FISHERY RESEARCH

IDAHO NATURAL PRODUCTION MONITORING AND EVALUATION

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IDAHO NATURAL PRODUCTION MONITORING AND EVALUATION

Project Progress Report

2008 Annual Report

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Part 4—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 (1988) documented some improvements in survival through the early 1980s, anadromous populations remained depressed and declined even further during the 1990s (Good et al. 2005). The effect was deleterious for 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 a mechanistic 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. Describe the 2008 adult escapement and age composition 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 the 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 2008. 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 2008 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 2008 (e.g., professional presentations) are also summarized in the Appendix. Finally, we summarize the data collected during 2008 that are applicable to the Viable Salmonid criteria (McElhany et al. 2000) for each spring/summer Chinook salmon (Table A1) and steelhead population (Table A2) in Idaho.

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PART 2—AGE COMPOSITION AND SMOLT-TO-ADULT RETURN RATES OF WILD ADULT SPRING/SUMMER CHINOOK SALMON IN THE SNAKE RIVER BASIN IN 2008

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 collected fin rays from carcasses to estimate age composition of the 2008 spawning run. The resulting age-length key was applied to the length frequency distribution at Lower Granite Dam to estimate the age composition. These data were combined with previously collected data to estimate smolt-to-adult return (SAR) rates. Of fish returning in 2008, we estimate 15.7% (2,551 fish) were one-ocean, 70.5% (11,483 fish) were two-ocean, 13.4% (2,188 fish) were three-ocean, and 0.5% (74 fish) were four-ocean. All adults have returned from the ocean for smolt years (SY) 1996 to 2004. Returns for SY 2005-2007 are still incomplete. The SAR rate to the dam for SY 2003 was 0.62%—the lowest since SY 1996. The SAR rate for SY 2004 was the second lowest (0.74%). We assigned ages to 648 fish based on scales collected at Lower Granite Dam and compared them to the 1,079 fish ages based on fin rays collected at spawning grounds. The two methods produced similar results. Accuracy continued to be very high for aging fin rays (95.3%) and scales (97.2%).

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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). Inadequate numbers of adults with passive integrated transponders (PIT tags) return to Idaho to accurately assess age composition; therefore, in 1998, this project began to collect fin rays from carcasses to determine ocean ages. The original motivation to use fin rays was the mismatch of carcass scale ages compared to known ocean ages of fish PIT-tagged as juveniles. Ocean ages based on fin rays have been >94% accurate in any given year based on known-age adults (Kiefer et al. 2001, 2002, 2004; Copeland et al. 2004, 2005, 2006, 2007b, 2008). 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; furthermore, 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 resorbs, resulting in the loss of annuli on the periphery of some scales. Accurate age determination is difficult for salmon with long spawning migrations (Chilton and Bilton 1986), such as those of Snake River salmon stocks. Further, 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 (NOAA Fisheries) personnel have been systematically sampling adult Chinook as they migrate upstream past Lower Granite Dam (Harmon 2009). Since 2006, we have investigated if scales collected at Lower Granite Dam can be used to estimate ages accurately for management purposes. Thus far, results have been encouraging (Copeland et al 2007b, 2008).

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 2008. We also compared 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 2008 to age categories and calculated SAR rates. There are now four years of scale collections from Lower Granite Dam (2005-2008). We conducted a formal comparison of data derived from the two aging structures.

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 86 known-age samples to estimate aging accuracy in 2008. 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.

Adult Chinook were systematically sampled at Lower Granite Dam by NOAA Fisheries personnel between April 14 and August 4 (Harmon 2009). When the trap is in operation, a gate rotates across the ladder to block upstream passage four times each hour. The sample rate in 2008 was 4%. Fish collected in the trap were measured to fork length (FL, nearest cm) and scales collected from an area just above the lateral line and slightly behind the dorsal fin. Hatchery fish were distinguished by either a clipped adipose fin or presence of a coded wire tag. We used scales collected from PIT-tagged wild/natural and hatchery fish trapped 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 not ageable. 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 samples to train readers and to help interpret hard-to-read fin rays and scales. This reference collection is comprised of Chinook tagged as juveniles with PIT tags or coded-wire tags (CWTs) and recovered as returning adults. Personnel were trained with reference samples, were tested, and had to have a 90% accuracy rate before they were allowed to proceed with reading current-year samples.

Ages were also assigned based on scale pattern analysis. Eight nonregenerated 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. The criteria for an annulus were the crowding of circuli outside of the check for ocean entry. Freshwater age was also determined, but only three samples were aged as other than 1-freshwater so only ocean ages are reported here. 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 run was based on lengths measured at Lower Granite Dam when scales were systematically sampled (Harmon 2009). Fish with a full adipose fin were assumed to be of natural origin. Chinook salmon missing all or part of the adipose fin, with a ventral clip, or that had a coded wire tag 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 spring/summer Chinook salmon passing Lower Granite Dam:

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

where n_j is the number of fish at ocean age j and N is the total escapement estimate. This gave the total escapement N. Hatchery fish were determined from their proportion in the total scale sample and subtracted from N. Total number of spring/summer Chinook was obtained from the Fish Passage Center web site (www.fpc.org).

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.

Comparison of Scale and Fin Ray Data

We conducted a comparison of the scale and fin ray data in two ways. In the first comparison, we expanded the ages from the scale sample to the run at large for 2005-2008 and used the data to estimate SAR values with accompanying 95% confidence intervals as above. We looked for overlap in the confidence intervals and any consistent differences. The scale sample ages were expanded to the overall run as recommended by Quinn and Deriso (1999) for simple random sampling. Using the notation from the previous section, this is

$$n_j = Na_j$$

where

$$a_j = \frac{m_j}{M}.$$

Note that the proportions a_j are determined from the scale sample without reference to length.

Next, we compared the variability in age assignments using only the 2008 data. The following equations are also from Quinn and Deriso (1999). The variance of the proportion at age determined using the scale sample is

$$Var(a_j) = a_j(1 - a_j)/M$$

and the standard error of number at age is

$$SE(n_j) = \sqrt{N^2 Var(a_j)}.$$

For the fin ray sample, the variance of the proportion at age is determined according to the two-stage variance estimator

$$Var(a_j) = \sum_{i=1}^{I} \frac{p_i^2 a_{ij}(1 - a_{ij})}{f_i - 1} + \sum_{i=1}^{I} \frac{p_i (a_{ij} - a_j)^2}{N}$$

and the standard error of number at age is the same as for the scale sample. Using standard errors puts the variability comparison on the same scale as abundance and is approximately half the width of a 95% confidence interval.

RESULTS

Fin Ray Aging, Age Composition, and SAR Rate

We examined fin rays from 1,125 wild/natural Chinook carcasses collected on spawning grounds in 2008. Ages could not be determined for 46 fish, leaving a final sample of 1,079 fish. Chinook with a fork length <45 cm were eliminated, because they might be minijacks that never emigrated to the ocean.

A total of 86 known-age fish were collected, of which 82 fish or 95.3% were aged correctly. Of the known-age validation sample, there were 16 one-ocean fish, 59 two-ocean fish, and 11 three-ocean fish.

In the aggregate, 6.8% of the carcasses were one-ocean, 64.4% were two-ocean, 27.8% were three-ocean, and 0.9% were four-ocean fish (Table 1). 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-ocean fish were 81 cm. The length distribution of three-ocean fish was bimodal with peaks at 88 cm and 93 cm. The length distribution of four-ocean fish was encompassed within that of three-ocean fish.

We estimated there were 16,296 unclipped, non-CWT Chinook returning in 2008. The age-length key from the fin ray samples (Table 1) was applied to the length frequency of these fish. Three fish were added to the >104 cm group because no fish this size were collected at Lower Granite Dam and the average number in this group was 56% of the 100 cm group (J. Johnson, unreported data). We estimated that the age composition of wild Chinook crossing Lower Granite Dam was 15.7% (2,551) one-ocean fish, 70.5% (11,483) two-ocean fish, 13.4% (2,188) three-ocean fish, and 0.5% (74) four-ocean fish. Smolt-to-adult return rates are complete for smolt cohorts through SY 2004 (Table 2). Returns for SY 2005-2007 are still incomplete. The SAR rate for smolts that went to sea in SY 2004, the last year for which all adults had returned in 2008, was 0.74%. Note that we updated Table 2 to reflect the current method of determining numbers of wild fish (applying the Lower Granite Dam hatchery:wild ratio to the total count from the Fish Passage Center). This has changed SAR values slightly from those reported previously for SYs 2002-2005.

Lower Granite Dam Scale Aging Evaluation

We examined scales from 775 adult Chinook sampled at Lower Granite Dam in 2008. There were 88 unclipped fish with coded wire tags that were dropped from the analysis. Ages could not be determined for 39 fish, and five fish were eliminated from the sample because their FL was <45 cm, leaving a final sample size of 643 fish.

We examined 106 hatchery and wild/natural known-age fish. Of those, 103 were aged correctly for an overall accuracy rate of 97.2%. Of the known-age validation sample, there were 19 one-ocean fish, 86 two-ocean fish, and two three-ocean fish. No known-age four-ocean fish were collected.

There was a single peak in the length distribution of 80 cm for two-ocean fish and dual peaks of 89 cm and 93 cm for three-ocean fish (Figure 3). There is more overlap in length among the age groups when looking at data derived from the scale sample. No fish >105 cm were collected at Lower Granite Dam, compared to 23 from the spawning ground samples.

Two-ocean fish comprised the majority of each year's return except for 2007 (Table 3). Note that we determined the proportion of unmarked, non-CWT fish directly from the scale sample in all years, which was not previously done for the 2005 return. The point estimates of SAR computed were all <2.00% (Table 4). Confidence intervals of all SAR values derived from scale data overlapped those of the respective values derived from fin ray data. In the comparison of 2008 age assignments, variability was similar (Table 5). The largest difference was in the three-ocean category. In relative terms, the standard errors were <10% of the mean abundance for both methodologies except for the least abundant group, the four-ocean fish.

DISCUSSION

Survival of wild Chinook salmon cohorts from upstream of Lower Granite Dam has continued to decline since SY 1999. The estimated survival of Chinook smolts from emigration past Lower Granite Dam in 2004 to their return for spawning (0.74%) was the second lowest since SY 1996, with only 2003 being lower. Returns for 2005-2007 are not yet complete. The low SAR for SY 2005 (0.38%) will change little because only four-ocean returns remain from this cohort. These estimates are in the low portion of the range of SAR rates from SY 1996-2004 (0.31-3.70%), the years for which we have accurate fin ray aging data. In general, an SAR of 2% is needed to stabilize Snake River spring/summer Chinook salmon populations at current abundances (Marmorek et al. 1996). That level has only been reached in three of the nine years with completed returns, and it is highly improbable that SY 2005 will reach this mark.

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. The scale age expansions given here have only been presented in figures (2006-2007) or not at all (2005) in prior project reports. This report contains the first full accounting of them. Overall, the age composition based on scales from Lower Granite Dam is similar to that determined from the carcass samples.

Each aging method has its advantages and disadvantages. In order to guide future monitoring, the trade-offs inherent in each method must be evaluated. The advantages of using scales collected at Lower Granite Dam include speed of analysis for managers and perceived

avoidance of any size bias in the collection based on the manner in which the fish are collected. Although accuracy of scale-based ages was comparable to fin rays in 2008 based on known-age PIT-tagged Chinook (97.2% vs. 95.3%). The fin ray sample is likely biased in two ways. First, there may be a size bias in the carcass sample because it is harder to locate smaller fish (Zhou 2002). But a more likely source of bias is generated by uneven sampling across populations. One of the basic assumptions is that the aged sample is a random subsample drawn from the length frequency sample (Quinn and Deriso 1999). Biases can result from drawing completely separate samples rather than true subsampling (Westrheim and Ricker 1978). An age-length key will give biased results if the age composition differs from that of the population from which it was drawn (Kimura 1977). Some populations may have greater weight in the carcass sample because more effort was expended to collect samples there or it was easier to find carcasses in some places. For example, the Lower Main Salmon population has a different age composition from others (Copeland et al., unpublished data) and we have targeted this population in the last two years. Bias will also result if there is significant size-selective prespawn mortality.

In contrast, the scale sample may also be size-biased. Although, sampling conducted at Lower Granite Dam is systematic and therefore unbiased in regards to the aggregate run, collection at the Lower Granite Dam trap missed the largest salmon in 2008. The largest Chinook salmon measured on the spawning grounds was 116 cm and there were 33 Chinook >102 cm sampled on the spawning grounds (3.1% of all carcasses collected). The largest length measured at Lower Granite Dam was 102 cm. We noted the same results in 2006 and 2007 (Copeland et. al. 2007b, Copeland et. al. 2008). Conceivably, size differences may be somewhat explained by kype development on the spawning grounds and relaxation of muscles and spine after death, but these explanations do not account for the entire magnitude of differences between samples. A final point worth noting was that we added to the longest length group because, although 2.1% of the carcasses were this size, none were collected at Lower Granite Dam. If these older, rarer fish are important to survey objectives, the age-length key approach is preferred (Smith 1989). More effort should then be devoted to sampling length groups in which these fish may be present, but that is not feasible at Lower Granite Dam. In any case, the age-length key approach was robust to differences in collection selectivity even though it was computationally inefficient (Westrheim and Ricker 1978; Morton and Bravington 2008).

The evaluation of the two methodologies showed that the age composition and SAR values estimated were similar. Further, variances in age composition were also similar. We expected the fin-ray methodology to be less precise because of the requirement that all age-length combinations in the key matrix must be estimated: 52 combinations versus four for the scale methodology. The inferential power of the data was similar regardless of the model in which it is imbedded (Morton and Bravington 2008) and previous work showed that the two methodologies can generate equivalent results (Smith 1989).

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 potentially biased to some degree. Scale processing is quicker, more cost-efficient, and generates approximately unbiased data. Although scale-aging procedures can be improved, we conclude that scale sampling at Lower Granite Dam produces equivalent information to the fin ray sampling and should be used to monitor all populations in aggregate.

Sampling for fin rays will continue as needed, e.g., the Idaho Supplementation Studies has requested population-specific age composition for their study streams.

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 2009:

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. This evaluation was started in 2008 but has not been completed.

2. Continue to collect and analyze scales from Lower Granite Dam. Use these data to estimate aggregate SAR values for this report.

3. Expand the known-age reference collection. In particular, increase number of known age three-ocean fish collected at Lower Granite Dam. For example, in 2008, only two three-ocean Chinook were collected out of 107 known-age samples, whereas 20% of the scale sample was that age. If necessary, use past years known-age fish to check accuracy of aging.

4. Identify where population-specific age data is needed and focus fin ray collections there. For example, Idaho Supplementation Studies needs to estimate adult productivity for each of their study streams, using ages derived from the spawning grounds.

5. Address Viable Salmonid Population criteria. ICTRT population designations???

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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 2008. Ages were based on fin rays.

Fork Length group (cm)	1 Ocean	2 Ocean	3 Ocean	4 Ocean
<50	1.00	0.00	0.00	0.00
50-54	1.00	0.00	0.00	0.00
55-59	0.97	0.03	0.00	0.00
60-64	0.67	0.33	0.00	0.00
65-69	0.09	0.91	0.00	0.00
70-74	0.01	0.98	0.01	0.00
75-79	0.01	0.94	0.04	0.00
80-84	0.01	0.91	0.08	0.01
85-89	0.01	0.45	0.53	0.01
90-94	0.00	0.16	0.82	0.02
95-99	0.00	0.04	0.94	0.02
100-104	0.00	0.00	0.95	0.05
>104	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 1997-2007. 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	94	1.85 (1.82-1.89)
2002	1,128,582	2,309	18,364	2,350	14	2.04 (2.02-2.07)
2003	1,455,786	1,276	6,056	1,519	154	0.62 (0.61-0.63)
2004	1,517,951	635	7,173	3,415	74	0.74 (0.73-0.76)
2005	1,734,464	312	4,007	2,188	[b]	0.38 (0.37-0.38)
2006	1,227,474	1,246	11,483	[b]	[b]	1.04 (1.02-1.06)
2007	787,150	2,551	[b]	[b]	[b]	0.32 (0.31-0.34)

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

Table 3. Number of wild Chinook at age as determined from the Lower Granite Dam scale sample for return years 2005 to 2008.

	Return year			
Age	**2005**	**2006**	**2007**	**2008**
1-ocean	394	282	1,123	2,314
2-ocean	5,911	6,812	3,789	11,266
3-ocean	2,776	1,899	3,901	2,691
4-ocean	54	25	10	25

Table 4. 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 determined from scale samples taken at Lower Granite Dam. The 95% confidence intervals are in parentheses.

Smolt Year	Smolts	One Ocean	Two Ocean	Three Ocean	Four Ocean	SAR (%)
2004	1,517,951	394	6,812	3,901	25	0.73 (0.72-0.75)
2005	1,734,464	282	3,789	2,691	[a]	0.39 (0.38-0.40)
2006	1,227,474	1,123	11,266	[a]	[a]	1.01 (0.99-1.03)
2007	787,150	2,314	[a]	[a]	[a]	0.29 (0.28-0.31)

[a] Adult return of cohort is incomplete.

Table 5. Comparison of variability in age assignments made from scale and fin ray data. Proportion (p) and number at each age are given with variance of proportion (Var(p)) and standard error (SE) for each age group and method.

	Ages from scales				Ages from fin rays			
	1-ocean	**2-ocean**	**3-ocean**	**4-ocean**	**1-ocean**	**2-ocean**	**3-ocean**	**4-ocean**
p	0.142	0.691	0.165	0.002	0.157	0.705	0.134	0.005
Var (p)	1.63×10^{-4}	3.26×10^{-4}	2.39×10^{-4}	2.14×10^{-6}	2.01×10^{-4}	2.78×10^{-4}	7.45×10^{-5}	2.75×10^{-6}
Number	2,314	11,266	2,691	25	2,551	11,483	2,188	74
SE	208	294	252	24	231	272	141	27

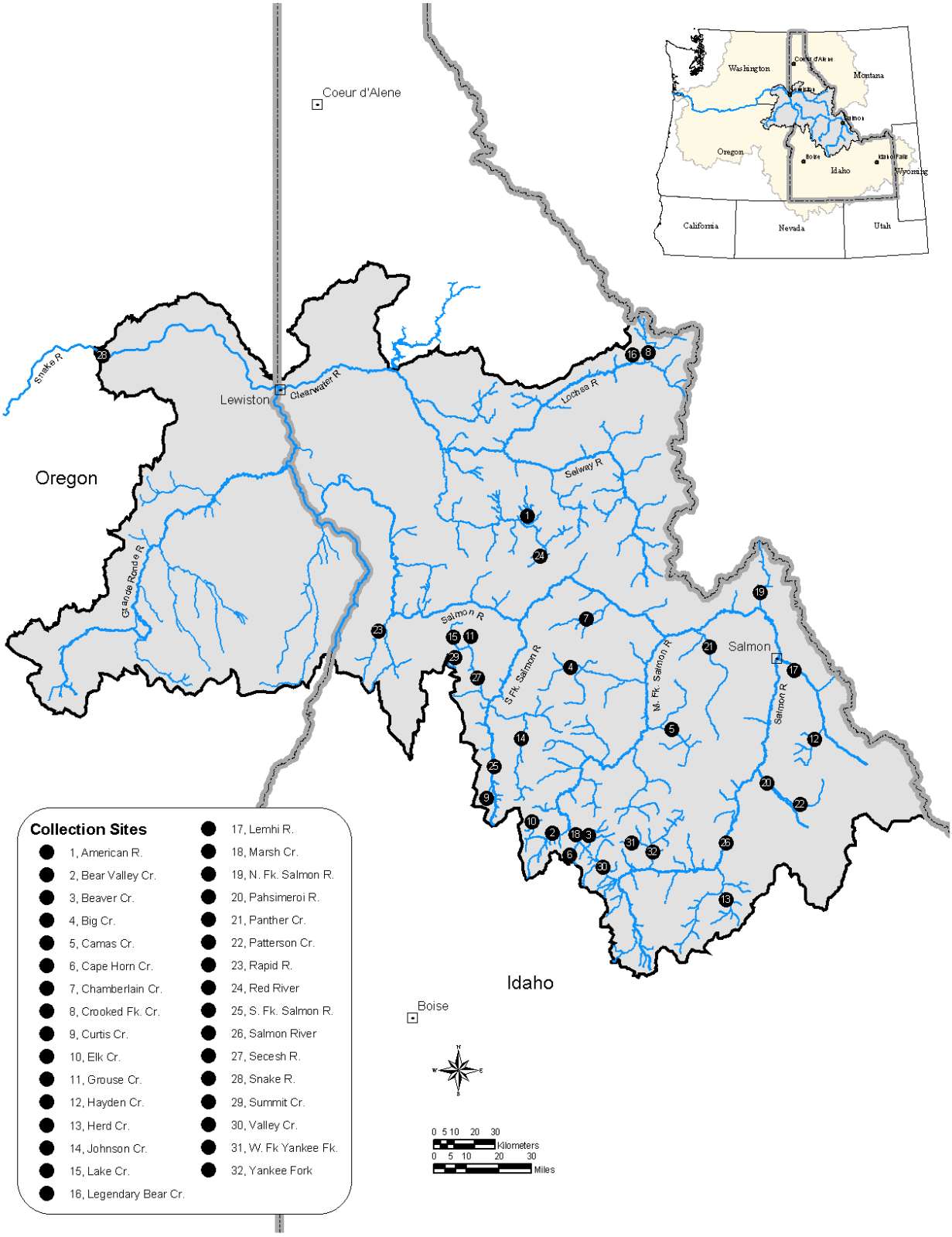

Figure 1. Location of sites where wild spring/summer Chinook salmon carcasses were collected in 2008.

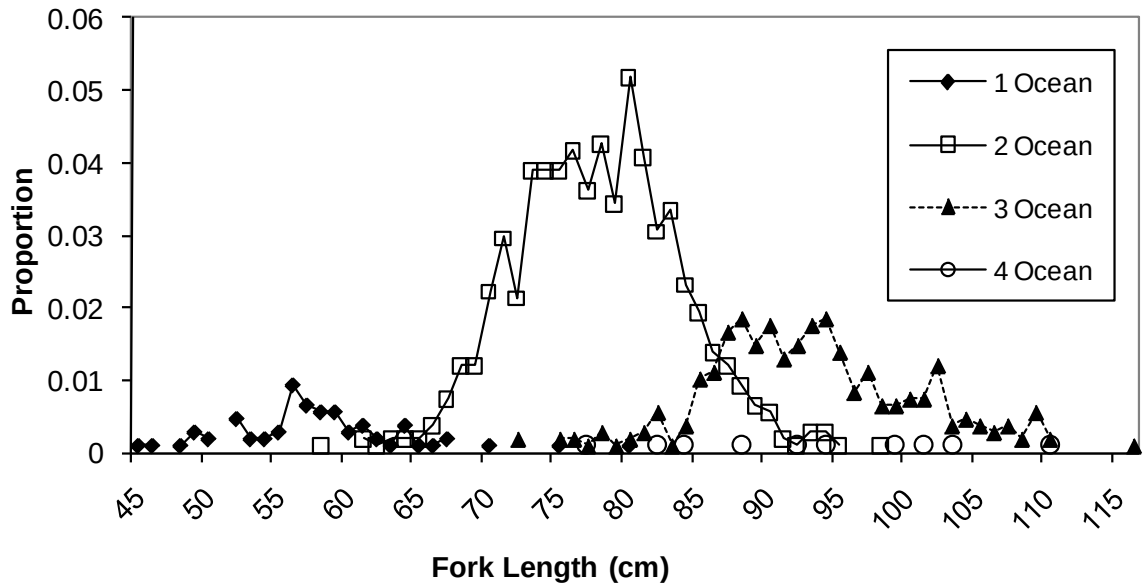

Figure 2. Length distribution by ocean age of wild Snake River spring/summer Chinook salmon carcasses collected on the spawning grounds in 2008. Ages were determined from fin rays (n = 1,079).

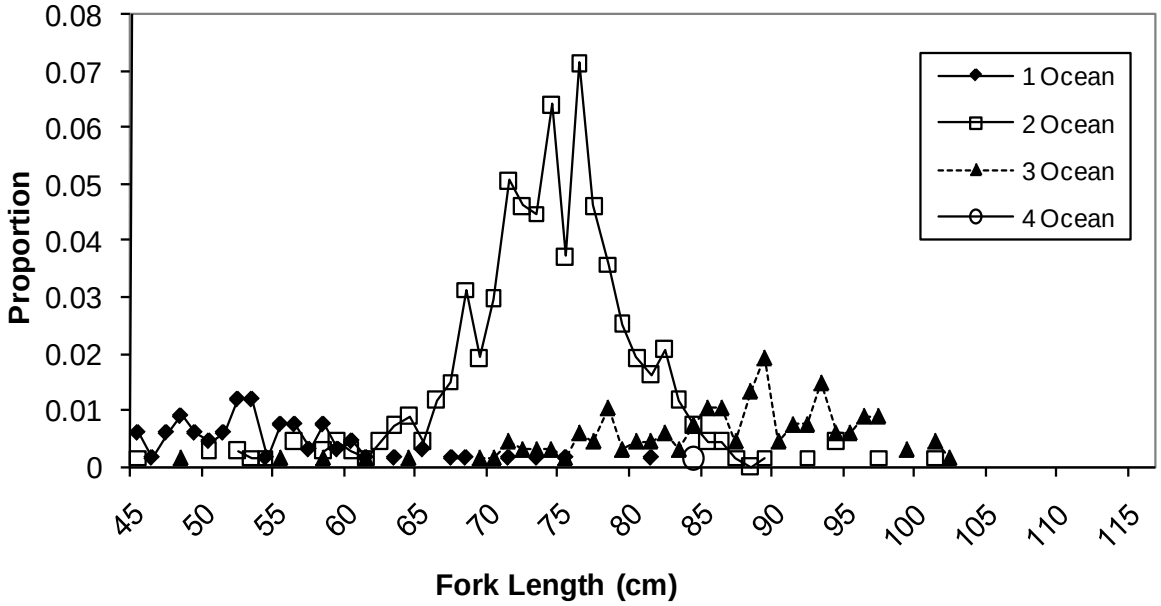

Figure 3. Length distribution by ocean age of wild Snake River spring/summer Chinook salmon collected at Lower Granite Dam in 2008. Ages were determined from scales (n = 672).

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 1990-2005 versus the number of smolts produced. Here, I updated the Beverton-Holt stock-recruit model with data from the 2006 brood year. The number of females available for natural reproduction in 2006 was 9,253 fish. I estimated that 856,556 naturally produced smolts from the 2006 brood year passed Lower Granite Dam. Based on data from the 1990–2006 brood years, I computed intrinsic productivity to be 432.5 smolts per female and asymptotic production to be 1.61 million smolts, as estimated by nonlinear fit (r^2 = 0.933, n = 17). I further estimated the number of females naturally reproducing was 8,562 fish in 2007 and 19,823 fish in 2008. Given that number of female parents, 1,119,758 naturally produced smolts should pass Lower Granite Dam in 2009 and 1,352,008 smolts in 2010.

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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). 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, 2008). 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. I also 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 2008 was obtained directly from the Fish Passage Center web site (www.fpc.org, accessed March 2009). 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 (Joseph Feldhaus, 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 (Chris Peery, University of Idaho, personal communication). 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 2008 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 2008, excluding jacks, was 72,758 fish (Table 6). Females comprised 56% of the adults. Estimated losses of females above Lower Granite Dam totaled 21,363 individuals

in 2008. Subtraction yielded a FANR estimate of 19,823 females. This figure accounts for estimated harvest by the Nez Perce Tribe but not by the Shoshone-Bannock Tribes.

The estimated number of smolts exiting the system via Lower Granite Dam during smolt year 2008 was 856,556 fish (Table 7). This estimate covers the period March 26 to July 15, 2008. The smolt estimate from SY 2008 completed the data set for the 1990-2006 brood years.

The Beverton-Holt model fit the data very well (Figure 4, r^2 = 0.933, n = 17). For the 1990–2006 brood years, intrinsic productivity was 432.5 smolts per female and asymptotic production was 1.61 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 17 pairs of estimates. The 2008 smolt migration (BY 2006) was only slightly larger than from last year (BY 2005) and was the second lowest smolt emigration since 2001 (BY 1999). However, both recent data points are within the outer envelope of the previous data. Note that smolt collection efficiencies have again been updated by Steve Smith (NWFSC) for BYs 2000-2005. For BY 2005, this meant an addition of 1,795 fish to last year's estimate but this was only 0.1%. Other adjustments were less.

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, 2008). The model tended to over-predict at low abundances and under-predict 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 2007 and BY 2008 in the Beverton-Holt model yielded a prediction of 1,119,758 smolts and 1,352,008 smolts, respectively. Assuming a 1:1 sex ratio, the smolt-to-adult return rate would have to be 1.53% and 2.93%, 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 BY 2008 will meet replacement. Replacement may be achievable for BY 2007 but that likely will be a small cohort.

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.

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Table 6. Estimated returns to Lower Granite Dam, percentage of females, losses to harvest and hatcheries, escapement, and females available for natural reproduction (FANR) for 2008. Actual hatchery take was adjusted by 20% and harvest by 10% to account for migratory losses.

	Run type	
Estimate	**Spring**	**Summer**
Dam count	50,146	22,612
% females	56.7	56.4
Females (#)	28,433	12,753
Hatchery	7,110	2,721
Harvest	9,123	2,409
Escapement	6,213	7,623
Total FANR	19,823	

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	1,128,582
2001	51,902	1,455,786
2002	31,415	1,517,951
2003	26,126	1,734,464
2004	28,374	1,227,474
2005	10,899	787,150
2006	9,253	856,556
2007	8,562	*1,119,758*[a]
2008	19,823	*1,352,008*[a]

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

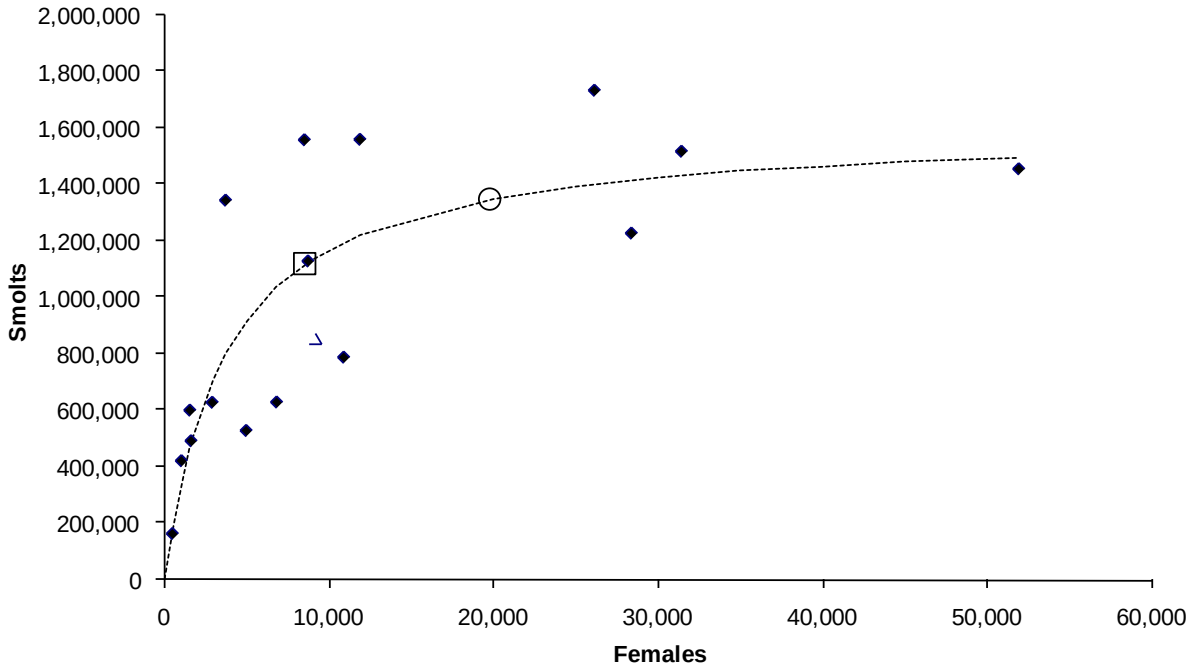

Figure 4. Comparison of observed data (BY 1990 to BY 2005) to model predictions for the Beverton Holt model. Observed data are filled diamonds. The BY 2006 point is a hollow triangle. The predictions for BY 2007 and BY 2008 are the hollow square and hollow circle, respectively.

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 summarized parr densities of steelhead trout *Oncorhynchus mykiss*, Chinook salmon *O. tshawytscha*, and other salmonids observed while snorkeling in 2008. We continued to use a rotating panel design and a protocol to assess crew efficiency. There were three types of sites: annual surveys (intensive watersheds), occasional surveys (extensive watersheds), and historic trend surveys. Sites for the first two panels were chosen using a probabilistic system from all potential sites within the anadromous waters of the target watersheds. Intensive watersheds surveyed in 2008 included Crooked Fork Creek, Crooked River, Marsh Creek, Pahsimeroi River, and Secesh River. We set a minimum of 115 sites for this panel and crews surveyed 109 sites. Extensive watersheds included the upper Selway River, Rapid River (Middle Fork Salmon River tributary), Big Creek, and Potlatch River. We set a minimum of 136 sites for this panel and crews surveyed 117 sites. Mean density of steelhead parr was greatest in the Potlatch River watershed (3.44 fish/100 m^2) and lowest in the Marsh Creek drainage (0.42 fish/100 m^2). Mean density of Chinook salmon was greatest in the Secesh River drainage (2.34 fish/100 m^2) and lowest in Rapid River (0.02 fish/100 m^2). No Chinook were observed in the Potlatch River drainage. Snorkel crews also surveyed 38 and 44 historic trend sites in the Salmon and Clearwater river drainages, respectively. Mark-resight studies were conducted at 35 sites to assess probability of detection for steelhead. Median crew efficiency was 31.1%, although there was great variability (range 0.0% - 76.5%).

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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 has 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).

To be more consistent with current survey design methodologies, 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 trends 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 2008. The data presented are summaries of salmonid densities observed. Formal quantitative analyses were not undertaken for this report.

METHODS

Planning took place during January 10-11, 2008. For the intensive panel, we chose Crooked Fork Creek and Crooked River in the Clearwater River subbasin; in the Salmon River subbasin, we chose Secesh River, Marsh Creek, and Pahsimeroi River. For the extensive panel, we chose the Selway River, Rapid River (Middle Fork Salmon River [MFSR] tributary), Big Creek, and Potlatch River. Regional biologists listed sites they desired to retain from the historical group, which were essentially the same as in 2007. We assigned effort in the target watersheds in excess of minimum sample sizes computed from power analyses of 2007 data (Copeland et al. 2008) and our experiences of how many sites could be done given watershed character and size. Forty sites were assigned to each large extensive watershed (Big Creek, Selway River, Potlatch River). Big Creek was partitioned into three geographic sections for surveying: upper Big Creek, including tributaries from the headwaters to Monumental Creek; Monumental Creek including tributaries, Crooked Creek, and nearby Big Creek Sites; and lower Big Creek, including tributaries downstream from Monumental Creek. We determined that each section was feasible for survey by a five- to six-person crew in an eight-day shift. Similarly, the Selway River was divided into thirds and the upper portion (upstream of and including Bear Creek) was surveyed. We realized that 40 sites was likely an optimistic goal for this watershed. The intensive watersheds and Rapid River (MFSR) were assigned desired sample sizes of either 20 or 25 (140 total). For Marsh Creek, Crooked River, and Crooked Fork, all sites surveyed during 2007 were visited again, along with enough new sites to round out a sample size of 25.

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 study watersheds. 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 *Oncorhynchus mykiss*; 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.

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.

We evaluated the efficiency of the crews at detecting juvenile steelhead 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 (by angling), measured, marked (caudal notch), and released within the selected site. The next day, snorkeling began approximately 50 m downstream of the main transect and number of 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 and recorded by length group. Finally, a section approximately 50 m in length upstream of the main section was snorkeled and number of marked fish was 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 summary of data collected at each site. Crew efficiency was computed as the number of marked fish seen in the target and oversample reaches divided by number marked.

RESULTS

Because of high and sustained snowmelt, not all planned surveys were completed. The training session occurred in the Potlatch River June 11-16. The surveys planned for June 25—July 2 were cancelled because of unsafe conditions and two crews did additional work in the Potlatch River. Lower Big Creek and Monumental Creek drainages were not done due to fire and time constraints. Crews also conducted additional re-sight surveys to round out their time. Surprisingly, 319 sites were surveyed out of the 325 sites planned. However, not all of the sites actually surveyed were on the planned list.

Intensive Panel Sites

The Pahsimeroi River basin was surveyed June 16–17 using several crews (Table 8). The target was 20 sites. Twenty-nine sites were visited, but only fifteen sites were acceptable to survey. Sites were rejected due to lack of water present in the channel (8), cattle in the river creating low visibility (3), high water levels (2), and a private landowner denied access (1). Six salmonid taxa were identified: trout fry, juvenile steelhead, Chinook salmon parr, bull trout *Salvelinus confluentus*, brook trout *Salvelinus fontinalis*, and mountain whitefish *Prosopium williamsoni*. Average abundance was greatest for brook trout (mean = 1.84 fish/100 m^2). Brook trout were found at seven sites.

The Crooked Fork basin was surveyed July 23—28 (Table 9). The target was 25 sites. A total of 23 sites were surveyed. Two sites were visited but not surveyed due to high water and numerous downfalls, which created unsafe conditions within the site. Five salmonid taxa were identified: juvenile steelhead, Chinook salmon parr and adults, westslope cutthroat trout *Oncorhynchus clarkii lewisi*, bull trout, and mountain whitefish. Hatchery Chinook parr were observed at two sites. Densities were low for all species. Cutthroat trout and steelhead were the

most commonly encountered species; both were observed at almost every site and had similar mean densities (1.51 fish/100 m^2 and 1.08 fish/10 0 m^2, respectively). Mountain whitefish (0.17 fish/100 m^2) were observed at most sites, but in very low numbers.

The Crooked River basin was surveyed July 10—15 (Table 10). The target was 25 sites. A total of 24 sites were surveyed. All sites that were visited were surveyed. Six salmonid taxa were identified: trout fry, steelhead juveniles, Chinook salmon parr and adults, cutthroat trout, bull trout, brook trout, and mountain whitefish. Cutthroat trout (mean = 2.32 fish/100 m^2) and steelhead (1.32 fish/100 m^2) were present throughout the watershed and were the most abundant taxa. Bull trout (0.24 fish/100 m^2) were observed primarily in the tributaries. Hatchery Chinook and hatchery steelhead were observed at one and two sites, respectively.

The Marsh Creek basin was surveyed July 16—28 (Table 11). The target was 25 sites. Twenty-seven sites were sampled. Seven salmonid taxa were identified: trout fry, juvenile steelhead, Chinook salmon parr, cutthroat trout, bull trout, brook trout, and mountain whitefish. Average abundance was greatest for Chinook salmon (mean = 1.95 fish/100 m^2). Brook trout were found at 13 sites. Hybrids between brook and bull trout were observed at three sites.

The Secesh River basin was surveyed August 6-17 (Table 12). Rainstorms and associated turbidity contributed to this protracted 12-day survey period. The target was 20 sites. Nineteen sites were surveyed. One site was upstream of fish barriers and was not surveyed. Seven salmonid taxa were identified: trout fry, steelhead parr, Chinook salmon parr, cutthroat trout, bull trout, brook trout, and mountain whitefish. Steelhead had a mean density of 1.80 fish/100 m^2, and were observed in all sites except those in Lake Creek and Summit Creek, the two headwater tributaries that form the main Secesh River. Discounting Lake Creek and Summit Creek surveys increased the mean density of steelhead to 2.85 fish/100 m^2. Chinook salmon had a mean density of 2.34 fish/100 m^2. Brook trout had a mean density of 2.14 fish/100 m^2, being skewed by one site in the headwaters of Lake Creek with a very high density of 23 brook trout/100 m^2. Removal of that site reduced mean density of brook trout to 0.98 fish/100 m^2 for the basin.

Extensive Panel Sites

The Potlatch River basin was surveyed June 15—July 1 (Table 13). The target was 40 sites. A total of 56 sites were surveyed. Fifteen sites were visited, but could not be surveyed due to lack of water (14) or poor visibility (1). Five salmonid taxa were identified: trout fry, juvenile steelhead, Chinook salmon parr, cutthroat trout, brook trout, and mountain whitefish. Two cutthroat trout were recorded in the survey. Due to the historical absence of cutthroat trout in the drainage and the inexperience of the field crews early in the season, these observations were likely misidentifications. Steelhead were the most abundant fish observed (mean density = 3.44 fish/100 m^2), and were present in the majority of the sites. Trout fry, which were most likely steelhead, and brook trout were also numerous (mean density = 2.00 fish/100 m^2 and 1.66 fish/100 m^2, respectively). However, both of these taxa were generally observed in high numbers in a small number of transects instead of spread evenly across the drainage. Whitefish (mean density = 0.02 fish/100 m^2) were only observed at four mainstem sites.

The Rapid River (MFSR) basin was sampled on July 21—August 12 (Table 14). The target was 25 sites and 25 were surveyed. Eighteen sites were rejected due to impassable trails to the sites. Seven salmonid taxa were identified: trout fry, juvenile steelhead, Chinook salmon parr, cutthroat trout, bull trout, brook trout, and mountain whitefish. Average abundance was greatest for trout fry (mean = 1.84 fish/100 m^2), but this was due to high densities at one site in

Float Creek. Cutthroat trout had the next highest densities and were present at more sites than any other taxa. Bull trout were also widespread but at low densities.

The Big Creek basin upstream of Monumental Creek was surveyed July 23-30 (Table 15). The target was 31 sites throughout the basin. Only the watershed upstream of Monumental Creek was surveyed. Eighteen sites were visited, of which 13 were surveyed. Three non-surveyed sites were found to have fish barriers downstream, and two had high flow and turbulence that prevented surveying. No mark-resight surveys were conducted in the Big Creek basin in 2008. Seven salmonid taxa were identified: trout fry, steelhead, Chinook salmon parr, cutthroat trout, bull trout, brook trout, and mountain whitefish. Steelhead were observed in all but two sites and comprised the highest mean density across all sites (2.73 fish/100 m^2). Cutthroat trout was the second most abundant species and was observed in all but one site, with a mean density of 1.52 fish/100 m^2. Bull trout were found in seven sites distributed throughout surveyed reaches, and brook trout were found only in one site near the headwaters of Big Creek.

The Selway River basin upstream of Bear Creek was surveyed August 8—September 10 (Table 16). A total of 23 sites were surveyed. Nineteen sites were not surveyed: seven due to fire, three were isolated from other sites, five were inaccessible, and one had no water. Isolated sites were not scheduled for surveys because they were not located near any other sites and it would have taken too much effort to survey those individual sites, as opposed to surveying a group of sites located near each other in the same time period. Inaccessible sites could not be reached during the scheduled survey trip. These sites were located a long way from roads in extremely steep terrain with dense underbrush and no trails. Six salmonid taxa were identified: trout fry, juvenile steelhead, Chinook salmon parr, cutthroat trout, bull trout, and mountain whitefish. Steelhead were the most abundant fish observed, at 2.05 fish/100 m^2. Cutthroat trout were almost as abundant, with 1.43 fish/100 m^2 observed. Both of these species were seen in most sites. Chinook salmon parr (0.83 fish/100 m^2) and mountain whitefish (0.59 fish/100 m^2) were observed almost exclusively in the mainstem Selway River, and Bear Creek and White Cap Creek, the two largest upper drainage tributaries.

Historic Trend Sites

Thirty-eight historic GPM sites were surveyed in the Salmon River basin during 2008 (Table 17). Typically, twenty-nine traditional sites are surveyed in the mainstem of the MFSR. However, personnel were only able to snorkel six of 29 traditional mainstem MFSR transects (July 19-28) before a rain event on the third day of surveys (July 21) resulted in zero visibility below Pungo Creek. Therefore, no MFSR historical transects and no traditional tributary transects were snorkeled in 2008. Four salmonid taxa were identified in the MFSR transects completed: juvenile steelhead, Chinook salmon parr, cutthroat trout, and mountain whitefish. Average abundance was greatest for Chinook salmon (mean density = 3.97 fish/100 m^2) with the highest observed for this species at the Velvet site (mean density = 20.27 fish/100 m^2). No trout fry or brook trout were observed in the MFSR. Four historic GPM sites were surveyed in the Marsh Creek basin during 2008. Seven salmonid taxa were identified: trout fry, juvenile steelhead, Chinook salmon parr, cutthroat trout, bull trout, brook trout, and mountain whitefish. Average abundance was greatest for Chinook salmon (mean = 4.35 fish/100 m^2).Three sites were surveyed in upper Big Creek basin, those with the longest period of surveys. We observed steelhead in all of these mainstem Big Creek sites, with observed density averaging 1.50 fish/100 m^2. Six historic trend sites were surveyed in the Secesh River basin. We observed steelhead parr in four of those sites for an average density of 1.33 fish/100 m^2. Lick Creek had the highest density of steelhead; one site with 7.35 fish/100 m^2 and one site with 7.56 trout fry

/100 m^2. Cutthroat trout were also observed in both Lick Creek sites, so observed trout fry were likely a combination of steelhead and cutthroat trout.

Forty-five historic trend sites were surveyed in the Clearwater River basin (Table 18): 19 in the Selway River basin, 12 in the Potlatch River basin, and 14 in tributaries of the South Fork Clearwater River. An additional five sites in the Selway River basin and two sites in the Lochsa basin were not surveyed due to fires or planning conflicts. Steelhead were found in most of these sites (41 of the 45 surveyed). Chinook salmon were observed in half of the sites, excluding the Potlatch River basin. Brook trout were observed only in the Potlatch and South Fork Clearwater rivers.

Detection Probability

We conducted mark-resight studies at 35 locations to assess detection probability (Table 19). Selected habitat variables were measured at these locations (data not shown). Snorkel crew efficiency in 2008 was variable among sites. Crews marked 843 fish and resighted 341 of them. Only 27 marked fish were observed outside of the main survey unit, 18 of which were downstream. Efficiencies ranged from 0% to 76% (median = 31.1%, interquartile range = 33.7%).

DISCUSSION

Sampling large wilderness watersheds is difficult. Learning how to sample them was one of our objectives. For extensive surveys of large basins, such as Big Creek and the Selway River, it seems that one third of the area reasonably can be surveyed in one field season, given a 40-site target. 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 wilderness basins, some sites will fall in remote areas, isolated from other sites, or in rugged areas with no trail access. In Big Creek, all planned sites were visited and some historic sites completed. But travel to some of the sites was very hazardous and likely a larger percentage of such sites would have been found if the rest of the basin had been surveyed as planned. For example, completion of the surveys of sites in Big Ramey Creek entailed over 12 km of travel off-trail one way, taxing the abilities of even a young, physically capable crew. The scope of the planned upper Selway survey was larger and many sites were not completed, despite the extended survey period. Sites not accessible from established trails tend to be located in deep canyons filled with thick brush. In our judgment, the information gained from surveying such sites (given they could eventually be safely reached, which is not certain) is exceeded by surveying more sites elsewhere. However, even then, travel time to and within the upper Selway militates against surveying 40 sites.

This is the second year that all GPM snorkel surveys were planned and coordinated as a group. The planning exercise facilitates identification of priorities and development of feasible plans to accomplish them. Crews were able to assist one another as conditions changed and reality imposed itself on the planned schedule. Group training also ensures uniformity in methods and increases data quality. We shifted the training session to the Potlatch drainage in 2008 because it is one of the few major basins without a large amount of runoff after May. We were able to use the Pahsimeroi basin as a back-up training location. However, this location is not as desirable because of its isolation and elevation. The crew from Idaho Steelhead Monitoring and Evaluation Studies (ISMES) participated in the training session and the data

collected by them for that effort are reported here. All snorkel crews from the two projects will coordinate in the future.

There was considerable variability in fish densities among sites. However, sites were distributed in a spatially balanced manner (Stevens and Olsen 2004), and samples 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 steelhead density for each watershed. The data were transformed to help control variance ($x' = \log_e[x]$). Sample sizes in 2008 were in excess of the minimum recommended at the 75% level. At the 50% level, minimum sample sizes were not met in the Marsh Creek, Pahsimeroi River, and Secesh River watersheds. In general, this seems to be associated with a percentage of zero observations exceeding one-third of the total. Based on this work, last year's analysis (Copeland et al. 2008), and logistical experiences, we continue to recommend a minimum of 25 sites for the intensive watersheds and others of similar area. Previously, we found that large extensive watersheds appeared well characterized by 40 sites (Copeland et al. 2008). This year's analysis found much less was required for upper Big Creek and the upper Selway River. However, we did not survey all sites planned in those basins, potentially creating a bias in average densities and associated variances. We continue to recommend a minimum of 40 sites for large extensive basins.

In the 2008 planning exercise, we identified Rapid River (MFSR) as a potentially significant source of steelhead production and targeted it for extensive sampling in 2008 (20 sites). Previous work found low densities in the upper Middle Fork Salmon River tributaries (Copeland et al. 2007). However, most of the sites surveyed historically were in tributaries to Bear Valley or Marsh creeks. Most of the habitat in these streams is low gradient and meandering through wide valleys, which is better for Chinook salmon than for steelhead (Scully et al. 1990). Rapid River (MFSR) had not been thoroughly surveyed and was known to harbor juvenile steelhead. During 2008, average steelhead density was more than two times higher in Rapid River compared to the adjacent Marsh Creek watershed. This is evidence that most of the good steelhead habitat in the upper Middle Fork Salmon River has not been adequately surveyed. An additional observation of interest was the occurrence of apparent *O. mykiss X clarkii* hybrids in this watershed (although these were lumped with cutthroat in Table 14). Hybridization is known to occur in other Middle Fork Salmon tributaries (Peterson 2004).

The mark-resight studies found that efficiency was lower in 2008 (median = 31.1%) than in 2007 (2007 median = 56.5%; Copeland et al. 2008). Qualitatively, the increased flows in 2008 caused lower temperatures and reduced visibility, compared to 2007. In 2008, we increased the extent of this work, both in number and habitat types/stream sizes. An effort was made to include low-density sites. The desired number of mark-resight studies was 10% of the total number of sites, which was exceeded. We now have data for 45 mark-resight attempts. Efficiencies were generally higher for surveys with combined higher temperature and visibility. How efficiency is influenced by other habitat variables that were measured has not yet been evaluated. In 2009, we will attempt to repeat resight surveys at a few selected sites over a range of stream temperatures (i.e. mark steelhead parr, then snorkel multiple times the following day at various temperatures to further evaluate the effect of that variable).

RECOMMENDATIONS

Priorities have changed in 2009, although the emphasis is still on steelhead. The top priority is to continue surveys of historic trend sites to allow estimation of juvenile-to-juvenile productivity such as done by Hall-Griswold and Petrosky (2002). This is the top data need for ESA steelhead status assessments. Surveys of selected historic sites will estimate this parameter and also allow tracking of trends in other salmonids. The second priority will be to develop spatial distribution data where distribution concerns were identified by the ICTRT (Interior Columbia Technical Recovery Team) as adding to demographic risk.

1. 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 Potlatch River drainage at the beginning of the field season

2. Field trips will be conducted in the following areas: South Fork Clearwater, Lower/Little Salmon, Lochsa, Secesh/South Fork Salmon, Pahsimeroi/Lemhi, Upper Salmon, Marsh/Bear Valley/Elk, Chamberlain/Salmon Canyon. Survey schedules will maximize the number of historic trend sites with adequate records, defined as at least one survey every five years since 1985. It will be up to the discretion of crew leaders how many and which sites are feasible to survey within the designated field schedule. ISMES personnel will assist in these surveys.

3. For extensive surveys, North Fork Salmon River and Panther Creek steelhead populations have highest priority. We will also continue the extensive survey of the Selway watershed. In 2009, we will focus on the drainage downstream from Moose Creek.

4. Four intensive watersheds will be sampled again in 2008, Crooked River, Crooked Fork, Rapid River, and Fish Creek. The latter two will be surveyed by ISMES personnel.

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

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Table 8. Densities (fish/100 m^2) of salmonids observed at intensive panel sites snorkeled in the Pahsimeroi River drainage, June 16—17, 2008. 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	Bull Trout	Brook Trout	Whitefish	Visibility (m)	Temp (C)
Falls Creek	156847	0.00	0.00	0.00	0.00	0.00	0.00	1.4	9.5
Falls Creek	287919	0.00	0.00	0.00	0.00	0.00	0.00	1.0	9.5
Patterson Cr	204847	0.00	0.00	0.00	0.81	0.00	0.00	3.0	8.0
Patterson Cr	303151	0.00	0.00	0.00	0.28	0.00	0.00	3.0	7.5
Patterson Cr	41007	0.00	0.00	0.00	0.00	0.00	0.00	1.3	5.0
Patterson Cr	17583	6.54	1.34	0.00	0.00	7.43	0.00	1.9	13.0
Patterson Cr	345263	0.00	6.55	0.00	0.00	6.42	0.00	1.9	15.0
Patterson C	214191	0.15	1.82	0.00	0.00	5.61	0.00	2.1	12.0
Patterson Cr	228527	0.26	1.45	0.00	0.00	1.85	0.53	2.1	12.0
Patterson Cr	262831	2.09	3.53	0.32	0.00	5.62	2.09	2.0	13.0
Pahsimeroi R	195759	1.23	0.35	1.23	0.00	0.53	0.35	1.9	14.0
Pahsimeroi R	203951	0.00	1.39	1.04	0.00	0.00	1.74	1.3	11.0
Pahsimeroi R	49839	0.00	2.15	3.89	0.00	0.10	2.35	1.5	11.0
Pahsimeroi R	57519	0.00	0.46	2.76	0.00	0.00	0.20	1.2	11.0
Pahsimeroi R	4271	0.00	0.92	0.40	0.00	0.00	1.72	1.3	12.0
Mean		**0.68**	**1.33**	**0.64**	**0.07**	**1.84**	**0.60**		
SD		**1.73**	**1.77**	**1.18**	**0.22**	**2.84**	**0.88**		

Table 9. Densities (fish/100 m^2) of salmonids observed at intensive panel sites snorkeled in the Crooked Fork Creek drainage, July 23—28, 2008. 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	Bull Trout	Hatchery Chinook	Visibility (m)	Temp (C°)
Crooked Fork	10049	2.28	0.00	4.55	0.00	0.00	0.00	---	11.0
Crooked Fork	12097	0.80	0.42	0.89	0.42	0.00	0.04	3.7	12.0
Brushy Fork	21313	1.28	0.00	0.09	0.09	0.00	0.00	2.4	12.0
Crooked Fork	28481	0.92	0.00	0.71	0.21	0.00	0.00	3.1	11.0
Boulder Creek	34625	6.36	0.00	0.91	0.00	0.00	0.00	6.5	13.0
Crooked Fork	48961	0.12	0.00	2.34	0.00	0.00	0.00	4.8	13.0
Crooked Fork	64321	2.73	0.00	1.36	0.97	0.00	0.25	13.2	13.3
Crooked Fork	67393	0.10	0.00	0.10	0.41	0.00	0.00	8.8	13.3
Crooked Fork	80705	0.00	0.00	9.24	0.00	0.28	0.00	5.7	10.0
Crooked Fork	94017	0.30	0.00	0.04	0.68	0.00	0.00	3.0	9.0
Crooked Fork	97089	1.73	0.26	0.00	0.26	0.00	0.00	9.4	13.3
Brushy Fork	101185	0.00	0.15	0.15	0.30	0.00	0.00	5.6	12.2
Brushy Fork	103233	0.66	0.00	0.06	0.12	0.00	0.00	2.7	10.0
Spruce Creek	111425	0.68	0.00	0.14	0.00	0.00	0.00	2.1	12.0
Brushy Fork	117569	2.72	0.18	2.45	0.09	0.00	0.00	3.6	14.4
Crooked Fork	122689	0.00	0.00	5.60	0.00	0.00	0.00	4.6	11.0
Spruce Creek	123969	0.00	0.00	0.00	0.00	0.00	0.00	4.7	12.0
Crooked Fork	132929	0.95	0.00	0.68	0.14	0.00	0.00	13.0	13.8
Brushy Fork	136001	0.00	0.00	0.05	0.05	0.00	0.00	4.0	8.0
Brushy Fork	150337	1.24	0.00	3.31	0.00	0.28	0.00	4.4	14.0
Crooked Fork	151361	0.98	0.37	0.33	0.05	0.00	0.00	3.9	14.0
Crooked Fork	159553	0.34	0.00	0.09	0.09	0.00	0.00	3.0	10.0
Crooked Fork	165697	0.72	0.00	1.58	0.00	0.14	0.00	3.7	13.0
Mean		**1.08**	**0.06**	**1.51**	**0.17**	**0.03**	**0.01**		
SD		**1.43**	**0.13**	**2.28**	**0.25**	**0.08**	**0.05**		

Table 10. Densities (fish/100 m^2) of salmonids observed at intensive panel sites snorkeled in the Crooked River drainage, July 10—15, 2008. 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	Bull trout	Hatchery Chinook	Hatchery Steelhead	Visibility (m)	Temp (C°)
W Fk Crooked River	236098	0.00	0.00	0.00	0.27	0.00	0.00	0.00	0.00	---	10.0
W Fk Crooked River	105026	0.00	0.25	0.00	0.50	0.00	0.00	0.00	0.00	---	9.0
W Fk Crooked River	170562	0.00	0.00	0.00	1.23	0.00	0.00	0.00	0.00	---	8.0
W Fk Crooked River	244290	0.00	0.21	0.00	3.39	0.00	1.69	0.00	0.00	3.8	9.0
W Fk Crooked River	178754	0.00	0.37	0.00	4.41	0.00	1.40	0.00	0.00	3.3	10.0
E Fk Crooked River	55874	0.00	1.16	0.00	1.16	0.19	0.58	0.00	0.00	1.6	8.0
E Fk Crooked River	219714	0.00	2.14	0.00	0.33	0.49	0.16	0.00	0.00	1.6	8.0
W Fk Crooked River	211522	0.00	0.45	0.00	5.13	0.00	0.22	0.00	0.00	2.0	12.0
W Fk Crooked River	256578	0.00	0.00	0.00	1.09	0.00	0.22	0.00	0.00	2.7	12.5
Crooked River	72258	0.00	1.28	0.00	2.55	0.00	0.85	0.00	0.00	3.7	11.0
Fivemile Creek	14914	0.28	1.70	1.14	0.00	0.00	0.00	0.00	0.00	---	11.0
Fivemile Creek	186946	0.50	1.00	0.00	1.00	0.00	0.25	0.00	0.00	---	10.5
Relief Creek	235074	0.00	0.00	0.00	4.67	0.00	0.00	0.00	0.00	---	8.5
Relief Creek	124482	0.00	1.08	0.00	0.36	0.00	0.00	0.00	0.00	1.8	12.0
Crooked River	214594	0.00	3.99	0.00	0.26	0.13	0.00	0.00	0.39	3.4	9.5
East Fork Relief Creek	247362	0.00	0.00	0.00	1.67	0.00	0.00	0.00	0.00	1.3	11.0
East Fork Relief Creek	157250	0.00	0.00	0.00	22.61	0.00	0.00	0.00	0.00	3.4	11.5
East Fork Relief Creek	58946	0.00	1.32	0.00	1.32	0.00	0.00	0.00	0.00	1.3	9.5
Relief Creek	181826	0.00	2.34	0.33	3.68	0.00	0.00	0.33	0.00	3.3	13.5
Crooked River	50754	0.00	0.44	0.24	0.15	0.05	0.00	0.00	0.00	1.2	10.0
Crooked River	202306	0.42	1.77	0.00	0.00	0.00	0.00	0.00	0.21	2.1	9.0
Crooked River	5698	0.00	0.88	0.44	0.00	0.00	0.00	0.00	0.00	2.9	15.0
Crooked River	73282	0.00	2.50	0.00	0.00	1.11	0.28	0.00	0.00	2.1	13.0
Crooked River	161346	0.00	7.94	0.20	0.00	0.10	0.00	0.00	0.00	1.9	11.0
Crooked River	243266	0.00	1.80	0.00	0.00	0.13	0.00	0.00	0.06	1.1	10.0
Mean		**0.05**	**1.36**	**0.10**	**2.31**	**0.09**	**0.24**	**0.01**	**0.03**		
SD		**0.14**	**1.73**	**0.25**	**4.63**	**0.24**	**0.46**	**0.07**	**0.09**		

Table 11. Densities (fish/100 m^2) of salmonids observed at intensive panel sites snorkeled in the Marsh Creek drainage, July 16 – 28, 2008. 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	Brook/ Bull Hybrid	Visibility (m)	Temp (C)
Knapp Creek	164695	0.00	0.00	0.00	0.00	0.00	0.53	0.00	0.00	4.0	10.0
Knapp Cr	130391	0.34	0.00	0.00	0.00	0.00	2.72	0.00	0.00	3.0	14.0
Knapp Cr	73047	0.40	0.66	0.00	0.00	0.00	3.05	0.00	0.00	3.0	16.0
Knapp Cr	40279	0.92	0.18	0.00	0.00	0.00	1.65	0.00	0.00	2.7	10.0
Knapp Cr	126295	0.46	0.62	1.54	0.00	0.00	1.39	0.00	0.00	3.0	14.0
Knapp Cr	60759	0.41	0.14	0.69	0.00	0.00	1.11	0.00	0.00	3.2	12.0
Bench Cr	101719	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.0	9.0
Swamp Cr	120151	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.0	9.0
Swamp Cr	21847	0.41	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.0	9.5
Marsh Cr	169303	0.28	0.28	3.98	0.00	0.00	0.28	0.57	0.00	2.5	10.0
Camp Cr	56663	0.00	0.00	6.35	0.00	0.00	0.91	0.00	0.00	2.0	9.0
Marsh Cr	89431	0.12	1.29	14.41	0.00	0.00	0.00	0.00	0.00	2.9	14.0
Cape Horn Cr	150871	0.00	1.28	16.64	0.00	0.00	0.80	0.16	0.16	2.7	14.0
Beaver Cr	32111	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.0	9.0
Beaver Cr	97111	0.00	0.00	0.00	0.00	0.63	0.00	0.00	0.00	3.0	9.0
Beaver Cr	83799	0.00	0.00	0.00	0.00	0.21	0.00	0.00	0.00	2.1	9.0
Marsh Cr	105815	0.43	3.83	8.29	0.00	0.11	0.21	1.17	0.11	2.5	14.0
Beaver Cr	15703	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.5	14.0
Beaver Cr	51031	0.19	0.76	0.00	0.19	0.38	0.76	0.00	0.00	3.6	14.0
Unnamed Trib of Winnemucca	141143	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.0	11.0
Winnemucca Cr	123735	0.00	0.00	0.00	0.00	0.54	0.54	0.00	0.00	2.0	12.0
Winnemucca Cr	18263	0.33	0.67	0.00	0.00	0.33	0.00	0.00	0.33	3.0	12.0
Bear Cr	109911	0.00	0.00	0.00	0.00	1.11	0.00	0.00	0.00	3.0	7.0
Beaver Cr	27991	0.00	0.00	0.00	0.00	0.00	0.00	0.57	0.00	3.1	9.5
Beaver Cr	11607	0.00	0.81	0.52	0.00	0.00	0.15	0.07	0.00	3.8	16.0
Lola Cr	60247	0.00	0.31	0.31	0.00	0.62	0.00	0.00	0.00	3.0	10.0
Marsh Cr	125783	0.08	0.46	0.00	0.00	0.00	0.00	1.59	0.00	3.9	9.0
Mean		**0.16**	**0.42**	**1.95**	**0.01**	**0.15**	**0.52**	**0.15**	**0.02**		
SD		**0.23**	**0.79**	**4.43**	**0.04**	**0.28**	**0.83**	**0.39**	**0.07**		

Table 12. Densities (fish/100 m^2) of salmonids observed at intensive panel sites snorkeled in the Secesh River drainage, August 6—17, 2008. 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	Visibility (m)	Temp (C°)
Lake Creek	6194	1.99	0.00	0.00	0.00	0.00	22.92	0.00	2.4	10.0
Lake Creek	51602	0.00	0.00	0.46	0.00	0.00	0.46	0.00	2.5	12.0
Lake Creek	10642	0.00	0.00	1.09	0.00	0.00	0.00	0.00	3.0	12.5
Summit Creek	13970	0.00	0.00	0.00	0.00	0.00	6.02	0.00	2.5	12.5
Summit Creek	79506	0.00	0.00	0.00	0.00	0.00	3.71	0.00	4.1	12.0
Summit Creek	30354	0.00	0.00	1.50	0.00	0.00	2.08	0.00	2.2	13.0
Lake Creek	87698	0.00	0.00	2.79	0.00	0.13	0.00	0.00	2.3	12.0
Grouse Creek	45010	0.00	0.34	5.45	0.17	0.00	1.19	0.17	2.6	10.0
Grouse Creek	77778	0.00	0.00	6.48	0.00	0.00	0.26	0.00	2.5	10.0
Secesh River	55583	0.07	0.18	0.44	0.00	0.00	0.04	0.15	2.4	14.0
Secesh River	88351	0.00	1.53	2.84	0.00	0.00	1.42	1.99	2.1	16.0
Lick Creek	60703	0.00	11.50	0.00	0.53	0.00	2.30	0.00	3.0	11.5
Secesh River	29471	0.00	4.23	2.37	0.51	0.06	0.00	0.45	1.8	12.0
Secesh River	62239	0.00	3.40	4.39	0.71	0.00	0.00	0.35	2.3	15.0
Secesh River	86815	0.00	2.98	1.83	0.69	0.00	0.00	0.34	1.8	11.5
Secesh River	54047	0.00	5.80	11.87	0.14	0.00	0.00	1.33	2.0	14.0
Split Creek	77087	0.00	0.58	0.00	0.00	0.00	0.00	0.00	2.5	8.0
Secesh River	17695	0.00	1.73	2.90	0.05	0.00	0.00	0.30	2.6	15.0
Zena Creek	25887	0.00	1.90	0.00	0.00	0.00	0.19	0.00	1.4	11.0
Mean		**0.11**	**1.80**	**2.34**	**0.15**	**0.01**	**2.14**	**0.27**		
SD		**0.46**	**2.91**	**3.03**	**0.25**	**0.03**	**5.28**	**0.52**		

Table 13. Densities (fish/100 m^2) of salmonids observed at extensive panel sites snorkeled in the Potlatch River basin, June 15—July 11, 2008. 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	Cutthroat Trout	Whitefish	Brook Trout	Visibility (m)	Temp (C°)
Bobs Creek	35697	0.00	0.00	0.00	0.00	6.55	1.6	14.0
Bobs Creek	86897	0.00	7.96	0.00	0.00	22.02	2.1	16.0
Bobs Creek	54129	0.00	1.07	0.00	0.00	2.14	1.0	10.5
Bobs Creek	37745	0.00	2.94	0.00	0.00	4.12	2.3	13.0
Bobs Creek	103281	0.00	3.43	0.00	0.00	8.15	1.3	15.0
EF Potlatch River	95089	0.00	0.00	0.00	0.00	25.26	1.4	8.0
EF Potlatch River	2929	0.00	10.86	0.00	0.00	7.43	1.4	9.0
EF Potlatch River	13169	0.00	16.18	0.00	0.00	2.14	1.1	11.0
EF Potlatch River	45937	0.00	1.12	0.00	0.00	14.52	1.5	12.0
EF Potlatch River	34786	0.00	0.00	0.18	0.00	0.00	1.2	13.0
Potlatch River	75746	4.58	0.46	0.00	0.00	0.00	1.3	19.0
Potlatch River	81890	0.00	0.00	0.00	0.00	0.00	1.4	17.0
Potlatch River	114706	0.00	0.00	0.00	0.00	0.00	1.5	18.0
Potlatch River	8210	0.00	0.00	0.00	0.00	0.00	1.4	18.0
Potlatch River	49170	0.17	0.00	0.17	0.17	0.00	0.9	16.0
Potlatch River	18402	0.28	0.28	0.00	0.00	0.00	1.2	---
Potlatch River	83938	0.72	1.74	0.00	0.00	0.31	1.2	20.0
Potlatch River	29666	12.35	0.00	0.00	0.00	0.00	1.0	14.0
Potlatch River	111586	8.18	0.00	0.00	0.00	0.00	1.2	16.0
Corral Creek	105442	0.00	0.00	0.00	0.00	0.00	0.8	21.0
Corral Creek	60386	7.72	0.00	0.00	0.00	0.00	0.8	21.0
Corral Creek	15330	16.81	0.00	0.00	0.00	0.00	1.1	26.0
Corral Creek	48098	4.93	0.55	0.00	0.00	0.27	1.1	13.5
Potlatch River	3042	0.98	0.33	0.00	0.40	0.00	2.1	18.0
Boulder Creek	81634	3.02	1.76	0.00	0.00	0.00	0.8	13.5
Potlatch River	114402	0.00	0.35	0.00	0.00	0.00	1.4	25.0
Potlatch River	48866	0.23	0.46	0.00	0.00	0.00	1.2	24.0
Leopold Creek	3810	0.00	2.59	0.00	0.00	0.00	0.9	13.5
Cedar Creek	16866	11.67	3.13	0.00	0.00	0.00	0.8	16.0
Potlatch River	66018	0.23	0.15	0.00	0.08	0.00	1.1	21.0
Potlatch River	482	0.00	0.19	0.00	0.00	0.00	1.9	25.0
Schwartz Creek	36882	0.47	0.00	0.00	0.00	0.00	0.8	13.5
EF Big Bear Creek	126946	0.00	14.43	0.00	0.00	0.00	1.7	11.0
Big Bear Creek	36882	0.00	0.00	0.00	0.00	0.00	0.5	11.5
Big Bear Creek	30690	18.25	0.00	0.00	0.00	0.00	1.7	---
Big Bear Creek	106514	0.00	0.00	0.00	0.00	0.00	1.0	---
Big Bear Creek	79842	0.00	0.00	0.00	0.00	0.00	1.0	24.0
Big Bear Creek	119826	0.00	0.00	0.00	0.00	0.00	2.4	11.4
Big Bear Creek	91154	0.00	17.23	0.00	0.00	0.00	1.0	20.0
WF Ltl Bear Creek	100882	0.00	0.51	0.00	0.00	0.00	1.0	16.0
WF Ltl Bear Creek	363026	5.18	0.40	0.00	0.00	0.00	1.3	17.5
WF Ltl Bear Creek	150034	0.00	1.15	0.00	0.00	0.00	1.1	17.0
WF Ltl Bear Creek	420882	1.67	3.06	0.00	0.00	0.00	1.7	16.0
WF Ltl Bear Creek	60434	0.00	0.00	0.00	0.00	0.00	1.0	17.0
WF Ltl Bear Creek	224274	2.01	4.69	0.00	0.00	0.00	1.0	16.0
WF Ltl Bear Creek	422930	0.00	8.90	0.00	0.00	0.00	1.9	16.0
WF Ltl Bear Creek	467986	0.00	31.62	0.00	0.00	0.00	---	15.0
WF Ltl Bear Creek	136210	0.00	5.49	0.00	0.00	0.00	1.4	---
Big Bear Creek	107538	0.73	41.40	0.00	0.00	0.00	1.3	18.0
Little Bear Creek	144402	2.13	4.06	0.00	0.00	0.00	2.4	---
Little Bear Creek	13330	2.56	3.92	0.00	0.00	0.00	2.4	---
Potlatch River	102114	0.00	0.00	0.00	0.00	0.00	2.3	23.0
Potlatch River	106210	0.00	0.24	0.00	0.00	0.00	2.8	23.0
Potlatch River	88082	0.00	0.12	0.00	0.62	0.00	3.2	20.0
Potlatch River	69138	0.00	0.08	0.00	0.00	0.00	3.2	21.0
Potlatch River	95762	6.95	0.00	0.00	0.00	0.00	3.5	20.0
Mean		**2.00**	**3.44**	**0.01**	**0.02**	**1.66**		
SD		**4.17**	**7.65**	**0.03**	**0.10**	**4.99**		

Table 14. Densities (fish/100 m^2) of salmonids observed at extensive panel sites snorkeled in the Rapid River (MFSR) drainage, July 21—August 12, 2008. 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	Bull Trout	Brook Trout	Whitefish	Visibility (m)	Temp (C)
Vanity Cr	383831	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.7	10.0
Vanity Cr	3567	0.00	0.58	0.00	0.00	0.19	0.19	0.00	3.0	9.5
Vanity Cr	396783	0.43	0.00	0.00	0.22	0.00	0.00	0.00	2.7	10.5
Rapid River	339439	0.39	0.97	0.00	1.16	0.97	0.00	0.00	3.0	12.0
Shady Cr	208367	0.00	0.00	0.00	0.00	1.28	0.00	0.00	3.0	9.0
Rapid River	44527	0.00	0.62	0.00	1.09	0.31	0.00	0.00	2.7	11.5
Rapid River	306671	0.00	0.42	0.00	0.00	0.14	0.00	0.00	3.6	8.0
Seafoam Cr	69103	0.00	0.00	0.00	0.95	0.19	0.00	0.00	3.2	11.0
Seafoam Cr	331247	0.00	2.40	0.00	0.55	0.18	0.00	0.00	3.1	11.0
Float Cr	321367	41.85	0.00	0.00	11.05	0.00	0.00	0.00	3.1	13.0
Float Cr	210415	0.57	5.11	0.00	1.14	0.00	0.00	0.00	3.1	13.0
Float Cr	177647	0.00	2.53	0.00	0.00	0.00	0.00	0.00	3.0	11.0
Float Cr	112111	0.00	2.71	0.00	0.68	0.68	0.00	0.00	2.6	12.0
Float Cr	46575	0.00	0.00	0.00	0.25	0.25	0.00	0.00	3.6	12.0
Float Cr	308719	0.00	1.46	0.00	0.24	0.24	0.00	0.00	3.0	12.0
Float Cr	347631	0.00	1.03	0.00	0.00	0.51	0.00	0.00	3.0	13.0
Float Cr	85487	0.00	2.61	0.00	2.61	0.74	0.00	0.00	3.0	11.0
Rapid River	183791	0.00	0.20	0.00	1.07	0.10	0.00	0.20	3.5	10.0
Rapid River	19951	1.15	0.00	0.00	0.29	0.10	0.00	1.15	3.6	11.0
Rapid River	232943	0.00	0.00	0.21	1.44	0.21	0.00	1.13	3.6	9.0
Rapid River	167407	0.27	0.13	0.00	1.21	0.27	0.00	0.40	3.0	15.0
Rapid River	36335	1.08	0.81	0.00	0.67	0.07	0.00	0.13	4.0	--
Rapid River	227823	0.25	0.51	0.00	0.38	0.13	0.00	0.38	3.0	11.0
Rapid River	21487	0.00	0.73	0.20	0.33	0.00	0.00	0.13	3.5	11.0
Rapid River	152559	0.00	2.34	0.11	0.49	0.00	0.00	0.33	3.0	11.0
Mean		**1.84**	**1.01**	**0.02**	**1.03**	**0.26**	**0.01**	**0.15**		
SD		**8.34**	**1.28**	**0.06**	**2.18**	**0.33**	**0.04**	**0.32**		

Table 15. Densities (fish/100 m^2) of salmonids observed at extensive panel sites snorkeled in the Big Creek drainage upstream of Monumental Creek, July 23—30, 2008. 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	Bull Trout	Brook Trout	Whitefish	Visibility (m)	Temp (C°)
Logan Creek	34335	0.00	1.83	0.00	3.20	3.20	0.00	0.00	1.7	10.0
Big Ramey Creek	38495	1.89	6.60	0.00	0.00	0.00	0.00	0.00	2.4	10.0
Big Ramey Creek	5727	0.00	0.24	0.00	1.46	0.00	0.00	0.00	2.3	9.0
Hand Creek	72031	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.8	10.5
Beaver Creek	88415	0.00	1.05	0.00	2.26	3.16	0.00	0.00	2.9	10.5
Beaver Creek	39263	0.00	1.35	0.00	2.56	1.81	0.00	0.15	2.1	10.0
Beaver Creek	28255	0.00	0.46	0.00	0.34	0.80	0.00	0.23	2.2	10.0
Big Creek	7775	0.00	3.95	2.96	1.38	0.00	0.20	0.20	2.0	11.0
Smith Creek	61023	0.00	0.00	0.00	1.04	2.08	0.00	0.00	3.7	11.0
Big Creek	73311	0.00	9.18	1.53	1.36	0.00	0.00	0.17	2.7	10.0
Beaver Creek	52831	0.00	2.66	0.00	1.45	0.00	0.00	0.60	4.0	10.0
Big Creek	11871	0.45	7.77	0.00	1.07	0.18	0.00	1.16	4.7	10.0
Big Ramey Creek	42591	0.00	0.42	0.00	3.59	1.90	0.00	0.00	6.3	7.0
Mean		**0.18**	**2.73**	**0.35**	**1.52**	**1.01**	**0.02**	**0.19**		
SD		**0.53**	**3.17**	**0.89**	**1.13**	**1.25**	**0.05**	**0.34**		

Table 16. Densities (fish/100 m^2) of salmonids observed at extensive panel sites snorkeled in the Selway River drainage upstream of and including Bear Creek, August 8—September 10, 2008. 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	Bull Trout	Visibility (m)	Temp (C°)
Burnt Knob Creek	39746	0.00	3.44	0.00	0.00	0.00	0.79	---	7.5
Deep Creek	33983	2.30	0.77	0.00	13.79	0.00	0.00	3.0	11.2
Selway River	45247	0.00	0.92	1.10	0.00	0.73	0.00	---	10.5
Selway River	27839	0.00	4.58	0.38	0.57	1.24	0.10	5.0	11.0
White Cap Creek	1922	0.00	4.64	0.00	0.11	0.00	0.00	2.3	14.0
White Cap Creek	34690	0.00	5.72	0.00	0.62	0.00	0.00	6.4	16.0
Ltl Clearwater R	28482	0.00	2.08	0.19	0.95	0.00	0.09	3.7	13.5
Magruder Creek	44866	0.00	1.09	0.00	6.56	0.00	0.00	---	8.0
Selway River	30530	0.00	0.36	8.02	0.27	0.13	0.04	5.7	14.0
Selway River	36674	0.00	2.03	4.95	1.80	6.31	0.45	4.3	16.3
White Cap Creek	23426	2.27	0.90	0.07	2.13	0.62	0.00	7.2	16.0
White Cap Creek	35714	0.63	1.25	1.43	1.70	0.00	0.00	6.1	16.0
Selway River	3906	0.00	0.90	0.00	0.13	0.13	0.02	3.5	14.0
Selway River	10050	0.00	0.17	0.00	1.71	3.68	0.00	4.1	12.0
Lynx Creek	40770	0.00	0.39	0.00	0.00	0.00	0.00	---	7.2
Running Creek	24386	0.00	0.00	0.00	0.00	0.00	0.00	---	7.2
Running Creek	25474	0.00	0.62	0.00	0.62	0.00	0.00	3.2	16.0
North Star Creek	21378	2.50	5.00	0.00	0.00	0.00	0.00	---	18.0
Bear Creek	16770	0.00	0.59	1.94	0.00	0.00	0.00	2.2	8.3
Bear Creek	24962	0.00	1.08	0.27	0.00	0.07	0.00	---	8.3
Paradise Creek	33666	0.12	4.05	0.00	0.71	0.00	0.00	---	10.0
Bear Creek	898	0.00	1.32	0.68	0.98	0.64	0.05	3.0	18.3
Elk Creek	42370	0.69	5.21	0.00	0.35	0.00	0.00	2.9	14.0
Mean		**0.37**	**2.05**	**0.83**	**1.43**	**0.59**	**0.07**		
SD		**0.81**	**1.87**	**1.92**	**3.04**	**1.48**	**0.18**		

Table 17. Densities (fish/100 m^2) of salmonids observed at historic trend sites snorkeled in the Salmon River drainage during 2008. 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	Whitefish	Brook/Bull Hybrid	Visibility (m)	Temp (C°)
Pahsimeroi River	Dowton Lane	0.13	4.51	12.49	0.07	0.00	0.07	0.59	0.00	1.3	14.0
Pahsimeroi River	Ponds	0.68	3.38	5.97	0.00	0.00	0.00	0.23	0.00	1.9	10.0
Pahsimeroi River	Weir	0.67	2.73	3.53	0.00	0.07	0.00	2.93	0.00	1.2	11.5
Hannah Slough	UPS Garden Cr	0.00	0.00	0.54	0.00	0.00	0.00	0.00	0.00	1.4	12.0
Slate Cr	Lower	0.00	0.46	0.00	0.00	0.00	0.00	0.00	0.00	1.6	13.0
Slate Cr	Lower Slate	0.00	0.72	0.00	0.00	0.00	0.00	0.00	0.00	2.2	14.0
Musgrove Cr	Culvert	1.74	5.22	0.00	0.00	0.00	1.09	0.00	0.00	2.3	14.0
Moyer Cr	End of Road	0.00	0.00	0.00	0.00	0.54	0.00	0.00	0.00	3.0	8.0
Moyer Cr	New Section	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.00	1.6	12.0
Panther Cr	US Cabin Cr	0.66	2.46	0.00	0.00	0.00	2.46	0.00	0.00	1.2	14.0
Panther Cr	PC 9	0.38	0.75	0.56	0.00	0.00	0.00	0.00	0.00	0.8	15.0
Panther Cr	McDonald Flat	0.00	2.72	1.14	0.00	0.14	0.00	0.72	0.00	1.4	--
Lemhi River	Lem3A	0.66	2.85	0.00	0.00	0.00	0.00	0.00	0.00	1.1	13.0
Lemhi River	Lem2B	0.13	1.86	0.00	0.00	0.00	0.00	0.00	0.00	1.0	13.0
Lemhi River	L58A	1.43	1.70	0.00	0.00	0.00	0.00	0.27	0.00	1.1	15.0
Lemhi River	13 Beyler	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.0	14.0
Big Springs Cr	1A	2.87	0.96	0.11	0.11	0.00	1.17	0.00	0.00	1.0	14.0
Big Springs Cr	BSC Bridge	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.0	17.0
Middle Fork Salmon River	Gardells Hole	0.00	0.17	0.08	1.00	0.00	0.00	0.67	0.00	2.5	12.5
Middle Fork Salmon River	Velvet	0.00	5.84	20.27	6.76	0.00	0.00	2.46	0.00	4.0	10.0
Middle Fork Salmon River	Elkhorn	0.00	1.25	1.96	1.43	0.00	0.00	1.96	0.00	4.0	12.0
Middle Fork Salmon River	Sheepeater	0.00	0.15	0.29	1.17	0.00	0.00	0.15	0.00	--	15.0
Middle Fork Salmon River	Rapid River	0.00	1.10	1.22	1.10	0.00	0.00	0.98	0.00	--	--
Middle Fork Salmon River	Pungo	0.00	0.32	0.00	2.27	0.00	0.00	1.62	0.00	2.5	12.0
Camas Cr	1 New Section	0.20	0.51	0.31	0.41	0.00	0.00	1.22	0.10	1.6	17.0
Big Creek	Abv Upr Culvert	0.00	0.18	0.00	1.06	1.41	0.00	0.00	0.00	4.0	10.0
Big Creek	Near ford	0.86	1.11	27.73	0.09	0.00	4.37	0.09	0.00	4.3	10.0
Big Creek	Logan Cr	0.10	3.20	0.00	0.87	0.10	0.00	0.39	0.00	4.0	12.0
Lake Creek	Willow Cr	0.00	0.00	1.20	0.00	0.00	0.24	0.24	0.00	2.3	10.0
Lake Creek	Burgdorf	0.00	0.10	1.72	0.00	0.00	0.20	0.30	0.00	2.3	12.0
Secesh River	Grouse	0.00	0.40	0.00	0.00	0.00	0.10	0.10	0.00	2.5	12.0
Secesh River	1	0.33	0.00	1.74	0.00	0.00	0.20	0.47	0.00	2.7	17.0
Lick Creek	L3	0.00	7.35	0.00	0.26	0.00	0.00	1.03	0.00	2.5	14.0
Lick Creek	L1	7.56	0.16	0.00	0.16	0.00	0.47	0.00	0.00	4.3	13.0
Knapp Cr	1A	0.00	0.63	3.55	0.00	0.21	1.67	0.63	0.21	3.0	17.0
Marsh Cr	6A	0.00	0.34	2.23	0.00	0.34	0.51	0.34	0.00	2.7	17.0
Marsh Cr	4B	0.40	0.20	11.60	0.00	0.00	0.40	0.20	0.00	--	14.0
Beaver Cr	3B	0.13	1.00	0.00	0.25	0.00	0.50	0.25	0.00	3.0	17.0

Table 18. Densities (fish/100 m^2) of salmonids observed at historic trend sites snorkeled in the Clearwater River drainage during 2008. 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	Bull Trout	Brook Trout	Hatchery Chinook	Hatchery Steelhead	Visibility (m)	Temp (C°)
Deep Creek	Cactus	0.00	6.76	4.50	1.35	0.23	0.00	0.00	0.00	0.00	3.7	13.0
White Cap Cr	3	0.00	0.43	0.14	0.29	0.47	0.00	0.00	0.00	0.00	5.0	16.0
White Cap Cr	2	0.00	0.63	0.16	0.24	0.31	0.00	0.00	0.00	0.00	5.7	18.0
White Cap Cr	1	0.00	0.47	0.14	0.25	0.47	0.04	0.00	0.00	0.00	5.0	18.0
Running Creek	1	0.0	0.3	1.0	0.3	0.0	0.0	0.00	0.0	0.00	---	---
Running Creek	2	0.00	0.20	0.00	0.20	0.00	0.00	0.00	0.00	0.00	3.2	17.0
Bear Creek	1	0.00	0.00	0.57	0.50	0.00	0.00	0.00	0.00	0.00	3.1	11.1
Bear Creek	2	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.0	10.5
EF Moose Cr	3	0.00	2.30	0.80	0.40	0.00	0.00	0.00	0.00	0.00	3.8	15.0
NF Moose Cr	4	0.07	1.99	0.17	0.62	0.89	0.03	0.00	0.03	0.00	---	16.0
Moose Creek	1	0.00	3.10	0.00	0.87	6.90	0.00	0.00	0.00	0.00	---	20.0
Three Links Cr	1	0.00	3.80	4.81	0.51	0.00	0.00	0.00	0.00	0.00	3.4	16.0
Selway River	Bad Luck Cr	0.00	0.00	0.06	0.87	2.67	0.00	0.00	0.00	0.00	4.5	14.0
Selway River	Big Bend	0.00	0.00	0.00	0.14	2.39	0.00	0.00	0.00	0.00	4.7	15.0
Selway River	N Star Ranch	0.00	0.00	0.00	0.61	3.47	0.00	0.00	0.00	0.00	4.8	15.0
Selway River	Magruder X-ing	0.00	6.31	2.39	0.39	0.39	0.04	0.00	0.00	0.00	4.9	15.0
Selway River	Hells Half Acre	0.00	2.61	0.00	1.18	0.74	0.12	0.00	0.00	0.00	4.1	11.0
Selway River	Beaver Point	0.00	0.75	10.68	0.58	0.51	0.14	0.00	0.00	0.00	4.7	15.0
Selway River	Ltl Clearwater	0.00	2.03	4.95	1.80	6.31	0.45	0.00	0.00	0.00	4.3	16.3
Red River	Below Weir	0.00	3.24	15.37	0.00	0.32	0.00	0.16	3.08	0.00	2.1	16.5
Red River	Old Bridge	0.00	1.06	23.52	0.12	0.12	0.00	0.24	0.12	0.00	1.8	17.0
Red River	Treat2	0.36	1.25	3.66	0.27	0.27	0.09	0.00	0.00	0.00	0.7	18.0
Red River	CSUP 5	1.69	4.43	4.82	0.13	0.13	0.00	0.00	0.00	0.00	1.8	14.0
American River	1	0.00	1.25	0.00	2.00	0.75	0.00	0.75	0.25	0.00	2.9	18.0
American River	Guntleys	0.00	4.81	0.00	1.07	3.21	0.00	1.61	0.00	0.00	2.8	19.0
American River	Flat Iron	0.00	1.24	0.00	1.99	0.50	0.00	0.82	0.00	0.00	3.0	17.0
American River	0.5mi Bel. Boxsing	0.00	4.02	0.50	0.00	1.01	0.00	0.50	0.00	0.00	3.0	17.5
American River	2	0.00	0.86	0.00	18.87	0.00	0.00	0.00	0.17	0.00	1.8	11.0
Crooked River	Treat2	0.19	4.64	0.19	0.93	0.37	0.19	0.00	5.19	0.00	2.9	9.0
Crooked River	Control2	0.00	2.09	0.42	0.00	0.42	0.00	0.00	3.77	0.00	1.8	9.0
Crooked River	Can3	0.00	3.79	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.8	12.0
Crooked River	Natural1	0.00	5.21	0.87	0.00	1.16	0.00	0.00	0.43	0.14	2.1	14.5
Crooked River	Meander1	0.00	5.63	1.13	0.00	4.13	0.00	0.00	1.63	0.25	2.5	12.0
EF Potlatch R	PFI7	0.00	7.29	0.00	0.00	0.00	0.00	3.63	0.00	0.00	1.4	14.0
EF Potlatch R	PFI4	1.03	14.36	0.00	0.00	0.00	0.00	12.28	0.00	0.00	1.4	16.0
EF Potlatch R	PFI5	0.00	15.82	0.00	0.00	0.00	0.00	5.07	0.00	0.00	1.8	15.0
EF Potlatch R	PFI3	0.00	11.04	0.00	0.00	0.00	0.00	1.84	0.00	0.00	1.6	11.0
EF Potlatch R	3	0.00	15.24	0.00	0.00	0.00	0.00	3.05	0.00	0.00	2.0	15.0
EF Potlatch R	PFI8	0.46	9.63	0.00	0.00	0.00	0.00	7.80	0.00	0.00	1.3	12.0
EF Potlatch R	PFI2	0.00	33.13	0.00	0.00	0.00	0.00	20.43	0.00	0.00	1.4	12.0
EF Potlatch R	PFI6	0.00	10.68	0.00	0.00	0.00	0.00	6.99	0.00	0.00	1.8	14.0
EF Potlatch R	PFI9	0.85	16.24	0.00	0.00	0.00	0.00	12.39	0.00	0.00	1.2	14.0
EF Potlatch R	PFI1	0.00	3.25	0.00	0.00	0.00	0.00	1.22	0.00	0.00	1.4	15.0
EF Potlatch R	2	0.00	0.86	0.00	0.00	0.00	0.00	0.37	0.00	0.00	2.5	16.0
EF Potlatch R	1	5.04	1.96	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.6	17.5

Table 19. 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.

Stream	Site	Number marked	Number resighted	Efficiency (%)	Visibility (m)	Temp (C)
Rapid River	19346	17	4	23.5	2.2	12.0
Rapid River	19346	17	5	29.4	1.5	14.5
Rapid River	62354	17	7	41.2	1.8	14.5
Fish Creek	57378	10	3	30.0	1.6	9.0
Fish Creek	102338	17	1	5.9	2.1	14.5
Fish Creek	20418	13	1	7.7	2.6	18.0
Fish Creek	172738	26	5	19.2	2.9	12.0
Fish Creek	12994	33	18	54.5	3.9	12.5
Fish Creek	GPM 2	28	17	60.7	3.6	16.0
Fish Creek	Weir Site	25	13	52.0	2.4	14.0
Fish Creek	Culvert	25	10	40.0	3.0	14.0
S Fk Salmon R	Molly's Resight	49	10	20.4	1.7	10.0
S Fk Salmon R	Resight 1	49	29	59.2	1.7	15.0
Lick Creek	Cow Cr Bridge Resight	34	26	76.5	2.4	12.0
Lick Creek	Screwtrap Resight	21	9	42.9	1.9	12.0
Lick Creek	L3	39	18	46.2	2.5	14.0
Lick Creek	Resight 1	34	23	67.6	2.8	12.0
Lick Creek	Resight 2	52	21	40.4	2.6	11.0
Brushy Fork	Resight	30	21	70.0	2.4	10.0
White Sand Creek	Resight	15	3	20.0	3.6	12.0
Crooked Fork Creek	3-2B	10	0	0.0	2.9	10.0
Red River	Resight	14	2	14.3	2.5	13.0
American River	3-Buffalo Pit	43	19	44.2	1.8	13.0
Red River	CSUP4	45	14	31.1	2.1	16.5
Crooked River	50754	18	3	16.7	1.2	10.0
White Cap Creek	39873	11	3	27.3	5.0	--
Selway River	3906	27	15	55.6	5.0	14.0
EF Potlatch River	PFI 6	23	13	56.5	1.8	13.0
EF Potlatch River	13169	18	12	66.7	1.1	11.0
EF Potlatch River	Resight	10	4	40.0	1.1	14.0
Pahsimeroi	Weir	25	4	16.0	1.2	11.5
Pahsimeroi	Ponds	16	1	6.3	1.9	10.0
Marsh Creek	5537	14	4	28.6	3.3	12.0
Marsh Creek	4673	9	2	22.2	4.0	10.5
Float Creek	321367	9	1	11.1	2.3	13.0

APPENDIX

Presentations by project personnel

Copeland, T., and D.A. Venditti. Comparison of local versus aggregate population productivity for naturally produced spring/summer Chinook salmon in the Snake River basin. Presented at the 2008 annual meeting of the Idaho Chapter American Fisheries Society. February 6-8, 2008, Post Falls, Idaho.

Copeland, T., and D.A. Venditti. Comparison of local versus aggregate population productivity for naturally produced spring/summer Chinook salmon in the Snake River basin. Presented at the 2008 annual meeting of the Western Division American Fisheries Society. May 5-7, 2008, Portland, Oregon.

Venditti, D.A., T. Copeland, and B. Barnett. Idaho Department of Fish and Game annual spawning ground survey workshop. August 12-13, 2008. Stanley, Idaho.

Copeland, T. Life history and salmon conservation. Lecture delivered to University of Idaho Fish Ecology class, October 16, 2008. 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 26-28, 2009.

Publications

Copeland, T., C.C. Kozfkay, J. Johnson, and M.R. Campbell. 2009. Do dead fish tell tales? DNA degradation in Chinook salmon (*Oncorhynchus tshawytscha*) carcasses. Northwest Science 83:140-147.

Data management

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

Data Collection:

1. Simplified picklist for agers.
2. Scale aging portion of database updated for easier sorting.

Quality Control:

1. Completed a complete check of every fin-ray age from 2004-2008.
2. Updated scale and fin ray aging manuals.
3. Produced Power Point tutorial on fin ray aging (to complement scale aging tutorial).

Storage:

1. Established protocols for saving data to the S drive, saving data to the external Terabyte drive, and for storage of archived images on CD.
2. Incorporated all of the biological samples from the Idaho Steelhead Monitoring and Evaluation Studies database into the INPMEP Biological Samples Database.

Dissemination:

1. Provided age data obtained from Chinook salmon carcasses in Idaho Supplementation Study study streams to ISS personnel. These data will be used to assign redds to cohort

for the ISS Phase 2 evaluation. Redd counts are the primary metric for evaluation of supplementation success in this study.

2. Provided age data to the Nez Perce Tribal fisheries personnel regarding Chinook salmon in Johnson Creek, Lake Creek, and Secesh River.
3. Provided age data to Charlie Petrosky, Interior Columbia Basin Technical Recovery Team, regarding age composition of Chinook in Sulphur Creek and other Upper Middle Fork Salmon populations.
4. Constructed a INPMEP Collaboration Web Site: This is a password protected web site workspace where cooperators can store/share ideas and documents pertaining to the project. Tools included in the site: posting announcements, events/meetings, discussion board, document library, picture library, Alerts, Outlook contacts list and task assignment page. It's a great way to store the NPM project documents for easy access and retrieval as well as an aid in report writing. http://nr2/npm/default.aspx
5. Mapping request sent to Ed Murrell at the National Marine Fisheries Service's Idaho Habitat Office. We provided a map with all present sampling infrastructure locations (state, federal, and tribal) overlaid on spring/summer Chinook and steelhead populations.

Other

1. Assisted Idaho and Federal law enforcement in an endangered species case with evidence involving steelhead scale patterns. The court case is ongoing and some project personnel may provide expert testimony.
2. Researched epoxy alternatives via e-mail, websites, and personal contact with present supplier.

Table A1. Data types collected by the Idaho Natural Production Monitoring and Evaluation Project in 2008 for each spring/summer Chinook population in Idaho, by Viable Salmonid Population criteria.

	Viable Salmonid Population criterion			
Population	**Abundance**	**Productivity**	**Spatial Structure**	**Diversity**
		Dry Clearwater major population group		
Upper South Fk Clearwater	Juv. densities (Crooked River)	Adult age composition	Juv. occurrence (Crooked River, historic trend sites)	Adult age composition
Lawyer Creek				
		Wet Clearwater major population group		
Lolo Creek				
Lochsa River	Juv. densities (Crooked Fork)	Adult age composition	Juv. occurrence (Crooked Fork, historic trend sites)	Adult age composition
Meadow Creek				
Moose Creek			Juv. occurrence (historic trend sites)	
Upper Selway	Juv. densities	Adult age composition	Juv. occurrence (basin & historic trend sites)	Adult age composition
		South Fork Salmon major population group		
Little Salmon				
South Fork Main		Adult age composition		Adult age composition
Secesh River	Juv. densities	Adult age composition	Juv. occurrence (basin & historic trend sites)	Adult age composition
East Fork South Fork		Adult age composition		Adult age composition
		Middle Fork Salmon major population group		
Marsh Creek	Juv. densities	Adult age composition	Juv. occurrence (basin & historic trend sites)	Adult age composition
Bear Valley/Elk Creek		Adult age composition, hatchery fraction		Adult age composition
Sulphur Creek		Adult age composition		Adult age composition
Loon Creek				
Camas Creek		Adult age composition		Adult age composition
Big Creek	Juv. densities (upper Big Creek)	Adult age composition		Adult age composition
Upper Main Middle Fork	Juv. densities (Rapid River)		Juv. occurrence (Rapid River & historic trend sites)	
Lower Main Middle Fork				
Chamberlain Creek		Adult age composition		Adult age composition
		Upper Salmon major population group		
Upper Main Salmon		Adult age composition		Adult age composition
Lower Main Salmon		Adult age composition, hatchery fraction		Adult age composition
Valley Creek		Adult age composition, hatchery fraction		Adult age composition
East Fork Salmon		Adult age composition		Adult age composition
Yankee Fork		Adult age composition		Adult age composition
Pahsimeroi River	Juv. densities	Adult age composition	Juv. occurrence (basin & historic trend sites)	Adult age composition
Lemhi River		Adult age composition	Juv. occurrence (historic trend sites)	Adult age composition
Panther Creek		Adult age composition	Juv. occurrence (historic trend sites)	Adult age composition
North Fork Salmon		Adult age composition	Juv. occurrence (historic trend sites)	Adult age composition

Table A2. Data types collected by the Idaho Natural Production Monitoring and Evaluation Project in 2008 for each steelhead population in Idaho, by Viable Salmonid Population criteria.

	Viable Salmonid Population criterion			
Population	**Abundance**	**Productivity**	**Spatial Structure**	**Diversity**
		Clearwater River major population group		
Lower Clearwater	Juvenile densities (Potlatch River)		Juvenile occurrence (Potlatch River)	
Lolo Creek				
South Fk Clearwater	Juvenile densities (Crooked River)		Juvenile occurrence (Crooked River & historic trend sites	
Selway River	Juvenile densities (upper Selway)		Juvenile occurrence (upper Selway & historic trend sites)	
Lochsa River	Juvenile densities (Crooked Fork)		Juvenile occurrence (Crooked Fork, historic trend sites)	
		Salmon River major population group		
Little Salmon River				
South Fork Salmon				
Secesh River	Juvenile densities		Juvenile occurrence (basin & historic trend sites)	
Chamberlain Creek				
Lower Middle Fork	Juvenile densities (upper Big Creek)		Juvenile occurrence (upper Big Creek & historic trend sites)	
Upper Middle Fork	Juvenile densities (Marsh Creek, Rapid River)		Juvenile occurrence (Marsh Creek, Rapid River & historic trend sites)	
Panther Creek			Juvenile occurrence (historic trend sites)	
North Fork Salmon			Juvenile occurrence (historic trend sites)	
Lemhi River			Juvenile occurrence (historic trend sites)	
Pahsimeroi River	Juvenile densities (Pahsimeroi River)		Juvenile occurrence (Pahsimeroi River & historic trend sites)	
East Fork Salmon				
Upper Salmon				

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