Accurate determination of the age structure is important for monitoring status and trends of wild adult spring/summer Snake River Chinook salmon *Oncorhynchus tshawytscha*. We used fin ray ages from spawning ground carcasses and the length frequency distribution at Lower Granite Dam to estimate the age composition of the 2006 spawning run. These data were combined with previously collected data and used to estimate smolt-to-adult return (SAR) rates. Of the fish returning to the dam in 2006, we estimated that 3.7% or 356 fish were one-ocean, 79.2% or 7,646 fish were two-ocean, 16.9% or 1,632 fish were three-ocean, and 0.2% or 15 fish were four-ocean. Overlap among age groups with respect to length has increased recently and was greatest in 2006. Hence, assignment of wild fish to cohort by length would be tenuous. All adults have returned from the ocean for smolt years (SY) 1996-2002, for which estimates of SAR rates ranged from 0.31% to 3.70%. Returns for SY 2003-2005 are still incomplete. The SAR values of wild spring/summer Chinook have declined since SY 2000. Concurrently, the proportion of each cohort returning as jacks also has declined, which has implications for the run forecasting model used in the Columbia basin. We assigned ages to 732 fish based on scales collected at the dam and compared them to the 559 fish ages based on fin rays collected at spawning grounds. The two methods produced similar results. Accuracy continued to be very high for fin rays (97%) but was less for scales (90%). We recommend: 1) more effort be expended towards collection of known-age fish, especially for scale samples, 2) assessment of the magnitude of size-selection bias for carcass collection, 3) continued interpretation of scales and refinement of the methodology, 4) focusing carcass collections on indicator stocks or areas of special interest, and 5) conducting a formal comparison of adult age composition as estimated from fin rays versus scales.

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INTRODUCTION

Age information is an important tool for management and recovery of Snake River spring/summer Chinook salmon *Oncorhynchus tshawytscha*. Accurate age data are essential to assign returning adults to a specific brood year and to estimate survival rates (Copeland et al., in press). This project began to collect fin rays from carcasses to determine ocean ages in 1998. The original motivation for this effort was the mismatch of carcass scale ages with known ocean ages of fish tagged as juveniles with passive integrated transponders (PIT tags). Ocean ages based on fin rays have been >97% accurate in any given year based on known-age adults (Kiefer et al. 2001, 2002, 2004; Copeland et al. 2004). These data then allow accurate reconstruction of the age structure of a spawning run.

Although ages based on fin rays have proven highly accurate, development of information from fin rays is slow. The fish must spawn and die before samples can be collected and the preparation and reading of fin rays is labor intensive. Scales can be prepared and read more quickly but ages from scales collected from carcasses have proven too inaccurate for rigorous use (Copeland et al., in press). When Pacific salmon leave the ocean for their spawning migration, they cease feeding and scale material begins resorbing. Resorption results in the loss of annuli on the periphery of some scales, making accurate age determination difficult for salmon with long spawning migrations (Chilton and Bilton 1986), such as those of Snake River salmon stocks. However, National Marine Fisheries Service personnel have been sampling spring/summer Chinook salmon as they migrate upstream past Lower Granite Dam. Scales taken at this point in the migration may be more useful than those from carcasses. In 2005, we began a feasibility study to see if scales collected at Lower Granite Dam can be used to estimate ages accurately enough for management use.

In this section of the report, we present the age structure of spring/summer Chinook salmon spawning in the Snake River basin upstream of Lower Granite Dam in 2006. The analyses of both fin rays and scales collected in 2006 are presented. These data were used to assign the naturally produced spawning run in 2006 to age categories. We updated and extended the smolt-to-adult return (SAR) rates previously calculated (smolt years 1998-2005) and added confidence intervals. We also examined changes in length-at-age of returning adults for the last four years.

METHODS

Sample Collection

The study area encompasses streams in the Snake River basin upstream of Lower Granite Dam known to support spawning populations of spring/summer Chinook salmon. Field personnel sampled carcasses from spawning areas throughout the study area (Figure 1). In general, these reaches were a subset of the redd count transects described by Hassemer (1993).

Collection techniques for fin ray samples were the same as used in past years (Copeland et al. 2004). Carcasses were measured to fork length (FL) and mid-eye to hypural length (cm). Dorsal fins were collected and inserted into a coin envelope. Approximately 16 mm^2 of fin tissue with good color (excluding the adipose fin) was removed and placed in a test tube filled with 95% ethanol. These tissue samples were catalogued and stored for future genetic analysis. All fin samples were placed in uniquely-numbered, prelabeled envelopes and vials and

transported to the IDFG Fisheries Research Office in Nampa, Idaho. Fin rays were stored in a freezer until preparation for aging.

The majority of fin ray samples were collected on spawning grounds from carcasses of wild adults that died naturally. A few samples were collected from wild adult carcasses that floated down to adult trapping weirs. Hatchery personnel collected up to 30 dorsal fins from known-age (PIT tagged) hatchery adults at Rapid River and McCall hatcheries. We used this set of known-age samples to estimate aging accuracy in the current year. The archive of past known-age fin rays was used as training material for new personnel and as a reference to help identify split annuli and other abnormalities.

Scales were collected from Chinook passing Lower Granite Dam. A random sample of adult Chinook was taken at Lower Granite Dam fish ladder by National Marine Fisheries Service personnel. When the trap is in operation, a gate is rotated across the ladder to block upstream passage for 10 minutes every hour (Harmon 2006). Their objective was to sample 10% of the run. We used scales collected from all PIT-tagged fish in order to provide known-age scale samples for accuracy assessment.

Sample Processing

To prepare fin rays for analysis, laboratory technicians removed dorsal fins from the freezer and placed them in wooden racks to dry. The fin rays were adjusted so the base of the fin was perpendicular to the rays. After drying 24 hours, the technicians removed excess material (i.e. bones, loose skin, and flesh), then epoxied and placed them on waxed paper to harden overnight under a fume hood. After hardening, the respective sample number was written on each fin. Laboratory technicians cut each fin into cross-sections by making eight to ten thin slices (1.2 mm) in each fin using a water-cooled, high-speed sectioning saw. Cross-sections were placed on a microscope slide to dry in the order in which they were sliced. Sections were affixed to the slides using a clear liquid mounting medium to improve resolution and preserve the sample.

Mounted fin ray sections were viewed using a compound microscope and green, filtered, transmitted light. Light passing through sections illuminated opaque (dark) zones alternating with translucent (light) zones (Figure 2). Opaque zones represent material deposited during the periods of rapid growth, while translucent zones represent material deposited during periods of slow growth (Ferreira et al. 1999). The translucent (light) zones are annuli between zones of ocean growth. Technicians counted the ocean annuli to assign an age to the fish.

We assembled a reference collection of known-age Chinook salmon to train readers and to help interpret hard-to-read fin rays. This reference collection was comprised of Chinook salmon tagged as juveniles with passive integrated transponder (PIT) or coded-wire tags and recovered as returning adults. Known-age samples and at least one experienced reader were critical to accurate age assignment. In addition, personnel were trained with fin rays collected in previous years and had to have a 90% accuracy rate before they were allowed to proceed with reading current-year fin rays.

All samples were independently aged by at least two technicians. Fins were read again in a referee session 1) if there was disagreement in age determination or 2) if the determined age did not match what was expected for fish length. During a referee session, a camera was attached to the microscope to display the image on a television screen. Three trained personnel

then viewed the fin together and arrived at a consensus age. In some cases, a consensus was not reached and the fin ray was classified as unreadable. Referee sessions were more frequent at the beginning of the current year's age analysis to ensure that newly trained personnel were accurate and to discuss any new abnormalities seen in growth patterns. Known-age samples were included in random order without technician knowledge to assess accuracy.

The process for preparing and reading scales closely duplicated the process used on fin rays. Scales were examined for regeneration. Eight non-regenerated scales were cleaned and mounted between two glass microscope slides. If no non-regenerated scales were available, the sample was deemed unreadable. Slides were placed under a microscope and a digital image taken of each scale for archiving. Two technicians independently viewed each image to assign ages. Technicians were not allowed to make assignments until they had passed a test on known-age fish with 90% accuracy. The criteria for an annulus were the crowding of circuli outside of the check for ocean entry. Only annuli after ocean entry were counted. If the technicians disagreed on an age or if the age was uncommon for the fish's length, a referee session was convened. Three trained personnel then viewed the scale together and arrived at a consensus age. Known-age samples were included in random order to assess accuracy. Because of the limited number of known-age scale samples, we included known-age samples collected in 2005.

Data Analysis

Size and sex influence carcass recovery rates, so carcass samples may not represent the true composition of the population (Zhou 2002). The length frequency distribution of the entire run was based on adult Chinook measured at Lower Granite Dam. Fish with a full adipose fin were assumed to be of natural origin. Chinook salmon missing all or part of the adipose fin were assumed to be of hatchery origin.

We parsed the 2006 spawning run passing Lower Granite Dam to smolt year, i.e. when fish left freshwater rearing habitat and entered the ocean. We used the resulting length data to construct the length-frequency distribution of naturally produced spring/summer Chinook salmon. First, we constructed a length frequency distribution by 5 cm increments using fork lengths estimates from Chinook measured at Lower Granite Dam:

$$p_i = \frac{f_i}{F},$$

where p_i is the proportion of the run in length category i, f_i is the number of fish in length category i, and F is the number of all fish measured. Similarly, the age distribution of each length group was calculated based on the carcass samples:

$$a_{ij} = \frac{m_{ij}}{M_i},$$

where a_{ij} is the proportion of carcasses of length i at ocean age j, m_{ij} is the number of carcasses of length i at ocean age j, and M_i is the total number of carcasses of length i. Scale data were treated similarly. The age distribution of the carcass sample was expanded to the entire run by multiplying the matrix of a_{ij} by the vector of p_i. These proportions were then summed for each age and multiplied by the number of wild spring/summer Chinook salmon passing Lower Granite Dam as estimated by the *U.S. v. Oregon* Technical Advisory Committee (TAC; S. Sharr, IDFG, personal communication):

$$n_j = N\sum_{j=1}^{4} p_i a_{ij} ,$$

where n_j is the number of fish at ocean age j and N is the total escapement estimate. The number of wild jacks was not estimated by TAC, so we adjusted the TAC estimate to account for all age groups by dividing by the proportion of the length frequency above the length limit for jacks (61 cm). This gave the total escapement N.

To estimate an aggregate SAR estimate for wild Snake River spring/summer Chinook salmon, we combined the age assignments with estimates of out-migrating smolts from a stock-recruitment analysis (see Part 3 of this report). To calculate a SAR for a particular smolt year (SY), we used the sum of ocean returns from that cohort as the numerator and the estimate of wild smolts arriving at Lower Granite Dam as the denominator:

$$SAR_k = \frac{\sum_{l=1}^{4} r_{k+l}}{S_k} ,$$

where SAR_k is the smolt-to-adult return rate of smolt year k, r_{k+l} is the return from that cohort in year $k+l$, l is ocean age, and S_k is the estimate of smolts migrating in year k. The maximum value of l is 4 because that is the maximum ocean age observed in the past (Copeland et al. 2004). We used formulas from Fleiss (1981) to estimate the 95% confidence limits on SAR values. The lower limit is given by

$$\frac{(2np + t_{\alpha/2}^2 - 1) - t_{\alpha/2}\sqrt{t_{\alpha/2}^2 - (2 + 1/n) + 4p(nq+1)}}{2(n + t_{\alpha/2}^2)}$$

and the upper limit by

$$\frac{(2np + t_{\alpha/2}^2 + 1) + t_{\alpha/2}\sqrt{t_{\alpha/2}^2 + (2 + 1/n) + 4p(nq+1)}}{2(n + t_{\alpha/2}^2)} ,$$

where n is the number of smolts, p is the SAR value as a proportion, q is 1-SAR, and $t_{\alpha/2}$ is 1.96. In 2006, TAC revised their previous adult escapement estimates (S. Sharr, IDFG, personal communication).

RESULTS

We examined fin rays from 605 naturally produced spring/summer Chinook salmon carcasses collected on spawning grounds in 2006. Ages could not be determined for 45 fish, and one fish did not have an associated fork length, leaving a final sample size of 559 fish. Field technicians and hatchery personnel also collected 71 known-age fish, of which we aged 69 fish or 97% correctly. Of the known-age validation sample, there were 12 one-ocean fish, 46 two-ocean fish, and 13 three-ocean fish. No known-age four-ocean fish were collected.

In aggregate, 68.5% of the carcasses were two-ocean fish (Figure 3). All fish <54 cm FL were classified as one-ocean, but some individuals >54 cm FL were also classified one-ocean (Table 1). Length distributions of one- and two-ocean groups overlapped by 10 cm. The overlap between two- and three-ocean ages was more substantial at 35 cm, although three-ocean fish

were more prevalent at longer lengths. The peaks in the length distributions for two- and three-ocean fish were 72 cm and 92 cm, respectively (Figure 3). The length distribution of four-ocean fish was encompassed within that of three-ocean fish.

We examined scales from 743 wild or naturally produced spring/summer Chinook salmon returning to Lower Granite Dam. There were 11 samples in which all the scales were regenerated and deemed unreadable, leaving a final sample size of 732 fish. Among these samples were interspersed 41 known-age fish from PIT tags, of which we aged 37 fish or 90% correctly. Five known-age samples were used for training and were included in the overall length frequency distribution.

The age composition based on scales from Lower Granite Dam was similar to that based on fin rays from carcasses. In aggregate, 76.5% of the scales were from two-ocean fish (Table 2). The length distribution of two-ocean fish completely overlapped that of one-ocean fish as well as most of the three-ocean fish (Figure 4). One-ocean fish were as large as 58 cm FL, while three-ocean fish were as small as 62 cm FL. The peaks in the length distributions for two- and three-ocean fish were 74 cm and 88 cm, respectively. There were two four-ocean fish, both measuring 89 cm FL.

The overall length distribution of the total sample at Lower Granite Dam was strongly unimodal with extended tails at both extremes (Figure 5) and was similar to the length distribution of carcass samples (Table 1). Most fish (69.6%) were in the 65-79 cm length groups (Table 3). In 2006, the largest Chinook salmon measured on the spawning grounds was 110 cm, but the largest length measured at Lower Granite Dam was 105 cm. For the total wild escapement at Lower Granite Dam, we estimated there were 3.7% in the one-ocean age class, 79.2% in the two-ocean age class, and 16.9% in the three-ocean age class with the remaining 0.2% in the four-ocean age class (Table 4).

We estimated SAR values for each smolt cohort through SY 2002. Estimated SAR values ranged from a low of 0.31% for smolt year 1996 to a high of 3.70% for smolt year 1999 (Table 5). Because 1998 was the first year for which we have age data, estimates were calculated for the SY 1996 SAR without one-ocean returns. The SAR for smolts that went to sea in SY 2002, the last year for which all adults had returned in 2006, was 2.03%. Returns for SY 2003-2005 are still incomplete. Confidence intervals were <10% of the estimates.

DISCUSSION

Although age data based on fin rays were highly accurate, there may be a size bias in the carcass sample because it is harder to locate smaller fish (Zhou 2002). Collection bias can be assessed by comparison of the length frequency of marked carcasses recovered above a weir to that of fish passed over the weir. Such data are available from weirs associated with the Idaho Supplementation Studies (Project 1989-098-00). Even so, the length-group-by-age approach used to expand the carcass sample to the Lower Granite Dam sample should minimize such biases. The length frequency distribution of collected carcasses closely resembled the length frequency distribution measured at the dam, so we believe the bias is small at the aggregate scale. A more likely source of bias is generated by uneven sampling across populations. Some populations may have greater weight in the carcass sample because more effort was expended in them or it was easier to find carcasses in some places. We caution that conclusions drawn solely from the carcass data should be evaluated with potential biases in mind.

We observed increasing overlap among age groups with respect to length from 2003 to 2006. The range of lengths within each age expanded because the length of the shortest Chinook decreased within each age group (Figure 6). There were PIT-tagged three-ocean individuals as small as 72 cm FL, smaller than observed for this age group in the past. The smallest three-ocean fish sampled at Lower Granite Dam was 68 cm FL. The lengths of four-ocean fish were contained within the distribution of three-ocean fish, as we have previously found (Copeland et al. 2004). We surmised that four-ocean fish were slow growers that stayed longer in the ocean before maturing (Ricker 1981; Quinn 2005). In particular, the change in age composition of the 55-64 cm length groups was noteworthy. Since this project began in 1998, only one two-ocean fish has been ≤59 cm before this year, and there were five in 2006. There were also proportionally more two-ocean Chinook in the 90-99 cm group in 2006 compared to other years. As the overlap between age categories grows, it becomes more difficult to identify a fish's age by its length.

The SAR values have declined since SY 2000. Smolt production has remained relatively high but ocean survival apparently has declined for SYs 2003-2005. The SAR values for SY 2003 and SY 2004 are not likely to increase greatly. For SY 2003, only four-ocean returns remain in the cohort and this age group has never added more than 0.05% to the SAR. If the SY 2004 cohort follows the average age structure (30% of the cohort returns after three years), the SAR computed here might increase to 0.70%. Another noteworthy aspect of the recent trend is the decline in number of jacks per smolt by half each year since SY 2002. For SY 2005, this rate was the lowest in the data series (0.02%; previous range 0.04%-2.16%). The current forecasting model used by TAC to predict run size is based chiefly on the number of jacks, under the assumption that the rate of precocial male maturation is constant. However, preseason forecasts have been overly optimistic for the last two years. These data imply that the rate of precocial male maturation has declined, resulting in over-predictions.

The 95% confidence bounds about the SARs given in this report are more precise than those shown in the last report (Copeland et al. 2006). There was a calculation error in that report that approximately doubled the value of the estimated bound. The confidence intervals reported here are relatively precise. The width of the confidence intervals was driven by the number of smolts on which the SAR estimate is based. On average, our estimates were based on over one million fish, which greatly improves statistical precision.

The age-at-length data based on scales were similar to the fin ray data. The extremes of scale ages extended further than for fin rays but distribution peaks were similar. The advantages of using scales collected at Lower Granite Dam include speed of analysis for managers and avoidance of any size bias in carcass collection (still unknown). However, the lower accuracy of scale-based ages is a concern and should be closely examined. This project is still developing the methodology and infrastructure necessary to develop scale data in a timely manner. The first three years are a feasibility study (data have been collected for the 2005 and 2006 runs, 2005 data not presented). Once in place, age data can be produced during the run instead of months after the spawn. We used known-age scales collected in 2005 for accuracy in combination with the 2006 collection because there was no archive to draw on for training and there were few known-age scales collected in 2006. Most of the PIT-tagged hatchery fish sampled at Lower Granite Dam turned out to have been tagged as adults at Bonneville Dam. Reliable accuracy checks require more known-age samples, preferably near 100 annually. Further, the scale archive should expand in order to function properly as a training and reference tool.

In the future, a formal comparison of fin-ray age structure to scale age structure should be completed. Criteria for the evaluation should include the accuracy and precision necessary for accurate assessment of adult survival for the aggregate stock. If the aggregate age structure based on scales collected at Lower Granite Dam is sufficiently accurate, collections of fin rays should focus on spawning areas where data are scanty or management interest is high. In the past, INPMEP personnel have not taken data on carcasses of hatchery fish. This oversight should be rectified.

CONCLUSIONS AND RECOMMENDATIONS

We concluded that the age data based on fin rays were highly accurate but some weaknesses and biases remain unaddressed. Overlap among age groups with respect to length has increased recently and was greatest in 2006. Accurate assignment of wild fish to cohort by length is tenuous. The SAR values of wild spring/summer Chinook have declined since SY 2000. Concurrently, the proportion of each cohort returning as jacks also has declined, implying that the run forecasting model used in the Columbia basin will over-predict.

With thought to improving the utility and accuracy of the age data, we make the following recommendations for 2007:

1. Put more effort towards collection of known-age fish. This is especially important for the future of scale ageing. For known-age fin rays, we will coordinate more closely with the hatchery system to get known-age fish during spawning operations and expand our search to include Clearwater, Sawtooth, and Pahsimeroi hatcheries.

2. Assess the magnitude of size-selection bias for carcass collection by comparing weir passage data to the marked carcasses recovered upstream of the weir.

3. Continue to read scales and refine the methodology.

4. Focus carcass collections on indicator stocks or areas of special interest. We recommend more intense sampling on areas where information is lacking (e.g., the Salmon River downstream of Sawtooth hatchery). Numbers and lengths of hatchery strays should be recorded.

5. Conduct a formal comparison of fin-ray age structure to scale age structure. At this time, scale ages will be available for the 2005-2007 returns, enough for a valid evaluation.

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Table 1. Number collected and proportion by ocean age for each 5-cm fork length group of wild Chinook salmon carcasses collected on spawning grounds in 2006. Ages were based on fin rays.

Length Group	Number Collected	Ocean Age			
		1	2	3	4
<50	1	1.00	0.00	0.00	0.00
50-54	4	1.00	0.00	0.00	0.00
55-59	5	0.00	1.00	0.00	0.00
60-64	19	0.05	0.89	0.05	0.00
65-69	65	0.03	0.92	0.05	0.00
70-74	154	0.00	0.93	0.07	0.00
75-79	127	0.00	0.89	0.11	0.00
80-84	64	0.00	0.69	0.31	0.00
85-89	53	0.00	0.37	0.63	0.00
90-94	41	0.00	0.24	0.73	0.02
95-99	11	0.00	0.25	0.75	0.00
100-104	7	0.00	0.00	0.86	0.14
105+	8	0.00	0.00	1.00	0.00

Table 2. Number collected and proportion by ocean age for each 5-cm fork length group of wild Chinook salmon sampled at Lower Granite Dam in 2006. Ages were based on scales.

Length Group	Number Collected	Ocean Age			
		1	2	3	4
<50	14	0.64	0.36	0.00	0.00
50-54	6	0.50	0.50	0.00	0.00
55-59	13	0.62	0.38	0.00	0.00
60-64	43	0.02	0.93	0.05	0.00
65-69	140	0.01	0.88	0.11	0.00
70-74	220	0.00	0.94	0.06	0.00
75-79	145	0.00	0.86	0.14	0.00
80-84	58	0.00	0.60	0.40	0.00
85-89	50	0.00	0.18	0.78	0.04
90-94	25	0.00	0.08	0.92	0.00
95-99	13	0.00	0.08	0.92	0.00
100-104	4	0.00	0.00	1.00	0.00
105+	1	0.00	0.00	1.00	0.00

Table 3. Number of fish measured and estimated proportion in each 5 cm fork length group of wild adult spring/summer Chinook salmon passing Lower Granite Dam during 2006.

Length Group	Number measured	Proportion
<50	15	0.02
50-54	6	0.01
55-59	13	0.02
60-64	43	0.06
65-69	142	0.19
70-74	223	0.30
75-79	148	0.20
80-84	60	0.08
85-89	55	0.07
90-94	25	0.03
95-99	13	0.02
100-104	4	0.01
105+	1	0.001

Table 4. Estimated proportion by ocean age and 5 cm fork length group, total proportion by age, and number by age of wild spring/summer Chinook salmon passing Lower Granite Dam in 2006.

	Ocean Age			
Length Group	1	2	3	4
<50	0.0201	0.0000	0.0000	0.0000
50-54	0.0080	0.0000	0.0000	0.0000
55-59	0.0000	0.0174	0.0000	0.0000
60-64	0.0030	0.0514	0.0030	0.0000
65-69	0.0058	0.1752	0.0088	0.0000
70-74	0.0000	0.2768	0.0213	0.0000
75-79	0.0000	0.1760	0.0218	0.0000
80-84	0.0000	0.0555	0.0247	0.0000
85-89	0.0000	0.0274	0.0461	0.0000
90-94	0.0000	0.0082	0.0245	0.0008
95-99	0.0000	0.0043	0.0130	0.0000
100-104	0.0000	0.0000	0.0046	0.0008
105+	0.0000	0.0000	0.0013	0.0000
Total Proportion	0.0369	0.7924	0.1691	0.0016
Number	356	7646	1632	15

Table 5. Number of smolts produced, number of adults returned by age, and estimated smolt-to-adult return (SAR) rate of the aggregated Snake River wild spring/summer Chinook salmon stock by smolt year. Upper and lower confidence bounds (CBs) mark the 95% confidence intervals for the SAR estimates.

	Smolt Year									
Variable	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**[a]	**2004**[a]	**2005**[a]
# Smolts	419826	161157	599159	1560298	1344382	490537	1128539	1455845	1517956	1734464
Adult age										
1 Ocean		161	241	1550	1829	364	2309	1276	592	356
2 Ocean	845	2206	7177	41999	15882	6518	18364	5643	7646	-
3 Ocean	467	423	1242	13532	23234	2115	2189	1632	-	-
4 Ocean	0	33	306	639	50	87	15	-	-	-
% SAR	0.31	1.75	1.50	3.70	3.05	1.85	2.03	0.59	0.54	0.02
Upper CB	0.33	1.82	1.47	3.73	3.08	1.89	2.05	0.60	0.55	0.02
Lower CB	0.30	1.69	1.53	3.67	3.02	1.81	2.00	0.58	0.53	0.02

[a] Adult return of cohort is not completed.

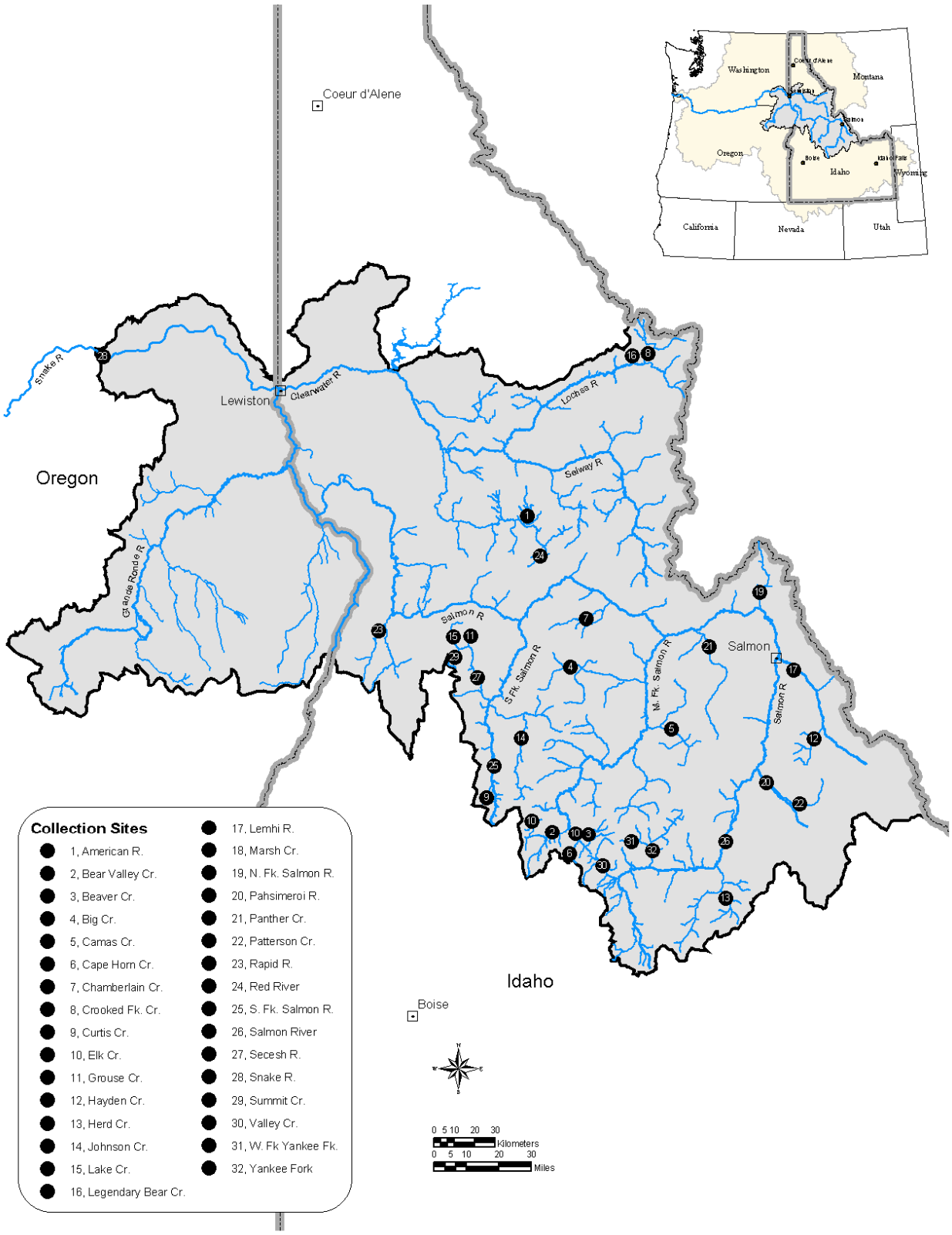

Figure 1. Location of sites where wild spring/summer Chinook salmon carcasses were collected in 2006.

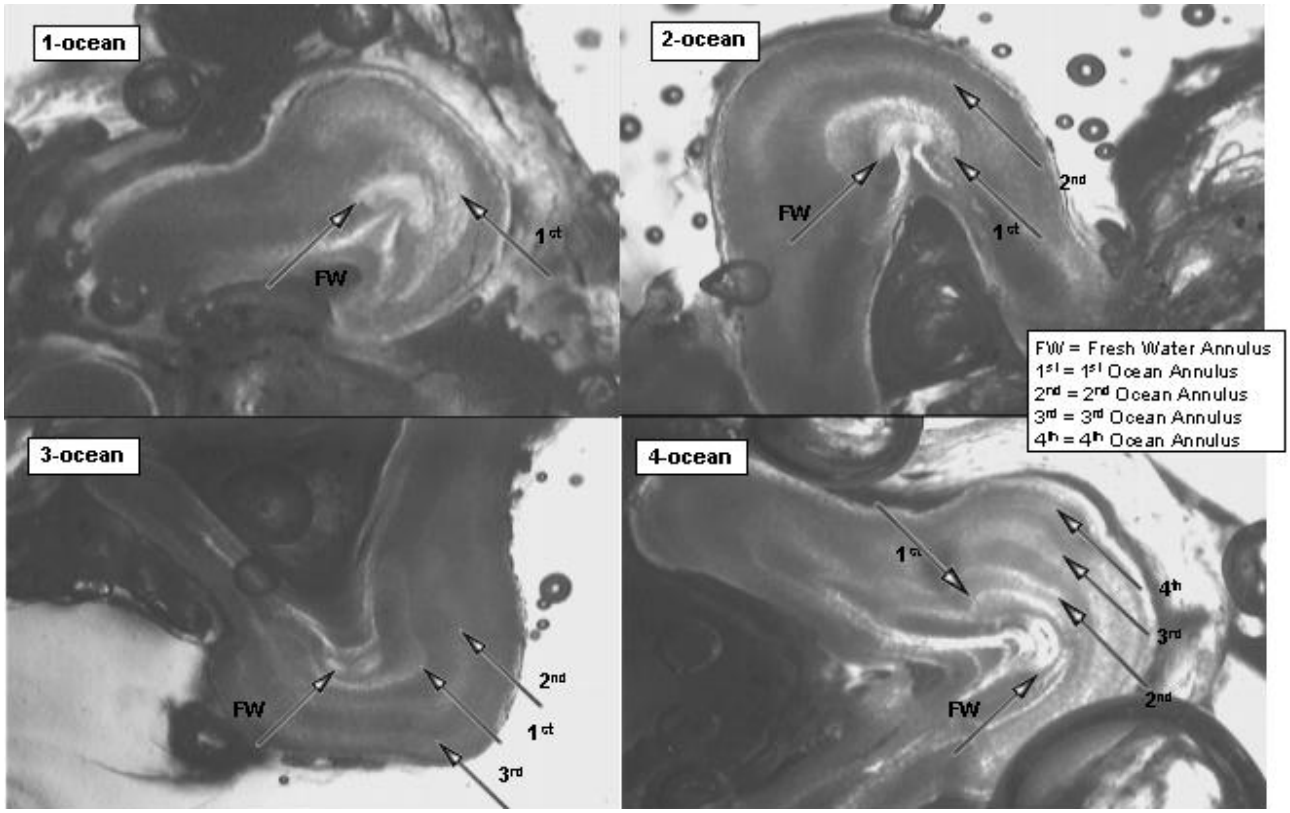

Figure 2. Example cross sections illustrating the patterns typical of the four ocean ages observed in dorsal fin rays collected from carcasses of Snake River spring/summer Chinook salmon. Light was transmitted from below.

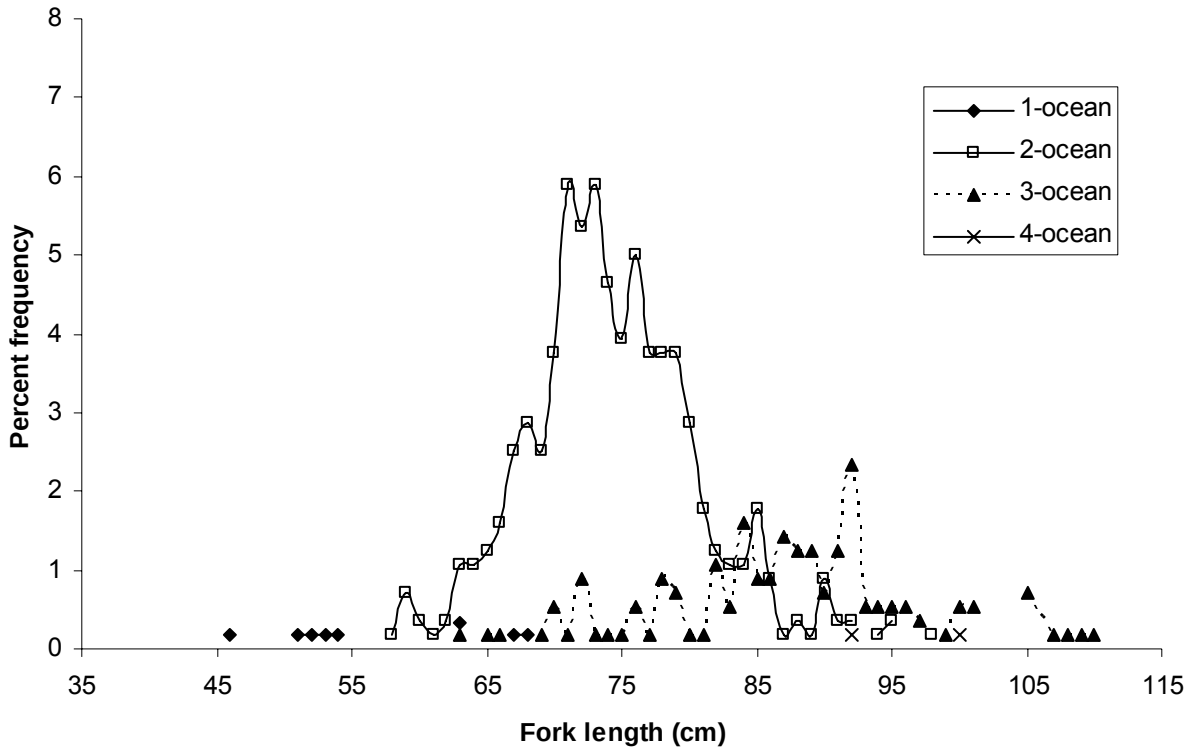

Figure 3. Length distribution by ocean age of wild Snake River spring/summer Chinook salmon collected in 2006. Ages were determined from fin rays collected from carcasses (n = 559).

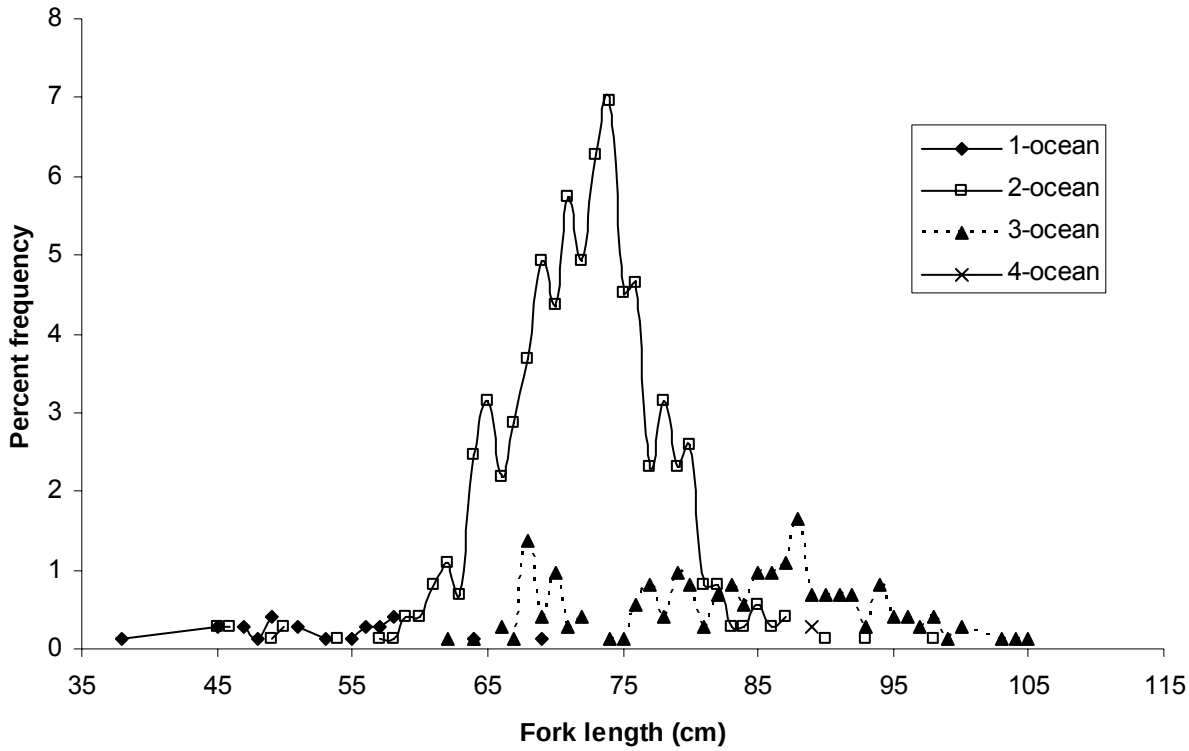

Figure 4. Length distribution by ocean age of wild Snake River spring/summer Chinook salmon collected in 2006. Ages were determined from scales collected from fish passing Lower Granite Dam (n = 732).

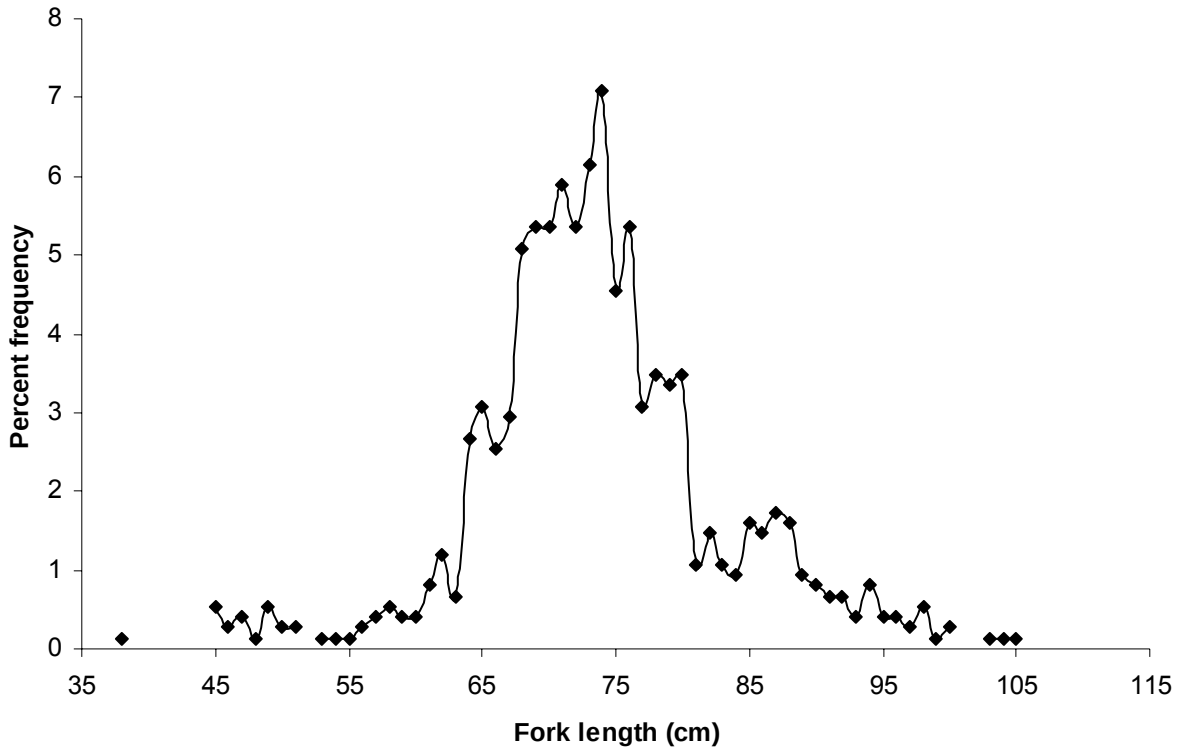

Figure 5. Length distribution of wild Snake River spring/summer Chinook crossing Lower Granite Dam in 2006 (n = 748).

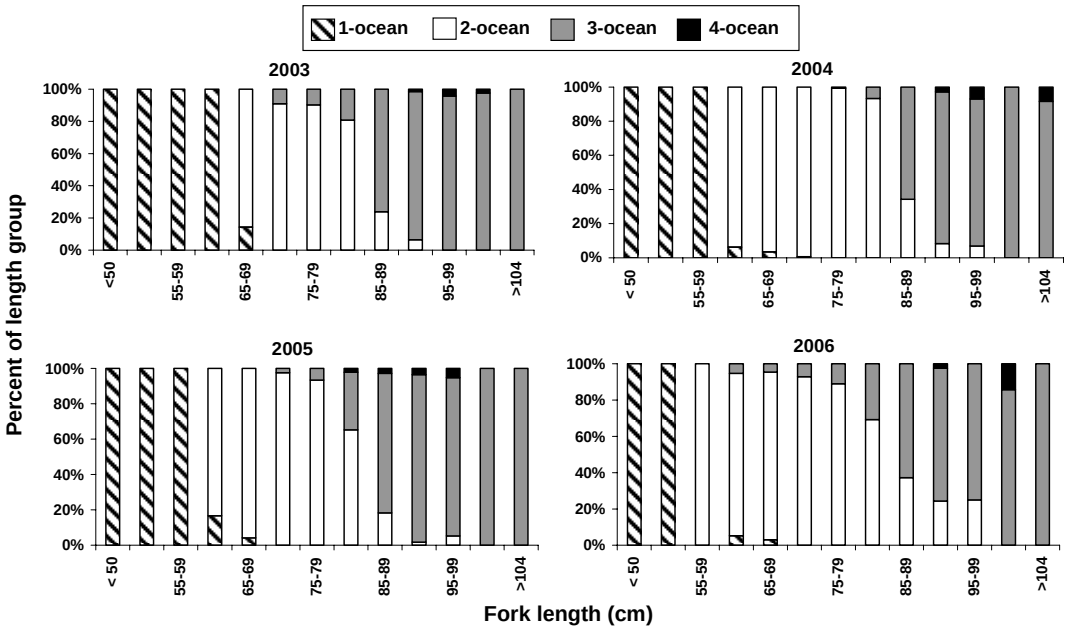

Figure 6. Age composition by length group of wild Chinook salmon based on fin rays collected in 2003 through 2006.

PART 3—THE STOCK-RECRUITMENT RELATIONSHIP FOR NATURALLY PRODUCED SPRING/SUMMER CHINOOK SALMON IN THE SNAKE RIVER BASIN

ABSTRACT

Stock-recruitment relationships are important to understanding how density-dependent factors affect abundance. In previous reports, I fit a Beverton-Holt curve to estimates of female spring/summer Chinook salmon *Oncorhynchus tshawytscha* available for natural reproduction above Lower Granite Dam during 1990-2003 versus the number of smolts produced. Here, I updated the Beverton-Holt stock-recruit model with data from the 2004 brood year and more recent estimates of detection efficiencies at Lower Granite Dam for smolt years 2004 and 2005. The estimated number of females available for natural reproduction was 28,374 in 2004. I also estimated the number of females spawning naturally in 2005 and 2006 to be 10,899 and 9,253, respectively. The estimated number of naturally produced smolts in 2006 (brood year 2004) was 1,225,679. The updated smolt estimate for smolt year 2004 (brood year 2002) increased 1.1% of the previously computed value, whereas the updated estimate for smolt year 2005 (brood year 2003) declined 5.5%. Based on data from the 1990–2004 brood years, I computed intrinsic productivity to be 474.5 smolts per female and asymptotic production to be 1.67 million smolts, as estimated by nonlinear fit (r^2 = 0.943). The paired female-smolt data fit a Beverton-Holt model very well. Parameter estimates appear to be reasonable descriptors of the system as it has existed in the last two decades. I recommend continuing to update the model. The model is valuable as a starting point for investigating the processes that produce the pattern, i.e. the combination of fish performance and habitat quality. Additionally, an aggregate egg-smolt survival rate can be computed by dividing the observed smolt/female ratio by average fecundity. Comparison to recent smolt-to-adult return rates showed that the aggregate stock likely would not meet replacement for the last three brood years. A return to extremely low abundances is likely unless smolt-to-adult return rates increase.

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INTRODUCTION

The relationship between parental abundance and subsequent recruitment of progeny is the focus of a significant portion of fisheries research and management efforts. A stock-recruitment analysis describes the demographic ability of a population to sustain itself, assuming all influential factors remain constant. This analysis is typically an empirical process simplifying the many intervening stages by aggregating life history stages (Hilborn and Walters 1992). The goal is to produce a predictive model, which is a description of the observed pattern, i.e. the regularities of the system under consideration (Rigler 1982). A mathematical model is chosen and fitted to the data, but such stock-recruit relationships often have had poor explanatory power (Hall 1988).

Sources of variation in survival of Pacific salmon *Oncorhynchus sp.* are split between freshwater and saltwater phases in approximately equal magnitudes (Bradford 1995). For threatened Snake River spring/summer (SRSS) Chinook salmon *O. tshawytscha*, survival during both freshwater and saltwater life stages must be understood for decision makers to effectively select measures to promote recovery. Stock-recruit data are also useful for evaluating the effectiveness of management efforts, such as habitat improvements (Bradford et al. 2005).

For salmon, smolt emigration is a convenient and meaningful stage to consider recruitment (Solomon 1985). Stock-recruitment relationships for Columbia River Basin Chinook salmon have been described using a Beverton-Holt (BH) function (NPPC 1986) or a Ricker function (Petrosky et al. 2001). In a BH function, the relationship is regulated by density-dependent mortality during the juvenile stage and is asymptotic in shape, with the asymptote representing carrying capacity (Beverton and Holt 1957). In a Ricker function, regulatory mechanisms cause declines in recruitment at higher stock densities (Ricker 1954). In general, most data sets have produced very poor fits to stock-recruitment relationships (Hall 1988). The most serious problem in a stock-recruitment analysis is error in estimation of adult and recruit abundance (Hilborn and Walters 1992). The Columbia River hydrosystem presents an opportunity to estimate the stock-recruitment inputs using the efficient counting systems present at the dams in the system. Previously, this project has constructed a stock-recruit model of smolt production by spring/summer Chinook salmon spawning naturally upstream of Lower Granite Dam (Kiefer et al. 2004; Copeland et al. 2004, 2005, 2006). Data are used to estimate the level of tagging necessary for downstream passage research on spring/summer Chinook in the main stem (Russ Kiefer, personal communication). Here, I updated the BH stock-recruit model with data from the 2004 brood year and more recent estimates of detection efficiencies at Lower Granite Dam in 2004 and 2005. Additionally, I estimated the number of females spawning naturally in 2005 and 2006.

METHODS

I derived an estimate of the number of spring/summer Chinook salmon females available for natural reproduction (FANR) upstream of Lower Granite Dam by duplicating the procedure used previously (Kiefer et al. 2004). The estimated number of adults (excluding jacks) passing Lower Granite Dam in 2004 and 2005 was obtained from the annual reports of the Fish Passage Center (FPC 2005, 2006). The data from 2006 was obtained directly from the Fish Passage Center web site (www.fpc.org, accessed February 2007). I obtained the total of spring/summer Chinook salmon (excluding jacks) captured at all Snake River basin hatchery traps and the number of females taken into hatcheries from unpublished Idaho Department of Fish and Game

(IDFG) hatchery reports, the Oregon Department of Fish & Wildlife (Fred Monzyk, personal communication), and the U.S. Fish & Wildlife Service (Ralph Roseburg, personal communication). I computed the percentage of females for all adults identified to sex at the weir by hatchery regional groups (Clearwater basin, McCall, Oregon, Pahsimeroi, Rapid River, Sawtooth). I also grouped females by run type (spring or summer) and mark (adipose and ventral clips versus unmarked). The total number of females taken for each hatchery (spawned, culled, or prespawning mortalities) was also noted. For each run type, the percentage of females, regardless of mark, was applied to the Lower Granite Dam counts to estimate the total number of female Chinook salmon passing Lower Granite Dam. The number of females taken by the hatcheries was adjusted for 20% migration mortality by dividing the raw estimates by 0.8. I obtained the total harvest estimates upstream of Lower Granite Dam from the IDFG Bureau of Fisheries. Female harvest was estimated by multiplying run-specific total harvest by run sex ratio and adjusted for 10% migration mortality based on telemetry studies (Chris Peery, University of Idaho, personal communication) by dividing the total estimate by 0.9. To compute FANR, the adjusted hatchery female number and the adjusted number of females harvested upstream of Lower Granite Dam were subtracted from the estimated number of females passing Lower Granite Dam. Spring and summer FANR estimates were combined to estimate total FANR.

Smolt production in 2006 was estimated using fish passage data collected at Lower Granite Dam. Passage data consisted of daily counts of wild smolts collected and estimated daily collection efficiencies (probability of detection at the dam). Daily smolt migration number was estimated by dividing the daily count by estimated collection efficiency for that day. I obtained the daily numbers of wild Chinook salmon smolts collected at Lower Granite Dam from the Fish Passage Center website. The estimated daily smolt collection efficiencies at Lower Granite Dam were provided by the Northwest Fisheries Science Center (NWFSC; Steve Smith, personal communication). Efficiencies were estimated by NWFSC personnel using procedures detailed in Sandford and Smith (2002). Daily abundance estimates were summed for the year. Because the daily efficiencies for 2004 and 2005 had been re-estimated, I recomputed smolt numbers for those years.

I used a BH function for the analysis. Previous work showed the BH function fit better than the Ricker function (Copeland et al. 2004). The number of females available for natural reproduction (FANR) for the brood years 1990-2004 and the number of smolts produced by brood years (BY) 1990-2002 had been previously estimated by Kiefer et al. (2004) and Copeland et al. (2004, 2005, 2006). To these data, I added the smolt estimate from the 2006 migration (BY 2004) and updated the smolt estimates for BY 2004 and 2005. The stock-recruit model was refit using the BH formula (Ricker 1975):

$$R = \frac{1}{\alpha + \beta / P}$$

where P = parent year spawning escapement (i.e. FANR), R = recruits (smolts) produced by parent year spawning escapement (P), and α and β are fitted parameters representing the slope at the origin and the asymptote. In this formulation, α is the inverse of asymptotic production and β is the inverse of slope at the origin (Quinn and Deriso 1999). Model parameters were estimated using iterative nonlinear regression (Gauss-Newton algorithm).

RESULTS

The estimated number of adult spring and summer Chinook salmon crossing Lower Granite Dam, excluding jacks, was 79,509 in 2004, 32,764 in 2005, and 29,628 in 2006 (Table 6). Females comprised the majority of adult salmon (less jacks) each year (range 53.7%—60.0%). Estimated losses of females above Lower Granite Dam totaled 18,779 in 2004, 7,860 in 2005, and 6,748 in 2006. Subtraction yielded FANR estimates of 28,374 in 2004, 10,899 in 2005, and 9,253 in 2006.

The estimated number of smolts exiting the system via Lower Granite Dam during smolt year 2006 was 1,225,679. This estimate covers the period March 26 to June 29, 2006. There were changes in the estimated efficiency of the smolt bypass system at Lower Granite Dam for 2004 and 2005. The updated smolt estimate for smolt year 2004 (brood year 2002) increased 1.1% of the previously computed value, whereas the estimate for smolt year 2005 (brood year 2003) declined 5.5%. The smolt estimate from SY 2006 completed the data set for the 1990-2004 brood years (Table 7).

The Beverton-Holt model fit the data very well (Figure 7, r^2 = 0.943). For the 1990–2004 brood years, intrinsic productivity was 474.5 smolts per female and asymptotic production was 1.67 million smolts. There is no obvious pattern in the model residuals when compared to predicted values (Figure 8). The variance might be constrained at low abundances, but there is no indication of accelerating variances with increasing abundance.

DISCUSSION

The complete data set now includes 15 pairs of estimates. The 2006 smolt migration (BY 2004) was near the middle of the observed values. The FANR for BY 2004 was the third highest. The last yearling smolt observed at Lower Granite Dam in 2006 was on June 29, which seemed rather early for the cessation of migration. However, >99.7% of the migration has passed Lower Granite Dam by this date in the recent past (2002-2005, data not shown), so any malfunctions in the bypass system or data omissions will not affect estimates greatly. Two clusters were apparent in the aggregated data: low smolt years ranging 161,000 to 628,000 and high smolt years ranging 1,125,000 to 1,560,000. The current system may have two possible states, low versus high smolt production (Copeland et al. 2005). The BY 2004 point lies within the high smolt abundance domain, where production is restricted by density-dependent mechanisms.

The model generated was very precise (r^2 >0.90). The parameters estimated here have not changed greatly from the previous three versions as fit by nonlinear algorithms (Copeland et al. 2004, 2005, 2006). The model tends to overpredict at low abundances and underpredict at high abundances, but unexplained variance was evenly distributed around zero. I concluded that the model is performing well. The model parameters are relatively insensitive to likely biases in the data (Copeland et al. 2006). However, Hilborn and Walters (1992) recommend at least 20 years of data in order to obtain reliable confidence intervals, so new data should continue to be added.

Plugging the FANRs for BY 2005 and BY 2006 into the Beverton-Holt model yielded a prediction of 1,260,466 smolts for BY 2005 (95% confidence interval 928,797—1,956,647) and 1,208,068 smolts for BY 2006 (95% confidence interval 881,235—1,916,570). Assuming a 1:1

sex ratio, the smolt-to-adult return rate would have to be 1.7% and 1.5%, respectively, to achieve replacement for these brood years. For BY 2004, the smolt-to-adult return rate necessary for replacement is 4.6%. Given the last few smolt-to-adult return rates estimated in Part 2 of this report, it is unlikely that any of the last three BYs will meet replacement. Given an SAR of 0.6% (likely for BYs 2004 and 2005, see Part 2), equilibrium is approximately 1,500 females.

To explore some of the factors producing the pattern described here, local stock recruit functions from eight populations in Idaho were compared to the aggregate stock recruit function (T. Copeland and D. Venditti, IDFG, unpublished data). Approximately 75% of the naturally produced smolts reaching Lower Granite Dam likely emigrated from their natal streams as fall parr. The weighted productivity estimate averaged from the study populations (448.9 smolts/female) was similar to the aggregate stock productivity estimated here. Furthermore, we suspected that density-dependent mortality was acting on juveniles that overwintered downstream of the spawning reaches. Subsequent comparisons of survival (natal stream to Lower Granite Dam) to redd counts showed that this intuition was correct. Juvenile Chinook that use rearing habitat downstream of the spawning reaches and in mainstem areas were once the most productive life history types in the Grand Ronde River but headwater rearing until smolting is the most viable under current conditions (Mobrand and Lestelle 1997). Viability of the different life history types in a salmon population directly influences the productivity and capacity with which the population generates young fish (Mobrand et al. 1997). Understanding these components of population productivity is important in evaluating population viability and scope for improvement (McElhany et al. 2000). For example, I speculate that habitat improvements should have the greatest impact on juvenile production if they are located in downstream overwintering areas.

In summary, the paired female-smolt data fit a Beverton-Holt model very well. Parameter estimates appear to be reasonable descriptors of the system as it has existed in the last two decades. I recommend continuing to update the model. The model is valuable as a starting point for investigating the interaction between fish performance (reproduction, growth, and survival) and habitat quality. The data also are used to estimate the level of tagging necessary for downstream passage research on spring/summer Chinook in the main stem (Russ Kiefer, personal communication). Additionally, an aggregate egg-smolt survival rate can be computed by dividing the observed smolt/female ratio by average fecundity. Lastly, the model predicts a return to extremely low abundances unless smolt-to-adult return rates increase above values likely for the last two brood years.

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Table 6. Estimated returns to Lower Granite Dam, percentage of females, losses to hatcheries and harvest, escapement, and females available for natural reproduction (FANR). Hatchery take was adjusted by 20% and harvest by 10% to account for migratory losses.

	Year and run type					
	2004		2005		2006	
Estimate	**Spring**	**Summer**	**Spring**	**Summer**	**Spring**	**Summer**
Dam count	70,742	8,767	26,028	6,736	22,570	7,058
% females	60.0	53.7	57.4	56.7	54.2	53.7
Females (#)	42,445	4,708	14,940	3,819	12,211	3,790
Hatchery	5,789	3,195	3,333	2,253	4,214	1,183
Harvest	8,696	1,099	1,507	767	1,138	213
Escapement	27,960	414	10,100	799	6,859	2,394
Total FANR	28,374		10,899		9,253	

Table 7. Abundance of females available for natural reproduction (FANR) and the number of naturally produced smolts by brood year.

Brood Year	FANR	Smolts
1990	4,976	527,000
1991	2,916	627,037
1992	6,826	627,942
1993	8,514	1,558,786
1994	1,043	419,826
1995	497	161,157
1996	1,556	599,159
1997	11,885	1,560,298
1998	3,726	1,344,382
1999	1,630	490,534
2000	8,733	1,128,539
2001	51,902	1,455,845
2002	31,415	1,517,956
2003	26,126	1,734,464
2004	28,374	1,225,679

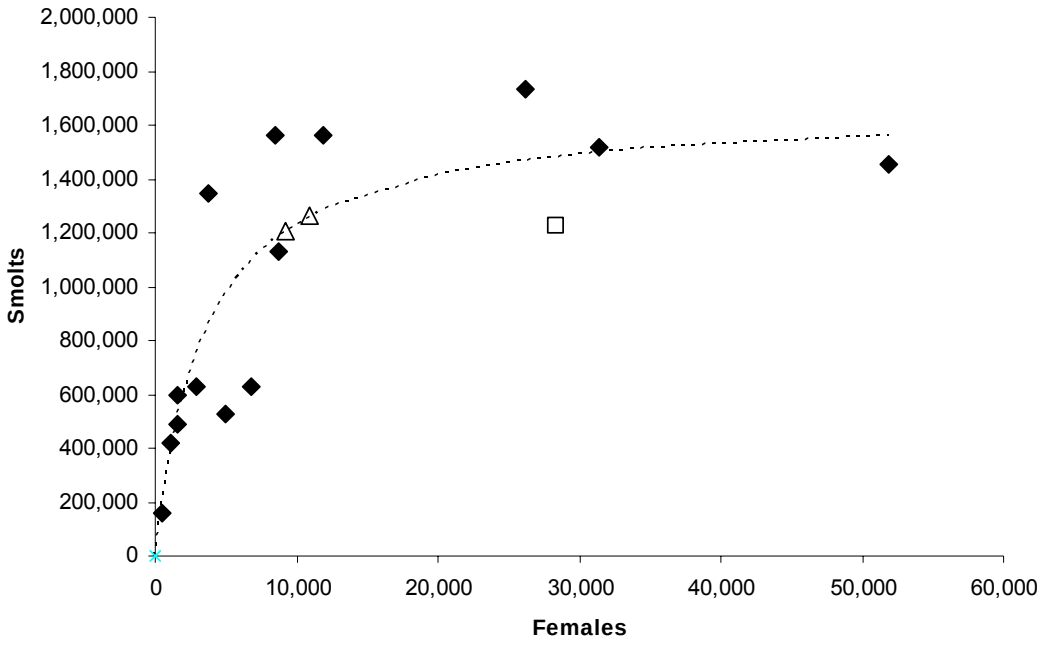

Figure 7. Comparison of observed data (BY 1990 to BY 2004) to model predictions for the linear fit of the Beverton-Holt model. Observed data are filled diamonds. The BY 2004 point is a hollow square. The predictions for BY 2005 and BY 2006 are the hollow triangles.

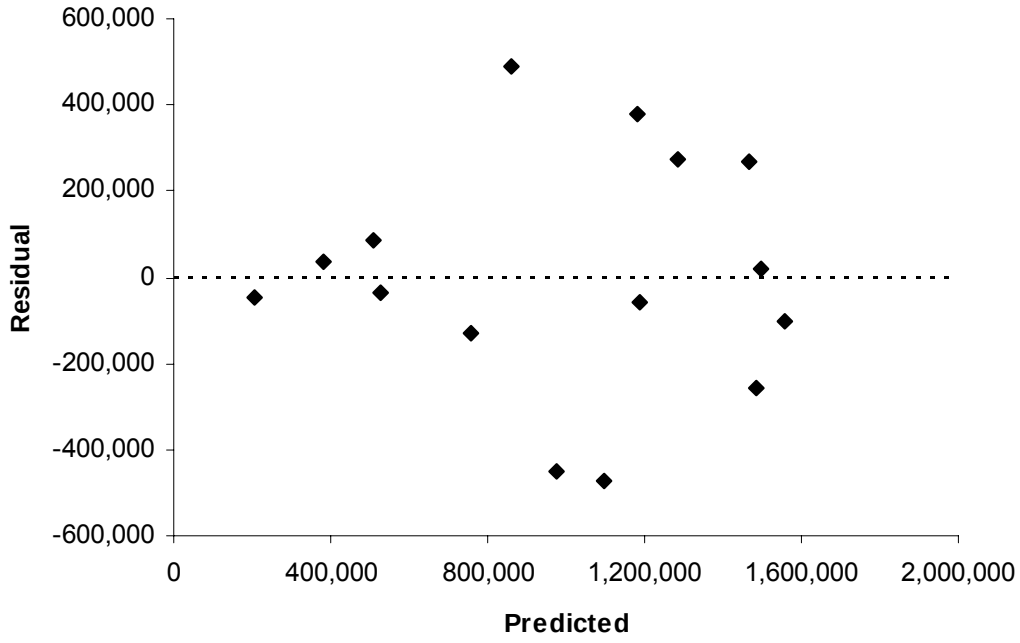

Figure 8. Beverton-Holt model residuals versus predicted values.

PART 4—IMPROVE THE PRECISION OF SMOLT-TO-ADULT SURVIVAL RATE ESTIMATES FOR WILD STEELHEAD TROUT BY PIT TAGGING ADDITIONAL JUVENILES

ABSTRACT

We placed 2,477 PIT tags in wild *O. mykiss* juveniles during summer 2006. The 2006 juvenile spring emigration from all populations sampled was unimodal in timing with a major peak on May 4 and a minor peak on May 17. Overall detection rate in 2006 of fish tagged in 2005 was 17.6% but varied from 2.8% to 21.3% among populations. The proportion of fish tagged in 2004 that delayed emigration to 2006 also varied among populations (10.2%-23.2%). This part of the project was phased out; 2006 was the last year of tagging, although fish tagged by this project may be detected until 2009.

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INTRODUCTION

Much research on protected anadromous salmonid stocks in the Columbia River basin has focused on downstream juvenile survival and smolt-to-adult return rates (SAR) (e.g., Raymond 1988). To facilitate this research, the National Marine Fisheries Service developed the passive integrated transponder (PIT) tag during the 1980s (Prentice et al. 1990a). These tags allow the individual identification of tagged fish as they migrate past the dams of the Columbia River hydrosystem without subsequent handling (Prentice et al. 1990b). Using this information, researchers can compute valid and reliable survival estimates for both juveniles and adults (Newman 1997; Skalski et al. 1998).

Fish passage downstream through a dam in the Columbia hydrosystem can be accomplished by several routes (Muir et al. 2001). To assess these hazards properly, survival estimates must be calculated separately for each route. Subdividing detections by route has reduced sample size, thus decreasing the precision and usefulness of subsequent survival estimates. Hence, there is a need to increase the number of PIT-tagged smolts, especially for wild steelhead trout *Oncorhynchus mykiss* (Newman 1997).

Little specific information exists about the populations that comprise the Snake River steelhead stock (ICBTRT 2003). In Idaho, many of the spawning and rearing stream reaches for wild steelhead are in rugged and remote wilderness areas that must be sampled with light, mobile gear such as electrofishing or angling. Most headwater streams in Idaho are very infertile and have low conductivity, rendering electrofishing ineffective (Petrosky and Holubetz 1987). Previous work by project personnel has shown that hook-and-line sampling with artificial flies can be effective at collecting juvenile steelhead (R. Kiefer, IDFG, personal communication).

In 1998, the Idaho Natural Production Monitoring and Evaluation Project (INPMEP) initiated efforts to increase the number of PIT-tagged steelhead smolts available to estimate downstream smolt survival and SAR. This year is the last year of fieldwork for this goal for INPMEP. Our objectives in this report were two-fold: 1) to summarize the results of fieldwork in 2006 and 2) to update our previous detection estimates based on new detections made during the 2006 emigration.

METHODS

Fieldwork in 2006 was conducted in four streams: North Fork Moose Creek; Chamberlain Creek; Camas Creek; and its major tributary, Yellowjacket Creek (Figure 9). These areas had high catch rates of young *O. mykiss* and detection rates >10% in previous work (except Yellowjacket Creek). All streams were believed to have minimal hatchery influence.

Wild steelhead trout juveniles were captured by angling with artificial flies during July and August 2006. Each angler carried a five-gallon bucket half filled with water to store captured fish temporarily while fishing. Water in the bucket was changed at least every 15-20 min when <10 fish were in the bucket and about every 10 min when >10 fish were in the bucket. Anglers transferred fish from buckets to submerged perforated plastic live-boxes (1.0 m x 0.5 m x 0.7 m) placed at approximately 1 km intervals throughout the stream.

We held captured fish in live-boxes overnight and tagged them the following morning. The delay allowed the fish to recover from collection stress and provided the coolest water

temperatures for tagging. We anesthetized the fish with MS-222 and injected PIT tags into the abdominal cavity using a 12-gauge hypodermic needle and modified syringe. Needles and PIT tags were sterilized by soaking them in a 70% alcohol solution for at least 10 min before tagging. Wild steelhead trout 65-249 mm FL were tagged while all others were released. Steelhead <65 mm FL were too small to tag. Wild steelhead trout >250 mm FL were most likely nonmigratory resident fish (Partridge 1985). After tagging, fish were returned to a live-box and allowed to recover before release. At the completion of fieldwork, project personnel uploaded PIT tag data to the Columbia River Basin PIT Tag Information System (PTAGIS).

Unique detection records from adult and juvenile detector sites in the Columbia River hydrosystem were obtained from the PTAGIS database (www.psmfc.org/pittag) in October 2006. The PTAGIS reports provided information on tagging dates, capture method, FL at release, release site, interrogation site, and date detected. To maintain continuity with past reports, interrogation reports from the four main smolt collection facilities (Lower Granite, Little Goose, Lower Monumental, and McNary dams) were used to determine detection rates for 2006.

To summarize fieldwork in 2006, we reported numbers tagged by stream. We also report the detections in 2006. The majority of these fish were tagged in 2005, but some were tagged during 2003 and 2004 in Bargamin Creek, Horse Creek, and Middle Fork Salmon River. Therefore, we updated all detection rates for populations previously sampled by this project. The detection rate for each stream was calculated by dividing the number detected by the total number of fish tagged in that stream in a particular year:

$$d_{ij} = \frac{\sum_{k=1}^{3} D_{i,j+k}}{T_{ij}}$$

for stream *i* sampled in year *j*, where *d* is the detection rate, *D* is the number of fish detected in the hydrosystem in year *j+k*, *k* is the number of years after tagging that the fish emigrated, and *T* is the number of fish tagged. The maximum value of *k* is 3, because that is the maximum delay in emigration observed in the past (Copeland et al. 2004). We also presented data on population-specific arrival times into the hydrosystem during 2006. For each of these streams, the dates were calculated when the 10th, 50th, and 90th percentile of total PIT tag detections occurred.

RESULTS

A total of 2,477 PIT tags were placed in wild *O. mykiss* juveniles in 2006. In Chamberlain Creek, 733 fish were tagged (mean fork length = 139.4 mm; Figure 10). There were 11 individuals previously tagged that were captured. There were 650 fish tagged in North Fork Moose Creek (mean fork length = 139.2 mm). Eleven previously tagged individuals were also captured. In Camas Creek, 700 individuals were tagged (mean fork length = 176.4 mm). Nine were recaptures from previous work. Lastly, 394 fish from Yellowjacket Creek were tagged (mean fork length = 154.5 mm). Nine fish were recaptures. In general, stream temperatures during fieldwork were high in Chamberlain and North Fork Moose creeks; therefore, catch rates were down in those streams. There were fewer small individuals in Camas Creek (Figure 10).

During the spring of 2006, juvenile detections for INPMEP-tagged fish totaled 6,041. Overall detection rate in 2006 of fish tagged in 2005 was 17.6% (Table 8). Detection rates varied among years and populations. Detection rates were highest in fish tagged in Camas Creek (21.3%) and lowest in fish tagged in Yellowjacket Creek (10.2%). Some individuals detected in 2006 (18%) were tagged prior to 2005. Of these, three were tagged in 2003 and 106 were tagged in 2004. We used the latter observations to update detection rates we previously estimated (Table 8).

The 2006 juvenile migration from the populations we sampled was unimodal in timing (Figure 11). The number of migrants arriving at Lower Granite Dam fluctuated but generally increased to the major peak on May 4. Thereafter, the number of arrivals dropped sharply for a week, then picked up slightly to a minor peak on May 17. Only one tagged individual was detected after May 31. Median date of arrival at Lower Granite Dam varied little among populations; median arrival dates ranged from April 24 to May 2 (Figure 12). Data for migrants from Bargamin Creek, Horse Creek, and Middle Fork Salmon River are not presented because only one detection each was recorded from these populations. Using the difference between the 10th and 90th percentile dates as an index of migration period, population migration periods varied from 13 to 27 days. Migrants from North Fork Moose Creek had the earliest 10th percentile date, April 12. The latest 90th percentile date was for the Chamberlain Creek population (May 17). Chamberlain Creek also had the longest migration period.

DISCUSSION

We encountered difficult field conditions in 2006. The spring snowpack was higher than recent years, so the field schedule was delayed in anticipation of an extended snowmelt. However, the snowpack melted faster than anticipated and water temperatures were warm at the lower elevation sites (Chamberlain and North Fork Moose creeks) at the time of field operations. To mitigate temperature effects on captured fish, we placed live wells where cooler tributaries entered the stream. However, lower catch rates did not allow us to place as many tags as we have done in the past at these two streams.

The length distribution of fish differed among populations. There were relatively few smaller fish captured in Camas Creek, causing the peak of the length distribution to be much sharper than elsewhere (Figure 10). In this population there is usually a minor mode or 'shoulder' on the length distribution at fork lengths <140 mm (data not shown). Modes in this range were apparent in the other populations; the major mode in the North Fork Moose Creek was at 110 mm. Although we did not take scales to determine ages, we believe this was a cohort entering the length range vulnerable to our gear.

Detection rates of steelhead juveniles tagged by this project have varied among years. Detection rates were lowest from fish tagged during the summer of 2001 (14.7%) and highest from the 2000 tagging (24.5%), including all delayed detections. The migration from the 2005 tagging was fourth highest out of eight, but detection rate may increase slightly from delayed detections in coming years. However, not all populations have been sampled every year; therefore, annual changes in the aggregate detection rate could be confounded by population differences. For tagging conducted during the summer of 2005, the highest detection rate came from Camas Creek and the lowest from the Lemhi River. Comparing Camas, North Fork Moose, Chamberlain, and Yellowjacket creeks over the last four years, Camas consistently has the highest detection rate, whereas Yellowjacket has the lowest. The reaches sampled in the latter

two streams are located just above their confluence; hence, they are almost contiguous. Presumably, the differences in detection rates are caused by differences in growth potential or ease in emigrating. Qualitatively, Yellowjacket Creek is colder and steeper than Camas Creek. We believe these features affect the expression of life history traits via growth and ease of emigration.

We detected a significant number (>10%) of fish that held over past their anticipated smolt year (i.e. tagged in 2004 but emigrated in 2006). Delayed emigrations comprised the largest proportion of total detections for the North Fork Moose Creek population, as in the past (Copeland et al. 2006). However, the holdover detection rates had increased in Camas and Chamberlain creeks from the 2005 migration, largely because more fish were tagged in 2004 than in 2005 in these populations, when examining the data relative to the year of detection (2006). Expressing holdover rate relative to the year of tagging rather than year of detection removes the effects of variable tagging effort among years (Table 9). Incidence of delayed migrants is lowest in Yellowjacket and Camas creeks and highest in North Fork Moose Creek, on average. On the other hand, the Chamberlain population appears quite variable in this regard.

The migration in 2006 was temporally limited, because migration timing was very similar among populations as it was in 2004 (Copeland et al. 2005). Initiation of migration was earlier for North Fork Moose Creek, similar to our previous findings (Copeland et al. 2004, 2005, 2006), but other population differences were likely masked. Previously, a multimodal distribution was observed when several populations are considered together (e.g., Copeland et al. 2004). We believe this is related to the early snowmelt and the decrease number of locations where we conducted operations.

Field work for PIT-tagging juvenile steelhead by this project will cease after 2006. This function will be assumed by Steelhead Monitoring & Evaluation Studies (project 1990-055-00) after 2006. We expect detections from tags placed possibly until 2009. Given, the increasing attention in the region on Snake River steelhead, these data will be valuable in assessing emigration timing and survival of wild populations in Idaho.

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Table 8. Stream-specific detection rates (%) for steelhead parr tagged by this project during 2003—2005 and percent of fish detected in 2006 that were tagged in 2004 (holdovers). Italicized values for 2003 and 2004 were updated from those reported by Copeland et al. (2006).

	Tagging Year			
Stream	**2003**	**2004**	**2005**	**Holdovers (%)**
Bargamin Creek	***17.2***	[a]	[a]	[a]
Camas Creek	23.4	***27.9***	21.3	15.4
Chamberlain Creek	12.6	***16.0***	19.5	16.5
Horse Creek	***16.1***	[a]	[a]	[a]
MF Salmon River	***25.3***	[a]	[a]	[a]
NF Moose Creek	22.9	***30.5***	19.2	23.2
Yellowjacket Creek	17.5	***12.6***	11.1	10.2

[a] No tagging.

Table 9. Percentage of all fish detected that migrated two years after tagging by tag year and stream.

	Year of tagging		
Stream	**2002**	**2003**	**2004**
Camas Creek	8.2	5.0	6.2
Chamberlain Creek	14.3	8.8	20.8
NF Moose Creek	35.3[a]	22.9	18.5
Yellowjacket Creek	11.1	11.6	8.8

[a] Tagging conducted in Moose Creek

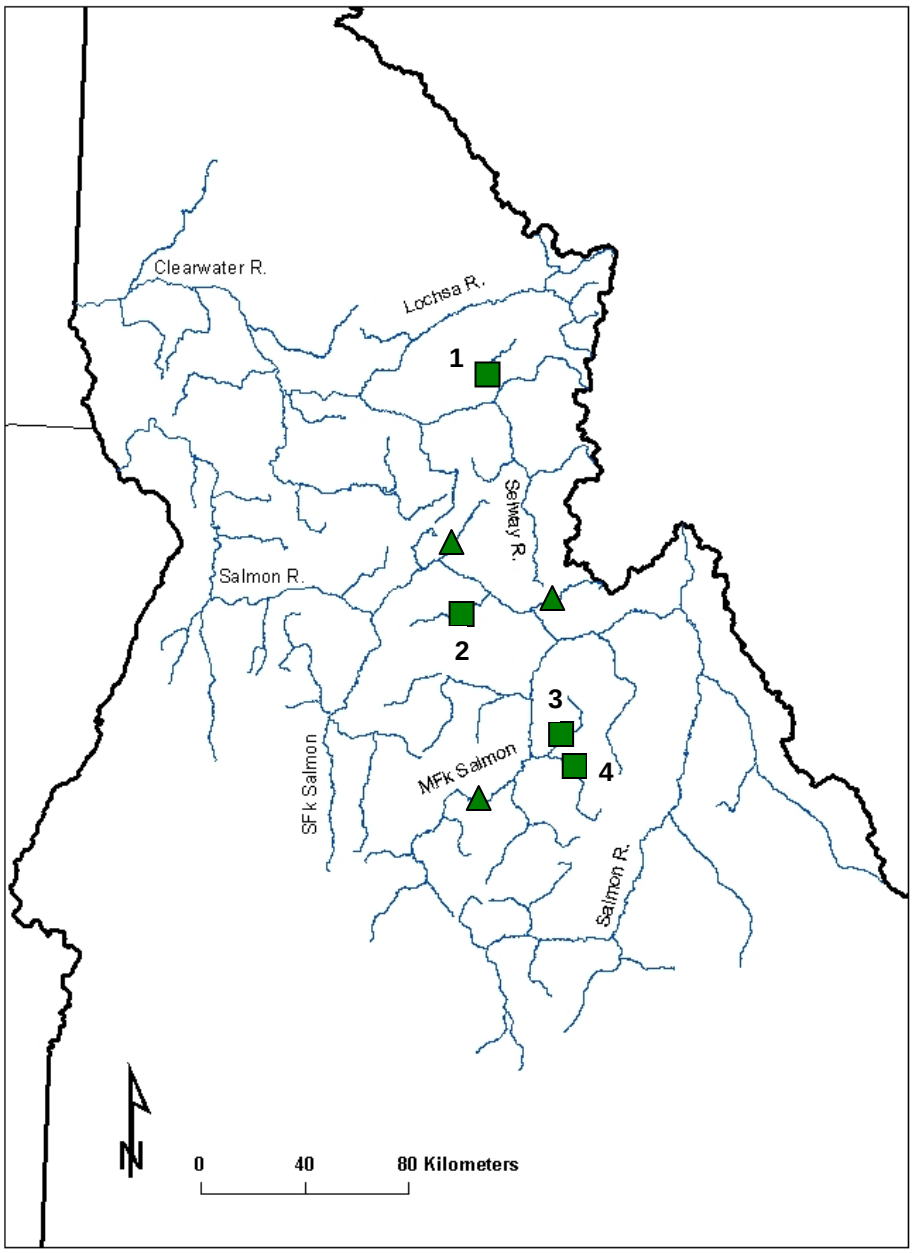

Figure 9. Locations where INPMEP personnel collected steelhead parr by angling in 2006 (squares; 1 = North Fork Moose Creek, 2 = Chamberlain Creek, 3 = Yellowjacket Creek, 4 = Camas Creek). Previously sampled sites are represented by triangles.

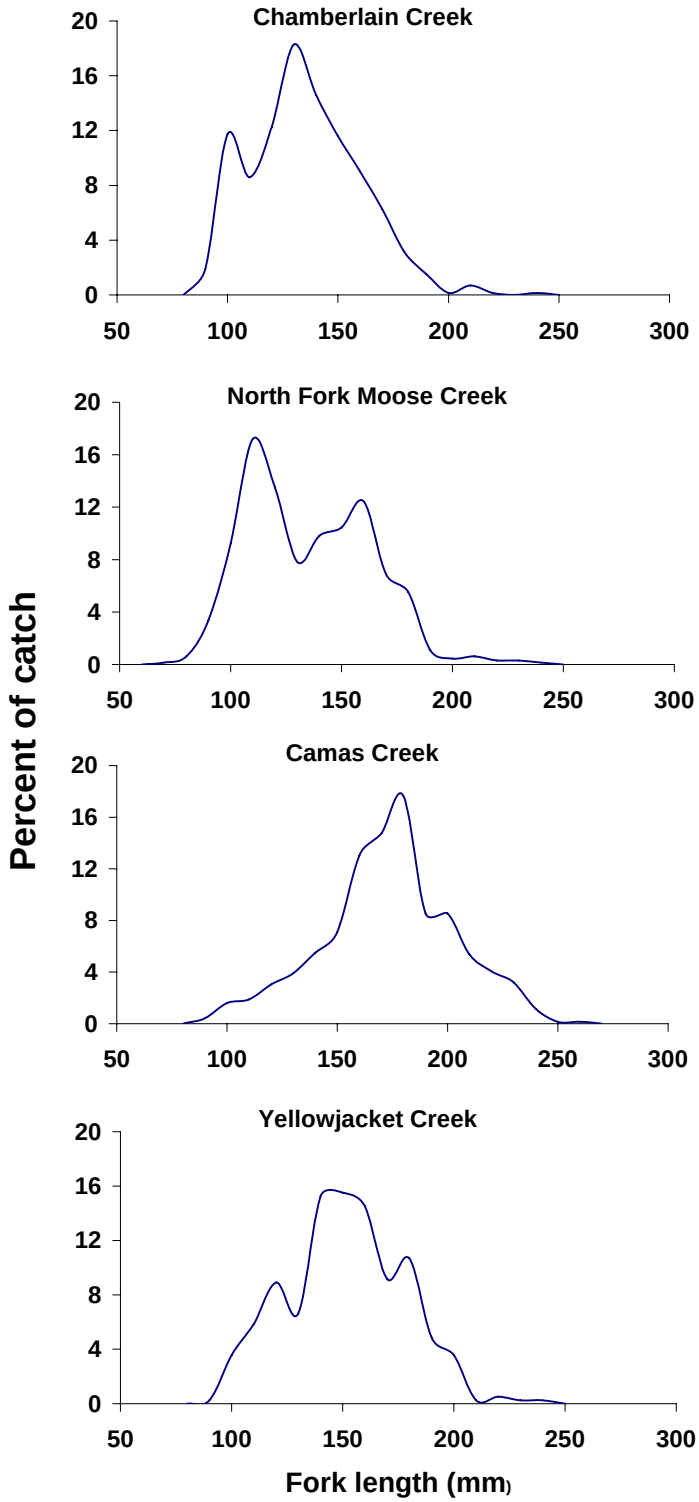

Figure 10. Length distribution of steelhead juveniles tagged during 2006 by population.

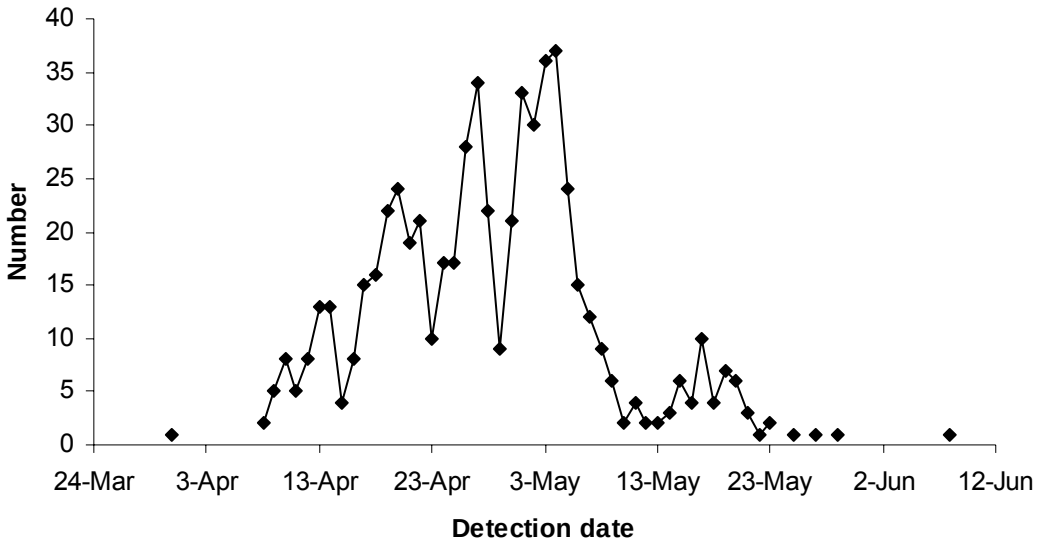

Figure 11. Date of arrival at Lower Granite Dam in 2006 of steelhead smolts tagged by project personnel.

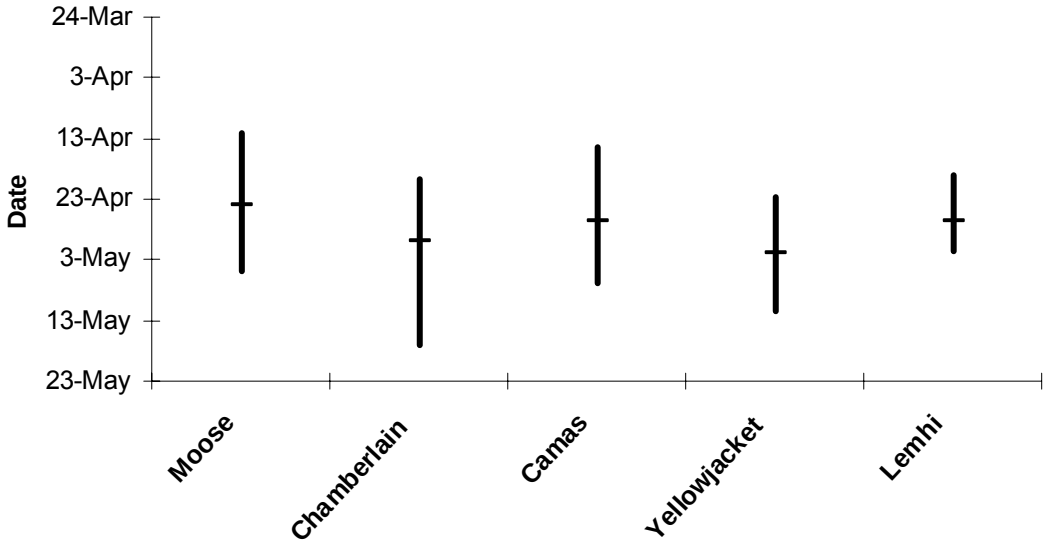

Figure 12. Population-specific arrival times at Lower Granite Dam in 2005. The vertical bar spans the 10th and 90th percentiles. The hash mark denotes the median arrival time. Streams are arranged from left to right by distance from Lower Granite Dam.

PART 5—MONITORING TRENDS IN ABUNDANCE OF ANADROMOUS SALMONID PARR IN IDAHO

ABSTRACT

The Idaho Department of Fish and Game has monitored abundance of juvenile anadromous salmonids since 1985. Our objective for this report was to summarize parr densities of steelhead trout and Chinook salmon observed during the years 2000-2006. Densities of steelhead and Chinook parr in Idaho increased from lows in the 1990s and peaked in the middle of the study period. For steelhead, most of this increase was in populations classified as wild A-run stocks. Densities in all B-run populations remained depressed. We concluded that steelhead parr densities tend to be greater in streams lower in the system compared to higher elevation headwater drainages, with the exception of the Pahsimeroi River. The increase for Chinook populations was greatest for wild stocks, all of which are in the Salmon River drainage. We recommend incorporation of probabilistic sampling during the 2007 field season. Additionally, the entire program will be reviewed for suitability to meet future information needs. Less effort will be expended in the field in 2007 and more directed towards planning efforts. Data will be reviewed to determine levels necessary to detect changes in abundance trends.

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INTRODUCTION

The Idaho Department of Fish and Game (IDFG) has monitored the abundance of juvenile anadromous salmonids since 1985 as part of the Idaho Natural Production Monitoring and Evaluation Project (INPMEP). This part of INPMEP is a long-term, general parr monitoring (GPM) program covering a broad geographic area. A formal sampling plan was developed in 1994 to coordinate and prioritize fieldwork for the purpose of developing trend information (Leitzinger and Holubetz 1994, cited in Hall-Griswold et al. 1995). Essentially, this plan designates 1) a core set of sites to sample annually, 2) sites sampled by other projects but producing data suitable for GPM, and 3) sites sampled occasionally or opportunistically. Sampling has continued on an annual basis as guided by this plan.

The last time results of the extensive GPM program were updated and summarized was by Hall-Griswold and Petrosky (2002) for the years 1997-1999 (see Kiefer et al. 2004 and Copeland et al. 2005 for partial presentations of GPM data). The objective of this part of the report was to summarize activities conducted for GPM during the years 2000-2006. The data presented are summaries of the numbers of Chinook salmon *Oncorhynchus tshawytscha* and steelhead trout *Oncorhynchus mykiss* parr observed. This section closely follows the format for data presentation used by Hall-Griswold and Petrosky (2002). Formal quantitative analyses were not undertaken for this report.

METHODS

Data were collected by snorkel surveys conducted by IDFG regional biologists. Snorkeling is the most efficient method for collecting data at most sites because most anadromous fish production streams in Idaho are clear and have low conductivity, decreasing the effectiveness of electrofishing (Petrosky and Holubetz 1987). Snorkel methods follow Petrosky and Holubetz (1986). Briefly, sites were snorkeled by divers moving upstream, with the number of divers varying according to stream size and visibility. Observers snorkeled slowly, identifying and counting all fish seen. All salmonids were tallied by species and length class (inches) except for Chinook parr, which were classified by age (0 or 1, see below). Other species observed were noted as present. Site length and mean width were recorded and area sampled computed. These methods follow IDFG standard stream survey protocol.

Raw data were proofread and entered into a central database by the regional biologists and their staff. The GPM database has been merged into IDFG's standard stream survey database. In the future, these data will be available via a link to the StreamNet web site (www.streamnet.org) as an Independent Data Set.

Annual summaries were based on density of Chinook and steelhead parr. Following past work, analysis focused only on a single cohort within a year: age-0 for Chinook and age-1 for steelhead. Chinook salmon parr were defined as age-0 salmon with fork lengths (FL) 45-99 mm (<4.0 in). Steelhead trout parr were defined as age-1 *O. mykiss* 80-120 mm FL (3.0–5.9 in). Parr densities for these two groups were expressed as number observed by divers divided by the area searched and expanded to 100 m^2. Densities were evaluated only in each species' preferred channel type as characterized by the Rosgen (1985) system. Preferred habitat for Chinook salmon was considered to be a C-channel reach, while preferred steelhead habitat was considered to be a B-channel reach (Petrosky and Holubetz 1988).

Parr density was also evaluated relative to an arbitrary estimate of habitat quality. Petrosky and Holubetz (1987) estimated streams with excellent habitat should support 108 Chinook parr per 100 m^2 or 20 steelhead parr per 100 m^2. These carrying capacity estimates were indexed to standard smolt capacity ratings for stream reaches developed by the Northwest Power Planning Council (NPPC) for poor, fair, good, and excellent habitat (NPPC 1986). Each site was rated as to its habitat quality as determined by NPCC (poor to excellent). The observed density was compared to the estimated carrying capacity for habitat of that quality (Table 10) to calculate a percent carrying capacity (PCC). This index provided a subjective but consistent means to evaluate habitat quality and carrying capacity if enough adults return to fully seed the available habitat.

For each species, mean densities were compared graphically among years within production areas (previously called 'cells'). Production areas are geographically grouped watersheds classified for each species relative to expected hatchery influence and adult migration timing. Watersheds were grouped based on IDFG anadromous fish management plans. Watersheds were classified as 'wild' if inhabited by a pure indigenous stock or as 'natural' if ancestry is influenced to some degree by hatchery operations. Adult migration timing for watersheds were classified as spring versus summer for Chinook salmon or A-run versus B-run for steelhead based on typical timing for passage over Bonneville Dam for the fish within a watershed. Because there are few wild summer Chinook populations, run timings were combined for that species and comparisons were made only as 'wild' versus 'natural'. Densities were averaged over all sites within a class and plotted versus year.

RESULTS

We used data collected from a median of 268 sites per year for steelhead and 243 sites per year for Chinook during 2000-2006 (Table 11; details on each site in Appendix A). Note that Chinook sites were a subset of steelhead sites because Chinook are more limited in their juvenile habitat and tend to occur lower in a watershed than steelhead. Each year for Chinook, more sites classified as natural were sampled than those classified as wild because most wild sites were located in more remote areas. For steelhead, sites classified as wild B-run were sampled more than any other class. Annual summaries of the data by production area are presented in Appendix B.

Density of steelhead trout yearling parr in B-channel habitat varied among years and run types (Figure 13). In general, sites within A-run watersheds had higher densities than those in B-run watersheds. Both A-run classes (wild and natural) showed slightly lower yearling parr densities in 2006 than 2000, while B-run stocks averaged slightly higher. Every class of steelhead parr decreased from 2003 to 2005, except natural A-run stock, which increased from 2004 to 2005. The lowest mean density for a class occurred in the natural B-run in 2001 (0.8/100m^2), the highest occurred in the wild A-run in 2003 (8.5/100m^2). Patterns in PCC of steelhead trout parr were similar to density patterns from 2000 to 2006, although some increases appear more dramatic when looking at PCC (Figure 14). All populations had PCC levels below 50% with the exception of wild A-run steelhead in 2000 and 2002-2004. When averaged yearly by class, steelhead parr densities from 2000 to 2006 ranged from 8.9% to 74.0% of rated carrying capacity.

Steelhead yearling trout parr densities were wide-ranging among production areas (Appendix B). No age-1 steelhead parr were detected in the East Fork Salmon River or in

tributaries to the lower Salmon River in 2003 and 2001, respectively. The highest average density occurred in 2000 when sites in Sheep Creek (Hells Canyon) averaged 28.05/100m^2. The lowest PCC for wild A-run steelhead occurred in 2001 on the lower Salmon River tributaries at 0.56%. For natural A-run steelhead, the lowest PCC occurred in 2005 in the headwaters of the Salmon River at 1.25%. In 2004, natural B-run steelhead on the East Fork Salmon River had a PCC of only 1.82%. Several PCCs of over 100% were recorded over the seven-year period. The highest PCC was recorded in 2000 for wild A-run steelhead in Snake River tributaries (Sheep Creek) at 186.01%. The wild A-run steelhead in the Lower Salmon River tributaries also had PCCs over 100% in 2002, 2003, and 2004 (167.89%, 134.80%, and 126.87%, respectively). Mainstem Clearwater River tributaries, also a wild A-run steelhead production area, had a PCC of 118.94% in 2004. The only production area type to have a PCC over 100% (other than wild A-run) was natural B-run steelhead in the Pahsimeroi River in 2003 at 120.93%.

Density of wild and natural Chinook salmon parr in C-channel habitat increased, then decreased, from 2000 to 2006 (Figure 15). The lowest mean annual densities for natural and wild Chinook salmon parr occurred in 2000 at 2.0/100m^2 and 0.5/100m^2, respectively. Natural Chinook salmon parr reached their highest density levels in 2003 at 22.4/100m^2 before declining to 16.4/100m^2 in 2005. Wild Chinook salmon parr did not reach their highest densities until 2004 at 40.8/100m^2 and then declined dramatically to 14.8/100m^2 in 2005 before slightly increasing to 18.7/100m^2 in 2006. Percent carrying capacity patterns were similar to patterns in density at C-channel sites (Figure 16). The increase seen in Chinook salmon parr densities from 2005 to 2006 in watersheds classified as 'Wild' was not seen when looking at PCC. The lowest yearly average PCCs reported for wild and natural runs occurred in 2000 at 1.0% and 2.7%, respectively. The highest yearly average PCC for natural populations occurred in 2003 at 25.1% and for wild populations in 2004 at 48.6%.

There was a wide range of parr densities among production areas (Appendix B). The lowest density recorded for age-0 Chinook was in the Little Salmon, a natural spring run, in 2005 with a density of 0.00/100m^2. The highest density observed for age-0 Chinook was in Salmon Canyon tributary streams at a density of 89.10/100m^2. The wide range of densities was mirrored in the PCCs. Lolo Creek had a PCC of 0.00% every year with the exception of 2006. In 2000, Hells Canyon tributaries also had an average PCC of 0.00%. South Fork Salmon had the highest PCC observed at 78.35% in 2003. In most production areas, PCCs consistently stayed well below 50%. Exceptions were South Fork Salmon, which had PCCs above 50% every year except 2000 and 2006, and Pahsimeroi, which had PCCs above 50% from 2003 through 2005.

DISCUSSION

Overall, the seven years covered by this report encompassed a period of increasing density for both species, which peaked in the middle of the study period. In this report, we summarized the information collected specifically for GPM. As such, only information specifically collected for parr monitoring was presented. Although data from stream surveys conducted for other purposes could be included, we did not in order to maintain continuity with past work. We will discuss results for steelhead first, then Chinook, and conclude with a section on our assumptions.

Steelhead parr densities increased during the study period relative to those recorded in the 1990s. The greatest increases were in the wild A-run populations. Densities in natural A-run

populations have increased also, although not as much. Parr densities in all populations classified as B-run remained low, which was a change from the historic pattern. In the 1980s, densities for wild B-run populations were the lowest, while natural B-run populations were higher and tracked densities in natural A-run populations closely (Scully et al. 1990). In the 1990s, densities of all production types (except wild A-run) converged at low levels (see Figures 5 and 6 in Hall-Griswold and Petrosky 2002). When densities of the A-run populations rebounded to 1980s levels, densities of natural B-run populations did not.

The differences among production types were confounded with differences in geographic location, so it is instructive to look for notable changes at the production area level. Specifically, were there any changes in density in an area when ranked against the others? To do this, we scaled steelhead PCC from each area by the maximum observed in that year and averaged these proportions for the periods 1993-1996, 1997-1999, and 2000-2006. We found that relative densities were consistently highest in Hells Canyon, the Little Salmon, the Lower Salmon, Salmon River Canyon, and the Pahsimeroi River (Table 12). Relative densities were consistently low in the Selway, Lochsa, South Fork Clearwater, and South Fork Salmon production areas. Extreme low densities were characteristic of the headwater Salmon, East Fork Salmon, and the Middle Fork Salmon and Lemhi (tied). These patterns were consistent among periods. However, there were increases in upper Salmon River tributaries (Middle Fork to Sawtooth weir) and lower Clearwater tributaries (mouth to Lolo Creek) during 2000-2006 versus the 1990s. Decreases in the South Fork Clearwater after the early 1990s were due to the cessation of adult outplants from Dworshak National Fish Hatchery in Crooked River after 1992 (Kiefer and Lockhart 1993, 1994). We concluded that steelhead densities tend to be greatest lower in the system (i.e. closer to the Columbia River) than in higher-elevation headwater drainages (e.g., the Salmon River headwaters). The major exception is the Pahsimeroi River, which is spring-fed, has an unusual hydrograph and excellent growth potential (Dave Venditti, Idaho Supplementation Studies, personal communication).

Densities of Chinook parr also increased to levels observed in the 1980s. The wild populations increased more than the natural populations, as previously noted (Copeland et al. 2005). The highest average Chinook densities for the entire GPM record occurred for wild stocks in 2004. Although densities have dropped in the last two years, they have not yet returned to the extreme lows recorded in 1995-1997 (see Hall-Griswold and Petrosky 2002).

We sought to explicate consistent patterns in Chinook parr density similar to the way we did with steelhead parr above. In general, the highest parr densities typically were in the Pahsimeroi, the South Fork Salmon, and the Salmon Canyon tributary production areas (Table 13). Conversely, the lowest densities were in Hells Canyon, Lolo Creek, Rapid River, and Lemhi River. The low densities in Hells Canyon should not be surprising because there is no recent record of spawning spring Chinook salmon in the Hells Canyon tributaries. The greatest increases in parr densities over the 1990s were in Salmon Canyon tributaries, Secesh River, Little Salmon, and South Fork Salmon. The greatest decreases were in the South Fork Clearwater. We previously noted that Clearwater Chinook populations did not rebound after the 1990s nadir as much as the Salmon populations (Copeland et al. 2005). The parr densities in the South Fork Clearwater during the 1980s may have been inflated by stocking of hatchery fry in Crooked River during that period (Scully et al. 1990; also see Table 12 in Kiefer and Forster 1991). Other than the Salmon–Clearwater dichotomy, we did not observe any general geographic patterns for Chinook parr.

The data presented here are powerful at the most general level because there is so much accumulated information but there are potential biases associated with each datum

(Copeland et al. 2005). Biases create potential problems for interpreting results with respect to some production groups. For example, trends for natural B-run populations are controlled by the South Fork Clearwater populations because few of the sampling sites were distributed to other populations in that group (see Appendix A). There are also sampling errors associated with three factors. First, not all sites were sampled each year, so means were computed over a group with shifting membership to a certain degree. This effect is exacerbated by the fact that some areas had relatively low levels of sampling effort (e.g., Pahsimeroi River). If that area has much natural variability in time and space, densities could be mischaracterized. Second, we implicitly assumed that the probability of detecting parr was equivalent among sites and years. Stream width has great influence on the ability to detect and count parr (Copeland et al. 2005; Thurow et al. 2006). This is a severe problem for assessing parr density of mainstem spawning populations, which always will be underestimated without development of a model compensating for changes in detection efficiency. Third, the surveys conducted for GPM are snapshots and may miss fish that move downstream. For some populations of Chinook salmon, a large proportion of age-0 parr may move downstream of the natal reach to rear before fieldwork in late summer (Petrosky and Holubetz 1988; Venditti et al. 2005). Although it is believed older steelhead parr use mainstem areas (Scully et al. 1990), it is not known if age-1 steelhead parr may move there as well. These potential biases need to be considered in any analyses of the data.

CONCLUSIONS AND RECOMMENDATIONS

Densities of steelhead and Chinook parr in Idaho increased from lows in the 1990s and peaked in the middle of the study period (2000-2006). For steelhead, most of this increase was in populations classified as wild A-run stocks. Densities in all B-run populations remained depressed. We concluded that steelhead parr densities tend to be highest lower in the system compared to higher-elevation headwater drainages with the exception of the Pahsimeroi River. The increase for Chinook populations was greatest for wild stocks.

Previously, we recommended incorporation of probabilistic sampling into the GPM program (Copeland et al. 2005). This element will be incorporated into the 2007 field season and should help address some of the biases mentioned previously. Additionally, the entire GPM program will be reviewed for suitability to meet future information needs. Less effort will be expended in the field in 2007 and more directed towards planning efforts. Data will be reviewed to determine sampling effort necessary to detect changes in abundance trends.

ACKNOWLEDGMENTS

We are grateful to the Bonneville Power Administration for support and funding of this research (Project 1991-073-00). Roy Beaty helped with contract administration. Jerry Harmon and his crew with the National Marine Fisheries Service provided data from the Lower Granite Dam fish trap for this work. Special thanks go to the many folks working for the Nez Perce Tribe, the Shoshone-Bannock Tribes, U.S. Fish and Wildlife Service, U.S. Forest Service, and other IDFG projects for collecting the aging fins and associated carcass data. The report benefited from reviews by Dan Garren and Martin Koenig.

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Table 10. Carrying capacity ratings (number per 100 m^2) based on assessment of habitat quality for Chinook and steelhead parr.

	Species	
Habitat quality	**Chinook**	**Steelhead**
Poor	12	6
Fair	44	10
Good	77	14
Excellent	108	20

Table 11. Number of sites sampled within watershed classes for steelhead and Chinook during 2000-2006.

	Steelhead				Chinook	
Year	**Wild A-run**	**Wild B-run**	**Natural A-run**	**Natural B-run**	**Wild**	**Natural**
2000	31	122	54	41	96	134
2001	37	147	62	39	89	178
2002	36	117	56	39	69	158
2003	36	109	57	42	63	162
2004	34	123	60	46	70	172
2005	38	135	60	48	104	162
2006	27	68	51	38	44	152

Table 12. Percent carrying capacity for steelhead trout parr (age 1) within each production area expressed as a proportion of the maximum value observed each year. Annual values were averaged within time period.

	Period		
Class/Production area	**1993-1996**	**1997-1999**	**2000-2006**
Wild B-runs			
Selway	0.27	0.14	0.15
Middle Fork Salmon River	0.04	0.06	0.10
South Fork Salmon River	0.14	0.14	0.15
Lochsa River	0.47	0.26	0.18
Natural B-runs			
South Fork Clearwater River	0.24	0.07	0.08
Lolo & Clear Creeks	0.13	0.12	
East Fork Salmon River	0.04	0.00	0.05
Natural A-runs			
Little Salmon River (except Rapid River)	0.52	0.36	0.40
Slate Creek (Lower Salmon tributary)	0.40	0.33	0.26
Upper Salmon tributaries	0.13	0.29	0.26
Pahsimeroi River	0.29	0.20	0.29
Lemhi River	0.47	0.25	0.11
Salmon headwaters	0.04	0.01	0.03
Hells Canyon (Granite Creek)	0.88	0.36	0.23
Wild A-runs			
Salmon Canyon tributaries	0.29	0.20	0.34
Hells Canyon (Sheep Creek)	0.75	0.66	0.58
Main Clearwater tributaries	0.27	0.17	0.40
Lower Salmon tributaries	0.85	1.00	1.00
Rapid River	0.56	0.25	0.36

Table 13. Percent carrying capacity for Chinook salmon parr (age 0) within each production area expressed as a proportion of the maximum value observed each year. Annual values were averaged within time period.

	Period		
Class/Production area	**1993-1996**	**1997-1999**	**2000-2006**
Wild spring-run			
Middle Fork Salmon River (above Indian Creek except Bear Valley/Elk)	0.09	0.27	0.13
Salmon Canyon	0.11	0.07	0.32
Bear Valley/Elk Creek	0.03	0.08	0.11
Hells Canyon	0.00	0.00	0.01
Lower Salmon	0.07	0.00	0.12
Wild summer-run			
Secesh River	0.08	0.01	0.26
Lower Middle Fork Salmon (below Indian Creek)	0.05		0.03
Upper Salmon River (Middle Fork to Sawtooth weir)	0.04	0.02	0.06
Natural spring-run			
Little Salmon River	0.02	0.02	0.24
Lemhi River	0.04	0.02	0.02
Upper Salmon tributaries	0.05	0.12	0.13
Salmon headwaters	0.34	0.06	0.22
South Fork Clearwater River	0.54	1.00	0.23
Lochsa River	0.03	0.02	0.08
Selway River	0.07	0.03	0.10
Lolo & Clear Creeks	0.07	0.06	0.00
Natural summer-run			
Rapid River	0.12	0.01	0.01
South Fork Salmon River	0.52	0.59	0.95
Pahsimeroi River	0.39	0.09	0.91

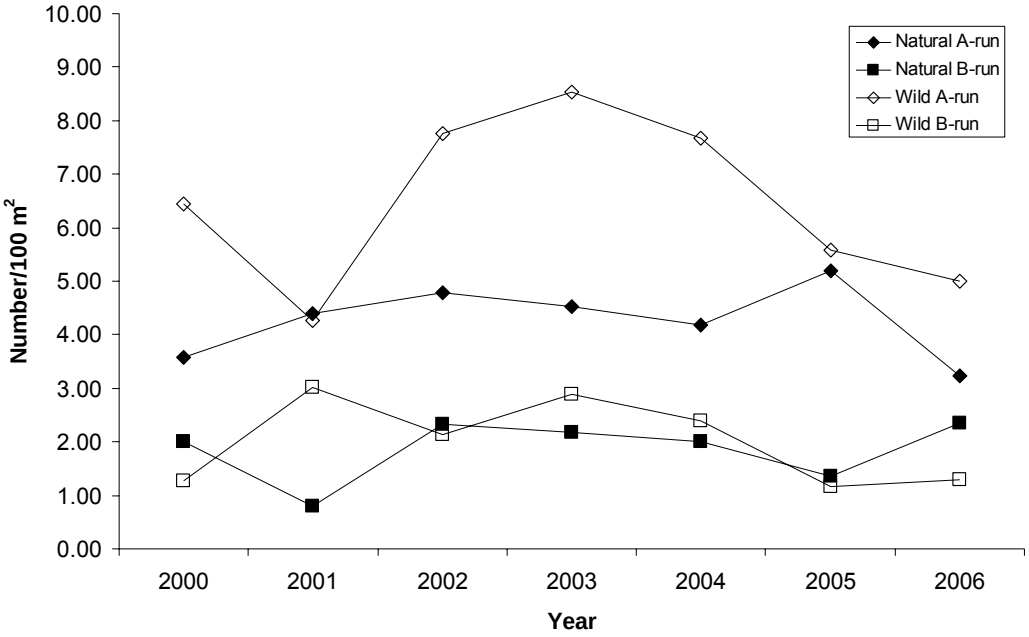

Figure 13. Mean annual density (number of age-1 steelhead trout/100 m^2 in B-channels) by adult run timing (A-run versus B-run) and hatchery influence (wild versus natural) in Idaho, 2000 through 2006.

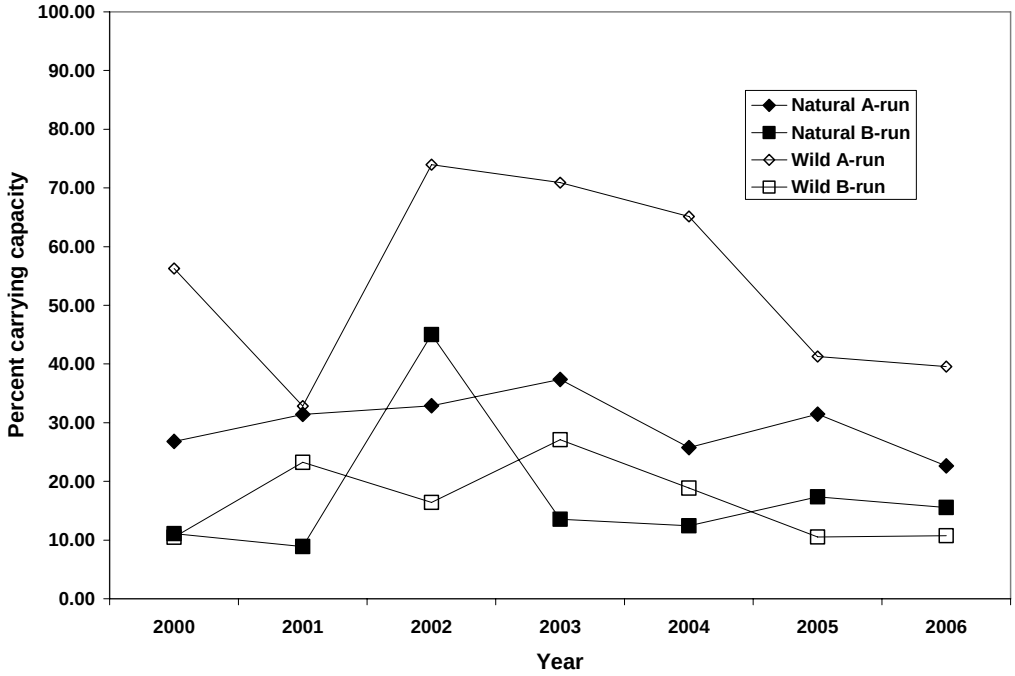

Figure 14. Percent carrying capacity of age-1 steelhead trout in watersheds classified by adult run timing (A-run versus B-run) and hatchery influence (wild versus natural) in Idaho, 2000 through 2006.

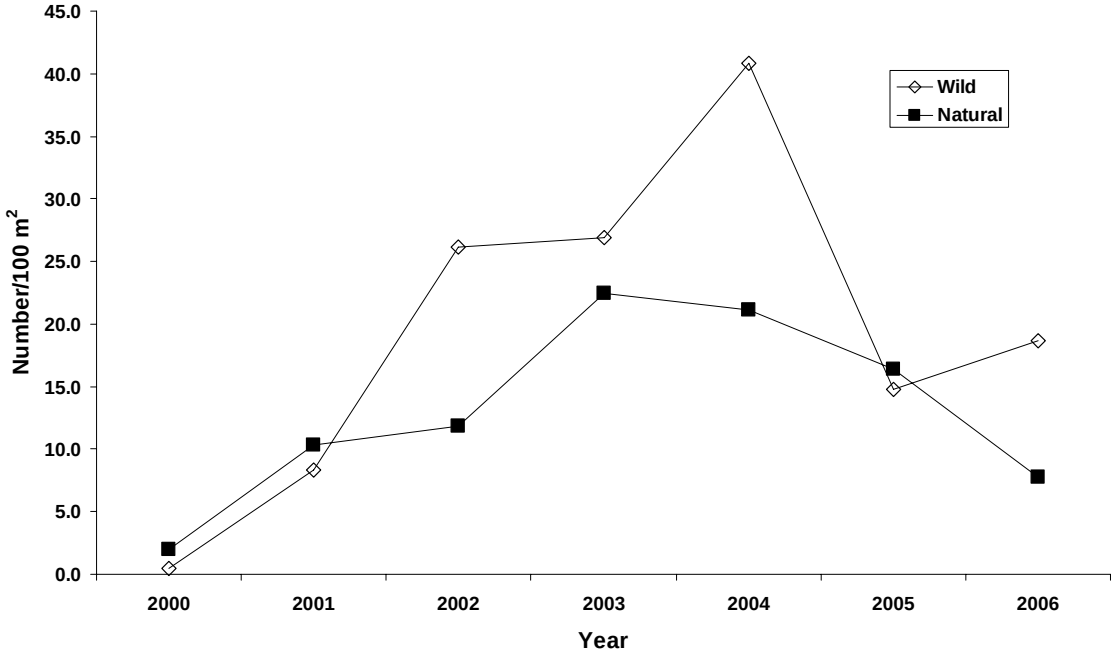

Figure 15. Mean annual density (number of age-0 Chinook salmon/100 m^2 in C-channels) by hatchery influence (wild versus natural) in Idaho, 2000 through 2006.

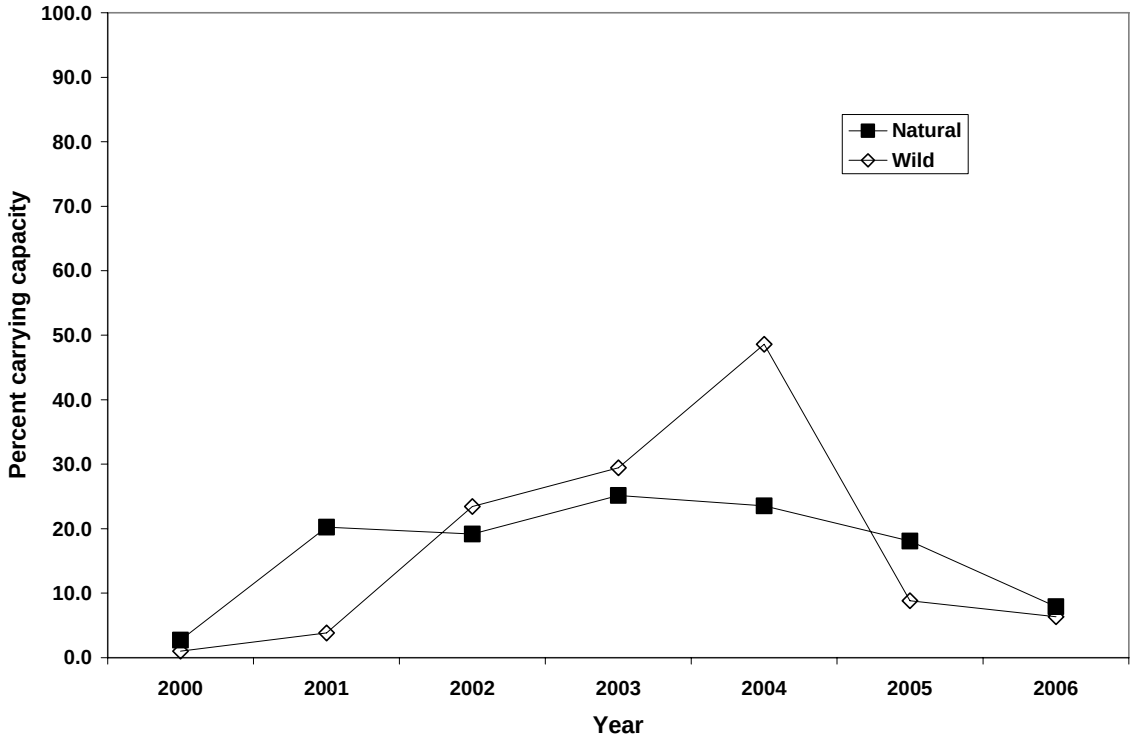

Figure 16. Percent carrying capacity of age-0 Chinook salmon in watersheds classified by hatchery influence (wild versus natural) in Idaho, 2000 through 2006.

APPENDICES

Appendix A. Table 1. Stream sites sampled for general parr monitoring during 2000-2006 by production area in Hells Canyon and the Salmon River drainage. Site names are a combination of stream, strata, and section. Channel type, steelhead production area (cell), Chinook production area (cell), and years sampled are also given.

Production Area/Stream	Strata	Section	Channel Type	Steelhead Cell[1]	Chinook Cell[2]	Years Sampled						
Hells Canyon												
Granite Creek	-99	1	B	14	4	2000	2001			2004	2005	
Granite Creek	-99	2	B	14	4					2004	2005	
Granite Creek	-99	3	B	14	4	2000	2001					
Sheep Creek	-99	1	B	16	4	2000	2001	2002	2003	2004	2005	
Sheep Creek	-99	2	B	16	4	2000	2001	2002	2003	2004	2005	
Salmon River Headwaters												
Alturas Lake Creek	1	1A	B	13	11	2000		2002				
Alturas Lake Creek	2	2A	B	13	11	2000						
Alturas Lake Creek	2	2B	C	13	11	2000	2001	2002	2003	2004	2005	2006
Salmon River	10	10AB	C	13	11	2000	2001	2002	2003	2004	2005	2006
Salmon River	2	2B	B	13	11	2000	2001	2002	2003	2004	2005	2006
Salmon River	3	3B	B	13	11	2000	2001	2002	2003	2004	2005	2006
Salmon River	3	3BRA	C	13	11	2000	2001	2002	2003	2004	2005	2006
Salmon River	4	4B	C	13	11	2000	2001	2002	2003	2004	2005	2006
Salmon River	7	7A	C	13	11	2000	2001	2002	2003	2004	2005	2006
Upper Salmon River												
East Fork Salmon River	Abv-Weir	2	C	7	10	2000	2001	2002	2003	2004	2005	2006
East Fork Salmon River	Abv-Weir	3	B	7	10	2000	2001	2002	2003	2004	2005	2006
East Fork Salmon River	Blw Weir	Fox Cr	C	7	10	2000	2001	2002	2003	2004	2005	2006
East Fork Salmon River	Blw Weir	Ziegler Hl	B	7	10	2000	2001	2002	2003	2004	2005	2006
Morgan Creek	Lower	Fence	B	10	10	2000	2001	2002	2003	2004	2005	2006
Morgan Creek	Upper	Blm Camp	C	10	10	2000	2001	2002	2003	2004	2005	2006
Moyer Creek	Above	New Sec	B	10	10	2000	2001	2002	2003	2004	2005	
North Fork Salmon River	2	DAHLONEGA	B	10	10	2000	2001	2002	2003	2004	2005	2006
North Fork Salmon River	2	HUGHES	B	10	10	2000	2001	2002	2003	2004	2005	2006
Panther Creek	-99	1.5DPC10	C	10	10			2002				
Panther Creek	-99	4THJULY	C	10	10			2002				
Panther Creek	Above	Pc10	C	10	10	2000	2001	2002	2003			
Panther Creek	Above	Pc9	C	10	10	2000	2001	2002	2003	2004	2005	2006
Panther Creek	Ds-Bigd	Pc4	B	10	10	2000	2001	2002	2003	2004	2005	2006
Panther Creek	Ds-Blackb	Pc6	B	10	10	2000	2001	2002	2003	2004	2005	2006
Panther Creek	Ds-Clear	Pc1	B	10	10	2000	2001	2002	2003			2006
Pine Creek	-99	Bridge	B	10	10		2001	2002	2003	2004	2005	2006

Appendix A. Table 1. Continued.

Production Area/Stream	Strata	Section	Channel Type	Steelhead Cell[1]	Chinook Cell[2]	Years Sampled						
Pine Creek	-99	Sawmill Cr	B	10	10		2001	2002	2003	2004	2005	2006
Redfish Lake Creek	-99	Lower	B	10	10	2000	2001	2002	2003	2004	2005	2006
Redfish Lake Creek	-99	Weir Ds	B	10	10	2000	2001	2002	2003	2004	2005	2006
Salmon River	1	Rbnsn-Bar	B	10	7	2000	2001	2002	2003	2004	2005	2006
Thompson Creek	Above	Two-Pole	C	10	10	2000	2001	2002	2003	2004	2005	2006
Thompson Creek	Below	1	C	10	10	2000	2001	2002	2003	2004	2005	2006
Valley Creek	1	B	C	10	10	2000	2001	2002	2003	2004	2005	
Valley Creek	3	A	C	10	10	2000	2001	2002	2003	2004	2005	
Valley Creek	3	B	C	10	10	2000	2001	2002	2003	2004	2005	
Valley Creek	6	B	B	10	10	2000	2001	2002	2003	2004	2005	
Warm Springs Creek	-99	Abvcab	B	10	10		2001	2002	2003	2004	2005	2006
Warm Springs Creek	-99	Cabins	B	10	10		2001	2002	2003	2004	2005	2006
West Fork Yankee Fork	2	6.2	C	10	10			2002		2004	2005	
Lemhi & Pahsimeroi Rivers												
Bear Valley Creek	HC1	B-Lower	B	12	9	2000	2001	2002	2003	2004	2005	2006
Bear Valley Creek	HC1	Camp	B	12	9	2000	2001	2002	2003	2004	2005	2006
Big Springs Creek	1	BSC BRIDGE	C	12	9	2000	2001	2002	2003	2004	2005	2006
Big Springs Creek	1	Cow Sign	C	12	9	2000	2001	2002	2003	2004	2005	2006
Big Springs Creek	LEM1	A	C	12	9	2000	2001	2002	2003	2004	2005	2006
Hayden Creek	HC2	B	B	12	9	2000	2001	2002	2003	2004	2005	2006
Hayden Creek	HC3	B	B	12	9	2000	2001	2002	2003	2004	2005	2006
Lemhi River	1	13 Beyeler	C	12	9	2000	2001	2002	2003	2004	2005	2006
Lemhi River	1	Lem3a	C	12	9	2000	2001	2002	2003	2004	2005	2006
Lemhi River	1	Pwrhs L58a	C	12	9	2000	2001	2002	2003	2004	2005	2006
Lemhi River	LEM2	B	C	12	9	2000	2001	2002	2003	2004	2005	2006
Pahsimeroi River	1	Ponds	C	11	18	2000	2001	2002	2003	2004	2005	2006
Pahsimeroi River	1	Us-P9 Div	C	11	18				2003			
Pahsimeroi River	Lower	Dwtnlane	C	11	18	2000	2001	2002	2003	2004	2005	2006
Pahsimeroi River	Weir	Weir	C	11	18	2000	2001	2002	2003	2004	2005	2006
Middle Fork Salmon River												
Bear Valley Creek	1	A	B	2	3			2002				
Bear Valley Creek	2	A	C	2	3	2000	2001	2002				
Bear Valley Creek	2	B	C	2	3	2000	2001	2002				
Bear Valley Creek	3	A	C	2	3	2000	2001	2002				
Bear Valley Creek	5	A	C	2	3	2000	2001	2002				
Bear Valley Creek	7	Big-Mdw-L	C	2	3	2000	2001	2002				
Bear Valley Creek	9	B	C	2	3	2000	2001	2002				

Appendix A. Table 1. Continued.

Production Area/Stream	Strata	Section	Channel Type	Steelhead Cell[1]	Chinook Cell[2]	Years Sampled						
Beaver Creek	1	A	B	2	1	2000	2001	2002	2003	2004	2005	2006
Beaver Creek	3	B	C	2	1	2000	2001	2002	2003	2004	2005	2006
Big Creek	Lower	L1	B	2	1	2000	2001		2003		2005	
Big Creek	Middle	Abv Beaver	B	2	1					2004		
Big Creek	Middle	Carpenter	B	2	1					2004		
Big Creek	Middle	Hard Boil	B	2	1					2004		
Big Creek	Middle	Taylor 1	B	2	1			2002		2004	2005	
Big Creek	Upper	Abv Hogbk	B	2	1	2000	2001	2002	2003	2004	2005	2006
Big Creek	Upper	Abv Jacobs	C	2	1	2000	2001	2002	2003	2004	2005	
Big Creek	Upper	Logan Cr	C	2	1	2000	2001	2002	2003	2004	2005	2006
Big Creek	Upper	Near Ford	C	2	1	2000		2002	2003	2004	2005	2006
Camas Creek	-99	1	C	2	1	2000	2001					
Camas Creek	-99	2	B	2	1	2000	2001	2002	2003	2004	2005	2006
Camas Creek	-99	Cam1	B	2	1	2000	2001	2002	2003	2004	2005	2006
Camas Creek	-99	L1-Mouth	B	2	1	2000			2003	2004	2005	
Camas Creek	-99	Upper	B	2	1			2002	2003	2004	2005	
Cape Horn Creek	1	A	B	2	1	2000	2001	2002	2003	2004	2005	2006
Cape Horn Creek	2	B	C	2	1	2000	2001	2002	2003	2004	2005	2006
Elk Creek	1	A	C	2	3	2000					2005	
Elk Creek	1	B	C	2	3	2000					2005	
Elk Creek	2	A	C	2	3	2000					2005	
Elk Creek	2	B	C	2	3	2000					2005	
Elk Creek	2	C	C	2	3	2000					2005	
Indian Creek	-99	Lower	B	2	1	2000	2001		2003	2004	2005	
Indian Creek	-99	Upper	B	2	1	2000	2001		2003	2004	2005	
Knapp Creek	1	A	C	2	1	2000	2001	2002	2003		2005	
Knapp Creek	1	B	C	2	1	2000	2001	2002	2003		2005	
Knapp Creek	1	Beaverdam	C	2	1	2000	2001	2002	2003		2005	
Knapp Creek	1	Campsite	C	2	1	2000	2001	2002	2003		2005	
Knapp Creek	1	Ds Div	C	2	1	2000	2001	2002	2003		2005	
Knapp Creek	1	Lckd Fence	C	2	1	2000	2001	2002	2003		2005	
Loon Creek	-99	L1-Bridge	B	2	1	2000	2001	2002	2003			
Loon Creek	-99	L2-Run	B	2	1	2000		2002	2003			
Loon Creek	C Channel	2	C	2	1	2000	2001	2002			2005	
Loon Creek	Lnm1	3	B	2	1	2000	2001	2002			2005	
Loon Creek	Pack Br	1	C	2	1	2000		2002			2005	
Marsh Creek	1	A	B	2	1	2000	2001	2002	2003	2004	2005	2006

Appendix A. Table 1. Continued.

Production Area/Stream	Strata	Section	Channel Type	Steelhead Cell[1]	Chinook Cell[2]	Years Sampled						
Marsh Creek	1	B	B	2	1	2000	2001	2002	2003	2004	2005	2006
Marsh Creek	3	A	C	2	1	2000	2001	2002	2003		2005	
Marsh Creek	4	B	C	2	1	2000	2001	2002	2003		2005	
Marsh Creek	5	A	C	2	1	2000	2001	2002	2003		2005	
Marble Creek	Lower	L1	B	2	1	2000	2001		2003		2005	
Marble Creek	Upper	Mar1	C	2	1		2001		2003		2005	
Marble Creek	Upper	Mar1b	B	2	1		2001		2003		2005	
Marble Creek	Upper	Mar2	B	2	1		2001		2003		2005	
Marble Creek	Upper	Sunnyside	C	2	1				2003			
Middle Fork Salmon River	1	Boundary	B	2	1	2000	2001	2002	2003	2004	2005	
Middle Fork Salmon River	1	Elkhorn	B	2	1	2000	2001	2002	2003	2004	2005	
Middle Fork Salmon River	1	Grdlhole	B	2	1	2000	2001	2002	2003	2004	2005	
Middle Fork Salmon River	1	Greyhound	B	2	1	2000	2001	2002	2003	2004	2005	
Middle Fork Salmon River	1	Indian	B	2	1	2000	2001	2002	2003	2004	2005	
Middle Fork Salmon River	1	Rapid-R	B	2	1	2000	2001	2002	2003	2004	2005	
Middle Fork Salmon River	1	Sheepeater	B	2	1	2000	2001	2002	2003	2004	2005	
Middle Fork Salmon River	1	Velvet	B	2	1		2001	2002	2003	2004	2005	
Middle Fork Salmon River	2	Cougar	B	2	1	2000			2003		2005	
Middle Fork Salmon River	2	Hosppl	B	2	1	2000			2003		2005	
Middle Fork Salmon River	2	Hosprun	B	2	1	2000			2003		2005	
Middle Fork Salmon River	2	Ljackass	B	2	1	2000			2003		2005	
Middle Fork Salmon River	2	Marblpl	B	2	1		2001		2003	2004	2005	
Middle Fork Salmon River	2	Pungo	B	2	1	2000	2001		2003	2004	2005	
Middle Fork Salmon River	2	Rock Is	B	2	1	2000					2005	
Middle Fork Salmon River	2	Skijump	B	2	1				2003		2005	
Middle Fork Salmon River	2	Tappanpool	B	2	1	2000			2003		2005	
Middle Fork Salmon River	2	Tappanrun	B	2	1	2000						
Middle Fork Salmon River	2	Whiteycx	B	2	1	2000			2003		2005	
Middle Fork Salmon River	3	Airstrip	B	2	1	2000			2003		2005	
Middle Fork Salmon River	3	Flying-B	B	2	1	2000			2003		2005	
Middle Fork Salmon River	3	Survey	B	2	1	2000					2005	
Middle Fork Salmon River	4	Big-Cr-Br	B	2	1	2000			2003		2005	
Middle Fork Salmon River	4	Goatpool	B	2	1				2003		2005	
Middle Fork Salmon River	4	Goatrun	B	2	1				2003		2005	
Middle Fork Salmon River	4	Litouzel	B	2	1	2000			2003		2005	
Middle Fork Salmon River	4	Lovebar	B	2	1	2000			2003		2005	
Middle Fork Salmon River	4	Otterbar	B	2	1	2000			2003		2005	

Appendix A. Table 1. Continued.

Production Area/Stream	Strata	Section	Channel Type	Steelhead Cell[1]	Chinook Cell[2]	Years Sampled						
Middle Fork Salmon River	4	ShipIsland	B	2	1	2000			2003		2005	
Monumental Creek	-99	Mon1	C	2	1		2001	2002	2003	2004	2005	
Monumental Creek	-99	Mon2	B	2	1		2001	2002	2003	2004	2005	2006
Monumental Creek	-99	Mon3	C	2	1		2001	2002	2003	2004	2005	2006
Monumental Creek	-99	Mon5	B	2	1		2001	2002	2003	2004	2005	2006
Pistol Creek	-99	L1	B	2	1	2000	2001		2003	2004	2005	
Pistol Creek	-99	L2	B	2	1	2000	2001		2003	2004	2005	
Rush Creek	-99	11	B	2	1			2002				
Sulphur Creek	2	3A	B	2	1						2005	
Sulphur Creek	2	4A	C	2	1						2005	
Sulphur Creek	2	4B	B	2	1						2005	
Sulphur Creek	2	Footbridge	B	2	1	2000						
Sulphur Creek	2	Rockslide	B	2	1	2000						
West Fork Monumental Creek	-99	Mon4	C	2	1		2001	2002	2003	2004	2005	2006
Salmon River Canyon												
Bargamin Creek	-99	1	B	15	2	2000	2001	2002	2003	2004	2005	2006
Bargamin Creek	-99	2	B	15	2	2000	2001	2002	2003	2004	2005	2006
Big Mallard Creek	-99	1	B	15	2	2000	2001	2002	2003	2004	2005	2006
Big Mallard Creek	-99	2	C	15	2	2000	2001	2002	2003	2004	2005	2006
Chamberlain Creek	-99	CHA1	C	15	2		2001	2002	2003	2004	2005	2006
Chamberlain Creek	-99	CHA4	C	15	2		2001	2002	2003	2004	2005	2006
Crooked Creek	-99	1	B	15	2	2000	2001	2002	2003	2004	2005	2006
Crooked Creek	-99	2	B	15	2	2000	2001	2002	2003	2004	2005	2006
Fish Creek	1	Trail Xing	B	15	2			2002				
Horse Creek	-99	L1	B	15	2		2001			2004	2005	2006
Horse Creek	-99	L2	B	15	2		2001			2004	2005	2006
Jersey Creek	-99	1	B	15	2	2000	2001	2002	2003	2004	2005	2006
Sheep Creek	-99	L1	B	15	2	2000					2005	2006
Sheep Creek	-99	L2	B	15	2	2000					2005	2006
West Fork Chamberlain Creek	-99	CHA2	C	15	2		2001	2002	2003	2004	2005	2006
West Fork Chamberlain Creek	-99	CHA3	C	15	2		2001	2002	2003	2004	2005	2006
South Fork Salmon River												
Burntlog Creek	-99	Buck	B	3	17	2000	2001	2002	2003	2004	2005	
Burntlog Creek	-99	Mouth	B	3	17	2000	2001	2002	2003	2004	2005	
Dollar Creek	-99	1	B	3	17				2003	2004	2005	
Dollar Creek	-99	Mouth	B	3	17	2000	2001	2002	2003	2004	2005	2006
East Fk South Fork Salmon River	Abv Jhnsn	3	B	3	17	2000	2001	2002	2003	2004	2005	2006

Appendix A. Table 1. Continued.

Production Area/Stream	Strata	Section	Channel Type	Steelhead Cell[1]	Chinook Cell[2]	Years Sampled						
East Fk South Fork Salmon River	Abv Jhnsn	Sugar Cr	B	3	17	2000	2001	2002	2003	2004	2005	2006
East Fk South Fork Salmon River	Blw Jhnsn	6	B	3	17	2000	2001	2002	2003	2004	2005	
East Fk South Fork Salmon River	Blw Jhnsn	7	B	3	17	2000	2001	2002	2003	2004	2005	
East Fk South Fork Salmon River	Blw Jhnsn	MP 35.8	B	3	17	2000	2001	2002	2003	2004	2005	2006
Johnson Creek	Lower Iv	L2	B	3	17	2000	2001	2002	2003	2004	2005	2006
Johnson Creek	Lower Iv	L3	B	3	17	2000	2001	2002	2003	2004	2005	
Johnson Creek	Mid Lowiii	PW3B	B	3	17	2000	2001	2002	2003	2004	2005	2006
Johnson Creek	Mid Upr Ii	PW3A	B	3	17	2000	2001	2002	2003	2004	2005	2006
Johnson Creek	Upper I	M1	C	3	17	2000	2001	2002	2003	2004	2005	2006
Johnson Creek	Upper I	M2	C	3	17	2000	2001	2002	2003	2004	2005	2006
Johnson Creek	Upper I	M2 SIDE	C	3	17	2000	2001		2003	2004	2005	2006
Johnson Creek	Upper I	M3	C	3	17	2000	2001	2002	2003	2004	2005	2006
Johnson Creek	Upper I	M3 SIDE	C	3	17	2000	2001		2003	2004	2005	2006
Johnson Creek	Upper I	PW1A	B	3	17	2000	2001	2002	2003	2004	2005	2006
Lake Creek	-99	Burgdorf	C	3	5		2001	2002	2003	2004	2005	2006
Lake Creek	-99	Willow Cr	C	3	5		2001	2002	2003	2004	2005	2006
Lick Creek	-99	L1	B	3	5	2000	2001	2002	2003	2004	2005	2006
Lick Creek	-99	L3	B	3	5	2000	2001	2002	2003	2004	2005	2006
Rock Creek	Upper I	M1	C	3	17	2000	2001	2002	2003	2004	2005	
Sand Creek	Upper I	M2	C	3	17	2000	2001	2002	2003	2004	2005	2006
Secesh River	-99	1	C	3	5			2002	2003	2004	2005	2006
Secesh River	-99	4	C	3	5		2001		2003	2004	2005	
Secesh River	-99	5	C	3	5					2004	2005	2006
Secesh River	-99	Grouse	B	3	5		2001	2002	2003	2004	2005	
Secesh River	-99	Long-Gulch	C	3	5		2001	2002	2003	2004	2005	2006
Secesh River	-99	L-Scsh-Mdw	C	3	5			2002				
Secesh River	-99	U-SCSH-MDW	C	3	5		2001	2002	2003			
South Fork Salmon River	-99	11	B	3	17	2000		2002	2003	2004	2005	2006
South Fork Salmon River	-99	14	B	3	17	2000	2001	2002	2003	2004	2005	2006
South Fork Salmon River	-99	16	B	3	17	2000	2001	2002	2003	2004	2005	2006
South Fork Salmon River	-99	5	C	3	17	2000	2001	2002	2003	2004	2005	2006
South Fork Salmon River	-99	7	B	3	17	2000	2001	2002	2003	2004	2005	2006
South Fork Salmon River	-99	Poverty	C	3	17	2000	2001	2002	2003	2004	2005	2006
South Fork Salmon River	-99	Stolle1	C	3	17	2000	2001	2002	2003	2004	2005	2006
South Fork Salmon River	-99	Stolle2	C	3	17	2000	2001	2002	2003	2004	2005	2006
Lower Salmon River												
John Day Creek	-99	1	B	18	19	2000			2003		2005	2006

Appendix A. Table 1. Continued.

Production Area/Stream	Strata	Section	Channel Type	Steelhead Cell[1]	Chinook Cell[2]	Years Sampled						
John Day Creek	-99	2	B	18	19	2000	2001	2002	2003	2004	2005	2006
Little Slate Creek	-99	7	B	9	19	2000	2001	2002		2004	2005	
Race Creek	-99	1	B	18	19	2000	2001		2003	2004	2005	2006
Skookumchuck Creek	-99	1	B	18	19	2000	2001	2002	2003			2006
Skookumchuck Creek	-99	2	B	18	19							2006
Skookumchuck Creek	-99	Mouth	B	18	19						2005	
Slate Creek	-99	1	B	9	19	2000	2001	2002		2004	2005	2006
Slate Creek	-99	2	B	9	19	2000	2001	2002	2003	2004	2005	2006
Slate Creek	-99	3	B	9	19	2000	2001		2003	2004	2005	2006
Slate Creek	-99	4	B	9	19	2000	2001	2002		2004	2005	2006
Slate Creek	-99	5	B	9	19	2000	2001	2002		2004	2005	
Slate Creek	-99	6	B	9	19	2000	2001	2002	2003	2004	2005	
South Fork White Bird Creek	-99	SF-#2	B	18	19	2000	2001	2002	2003	2004	2005	2006
South Fork White Bird Creek	-99	SF-#3	B	18	19	2000	2001		2003	2004	2005	2006
White Bird Creek	-99	1	B	18	19	2000	2001	2002	2003	2004	2005	2006
Little Salmon River												
Boulder Creek	Above	1	C	8	8	2000	2001	2002	2003	2004	2005	2006
Boulder Creek	Above	2	B	8	8	2000	2001	2002	2003	2004	2005	2006
Boulder Creek	Below	3	B	8	8		2001	2002	2003	2004	2005	2006
Boulder Creek	Below	5	B	8	8	2000	2001	2002	2003	2004	2005	2006
Hazard Creek	-99	HAZ1	B	8	8	2000	2001	2002	2003	2004	2005	2006
Hazard Creek	-99	HAZ2	B	8	8	2000	2001	2002	2003	2004	2005	2006
Little Salmon River	-99	1	B	8	8	2000	2001	2002	2003	2004	2005	2006
Little Salmon River	-99	1.5	B	8	8	2000	2001	2002	2003	2004	2005	2006
Little Salmon River	-99	2	B	8	8	2000	2001	2002	2003	2004	2005	2006
Rapid River	Abv W Fk	4	B	19	16	2000	2001	2002	2003	2004	2005	
Rapid River	Abv W Fk	Castle Cr	B	19	16	2000	2001	2002	2003		2005	
Rapid River	Abv W Fk	Copper Cr	B	19	16	2000	2001	2002	2003	2004	2005	
Rapid River	Abv W Fk	Cora Cliff	B	19	16	2000	2001	2002	2003	2004	2005	
Rapid River	Abv W Fk	Paradise	B	19	16	2000	2001	2002	2003	2004	2005	
Rapid River	Abv W Fk	Wyant	B	19	16	2000	2001	2002	2003	2004	2005	
Rapid River	Blw W Fk	5	B	19	16	2000	2001	2002	2003	2004	2005	
Rapid River	Blw W Fk	6	B	19	16	2000	2001	2002	2003	2004	2005	
Rapid River	Blw W Fk	7	B	19	16	2000	2001	2002	2003	2004	2005	
Rapid River	Blw W Fk	Cliff Hang	B	19	16	2000	2001	2002	2003	2004	2005	
Rapid River	Blw W Fk	RAP2	B	19	16	2000	2001	2002	2003	2004	2005	2006
West Fork Rapid River	Blw Falls	RAP1	B	19	16	2000	2001	2002	2003	2004	2005	

Appendix A. Table 1. Continued.

[1] Steelhead: 2-Middle Fork Salmon, 3-South Fork Salmon, 7-East Fork salmon, 8-Little Salmon, 9-Lower Salmon natural, 10-Upper Salmon, 11-Pahsimeroi, 12- Lemhi, 13-Headwaters Salmon, 14-Hells Canyon natural, 15-Salmon Canyon, 16-Hells Canon wild, 18-Lower Salmon wild, 19-Rapid River.

[2] Chinook: 1-Middle Fork Salmon (above Indian Creek and all tributaries except Bear Valley/Elk), 2-Salmon Canyon, 3-Bear Valley & Elk creeks, 4-Hells Canyon, 5-Secesh, 6-Middle Fork Salmon (mainstem below Indian Creek), 7-Upper Salmon (mainstem Middle Fork to Redfish Lake Creek & East Fork moth to weir), 8-Little Salmon (except Rapid River), 9-Lemhi, 10-Upper salmon tributaries, 11-Salmon headwaters (mainstem & tributaries Redfish Lake Creek upstream), 16-Rapid River, 17-South Fork Salmon, 18-Pahsimeroi.

Appendix A. Table 2. Stream sites sampled for general parr monitoring during 2000-2006 by production area in the Clearwater River drainage. Site names are a combination of stream, strata, and section. Channel type, steelhead production area (cell), Chinook production area (cell), and years sampled are also given.

Production Area/Stream	Strata	Section	Channel Type	Steelhead Cell[1]	Chinook Cell[2]	Years Sampled						
Selway River												
Bear Creek	-99	1	B	1	14			2002		2004		
Bear Creek	-99	2	B	1	14			2002		2004	2005	
Deep Creek	-99	Cactus	B	1	14		2001	2002	2003	2004	2005	2006
Deep Creek	-99	Scimitar	B	1	14		2001	2002	2003	2004	2005	2006
East Fork Moose Creek	-99	3	B	1	14			2002		2004	2005	
Gedney Creek	-99	1	B	1	14	2000	2001	2002	2003	2004		
Gedney Creek	-99	2	B	1	14	2000	2001	2002	2003	2004		
Little Clearwater River	-99	1	B	1	14		2001	2002	2003	2004	2005	2006
Little Clearwater River	-99	2	B	1	14		2001	2002	2003			2006
Marten Creek	-99	1	B	1	14					2004	2005	
Meadow Creek	-99	1	B	1	14	2000	2001	2002	2003	2004	2005	
Meadow Creek	-99	2	B	1	14	2000	2001	2002	2003	2004	2005	
Moose Creek	-99	1	B	1	14			2002		2004	2005	
Moose Creek	-99	2	B	1	14			2002		2004		
North Fork Moose Creek	-99	4	B	1	14			2002		2004	2005	
OHara Creek	-99	1	C	1	14	2000	2001	2002	2003	2004		
OHara Creek	-99	2	B	1	14	2000	2001	2002	2003	2004		
Otter Creek	-99	1	B	1	14						2005	
Running Creek	-99	1	B	1	14			2002		2004		
Running Creek	-99	2	B	1	14			2002		2004		
Selway River	-99	Badluck Cr	B	1	14			2002		2004	2005	
Selway River	-99	Beaverpt	C	1	14		2001		2003	2004	2005	2006
Selway River	-99	Divide	B	1	14						2005	
Selway River	-99	Hellshalf	B	1	14		2001	2002	2003	2004	2005	2006
Selway River	-99	Ladle	B	1	14						2005	
Selway River	-99	Little-Cw	B	1	14		2001	2002	2003	2004	2005	2006
Selway River	-99	Mag-Xing	C	1	14		2001	2002	2003	2004	2005	2006
Selway River	-99	Running Cr	B	1	14			2002				
Three Links Creek	-99	1	B	1	14					2004		
White Cap Creek	3	1	B	1	14		2001		2003	2004	2005	
White Cap Creek	3	2	B	1	14		2001		2003	2004	2005	
White Cap Creek	3	3	B	1	14		2001		2003	2004	2005	

Appendix A. Table 2. Continued.

Production Area/Stream	Strata	Section	Channel Type	Steelhead Cell[1]	Chinook Cell[2]	Years Sampled						
Lochsa River												
Brushy Fork	3	1	B	4	13		2001	2002	2003	2004	2005	2006
Brushy Fork	3	2	B	4	13		2001	2002	2003	2004	2005	2006
Colt Creek	-99	Bridge	B	4	13	2000	2001	2002	2003	2004	2005	2006
Crooked Fork Lochsa River	1	2A	B	4	13		2001	2002	2003	2004	2005	2006
Crooked Fork Lochsa River	2	3A	B	4	13		2001	2002	2003	2004	2005	2006
Crooked Fork Lochsa River	2	4A	B	4	13		2001	2002	2003	2004	2005	2006
Crooked Fork Lochsa River	3	1	B	4	13		2001	2002	2003	2004	2005	2006
Crooked Fork Lochsa River	3	2	C	4	13		2001	2002	2003	2004	2005	2006
Crooked Fork Lochsa River	3	2B	B	4	13		2001	2002	2003	2004	2005	2006
Crooked Fork Lochsa River	4	1B	B	4	13	2000	2001	2002	2003	2004	2005	2006
Fire Creek	-99	1	B	4	13	2000	2001	2002	2003	2004		
Fire Creek	-99	2	B	4	13	2000	2001	2002	2003	2004		
Fish Creek	-99	1	B	4	13		2001	2002	2003	2004		
Fish Creek	-99	2	B	4	13		2001	2002	2003	2004		
Hopeful Creek	1	1-Boogiedn	B	4	13		2001	2002	2003	2004	2005	2006
Lochsa River	-99	L1	B	4	13	2000	2001	2002		2004	2005	2006
Lochsa River	-99	L2	B	4	13	2000	2001	2002	2003	2004	2005	2006
Lochsa River	-99	L3	B	4	13	2000	2001	2002		2004	2005	2006
Lochsa River	-99	L4	B	4	13	2000	2001	2002		2004	2005	2006
Old Man Creek	-99	1	B	4	13	2000	2001	2002	2003	2004		
Papoose Creek	-99	1	B	4	13		2001					
Papoose Creek	-99	2	B	4	13		2001					
Papoose Creek	-99	4	C	4	13		2001					
Papoose Creek	-99	5	C	4	13		2001					
Papoose Creek	-99	6	B	4	13		2001					
Papoose Creek	-99	7	C	4	13		2001					
Papoose Creek	-99	8	B	4	13		2001					
Postoffice Creek	-99	1	B	4	13	2000	2001	2002	2003	2004		
Postoffice Creek	-99	2	B	4	13	2000	2001	2002	2003	2004		
Split Creek	-99	1	B	4	13	2000	2001	2002	2003	2004		
Split Creek	-99	2	B	4	13	2000	2001	2002	2003	2004		
Squaw Creek	-99	1	B	4	13		2001					
Squaw Creek	-99	10	B	4	13		2001					
Squaw Creek	-99	11	B	4	13		2001					
Squaw Creek	-99	2	B	4	13		2001					
Squaw Creek	-99	3	B	4	13		2001					

Appendix A. Table 2. Continued.

Production Area/Stream	Strata	Section	Channel Type	Steelhead Cell[1]	Chinook Cell[2]	Years Sampled						
Squaw Creek	-99	4	C	4	13		2001					
Squaw Creek	-99	5	C	4	13		2001					
Squaw Creek	-99	6	B	4	13		2001					
Squaw Creek	-99	7	B	4	13		2001					
Squaw Creek	-99	8	B	4	13		2001					
Squaw Creek	-99	9	B	4	13		2001					
Warm Springs Creek	-99	1	B	4	13	2000	2001		2003	2004		
White Sands Creek	-99	Lwrmonitor	B	4	13	2000		2002	2003		2005	2006
South Fork Clearwater River												
American River	1	0.75U	C	5	12	2000	2001	2002		2004	2005	2006
American River	1	1.25U	C	5	12	2000	2001	2002		2004	2005	2006
American River	1	1.75U	C	5	12	2000	2001	2002	2003	2004	2005	2006
American River	2	1	C	5	12	2000	2001	2002	2003	2004	2005	2006
American River	3	2	B	5	12	2000	2001	2002	2003	2004	2005	2006
Crooked River	1	Boulder-A	B	5	12			2002		2004	2005	2006
Crooked River	1	Boulder-B	B	5	12				2003	2004	2005	2006
Crooked River	1	Controla	B	5	12			2002				
Crooked River	1	Controlb	B	5	12	2000	2001	2002		2004	2005	2006
Crooked River	1	Pond-A	C	5	12	2000						
Crooked River	1	Sill-Log-A	B	5	12				2003			
Crooked River	1	Sill-Log-B	B	5	12	2000	2001	2002		2004	2005	2006
Crooked River	2	Control1	B	5	12	2000	2001	2002	2003	2004	2005	2006
Crooked River	2	Control2	B	5	12	2000	2001	2002	2003	2004	2005	2006
Crooked River	2	Pond U	C	5	12			2002				
Crooked River	2	Treat2	B	5	12	2000	2001	2002	2003	2004	2005	2006
Crooked River	3	Natural1	C	5	12	2000	2001	2002	2003	2004	2005	2006
Crooked River	3	Natural3	C	5	12	2000	2001	2002	2003	2004	2005	2006
Crooked River	3	Pond S3	C	5	12				2003			
Crooked River	4	Meander1	C	5	12	2000	2001	2002	2003	2004	2005	2006
Crooked River	4	Pond S1	C	5	12			2002		2004	2005	2006
Crooked River	4	Pond S2	C	5	12	2000	2001		2003	2004	2005	2006
Crooked River	C	Can1	B	5	12		2001	2002				
Crooked River	C	Can2	B	5	12	2000	2001	2002	2003	2004	2005	2006
Crooked River	C	Can3	B	5	12	2000	2001	2002	2003	2004	2005	2006
Crooked River	H	Orogrande1	B	5	12	2000	2001			2004	2005	2006
East Fork Crooked River	H	EF1	B	5	12	2000	2001	2002	2003	2004	2005	
East Fork Crooked River	H	EF2	B	5	12	2000	2001	2002		2004	2005	

Appendix A. Table 2. Continued.

Production Area/Stream	Strata	Section	Channel Type	Steelhead Cell[1]	Chinook Cell[2]	Years Sampled						
Fivemile Creek	1	1B	B	5	12	2000	2001	2002		2004	2005	2006
Johns Creek	1	1	B	5	12	2000			2003		2005	2006
Johns Creek	1	2	B	5	12	2000			2003		2005	2006
Johns Creek	2	3	B	5	12	2000	2001		2003	2004	2005	2006
Johns Creek	2	4	B	5	12	2000	2001		2003	2004	2005	
Meadow Creek	-99	Meadow	C	5	12						2005	2006
Meadow Creek	-99	MP2	B	5	12						2005	2006
Moores Creek	-99	1	B	5	12	2000	2001		2003	2004	2005	
Moores Creek	-99	2	C	5	12	2000	2001			2004	2005	2006
Red River	1	CNTL 1	C	5	12	2000	2001	2002	2003	2004	2005	2006
Red River	1	CNTL 2	C	5	12	2000	2001	2002	2003	2004	2005	2006
Red River	2	CNTL 2	B	5	12	2000	2001	2002	2003	2004	2005	
Red River	2	TREAT 2	B	5	12	2000	2001	2002	2003	2004	2005	
Red River	4	CNTL 2	C	5	12	2000	2001	2002	2003	2004	2005	
Red River	4	TREAT 2	C	5	12	2000	2001	2002	2003	2004	2005	
Red River	4	TREAT C2	C	5	12	2000						
Red River	5	CNTL 2	C	5	12	2000	2001	2002	2003	2004	2005	
Red River	5	TREAT 2	C	5	12	2000	2001	2002	2003	2004	2005	
Relief Creek	1	1A	C	5	12	2000	2001	2002	2003	2004	2005	2006
Relief Creek	1	1B	B	5	12				2003	2004	2005	2006
Relief Creek	2	2A	C	5	12	2000	2001	2002		2004	2005	2006
Tenmile Creek	-99	1	B	5	12	2000	2001		2003	2004	2005	2006
Tenmile Creek	-99	2	B	5	12	2000	2001		2003	2004	2005	2006
West Fork Crooked River	H	WF1	B	5	12	2000	2001	2002	2003	2004	2005	
West Fork Crooked River	H	WF2	B	5	12	2000	2001	2002	2003	2004	2005	
Mainstem Clearwater River												
Bedrock Creek	-99	1	B	17	15						2005	
Big Canyon Creek	-99	1	B	17	15		2001	2002	2003	2004	2005	2006
East Fork Potlatch River	-99	1	B	17	15	2000	2001	2002	2003	2004	2005	2006
East Fork Potlatch River	-99	2	C	17	15	2000	2001	2002	2003	2004	2005	2006
East Fork Potlatch River	-99	3	C	17	15	2000	2001	2002	2003	2004	2005	2006
Lolo Creek	-99	Transect4	B	6	15	2000						
Mission Creek	-99	1	B	17	15	2000	2001	2002	2003	2004	2005	
Mission Creek	-99	2	B	17	15	2000		2002	2003	2004	2005	2006
Potlatch River	-99	1	B	17	15		2001	2002	2003		2005	2006
Potlatch River	-99	Kendrick	B	17	15			2002	2003	2004	2005	2006

Appendix A. Table 2. Continued.

[1] Steelhead production areas: 1-Selway, 4-Lochsa, 6-Clearwater (mainstem & tributaries between Lolo & Clear creeks), 17-Lower Clearwater (mainstem tributaries downstream of Lolo Creek).

[2] Chinook production areas: 12-South Fork Clearwater, 13-Lochsa, 14-Selway, 15-Clearwater (mainstem & tributaries between Lolo & Clear creeks).

Appendix B. Table 1. Mean percent carrying capacity (PCC) in all monitoring sites and mean density (number/100 m^2) in B-channel sites for age-1 steelhead parr sampled during 2000. Values are averaged by production area for each run type – hatchery influence class. Production area numbers match codes from Appendix A.

Class/Production area	PCC	No. Sites	No. Streams	Density	No. Sites	No. Streams
Wild B-run						
1. Selway R	24.02	6	3	2.29	5	3
2. Middle Fk Salmon R	5.11	71	14	0.45	45	11
3. South Fk Salmon R	19.74	31	7	2.54	18	5
4. Lochsa R	17.08	14	8	2.55	14	8
Natural B-run						
5. South Fk Clearwater R	9.22	41	10	1.68	23	9
6. Mainstem Clearwater & tribs (Lolo Cr)	No sites sampled	-	-	No sites sampled	-	-
7. East Fk Salmon R	No sites sampled	-	-	No sites sampled	-	-
Natural A-run						
8. Little Salmon R	50.70	8	3	6.98	8	3
9. Lower Salmon R	24.12	7	2	2.93	7	2
10. Upper Salmon R	29.14	16	7	2.61	10	6
11. Pahsimeroi R	16.90	3	1	No B-channels	-	-
12. Lemhi R	22.44	11	5	0.87	4	2
13. Headwaters Salmon R	1.60	7	2	0.45	2	1
14. Snake R tribs (Granite Cr)	48.98	2	1	5.48	2	1
Wild A-run						
15. Salmon Canyon tribs	40.63	6	4	3.62	6	4
16. Snake R tribs (Sheep Cr)	186.01	2	1	28.05	2	1
17. Mainstem Clearwater R tribs	52.00	5	2	3.34	3	2
18. Lower Salmon R tribs	97.63	6	4	12.09	6	4
19. Rapid R (above weir)	23.54	12	2	2.21	12	2

Appendix B. Table 2. Mean percent carrying capacity (PCC) in all monitoring sites and mean density (number/100 m^2) in B-channel sites for age-1 steelhead parr sampled during 2001. Values are averaged by production area for each run type – hatchery influence class. Production area numbers match codes from Appendix A.

Class/Production area	PCC	No. Sites	No. Streams	Density	No. Sites	No. Streams
Wild B-run						
1. Selway R	20.05	15	6	2.51	12	6
2. Middle Fk Salmon R	14.49	54	14	2.10	34	12
3. South Fk Salmon R	17.35	36	9	2.08	18	5
4. Lochsa R	42.50	42	13	4.55	36	13
Natural B-run						
5. South Fk Clearwater R	6.37	35	8	0.55	19	7
6. Mainstem Clearwater & tribs (Lolo Cr)	No sites sampled	-	-	No sites sampled	-	-
7. East Fk Salmon R	5.30	4	1	1.22	2	1
Natural A-run						
8. Little Salmon R	75.16	9	3	13.23	7	3
9. Lower Salmon R	1.67	7	2	0.15	7	2
10. Upper Salmon R	39.65	23	10	4.06	15	9
11. Pahsimeroi R	33.92	3	1	No B-channels	-	-
12. Lemhi R	16.77	11	5	1.11	4	2
13. Headwaters Salmon R	7.85	7	2	1.21	2	1
14. Snake R tribs (Granite Cr)	3.48	2	1	0.59	2	1
Wild A-run						
15. Salmon Canyon tribs	31.04	10	6	4.06	6	4
16. Snake R tribs (Sheep Cr)	66.13	4	1	8.24	4	1
17. Mainstem Clearwater R tribs	22.82	6	4	1.76	4	4
18. Lower Salmon R tribs	0.56	5	4	0.00	5	4
19. Rapid R (above weir)	41.63	12	2	5.65	12	2

Appendix B. Table 3. Mean percent carrying capacity (PCC) in all monitoring sites and mean density (number/100 m^2) in B-channel sites for age-1 steelhead parr sampled during 2002. Values are averaged by production area for each run type – hatchery influence class. Production area numbers match codes from Appendix A.

Class/Production area	PCC	No. Sites	No. Streams	Density	No. Sites	No. Streams
Wild B-run						
1. Selway R	10.72	20	10	0.96	18	10
2. Middle Fk Salmon R	8.78	40	12	1.31	16	10
3. South Fk Salmon R	23.00	33	9	3.49	20	6
4. Lochsa R	28.99	24	10	2.89	23	10
Natural B-run						
5. South Fk Clearwater R	47.90	35	7	1.91	18	6
6. Mainstem Clearwater & tribs (Lolo Cr)	No sites sampled	-	-	No sites sampled	-	-
7. East Fk Salmon R	8.87	4	1	1.43	2	1
Natural A-run						
8. Little Salmon R	54.39	9	3	8.27	9	3
9. Lower Salmon R	44.10	6	2	4.84	6	2
10. Upper Salmon R	31.14	20	9	3.92	12	8
11. Pahsimeroi R	70.12	3	1	No B-channels	-	-
12. Lemhi R	18.73	11	4	1.46	4	2
13. Headwaters Salmon R	6.89	7	2	0.64	2	1
14. Snake R tribs (Granite Cr)	no sites sampled	-	-	no sites sampled	-	-
Wild A-run						
15. Salmon Canyon tribs	56.26	9	6	5.09	6	5
16. Snake R tribs (Sheep Cr)	45.73	2	1	5.40	2	1
17. Mainstem Clearwater R tribs	92.34	9	4	5.51	6	4
18. Lower Salmon R tribs	167.89	4	4	19.25	4	4
19. Rapid R (above weir)	46.84	12	2	5.77	11	2

Appendix B. Table 4. Mean percent carrying capacity (PCC) in all monitoring sites and mean density (number/100 m^2) in B-channel sites for age-1 steelhead parr sampled during 2003. Values are averaged by production area for each run type – hatchery influence class. Production area numbers match codes from Appendix A.

Class/Production area	PCC	No. Sites	No. Streams	Density	No. Sites	No. Streams
Wild B-run						
1. Selway R	86.89	15	6	5.91	12	6
2. Middle Fk Salmon R	13.80	36	12	1.21	16	10
3. South Fk Salmon R	19.50	36	9	2.69	20	6
4. Lochsa R	24.04	22	11	2.98	20	11
Natural B-run						
5. South Fk Clearwater R	10.54	38	9	1.95	23	9
6. Mainstem Clearwater & tribs (Lolo Cr)	No sites sampled	-	-	No sites sampled	-	-
7. East Fk Salmon R	15.96	4	1	0.00	2	1
Natural A-run						
8. Little Salmon R	53.45	9	3	7.58	8	3
9. Lower Salmon R	34.20	3	1	5.20	3	1
10. Upper Salmon R	35.07	23	10	4.04	15	9
11. Pahsimeroi R	120.93	4	1	No B-channels	-	-
12. Lemhi R	20.64	11	4	1.95	4	2
13. Headwaters Salmon R	4.29	7	2	0.16	2	1
14. Snake R tribs (Granite Cr)	No sites sampled	-	-	No sites sampled	-	-
Wild A-run						
15. Salmon Canyon tribs	44.72	8	5	4.13	4	3
16. Snake R tribs (Sheep Cr)	35.90	2	1	5.03	2	1
17. Mainstem Clearwater R tribs	91.96	8	4	8.27	6	4
18. Lower Salmon R tribs	134.80	6	4	19.27	6	4
19. Rapid R (above weir)	48.17	12	2	5.33	12	2

Appendix B. Table 5. Mean percent carrying capacity (PCC) in all monitoring sites and mean density (number/100 m^2) in B-channel sites for age-1 steelhead parr sampled during 2004. Values are averaged by production area for each run type – hatchery influence class. Production area numbers match codes from Appendix A.

Class/Production area	PCC	No. Sites	No. Streams	Density	No. Sites	No. Streams
Wild B-run						
1. Selway R	14.90	25	13	1.99	22	13
2. Middle Fk Salmon R	17.05	37	10	1.28	26	8
3. South Fk Salmon R	18.75	36	9	3.72	16	6
4. Lochsa R	31.38	25	11	3.77	24	11
Natural B-run						
5. South Fk Clearwater R	9.74	42	10	1.43	24	10
6. Mainstem Clearwater & tribs (Lolo Cr)	No sites sampled	-	-	No sites sampled	-	-
7. East Fk Salmon R	1.82	4	1	0.11	2	1
Natural A-run						
8. Little Salmon R	48.01	9	3	7.20	5	3
9. Lower Salmon R	39.92	7	2	6.23	7	2
10. Upper Salmon R	25.47	21	10	3.63	14	9
11. Pahsimeroi R	32.34	3	1	No B-channels	-	-
12. Lemhi R	12.18	11	4	1.48	4	2
13. Headwaters Salmon R	2.74	7	2	0.20	2	1
14. Snake R tribs (Granite Cr)	24.85	2	1	2.73	2	1
Wild A-run						
15. Salmon Canyon tribs	43.91	10	6	5.79	6	4
16. Snake R tribs (Sheep Cr)	11.29	2	1	1.44	2	1
17. Mainstem Clearwater R tribs	118.94	7	4	7.78	5	4
18. Lower Salmon R tribs	126.87	4	3	22.64	4	3
19. Rapid R (above weir)	37.57	11	2	4.37	11	2

Appendix B. Table 6. Mean percent carrying capacity (PCC) in all monitoring sites and mean density (number/100 m^2) in B-channel sites for age-1 steelhead parr sampled during 2005. Values are averaged by production area for each run type – hatchery influence class. Production area numbers match codes from Appendix A.

Class/Production area	PCC	No. Sites	No. Streams	Density	No. Sites	No. Streams
Wild B-run						
1. Selway R	14.89	16	9	1.47	14	9
2. Middle Fk Salmon R	7.98	68	14	0.64	48	12
3. South Fk Salmon R	16.97	36	9	2.86	19	6
4. Lochsa R	10.57	15	5	1.41	15	5
Natural B-run						
5. South Fk Clearwater R	15.92	44	10	0.93	30	10
6. Mainstem Clearwater & tribs (Lolo Cr)	No sites sampled	-	-	No sites sampled	-	-
7. East Fk Salmon R	4.74	4	1	0.57	3	1
Natural A-run						
8. Little Salmon R	48.28	9	3	8.02	8	3
9. Lower Salmon R	29.91	7	2	4.39	7	2
10. Upper Salmon R	43.95	21	10	5.62	15	9
11. Pahsimeroi R	25.02	3	1	No B-channels	-	-
12. Lemhi R	9.50	11	4	1.87	3	2
13. Headwaters Salmon R	1.25	7	2	0.06	3	1
14. Snake R tribs (Granite Cr)	65.93	2	1	6.17	2	1
Wild A-run						
15. Salmon Canyon tribs	27.46	12	7	3.28	8	5
16. Snake R tribs (Sheep Cr)	87.27	2	1	10.25	2	1
17. Mainstem Clearwater R tribs	34.79	7	4	3.82	7	4
18. Lower Salmon R tribs	59.12	5	3	9.84	5	3
19. Rapid R (above weir)	43.82	12	2	5.57	12	2

Appendix B. Table 7. Mean percent carrying capacity (PCC) in all monitoring sites and mean density (number/100 m^2) in B-channel sites for age-1 steelhead parr sampled during 2006. Values are averaged by production area for each run type – hatchery influence class. Production area numbers match codes from Appendix A.

Class/Production area	PCC	No. Sites	No. Streams	Density	No. Sites	No. Streams
Wild B-run						
1. Selway R	10.50	9	3	1.67	7	3
2. Middle Fk Salmon R	9.77	15	7	1.01	12	7
3. South Fk Salmon R	11.87	29	8	1.38	20	7
4. Lochsa R	12.82	15	5	1.62	14	5
Natural B-run						
5. South Fk Clearwater R	15.92	34	9	2.62	18	6
6. Mainstem Clearwater & tribs (Lolo Cr)	No sites sampled	-	-	No sites sampled	-	-
7. East Fk Salmon R	2.94	4	1	0.26	4	1
Natural A-run						
8. Little Salmon R	51.05	9	3	7.42	9	3
9. Lower Salmon R	36.54	4	1	5.01	4	1
10. Upper Salmon R	24.09	18	9	1.42	15	9
11. Pahsimeroi R	12.88	3	1	No B-channels	-	-
12. Lemhi R	5.16	11	4	0.75	4	3
13. Headwaters Salmon R	3.39	6	1	0.05	2	1
14. Snake R tribs (Granite Cr)	No sites sampled	-	-	No sites sampled	-	-
Wild A-run						
15. Salmon Canyon tribs	38.68	12	7	4.85	10	6
16. Snake R tribs (Sheep Cr)	No sites sampled	-	-	No sites sampled	-	-
17. Mainstem Clearwater R tribs	11.45	7	4	0.31	5	4
18. Lower Salmon R tribs	69.92	7	4	8.87	7	4
19. Rapid R (above weir)	34.26	1	1	2.59	1	1

Appendix B. Table 8. Mean percent carrying capacity (PCC) in all monitoring sites and mean density (number/100 m^2) in C-channel sites for age-0 chinook parr sampled during 2000. Values are averaged by production area for each run type – hatchery influence class. Production area numbers match codes from Appendix A.

Class/Production area	PCC	Sites	Streams	Density	Sites	Streams
Wild Spring						
1. Middle Fk Salmon R (w/o Bear Valley/ Elk Cr)	0.99	61	12	0.59	15	6
2. Salmon R Canyon & tribs (Chamberlain Cr)	0.50	4	2	No C-channels	-	-
3. Bear Valley/Elk Cr	0.63	11	2	0.37	11	2
4. Snake R tribs (Granite/Sheep Cr)	0.00	4	2	No C-channels	-	-
19. Lower Salmon R	1.75	13	6	No C-channels	-	-
Wild Summer						
5. Secesh R	0.00	2	1	No C-channels	-	-
6. Middle Fk Salmon R	No sites sampled	-	-	No sites sampled	-	-
7. Upper Salmon R (Middle Fk to Redfish Lk Cr and East Fk mouth to weir)	0.82	1	1	No C-channels	-	-
Natural Spring						
8. Little Salmon R	2.39	2	5	No C-channels	-	-
9. Lemhi R	1.32	11	5	2.04	7	3
10. Upper Salmon R	1.53	15	6	1.07	6	3
11. Headwaters Salmon R	2.52	7	2	1.08	5	2
12. South Fk Clearwater R	1.36	40	9	0.87	18	5
13. Lochsa R	0.38	9	5	No C-channels	-	-
14. Selway R	0.33	4	2	No C-channels	-	-
15. Mainstem Clearwater R & tribs	0.00	2	1	No C-channels	-	-
Natural Summer						
16. Rapid River	0.41	12	2	No C-channels	-	-
17. South Fk Salmon R	7.16	29	7	2.46	13	4
18. Pahsimeroi	13.51	3	1	10.40	3	1

Appendix B. Table 9. Mean percent carrying capacity (PCC) in all monitoring sites and mean density (number/100 m^2) in C-channel sites for age-0 chinook parr sampled during 2001. Values are averaged by production area for each run type – hatchery influence class. Production area numbers match codes from Appendix A.

Class/Production area	PCC	Sites	Streams	Density	Sites	Streams
Wild Spring						
1. Middle Fk Salmon R (w/o Bear Valley/ Elk Cr)	2.03	48	13	4.50	14	7
2. Salmon R Canyon & tribs (Chamberlain Cr)	13.52	8	4	23.84	4	2
3. Bear Valley/Elk Cr	5.38	6	1	4.14	6	1
4. Snake R tribs (Granite/Sheep Cr)	0.05	6	2	No C-channels	-	-
19. Lower Salmon R	1.83	12	6	No C-channels	-	-
Wild Summer						
5. Secesh R	12.73	8	3	9.65	7	3
6. Middle Fk Salmon R	No sites sampled	-	-	No sites sampled	-	-
7. Upper Salmon R (Middle Fk to Redfish Lk Cr and East Fk mouth to weir)	3.50	1	1	No C-channels	-	-
Natural Spring						
8. Little Salmon R	21.19	6	2	No C-channels	-	-
9. Lemhi R	0.78	11	5	1.31	7	3
10. Upper Salmon R	7.69	24	9	4.96	10	5
11. Headwaters Salmon R	7.96	7	2	3.37	5	2
12. South Fk Clearwater R	17.37	36	8	14.78	17	5
13. Lochsa R	18.38	37	10	11.74	6	3
14. Selway R	36.33	13	5	24.67	2	1
15. Mainstem Clearwater R & tribs	0.00	1	1	No C-channels	-	-
Natural Summer						
16. Rapid River	0.02	12	2	No C-channels	-	-
17. South Fk Salmon R	50.59	28	6	14.80	11	4
18. Pahsimeroi	13.70	3	1	10.55	3	1

Appendix B. Table 10. Mean percent carrying capacity (PCC) in all monitoring sites and mean density (number/100 m^2) in C-channel sites for age-0 chinook parr sampled during 2002. Values are averaged by production area for each run type – hatchery influence class. Production area numbers match codes from Appendix A.

Class/Production area	PCC	Sites	Streams	Density	Sites	Streams
Wild Spring						
1. Middle Fk Salmon R (w/o Bear Valley/ Elk Cr)	18.02	33	11	18.48	18	8
2.Salmon R Canyon & tribs (Chamberlain Cr)	54.52	7	4	89.10	3	2
3. Bear Valley/Elk Cr	11.70	7	1	10.07	6	1
4. Snake R tribs (Granite/Sheep Cr)	18.70	2	1	No C-channels	-	-
19. Lower Salmon R	21.77	10	6	No C-channels	-	-
Wild Summer						
5. Secesh R	28.92	9	3	33.84	6	2
6. Middle Fk Salmon R	No sites sampled	-	-	No sites sampled	-	-
7. Upper Salmon R (Middle Fk to Redfish Lk Cr and East Fk mouth to weir)	13.10	1	1	No C-channels	-	-
Natural Spring						
8. Little Salmon R	16.54	6	2	No C-channels	-	-
9. Lemhi R	7.78	11	4	10.00	7	2
10. Upper Salmon R	23.41	21	8	3.50	10	5
11. Headwaters Salmon R	21.71	7	2	9.99	5	2
12. South Fk Clearwater R	13.83	36	7	9.16	18	5
13. Lochsa R	3.16	19	7	3.29	1	1
14. Selway R	5.20	17	9	1.30	1	1
15. Mainstem Clearwater R & tribs	0.00	2	1	No C-channels	-	-
Natural Summer						
16. Rapid River	0.74	12	2	1.10	1	1
17. South Fk Salmon R	59.14	24	6	27.19	7	4
18. Pahsimeroi	49.36	3	1	38.01	3	1

Appendix B. Table 11. Mean percent carrying capacity (PCC) in all monitoring sites and mean density (number/100 m^2) in C-channel sites for age-0 chinook parr sampled during 2003. Values are averaged by production area for each run type – hatchery influence class. Production area numbers match codes from Appendix A.

Class/Production area	PCC	Sites	Streams	Density	Sites	Streams
Wild Spring						
1. Middle Fk Salmon R (w/o Bear Valley/ Elk Cr)	39.37	36	12	27.29	20	8
2.Salmon R Canyon & tribs (Chamberlain Cr)	25.29	6	3	35.92	4	2
3. Bear Valley/Elk Cr	No sites sampled	-	-	No sites sampled	-	-
4. Snake R tribs (Granite/Sheep Cr)	0.72	2	1	No C-channels	-	-
19. Lower Salmon R	8.57	9	5	No C-channels	-	-
Wild Summer						
5. Secesh R	16.79	9	2	19.46	6	2
6. Middle Fk Salmon R	No sites sampled	-	-	No sites sampled	-	-
7. Upper Salmon R (Middle Fk to Redfish Lk Cr and East Fk mouth to weir)	0.16	1	1	No C-channels	-	-
Natural Spring						
8. Little Salmon R	18.54	6	2	0.40	1	1
9. Lemhi R	1.70	11	4	2.72	7	2
10. Upper Salmon R	9.73	24	9	5.33	10	5
11. Headwaters Salmon R	26.95	7	2	11.25	5	2
12. South Fk Clearwater R	22.73	39	9	25.97	16	5
13. Lochsa R	9.41	17	8	41.02	1	1
14. Selway R	8.34	13	5	21.92	2	1
15. Mainstem Clearwater R & tribs	0.00	2	1	No C-channels	-	-
Natural Summer						
16. Rapid River	0.89	12	2	No C-channels	-	-
17. South Fk Salmon R	78.35	27	6	40.80	10	4
18. Pahsimeroi	71.14	4	1	54.78	4	1

Appendix B. Table 12. Mean percent carrying capacity (PCC) in all monitoring sites and mean density (number/100 m^2) in C-channel sites for age-0 chinook parr sampled during 2004. Values are averaged by production area for each run type – hatchery influence class. Production area numbers match codes from Appendix A.

Class/Production area	PCC	Sites	Streams	Density	Sites	Streams
Wild Spring						
1. Middle Fk Salmon R (w/o Bear Valley/ Elk Cr)	73.93	37	10	48.48	11	5
2. Salmon R Canyon & tribs (Chamberlain Cr)	23.40	8	4	37.16	4	2
3. Bear Valley/Elk Cr	No sites sampled	-	-	No sites sampled	-	-
4. Snake R tribs (Granite/Sheep Cr)	0.93	4	2	No C-channels	-	-
19. Lower Salmon R	13.11	11	5	No C-channels	-	-
Wild Summer						
5. Secesh R	26.03	9	3	29.19	6	2
6. Middle Fk Salmon R	No sites sampled	-	-	No sites sampled	-	-
7. Upper Salmon R (Middle Fk to Redfish Lk Cr and East Fk mouth to weir)	5.40	1	1	No C-channels	-	-
Natural Spring						
8. Little Salmon R	18.39	6	2	6.97	4	2
9. Lemhi R	3.60	11	4	1.70	7	2
10. Upper Salmon R	9.75	22	9	9.41	9	5
11. Headwaters Salmon R	15.97	7	2	7.11	5	2
12. South Fk Clearwater R	32.33	41	9	29.25	18	5
13. Lochsa R	5.92	20	8	15.71	1	1
14. Selway R	4.68	22	11	1.18	2	1
15. Mainstem Clearwater R & tribs	0.00	2	1	No C-channels	-	-
Natural Summer						
16. Rapid River	4.35	11	2	No C-channels	-	-
17. South Fk Salmon R	67.98	27	6	34.68	14	5
18. Pahsimeroi	60.46	3	1	46.56	3	1

Appendix B. Table 13. Mean percent carrying capacity (PCC) in all monitoring sites and mean density (number/100 m^2) in C-channel sites for age-0 chinook parr sampled during 2005. Values are averaged by production area for each run type – hatchery influence class. Production area numbers match codes from Appendix A.

Class/Production area	PCC	Sites	Streams	Density	Sites	Streams
Wild Spring						
1. Middle Fk Salmon R (w/o Bear Valley/ Elk Cr)	4.77	63	13	7.74	15	8
2. Salmon R Canyon & tribs (Chamberlain Cr)	20.96	10	5	47.97	4	2
3. Bear Valley/Elk Cr	6.82	5	1	3.06	5	1
4. Snake R tribs (Granite/Sheep Cr)	28.05	4	2	No C-channels	-	-
19. Lower Salmon R	7.75	12	5	No C-channels	-	-
Wild Summer						
5. Secesh R	17.42	9	3	20.14	6	2
6. Middle Fk Salmon R	No sites sampled	-	-	No sites sampled	-	-
7. Upper Salmon R (Middle Fk to Redfish Lk Cr and East Fk mouth to weir)	0.50	1	1	No C-channels	-	-
Natural Spring						
8. Little Salmon R	10.05	6	2	0.00	1	1
9. Lemhi R	1.06	11	4	1.52	8	3
10. Upper Salmon R	5.31	22	9	3.19	7	4
11. Headwaters Salmon R	15.87	7	2	5.73	4	2
12. South Fk Clearwater R	10.42	42	9	6.99	14	5
13. Lochsa R	5.41	15	5	No C-channels	-	-
14. Selway R	16.93	15	8	28.13	2	2
15. Mainstem Clearwater R & tribs	0.00	2	1	No C-channels	-	-
Natural Summer						
16. Rapid River	1.45	12	2	No C-channels	-	-
17. South Fk Salmon R	61.93	27	6	41.74	11	4
18. Pahsimeroi	64.85	3	1	49.94	3	1

Appendix B. Table 14. Mean percent carrying capacity (PCC) in all monitoring sites and mean density (number/100 m^2) in C-channel sites for age-0 chinook parr sampled during 2006. Values are averaged by production area for each run type – hatchery influence class. Production area numbers match codes from Appendix A.

Class/Production area	PCC	Sites	Streams	Density	Sites	Streams
Wild Spring						
1. Middle Fk Salmon R (w/o Bear Valley/ Elk Cr)	6.13	15	7	13.65	3	3
2. Salmon R Canyon & tribs (Chamberlain Cr)	9.90	10	5	26.22	2	1
3. Bear Valley/Elk Cr	No sites sampled	-	-	No sites sampled	-	-
4. Snake R tribs (Granite/Sheep Cr)	No sites sampled	-	-	No sites sampled	-	-
19. Lower Salmon R	5.70	11	5	No C-channels	-	-
Wild Summer						
5. Secesh R	No sites sampled	-	-	No sites sampled	-	-
6. Middle Fk Salmon R	1.61	7	3	No C-channels	-	-
7. Upper Salmon R (Middle Fk to Redfish Lk Cr and East Fk mouth to weir)	0.85	1	1	No C-channels	-	-
Natural Spring						
8. Little Salmon R	5.05	6	2	No C-channels	-	-
9. Lemhi R	0.51	11	4	0.63	7	3
10. Upper Salmon R	7.02	19	8	2.40	2	2
11. Headwaters Salmon R	9.53	6	1	6.21	4	1
12. South Fk Clearwater R	3.89	32	7	5.76	15	5
13. Lochsa R	2.82	15	5	12.89	1	1
14. Selway R	4.55	9	3	10.98	2	1
15. Mainstem Clearwater R & tribs	3.06	1	1	No C-channels	-	-
Natural Summer						
16. Rapid River	0.42	1	1	No C-channels	-	-
17. South Fk Salmon R	19.09	22	5	7.56	9	3
18. Pahsimeroi	47.82	3	1	36.82	3	1

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