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FISHERY RESEARCH

IDAHO NATURAL PRODUCTION MONITORING AND EVALUATION

Annual Progress Report
February 1, 2007—January 31, 2008

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Idaho Natural Production Monitoring and Evaluation

Project Progress Report

2007 Annual Report

Part 1—Project Overview
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
Part 3—The stock-recruitment relationship for naturally produced spring/summer Chinook salmon in the Snake River basin
Part 4—Monitoring trends in abundance of anadromous salmonids parr in Idaho

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To

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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 trout and Chinook salmon in Idaho (IDFG 2007).

Project Objectives

We have grouped project tasks into three 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 2007 adult escapement and describe the age structure of the spawning run of naturally produced spring/summer Chinook salmon passing Lower Granite Dam.

Objective 2. Monitor the juvenile production of Chinook salmon and steelhead trout for the major population groups (MPGs) within the Clearwater and Salmon subbasins.

Objective 3. Evaluate life cycle survival and the freshwater productivity/production of Snake River spring/summer Chinook salmon. There are two components: update/refine a stock-recruit model and estimate aggregate smolt-to-adult survival.

Report Topics

In this annual progress report, we present technical results for work done during 2007. Part 2 contains detailed results of INPMEP aging research and estimation of smolt-to-adult return rates for wild and naturally produced Chinook salmon (Objectives 1 and 3). 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 3). Part 4 is a summary of the parr density data (Objective 2) collected in 2007 using the new site selection procedure. Data are maintained in computer databases housed at the IDFG Nampa Fisheries Research office (described in the Appendix) and are available from the first author. Other project accomplishments during 2007 (e.g., professional presentations) are also summarized in the Appendix.

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PART 2—MONITORING AGE COMPOSITION OF WILD ADULT SPRING/SUMMER CHINOOK SALMON IN THE SNAKE RIVER BASIN IN 2007 TO ESTIMATE SMOLT-TO-ADULT RETURN RATES

ABSTRACT

Accurate determination of adult age composition is necessary for monitoring status and trends of wild or naturally produced Snake River spring/summer 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 2007 spawning run. These data were combined with previously collected data to estimate smolt-to-adult return (SAR) rates. Of the fish returning to the dam in 2007, we estimate that 14.1% or 1,462 fish were one-ocean, 45.4% or 4,702 fish were two-ocean, 38.7% or 4,007 fish were three-ocean, and 1.7% or 181 fish were four-ocean. All adults have returned from the ocean through smolt year (SY) 2003. Returns for SY 2004-2007 are still incomplete. The SAR rate to the dam for SY 2003 was 0.60% - the lowest since SY 1996. We assigned ages to 887 fish based on scales collected at the dam and compared them to the 747 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 (94.6%) but was even higher for scales (98.7%).

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INTRODUCTION

Age information is an important tool for management and recovery of wild or naturally produced Snake River spring/summer Chinook salmon *Oncorhynchus tshawytscha*, hereafter Chinook unless otherwise noted. Accurate age data are essential to assign returning adults to a specific brood year and to estimate survival rates (Copeland et al. 2007a). Because inadequate numbers of adults with passive integrated transponders (PIT tags) return to Idaho to accurately assess age composition, this project began to collect fin rays from carcasses to determine ocean ages in 1998. The original motivation to use fin rays was the mismatch of carcass scale ages with known ocean ages of fish tagged as juveniles with 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, 2005, 2006, 2007b). These fin ray data allow accurate reconstruction of the age structure of a spawning run and accurate estimates of smolt-to-adult return (SAR) rates.

Although ages based on fin rays have proven highly accurate, development of information from fin rays is slow and the samples are probably biased. The fish must spawn and die before sample collection and the preparation and reading of fin rays is labor intensive. Scales collected from carcasses are prepared and read more quickly but the ages are less accurate (Copeland et al. 2007a). 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. Further, both fin ray and scale samples taken from carcasses may be biased by available fish size or toward stocks where spawning ground surveys are conducted.

Since 2005, National Oceanic and Atmospheric Administration Fisheries (NOAAF) personnel have been systematically sampling adult Chinook as they migrate upstream past Lower Granite Dam (Harmon 2008). Since 2005, we have investigated if scales collected at Lower Granite Dam can be used to estimate ages accurately for management purposes. Results have been encouraging (Copeland et al 2007b).

In this section of the report, we present the age composition of Chinook spawning in the Snake River basin upstream of Lower Granite Dam in 2007. We also compare ages from fin rays collected from carcasses with scales collected at the dam. Using the fin ray data, we assigned the naturally produced spawning run in 2007 to age categories and calculated SAR rates.

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 Idaho portion of 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). 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 at adult trapping weirs. Hatchery personnel also collected dorsal fins from known-age (PIT tagged) hatchery adults at Rapid River, Sawtooth, Clearwater, Pahsimeroi, and McCall hatcheries. We used this set of 260 known-age samples to estimate aging accuracy in 2007. 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.

Lengths were measured (fork length, FL) and scales were collected from Chinook passing Lower Granite Dam by NOAAF personnel (Harmon 2008). Adult Chinook were systematically sampled. When the trap is in operation, a gate is rotated across the ladder to block upstream passage four times each hour. The objective in 2007 was to sample 10% of the run. We used scales collected from the 93 PIT-tagged wild/natural and hatchery fish that were trapped in order to provide known-age scale samples for accuracy assessment.

Sample Processing

Fin rays were dried, epoxied, sliced and mounted on microscope slides (see Copeland et al. 2007b for a full description). All samples were aged independently by two technicians. Fins were read again in a referee session if there was disagreement in age determination or if the determined age did not match what was expected for fish length. Three personnel 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.

We have assembled a reference collection of known-age Chinook to train readers and to help interpret hard-to-read fin rays. This reference collection is comprised of Chinook tagged as juveniles with PIT tags or coded-wire tags and recovered as returning adults. Personnel were trained with reference fin rays, were tested, and had to have a 90% accuracy rate before they were allowed to proceed with reading current-year fin rays.

Scales were examined for regeneration. Eight non-regenerated scales were cleaned and mounted between two glass microscope slides. If only regenerated scales were available, the sample was deemed unreadable. Slides were placed under a microscope and a digital image taken of the best scales 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.

Data Analysis

The length frequency distribution of the entire run was based on lengths measured at Lower Granite Dam when scales were systematically sampled (Harmon 2008). 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 used the resulting length data to construct a length frequency distribution by 5 cm increments:

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

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, only the number of adult-sized Chinook. We adjusted the TAC estimate to account for all age groups by dividing by the proportion of the scale sample 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.

RESULTS

Age Composition and SAR Rate

We examined fin rays from 789 Chinook carcasses collected on spawning grounds in 2007. Ages could not be determined for 37 fish, one fish had no fork length recorded, and four Chinook were eliminated from the sample because they were under 45 cm and potentially minijacks, i.e. precocial males that never reach the ocean. No Chinook under 45 cm had been collected and included in past reports. This left a final sample size of 747 fish.

We significantly increased collection of known-age fish in 2007 by including Clearwater, Sawtooth, and Pahsimeroi hatcheries. A total of 260 known-age fish were collected, of which 246 fish or 94.6% were aged correctly. The known-age fish were placed randomly throughout the sample of non-known-age fish. Of the known-age validation sample, there were 105 one-ocean fish, 110 two-ocean fish, and 45 three-ocean fish. Eight of nine known-age two-ocean samples were mis-aged as three-ocean. Further review was not helpful as we were unable to recognize any visual differences in annuli between the mis-aged two-ocean fish and a valid three-ocean fish.

In the aggregate, 8.4% of the carcasses were one-ocean, 35.2% were two-ocean, 53.9% were three-ocean, and 2.4% were four-ocean fish (Table 3). All fish <55 cm FL were classified as one-ocean, but some individuals ≥55 cm FL were also classified as one-ocean. Length distributions of one and two-ocean groups overlapped by 9 cm (Figure 2). The overlap between two and three-ocean ages was more substantial at 22 cm, although three-ocean fish were more prevalent at longer lengths. The peaks in the length distributions for two- and three-ocean fish were 76 cm and 89 cm, respectively. The length distribution of four-ocean fish was encompassed within that of three-ocean fish.

Of the 10,352 Chinook returning to the dam in 2007, based on the fin ray age-length key, we estimated that 14.1% or 1,462 fish were one-ocean, 45.4% or 4,702 fish were two-ocean, 38.7% or 4,007 fish were three-ocean, and 1.7% or 181 fish were four-ocean. Smolt-to-adult return rates were completed for smolt cohorts through SY 2003 (Table 2). Returns for SY 2004-2007 are still incomplete. The SAR rate for smolts that went to sea in SY 2003, the last year for which all adults had returned in 2007, was 0.60%.

Lower Granite Dam Scale Aging Evaluation

We examined scales from 887 adult Chinook returning to Lower Granite Dam in 2007. Ages could not be determined for 14 fish, and 17 fish were eliminated from the sample because they were under 45 cm and potentially minijacks. This left a final sample size of 856 fish. We examined 93 hatchery and wild/natural known-age fish. Of those, 91 were aged correctly for an overall accuracy rate of 97.8%. Of the known-age validation sample, there were 49 one-ocean fish, 28 two-ocean fish, and 16 three-ocean fish. The peaks in the length distributions for two and three-ocean fish were 76 cm and 89 cm, respectively (Figure 3).

The age composition based on scales from Lower Granite Dam was similar to that based on fin rays from carcasses (Table 3). The length distribution of two-ocean fish almost completely overlapped that of one-ocean fish as well as most of the three-ocean fish (Figure 3). Two-ocean fish were as small as 46 cm and as large as 98 cm FL, while three-ocean fish were as small as 65 cm FL. Only one four-ocean fish was aged.

DISCUSSION

The age-at-length data based on scales were similar to the fin ray data. The extremes of the length distribution at each age based on scales extended further than that for fin rays but 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. Accuracy of scale-based ages was higher than fin rays in 2007 (98.7% n = 92 vs. 94.6% n = 260), though this has not been the case in the past (Copeland et al 2007b).

Survival of Chinook salmon upstream of Lower Granite Dam has continued to decline since 1999. The estimated survival of Chinook from emigration past Lower Granite Dam in 2003 to their return for spawning (0.60%) was the lowest since SY 1996. The low tentative estimate for SY 2004 (0.81%) will change little because only 4-ocean returns remain from this cohort. These estimates are in the low portion of the range of SAR rates from SY 1996-2003 (0.31-3.70%) for which we have accurate fin ray aging data. In general, an SAR of 2% is necessary to stabilize Snake River spring/summer Chinook salmon populations at current abundances (Marmorek et al. 1996). That level has only been reached in 2 of 12 years.

These results highlight the importance of accurate age data for monitoring the status of Snake River spring/summer Chinook salmon. The current program is in transition between methods of acquiring age data, from fin rays collected on the spawning grounds to scales collected at Lower Granite Dam. Each method has its advantages and disadvantages. In order to guide future monitoring, the trade-offs inherent in each methods must be evaluated.

Although age data based on fin rays were highly accurate (>94%), the way fin rays are collected is likely biased in two ways. There may be a size bias in the carcass sample because it is harder to locate smaller fish (Zhou 2002). 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 to collect them or it was easier to find carcasses in some places.

Sampling conducted at Lower Granite Dam is systematic and therefore unbiased in regards to the aggregate run. However, systematic collection at the Lower Granite Dam trap appeared to miss the largest salmon. In 2007, the largest Chinook salmon measured on the spawning grounds was 113 cm, but the largest length measured at Lower Granite Dam was 105 cm. No Chinook sampled at Lower Granite Dam were >105 cm but there were 23 Chinook >105 cm sampled on the spawning grounds (3% of all carcasses collected). We noted the same results in 2006 (Copeland et. al. 2007b).

Neither of the two methods alone will address all monitoring objectives in an efficient manner. Population-specific evaluations (e.g., Copeland et al. 2005) are not possible using scales collected at Lower Granite Dam. The only way to compare populations is to collect fin rays on the spawning grounds. These data will be important in monitoring for recovery plans, which are population specific (ICTRT 2005). But processing of fin rays is time-consuming, labor-intensive, and the data are biased to some degree; scale processing is quicker, more cost-efficient, and generates unbiased data. Once in place, a scale sampling program allows age data to be produced during the run instead of months after they spawn. We still are developing the methodology and infrastructure necessary to develop scale data in a timely manner. Further, the known-age scale archive should expand in order to function properly as a training and reference tool. Scale sampling should become prominent in monitoring of all populations in aggregate but sampling for fin rays will continue as needed.

In the future, we recommend a formal statistical comparison of age composition using fin rays versus scales. Criteria for the evaluation should include the accuracy and precision necessary to accurately assess smolt-to-adult survival of the aggregate stock. If the aggregate age composition based on scales collected at Lower Granite Dam is sufficiently accurate and precise, collections of fin rays should focus on spawning areas where population-level data are needed or management interest is high.

RECOMMENDATIONS

With thought to improving the utility and accuracy of the age data, as well as exploring potential cost savings, we make the following recommendations for 2008:

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

2. Continue to collect and analyze scales from Lower Granite Dam and expand the known-age reference collection.

3. Conduct a formal statistical comparison of age composition using fin rays versus scales.

4. Assess degree of scale resorption and aging accuracy between Lower Granite Dam and spawning grounds.

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Table 1. Number and proportion by ocean age for each 5-cm fork length group of wild Chinook salmon carcasses aged in 2007. Ages were based on fin rays.

		Proportion			
Length group	**Number aged**	**1 Ocean**	**2 Ocean**	**3 Ocean**	**4 Ocean**
<50	13	1.00	0.00	0.00	0.00
50-54	22	1.00	0.00	0.00	0.00
55-59	22	0.86	0.14	0.00	0.00
60-64	9	0.67	0.33	0.00	0.00
65-69	35	0.09	0.91	0.00	0.00
70-74	65	0.00	0.98	0.02	0.00
75-79	100	0.00	0.95	0.05	0.00
80-84	96	0.00	0.51	0.47	0.02
85-89	162	0.00	0.09	0.87	0.04
90-94	125	0.00	0.02	0.94	0.05
95-99	45	0.00	0.02	0.96	0.02
100-104	27	0.00	0.00	0.96	0.04
>104	26	0.00	0.00	0.96	0.04

Table 2. 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 for smolt years 2002-2006. The 95% confidence intervals are in parentheses.

Smolt Year	Smolts	One Ocean	Two Ocean	Three Ocean	Four Ocean	SAR (%)
1996	419,826	[a]	845	467	0	0.31 (0.30-0.33)
1997	161,157	161	2,206	423	33	1.75 (1.69-1.82)
1998	599,159	241	7,177	1,242	306	1.50 (1.47-1.53)
1999	1,560,298	1,550	41,999	13,532	639	3.70 (3.67-3.73)
2000	1,344,382	1,829	15,882	23,234	50	3.05 (3.02-3.08)
2001	490,534	364	6,518	2,115	87	1.85 (1.81-1.89)
2002	1,128,539	2,309	18,364	2,189	15	2.03 (2.00-2.05)
2003	1,455,845	1,276	5,643	1,632	181	0.60 (0.59-0.61)
2004	1,517,956	592	7,646	4,007	[b]	0.81 (0.79-0.82)
2005	1,734,464	335	4,702	[b]	[b]	0.29 (0.28-0.30)
2006	1,225,679	1,462	[b]	[b]	[b]	0.12 (0.11-0.13)

[a] One-ocean samples were not collected.
[b] Adult return of cohort is not completed.

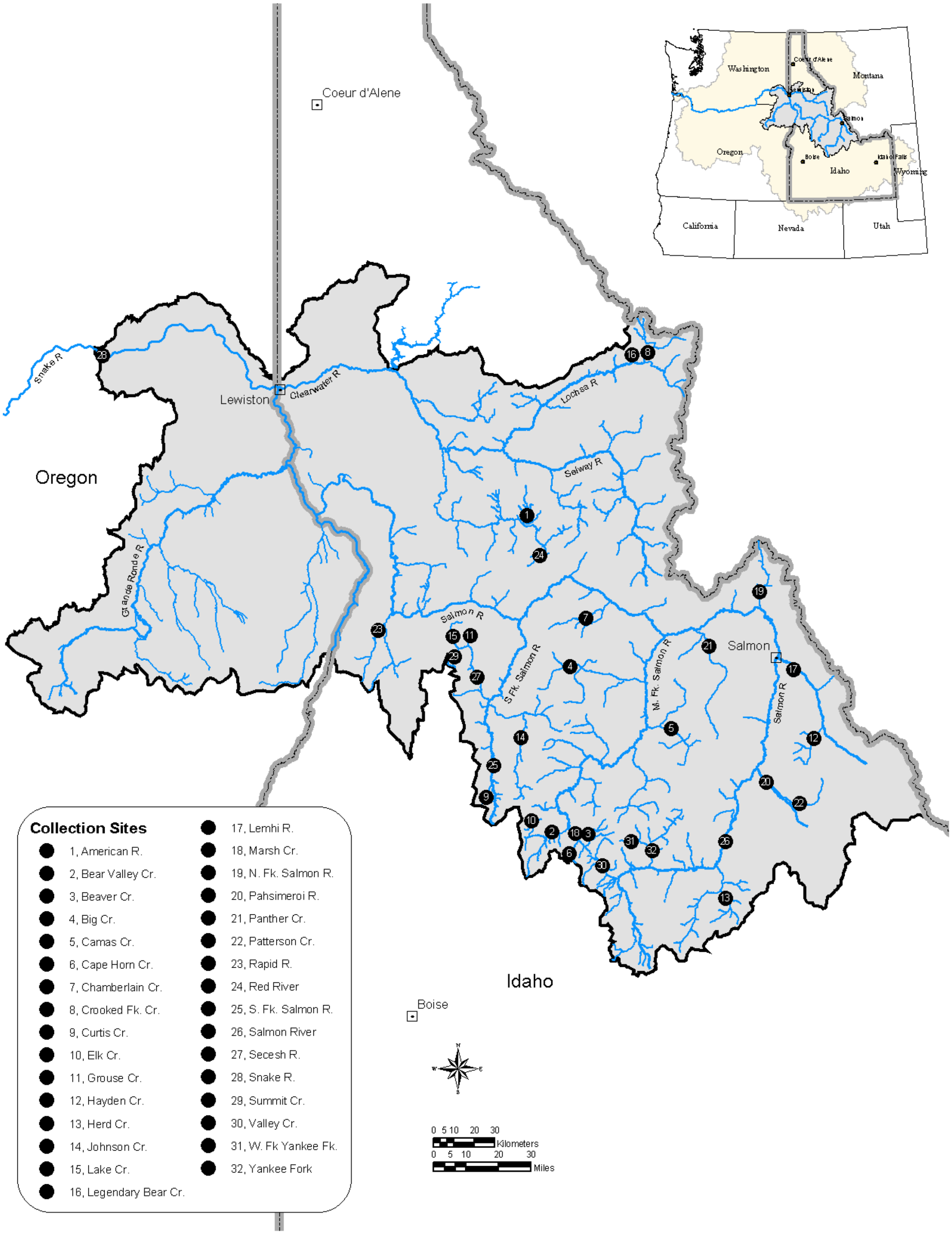

Figure 1. Location of sites where wild spring/summer Chinook salmon carcasses were collected in 2007.

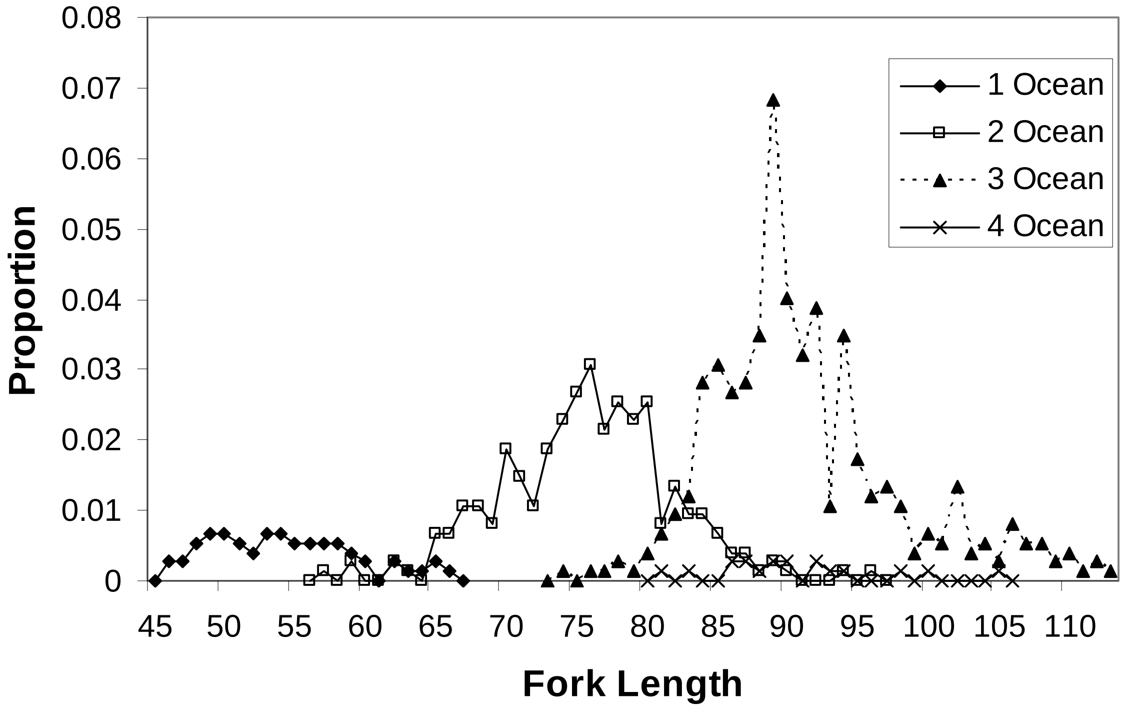

Figure 2. Length distribution by ocean age of wild Snake River spring/summer Chinook salmon carcasses collected on the spawning grounds in 2007. Ages were determined from fin rays (n = 747).

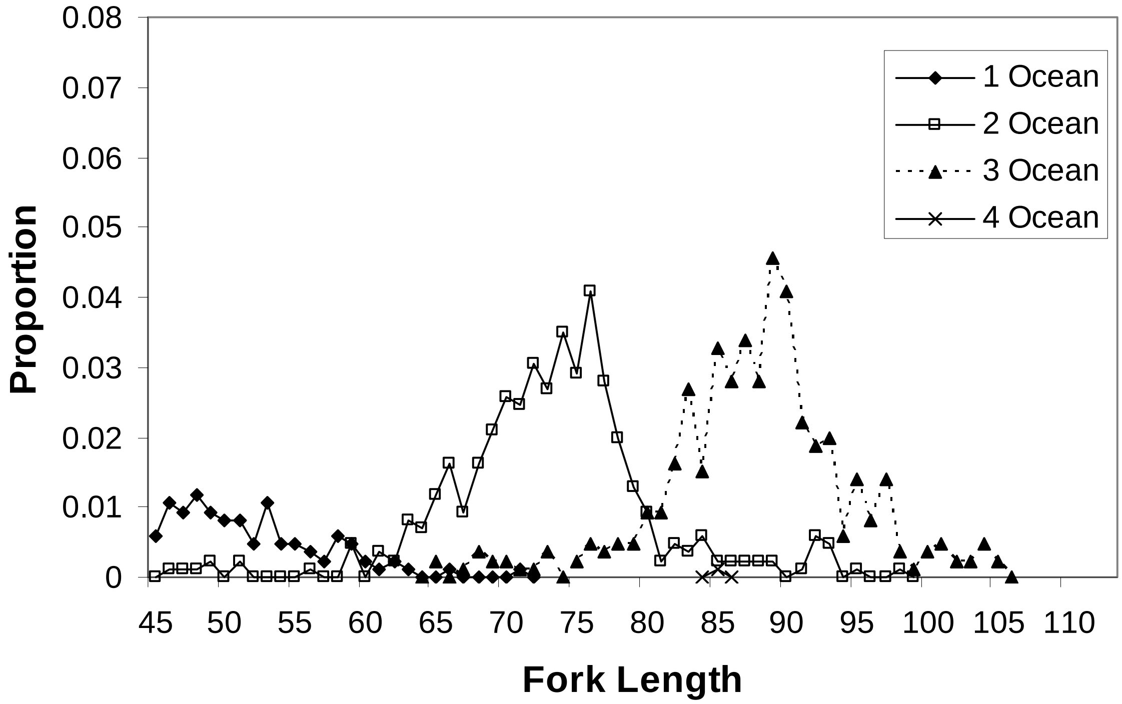

Figure 3. Length distribution by ocean age of wild Snake River spring/summer Chinook salmon collected at Lower Granite Dam in 2007. Ages were determined from scales (n = 887).

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 1990-2004 versus the number of smolts produced. Here, I updated the Beverton-Holt stock-recruit model with data from the 2005 brood year. The number of females available for natural reproduction in 2005 was 10,899 fish. I estimated that 787,152 naturally produced smolts from the 2005 brood year passed Lower Granite Dam. Based on data from the 1990–2005 brood years, I computed intrinsic productivity to be 453.9 smolts per female and asymptotic production to be 1.62 million smolts, as estimated by nonlinear fit (r^2 = 0.935, n = 16). I further estimated the number of females naturally reproducing in 2007 was 8,562 fish. Given that number of female parents, 1,143,736 naturally produced smolts should pass Lower Granite Dam in 2009. Comparison to recent smolt-to-adult return rates showed that the aggregate stock likely would not meet replacement for the last two 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 Chinook salmon *O. tshawytscha*, variance in 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 (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 a unique opportunity to estimate the stock-recruitment inputs (i.e. adult and smolt abundances) 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, 2007). The model is 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 2005 brood year. Additionally, I estimated the number of females spawning naturally in 2007.

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 2007 was obtained directly from the Fish Passage Center web site (www.fpc.org, accessed January 2008). The spring run lasted from March 1 to June 17 and the summer run lasted from June 18 to August 17. 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 (Howard Burge, personal communication). I computed the percentage of females for all adults identified to sex at weirs by run type. McCall and Pahsimeroi hatcheries were considered summer runs and all others spring run. 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 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. 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). Only the South Fork Salmon River fishery was considered a summer run fishery. 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 2007 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 wild 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.

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 1990-2005 and the number of smolts produced by brood years (BY) 1990-2004 had been previously estimated by Kiefer et al. (2004) and Copeland et al. (2004, 2005, 2006, 2007). To these data, I added the smolt estimate from the 2007 migration (BY 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 during 2007, excluding jacks, was 30,184 fish (Table 3). Overall, females comprised 52% of the adults. Estimated losses of females above Lower Granite Dam totaled 7,157 individuals in 2007. Subtraction yielded a FANR estimate of 8,562 females.

The estimated number of smolts exiting the system via Lower Granite Dam during smolt year 2007 was 787,152 fish (Table 4). This estimate covers the period March 26 to July 17, 2007. The smolt estimate from SY 2007 completed the data set for the 1990-2005 brood years.

The Beverton-Holt model fit the data very well (Figure 4, r^2 = 0.935, n = 16). For the 1990–2005 brood years, intrinsic productivity was 453.9 smolts per female and asymptotic production was 1.62 million smolts. There was no obvious pattern in the model residuals when compared to predicted values (data not shown). The variance might be constrained at low abundances, but there was no indication of accelerating variances with increasing abundance.

DISCUSSION

The complete data set now includes 16 pairs of estimates. The 2007 smolt migration (BY 2005) was the lowest since BY 1999. The 2007 smolt migration also had the second largest negative residual in the model, after BY 1992. Two clusters were apparent in the aggregated data: low smolt years below 1 million and high smolt years above 1 million. The current system may have two possible states, low versus high smolt production (Copeland et al. 2005). The BY 2005 point lies near the top of the low smolt abundance domain, where production is unrestricted by density-dependent mechanisms. Stream flows were low during the summer of 2006 and the 2006-2007 snowpack was below average. I hypothesize that low flows resulted in fewer young than predicted because of poor survival from egg to Lower Granite Dam for BY 2005.

The model generated was very precise (r^2 >0.90). The parameters estimated here have not changed greatly from the previous versions as fit by nonlinear algorithms (Copeland et al. 2004, 2005, 2006, 2007). The model tended to overpredict at low abundances and underpredict at high abundances, but unexplained variance was evenly distributed around zero. I concluded that the model was performing well. The model parameters were relatively insensitive to likely biases in the data (Copeland et al. 2006). However, Hilborn and Walters (1992) recommended at least 20 years of data in order to obtain reliable confidence intervals, so new data should continue to be added.

Using the FANRs for BY 2006 and BY 2007 in the Beverton-Holt model yielded a prediction of 1,169,439 smolts for BY 2006 and 1,143,736 smolts for BY 2007. Assuming a 1:1 sex ratio, the smolt-to-adult return rate would have to be 1.58% and 1.50%, respectively, to achieve replacement for these brood years. Given the recent smolt-to-adult return rates estimated in Part 2 of this report, it is unlikely that any of the last two BYs will meet replacement.

In summary, the paired female-smolt data fit a Beverton-Holt model very well. Parameter estimates appeared to be reasonable descriptors of the system during 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 set levels of allowable take for ESA permits and to estimate the level of tagging necessary for downstream passage research on spring/summer Chinook in the main stem (Russ Kiefer, IDFG, 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 predicted 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 3. Estimated returns to Lower Granite Dam, percentage of females, losses to harvest and hatcheries, escapement, and females available for natural reproduction (FANR) for 2007. Actual hatchery take was adjusted by 20% and harvest by 10% to account for migratory losses.

	Run type	
Estimate	**Spring**	**Summer**
Dam count	22,481	7,703
% females	53.2	48.8
Females (#)	11,960	3,759
Hatchery	4,878	1,104
Harvest	869	306
Escapement	6,213	2,349
Total FANR	8,562	

Table 4. 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
2005	10,899	787,152
2006	9,253	1,169,439[a]
2007	8,562	1,143,736[a]

[a] Predicted values based on the Beverton-Holt model.

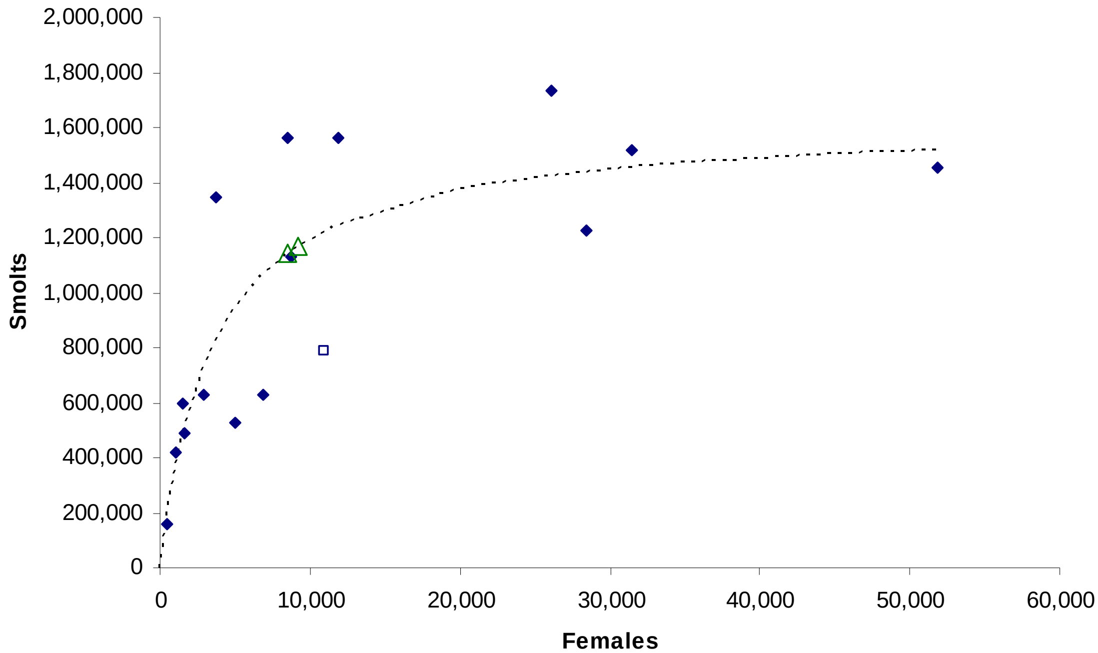

Figure 4. Comparison of observed data (BY 1990 to BY 2005) to model predictions for the Beverton Holt model. Observed data are filled diamonds. The BY 2005 point is a hollow square. The predictions for BY 2006 and BY 2007 are the hollow triangles.

PART 4—MONITORING ABUNDANCE OF ANADROMOUS SALMONID PARR IN IDAHO

ABSTRACT

The Idaho Department of Fish and Game has monitored abundance of juvenile anadromous salmonids since 1985. In this report, we summarize parr densities of steelhead trout *Oncorhynchus mykiss*, Chinook salmon *O. tshawytscha*, and other salmonids observed while snorkeling in 2007. This year we adopted a new rotating panel design and incorporated a protocol to assess crew efficiency. There were three types of sites: annual surveys (intensive watersheds), occasional surveys (extensive watersheds), and historic trend. Sites for the first two were chosen using a probabilistic system from all potential sites within the anadromous waters of the target watersheds. Intensive watersheds surveyed in 2007 included Crooked Fork Creek, Crooked River, and Marsh Creek. We set a minimum of 41 sites for this panel and crews surveyed 43 sites. Steelhead had the highest mean abundance in the Crooked Fork Creek watershed. Westslope cutthroat trout had the highest mean abundance in the Crooked River watershed. Chinook salmon had the highest mean abundance in the Marsh Creek watershed. Extensive watersheds included the Selway River and the upper Salmon River. We set a minimum of 80 sites for this panel and crews surveyed 45 sites. The Selway watershed survey was aborted because of wildfires. Brook trout were the most common species in the upper Salmon River watershed. Snorkel crews also surveyed 45 and 28 historic trend sites in the Salmon and Clearwater river drainages, respectively. Mark-resight studies were conducted at 10 sites to assess probability of detection for steelhead. Median crew efficiency was 56.5%, although there was great variability.

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INTRODUCTION

The Idaho Department of Fish and Game (IDFG) has monitored the abundance of juvenile anadromous salmonids using snorkel surveys 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. The original intent was to track natural production of anadromous salmonids to evaluate off-site habitat mitigation projects funded by the Bonneville Power Administration (Petrosky and Holubetz 1985). Since the listing of Idaho's anadromous salmonids under the Endangered Species Act in the 1990s, the focus shifted to tracking population trends. A formal sampling plan was developed in 1994 to coordinate and prioritize fieldwork to obtain trend information (Leitzinger and Holubetz 1994, cited in Hall-Griswold et al. 1995). Essentially, this plan designated 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. While this plan resulted in a large amount of data useful for trend analysis at a very large scale (i.e. Salmon or Clearwater subbasins), it was not consistent with recent developments in survey protocols in the Columbia basin (Jordan et al. 2003, ISRP 2005).

The GPM program needed to change. Previously, we identified two biases inherent within the GPM program (Copeland et al. 2005, 2007). First, site selection was made subjectively by IDFG fisheries biologists on a case-by-case basis; therefore, sites did not constitute an unbiased sample of the target population, the anadromous streams in Idaho. Second, the data were raw counts, which were influenced by both the number of fish present and the ability of the snorkelers to see them. The GPM program needed to change to address these biases, yet remain flexible enough to incorporate local needs for continuity and trend series. We did this in two steps.

In 2007, we adopted a rotating panel design (Larsen et al. 2001) with three objectives. The first objective was to calibrate summer snorkel surveys with production of juvenile emigrants from target watersheds. To address this objective, we chose smaller watersheds with emigrant trapping and designated these for annual sampling (intensive panel). This panel will also serve to estimate trend in the future. The second objective was to track status (distribution and abundance) at the major population group level (see ICTRT 2003 for designations). To address this objective, we chose larger watersheds analogous to major population groups for sampling on an occasional basis (extensive panel). Associated with the extensive panel was the objective to assess the feasibility of using a probabilistic sampling design in a large wilderness basin. The third objective was to keep important local trend data sets intact. Sites in this panel were designated from historic trend sites by local IDFG fisheries biologists. This last panel also serves as a link between past and future GPM data. Within the first two panels, site selection was based on a generalized random-tessellation stratification design to be a spatially-balanced probabilistic selection from all potential sites (Stevens and Olsen 2004), thus addressing spatial bias.

The second change we made in 2007 was to address variations in ability to observe fish in the wild (detection probability). Trends in abundance can be obscured or biased by spatial or temporal trends in detection probability (Link and Sauer 1998). Survey designs should therefore assess detection probability in some proportion of sites visited (Pollock et al. 2002). For a subset of sites, we adapted the protocol of Thurow et al. (2006), who provided a model relating habitat and fish size to detection probability.

The objective of this part of the report was to summarize activities conducted for GPM during 2007. The data presented are summaries of salmonid densities observed. Formal quantitative analyses were not undertaken for this report.

METHODS

We identified several watersheds of interest. For the intensive panel, we chose Crooked Fork Creek and Crooked River in the Clearwater River subbasin; in the Salmon River subbasin, we chose Marsh Creek and the Pahsimeroi River. For the extensive panel, we chose the Selway and upper Salmon (above the Middle Fork confluence) rivers. We estimated 200 sites could be surveyed in 2007. Regional biologists listed 74 sites they desired to retain from the historical group. We then parsed the remaining effort into the target watersheds. Forty sites were assigned to each extensive watershed. The remaining sites were assigned to the intensive watersheds based on estimated length of streams producing anadromous fish (see below), subject to the constraint of 10 sites at a minimum per watershed.

For the intensive and extensive panels, site selection was based on a generalized random-tessellation stratification design (Stevens and Olsen 2004) to be a spatially-balanced probabilistic selection from all potential sites. A list of all potential sites in the Clearwater and Salmon basins was obtained from the US-EPA office in Corvallis, Oregon. These sites were plotted on a 1:100,000 stream layer and their order randomized by EPA. We used the anadromous stream data layer from StreamNet (www.streamnet.org) to determine which sites in each watershed were within the anadromous production zone. Sites that fell within a 100 m buffer of an anadromous stream were retained. An ordered list of approximately twice the desired number of sites was drawn for the various watersheds of interest. Each potential site had a unique site identifier for data entry forms and the IDFG Standard Stream Survey database. Site priority started with the lowest number (high priority) and proceeded to the highest number (low priority). High priority sites were included or rejected before lower-priority sites could be considered in survey plans. Criteria for rejection were: 1) the site could not be safely surveyed or site boundaries adjusted to make it safe (see next paragraph); 2) the location was above barriers to spring movement of adult steelhead; 3) there was no water at the time of survey; 4) the owner denied access to the site; or 5) the site was too wide or complex to be surveyed efficiently by the full crew. Survey dates were arranged as logistics dictated and did not always follow the site priority order.

Field surveys were performed during summer base flow conditions. Site locations and lengths were adjusted by the crew leader based on actual stream conditions. The desired average site length was 100 m. Actual site bounds were adjusted to fit within hydraulic controls. If necessary, a site was moved up to 500 m from the designated point. The percentage of each habitat type (pool, pocket water, riffle, or run) within the site was recorded. One to five snorkelers counted fish in each site, depending on the stream width and visibility. All salmonids were counted and size estimated to the nearest inch while moving slowly upstream. Chinook salmon *Oncorhynchus tshawytscha* parr were assigned an age based on length. Nonsalmonids were noted if present. After the crew snorkeled each site, they measured its length and up to ten widths to calculate the surface area. Data were entered into the IDFG Standard Stream Survey database. We present summaries of salmonid densities (standardized to number per 100 m^2) observed by watershed and for the historic trend panel in an approximate upstream-downstream order.

We evaluated the efficiency of the crews at detecting juvenile steelhead *Oncorhynchus mykiss* at a subset of sites. A protocol modified from Thurow et al. (2006) was designed to allow us to estimate efficiency through observation of marked individuals. Briefly, juvenile steelhead were caught, measured, marked (caudal notch), and released within the selected site. The next day, snorkeling began approximately 50 m downstream of the main transect and the marked fish were recorded. Boundaries of main and subsidiary transects were adjusted to begin and end at hydraulic controls. Then, the main 100 m section was snorkeled and all salmonids were counted, measured, and recorded. Finally, a section approximately 50 m in length upstream of the main section was snorkeled and the marked fish were recorded. The habitat variables described by Thurow et al. (2006) were measured in the target section. The intent is to use these data to validate the use of Thurow et al.'s (2006) model relating habitat conditions to daytime snorkel survey efficiency for *O. mykiss*. A target of 10% of the sites sampled was set. We present a rough summary of data collected at each site.

RESULTS

During planning, it became apparent that not all watersheds could be done at the scale desired. We revised the extensive survey of the upper Salmon River watershed to the area upstream of the Yankee Fork confluence, including the Yankee Fork watershed. Given crew time constraints, the Pahsimeroi River watershed was not done.

Intensive Panel Sites

The Crooked Fork Creek basin was surveyed June 27-29. The target was 14 sites. Three sites were visited but were not surveyed because of high water and unsafe conditions. Fifteen sites were sampled (Table 5). Four salmonid taxa were identified: juvenile steelhead, Chinook salmon parr, westslope cutthroat trout *Oncorhynchus clarkii lewisi*, and mountain whitefish *Prosopium williamsoni*. Densities were low for all species. Cutthroat trout and steelhead were the most commonly encountered species; both were observed at nine sites and had similar mean densities (0.79 fish/100m^2 and 0.92 fish/100m^2, respectively). Cutthroat trout were most abundant in the headwaters, while steelhead were more evenly distributed.

The Crooked River basin was surveyed June 30 to July 2. The target was 10 sites. One site was visited but was not surveyed because of high gradient and shallow water. Thirteen sites were sampled (Table 6). Four salmonid taxa were identified: trout fry *Oncorhynchus* sp., juvenile steelhead, Chinook salmon parr, cutthroat trout, and mountain whitefish. Cutthroat trout were present throughout the watershed and were the most abundant taxa (mean = 7.04 fish/100m^2). Steelhead and whitefish presence was occasional and densities were highest in the lower reaches.

The Marsh Creek basin was surveyed July 31 to August 13. The target was 17 sites. One site was rejected in the field because it was extremely silty and could not be efficiently surveyed. Fifteen sites were sampled (Table 7). Seven salmonid taxa were identified: trout fry, juvenile steelhead, Chinook salmon parr, cutthroat trout, bull trout *Salvelinus confluentus*, brook trout *S. fontinalis*, and mountain whitefish. Brook trout were found at 11 sites. Average abundance was greatest for Chinook salmon (mean = 4.24 fish/100m^2). Cutthroat trout were concentrated in the lower sites. Except for one upper site, whitefish were confined to the lower sites.

Extensive Panel Sites

The Salmon River basin upstream of the Yankee Fork confluence was surveyed from July 1 to August 15. Nine sites were visited but not surveyed for one of four reasons (access denied, too shallow, too turbid, too wide). Thirty-nine sites were surveyed (Table 8). Eight salmonid taxa were identified: trout fry, hatchery and natural steelhead, Chinook salmon parr, cutthroat trout, bull trout, brook trout, and mountain whitefish. Brook trout occurred at 23 of 39 sites and had the highest mean density (4.87 fish/100m^2). Brook trout were especially abundant in sites in the Sawtooth Valley. The mean natural steelhead density was 2.71 fish/100 m^2. Hatchery steelhead were found in three sites: two in the Salmon River near Sawtooth Fish Hatchery and one in lower Valley Creek. Cutthroat and bull trout were the least abundant and most infrequently encountered species.

The Selway River basin was surveyed July 27 to August 1. Only six sites were surveyed due to wildfires in the area; the crew had to be evacuated by air from the Moose Creek Ranger Station. Site dimensions were not recorded for three sites, so densities were calculated for only three sites (Table 9). Five salmonid taxa were identified: trout fry, juvenile steelhead, Chinook salmon parr, cutthroat trout, and mountain whitefish. Steelhead densities were very high (10.70 fish/100m^2).

Historic Trend Sites

Forty-five historic GPM sites were surveyed in the Salmon River basin during 2007 (Table 10). The majority of these were on the Middle Fork Salmon River. Steelhead were the most commonly occurring species. No trout fry or brook trout were observed in the Middle Fork Salmon River but cutthroat trout were common and abundant. The Chinook salmon densities observed in Hannah Slough (a side channel of the Salmon River) were the highest densities observed for this species in 2007.

Twenty-eight historic trend sites were surveyed in the Clearwater River basin (Table 11). Twelve were in tributaries of the Selway River, two in the Lochsa basin, and 14 in tributaries of the South Fork Clearwater River. Steelhead and Chinook salmon were found in most of these sites (24 and 22 sites, respectively).

Detection Probability

We conducted mark-resight studies at ten locations to assess detection probability. Selected habitat variables were measured at these locations (data not shown). Snorkel crew efficiency in 2007 was high but variable (Table 12). Crews marked 285 fish and resighted 154 of them. Only 12 were observed outside of the main survey unit; 9 of which were upstream. Efficiencies ranged from 22% to 104% (median = 56.5%). The highest value was the result of double counting fish.

DISCUSSION

Sampling large wilderness watersheds is difficult. Learning how to sample them was an unstated objective. We estimated *a priori* that crews could sample 200 sites during the field season. Only 163 sites actually were surveyed. The largest impact on the schedule was the cancellation of the Selway sampling because of wildfires in much of the watershed. After the planning exercise, we scaled back the scope of the Salmon River survey. For extensive surveys of large basins, such as these two, it seems that one third of the area reasonably can be surveyed in one field season, given a 40-site target. Travel time among sites was lengthy, so the Pahsimeroi watershed was not surveyed in order to complete the upper Salmon work. Some time was spent visiting sites that were not surveyed. In contrast, intensive panel sites were closer together and less time was spent traveling and, in some cases, additional sites were completed.

In the future, the GPM program will focus primarily on steelhead. Chinook populations can be extensively monitored using redd counts. Steelhead redd counts in Idaho do not provide reliable estimates of population abundance because of turbidity and changing flow conditions during the spring spawning period (Thurow 1985). Therefore, extensive steelhead population status monitoring will have to focus on juveniles. For extensive monitoring in central Idaho, snorkel surveys are the best option (Petrosky and Holubetz 1985). This effort will involve closer integration with Idaho Steelhead Monitoring and Evaluation Studies (ISMES). We began this in 2007 by adopting the GPM protocol for ISMES and using the same probabilistic site selection scheme (Copeland and Putnam 2008), as well as organizing a collective training session for all IDFG anadromous snorkel crews at Fish Creek in the Lochsa drainage.

There was considerable variability in fish densities among sites. However, the sites were distributed in a spatially balanced manner (Stevens and Olsen 2004) and so the sample should not be biased with reference to fish densities in anadromous streams. We conducted a simple power analysis to see if enough sites were surveyed to adequately represent the watersheds of interest (data not shown). We assumed a desired risk of Type I error of 10% and power of 80% in order to tell a difference from 50% or 75% of the observed mean for each watershed. A full analysis will be completed when more data become available. Preliminarily, sample sizes in 2007 were close to the minimum recommended if the data are transformed to help control variance. Based on the preliminary analysis and logistical experiences, we recommend a minimum of 25 sites for the intensive watersheds surveyed in 2008. Large extensive watersheds appear to be well-characterized by 40 sites.

During mark-resight studies, variability in detection probabilities was evident but crew efficiencies were better than anticipated (>28.6%). We concluded that GPM crews should detect steelhead in a particular site if they are present. However, abundance estimates may be greatly influenced by detection probability. We tried both dorsal and upper caudal fin clips during the training session and found the upper caudal was most visible. A few deficiencies in the protocol were noted. Specifically, there are concerns with herding fish from the main reach upstream and double counting of fish. We believe these can be easily addressed by proper crew training. Approximate distances of marked fish from the main reach boundary should be recorded. During the marking effort, crews should make efforts to keep marked fish as close as possible to their capture location. Lastly, in 2007, sites for mark-resight studies were picked for crew convenience. In 2008, we will try to increase the extent of this work, both in number and habitat types/stream sizes. The desired number of mark-resight studies is 10% of the total number of sites.

RECOMMENDATIONS

We recommend the new initiatives begun in 2007 should be continued in 2008.

1. For extensive watersheds, scale can be adjusted following careful consideration of logistics. This will be an iterative process because we are still learning how logistics interact with the probabilistic site selection scheme. Approximately one third of the Selway will be surveyed in 2008. The Big Creek watershed will also be sampled (31 sites). Lastly, we identified Rapid River (Middle Fork Salmon tributary) as a potentially significant source of steelhead production and targeted it for extensive sampling in 2008 (20 sites).

2. Intensive watersheds will be sampled again in 2008. For the Pahsimeroi watershed, 20 sites will be the minimum.

3. Focus on steelhead. Adequacy of sample sizes should be assessed using densities of this species.

4. Gather data regarding detection probability. These data may help explain variability among sites and reduce the necessary sample sizes.

5. With the new scope of GPM, careful coordination, in terms of planning and training, is vital. Preseason planning will involve all regional and ISMES personnel. Continue the annual crew training exercise in the Clearwater region at the beginning of the field season.

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Table 5. Densities (fish/100 m^2) of salmonids observed at intensive panel sites snorkeled in the Crooked Fork Creek drainage, June 27-29, 2007. Trout fry = all trout <50 mm. Sites are arranged roughly in upstream to downstream order. Mean and standard deviation are given by species.

Stream	Site	Steelhead	Chinook Salmon	Cutthroat Trout	Whitefish
Crooked Fk Creek	2921	0.00	0.00	6.31	0.00
Crooked Fk Creek	4439	0.00	0.00	1.75	0.00
Crooked Fk Creek	1781	2.17	0.00	0.31	0.00
Boulder Creek	1259	6.35	0.00	0.91	0.00
Crooked Fk Creek	4811	0.51	0.00	0.51	0.26
Crooked Fk Creek	2444	0.00	0.00	0.17	0.00
Crooked Fk Creek	2329	0.00	0.30	0.91	3.03
Spruce Creek	4483	0.00	0.00	0.00	0.00
Spruce Creek	4031	0.91	0.00	0.00	0.00
Brushy Fork	776	0.00	0.00	0.00	0.30
Brushy Fork	6112	1.21	0.00	0.00	0.00
Brushy Fork	4924	1.14	0.00	0.00	0.13
Brushy Fork	3657	0.51	0.00	0.00	0.17
Crooked Fk Creek	3395	0.08	0.00	0.17	0.00
Crooked Fk Creek	437	0.90	0.65	0.82	0.74
Mean		0.92	0.06	0.79	0.31
SD		1.63	0.18	1.61	0.78

Table 6. Densities (fish/100 m^2) of salmonids observed at intensive panel sites snorkeled in the Crooked River drainage, June 30 to July 2, 2007. Trout fry = all trout <50 mm. Sites are arranged roughly in upstream to downstream order. Mean and standard deviation are given by species.

Stream	Site	Trout Fry	Steelhead	Chinook Salmon	Cutthroat Trout	Whitefish
W Fk Crooked River	3798	0.00	0.00	0.00	1.72	0.00
E Fk Crooked River	2031	0.00	0.00	0.00	2.86	0.00
E Fk Crooked River	7952	0.00	0.68	0.00	4.73	0.68
W Fk Crooked River	6474	0.00	0.00	0.00	7.79	0.00
W Fk Crooked River	7655	0.00	0.00	0.00	19.65	0.00
Crooked River	2621	0.00	1.72	0.00	4.74	0.43
Fivemile Creek	538	0.00	0.00	0.00	0.00	0.00
E Fk Relief Creek	5692	9.50	1.90	0.00	32.29	0.00
Relief Creek	4504	0.00	0.00	0.00	11.30	0.00
E Fk Relief Creek	2136	0.00	0.00	0.00	4.52	0.00
Crooked River	1844	0.00	9.07	0.00	0.57	0.00
Crooked River	206	0.00	12.70	0.00	1.41	0.71
Crooked River	2656	0.00	2.50	0.00	0.00	1.11
Mean		0.73	2.20	0.00	7.04	0.23
SD		2.63	4.02	0.00	9.36	0.38

Table 7. Densities (fish/100 m^2) of salmonids observed at intensive panel sites snorkeled in the Marsh Creek drainage, July 31 to August 13, 2007. Trout fry = all trout <50 mm. Sites are arranged roughly in upstream to downstream order. Mean and standard deviation are given by species.

Stream	Site	Trout Fry	Steelhead	Chinook Salmon	Cutthroat Trout	Bull Trout	Brook Trout	Whitefish
Knapp Creek	73047	0.41	0.14	0.41	0.00	0.14	2.34	0.00
Knapp Creek	40279	0.30	0.00	0.61	0.00	0.00	3.35	0.00
Knapp Creek	60759	0.86	0.00	4.89	0.00	0.00	2.59	2.59
Swamp Creek	21847	4.00	1.00	6.00	0.00	0.00	2.50	0.00
Camp Creek	56663	1.90	0.00	34.25	0.00	0.00	11.42	0.00
Beaver Creek	32111	0.00	0.00	0.00	0.00	3.39	0.00	0.00
Beaver Creek	97111	0.00	0.00	0.00	0.00	4.19	0.00	0.00
Beaver Creek	83799	0.44	0.00	0.00	0.00	0.00	0.22	0.00
Beaver Creek	51031	0.00	0.58	0.00	0.00	0.00	0.19	0.00
Beaver Creek	15703	0.00	1.37	1.37	0.27	0.00	0.55	0.00
Winnemucca Cr	18263	0.00	0.29	0.00	0.00	0.59	1.46	0.00
Beaver Creek	27991	0.16	0.16	0.66	0.41	0.00	0.08	0.25
Beaver Creek	11607	4.93	0.58	10.11	0.38	0.19	0.58	0.26
Lola Creek	60247	0.00	0.95	0.00	0.00	0.63	0.00	0.00
Marsh Creek	3114	0.51	0.45	5.31	0.51	0.00	0.00	3.01
Mean		0.90	0.37	4.24	0.10	0.61	1.69	0.41
SD		1.54	0.44	8.85	0.19	1.32	2.93	0.98

Table 8. Densities (fish/100 m^2) of salmonids observed at extensive panel sites snorkeled in the Salmon River upstream of and including the Yankee Fork watershed, July 1 to August 15, 2007. Trout fry = all trout <50 mm. Sites are arranged roughly in upstream to downstream order. Mean and standard deviation are given by species.

Stream	Site	Trout Fry	Steelhead (Natural)	Steelhead (Hatchery)	Chinook Salmon	Cutthroat Trout	Bull Trout	Brook Trout	Whitefish
Salmon River	30183	2.44	0.00	0.00	0.00	0.00	0.00	0.30	0.00
Frenchman Creek	15847	3.42	0.00	0.00	0.00	0.00	0.00	20.54	0.00
Frenchman Creek	17383	0.00	0.00	0.00	0.00	0.00	0.00	17.87	0.00
Salmon River	39399	0.30	0.60	0.00	5.11	0.00	0.30	2.11	2.41
Smiley Creek	64999	0.00	0.00	0.00	0.00	0.00	0.00	56.20	0.00
Beaver Creek	63975	0.00	0.16	0.00	0.00	0.00	0.00	6.74	0.00
Beaver Creek	27111	1.80	0.00	0.00	0.00	0.00	0.00	12.08	0.00
Twin Creek	54759	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pole Creek	46567	0.74	0.00	0.00	13.48	0.00	0.00	8.09	0.00
Salmon River	57111	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14
Salmon River	7959	0.00	0.00	0.00	4.51	0.00	0.00	0.00	1.22
Alturas Lk Creek	32919	0.00	0.10	0.00	0.52	0.00	0.00	0.21	1.36
Salmon River	22295	0.08	0.08	0.00	0.29	0.00	0.00	0.00	0.38
Champion Creek	14103	0.93	0.93	0.00	0.00	0.00	0.00	2.78	0.00
Fisher Creek	55063	5.94	0.85	0.00	11.03	0.00	0.00	17.82	0.00
Fisher Creek	38679	0.00	6.93	0.00	0.00	0.00	0.00	0.00	0.00
Salmon River	59159	0.00	0.00	0.00	0.18	0.00	0.00	0.00	3.44
Williams Creek	45207	3.67	0.00	0.00	8.81	0.00	0.00	21.28	0.00
Salmon River	51351	0.00	0.00	0.00	0.53	0.00	0.00	0.05	3.36
Salmon River	12439	0.80	0.58	4.92	3.47	0.00	0.00	0.00	3.62
Salmon River	2199	0.96	2.70	2.28	21.10	0.06	0.42	0.06	11.33
Valley Creek	17239	0.68	0.17	0.00	0.00	0.34	0.00	1.02	0.00
Trap Creek	29527	2.51	0.00	0.00	0.00	0.00	0.00	5.02	0.31
Trap Creek	45911	2.48	0.00	0.00	0.00	0.00	0.00	8.82	0.00
Elk Creek	22615	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Elk Creek	2903	5.91	2.17	0.00	3.14	0.60	0.00	1.93	0.96
Park Creek	30615	16.60	64.04	0.00	0.00	0.00	1.19	3.56	0.00
Valley Creek	14231	2.29	2.51	0.00	2.94	0.00	0.00	0.11	0.98
Crooked Creek	46999	3.23	0.00	0.00	0.00	0.00	0.68	0.00	0.00
Valley Creek	6039	0.00	0.04	0.00	0.04	0.00	0.00	0.00	0.04
Valley Creek	58711	0.20	0.26	0.20	0.20	0.00	0.00	0.07	1.05
Big Casino Creek	1367	0.00	0.00	0.00	0.00	0.00	0.00	2.53	0.00
East Basin Creek	54871	0.00	3.08	0.00	0.00	0.00	0.00	0.00	0.00
East Basin Creek	38487	10.39	1.95	0.00	0.00	0.00	0.32	0.00	0.00

Table 8. Continued.

Stream	Site	Trout Fry	Steelhead (Natural)	Steelhead (Hatchery)	Chinook Salmon	Cutthroat Trout	Bull Trout	Brook Trout	Whitefish
Eightmile Cr.	49007	0.00	0.00	0.00	0.00	0.00	0.26	0.00	0.00
Sixmile Creek	49391	0.00	1.51	0.00	0.00	0.00	0.00	0.76	0.00
Lighting Creek	47447	3.23	2.42	0.00	0.00	0.40	0.00	0.00	0.00
Ramey Creek	26967	0.00	1.31	0.00	0.00	6.54	0.00	0.00	0.00
Ramey Creek	6487	18.04	13.34	0.00	1.18	0.00	0.00	0.00	0.00
Mean		2.22	2.71	0.19	1.96	0.20	0.08	4.87	0.78
SD		4.18	10.37	0.86	4.46	1.05	0.23	10.44	2.01

Table 9. Densities (fish/100 m^2) of salmonids observed at extensive panel sites snorkeled in the Selway River drainage, July 27 to August 1, 2007. Trout fry = all trout <50 mm. Sites are arranged in upstream to downstream order. Mean and standard deviation are given by species.

Stream	Site	Trout Fry	Steelhead	Chinook Salmon	Cutthroat Trout	Whitefish
N Fk Moose Creek	12738	2.33	22.22	0.00	2.07	0.00
Gedney Creek	1474	3.27	6.68	0.68	3.54	0.27
Gedney Creek	14786	2.21	3.20	0.46	1.07	0.08
Mean		2.60	10.70	0.38	2.23	0.12
SD		0.58	10.13	0.35	1.24	0.14

Table 10. Densities (fish/100 m^2) of salmonids observed at historic trend sites snorkeled in the Salmon River drainage during 2007. Trout fry = all trout <50 mm. Sites are arranged roughly in upstream to downstream order within each stream.

Stream	Site	Trout Fry	Steelhead	Chinook Salmon	Cutthroat Trout	Bull Trout	Brook Trout	Mountain Whitefish
Pahsimeroi River	Dowton Lane	17.62	8.71	18.54	2.87	0.00	1.33	3.48
Pahsimeroi River	Ponds	13.48	9.98	10.75	0.39	0.00	0.00	1.43
Pahsimeroi River	Weir	5.74	2.64	7.12	0.00	0.00	0.00	17.68
Hannah Slough	UPS Garden Cr	0.14	0.28	50.11	0.00	0.00	0.00	0.00
Panther Creek	PC9	0.00	2.26	0.00	0.00	0.00	0.00	0.00
Panther Creek	US Cabin Cr	0.00	1.70	0.00	0.00	0.00	2.91	0.00
Panther Creek	PC6	0.30	2.39	0.15	0.00	0.00	0.00	0.00
Lemhi River	Lem3A	0.00	3.54	0.00	0.00	0.00	6.42	0.00
Lemhi River	B	0.00	4.39	1.29	0.00	0.00	0.00	13.70
Lemhi River	PWRHS L58A	0.00	5.82	0.14	0.00	0.00	0.00	2.22
Lemhi River	13 Beyeler	0.00	0.13	0.00	0.00	0.00	0.13	0.13
Big Springs Creek	A	20.63	2.23	1.91	0.00	0.00	1.06	0.00
Big Springs Creek	BSC Bridge	0.41	3.24	0.00	0.00	0.00	0.00	0.00
N Fk Salmon River	Hughes	0.00	6.08	0.30	0.10	1.70	0.50	0.00
N Fk Salmon River	Dahlonega	0.09	3.59	0.72	0.18	0.00	0.00	1.61
M Fk Salmon River	Boundary	0.00	0.10	0.10	2.50	0.00	0.00	0.14
M Fk Salmon River	Gardells Hole	0.00	0.20	0.30	1.90	0.00	0.00	1.92
M Fk Salmon River	Velvet	0.00	1.20	0.00	3.70	0.61	0.00	1.23
M Fk Salmon River	Elkhorn	0.00	0.20	0.00	0.20	0.00	0.00	2.14
M Fk Salmon River	Sheepeater	0.00	0.30	1.20	0.70	0.00	0.00	1.17
M Fk Salmon River	Rapid River	0.00	0.20	0.10	1.60	0.00	0.00	0.98
M Fk Salmon River	Indian	0.00	0.20	0.20	0.60	0.00	0.00	0.00
M Fk Salmon River	Pungo	0.00	0.00	1.10	2.60	0.00	0.00	3.73
M Fk Salmon River	Marble Pool	0.00	0.20	0.00	2.40	0.00	0.00	1.36
M Fk Salmon River	Skijump	0.00	0.20	0.00	1.40	0.00	0.00	1.51
M Fk Salmon River	Lower Jackass	0.00	0.10	0.00	0.30	0.00	0.00	0.18
M Fk Salmon River	Cougar	0.00	0.00	0.00	0.70	0.00	0.00	5.22
M Fk Salmon River	Whitey Cox	0.00	0.00	0.00	1.00	0.00	0.00	1.30
M Fk Salmon River	Rock Island	0.00	0.50	0.00	0.50	0.00	0.00	0.48
M Fk Salmon River	Hospital Pool	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M Fk Salmon River	Tappan Pool	0.00	0.90	0.00	2.70	0.00	0.00	0.00
M Fk Salmon River	Flying B	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M Fk Salmon River	Airstrip	0.00	1.10	0.00	0.20	0.00	0.00	0.41
M Fk Salmon River	Survey	0.00	0.20	0.00	0.20	0.00	0.00	0.00
M Fk Salmon River	Big Creek Bridge	0.00	0.00	0.00	0.30	0.00	0.00	0.00

Table 10. Continued.

Stream	Site	Trout Fry	Steelhead	Chinook Salmon	Cutthroat Trout	Bull Trout	Brook Trout	Mountain Whitefish
M Fk Salmon River	Love Bar	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M Fk Salmon River	Ship Island	0.00	0.00	0.00	0.10	0.00	0.00	0.00
M Fk Salmon River	Otter Bar	0.00	0. 30	0.00	0.00	0.00	0.00	0.00
M Fk Salmon River	Goat Creek Pool	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M Fk Salmon River	Goat Creek Run	0.00	0.30	0.00	4.30	0.63	0.00	0.00
M Fk Salmon River	Hancock Rapid Hole	0.00	0.00	0.00	0.00	0.00	0.00	0.00
M Fk Salmon River	Bernard Airstrip	0.00	1.14	0.00	0.23	0.00	0.00	0.00
M Fk Salmon River	White Cr Pack Bridge	0.00	0.15	0.00	1.08	0.00	0.00	0.74
M Fk Salmon River	Little Cr Guard Station	0.00	0.41	0.00	0.62	0.00	0.00	0.93
M Fk Salmon River	Mahoney Camp	0.00	0.00	0.00	3.67	0.00	0.00	1.33

Table 11. Densities (fish/100 m^2) of salmonids observed at historic trend sites snorkeled in the Clearwater River drainage during 2007. Trout fry = all trout <50 mm. Sites are arranged roughly in upstream to downstream order within each stream.

Stream	Site	Trout Fry	Steelhead	Chinook Salmon	Cutthroat Trout	Whitefish
Red River	Below Weir	0.00	5.36	18.76	0.00	1.15
Red River	Old Bridge	0.84	0.00	2.10	0.00	0.00
Red River	Treat2	1.21	1.21	0.19	0.00	1.48
Red River	CUSP 5	1.33	0.89	40.78	0.00	0.89
American River	1	0.00	0.00	0.00	0.51	0.00
American River	Guntleys	1.70	0.85	1.70	0.00	7.66
American River	Flat Iron	1.90	0.00	4.94	0.00	0.76
American River	0.5mi below Boxsing	0.00	1.08	10.84	0.00	0.00
American River	2	12.93	1.93	44.02	0.00	0.64
Crooked River	Treat2	0.00	4.88	1.16	0.00	0.46
Crooked River	Control2	0.00	0.43	0.00	0.00	0.43
Crooked River	Can3	3.42	2.49	0.16	0.16	0.16
Crooked River	Natural1	0.29	3.16	0.00	0.00	0.29
Crooked River	Meander1	3.78	1.45	3.78	0.00	5.23
Deep Creek	Scimitar	0.00	4.17	0.35	2.61	0.00
Deep Creek	Cactus	0.21	8.19	2.52	3.15	0.00
Ltl Clearwater R	2	0.00	1.08	2.70	0.81	1.08
Ltl Clearwater R	1	0.00	1.70	6.22	0.00	0.57
White Cap Cr	3	0.00	0.46	0.52	0.75	0.00
White Cap Cr	2	0.00	0.00	0.07	0.28	0.00
White Cap Cr	1	0.00	1.44	1.71	0.13	0.00
E Fk Moose Cr	3	0.00	3.88	1.11	0.39	0.00
Moose Creek	1	0.00	1.62	0.19	0.48	0.00
Three Links Creek	1	0.00	9.63	0.00	1.77	0.00
Gedney Creek	2	0.85	5.65	0.28	0.00	0.28
Gedney Creek	1	1.24	5.93	0.27	0.00	0.27
Split Creek	2	0.63	9.70	0.00	0.00	0.00
Split Creek	1	0.39	8.18	0.00	0.00	0.00

Table 12. Steelhead trout detection probabilities in different habitat types. Fish were marked with an upper caudal clip in the main unit and resighted during a subsequent snorkel survey. At least 50 m was snorkeled above and below the main unit.

						Fish resighted	
Stream/Site	**Unit**	**Length (m)**	**Habitat Type**	**Marked**	**Observed**	**Number**	**%**
Rapid River 1	below	62			87	1	2.8
	main	109	run	36	187	26	72.2
	above	49			75	0	0.0
Rapid River 2	below	50			78	0	0.0
	main	104	riffle	25	106	24	96.0
	above	46			73	2	8.0
Fish Creek 1	below	67			88	0	0.0
	main	115	pocket water	89	170	33	37.1
	above	58			80	0	0.0
Fish Creek 2	below				61	1	1.5
	main	100	pocket water	68	130	32	47.1
	above				31	3	4.4
NF Salmon	below	59			75	0	0.0
	main	160	pocket water	14	113	7	50.0
	above	50			30	2	14.3
Pahsimeroi	below	60			128	0	0.0
	main	121	run	21	272	8	38.1
	above				161	0	0.0
Red River 1	below	50			4	0	0.0
	main	100	riffle	7	5	2	28.6
	above	50			3	0	0.0
Red River 2	below	50			1	0	0.0
	main	100	riffle	5	10	2	40.0
	above	50			5	1	20.0
Crooked River 1	below	50			13	1	9.1
	main	100	riffle/run	11	32	6	54.5
	above	50			17	0	0.0
Crooked River 2	below	50			3	0	0.0
	main	100	riffle/glide	9	12	2	22.2
	above	50			12	1	11.1

APPENDIX

Presentations by project personnel

Copeland, T., and D.A. Venditti. Population contributions of life history variations in juvenile Chinook salmon. Presented at the 2007 annual meeting of the Idaho Chapter American Fisheries Society. February 21-23, 2007, Boise, Idaho.

Copeland, T., and J. White. Salmon aging! which method to use: scales? fin rays? both? Presented at Nez Perce Tribe 11th annual spawning ground workshop. August 7-8, 2007. McCall, Idaho.

Venditti, D.A., T. Copeland, and J. Johnson. Idaho Department of Fish and Game annual spawning ground survey workshop. August 14-15, 2007. Stanley, Idaho.

Copeland, T., and D.A. Venditti. Contribution to smolt production by life history types in a Chinook salmon population. Presented at the 137th annual meeting of the American Fisheries Society. September 2-6, 2007. San Francisco, California.

Copeland, T. Life history and salmon conservation. Lecture delivered to University of Idaho Fish Ecology class, October 16, 2007. Moscow, Idaho.

Copeland, T. Viability of natural populations: data types and collection efforts. Presented at the Idaho Department of Fish and Game Anadromous Section meeting. January 28-31, 2008.

Publications

Copeland, T., M. W. Hyatt, and J. Johnson. 2007. Comparison of methods used to age spring/summer chinook salmon in Idaho: validation and simulated effects on estimated age composition. North American Journal of Fisheries Management 27:1393-1401. http://afs.allenpress.com/perlserv/?request=get-abstract&doi=10.1577%2FM06-080.1

Data management

These activities were largely directed at the Standard Stream Survey Database (SSS); formerly known as the General Parr Monitoring Database. Core data management components include collection, quality control, storage, retrieval, dissemination, and archiving.

Data Collection:

1. Data Entry using a Microsoft (MS) Visual Basic.net stand-alone program packaged in a MSI file for easy download and installation on domain networked PC's or laptops.
2. The program is also available to IDFG personnel in a web application at work or in the field via the departments Citrix server.

Quality Control:

1. Tighter constraints and validation procedures were instituted on entry fields to reduce typing errors and ensure accurate data entry.
2. More standardized pick lists were applied for better data consistency.
3. All additions, edits and deletions are date- and time-stamped along with the corresponding username.
4. Ongoing routine maintenance on server with service packs and updates being applied to both MS SQL server 2000 and MS server 2003 software.

Appendix A. Continued.

Storage:

1. Larger Storage space, 500 Gigabyte NTFS formatted hard drive to handle the increased volume of data associated with attached photos and files.
2. Broadband network speeds were increased by better hardware/software configuration on the IDFG domain T1 line.

Retrieval:

1. Customized queries and report builder using a SQL server linked MS Access interface template.
2. A Sharepoint collaborative meeting space on the Natural Production Monitoring (NPM) research intranet was created for help with technical issues and other SSS database related items. The site contains a discussion board, support portal with E-mail alerts and a file library to house application downloads and associated electronic documentation.

Dissemination:

1. Seventeen "canned" reports were added to the MS SQL report server. All data and reports can be exported in standard formats.
2. Most external data requests are handled by IDFG personnel by phone or E-mail, but access is available using a temporary issued username and password through the department's Citrix server.
3. Use varies with increases at the end of the field season and during the reporting off-season. Common uses both from within and outside IDFG include:
    - Storage of survey data in a centralized repository.
    - Trends in population structure and habitat change for inter-stream comparison.
    - Public inquiries on specific streams.
    - Species presence/absence reporting.
    - Abundance and presence/absence information for habitat restoration projects.
    - Aids to management planning and policy decisions.
    - Fish density data for sub-basin planning.
4. Data were posted on StreamNet. These include updates to the Generalized Fish Distribution in Idaho and posting of the 2000-2006 General Parr Monitoring data. http://www.streamnet.org/online-data/ids.cfm?id=123&keywords=

Data Archiving and Backups:

1. Daily and monthly scheduled backup are performed on all SSS data and associated tables.
2. Offsite archiving for catastrophic failures.
3. Complete logging of every database transaction with the ability to roll back the database to any point in time.

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