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IDAHO HABITAT AND NATURAL PRODUCTION MONITORING

Annual Report 1989

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REPORT SECTIONS

EXECUTIVE SUMMARY

Project 83-7 was established under the Northwest Power Planning Council's 1982 Fish and Wildlife Program, Measure 704(d)(l) to monitor natural production of anadromous fish, evaluate BPA habitat improvement projects, and develop a credit record for off-site mitigation projects in Idaho.

The Idaho Department of Fish and Game has been monitoring and evaluating existing and proposed habitat improvement projects for steelhead and chinook in the Clearwater and Salmon subbasins since 1984. Projects included in the monitoring are funded by, or proposed for funding by, the Bonneville Power Administration under the Northwest Power Planning Act as off-site mitigation for downstream hydropower development on the Snake and Columbia rivers. This monitoring project is also funded under the same Authority.

A mitigation record has been developed which uses actual and potential increases in smolt production as the measures of benefit from a habitat improvement project. Determination of full benefit from a project depends on presence of adequate numbers of fish to document actual increases in fish production. The depressed nature of upriver anadromous stocks has precluded attainment of full benefit of any habitat project in Idaho. Partial benefit is credited to the mitigation record in the interim period of run restoration.

Project 83-7 is divided into two subprojects: general and intensive monitoring. Primary objectives of the general monitoring subproject (Part I) are to determine natural production increases due to habitat improvement projects in terms of parr production and to determine natural production status and trends in Idaho. The second objective is accomplished by combining parr density data from monitoring and evaluation of BPA habitat projects and from other IDFG management and research activities.

Primary objectives of the intensive monitoring subproject (Part II) are to determine the number of returning chinook and steelhead adults necessary to achieve optimal smolt production and to develop mitigation accounting based on increases in smolt production. Two locations are being intensively studied to meet these objectives. Field work began in 1987 in the upper Salmon River and Crooked River (South Fork Clearwater River tributary).

Project Benefits

Project benefits to date, estimated in terms of annual smolt production, averaged 55,482 chinook and 6,271 steelhead from 1986 to 1989 (Summary Tables 1 and 2). None of the habitat projects have yet realized their full potential due to low escapements and a time lag in physical habitat and population responses. Barrier removal, off-channel development, and instream structure projects contributed 71%, 8%, and 21% of the total parr benefits, respectively. Sediment reduction projects are still in progress, and anticipated benefits are yet to accrue.

Summary Table 1. Steelhead parr and smolt benefit estimates attributable to Bonneville Power Administration habitat improvements evaluated by this Project.

1986-89 Project type	Parr production years 1985	1986	1987	1988	1989	Averase
Barrier Removals						
Parr	210	8,985	7,660	6,106	3,808	6,640
Smolts	92	3,953	3,370	2,687	1,676	2,922
Off-Channel Development						
Parr	--	327	3,076	1,108	1,446	1,489
Smolts	--	144	1,353	488	636	655
Instream Structures						
Parr	5,803	5,833	9,590	3,553	5,520	6,124
Smolts	2,553	2,567	4,220	1,563	2,429	2,695
Sediment Reduction						
Parr	(Projects were initiated in 1987 and have not yet matured.)					
Smolts						
Totals						
Parr	6,013	15,145	20,326	10,767	10,774	14,253
Smolts	2,646	6,664	8,843	4,737	4,741	6,271

Summary Table 2. Chinook parr and smolt benefit estimates attributable to Bonneville Power Administration habitat improvements evaluated by this project.

1986-89 Project type	Parr production years 1985	1986	1987	1988	1989	Average
Barrier Removals						
Parr	12,557	103,336	64,370	99,452	155,128	105,572
Smolts	4,897	40,301	25,104	38,786	60,450	41,160
Off-Channel Development						
Parr	--	4,339	209	5,865	32,209	10,656
Smolts	--	1,692	82	2,287	12,562	4,156
Instream Structures						
Parr	14,958	-15,183	51,183	37,716	30,570	26,072
Smolts	5,834	-5,921	19,961	14,709	11,709	10,163
Sediment Reduction						
Parr	(Projects were initiated in 1987 and have not yet matured.)					
Smolts						
Totals						
Parr	27,515	92,437	115,614	143,033	217,907	142,248
Smolts	10,731	36,070	48,089	55,783	84,984	55,482

Benefits of habitat improvement projects in terms of adult returns and resulting seeding levels will ultimately depend on improved flow and passage conditions. Estimation of adult returns and economic benefits from the habitat projects is beyond the scope of Project 83-7, but will be possible as the System Monitoring and Evaluation Program begins to provide the relevant data. We developed an example of expected adult returns and economic benefits based on recent average smolt-to-adult return rates. The habitat projects monitored to date could result in about 100 adult steelhead and 200 adult chinook returned to Idaho annually for the first generation (Summary Table 3). The adult benefits would increase substantially with time if populations rebuild, and be negligible if they decline. Based on Meyers (1982), economic value for first generation returns to Idaho would be $38,000 for steelhead and $113,000 for chinook.

Due to chronic poor passage survival, the number of smolts attributed to the habitat projects is small compared to the projects' potential. Compared to Subbasin Planning estimates of natural smolt potential in Idaho of 15.5 million spring/summer chinook and 4.5 million steelhead, the increased production is extremely small. However, for a limited number of degraded streams, habitat improvement could yield significant benefits if the passage problem is solved.

General Monitoring

Major findings from parr density monitoring are:

1) Chinook and steelhead parr densities averaged 10 and 20 times higher, respectively, in pristine ungrazed sections than in the heavily sedimented Bear Valley/Elk Creek (BVC/EC) sections. Substrate surface sand in the BVC/EC and ungrazed sections averaged 46% and 209, respectively.

2) Wild (indigenous) A-run steelhead density in 1985-1989 averaged 75% of carrying capacity (PCC), whereas wild B-run steelhead PCC averaged only 12%. Natural (hatchery influenced) A- and B-run steelhead PCC were intermediate to those of wild A- and B-runs.

3) In 1989, the areas with highest densities of wild chinook parr were the Middle Fork Salmon River tributaries (excluding the Bear Valley drainage) and Chamberlain Basin, both areas predominately in designated wilderness with minimal land use problems.

4) Populations of chinook parr were at depressed levels in 1985-1989. Wild and natural chinook (both spring and summer runs) averaged 12% and 19% of carrying capacities, respectively.

5) No significant trend of rebuilding or decline of wild or natural chinook parr PCC was detected in 1985-1989, although slight positive trends were apparent in the data. However, there was a significant positive trend in density of natural chinook parr in C- (meandered) channels during this period.

Summary Table 3. Expected first generation adult chinook and steelhead returns and their economic values, annual and capitalized, under a range of smolt-to-adult **returns(SAR),** which result from a range of Snake River discharges during the smolt migration.

Species	No. of parr	No. of smolts	SAR	No. of adults	Value/ adult $	Annual value $	Capitalized value $[b]
Chinook	142,248	55,482	0.37[a]	205	550	112,750	1,409,375
"	"	"	0.25	139	"	76,450	955,625
"	"	"	0.50	277	"	152,350	1,904,375
"	"	"	0.75	416	"	228,800	2,860,000
"	"	"	1.00	555	"	305,250	3,815,625
"	"	"	1.25	694	"	381,700	4,393,125
Steelhead	14,253	6,271	1.67[a]	105	359	37,695	471,188
"	"	"	0.50	31	"	11,129	139,113
"	"	"	1.00	63	"	22,617	282,713
"	"	"	1.50	94	"	33,746	421,825
"	"	"	2.00	125	"	44,875	560,938
"	"	"	2.50	157	"	56,363	704,538
"	"	"	3.00	188	"	67,492	843,650

[a]**Average** smolt-to-adult returns used for sub-basin planning.

[b]**Capitalized** value **(Barlowe** 1978, page 182) is the amount of money that would have to be invested at the current available rate (8%) to generate the annual value in perpetuity. It is equal to the annual value divided by the decimal equivalent of the interest rate, or 0.08 in this particular case.

6) A redd density of 52/ha and parr density of 102/100 m^2 in one Sulphur Creek redd count trend area provided the first observation near carrying capacity to develop a chinook reproduction curve based on redds and parr. The observed parr density was similar to earlier estimates of 108/100 m^2 based on fry stocking studies.

7) Survival from 17 fry plant evaluations in 1986-1989 for green egg-to-parr averaged 14.1%, similar to survival from natural spawning in good habitat.

8) Green egg-to-parr survival for wild chinook spawning was 2.1% in the heavily sedimented Bear Valley/Elk creek and 11.6% in the moderately sedimented Sulphur Creek. Green egg-to-parr survival has averaged 15.0% for all Middle Fork Salmon River estimates since 1984 and 20.8% when Bear Valley/Elk Creek data are excluded.

Intensive Monitoring

Major findings from the intensive monitoring subproject are:

1) Estimates of egg-to-parr survival rates from naturally-spawning spring chinook for the entire upper Salmon River averaged 5.5% (range 5.1% to 6.7%).

2) Estimates of egg-to-parr survival rates from natural spawners and adult outplants in the headwater streams of upper Salmon River averaged 24.4% (range 16.1% to 32.0%).

3) Estimates of 1989 parr-to-smolt survival rates to the head of Lower Granite Reservoir pool from PIT tag detections were 9.7% and 5.2% for chinook and 20.4% and 33.5% for age 2+ steelhead from upper Salmon River and Crooked River, respectively. Estimates of these 1988 survival rates from upper Salmon River were 12.3% for chinook 23.3% for age 2+ steelhead.

4) During 1988, natural chinook and steelhead smolts we tagged in upper Salmon River exhibited similar timing of arrival to Lower Granite Reservoir Dam, as did all wild/natural steelhead smolts. However, when compared to all chinook at Lower Granite Reservoir Dam (which are not separated into wild and hatchery components), the upper Salmon River smolts had a later peak arrival. The upper Salmon River smolts had two major peaks in arrival at Lower Granite Reservoir Dam, and both peaks began three to four days after a major increase in the flows at Lower Granite Reservoir Dam.

5) In 1989, natural chinook and steelhead smolts from upper Salmon River exhibited very similar timings of arrival at Lower Granite Reservoir Dam as they did in 1988. In 1989, natural steelhead smolts from Crooked River arrived at lower Granite Reservoir Dam with the same timing as the upper Salmon River chinook and steelhead. The peak arrival of chinook smolts from Crooked River at Lower Granite Reservoir Dam in 1989 occurred later than the other groups studied and coincided with the last peak of flows at Lower Granite Reservoir Dam in early June.

6) Our chinook supplementation evaluation indicates that adult outplants in low gradient headwater streams produce higher **egg-to-parr** survival rates than either eyed-egg or fry outplants.

Other findings of this subproject are:

1) In both study areas, proportionally more chinook than steelhead parr emigrate in the fall, and a smaller percentage of parr outmigrate in the fall from Crooked River (the lower elevation stream) than from upper Salmon River. Percentages of the summer parr population accounted for in the fall outmigration were similar for both years studied (1988 and **1989),** and the means were 60% and 17% of the chinook and 44% and 3% of the steelhead in upper Salmon River and Crooked River, respectively.

2) Mortality of chinook and steelhead juveniles rearing above the Busterback irrigation diversion on the upper Salmon River can be up to four times higher than mortality of parr rearing below the diversion because of dewatering in late August and September, when the majority of parr emigrate from summer rearing areas. In fall 1988, a large beaver pond just above the Busterback diversion apparentlyprovidedadequateoverwinteringhabitat and greatly reduced this mortality factor for the run 1989 smolts.

3) The Busterback and Alturas Lake Creek diversions block a majority of the adult chinook from reaching the low gradient headwater streams where we have observed much higher **egg-to-parr** survival rates.

4) Off-channel ponds connected to Crooked River with Bonneville Power Administration habitat improvement funds reared densities of chinook parr in 1989 that were more than twice Petrosky and Holubetz's (1987) estimate of chinook parr density at full seeding. This strategy was recommended for rehabilitation of other streams degraded by dredge mining.

IDAHO HABITAT/NATURAL PRODUCTION MONITORING

Part I
General Monitoring Subproject

Annual Report 1989

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Project 83-7
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TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF TABLES (Cont.)

Page

LIST OF FIGURES

Page

LIST OF APPENDICES

LIST OF APPENDICES (Cont.)

INTRODUCTION

The Idaho Department of Fish and Game (IDFG) has been monitoring and evaluating proposed and existing habitat improvement projects for **rainbow-**steelhead trout Oncorhvnchus mvkiss, hereafter called steelhead, and chinook salmon **O.** tshawvtscha, hereafter called chinook, in the Clearwater and Salmon river drainages (Figure 1) for the past five years. Projects included in the evaluation are funded by or proposed for funding by the Bonneville Power Administration (BPA) (1985) under the Northwest Power Planning Act as off-site mitigation for downstream hydropower development on the Snake and Columbia rivers. This evaluation project is also funded under the same authority (Fish and Wildlife Program, Northwest Power Planning Council).

A mitigation record is being developed using increased carrying capacity and/or survival as the best measure of benefit from a habitat enhancement project. Determination of full benefit from a project depends on completion or maturation of the project and presence of adequate numbers of fish to document actual increases in fish production. The depressed status of upriver anadromous stocks have precluded measuring full benefits of any habitat project in Idaho. Partial benefit is credited to the mitigation record in the interim period of run restoration.

According to the BPA Work Plan (BPA **1985),** project implementors have the major responsibility for measuring physical habitat and estimating habitat change. To date, Idaho habitat projects have been implemented primarily by the U.S. Forest Service **(USFS).** The Shoshone-Bannock Tribes (SBT) have sponsored three projects (Bear Valley Mine, Yankee Fork, and the proposed East Fork Salmon River projects). IDFG implemented two barrier removal projects (Johnson Creek and Boulder Creek) that the USFS was unable to sponsor at that time. The role of IDFG in physical habitat monitoring is primarily to link habitat quality or habitat change to changes in actual and potential fish production.

Estimation of anadromous fish response to BPA habitat projects in Idaho is generally the responsibility of IDFG (BPA 1985). However, the SBT have primary responsibility for developing the mitigation record for the three projects that they have sponsored.

Approaches to monitor habitat projects and document a record of credit were developed in 1984-1985 (Petrosky and Holubetz 1985, 1986). The IDFG evaluation approach consists of three basic integrated levels: parr density monitoring, parr standing stock evaluations, and estimation of survival rates between major fresh water life stages (egg, **parr, smolt)** of chinook and steelhead. The latter is referred to as "intensive studies." Annual general monitoring of anadromous fish densities in a small number of sections for each project is being used to follow population trends and define seeding levels. For most projects, standing stock estimates of parr will be used to estimate smolt production based on survival rates from **parr-to-smolt** stages. Intensive studies (Kiefer and Forster 1990) estimate survival rates from **egg-to-parr** and **parr-to-smolt** and provide other basic biological information that is needed to evaluate the Fish and Wildlife Program.

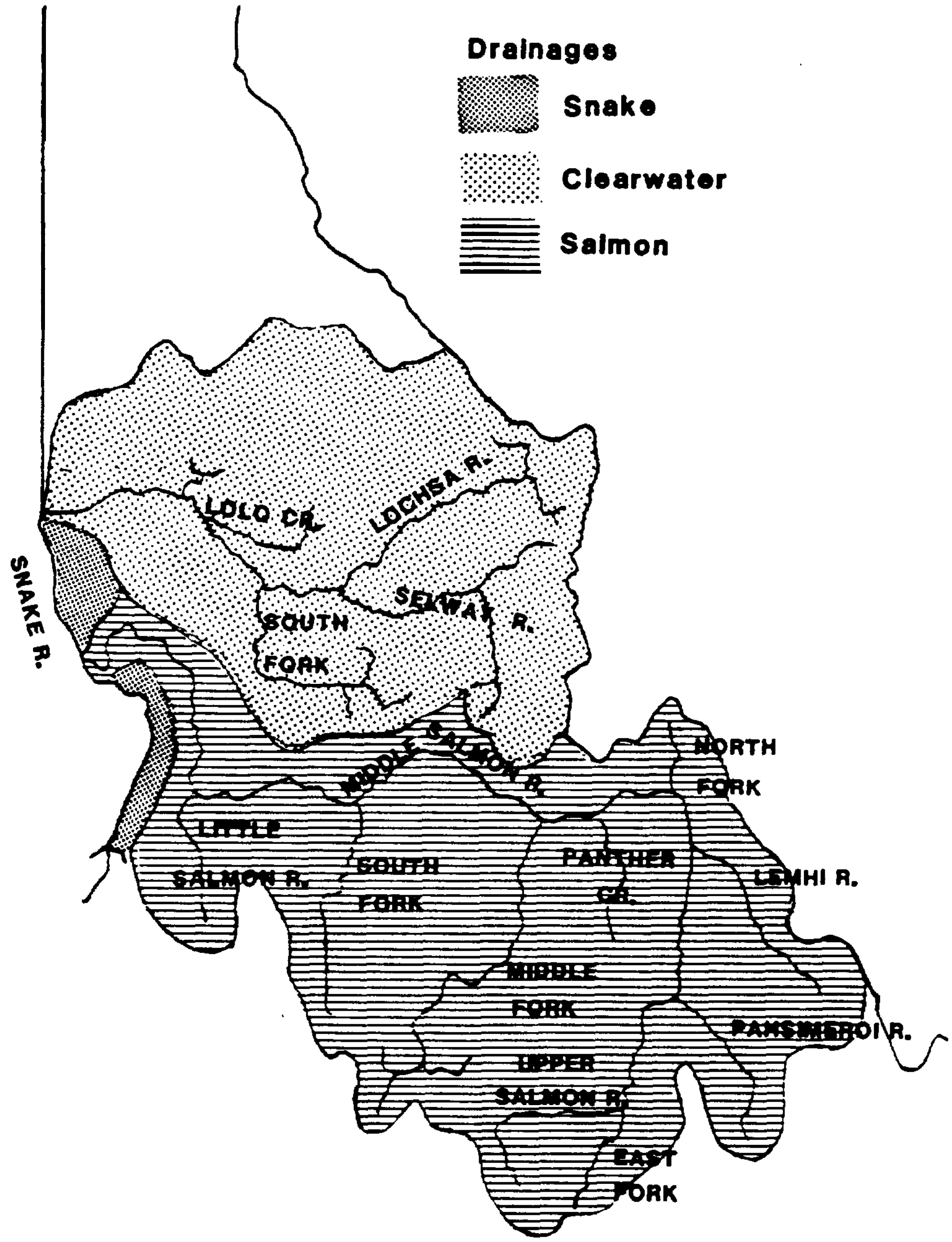

Figure 1. Idaho's anadromous fish waters showing major drainages of the Clearwater, Salmon, and Snake River subbasins.

A physical habitat and parr density database has been developed for BPA habitat projects in Idaho. The data will be integrated among the three evaluation levels. The schedule of BPA habitat project implementation and IDFG general monitoring-evaluation activities from **1983-1989** is presented in Table 1. A complete mitigation record will be made when three conditions are met: 1) the habitat project is completed or at full maturation, 2) the fish population affected is observed at full seeding, or a full seeding level has been determined for the affected habitat type, and 3) the appropriate survival rates from summer parr stage to smolt stage have been determined from the intensive studies. Although most fish populations have not approached full seeding, the general and intensive monitoring results provide inferences into effectiveness of habitat projects and the status of wild/natural anadromous fish in Idaho.

After a habitat enhancement project has been implemented, and prior to the time that the aforementioned conditions have been met, IDFG has constructed a partial mitigation record based on estimated increases in parr and smolt production. Monitoring data are essential to establish trends and estimate partial benefits during the years that project evaluations are not conducted.

In 1989, the general monitoring and evaluation project focused on six areas: 1) general density monitoring, 2) anadromous fish introductions above treated passage barriers, 3) Comparisons of anadromous fish populations at different levels of sedimentation, 4) investigations into rearing potential for chinook, 5) comparisons of densities and percent carrying capacities between wild and natural populations of both steelhead and chinook, and 6) comparisons of densities and percent carrying capacities of **A-** and B-run steelhead **parr.**

METHODS

Project 83-7 has been monitoring parr densities in stream sections within the Clearwater and Salmon river drainages since 1984. Additionally, the IDFG fisheries research section and regional fisheries programs have monitored parr densities in stream sections in coordination with the evaluation project so that parr densities are being monitored in all major anadromous fish production areas of Idaho. Other contributors to the monitoring data set include the U.S. Fish and Wildlife Service's Fisheries Resource Office in Ahsahka and the Bureau of Land Management at Cottonwood. We anticipate adding sections from the Forest Service and Tribes in 1990. The number of sections monitored annually since 1984 is shown in Table 2.

Physical Habitat

Monitoring sections provide an annual index of anadromous fish abundance in different habitat types and drainages. Monitoring sections are approximately 100 m long with boundaries at defined breaks between habitat types; sections included at least one riffle-pool sequence. Streams, project strata, and

Table 1. Schedule of BPA project implementation (I) and evaluation activities (P = pretreatment evaluation, M = monitoring, and E = post-treatment evaluation) in Idaho, 1983-1988.

Project	Project type[a]	1983	1984	1985	1986	1987	1988	1989
Lo10 Creek	IS	I	I,P,E	E	M	M	M	M
Eldorado Creek	PA		I,P	I,M	E	M	M	M
Upper Lochsa River	IS	I	I,E	M	M	M	M	M
Crooked Fork Creek	PA		I,P	I,P	E	E	E	E
Colt Creek	PA				I	M	M	M
Crooked River	PA		I,P	M	E	M	M	E
	IS		I,P	I,P,M	E	M	M	M
	oc		I,M	I,M	I,E	I,M	I,E	E
Red River	BC	I	I,M	M	M	M	M	M
	IS	I,M	I,M	I,M	E	M	M	M
	RR							
Meadow Creek	PA					I,M	M	M
Panther Creek	SP		P	M	M	M	M	M
Pine Creek	PA					I,M	M	
Lemhi River	IF			P	M	M	M	
Upper Salmon River	IF		P	P	M	P	P	P
	RR		M	P	M	P	P	P
Alturas Lake Creek	IF		P	M	M	P	P	P
Pole Creek	PA	I	M	M	M	E	E	E
	RR		M	P	M	P	M	M
Valley Creek	RR			P	M	M	M	M
	PA			P	M	M	I,M	M
Bear Valley Creek	SP		I,P	I,P	I,M	M	M	M
	RR		M	P	P	M	I,M	I,M
Elk Creek	RR		M	P	P	M	I,M	I,M
Marsh Creek	RR		M	P	M	M	M	M
Knapp Creek	PA		M	P	M	I,M	M	M
Camas Creek	RR		M	M	M	M	I,M	M
	BC		M	M	M	M	M	M
Johnson Creek	PA		I,P	I,E	I,E	E	E	M
South Fork Tributaries	PA				I,M	M	M	M
Boulder Creek	PA		P	I,P	E	M	E	M
Loon Creek	co			M	M	M	-	M
Sulphur Creek	co		M	M	P	M	M	E
South Fork Salmon	co		M	M	M	M	M	M

[a]BC = bank-channel rehabilitation, CO = control stream, IF = improved flows, IS = instream structure, OC = off-channel developments, PA = passage, RR = riparian revegetation, and SP = sedimentation and pollution control.

Table 2. Number of sections where steelhead and chinook parr were monitored in Idaho by BPA project 83-7 and other management and research programs from 1984 through 1989.

Year	Number of steelhead sections	Number of chinook sections[a]
1984	60	37
1985	184	139
1986	190	156
1987	225	178
1988	225	175
1989	268	216

[a]Chinook sections are a subset of the steelhead sections.

sections were cross-referenced to the Environmental Protection Agency (EPA) reach numbering system (NWPPC and BPA 1989). Sections monitored in 1989 are listed in Appendix A.

Physical habitat variables were standardized and measured at least once since 1984 in each established density monitoring section and in most other sections used in habitat project evaluations. The physical habitat variables other than width and length were not measured every year in each section due to time constraints (parr densities in all sections need to be sampled within a two-month period from late June to the latter part of August) and because the physical habitat was relatively stable from year to year. The same physical variables were measured in the parallel IDFG-funded monitoring program. IDFG has encouraged other agencies and tribes to incorporate this standardized variable list (Appendix A-2) into their monitoring programs. More intensive physical habitat monitoring for BPA habitat projects in Idaho is carried out by Project 84-24, which incorporates these standardized variables.

Physical habitat variables measured in each section were percent of pool, run, riffle, pocket water, and backwater; percent of substrate surface sand, gravel, rubble, boulder, and bedrock; section length, average width and depth, gradient, and channel type (Rosgen 1985). The techniques used to collect the physical habitat data are described in Petrosky and Holubetz (1988). Physical habitat data collected during 1984-1988 were summarized by channel type. This variable simultaneously categorizes several morphological characteristics, and was used as a primary classification to compare composition of habitat types and substrate within and between streams and to investigate chinook and steelhead rearing potential and population response to sedimentation.

The physical habitat database is being used in conjunction with data collected by project implementors to develop the mitigation record for BPA habitat projects. Quantity and quality of habitat added and improved are estimated primarily by project implementors. Actual and potential production of steelhead and chinook parr attributable to each project are estimated using relationships developed from this database.

The effects of substrate sand on parr densities in the Middle Fork of the Salmon River drainage were analyzed. All major Middle Fork Salmon River tributaries have wild chinook populations. Most of the tributaries are in pristine watersheds, while the Bear Valley/Elk Creek drainage has been severely degraded from grazing, mining, and logging. Thus, the Middle Fork Salmon River is an excellent drainage to evaluate the effects of land use on sedimentation and chinook salmon populations.

We classified the monitoring sections according to two major channel types (Rosgen 1985) and compared parr density trends within these channel types. Petrosky and Holubetz (1988) and Scully et al. (1990) demonstrated the effect of channel type on both steelhead and chinook parr densities. A comparison of parr densities in B and C channels showed that chinook densities were 3.5 times higher in C channels, while steelhead densities were 2-3 times higher in B channels. The B channels are confined in valleys or canyons and have high enough gradient that most fine materials are flushed out. A significant part of the substrate composition may be comprised of boulders larger than 30 cm diameter. The C channel streams, in contrast, meander through flat, alluvial valleys and are characterized by deposition of fine materials and low velocities. Substrate composition in C channels has a high percentage of small materials, sand, and gravel. In unstable watersheds, sand may be the predominant substrate type in C channels. In general, sections classified as C channels had gradients less than 1.5% while B channel sections had gradients in excess of 1.5%.

Parr Density Monitoring

In 1984-1989, the BPA general monitoring and intensive monitoring subprojects established a total of 166 monitoring sections to index the annual abundance of steelhead and chinook parr in BPA habitat project streams. Steelhead parr are defined here as age 1+ and age 2+, with respective lengths of 8-15 cm (3.0-5.9 in) and 15-23 cm (6.0-8.9 in). The steelhead length-at-age intervals are similar to those defined by Thurow (1987). Chinook parr are age 0+, with lengths less than 10 cm (4 in). These data, and data from the parallel IDFG-funded monitoring program, were used to index trends in annual abundance, estimate rearing potential in different habitats, and develop relationships between adult escapements and juvenile fish densities. Mitigation benefits are being determined in part from density trends and habitat-fish relationships developed from this database.

Most anadromous fish production streams in Idaho are clear and have low conductivity. In these streams, snorkel counts by trained observers are preferred over estimates obtained from electrofishing. Comparisons of snorkel counts and electrofishing estimates in typical Idaho anadromous streams (Petrosky and Holubetz 1987) demonstrated that direct observation is an excellent method of surveying salmon and steelhead parr populations. Hankin and Reeves (1988) presented similar evidence for western Oregon streams. In larger streams, electrofishing surveys are neither practical nor reliable for juvenile fish. We obtained density estimates by snorkeling in all sections, except those in the highly conductive and slightly turbid Lemhi River, which we electrofished. Survey methods and fish population field forms were presented in Petrosky and Holubetz (1986).

We snorkeled the monitoring sections with a team of divers working upstream. Crew size ranged from one for small streams to five or more for larger streams. The combined programs monitored sections in 100 streams, representing a variety of stocks, production types, and habitats. Parr densities were compared among all major anadromous fish drainages in Idaho during 1985-1989. We summarized steelhead and chinook parr densities by year and production type (wild or natural). Because of the preference of steelhead for B channels and chinook for C channels, parr density comparisons among drainages incorporated only the preferred channel type for each species. We analyzed A-run and B-run steelhead separately because of large differences in Columbia River harvest rates and escapements between the two runs.

We also estimated parr density as a percent of carrying capacity (PCC) using standardized smolt capacity ratings developed for Subbasin Planning by the System Planning Group for the Northwest Power Planning Council (NWPPC 1986). The parr density database was merged with the NWPPC's species presence/absence database using the common variable, EPA reach number. The NWPPC file rates each EPA reach as being poor, fair, good, or excellent habitat for rearing chinook and steelhead smolts. We converted the NWPPC smolt ratings to parr capacities to estimate PCC. Petrosky and Holubetz (1988) defined parr carrying capacity in excellent habitat as 108/100 m^2 for chinook and 20/100 m^2 for steelhead. The NWPPC smolt capacity rating from excellent habitat for chinook and steelhead are 90 and 10 smolts/100 m^2, respectively. Thus, chinook parr carrying capacity for poor, fair, and good habitat were determined proportionally from NWPPC smolt ratings as 12, 44, and 77/100 m^2. Steelhead parr carrying capacity was similarly estimated as 6, 10 and 14/100 m^2, respectively. Excellent habitat for chinook would be undisturbed C channel streams, and good habitat would be in similar quality B channels. For steelhead, excellent habitat would be in undisturbed B channels, and good habitat would be in undisturbed C channels. The C channels in productive spring-fed streams could also be classified as excellent steelhead rearing habitat. Degraded streams received ratings of fair and poor for both species depending on the degree of disturbance and channel type. Because the different habitat types and quality ratings are considered in the carrying capacity rating system, both B and C channel sections are analyzed for both species, unlike the analysis for the statistic parr density.

Parr Density Comparisons

We compared steelhead and chinook parr densities and PCC among classes and years for 1985-1989. Steelhead classes were wild A-run, wild B-run, natural A-run and natural B-run. Chinook classes were wild and natural.

Wild (indigenous) steelhead populations in Idaho presently occur in the lower tributaries (below the mouth of the North Fork) and Selway River of the Clearwater River drainage, in most small Snake River tributaries, and in most small main stem Salmon River tributaries down stream from the mouth of the Middle Fork Salmon River and in the entire Middle Fork and South Fork Salmon rivers, and in Rapid River, tributary to the Little Salmon River (Figure 2). Areas not listed above were considered in this analysis to have natural (hatchery-influenced) populations.

Wild chinook populations in Idaho presently occur throughout the Middle Fork Salmon River drainage and the Secesh River, as well as in a few small Salmon River tributaries (Figure 3). The remainder of Idaho's chinook waters were classified as natural populations in this analysis. Because sample size was small for summer chinook, we combined spring and summer chinook and compared only wild and natural classes.

For steelhead, the statistic PCC used the density of age 1+ and age 2+ steelhead parr relative to maximum density that could occur in the section. The PCC statistic may be most appropriate for comparing relative status of populations because it incorporates an estimate of the carrying capacity.

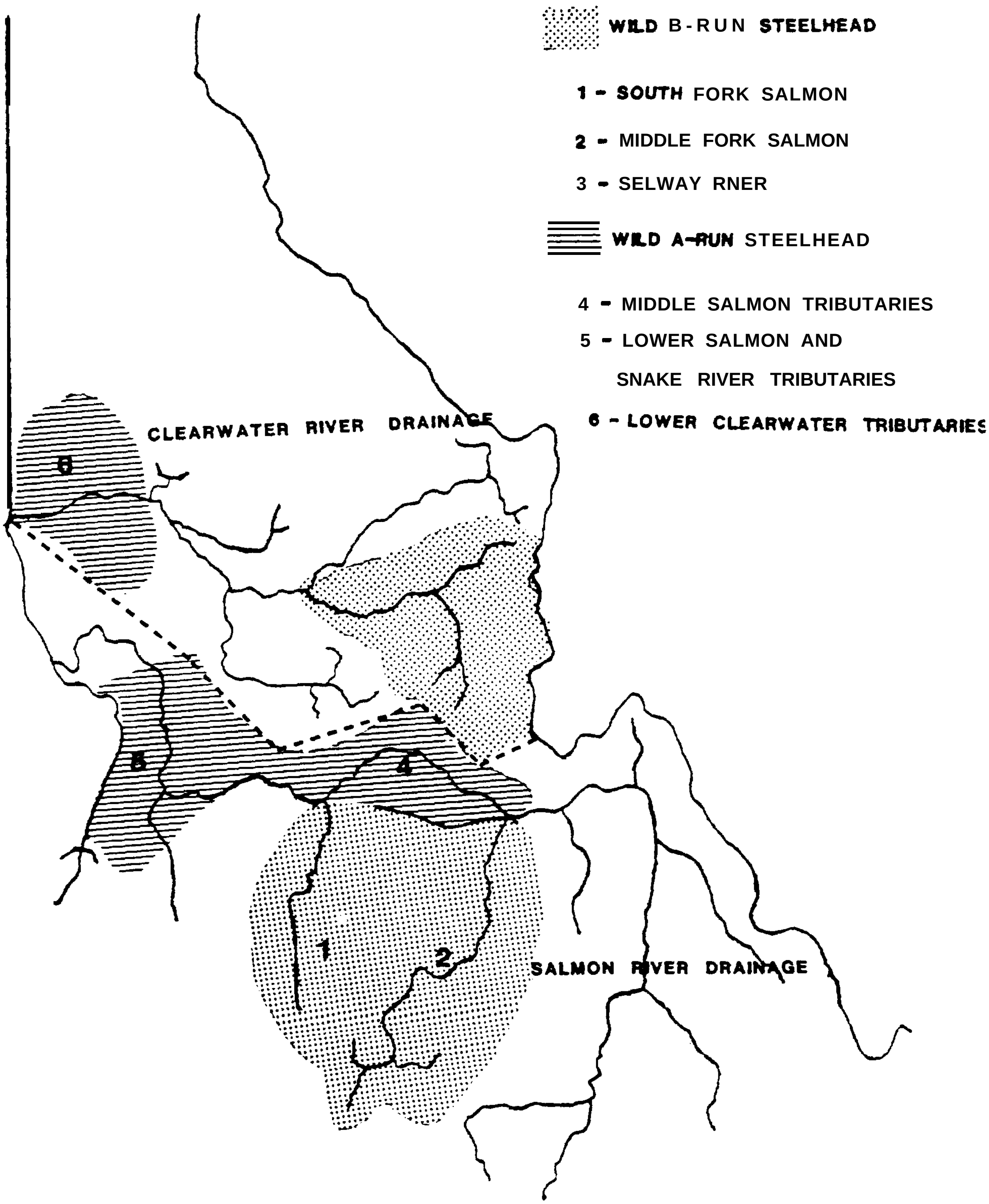

Figure 2. Present distribution of wild A-run and B-run steelhead production areas in Idaho.

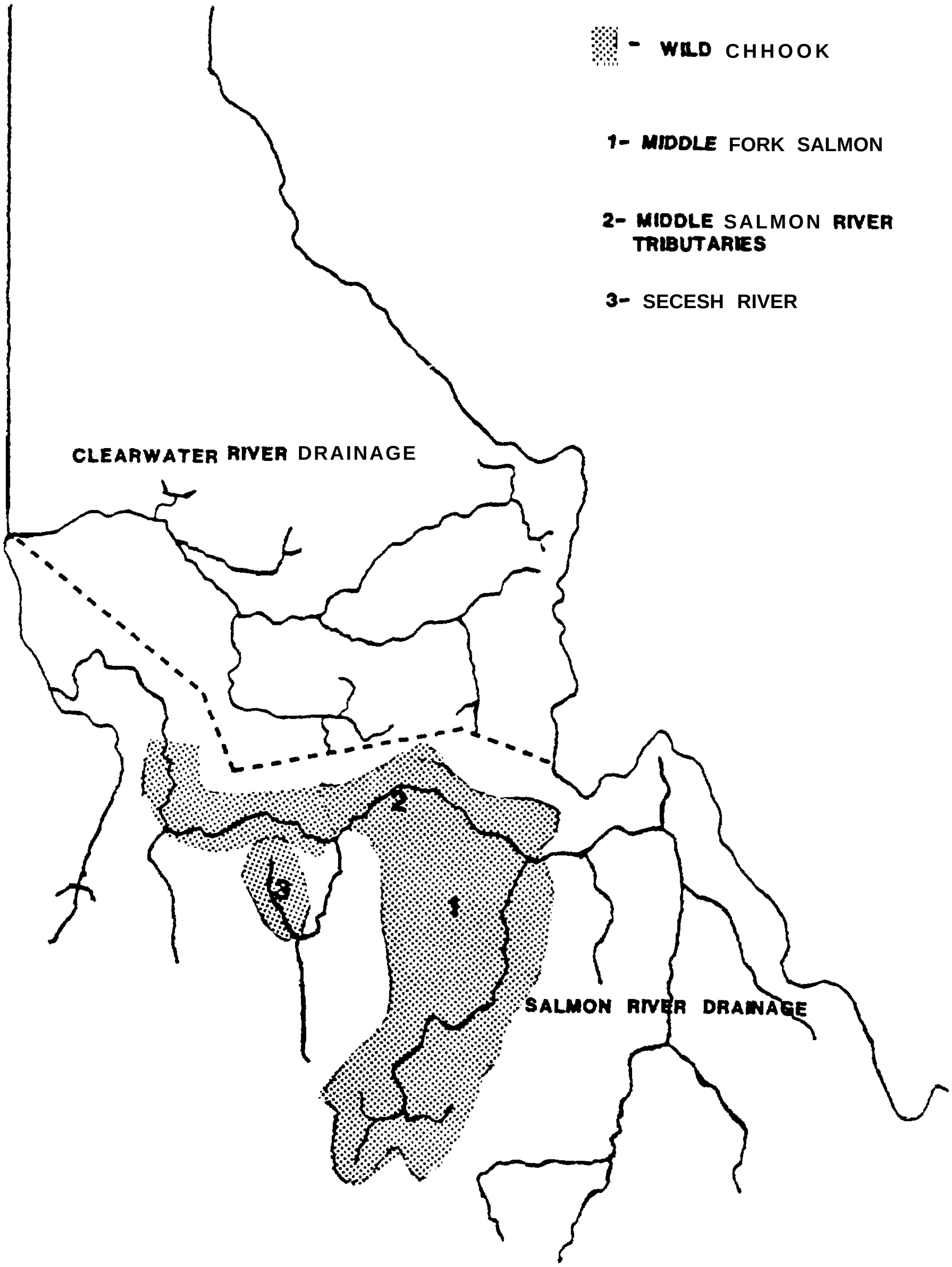

Figure **3.** Present distribution of wild chinook production areas in Idaho.

Differences in channel type, gradient, stream size, and sediment level are accounted for, in part, by the rating. Because the PCC for steelhead includes both age 1+ and age 2+ parr, it may mask annual differences resulting from adult escapement from two brood years.

The best index of steelhead escapement is probably the age 1+ parr density in B channels. In underseeded conditions, as occur in most of Idaho's anadromous fish waters, there is sufficient B channel habitat to support the age 1+ steelhead parr and few are forced into the less desirable C channel habitat. Also, unlike age 2+ parr, none of the age 1+ cohort would have previously smolted.

For chinook, both parr density and PCC are for a single age class (age 0+) and brood year. Thus, the best overall index may be PCC, rather than density in C channels, because PCC has a larger sample size, incorporating both B and C channel sections. At extremely low escapements, relatively fewer chinook parr and a smaller PCC would be expected in the less preferred B channel habitat.

The appropriate model to test for effects of class and year, on monitoring data in fixed sections, is a one-way analysis of variance with repeated measures on years. Several sections in the data set had missing values for one or more years during 1985 through 1989. Because SYSTAT (Wilkinson 1988) deleted all data from sections with one or more missing values, we were unable to run the repeated measures models without deleting all information from several sections. Future analyses will attempt to statistically approximate the missing values for use in repeated measures models.

To approximate the effects of class and year on parr density and PCC, we used a two-factor analysis of variance with categories of class (wild A-run, natural B-run, etc.) and year and class x year interaction. We then ran a one-way analysis of variance tests within class and year and simple linear regressions on years to investigate trends of rebuilding. Tests of significance would differ from the repeated measures model somewhat because of differing degrees of freedom and error terms.

Anadromous Fish Introductions

The 1984-1989 chinook and steelhead releases into BPA project and monitoring streams are summarized in Appendices A-3 and A-4, respectively. Chinook fry were stocked by this project in 1989 to establish populations above barrier-removal projects and to evaluate chinook rearing potential in different habitats in Johnson Creek and in upper Lochsa River tributaries.

Chinook Reproduction Curves

Columbia River Basin system planning documents (NWPPC 1986) assume smolt carrying capacity of rearing habitat to be a density-dependent relationship in the form of a Beverton-Holt function (Ricker 1975). As redd densities increase, smolt (or parr) densities increase to an asymptote (carrying capacity).

Scully et al. (1990) and Petrosky and Holubetz (1988) compared densities of age 0+ chinook from Salmon River streams to densities of redds in IDFG spawning ground survey reaches of the same streams. Both studies classified stream reaches by average percent surface sand (o-309, 30-40%, and >40%) in the monitoring sections. The comparisons were limited to low gradient (C channel) reaches that have a predominance of age 5, spawners (age 5, two years in freshwater, three years in saltwater). The previous analyses were characterized by low escapements. Chinook reproduction curves were further developed for the Salmon River with the addition of redd counts from 20 established chinook redd count reaches in 1988 (White and Cochnauer 1989) and 48 parr density monitoring sections in 1989 (Appendix A-5). The relationship between redds/hectare and parr/100 m^2 in stream reaches with less than 35% surface sand was described using the linear regression form of the Beverton-Holt reproduction curve (Ricker 1975), where parents (P) = redds/ha and recruits (R) = parr/100 m^2. A data set of 66 redd:parr observations from brood years 1983-1988 was analyzed. To reduce potential leverage of outliers at low escapements, we included only observations where parr density exceeded 1/100 m^2 and P/R > 1.

Chinook Egg-to-Parr Survival

Fry Stocking

In 1989, chinook fry were stocked in portions of Johnson Creek and in the upper Lochsa River tributaries of Crooked Fork, Hopeful, White Sand, and Big Flat creeks. Johnson Creek and its tributaries of Rock and Sand creeks were stocked on May 8 by helicopter with a total of 200,000 McCall summer chinook fry (average 409/lb). Four sites in the upper Lochsa River were stocked by helicopter on May 10 and 11, 1989 with 189,600 Dworshak spring chinook fry (average 153/lb.)

To estimate survival of chinook fry to the parr stage, we systematically established snorkel sections at 0.5 km intervals beginning at each stocking site and extending 1.0 km upstream and 3.0 km downstream. We estimated fish densities, total abundance, and fry-to-parr survival in the upper Lochsa River tributaries during August 10-14, 1989. Petrosky and Holubetz (1988) described the procedures used to estimate total abundance and fry-to-parr survival based on systematic stratified sampling of parr densities in the established sections.

The 1989 estimates were summarized with previous estimates by Scully et al. (1990) and Petrosky and Holubetz (1988). To express survival estimates in terms of egg-to-parr, we assumed constant survival rates in Idaho hatcheries of 85% for green egg-to-eyed-egg, and 75% for green egg-to-fry (S. Huffaker, Idaho Department of Fish and Game, personal communication).

Parr densities were monitored in Johnson Creek and its tributaries of Rock and Sand creeks in 1989, but total abundance sampling was not estimated.

Wild/Natural Spawners

We compared **egg-to-parr** survival for brood year (BY) 1988 wild spring chinook in the heavily sedimented Bear Valley/Elk Creek drainage and the pristine Sulphur Creek drainage, adjacent Middle Fork Salmon River tributaries. Both streams received moderate escapements in 1988 (White and Cochnauer 1989).

We estimated total parr abundance for Sulphur Creek in 1989. Total abundance in Bear Valley Creek was estimated through Project 83-359 monitoring (M. Rowe, Shoshone-Bannock Tribes, personal communication, Appendix A-6).

The 1989 **egg-to-parr** estimates were summarized with previous estimates by Scully et al. (1990) and Petrosky and Holubetz (1988) according to sediment class **(<30%, 30-40%,** and **>40%** surface sand).

Partial Project Benefits

Partial project benefits were estimated from 1985 through 1989 according to the project-specific approaches in Petrosky and Holubetz (1986) and the tabular procedures in Appendix B.

Four general types of habitat improvement projects were evaluated: barrier removals, off-channel developments, **instream** structures, and sediment reduction. Barrier removals and off-channel developments were evaluated by estimating the population of affected anadromous salmonids which reared upstream of the barrier removal site or within the off-channel developments. Total abundance was estimated by stratified random or systematic sampling (Cochran 1963). In years when total abundance was not estimated directly, densities in the affected areas were monitored at one or more snorkeling sections per project, and monitored densities were expanded to population estimates using procedures described in Appendix B.

During 1983 and 1984, Clearwater and **Nez Perce** National Forest personnel placed structures in Crooked River, Red River, and Lo10 Creek to improve degraded habitat that resulted from mining, logging, and grazing activities. During the five years following these structure placements, the IDFG monitored control and treated stream sections to evaluate project benefits in terms of increased parr densities.

In some years and streams, a large number of replicate sections were sampled to analyze responses of parr densities to **instream** structures within a given year (Petrosky and Holubetz 1985, 1986, 1987). Scully et al. **(1990)** analyzed, with repeatedmeasures analyses of variance, monitoring data replicated annually from 1985 through 1988, from control and treatment sections in two strata (stream reaches) each from Crooked River, Lo10 Creek, and Red River. We analyzed the effects of **instream** structures separately for each of the three streams, then grouped the streams in a second analysis. The response variables were densities of age 1+ and age 2+ steelhead and age 0+ chinook. Treatments evaluated consisted of boulder clusters and log weirs (sill logs) on Crooked River; boulder clusters and deflector logs on Red River; and boulder clusters, log weirs, and deflector logs on Lolo Creek.

In 1987, the Boise National Forest began a project (84-24) to reduce sediment recruitment and revegetate the riparian zone of Bear Valley/Elk Creek in conjunction with improved grazing management (Andrews and Everson 1988). The restoration is expected to be slow and hinges on achievement of improved grazing management. We are evaluating the success of this work, in part, in terms of increased parr density in this drainage relative to densities in control drainages.

Benefits from sediment reduction/riparian revegetation projects will be analyzed after completed projects have matured and the physical habitat has responded to the changes. Pretreatment data document the low parr density and low egg-to-parr survival in heavily sedimented streams when compared to pristine, control streams in the same drainage. When parr density and egg-to-parr survival improve in response to the projects, comparisons will be made to determine if significant improvements have occurred in the ratio of parr density in sedimented streams:control streams and in the egg-to-parr survival of treated streams. Because of the time lag between treatment and habitat response, analyses to date are limited to comparisons between streams with different sediment levels.

Database Manasement and Statistical Analyses

All biological and physical data from 1984 through 1989 were entered into dBase III+ files for easy access and arrangement for various analyses, These files are available for use by project implementors, Tribes, and natural resource agencies upon request.

Summary statistics, analysis of variance, and regressions were done with the statistical software SYSTAT (Wilkinson 1988). Statistical differences were considered significant at probabilities less than 0.10.

RESULTS AND DISCUSSION

Substrate Sand and Parr Densities

From 1985 through 1989, we monitored chinook and steelhead parr densities in ten sections of the heavily sedimented Bear Valley/Elk Creek (BVC/EC) drainage of the Middle Fork Salmon River and in 11 control stream sections of the Middle Fork Salmon River and Chamberlain Creek drainages. We use the term "control" as an analogue to a desired future condition. The controls were similar to the BVC/EC sections in terms of channel type (C) and wild fish management, but the control drainages were the only ones not grazed by cattle. Chinook and steelhead parr densities averaged ten and twenty times higher, respectively, in the control sections than in BVC/EC sections (Figure 4). The differences were significant ($p<0.001$) for each species. Surface substrate sand in the BVC/EC and control sections averaged 46% and 20%, respectively (Appendix A-7).

Age 0+ chinook densities in the BVC/EC sections have shown a positive but not significant ($p=0.12$) trend from 1985 through 1989, increasing from 1.8/100 m^2 to 3.3/100 m^2. Control section densities increased from 19/100 m^2 to 30/100 m^2 during the same period, although this trend was not significant ($p=0.34$). The density ratio of BVC/EC:control sections increased from an average 0.08 in 1985-1987 to 0.12 in 1988-1989. This suggests a slight improvement in rearing conditions in BVC/EC areas relative to conditions in control areas for chinook. However, the ratios are still low relative to the ideal (1.0).

Age 1+ steelhead density in BVC/EC sections declined significantly ($p=0.006$) from 1985 through 1989 from 0.38/100 m^2 to 0.01/100 m^2. Steelhead densities in control streams increased from 1.20/100 m^2 to 2.64/100 m^2 during the same period, although the trend was not significant ($p=0.36$). The ratio of BVC/EC:control section densities, which averaged 0.14 in 1985-1987, decreased to 0.04 in 1988 and 0.004 in 1989. Unlike the situation for chinook, the BVC/EC:control ratios do not suggest any improvements in steelhead rearing conditions.

It is difficult to determine whether actual changes in rearing conditions have begun in BVC/EC because 1) a lag time of several years for sediment reduction is expected, 2) no grazing management changes have occurred, and 3) rearing conditions are very poor as reflected in the small BVC/EC:control ratios. The ratios will be compared in future analyses with physical habitat monitoring data from Project 84-24 to evaluate possible trends in sediment conditions due to project activities.

Parr Density Monitoring

Steelhead Parr

The lowest mean density for steelhead parr in 1989 was for wild B-run in the Middle Fork Salmon River, 1.2/100 m^2, and the highest was for wild A-run in the Snake River, 12.3/100 m^2 (Table 3). Of the natural steelhead cells, the highest densities were in the very lightly supplemented Snake River tributaries (natural A-run), 6.5/100 m^2, and Lochsa River (natural B-run), 5.0/100 m^2. The upper Salmon River, which is heavily supplemented with Snake River A-run steelhead, had the lowest density, 1.6/100 m^2, of any natural A-run steelhead cell.

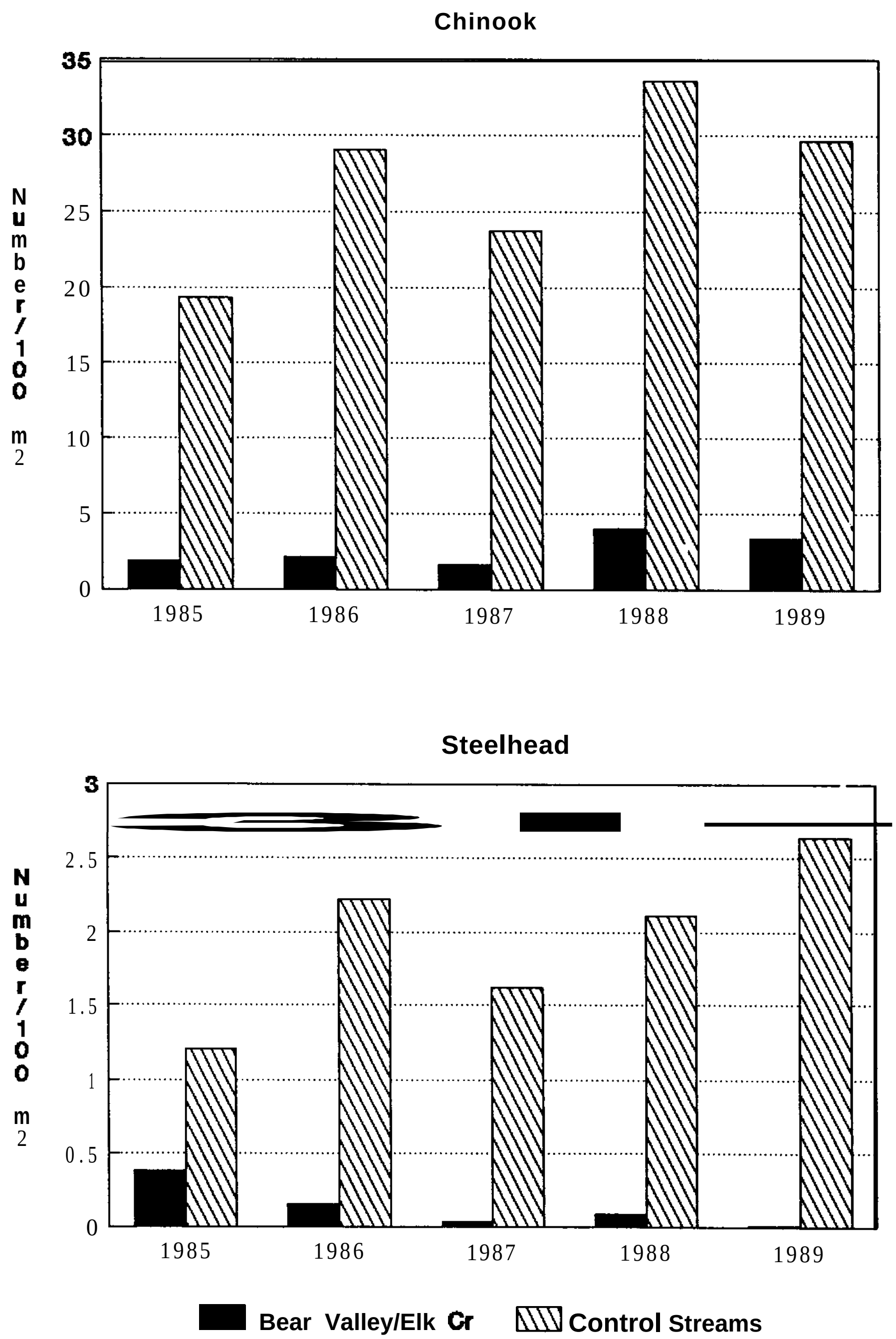

Figure 4. Average annual densities of chinook and steelhead parr in the heavily sedimented Bear Valley/Elk Creek drainage and Middle Fork Salmon River control streams.

Table 3. Percent carrying capacity (PCC) for ages-l+ and -2+ steelhead in all monitoring sections and densities (number/l00 m^2) of age 1+ steelhead parr in B channels, 1989.

Class, Cell	PCC (n)	Age 1+ density in B channels (n)
Wild B-run		
I. Selway River	15 (18)	1.6 (16)
2. Middle Fork Salmon River	7 (47)	1.2 (21)
3. South Fork Salmon River	15 (28)	2.5 (15)
Natural B-run		
4. Lochsa River	41 (15)	5.0 (15)
5. South Fork Clearwater River	25 (41)	2.8 (26)
6. Lo10 Creek	14 (10)	1.0 (7)
Natural A-run		
7. Little Salmon River, Hazard Cr., Slate Creek and the East Fork Salmon River (A-run streams with B-run or A- and B-run supplementation histories)	39 (II)	5.5 (7)
8. Upper Salmon River	11 (54)	1.6 (22)
9. Eastern Salmon River tributaries (Pahsimeroi, Lemhi and North Fork Salmon rivers)	38 (14)	1.7 (5)
10. Snake River of Captain John and Granite creeks; and the Little Salmon River tributary of Boulder Creek.	44 (9)	6.5 (8)
Wild A-run		
11. Middle Salmon River tributaries of Bargamin, Sheep, Chamberlain and Horse creeks	45 (12)	4.9 (10)
12. Snake River tributaries of Sheep and Wolf creeks; lower Clearwater River tributary of Big Canyon Creek; lower Salmon River tributary of Whitebird Creek; and the Little Salmon R. tributary, Rapid River.	89 (9)	12.3 (9)

Percent Carrying Capacity

Parr monitoring in 1985-1989 demonstrated depressed levels of some steelhead populations. Wild A-run steelhead density in 1985-1989 averaged 75% of PCC, whereas wild B-run averaged 12% (Figure 5, Table 4). Two-way analysis of variance of steelhead PCC, with categories of year and run type, demonstrated highly significant differences (p<0.001) between steelheadruntypes, significant differences (p=0.07) between years, and a significant interaction (p=0.018) between run types and years. Although annual changes occurred within run types, they were generally small relative to the difference between run types. The PCC for wild A-run was 5 to 8 times larger than for wild B-run in all years. Natural A- and B-run steelhead maintained PCC intermediate between the two wild run-types.

PCC of wild A-run steelhead parr was greater than any of the other three run types in each of the five years analyzed. Natural A- and B-runs were not significantly different in any year. Natural A- and B-run PCC's were significantly higher than for wild B-run PCC's in most, but not all, years.

There were no annual differences within run types for wild A's, wild B's, or natural A's from 1985 through 1989. There were highly significant differences (p<0.001) between mean annual values for natural B's, with mean PCC being lower in 1985 than in 1986, 1987, or 1988. Also, the mean value in 1989 was significantly lower than in 1986 and 1987.

Linear regression of PCC on years showed no evidence of a rebuilding trend in 1985-1989, within any run type (Table 5). Natural A-run PCC declined moderately (p=0.09).

Age 1+ Density in B Channels

Comparisons among run types and years of age 1+ steelhead parr densities in preferred B channel habitats were similar to those reported for PCC. Wild A-run and wild B-run densities show the greatest separation, with mean annual densities of wild A-run steelhead consistently 3.5 to 6.6 times higher than densities of wild B's. There was no significant trend of rebuilding or decline during 1985-1989 for either of the wild run types (Table 6 and Figure 6). There were significant differences between annual densities of both natural A- and natural B-run types, but no significant trends of rebuilding (Table 7). The only significant trend in 1985-1989 was of decline (p=0.07) for natural A-run steelhead.

Chinook **Parr**

In 1989, the areas with highest densities of wild chinook were the Middle Fork Salmon River (excluding Bear Valley drainage) and Chamberlain Basin (Table

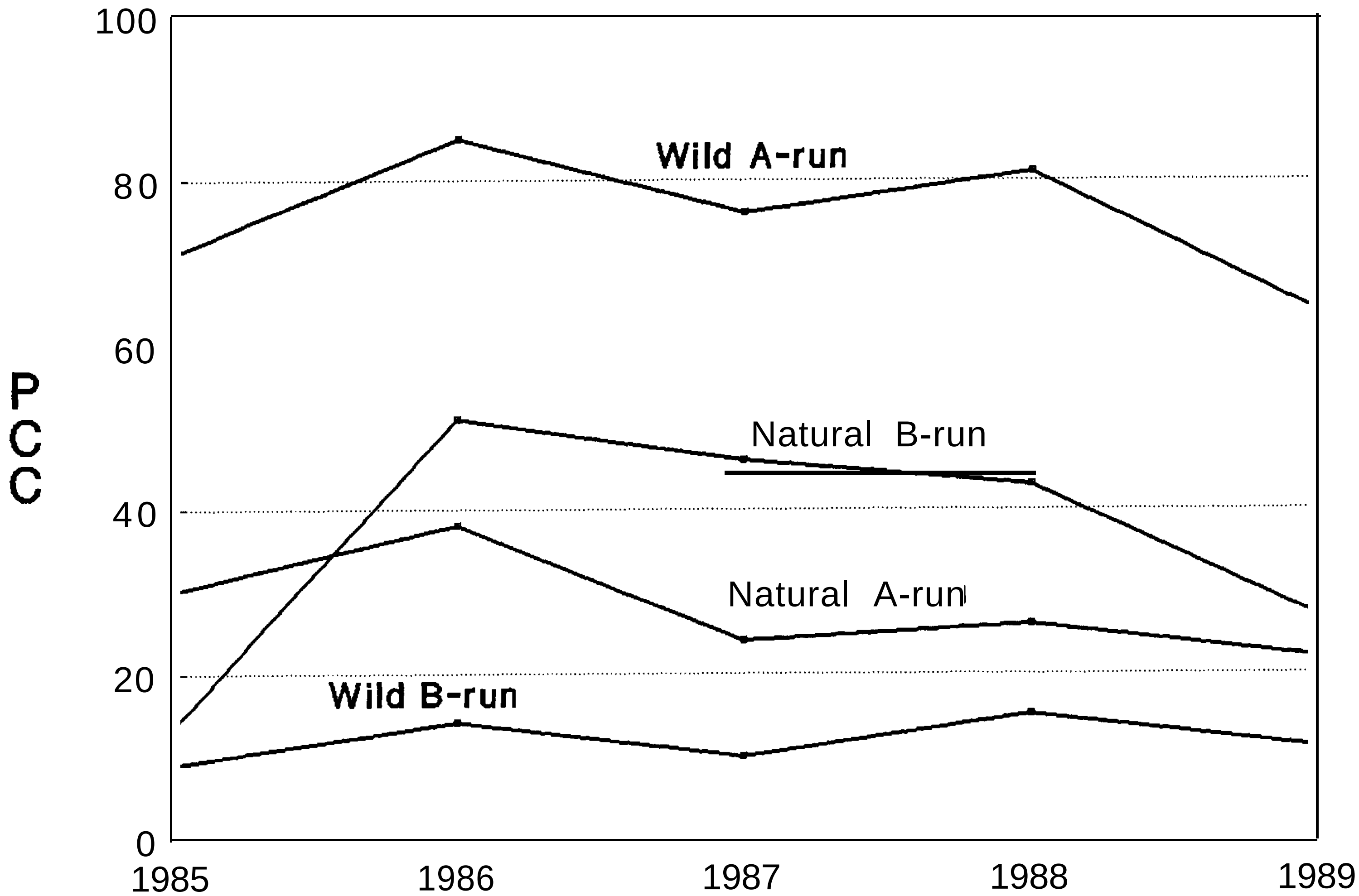

Figure 5. Mean annual Percent of Carrying Capacity (PCC) of four classes of steelhead parr ages 1+ and 2+) in Idaho, 1985-1989.

Table 4. Mean percent carrying capacity (PCC) of age-l+ and age-2+ steelhead parr by class and year, F-tests for class and year, and ratio of wild A-run to wild B-run PCC, 1985-89.

						Test on year		
Class[a]	1985	1986	1987	1988	1989	F	P	n
WA	71	85	76	81	64	0.44	0.78	99
WB	9	14	10	15	11	1.64	0.16	397
NA	30	38	24	26	22	1.48	0.21	405
NB	13	51	46	43	27	7.17	<0.001	235
Test on Class								
F	13.03	22.34	20.51	18.78	23.16			
P	<0.001	<0.001	<0.001	0.006	<0.001			
n	186	198	225	259	268			
WA/WB Ratio	7.9	6.1	7.6	5.4	5.8			

[a]W=wild, N=natural, A=A-run, B=B-run

Table 5. Linear regression statistics for percent carrying capacity of age 1+ and age 2+ steelhead parr for wild A-run (WA), wild B-run (WB), natural A-run (NA) and natural B-run (NB) on year, 1985-89.

Class	Slope	r^2	F	P	n
WA	-2.47	co.01	0.36	0.55	99
WB	0.28	co.01	0.20	0.65	397
NA	-2.48	co.01	2.88	0.09	405
NB	0.10	co.01	0.00	0.95	235

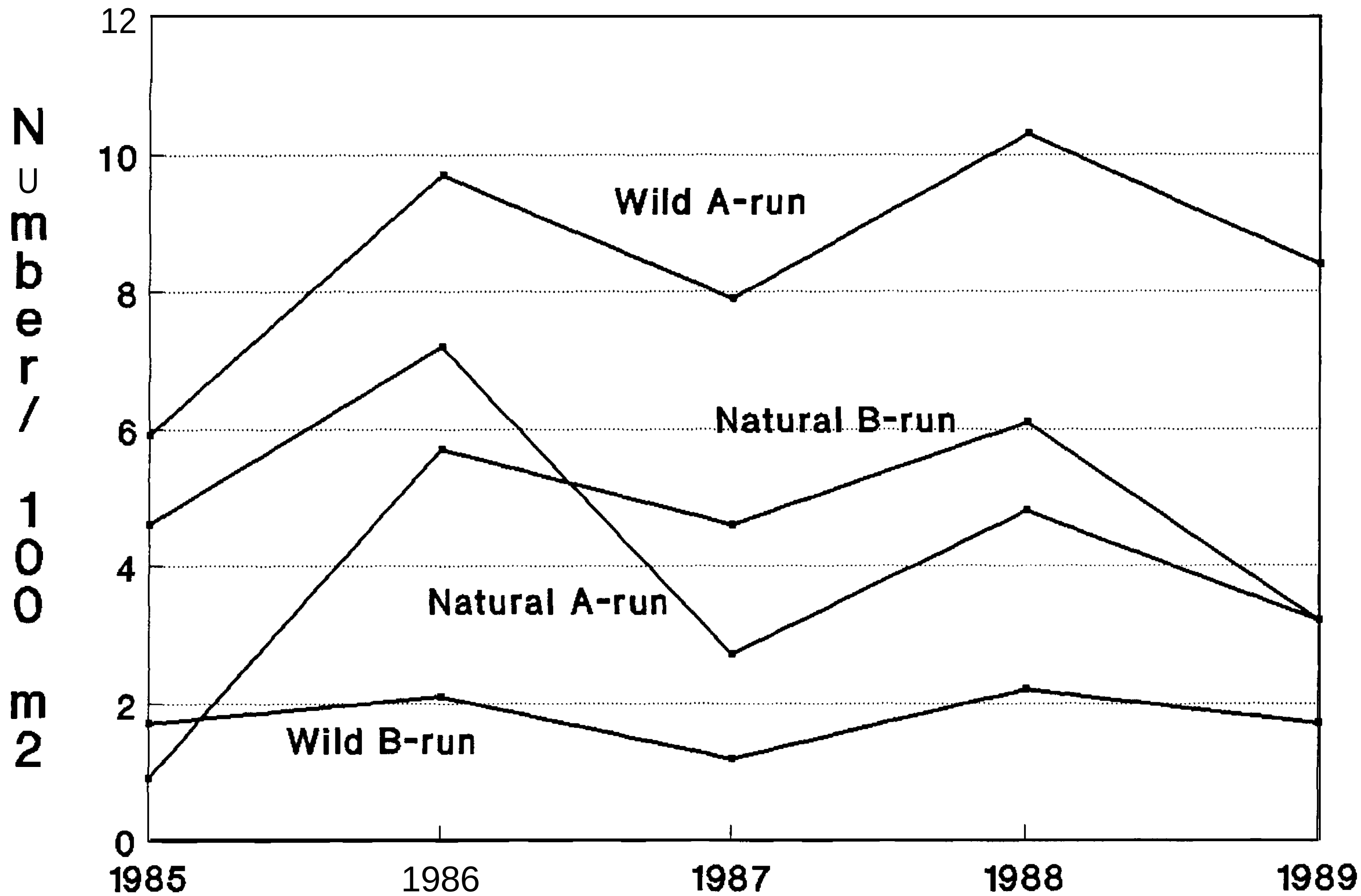

Figure 6. Mean annual density (number of age 1+ steelhead/100 m^2) of four classes of steelhead parr in Idaho, 1985-1989.

Table 6. Mean density in B channels of age 1+ steelhead parr by class and year, F-tests for class and year, and ratio of wild A-run and wild B-run densities, 1985-89.

Class[a]	1985	1986	1987	1988	1989	Test on year F	Test on year p	Test on year n
WA	5.9	9.7	7.9	10.3	8.4	0.91	0.46	93
WB	1.7	2.1	1.2	2.2	1.7	1.20	0.31	215
NA	4.6	7.2	2.7	4.8	3.2	3.78	0.006	179
NB	0.9	5.7	4.6	6.1	3.2	4.32	0.002	157
Test on Class								
F	6.45	10.50	15.18	8.84	11.43			
P	0.001	<0.001	<0.001	<0.001	to.001			
n	93	117	122	151	161			
WA/WB Ratio	3.5	4.6	6.6	4.7	4.9			

[a]W=wild, N=natural, A=A-run, B=B-run

Table 7. Linear regression statistics for age-1+ steelhead parr density in B channels for wild A-run (WA), wild B-run (WB), natural A-run (NA) and natural B-run (NB) on year, 1985-89.

Class	Slope	r^2	F	p	n
WA	0.48	co.01	0.75	0.39	93
WB	0.02	<0.01	0.03	0.86	215
NA	-0.51	0.02	3.23	0.07	179
NB	0.23	x0.01	0.54	0.46	157

8), both areas mostly in designated wilderness with minimal land use problems. Highest densities of natural chinook occurred in areas of intensive supplementation programs, primarily fry stocking. Parr density in C channels and PCC in all monitoring sections generally mirrored each other within cells; although, there were some differences when sample sizes were small for C channel sections in high gradient drainages.

Percent Carrying Capacity

Parr monitoring in 1985-1989 demonstrated depressed levels of chinook populations. Wild spring and summer chinook density averaged 12% of the rated carrying capacity. Natural spring and summer chinook PCC averaged 19%. The PCC of age 0+ chinook parr was analyzed in a two-way analysis of variance with categories of year and class. No trend of rebuilding or decline from 1985-1989 was observed (p=0.69). The PCC was significantly different between wild and natural classes (p=0.001), and there was no interaction between years and classes (p=0.669).

PCC for natural chinook was higher than for wild chinook in each year (Figure 7), and levels of significance (p) for these annual comparisons ranged from 0.045 to 0.11 in all years but 1987 (Table 9). PCC for wild chinook always was low, however, with PCC ranging from 9% to 15%. PCC for natural chinook ranged from 17% to 23%. There were no significant differences between years for either wild (p=0.57) or natural (p=0.51) runs. Linear regressions of PCC on years suggested positive trends for 1985-1989 (Table 10), but the slopes were not significant for wild (p=0.45) or natural (p=0.24) chinook.

Age 0+ Density in C channels

Trends in age 0+ chinook parr density (number/100 m^2) in C channels were analyzed in a two-way analysis of variance with categories of year and class. Class (wild and natural) means differed significantly (0.091, but years and class by year interaction did not (p=0.24 and 0.16, respectively).

One-way analyses of variance (Table 11) demonstrated that no significant difference occurred between years in densities of wild chinook parr (p=0.34), but a significant difference occurred between years for natural chinook (p=0.07). The significantly different means were 16.2 and 32.5/100 m^2 (Tukey's HSD multiple comparisons) from 1985 and 1989, respectively. Annually, the only significant difference occurred in 1989 when wild and natural densities were 13.9 and 32.5, respectively (p=0.032). Regressions of chinook parr density on years (Table 12) produced positive slopes for each run type, but the only significant slope was for natural chinook (p=0.02).

Although natural chinook parr density in C channels generally exceeded wild chinook parr density (except in 1987), the only large change to occur for natural chinook during the five-year interval was the increase from an average of 18.9

Table 8. Percent carrying capacity (PCC) for chinook parr in all monitoring sections and density of chinook parr in C channels, 1989.

Class, Cell	PCC (n)	Age 0+ density in C channels (n)
Wild (Spring)		
1. Middle Fork Salmon River (Without Bear Valley/Elk Creek)	21 (33)	20.7 (16)
2. Salmon River canyon tributaries (without Chamberlain Basin)	1 (15)	-- (0)
4. Chamberlain Basin	23 (4)	25.0 (2)
5. Bear Valley/Elk Creek	5 (7)	7.3 (4)
Wild (Summer)		
3. Middle Fork Salmon, Secesh and upper Salmon rivers	5 (7)	7.3 (4)
Natural (Spring)		
6. Upper Salmon River	17 (36)	19.2 (21)
7. Pahsimeroi, Lemhi, North Fork Salmon rivers and Panther Creek	38 (9)	42.2 (6)
9. Little Salmon River	11 (7)	-- (0)
10. Selway River	2 (18)	12.0 (2)
11. Lochsa River	8 (14)	-- (0)
12. South Fork Clearwater River	44 (39)	53.2 (14)
13. Lolo Creek	12 (7)	27.9 (1)
Natural (Summer)		
8. South Fork Salmon River	20 (15)	26.7 (4)

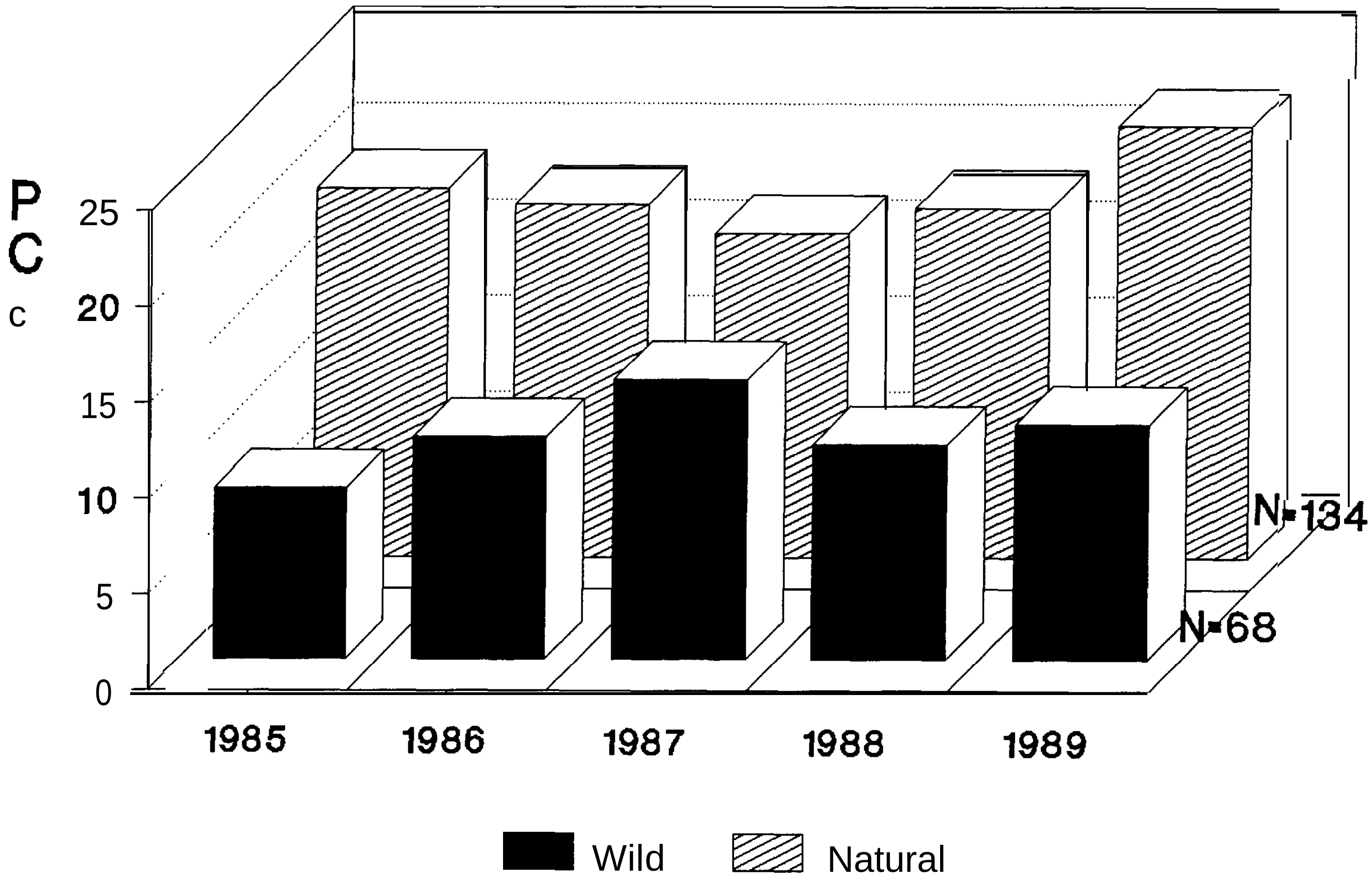

Figure 7. Mean annual Percent of Carrying Capacity (PCC) of two classes of chinook parr (age 0+) in Idaho, 1985-1989.

Table 9. Mean percent carrying capacity **(PCC)** of chinook parr by class and **year,** and tests for class and year, 1985-89.

						Test on year		
Class	1985	1986	1987	1988	1989	F	p	n
Wild Spring/ Summer	8.9	11.6	15.0	11.2	12.5	0.73	0.57	322
Natural Spring/ Summer	18.1	17.5	16.7	17.4	23.0	0.82	0.51	579
Test on Class								
t	2.02	1.60	0.39	1.68	1.935			
P	0.045	0.11	0.70	0.096	0.054			
n	141	165	175	204	216			

Table 10. Linear regression statistics for PCC of wild and natural chinook parr on year, 1985-1989.

Class	Slope	r^2	F	p	n
Wild	0.612	<0.01	0.58	0.49	322
Natural	1.135	co.01	1.37	0.24	579

Table 11. Mean density in C channels of chinook parr by class and year, and tests for class and year, 1985-89.

Class	1985	1986	1987	1988	1989	Test on year F	p	n
Wild Spring/ Summer	13.0	15.4	23.9	16.7	13.9	1.15	0.34	142
Natural Spring/ Summer	16.2	18.7	21.8	18.5	32.5	2.23	0.067	223
Test on Class								
t	0.59	0.61	0.32	0.40	2.18			
P	0.55	0.54	0.75	0.69	0.03			
n	66	65	77	77	88			

Table 12. Linear regression statistics for density in C channels of wild and natural chinook parr on year, 1985-89.

Class	Slope	r^2	F	P	n
Wild	0.118	co.01	0.008	0.93	142
Natural	3.279	0.02	5.47	0.02	223

from 1985 through 1988 to 32.5 in 1989 (Figure 8). This magnitude of change was not observed in the PCC statistic, indicating that the greatest increases in parr density occurred in high quality habitat, which would have the least change in PCC per unit change in density.

Chinook Reproduction Curves

Chinook reproduction curves were developed for Salmon River drainage streams where percent of surface sand was less than 35%. This classification included Sulphur Creek data in the model (33% surface sand), but excluded data from the heavily sedimented Bear Valley/Elk Creek sections (average of 46% surface sand). The relationship was:

Redd density/Parr density=0.103 + 0.010 redd density

$r^2=0.337$, $p<0.001$, and $n=66$

where redd density = redds/hectare and parr density = age 0+ parr/100 m^2.

This equation produced a reproduction curve with an estimated carrying capacity of 85 parr/100 m^2 at a redd density of 60/ha (Figure 9).

We expected, and observed, a high degree of variation in both parr density and redd density data. Inspection of the raw data suggests that some future refinements could be made in the relationship. For example, the Marsh Creek drainage is divided into four redd count reaches, which were summarized separately in this analysis. Movement of parr between redd count reaches in Marsh and Knapp creeks is likely and probably contributed variation in the redd:parr relationship.

The Beverton-Holt model predicted a carrying capacity 80% of that determined earlier by fry stocking (Petrosky and Holubetz 1988). All the redd densities observed during 1983-1988 have been low to intermediate (except upper Sulphur Creek), relative to escapements needed to reach carrying capacity. More data from high redd density transects are needed to improve the reproduction curve. Redd densities in the 1960s in Marsh Creek averaged 19/ha (Petrosky and Holubetz 1988). Of the 66 redd:parr observations used in this report, only 12 had redd densities greater than 5/ha and only 5 exceeded IO/ha.

Chinook Egg-to-Parr Survival

The mean unweighted survival rate from mid-May to mid-August for the 17 fry plant evaluations in 1986-1989 was 18.9% (Table 13). The average value for 1989 alone was 15.6%. The 1989 fry, from Dworshak National Fish Hatchery, were released in upper Lochsa River tributaries and had survival rates ranging from 6.8% in Hopeful Creek to 23.7% in Big Flat Creek. Mean survival of the 17 fry plant evaluations from green egg to parr would be 14.1%.

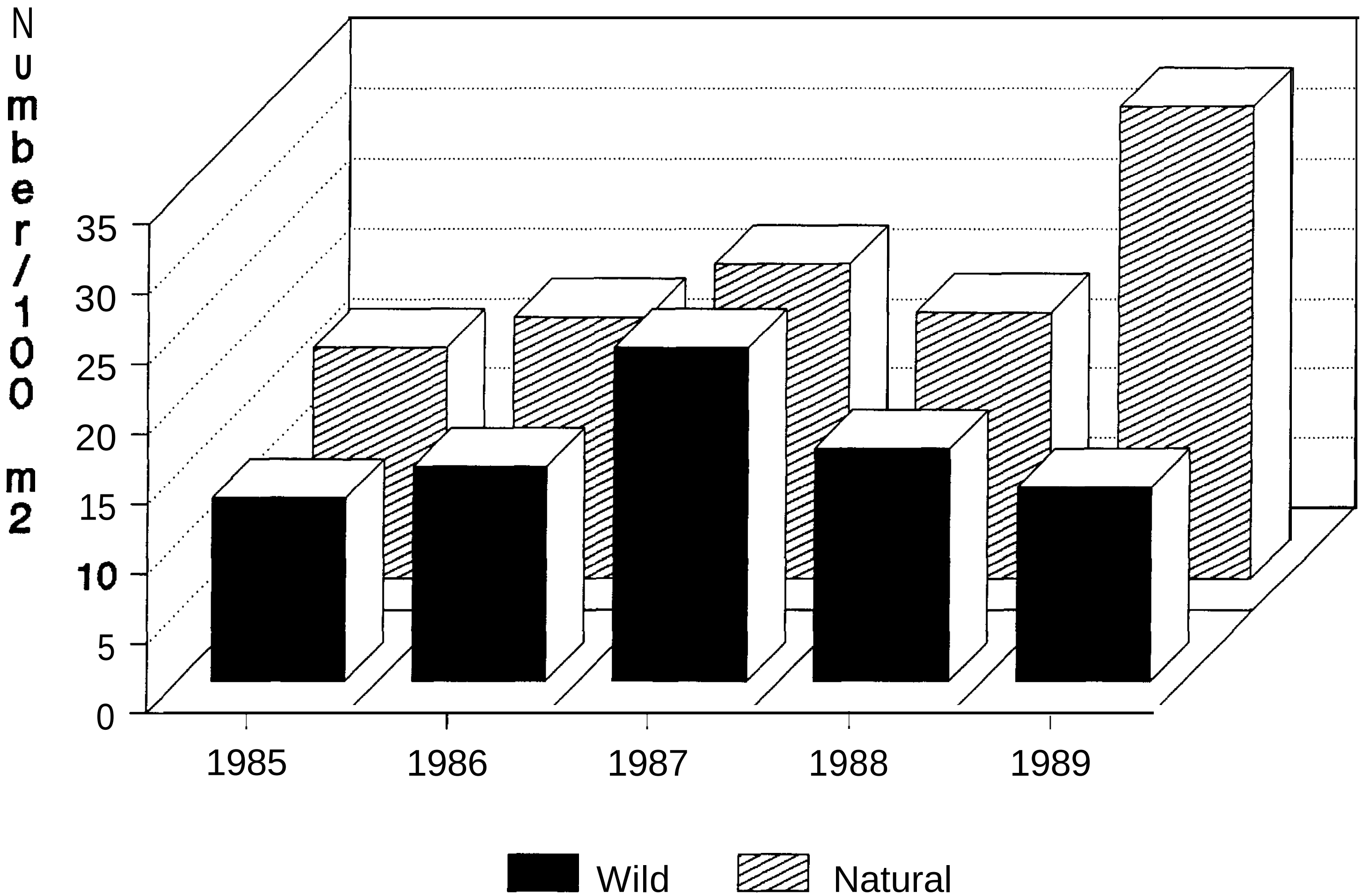

Figure 8. Mean annual density (number/100 m^2) of two classes of chinook parr (age 0+) in Idaho, 1985-1989.

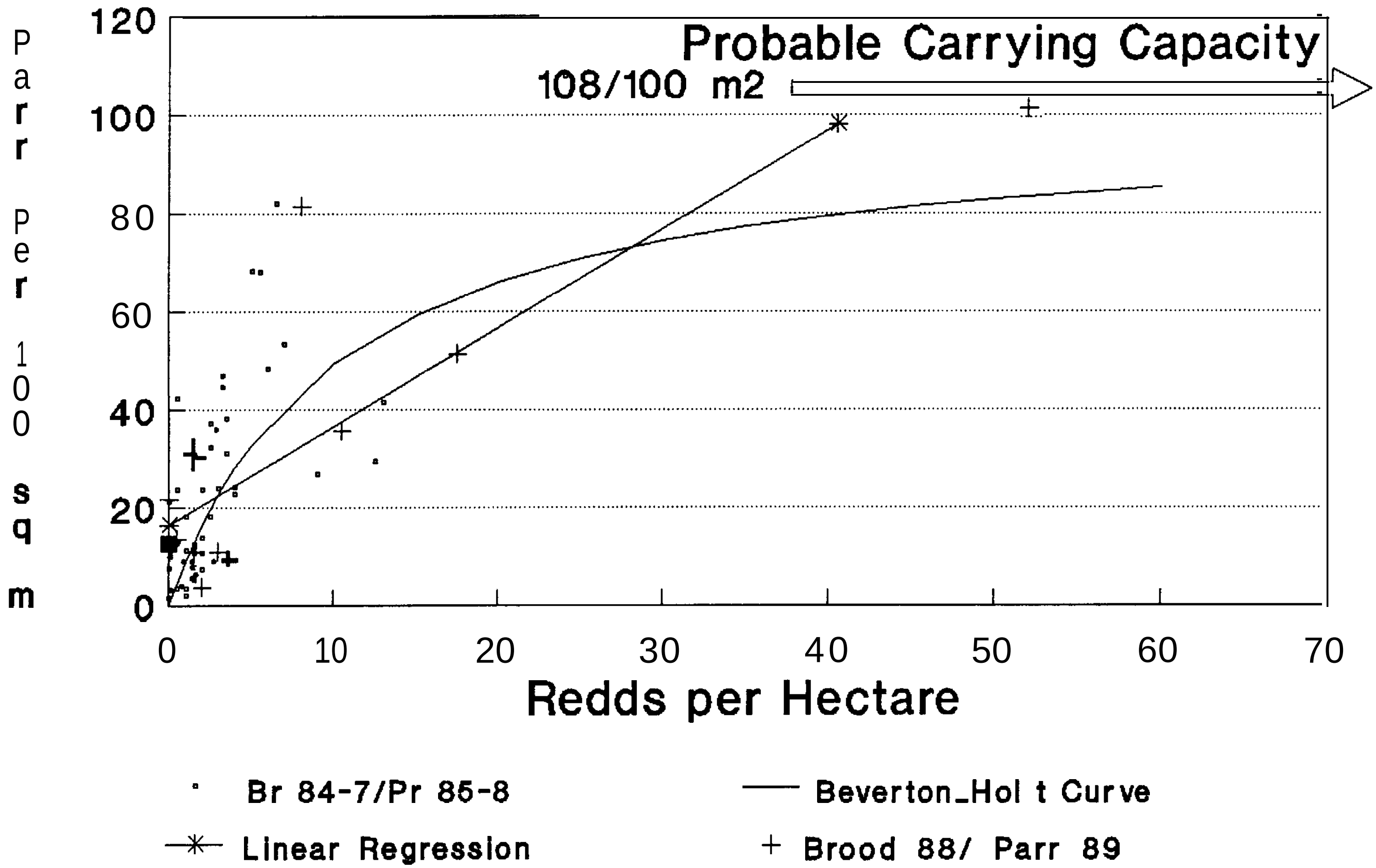

Figure 9. Linear and hyperbolic (Beverton-Holt) regression lines for the density of chinook parr expected as redds/hectare increase. The large arrow represents our best estimate of parr carrying capacity. Scatter points represent redds/ha:parr/100 m^2 data from upper and Middle Fork Salmon River for brood years 1983-1987, for streams with <35% substrate sand. +'s represent the same data for brood year 1988.

Table 13. Mid-August parr survival from mid-May fry releases of chinook salmon into seven Idaho streams from 1986 to 1988.

Stream	year	# stocked (mid-May)	# survived to mid-August (± 2SE as a %)	% survival
White Sand Cr.	1987	152,200	45,064 ± 23.0%	29.6
	1988	108,300	26,470 ± 5.9%	24.4
	1989	58,400	10,042 ± 17.2%	17.2
Big Flat Cr.	1987	97,800	22,106 ± 13.0%	22.6
	1988	72,200	23,753 ± 4.8%	32.9
	1989	37,800	8,973 ± 12.0%	23.7
Crooked Fork Cr.	1986	101,100	11,457 ± 53.0%	11.3
	1987	164,300	32,568 ± 25.0%	19.8
	1988	40,600	8,860 ± 16.8%	21.8
	1989	46,700	7,467 ± 31.9%	16.0
Hopeful Cr.	1986	55,100	6,131 ± 136.0%	11.1
	1988	62,200	8,796 ± 9.0%	14.1
	1989	46,700	3,163 ± 22.2%	6.8
Eldorado Cr.	1986	199,000	30,203 ± 44.0%	15.2
Boulder Cr.	1986	99,900	28,112 ± 88.0%	28.1
Johnson Cr.	1986	186,000	23,711 ± 43.0%	12.8
	1987	34,500	3,102 ± 92.0%	13.3
unweighted mean % survival:				18.9
Green egg to parr survival (75% x 18.9):				14.1

The number of chinook fry stocked in the upper Lochsa tributaries in 1986, 1987, 1988, and 1989 were 156,200, 414,000, 283,000, and 190,000, respectively. The fry stocked in 1989 were much larger (3.0 grams) than in 1988 (1.2 grams). Snorkelers in August 1989 reported seeing several dead chinook parr in each of the stocked tributaries, a condition which had not been noticed in previous years.

Even though fewer chinook fry were stocked in 1989 than in 1988, the parr were well dispersed from the stocking sites in 1989. Maximum densities observed in sections of Crooked Fork, Hopeful, White Sand, and Big Flat creeks were 69, 20, 30, and 37/100 m^2 in 1989 compared to 112, 55, 100, and 90/100 m^2 in 1988, respectively (Appendix A-3).

Precision was not as good in 1989 as in 1988. Bounds on the error of estimation ($\pm$ 2 SE), expressed as a percentage of the mean, averaged 23% and 9.5%, respectively. The error of estimation in 1989 was considerably higher in the B channel streams (27.1% in Crooked Fork and Hopeful Creeks) than in the C channel streams (19.1% in Big Flat and White Sand Creeks). Estimated chinook fry-to-parr survival (May to August) averaged 15.9% For the four streams in 1989. Estimated survival was lower in the B channel streams (11.4%) compared to the C channel streams (20.4%). Survival estimates were conservative, since some parr probably dispersed outside the study area.

Wild/Natural Spawning

Egg-to-Parr survival for wild chinook spawning was estimated in the Middle Fork Salmon River tributaries of Bear Valley Creek and Sulphur Creek (Table 14) in 1989. Based on an average fecundity of 5,900 eggs and 1.5 redds per female (Ortmann 1968), egg-to-parr survival was 11.6% in the near-pristine Sulphur Creek and 2.1% for Bear Valley Creek. Mean egg-to-parr survival is 15.0% for all Middle Fork Salmon River data since 1985. If the highly sedimented Bear Valley and Elk Creek data are excluded, resulting in a set of streams similar in quality to those where fry planting evaluations occurred, then egg-to-parr survival from wild/natural spawning was superior to that from fry planting (20.1% versus 14.1%). If we assumed only one redd per female (Bjornn 1978), then the estimate (13.4%) would be very similar to fry planting.

Partial Project Benefits

The Fish and Wildlife Program has funded habitat enhancement projects in Idaho to increase spawning and rearing potential for steelhead and chinook. Projects include barrier removals, off-channel developments, instream structures, and sediment reduction. Although benefits to date are modest, 14 of the 16 projects evaluated had measurable production that could be attributed to the enhancement projects (Tables 15 and 16; Appendix B).

Table 14. Wild/natural chinook egg to parr survival estimates by % sand categories. The analysis assumes a fecundity of 5,900 eggs/female and 1.5 redds/female.

% surface sand	Stream	year	% survival
<30%	Marsh Cr.	1985	32.5
	Salmon R.	1985	25.5
			x = 29.0
30-40%	Herd Cr.[a]	1986	13.0
		1987	13.3
	Sulphur Cr.	1989	11.6
			x = 12.6
>40%	Elk Cr.	1985	6.2
		1986	1.7
		1987	1.2
	Bear Valley Cr.[a]	1984	8.2
		1985	2.2
		1986	1.2
		1989	2.1
			x = 3.3

All habitats (Mean of sand category means): = 15.0%
Mean without Bear Valley and Elk Creeks: = 20.8%

[a]Shoshone-Bannock tribe data on parr abundance.

Table 15. Steelhead parr and smolt benefit estimates attributable to Bonneville Power Administration habitat improvements evaluated by this project.

Project type	Parr production years					1986-89
	1985	1986	1987	1988	1989	Average
Barrier Removals						
Parr	210	8,985	7,660	6,106	3,808	6,640
Smolts	92	3,953	3,370	2,687	1,676	2,922
Off-Channel Development						
Parr	--	327	3,076	1,108	1,446	1,489
Smolts	--	144	1,353	488	636	655
Instream Structures						
Parr	5,803	5,833	9,590	3,553	5,520	6,124
Smolts	2,553	2,567	4,220	1,563	2,429	2,695
Sediment Reduction						
Parr	(Projects were initiated in 1987 and have not yet matured.)					
Smolts						
Totals						
Parr	6,013	15,145	20,326	10,767	10,774	14,253
Smolts	2,646	6,664	8,843	4,737	4,741	6,271

Table 16. Chinook parr and smolt benefit estimates attributable to Bonneville Power Administration habitat improvements evaluated by this project.

Project type	Parr production years					1986-89
	1985	1986	1987	1988	1989	Average
Barrier Removals						
Parr	12,557	103,336	64,370	99,452	155,128	105,572
Smolts	4,897	40,301	25,104	38,786	60,450	41,160
Off-Channel Development						
Parr	--	4,339	209	5,865	32,209	10,656
Smolts	--	1,692	82	2,287	12,562	4,156
Instream Structures						
Parr	14,958	-15,183	51,183	37,716	30,570	26,072
Smolts	5,834	-5,921	19,961	14,709	11,709	10,163
Sediment Reduction						
Parr	(Projects were initiated in 1987 and have not yet matured.)					
Smolts						
Totals						
Parr	27,515	92,437	115,614	143,033	217,907	142,248
Smolts	10,731	36,070	48,089	55,783	84,984	55,482

Barrier removals, followed by instream structures, have had the largest positive effect on anadromous fish production to date. Off-channel developments, in the form of connected ponds, have very high chinook parr carrying capacity, with observed densities in supplemented ponds in excess of 200/100 m^2. However, the amount of surface area in off-channel developments thus far created has been small (see appendices B-6c and B-7b) and total smolt production benefits slight. The sediment reduction project on the Bear Valley/Elk Creek drainage depends on improved grazing management and will not produce full benefits in terms of reduced sediment and increased egg-to-parr survival for several years. A slight improvement occurred in the ratio of chinook parr density, but not in the ratio of steelhead parr density in 1987-89 for BVC/EC:control streams (Appendix B-10).

Quantification of instream structure benefits has been the most difficult. Monitoring of parr densities in treatment and control sections suggest some project benefits have occurred. More intensive evaluations by this project have detected some significant density increases due to the structures, but the majority of differences were not significant (Petrosky and Holubetz 1985, 1986, and 1987). Clearwater Biostudies, Inc. (1988) found that age 0+ chinook and ages 1+ and older steelhead parr were generally more abundant in enhanced than un-enhanced habitat in Lo10 Creek. The mean percent density increases observed after project completion (1986-89) in Lo10 Creek, Crooked River, and Red River were 38%, 32%, and -26% for steelhead and 20%, 34%, and 34% for chinook, respectively.

Although the evidence is statistically weak (due to high variability in the data and thus low power of the tests), it appears that modest density increases have occurred due to the three instream structure projects. For current mitigation accounting, we have assumed that the density differences are real. These estimates will be revised as necessary, based on future evaluations with increased sample size. In this report, we estimated benefits as the mean difference in parr density each year between control and treatment sections (Appendix B-l, B-6b, and B-7a). The mean differences in parr density were multiplied by the stream surface area in the affected reaches and factored by the estimated parr-to-smolt survival. This approach probably overestimated instream structure benefits since we have not yet determined the portion of the reaches that were not affected by the structures (i.e. areas that would classify as control areas or that were not treated because of preexisting good habitat). However, the amount of area not treated in the instream structure project reaches is small relative to the area treated. Estimates of the treated surface area will be incorporated in future reports.

Instream structure projects in Lo10 Creek, Crooked River, and Red River will be evaluated again in 1990-1991. Sampling effort will be increased, with the objective of detecting significant differences if parr densities in treated sections exceed those in controls by at least 30%.

Kiefer and Forster (1990) determined average parr-to-smolt survival rates of 39% for chinook and 44% for steelhead for 1988-1989 from the upper Salmon River and Crooked River. During the period when most habitat enhancement projects were mature (1986-89), annual benefits averaged 6,271 steelhead smolts and 55,482 chinook smolts (Tables 15 and 16, respectively).

Maximizing benefits from habitat improvement projects depends on adequate main stem flows and good passage survival of smolts in the Snake and Columbia rivers. Determination of benefits in terms of adult returns and economic benefits is beyond the scope of Project 83-7, but will be possible based on these parr and smolt estimates and the future System Monitoring and Evaluation Program (section 206(d)) data on smolt to adult returns to the Columbia River and to Idaho.

Based on recent average return rates of 1.67% for A-run steelhead and 0.37% for chinook, the estimated smolt benefits would result in adult benefits of 105 steelhead and 205 chinook returning to Idaho for the first generation. Meyers (19821 assigned respective values of $359 and $550 per adult steelhead and chinook returning to the Columbia River system. Using these values, and Idaho returns, the average first generation benefit from the BPA projects implemented in Idaho would be $37,695 for steelhead and $112,750 for chinook. The benefits would increase substantially with time if populations rebuild due to improved flows and passage survival. Conversely, the benefits would be negligible if populations decline. The calculations in Table 17 illustrate the range of first generation benefits that could occur depending on passage survival conditions and smolt-to-adult returns.

The number of smolts attributed to the habitat projects to date is small relative to the projects' potential. This is due primarily to chronic poor passage survival and the resulting underescaped, depressed populations.

In BPA habitat improvement project areas, chinook densities averaged 23% of the rated capacity; 15% of the PCC was attributed to the projects (Figure 10; Appendix Cl). Project benefits were artificially high for chinook due to fry stocking in many streams, either to establish natural populations or to supplement natural production in the project areas.

Steelhead PCC averaged 12% in habitat improvement project streams (Figure 10; Appendix C2). Only 5% of the PCC was attributed to the projects. Most steelhead projects were in B run production areas or in A run areas of the upper Salmon River, both areas with extremely depressed populations.

Seventy-seven percent and 88% of carrying capacity for chinook and steelhead, respectively, remained unoccupied in the project streams (Figure 10). Stocking has artificially increased the PCC in some project streams, but not to an extent that has overcome the escapement deficit from poor passage survival.

Compared to **Subbasin** Planning estimates of natural smolt potential in Idaho of 15.5 million spring/summer chinook and 4.5 million steelhead, the increased production from implemented habitat projects is extremely small. If all Idaho habitat improvement projects identified in **Subbasin** Planning were implemented, total smolt potential would increase only 17% for chinook and 9% for steelhead because the productive capacity remains high for the majority of Idaho anadromous fish streams. However, for a limited number of degraded streams, habitat improvement could yield significant benefits if the passage survival problem is solved.

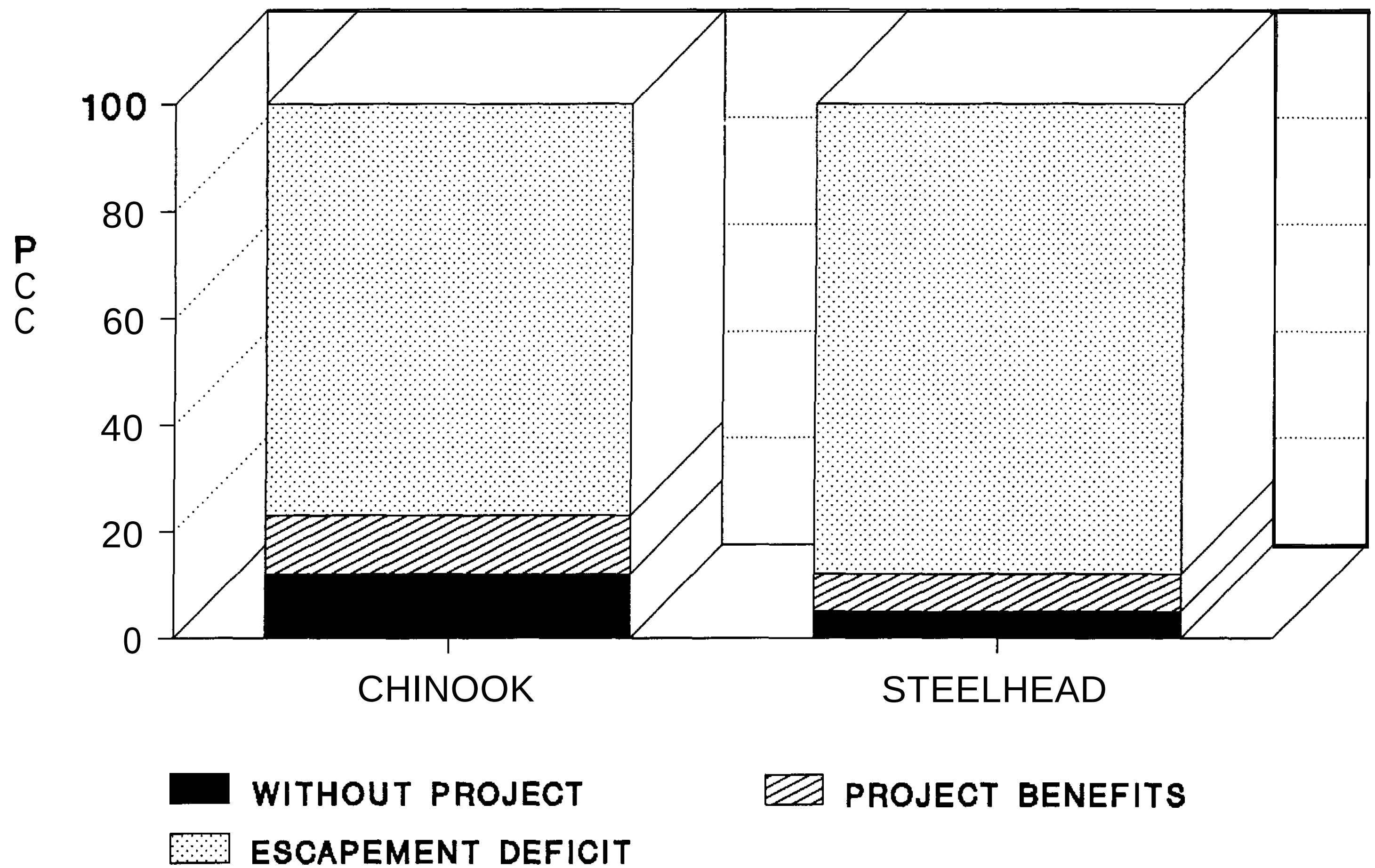

Figure 10. Mean percent of rated carrying capacity for chinook and steelhead parr without habitat projects, project benefits, and unrealized potential due to escapement deficit, BPA habitat improvement areas, Idaho, 1986-1989.

Table 17. Expected first generation adult chinook and steelhead returns and their economic values, annual and capitalized, under a range of smolt-to-adult returns, which result from a range of Snake River discharges during the smolt migration.

Species	No. of Parr	No. of Smolts	SAR	No. of Adults	Value/ Adult $	Annual Value $	Capitalized Value $[b]
Chinook	142,248	55,482	0.37[a]	205	550	112,750	1,409,375
"	"	"	0.25	139	"	76,450	955,625
"	"	"	0.50	277	"	152,350	1,904,375
"	"	"	0.75	416	"	220,800	2,860,000
"	"	"	1.00	555	"	305,250	3,815,625
"	"	"	1.25	694	"	381,700	4,393,125
Steelhead	14,253	6,271	1.67[a]	105	359	37,695	471,188
"	"	"	0.50	31	"	11,129	139,113
"	"	"	1.00	63	"	22,617	282,713
"	"	"	1.50	94	"	33,746	421,825
"	"	"	2.00	125	"	44,875	560,938
"	"	"	2.50	157	"	56,363	704,538
"	"	"	3.00	188	"	67,492	843,650

[a] Average smolt-to-adult return rates used for sub-basin planning.

[b] **Capitalized** value **(Barlowe** 1978, page 182) is the amount of money that would have to be invested at the current available rate (8%) to generate the annual value in perpetuity. It is equal to the annual value divided by the decimal equivalent of the interest rate, or 0.08 in this particular case.

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A P P E N D I C E S

Appendix A-l. Monitoring locations (stream, stratum, and section), EPA stream reach codes, channel types, class of steelhead and chinook at each location, and whether or not chinook are monitored at each location. Chinook are not monitored in sections where supplementaion is occurring in previously vacant chinook habitat. These areas are classified as "D" for developing populations.

EPA Stream Reach	Stream Name	Stratum	Section	Channel Type	Steelhead Class W vs N A vs B	Chinook Class W vs N Spr vs Sum	Chinook Monitor Section Yes/No ?
** Snake R, above mouth Salmon R							
1706010101000	GRANITE CR		1	B	NA	WSPR	N
1706010101000	GRANITE CR		2	B	NA	WSPR	N
1706010101000	GRANITE CR		3	B	NA	WSPR	N
1706010101300	SHEEP CR		1	B	WA	WSPR	N
1706010101300	SHEEP CR		2	B	WA	WSPR	N
1706010101400	WOLF CR		1	B	WA	WSPR	N
** Snake R, below mouth Salmon R							
1706010303900	CAPTAIN JOHN CR		1	B	NA	WSPR	N
1706010303900	CAPTAIN JOHN CR		2	B	NA	WSPR	N
** Upper Salmon R							
1706020100200	MORGAN CR	LOWER	FENCE	B	NA	NSPR	Y
1706020100200	MORGAN CR	UPPER	BLM-CAMP	C	NA	NSPR	N
1706020103500	THOMPSON CR	ABOVE	TWO-POLE	B	NA	NSPR	Y
1706020103500	THOMPSON CR	BELOW	1	B	NA	NSPR	Y
1706020103900	SALMONR		RBNSN-BAR	B	NA	WSUM	Y
1706020105200	VALLEY CR	1	B	C	NA	NSPR	Y
1706020105300	VALLEY CR	3	A	C	NA	NSPR	Y
1706020105400	VALLEY CR	3	B	C	NA	NSPR	Y
1706020105500	VALLEY CR	6	B	B	NA	NSPR	Y
1706020106000	SALMON R	2	B	B	NA	NSPR	Y
1706020106100	REDFISH LK CR		LOWER	B	NA	NSPR	Y
1706020106100	REDFISH LK CR		WEIR-DS	B	NA	NSPR	Y
1706020106900	SALMON R	3	A	B	NA	NSPR	Y
1706020106900	SALMON R	3	B	B	NA	NSPR	Y
1706020106900	SALMON R	3	BRA	C	NA	NSPR	Y
1706020106900	SALMONR	3	BRB	C	NA	NSPR	Y
1706020107001	SALMON R	4	A	C	NA	NSPR	Y
1706020107001.5	SALMON R	4	BRA	C	NA	NSPR	Y
1706020107100	SALMONR	4	B	C	NA	NSPR	Y
1706020107100	SALMON R	5	A	B	NA	NSPR	Y
1706020107500	SALMONR	5	B	B	NA	NSPR	Y
1706020107501	SALMONR	6	A	C	NA	NSPR	Y
1706020107501	SALMONR	6	B	B	NA	NSPR	Y
1706020107700	ALTURAS LK CR	DS-DVRSN	1A	B	NA	NSPR	Y
1706020107700	ALTURAS LK CR	DS-DVRSN	1B	C	NA	NSPR	Y
1706020107700	ALTURAS LK CR	DS-DVRSN	1C	C	NA	NSPR	Y
1706020107700	ALTURAS LK CR	US-DVRSN	2A	B	NA	NSPR	D
1706020107700	ALTURAS LK CR	US-DVRSN	2B	B	NA	NSPR	D
1706020108100	ALTURAS LK CR	US-LAKE	3A	C	NA	NSPR	D
1706020108100	ALTURAS LK CR	US-LAKE	3B	C	NA	NSPR	D
1706020108200	SALMON R	7	A	C	NA	NSPR	Y

1706020108200	SALMON R	7	B	C	NA	NSPR	Y
1706020108200	SALMON R	8	A	C	NA	NSPR	Y
1706020108200	SALMON R	8	B	C	NA	NSPR	Y
1706020108300	SMILEY CR	1	A	B	NA	NSPR	D
1706020108300	SMILEY CR	1	B	C	NA	NSPR	D
1706020108300	SMILEY CR	2	B	C	NA	NSPR	D
1706020108400	SALMON R	10	A	B	NA	NSPR	Y
1706020108400	SALMON R	10	B	C	NA	NSPR	Y
1706020108400	SALMON R	9	A	C	NA	NSPR	Y
1706020108400	SALMON R	9	B	B	NA	NSPR	Y
1706020109800	SALMON R, E FK	BELOW-WEIR	8	C	NA	NSPR	Y
1706020110300	SALMON R, E FK	BELOW-WEIR	5	C	NA	NSPR	Y
1706020110700	SALMON R, E FK	ABOVE-WEIR	2	C	NA	NSPR	Y
1706020110700	SALMON R, E FK	ABOVE-WEIR	3	C	NA	NSPR	Y
1706020114700	BEAVER CR	1	A	C	NA	NSPR	D
1706020114700	BEAVER CR	1	B	C	NA	NSPR	D
1706020114700	BEAVER CR	2	A	C	NA	NSPR	D
1706020114700	BEAVER CR	2	B	C	NA	NSPR	D
1706020114800	FRENCHMAN CR		1A	B	NA	NSPR	D
1706020114800	FRENCHMAN CR		1B	B	NA	NSPR	D
1706020114900	POLE CR	I	A	C	NA	NSPR	D
1706020114900	POLE CR	I	B	C	NA	NSPR	D
1706020114900	POLE CR	II	A	C	NA	NSPR	D
1706020114900	POLE CR	IV	A	C	NA	NSPR	D
1706020114900	POLE CR	IV	B	B	NA	NSPR	D
1706020114900	POLE CR	V	A	C	NA	NSPR	D
1706020114900	POLE CR	V	B	C	NA	NSPR	D
** Pahsimeroi R							
1706020200100	PAHSIMEROI R		DWTNLANE	C	NA	NSUM	Y
1706020200100	PAHSIMEROI R		LOWER	C	NA	NSUM	Y
** N Fk Salmon R and Panther Cr							
1706020300600	PANTHER CR	DS-CLEAR	PC1	B	NA	NSPR	N
1706020301000	PANTHER CR	DS-BIGD	PC4	B	NA	NSPR	N
1706020301400	PANTHER CR	DS-BLACKB	PC6	C	NA	NSPR	N
1706020302000	PANTHER CR	ABOVE	PC9	C	NA	NSPR	N
1706020302200	PANTHER CR	ABOVE	PC10	C	NA	NSPR	N
1706020302300	MOYER CR	ABOVE	MO1	C	NA	NSPR	Y
1706020307500	SALMON R, N FK		HUGHES	C	NA	NSPR	Y
1706020307700	SALMON R. N FK		DAHLDNEGA	B	NA	NSPR	Y
** Lemhi R							
1706020402400	HAYDEN CR	HC3	B	B	NA	NSPR	Y
1706020402600	BEAR VALLEY CR	HC1	B	C	NA	NSPR	Y
1706020402800	HAYDEN CR	HC2	B	B	NA	NSPR	Y
1706020408300	BIG SPRINGS CR	LEM1	A	C	NA	NSPR	Y
** Upper Middle Fk Salmon R							
1706020500600	MARBLE CR	UPPER	MAR1	B	WB	WSPR	N
1706020500600	MARBLE CR	UPPER	MAR2	B	WB	WSPR	N
1706020501100	PISTOL CR		L1	B	WB	WSPR	Y

1706020501100	PISTOL CR		L2	B	WB	WSPR	Y
1706020502100	SULPHUR CR	3	A	B	WB	WSPR	Y
1706020502100	SULPHUR CR	4	A	C	WB	WSPR	Y
1706020502100	SULPHUR CR	4	B	B	WB	WSPR	Y
1706020502300	BEAR VALLEY CR	1	A	B	WB	WSPR	Y
1706020502500	BEAR VALLEY CR	2	A	C	WB	WSPR	Y
1706020502500	BEAR VALLEY CR	2	B	C	WB	WSPR	Y
1706020502600	ELK CR		A	C	WB	WSPR	Y
1706020502600	ELK CR		B	C	WB	WSPR	Y
1706020502600	ELK CR	2	A	C	WB	WSPR	Y
1706020502600	ELK CR	2	B	C	WB	WSPR	Y
1706020502700	BEAR VALLEY CR	3	A	C	WB	WSPR	Y
1706020502800	BEAR VALLEY CR	5	A	C	WB	WSPR	Y
1706020502800	BEAR VALLEY CR	7	BIG-MDW-L	C	WB	WSPR	Y
1706020502800	BEAR VALLEY CR	9	B	C	WB	WSPR	Y
1706020503200	MARSH CR		A	B	WB	WSPR	Y
1706020503200	MARSH CR		B	B	WB	WSPR	Y
1706020503400	CAPE HORN CR	1	A	C	WB	WSPR	Y
1706020503400	CAPE HORN CR	2	B	C	WB	WSPR	Y
1706020503500	MARSH CR	4	B	C	Wb	WSPR	Y
1706020503502	MARSH CR	5	A	C	WB	WSPR	Y
1706020503503	KNAPP CR		A	C	WB	WSPR	Y
1706020503503	KNAPP CR	2	B	C	WB	WSPR	Y
1706020503600	BEAVER CR		A	B	WB	WSPR	Y
1706020503600	BEAVER CR	3	B	C	WB	WSPR	Y
1706020505000	LOON CR		1	C	WB	WSPR	Y
1706020505000	LOON CR		2	C	WB	WSPR	Y
1706020505000	LOON CR		Ll	B	WB	WSPR	Y
1706020505000	LOON CR		L2	B	WB	WSPR	Y
1706020505000	LOON CR		LNM1	B	WB	WSPR	Y
1706020506300	MARSH CR	6	A	C	WB	WSPR	Y
1706020508400	BEARSKIN CR	1	B	B	WB	WSPR	Y
** Lower Middle Fk Salmon R							
1706020600700	BIG CR	LOWER	L1	B	WB	WSPR	Y
1706020601100	BIG CR	MIDDLE	TAYLOR1	C	WB	WSPR	Y
1706020603200	BIG CR	UPPER	BIG1	B	WB	WSPR	Y
1706020603600	MONUMENTAL CR		MON5	C	WB	WSPR	Y
1706020603700	MONUMENTAL CR, W FK		MON4	C	WB	WSPR	Y
1706020603800	MONUMENTAL CR		MON1	B	WB	WSPR	Y
1706020603800	MONUMENTAL CR		MON2	B	WB	WSPR	Y
1706020603800	MONUMENTAL CR		MON3	B	WB	WSPR	Y
1706020605100	CAMAS CR		L1	B	WB	WSPR	Y
1706020605200	CAMASCR		1	C	WB	WSPR	Y
1706020605200	CAMASCR		2	C	WB	WSPR	Y
1706020605200	CAMASCR		CAM1	B	WB	WSPR	Y
** Upper Salmon R canyon							
1706020703800	CHAMBERLAIN CR		Ll	B	WA	WSPR	Y
1706020703800	CHAMBERLAIN CR		L2	B	WA	WSPR	Y
1706020704200	CHAMBERLAIN CR		CHA1	B	WA	WSPR	Y
1706020704300	CHAMBERLAIN CR, W FK		CHA2	C	WA	WSPR	Y

Appendix A-l. Continued.

1706020704300	CHAMBERLAIN CR, W FK		CHA3	B	WA	WSPR	Y
1706020704400	CHAMBERLAIN CR		CHA4	C	WA	WSPR	Y
1706020707000	HORSE CR		il	B	WA	WSPR	Y
1706020707000	HORSE CR		L2	B	WA	WSPR	Y
1706020708000	BARGAMIN CR		L1	B	WA	WSPR	Y
1706020708000	BARGAMIN CR		L2	B	WA	WSPR	Y
1706020709300	SHEEP CR		L1	B	WA	WSPR	Y
1706020709300	SHEEP CR		L2	B	WA	WSPR	Y

** S Fk Salmon R

1706020801601	SECESH R		GROUSE	B	WB	WSUM	Y
1706020801601	SECESH R		LONG-GULCH	C	WB	WSUM	Y
1706020801601	SECESH R		U-SCSH-MDW	C	WB	WSUM	Y
1706020801700	LAKE CR		BURGDORF	C	WB	WSUM	Y
1706020801700	LAKE CR		WILLOW	C	WB	WSUM	Y
1706020802000	LICK CR		L3	B	WB	WSUM	Y
1706020802200	SALMON R, S FK		16	B	WB	NSUM	Y
1706020802400	SALMON R, S FK		14	B	WB	NSUM	Y
1706020802900	SALMON R, S FK		11	B	WB	NSUM	Y
1706020802900	SALMON R, S FK		POVERTY	C	WB	NSUM	Y
1706020803200	DOLLAR CR		1	B	WB	NSUM	Y
1706020803300	SALMON R, S FK		7	B	WB	NSUM	Y
1706020803400	SALMON R, S FK		5	C	WB	NSUM	Y
1706020803600	SALMON R, S FK	STOLLE	1	C	WB	NSUM	Y
1706020803600	SALMON R, S FK	STOLLE	2	C	WB	NSUM	Y
1706020804200	SALMON R, S FK E FK		7	B	WB	NSUM	Y
1706020804300	SALMON R, S FK E FK		6	B	WB	NSUM	Y
1706020804400	JOHNSON CR	LOWER	L2	B	WB	NSUM	Y
1706020804400	JOHNSON CR	LOWER	L3	B	WB	NSUM	Y
1706020804700	JOHNSON CR	ABOVE	Ml	C	WB	NSUM	D
1706020804700	JOHNSON CR	ABOVE	M2	C	WB	NSUM	D
1706020804700	JOHNSON CR	ABOVE	M3	C	WB	NSUM	D
1706020804700	JOHNSON CR	ABOVE	PW1A	B	WB	NSUM	D
1706020804700	JOHNSON CR	ABOVE	PW3A	B	WB	NSUM	D
1706020804700	JOHNSON CR	BELOW	PW3B	B	WB	NSUM	Y
1706020805100	SALMON R, S FK E FK		3	B	WB	NSUM	Y
1706020807400	SAND CR	ABOVE	M2	C	WB	NSUM	D
1706020809800	ROCK CR	ABOVE	Ml	C	WB	NSUM	D

** Lower Salmon R canyon

1706020902500	SLATE CR	12.1		B	NA	WSPR	Y
1706020902500	SLATE CR	4.3		B	NA	WSPR	Y
1706020902500	SLATE CR	6.7		B	NA	WSPR	Y
1706020902500	SLATE CR	8.1		B	NA	WSPR	Y
1706020903000	WHITEBIRD CR			B	WA	WSPR	Y
1706020903000	WHITEBIRD CR		1	B	WA	WSPR	Y
1706020903000	WHITEBIRD CR		3	B	WA	WSPR	Y

** Little Salmon R

1706021000200	RAPID R		RAP2	B	WA	NSUM	Y
1706021000300	RAPID R, W FK		RAP1	B	WA	NSUM	Y
1706021000700	LITTLE SALMON R		2	B	NA	NSPR	Y

Appendix A-l. Continued.

1706021000900	BOULDER CR	ABOVE	1	C	NA	NSPR	D
1706021000900	BOULDER CR	ABOVE	2	B	NA	NSPR	D
1706021000900	BOULDER CR	BELOW	3	B	NA	NSPR	Y
1706021000900	BOULDER CR	BELOW	5	B	NA	NSPR	Y
1706021001000	LITTLE SALMON R		1	B	NA	NSPR	Y
1706021002600	HAZARD CR		HAZ1	B	NA	NSPR	Y
** Upper Selway R							
1706030100800	RUNNING CR		1	B	WB	NSPR	Y
1706030100800	RUNNING CR		2	B	WB	NSPR	Y
1706030101300	SELWAY R		LITTLE-CW	B	WB	NSPR	Y
1706030101300	SELWAY R		MAG-XING	C	WB	NSPR	Y
1706030101400	SELWAY R		HELLSHALF	B	WB	NSPR	Y
1706030101900	DEEP CR		CACTUS	B	WB	NSPR	Y
1706030101900	DEEP CR		SCIMITAR	C	WB	NSPR	Y
1706030102100	WHITE CAP CR		BRIDGE	B	WB	NSPR	Y
1706030102100	WHITE CAP CR		UPPER	B	WB	NSPR	Y
1706030102100	WHITE CAP CR		WILDERNESS	B	WB	NSPR	Y
1706030102400	BEAR CR		1	B	WB	NSPR	Y
1706030102400	BEAR CR		2	B	WB	NSPR	Y
** Lower Selway R							
1706030201000	OTTER CR			B	WB	NSPR	Y
1706030201400	MOOSE CR		1	B	WB	NSPR	Y
1706030201400	MOOSE CR		2	B	WB	NSPR	Y
1706030201500	MOOSE CR		3	B	WB	NSPR	Y
1706030203000	MOOSE CR, N FK			B	WB	NSPR	Y
1706030203900	THREE LINKS CR			B	WB	NSPR	Y
** Lochsa R							
1706030300600	OLD MAN CR			B	NB	NSPR	N
1706030300800	LDCHSA R		L4	B	NB	NSPR	Y
1706030301800	PDST OFFICE CR		1	B	NB	NSPR	Y
1706030301800	POST OFFICE CR		2	B	NB	NSPR	Y
1706030301900	WARM SPRINGS CR			B	NB	NSPR	Y
1706030302300	LDCHSA R		L1	B	NB	NSPR	Y
1706030302700	WHITE SAND CR	LOWER	WS1	B	NB	NSPR	Y
1706030304200	CROOKED FK CR	BELOW	2B	B	NB	NSPR	Y
1706030304300	BRUSHY FK CR		1	B	NB	NSPR	Y
1706030304300	BRUSHY FK CR		2	B	NB	NSPR	Y
1706030304600	CROOKED FK CR		1	B	NB	NSPR	Y
1706030304600	CROOKED FK CR		2	B	NB	NSPR	Y
1706030304600	CROOKED FK CR	BELOW	1B	B	NB	NSPR	Y
1706030305400	FISH CR		1	B	NB	NSPR	Y
1706030305400	FISH CR		2	B	NB	NSPR	Y
** S Fk Clearwater R							
1706030501600	JOHNS CR	0.5	1	B	NB	NSPR	Y
1706030501600	JOHNS CR	1	2	B	NB	NSPR	Y
1706030502000	JOHNS CR		4	B	NB	NSPR	Y
1706030502000	JOHNS CR	2	3	B	NB	NSPR	Y
1706030503300	CROOKED R	C	CAN1	B	NB	NSPR	Y

Appendix A-l . Continued.

1706030503300	CROOKED R	C	CAN2	B	NB	NSPR	Y
1706030503300	CROOKED R	C	CAN3	B	NB	NSPR	Y
1706030503300	CROOKED R	II	CONTROL2	B	NB	NSPR	Y
1706030503300	CROOKED R	II	TREAT2	B	NB	NSPR	Y
1706030503300	CROOKED R	III	NATURAL1	C	NB	NSPR	Y
1706030503300	CROOKED R	IV	MEANDER1	C	NB	NSPR	Y
1706030503300	CROOKED R	IV	MEANDER2	C	NB	NSPR	Y
1706030503301	CROOKED R	H	OROGRANDE1	B	NB	NSPR	Y
1706030503301	CROOKED R	I	BOULDER-A	B	NB	NSPR	Y
1706030503301	CROOKED R	I	BOULDER-B	B	NB	NSPR	Y
1706030503301	CROOKED R	I	CONTROL1	B	NB	NSPR	Y
1706030503301	CROOKED R	I	SILL-LOG-A	B	NB	NSPR	Y
1706030503301	CROOKED R	I	SILL-LOG-B	B	NB	NSPR	Y
1706030503301	CROOKED R	II	TREAT1	B	NB	NSPR	Y
1706030503302	CROOKED R, W FK	H	WF1	B	NB	NSPR	Y
1706030503302	CROOKED R, W FK	H	WF2	B	NB	NSPR	Y
1706030503600	RED R	IV	CONTROL2	C	NB	NSPR	Y
1706030503600	RED R	IV	TREAT2	C	NB	NSPR	Y
1706030503600	RED R	V	CONTROL2	C	NB	NSPR	Y
1706030503600	RED R	V	TREAT2	C	NB	NSPR	Y
1706030503800	RED R	I	CONTROL1	C	NB	NSPR	Y
1706030503800	RED R	I	CONTROL2	C	NB	NSPR	Y
1706030503800	RED R	II	CONTROL2	B	NB	NSPR	Y
1706030503900	RED R	II	TREAT2	B	NB	NSPR	Y
1706030504100	AMERICAN R		1	C	NB	NSPR	Y
1706030504100	AMERICAN R		2	C	NB	NSPR	Y
1706030504300	NEWSDME CR		MOUTH	C	NB	NSPR	Y
1706030504300	NEWSDME CR	MAIN	4MI	C	NB	NSPR	Y
1706030504300	NEWSDME CR	MAIN@SIDE	7MI	B	NB	NSPR	Y
1706030504800	MEADOW CR	CANYON	MILEPOST2	B	NB	NSPR	D
1706030504800	MEADOW CR	MEADOW	GRAZED	C	NB	NSPR	D
1706030507100	RELIEF CR	RC	RELIEF-CR1	C	NB	NSPR	Y
1706030507100	RELIEF CR	RC	RELIEF-CR2	B	NB	NSPR	Y
1706030507100	RELIEF CR	RC	RELIEF-CR3	B	NB	NSPR	Y
1706030507200	CROOKED R, E FK	H	EF1	B	NB	NSPR	Y
1706030507200	CROOKED R, E FK	H	EF2	B	NB	NSPR	Y
** Lower Clearwater R							
1706030602200	BIG CANYON CR		1	B	WA	NSPR	N
1706030603600	LOLO CR	DOWNSTREAM	DS6	B	NB	NSPR	Y
1706030603600	LOLO CR	DOWNSTREAM	RUN6	B	NB	NSPR	Y
1706030603700	ELDORADO CR	ABOVE	1HG	B	NB	NSPR	D
1706030603700	ELDDRADO CR	ABOVE	2LG	C	NB	NSPR	D
1706030603700	ELDDRADO CR	ABOVE	2M	C	NB	NSPR	D
1706030603700	ELDORADO CR	BELOW	1B	B	NB	NSPR	Y
1706030603900	LOLO CR	UPSTREAM	8303	C	NB	NSPR	Y
1706030603900	LOLO CR	UPSTREAM	8360	B	NB	NSPR	Y
1706030603900	LOLO CR	UPSTREAM	RUN1	B	NB	NSPR	
1706030603900	LOLO CR	UPSTREAM	RUN7	B	NB	NSPR	Y

Appendix A-2. Form used for recording physical data at parr monitoring and evaluation sections.

Stream ____________ Date ____________ Collectors ____________

Length (M) ____________ Comments ____________

EPA Reach # ____________ Vertical Drop (M) ____________

Gradient (%) ____________

PROGRAM:
Stratum ____________
Section ____________
Channel Type: ____________
B = Confined, Sediment flushing
C = Meandered, depositional
__ = Other, see Rosgen's Channel Types

Transect (m) from downstream	Width 1(m)	Habitat	Location on transect (1 to r)	Depth 1(m)	% Substrate Clas by Area: Sand 0	Gravel (up to 3")	Rubble (3" to 12")	Boulder (>12")	Bedrock			
			1/4									
			1/2									
			3/4									
			1/4									
			1/2									
			3/4									
			1/4									
			1/2									
			3/4									
			1/4									
			1/2									
			3/4									
			1/4									
			1/2									
			3/4									

Habitat: 1 = Pool; 2 = Run; 3 = Pocket Water **4 = Riffle;** 5 = Backwater

Appendix A-3. Summary of hatchery chinook releases (in thousands) into natural production areas of BPA habitat and monitoring streams, 1984-1989.

Stream	Race[a]	Size	1984	1985	1986	1987	1988	1989
Lolo Creek	SP	egg	0	0	0	0	0	0
		fry	0	0	0	133	148	94
		smolt	0	0	0	0	0	0
		adult	0	0	0	0	0	0
Eldorado Creek	SP	egg	0	0	0	0	0	0
		fry	0	0	270	119	53	170
		smolt	0	0	0	0	0	12
		adult	0	0	0	0	0	0
Crooked Fork Creek	SP	egg	0	0	0	0	0	0
		fry	0	0	200	349	138	99
		smolt	0	0	0	0	0	0
		adult	0	0	0	0	0	0
Crooked River	SP	egg	0	0	0	50	0	0
		fry	0	0	350	0	200	202
		smolt	0	0	0	479	0	200
		adult	0	0	0	0	0	0
Red River	SP	egg	0	0	0	331	0	0
		fry	0	0	0	0	50	0
		smolt	0	80	137	195	0	0
		adult	0	0	0	0	0	0
Meadow Creek	SP	egg	0	0	0	0	0	0
		fry	0	0	0	0	100	39
		smolt	0	0	0	0	0	0
		adult	0	0	0	0	0	0
Panther Creek	SP	egg	0	0	0	137	0	0
		fry	0	0	0	0	0	0
		smolt	0	0	0	0	0	0
		adult	0	0	3.38	0	0	0
Lemhi River	SP	egg	0	0	0	0	0	0
		fry	0	0	1	0	0	0
		smolt	0	0	0	0	0	0
		adult	0	0	0.02	0	0	0.035
East Fork of the Salmon River	SP	egg	0	0	0	0	0	0
		fry	0	0	1	0	0	0
		smolt	0	0	109	195	249	393
		adult	0	0	0	0	0	0.069

Appendix A-3. Continued.

Stream	Race[a]	Size	1984	1985	1986	1987	1988	1989
Upper Salmon River	SP	egg	0	0	0	0	0	0
		fry	0	0	0	0	0	126
		smolt	231	420	348	1185	1605	0
		adult	0	0	0	0.01	0	0.47
Alturas Lake Creek	SP	egg	0	0	0	0	0	0
		fry	0	0	0	0	0	72
		smolt	0	0	0	0	0	0
		adult	0	0	0	0	0	0
Pole Creek	SP	egg	0	0	0	0	0	0
		fry	0	0	0	0	24	72
		smolt	0	0	0	0	0	0
		adult	0	0	0	0	0	0.03
Valley Creek	SP	egg	0	0	0	0	0	0
		fry	0	0	0	0	0	0
		smolt	0	0	0	0	0	0
		adult	0	0	0	0	0	0
South Fork Salmon River	su	egg	0	0	0	0	0	0
		fry	0	0	0	0	0	0
		smolt	270	564	970	958	1060	975
		adult	0	0	0	0	0	0.206
Dollar Creek	su	egg	0	0	0	0	0	0
		fry	0	0	0	0	0	0
		smolt	0	0	0	0	0	0
		adult	0	0	0	0	0	0
Upper Johnson Creek and tribs.	su	egg	0	0	0	0	0	0
		fry	0	51	178	118	367	301
		smolt	0	0	0	0	0	0
		adult	0	0	0	0	0	0
Boulder Creek	SP	egg	0	0	0	140	141	0
		fry	0	0	101	0	0	0
		smolt	0	0	0	0	0	0
		adult	0	0	0	0	0	0
Little Salmon	SP	egg	0	0	0	0	0	0
		fry	0	0	0	0	30	150
		smolt	0	0	0	0	0	0
		adult	0	0	0	0	0	0

[a]SP=spring chinook; SU=summer chinook

Appendix A-4. Summary of hatchery steelhead releases (in thousands) into natural production areas in BPA habitat project and monitoring streams, 1984-1989.

Stream	Race[a]	Size	1984	1985	1986	1987	1988	1989
Lo10 Creek	SB	egg	0	0	0	0	0	0
		fry	0	0	0	0	0	0
		smolt	0	0	0	0	200	0
		adult	0	0	0	0	0	0
Eldorado Creek	SB	egg	0	0	0	0	0	0
		fry	0	0	0	0	0	0
		smolt	0	121	197	0	201	109
		adult	0	1.15	0.15	0	0	0
Crooked Fork Creek	SB	egg	0	0	0	0	0	0
		fry	0	0	0	0	0	0
		smolt	0	0	0	0	0	0
		adult	0	0	0	0	0	0
Colt Creek	SB	egg	0	0	0	0	0	0
		fry	0	0	0	0	0	0
		smolt	0	0	0	0	0	0
		adult	0	0	0	0	0	0
Crooked River	SB	egg	0	0	0	0	0	0
		fry	0	0	0	0	0	0
		smolt	34	42	141	159	201	82
		adult	0	1.73	0	5.2	0	0
Red River	SB	egg	0	731	0	0	182	0
		fry	0	0	0	0	0	0
		smolt	74	80	0	0	0	0
		adult	0	0	0	0	0	0
Meadow Creek	SB	egg	0	0	0	770	1022	0
		fry	0	0	0	0	0	0
		smolt	0	0	0	0	0	0
		adult	0	0	0	0	0	0
Panther Creek	SA	egg	0	0	0	0	0	0
		fry	305	485	625	378	0	282
		smolt	0	208	246	300	237	0
		adult	0.68	0.15	0.12	0	0	0
Pine Creek	SA	egg	0	0	0	0	0	0
		fry	25	0	0	0	0	0
		smolt	0	0	0	0	0	0
		adult	0	0	0	0	0	0

Appendix A-4. Continued.

Stream	Race[a]	Size	1984	1985	1986	1987	1988	1989
Lemhi River	SA	egg	0	0	0	0	0	0
		fry	270	923	718	185	170	255
		smolt	0	0	0	0	0	0
		adult	4.28	0.87	0.68	1.01	0	0
East Fork Salmon River	SB	egg	0	0	0	0	0	0
		fry	0	19	789	0	0	0
		smolt	426	270	495	485	304	890
		adult	0	0	0.42	0.05	0	0.224
Upper Salmon River	SA	egg	0	0	0	0	0	0
		fry	0	503	533	0	327	196
		smolt	724	786	637	688	1253	821
		adult	2.66	0	0	0	0.08	0.378
Alturas Lake Creek	SA	egg	0	0	0	0	0	0
		fry	0	32	300	175	105	84
		smolt	0	0	0	0	0	0
		adult	0	0	0	0	0	0
Pole Creek	SA	egg	0	0	0	0	0	0
		fry	318	488	349	189	106	81
		smolt	0	0	0	0	0	0
		adult	0	0	0	0	0	0
Valley Creek	SA	egg	0	0	0	0	0	0
		fry	215	173	0	142	210	0
		smolt	0	0	0	0	0	0
		adult	1.55	0.10	0.50	0	0	0
Boulder Creek	SA	egg	0	0	0	0	0	0
		fry	149	0	27	0	0	0
		smolt	0	0	0	0	0	0
		adult	0	0	0	0	0	0
Little	SA	egg	0	0	0	0	0	0
		fry	0	82	126	0	0	0
		smolt	0	0	0	0	0	0
		adult	0	0	0	0	0	0

[a] SA~A-run steelhead; SB=B-run steelhead

Appendix A-5. Chinook redd counts and parr densities in traditional redd monitoring reaches of the Middle Fork and Upper Salmon river drainages. Percent of substrate surface sediment (particles less than 6.4 mm) in parr density monitoring sections, parr carrying capacity ratings and hectares of water in the redd monitoring reaches are also listed.

Sediment class	Stream	Redd count reach upstream/downstream	Redd surveys Hectares	Redds	Redds/ha	Parr C C	Parr surveys no./100 m²	n
<30%	Salmon River	headwaters/diversion	3.5	0	0	77	16.3	5
"	Salmon River	diversion/bridge	19.2	8	0.4	96	13.5	5
"	Salmon River	bridge/Sawtooth Weir	33.6	42	1.3	96	10.8	5
"	Alturas Lake Creek	Alpine Cr./Alturas Lk.	2.6	0	0	108	2.6	2
"	Alturas Lake Creek	Cabin Cr. Bridge/mouth	4.1	1	0.2	108	0	1
"	Pole Creek	headwaters/diversion	3.5	0	0	108	0.5	4
"	Pole Creek	diversion/mouth	2.8	0	0	108	na	0
"	Valley Creek	Trap Cr./Stanley L. Cr.	8.4	12	1.4	77	34.2	2
"	East Fork Salmon River	weir/Herd Cr.	15.2	27	1.8	108	14.7	1
"	East Fork Salmon River	Herd Cr./mouth	24.2	76	3.1	77	10.7	1
"	Marsh Creek	airstrip/Cape Horn Cr.	8.6	149	17.3	98	51.2	3
"	Knapp Creek	beaver ponds/mouth	2.1	0	0	108	21.5	1
"	Cape Horn Creek	Banner Cr./mouth	5.1	53	10.4	108	35.5	2
"	Beaver Creek	Bear Cr./bridge	8.0	15	1.9	108	3.5	2
"	Loon Creek	Cabin Cr./steep canyon	4.5	na	na	44	0.5	2
"	Camas Creek	Castle Cr./Hammer Cr.	15.6	na	na	77	2.3	2
30-40%	Bear Valley Creek	P.B. Dredge/Elk Cr.	23.8	134	5.6	77	3.6	3
"	Sulphur Creek	Ranch/lower	5.2	41	7.9	108	81.5	2
"	Sulphur Creek	Island/ranch[a]	1.9	99	52.2	108	101.6	2

Appendix A-5. Continued.

Sediment class	Stream	Redd count reach upstream/downstream	Redd surveys Hectares	Redds	Redds/ha	Parr C C	Parr surveys no./100 m^2	n
>40%	Valley Creek	Stanley Lk. Cr./mouth	19.3	33	1.7	77	53.6	1
"	Bear Valley Creek	Elk Cr./Fir Cr.	26.1	149	5.7	77	0.6	2
"	Elk Creek	W. Fk Elk Cr./Fir Cr.	11.3	242	21.4	44	7.3	2
"	Elk Creek	Bearskin Cr./ Bear Valley Cr.	14.6	88	6.0	44	2.8	2

[a] A new redd count/parr count reach beginning in 1988.

Appendix A-6. Letter from M. Rowe, Shoshone-Bannock Tribes, with results of wild chinook egg-to-parr survival in the heavily sedimented Bear Valley Creek.

The SHOSHONE-BANNOCK TRIBES

FORT HALL INDIAN RESERVATION
PHONE (208) 238-3748
(208) 238-3900
(208) 238-3914

TRIBES OF THE FORT HALL RESERVATION — SHOSHONE BANNOCK — IDAHO

FISHERIES DEPARTMENT
P. O. BOX 306
FORT HALL, IDAHO 83203

May 30, 1990

Dick Scully
Idaho Department of Fish and Game
Eagle Fish Hatchery
1798 Trout Road
Eagle, ID 83616

Dear Dick:

We estimated egg to parr survival in Bear Valley Creek in 1989 at about 1.4%.

Mid-June abundance	20,948 fish
Mid-August abundance	18,950 fish

234 redds (1988) @ 1 f/redd x 6121 eggs/f = 1,432,314 eggs

egg - June parr survival $\frac{20,948}{1,432,314} = 1.5\%$

egg - August parr survival $\frac{18,950}{1,432,314}$ [illegible]

We will be working in Yankee Fork the week of July 9 - 13. You are welcome to join us then. If that is inconvenient, please let me know and I will round up the other dates we will be in Yankee Fork.

Hope this is what you needed. If you need more information let me know.

Sincerely,

Mike Rowe
Project Leader

cc: files

Appendix A-7. Percent surface sand and density of wild chinook and steelhead parr in established monitoring sections in the heavily sedimented Bear Valley/Elk Creek drainage and control streams in the Middle Fork Salmon River drainage, 1985-1989.

Stream condition	Stream	Section	% sand	Chinook parr/100 m² 1985	1986	1987	1988	1989	Steelhead parr/100 m² 1985	1986	1987	1988	1989
Excessive	Bear	2A	43	1.9	3.0	0.9	4.2	0.8	0.1	0.1	0.0	0.0	0.0
Sediment	Valley Cr.	2B	71	0.0	0.3	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
"	"	3A	25	1.0	4.7	7.7	5.6	6.4	0.0	0.8	0.1	0.3	0.0
"	"	5A	28	0.2	4.1	1.3	2.9	4.3	0.0	0.0	0.0	0.2	0.1
"	"	9B	55	0.0	0.0	2.2	2.6	1.0	0.0	0.0	0.0	0.0	0.0
"	Elk Cr.	1A	44	0.4	0.0	0.1	0.1	0.5	0.4	0.0	0.0	0.1	0.0
"	"	1B	54	1.4	0.6	0.1	11.9	5.2	1.4	0.6	0.0	0.3	0.0
"	"	2A	53	0.0	0.0	0.0	0.2	9.4	0.0	0.1	0.0	0.0	0.1
"	"	2B	37	1.1	0.2	3.8	11.6	5.1	1.1	0.2	0.0	0.3	0.0
		Means:	46	0.7	1.4	1.8	4.3	3.7	0.3	0.2	0.0	0.1	0.0
Control	Knapp Cr.	1A	26	23.6	7.2	10.4	11.1	21.5	1.1	0.7	3.5	3.4	2.2
Streams	Beaver Cr.	1A	4	12.9	7.2	0.5	9.8	13.4	1.4	0.0	0.1	1.2	0.5
"	"	3B	11	10.8	28.6	5.9	26.8	6.5	1.2	2.1	0.7	2.4	1.4
"	Cape	2B	20	49.0	10.7	96.8	55.7	50.7	0.2	0.0	0.0	0.0	0.0
"	Horn Cr.	1A	8	34.7	14.5	39.4	40.7	20.3	0.1	0.6	0.9	4.2	0.1
"	Sulphur Cr.	4A	36	0.1	25.8	39.9	24.1	55.6	0.0	0.3	3.2	3.4	4.4
"	"	4B	30	18.1	62.6	18.8	67.9	107.3	1.0	1.0	0.2	4.4	5.0
		Control Means:	20	23.1	22.4	30.2	33.7	39.3	0.7	0.7	1.2	2.7	1.9

Appendix B. Mitigation benefits from habitat enhancement project.

The following sections describe habitat enhancement projects, surface areas affected, and parr production from each project. Project benefits are described in terms of parr production in the appendix tables. These benefits are converted to expected smolt production in text tables 15 and 16, based on parr-to-smolt survival rates determined by the Intensive Evaluation and Monitoring section of project 83-7.

Appendix B-l. Proposed definition of mitigation benefits for implemented projects on **Lolo** Creek.

<u>Project Type</u>: **Instream** Structures

<u>Year Implemented</u>: 1983-1984

<u>Sponsor:</u> Clearwater National Forest

	Species Benefited	
Enhancement	B-Run Steelhead	Spring Chinook
Production Type:	natural	natural
Hectares Enhanced:	22.5	22.5

<u>Production Constraints</u>: High sediment levels

<u>Definition of Benefits</u>: Statistical comparison of steelhead and chinook parr densities in treated and untreated sections will be done at 3- to 5-year intervals to determine the difference in densities. Parr density benefits were determined by subtracting control density from treatment density.

Evaluations were conducted in 1984 and 1985 at relatively low parr abundance. The 1985 evaluation determined that sections with structures supported higher rainbow-steelhead parr density (1.8/100 m^2 or 66%) than untreated sections. No difference was noted for chinook.

A randomized block analysis of variance was done for the 1988 report using one treatment and control section in one stratum and two treatment and control sections from a second stratum, repeated annually from 1985 through 1988. Average densities of chinook and steelhead parr were 19% and 46% higher in treatment than control sections, respectively. Statistically, treatment densities were significantly higher ($p=0.03$) for chinook, but the steelhead densities did not differ ($p=0.42$).

Rppendi x tabl e Rl-ch

LOCATION OF RFFECTEO REACH:From Yoosa Cr. to Brown's Cr. in 1984 and from Yoosa Cr. to the Forest Boundary from 1985 onward.

DRAINAGE:Clearwater R. STREAM: Lolo Cr.

SPECIES: Spring Chinook, Natural PROJECT TYPE: Instream Structures

YEAR INITIATED: 1983-84 EXPECTED PROJECT LIFE (YRS) :

AFFECTED EPR-RERCH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF RERCH UTILIZED	KMS OF REACH AFFECTED	M2 OF RERCH AFFECTED	HABITAT RATING	$/M2	PRER POTENTIHL
Eldorado/Brown's Cr. 1706030603800	1.77	10.7	100	1.77	18882	3	44	8308
Brown's/Yoosa Cr. 1706030603300	14.159	10.7	100	14.16	151942	2	77	116225
Yakus/Eldorado Cr. 1706030603600	5.632	17.1	100	3.17	53920	3	44	23725
				19.1	224744			148258

	1984	1985	1986	1987	1988	1989
SAMPLE SIZE:	t=12,c=6	t=26,c=16	t=3,c=3	t=3,c=3	t=3,c=3	t=3,c=3
PARR/100 M2 :						
MEAN	2.8	7	18.6	19.1	31.2	9.8
TREATMENT	4.7	9.4	13.3	25.7	33.2	14.1
CONTROL	0.8	4.6	23.9	12.4	29.2	5.6
BENEFIT DENSITY:	3.9	4.8	-10.6	13.3	4	8.5
% OF DENSITY FROM BENEFIT :	83	51	-44	52	12	60
TOTAL PRRR FROM BENEFIT :	2693 a	10788	-23823	29891	8990	19103

a. In 1984 only 12.87/14.16 km of the Yoosa Cr to Brown's Cr reach was treated, and an estimated 50% of this reach contained instream structures. Thus, benefits in 1984 were applied to 116,225 m2 x (12.87/14.16) x 0.5 =52,818 m2

Appendix table B1-sh

LOCATION OF AFFECTED REACH: From Yoosa Cr. to Brown's Cr.. in 1984 and from Yoosa Cr. to the Forest Boundary from 1985 onward.

DRAINAGE: Clearwater R. STREAM: Lolo Cr.

SPECIES: Sum. Steelhead, Nat. B's PROJECT TYPE: Instream Structures

YEAR INITIATED: 1983-84 EXPECTED PROJECT LIFE (YRS):

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH OF REACH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	$/M2	PHRR POTENTIAL
Eldorado/Brown's Cr. 1706030603800	1.77	10.7	100	1.77	18882	2	14	2643
Brown's/Yoosa Cr. 1706030603900	14.159	10.7	100	14.16	151942	2	14	21272
Yakus/Eldorado Cr. 17060.30603600	5.632	17.1	100	3.17	53920	2	14	7549
				19.1	224744 a			31464

	1984	1985	1986	1987	1988	1989
SAMPLE SIZE:	t=12,c=6	t=26,c=16	t=3,c=3	t=3,c=3	t=3,c=3	t=3,c=3
PARR/100 M2:						
MEAN	11.2	5.3	5.4	6.2	4.5	1.9
TREATMENT	12.1	6.4	6.7	7.2	4.9	2.9
CONTROL	10	4.1	4	52.	4.1	0.9
BENEFIT DENSITY:	2.1	2.3	2.7	2	0.8	2
% OF DENSITY FROM BENEFIT:	17	36	40	28	16	69
TOTAL PARR FROM BENEFIT:	1109 a	5161	6068	4495	1798	4495

a. In 1984 only 12.87/14.16 km of the Yoosa Cr to Broun's Cr reach was treated. and an estimated 50% of this reach contained instream structures. Thus, benefits in 1984 were applied to 116.225 m2 x (12.87/14.16) x 0.5 =52,818 m2

Appendix B-2. Proposed definition of mitigation benefits for implemented project in Eldorado Creek.

Project Type: Passage barriers

Year Implemented: 1984-1985

Sponsor: Clearwater National Forest

Enhancement	Species Benefited	
	B-Run Steelhead	Spring Chinook
Production Type:	natural	natural
Hectares Added:	14.3	14.3

Production Constraints: High sediment levels

Definition of Benefits: Complete passage barriers to adults of both species were removed. Benefits will be determined from estimated numbers of parr reared above the project at **3-** to **5-year** intervals.

Total abundance of steelhead parr above the project was estimated in August 1986 following an **outplant** of 1,150 Dworshak National Fish Hatchery adult steelhead in 1985. An estimated 7,310 yearling steelhead were present above the project in 1986, and additional parr were produced downstream of the project.

Total abundance of chinook parr above the project was estimated in August 1986 following an **outplant** of 270,000 Rapid River Hatchery chinook fry in **April-**May. August 1986 abundance totaled 30,203 (11.2% survival). Most of the area was underseeded as evidenced by decreases in abundance away from stocking sites.

Total abundance of chinook and steelhead was estimated in 1986 using stratified sampling. Steelhead population abundance estimates for other years are the product of mean density in monitoring sections, and total production area added. Chinook population abundance for 1987 through 1989 were based on 1986 estimates of **fry-to-parr** survival (11.2%) multiplied by the number of fry introduced.

Appendix table B2-ch

LOCATION OF AFFECTED REACH: The entire upper Eldorado Cr, beginning at barrier removal site, one mile up from the mouth.

DRAINAGE: Clearwater R, Lolo Cr   STREAM: Eldorado Cr

SPECIES: Spring Chinook, Natural   PROJECT TYPE: Barrier Removal

YEAR INITIATED: 1984-85   EXPECTED PROJECT LIFE (YRS): 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	#/M2	PARR POTENTIAL
Entire stream length 1706030603700	28.96	6.1	86	27.35	143478	2	77	110478

	1984	1985	1986	1987	1988	1989
SAMPLE SIZE:	c=4	c=6	t=17	t=3	t=3	t=3
PARR/100 M2:						
MEAN						
TREATMENT			29.9	58.1	26.9	73.4
CONTROL	0	0				
BENEFIT DENSITY:			29.9	58.1	26.9	73.4
% OF DENSITY FROM BENEFIT:			100	100	100	100
TOTAL PARR FROM BENEFIT:			30206 a	13328 b	5936 b	20460 b

a. Population estimate derived from stratified sampling in August 1986. Summer parr were survivors from 270,000 fry stocked in April and May 1986. Fry to parr survival was 11.2%.

b. Based on numbers of fry stocked multiplied by the fry to parr survival rate estimated in 1986.

Appendix table B2-sh

LOCATION OF AFFECTED REACH:The entire upper Eldorado Cr, beginning at barrier removal site, one mile up from the mouth.

DRAINAGE:Clearwater R, Lolo Cr STREAM: Eldorado Cr

SPECIES: Sum. Steelhead, Nat. B's PROJECT TYPE: Barrier Removal

YEAR INITIATED: 1984-85 EXPECTED PROJECT LIFE (YRS): 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	#/M2	PARR POTENTIAL
Entire stream length 17060306603700	28.96	6.1	86	27.35	143478	3	10	14348

	1984	1985	1986	1987	1988	1989
SAMPLE SIZE:	c=4	c=6	t=17	t=3	t=3	t=3
PARR/100 M2:						
MEAN						
TREATMENT			3.9	3.7	0.91	1
CONTROL	0	0				
BENEFIT DENSITY:			3.9	3.7	0.91	1
% OF DENSITY FROM BENEFIT:			100	100	100	100
TOTAL PARR FROM BENEFIT:			7310 a	5309 b	1306 b	1435 b

a. Population estimate derived from stratified sampling in August 1986. Summer parr were survivors from 270,000 fry stocked in April and May 1986. Fry to parr survival was 11.2%.

b. Based on parr density x surface area/100.

Appendix B-3. Proposed definition of mitigation benefits for implemented projects on the upper **Lochsa** River.

Project Type: **Instream** structures (lower White Sand and Crooked Fork Creeks)

Year Implemented: 1983-1984

Sponsor: Clearwater National Forest

	Species Benefited	
Enhancement	B-Run Steelhead	Spring Chinook
Production Type:	natural	natural
Hectares Added:	16.7	16.7

Production Constraints:

Definition of Benefits: An evaluation was conducted in 1984 at low parr abundance for both species. Little habitat change was observed, and no difference in densities for either species was detected between treated and untreated sections. A high rate of structure failure occurred the first year after implementation. No definable benefits are anticipated from this project, and its evaluation has been discontinued.

Appendix B-4. Proposed definition of mitigation benefits for implemented projects on Crooked Fork Creek.

Project Type: Passage barriers

Year Implemented: 1984-1985

Sponsor: Clearwater National Forest

Enhancement	Species Benefited: B-Run Steelhead	Species Benefited: Spring Chinook
Production Type:	natural	natural
Hectares Added:	10.7	10.5

Production Constraints:

Definition of Benefits: Passage barriers to adults of both species were removed. Benefits will be determined from estimated numbers of parr reared above the project at 3- to 5-year intervals.

As of 1989, steelhead fry had not been allocated for introductions into upper Crooked Fork Creek. An estimated 500 rainbow-steelhead parr reared above the project in 1986.

Total abundance of chinook parr above the project was estimated in August of 1986, 1987, 1988, and 1989 following May fry plants of 156,200, 164,400, 102,800, and 93,400, respectively. Estimated parr abundance was 17,600, 32,600, 17,700, and 10,630, respectively. Average survival rate for these four years was 16.1% and ranged from 11.3% to 19.8%. Most of the area was underseeded in both years as evidenced by decreases in abundance away from stocking sites.

The barrier had been a complete block to adult chinook passage and a partial block to steelhead. We assumed 90% of adult steelhead were blocked based on occasional observations of steelhead parr above and prior to the project (Al Espinosa, personal communication). Hence, steelhead parr abundance was multiplied by 0.90 to estimate project benefits.

No steelhead supplementation has occurred above the project. Pioneering by wild/natural adults will be the source of population rebuilding.

Appendix table B4-ch

LOCATION OF AFFECTED REACH: From Barrier removal project, 1.21 km above mouth of Boulder Cr up to headwaters of Crooked Fk and Hopeful creeks.

DRAINAGE: Clearwater R, Lochsa R   STREAM: Crooked Fk Cr

SPECIES: Spring Chinook, Natural   PROJECT TYPE: Barrier Removal

YEAR INITIATED: 1984-85   EXPECTED PROJECT LIFE (YRS): 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	#/M2	PARR POTENTIAL
Boulder to Hopeful Cr 1706030304700	8.85	8.5	100	7.64	64940	3	44	28574
All Hopeful Cr 1706030304701	6.28	4.9	64	6.28	19585	2	77	15080
Above Hopeful Cr 170603030	6.44	3.7	75	6.44	17655	2	77	13594
					102180			57248

	1984	1985	1986	1987	1988	1989
SAMPLE SIZE:	c=4	c=4	t=13	t=22	t=18	t=18
PARR/100 M2:						
MEAN						
TREATMENT						
CONTROL	0	0				
BENEFIT DENSITY:						
% OF DENSITY FROM BENEFIT:						
TOTAL PARR FROM BENEFIT:			17600 a	32600 a	17700 a	10600 a

a. Parr numbers estimated by stratified sampling annually, from 1986 through 1989.

Hppendix tabl e B4-sh

LOCATION OF AFFECTED REACH: From Barrier removal project, 1.21 km above mouth of Boulder Cr up to headwaters of Crooked Fk and Hopeful creeks.

DRAINAGE: Clearwater R, Lochsa R   STREAM: Crooked Fk Cr

SPECIES: Sum. Steelhead, Nat. E's   PROJECT TYPE: Barrier Removal

YEAR INITIATED: 1984-85   EXPECTED PROJECT LIFE (YRS): 50+

AFFECTED EPR-RERCH	EPR-RERCH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF RERCH AFFECTED	M2 OF RERCH AFFECTED	HRBX TAT RATING	$/M2	PRRR POTENT-IRL
Boulder to Hopeful Cr 1706030304700	8.85	8.5	100	7.64	64940	3	44	28574
All Hopeful Cr 1706030304701	6.28	4.9	77	6.28	23694	2	77	18244
Above Hopeful Cr 170603030	6.44	3.7	75	6.44	17871	2	77	13761
					106505			60579

	1984	1985	1986	1987	1988	1969
SAMPLE SIZE :	c=4	c=4	t=13	t=22	t=18	t=18
PARR/100 M2 : MEAN						
TREATMENT			0.29	0.09	0	0
CONTROL	0.03	0				
BENEFIT DENSITY:			0.26 a	0.08 a		
% OF UENSI TY FROM BENEFIT:			90	90	90	90
TOTAL PRRR FROM BENEFIT:			277	85	0	0 a

Appendix B-5. Proposed definition of mitigation benefits for implemented project on Colt Creek.

Project **Type**: Passage barriers

Year Implemented: 1986

Sponsor: Clearwater National Forest

Enhancement	Species Benefited	
	B-Run Steelhead	**Spring** Chinook
Production Type:	natural	natural
Hectares Added:	6.1	0

Production Constraints: Gradient judged too steep to achieve chinook passage.

Definition of Benefits: Passage barriers to adult steelhead were removed. Benefits will be determined from estimated numbers of steelhead parr reared above the barriers at **3-** to 5-year intervals (after introductions begin or a pioneering population is established).

As of 1988, steelhead fry have not been allocated for introductions into Colt Creek. No rainbow-steelhead parr were observed in the monitoring section from 1987 to 1989.

Appendix table B5-sh

LOCATI UN OF AFFECTED REACH: Upper Col t Creek. beginning at the barrier removal project, 1/2 mile bove mouth.

DRAINAGE: Clearwater R, Lochsa R, White Sand Cr   STREAM: Ccl t Cr

SPECIES: Sum. Steelhead, Nat. B's   PROJECT TYPE: Bar rier Removal

YEAR INITIATED: 1986   EXPECTED PROJECT LITLIFE (YRS):

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REHCH UTI LI ZED	KMS OF REACH AFFECTED	M2 OF REHCH AFFECTED	HABITAT RATI NG	#/M2	PARR POTENTIAL
1706030303800	20.92	3	100	20.11	61303	2	14	8582

	1984	1985	1986	1987	1988	1989
SAMPLE SI ZE:				c=1	t=1	t=1
PARR/100 M2:						
MEAN						
TREATMENT					0	0
CONTROL				0		
BENEFIT DENSITY:						
% OF DENSITY FROM BENEFIT:						
TOTAL PARR FROM BENEFIT:					0	0

Appendix B-6a. Proposed definition of mitigation benefits for implemented projects on Crooked River.

Project Type: Passage barrier (culvert)

Year Implemented: 1984

Sponsor: Nez Perce National Forest

	Species Benefited	
Enhancement	B-Run Steelhead	Spring Chinook
Production Type:	natural	natural
Hectares Added:	12.7	8.4

Production Constraints: **Channelized** (treated with structures in 1985), lack of riparian vegetation for 6.1 km upstream of barrier culvert.

Definition of Benefits: A partial barrier to adult steelhead and chinook was removed by replacement of a culvert with a bridge. Benefits will be determined annually from estimated numbers of parr reared above the project. Fifty percent of this production is assumed to be the mitigation benefit.

Total abundance was estimated in Crooked River between the project and the confluence of its East and West forks in 1986 and 1987. Beginning in 1988, the usable area in the East and West forks have been included in the total abundance estimates.

Appendix table 86a-ch

LOCATION OF AFFECTED REACH: Beginning 13.0 km above the mouth (1.0 km above the mouth of Relief Cr.) and continued to the confluence of the east and west forks in 1986 and 1987 and included these two forks in 1988.

DRAINAGE: Clearwater R STREAM: Crooked R

SPECIES: Spring Chinook, Natural PROJECT TYPE: Barrier (partial) Removal

YEAR INITIATED: 1984 EXPECTED PROJECT LIFE (YRS): 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	#/M2	PARR POTENTIAL
Crooked River 1706030503301	7.241	10.1	100	6.33	63670	3	44	28015
Crooked R, E Fk 1706030507200	10.14	3.7	24	10.14	8898	3	44	3915
Crooked R, W Fk 1706030503302	7.56	4.9	32	7.56	11802	3	44	5193
					84370			37123

	1984	1985	1986	1987	1988	1989
SAMPLE SIZE:	C=11	t=4	t=16	t=3	t=11	t=12
PARR/100 M2: MEAN						
TREATMENT		16.82				21.8
CONTROL	0.23					
BENEFIT DENSITY:						10.9
% OF DENSITY FROM BENEFIT:		50	50	50	50	50
TOTAL PARR FROM BENEFIT:		5351 a	3707 b	742 b	7061 b	7061 c

PRE TREAT. No's: 146

a. Estimate is (surface area/100*average density) times 50% as the barrier benefit.

b. Estimates are 50% of that obtained from stratified sampling, assuming barrier removal benifit from barrier removal is 50% of adult passage.

c. Estimate is surface area/100 x 50% of weighted average density, relative to surface areas in each EPA reach.

Appendix table B6a-sh

LOCATION OF AFFECTED REACH: Beginning 13.0 km above the mouth (1.0 km above the mouth of Relief Cr.) and continued to the confluence of the east and west forks in 1286 and 1987 and included these two forks in 1988.

DRAINAGE: Clearwater R STREAM: Crooked R

SPECIES: Sum. Steelhead, Hat.. B's PROJECT TYPE: Barr-1 er (parti al) Removal

YEAR INITIATED: 1984 EXPECTED PROJECT LIFE (YRS) : 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REHC H AFFECTED	HABI THT RATING	#/M2	PARR POTENT-It-U.
Crooked River 1706030503301	7.241	10.1	100	6.33	63670	2	14	8914
Crooked R, E Fk 1706030507200	10.14	3.7	71	10.14	26638	1	20	5328
Crooked R, W F k 1706030503302	7.56	4.9	100	7.56	37044	1	20	7409
					127352			21651

	1'384	1285	1986	1987	1988	1989
SAMPLE SI ZE :	c=11	c=4	t=16	t=3	t=11	t=12
PARR./100 M2:						
MEAN						
TREATMENT						1.48
CONTROL	cl.28	n.22				
BE NEFI T DENSITY:						0.74
% OF DENSITY FROM BENEFIT :						50
TOTAL PARR FROM BENEFIT:			1375 a	1174 a	1958 a	942 b
PRE-TREAT. Ho's:	178	618				

a. Estimates are 50% of that obtained from stratified sampling, assuming barrier removal benefit to be 50% of adult passage.

b. Estimate is surface area/100 x 50% of wieghted average density, relative to surface areas in each EPA reach.

Appendix B-6b. (Crooked River, continued).

Project Type: **Instream** structures, riparian revegetation

Year Implemented: 1984-1985

Sponsor: Nez **Perce** National Forest

Enhancement	Species Benefited	
	B-Run Steelhead	Spring Chinook
Production Type:	natural	natural
Hectares Enhanced:	7.2	7.2

Production Constraints: Channelized, lack of riparian vegetation.

Definition of Benefits: Statistical comparisons of steelhead and chinook parr densities in treated and untreated sections will be done at **3-** to 5-year intervals to determine the differences in densities.

An evaluation was conducted in July and August 1986 at a fully seeded condition for yearling steelhead and moderate seeding levels for chinook. Alteration of habitat by the structures had occurred; riparian conditions had not yet improved. No difference in densities could be attributed to the **instream** structure project.

A randomized block analysis of variance was done for the 1988 report using one treatment and one control section in each of two strata; repeated annually from 1985 through 1988 to compare parr densities for both chinook and steelhead. Average densities of chinook and steelhead parr were 3.8% and 42.1% higher, respectively, in treatment than control sections. Statistically, the comparisons of treatment and control densities were not significant for either species **($p=0.97$** and **$p=0.44$,** respectively).

Appendix table B6b-ch

LOCATION OF AFFECTED REACH: Beginning 14.1 kn upstream from the mouth, at t h o culvert removal site and continuing upstream 1.24 kms.

DRAINAGE: Clearwater R STREAM: Crooked R

SPECIES: Spring Chinook, Natural PROJECT TYPE: Instream Structure5

YEAR INITIATED: 1984-85 EXPECTED PROJECT LIFE (YRS): 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM3	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	#/M2	PARR POTENTIAL
1706030503301	7.241	10.1	100	2.735	26627	3	44	11715.88
1706030503300	12.55	10.1	100	4.505	4550 1	2	77	35035.77
					72128			46751.65

	1984	1985	1986	1987	1988	1989
SAMPLE SIZE:		t=2,c 3	t=2,c=2	t=2,c=2	t=2,c=2	t=2,c=2
PARR/100 M2:						
MEAN		46	20.4	2.1	21.7	22.2
TREATMENT		42.1	19.8	3.5	26.4	24.8
CONTROL		4Y.7	21	0.6	16.9	13.5
BENEFIT DENSITY:		-7.1	-1.2	2.7	9.5	5.3
% OF DENSITY FROM BENEFIT:		-17	-6	83	36	21
TOTAL PARR FROM BENEFIT:		-5121	886	2092	6852	3823

Appendix table B6b-sh

LOCATION OF AFFECTED REACH: Beginning 14.1 km upstream from the mouth, at the culvert removal site and continuing upstream 7.24 kms.

DRAINAGE: Clearwater R STREAM: Crooked R

SPECIES: Sum. Steelhead. Nat. B's PROJECT TYPE: Instream Structures

YEAR INITIATED: 1984-85 EXPECTED PROJECT LIFE (YRS): 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	#/M2	PARR POTENTIAL
17060305503301	7.241	10.1	100	2.735	26627	2	14	3727.78
17060305503300	12.55	10.1.	100	4.505	45501	2	14	6370.14
					72128			10027.92

	1984	1985	1986	1987	1988	1989
SAMPLE SIZE:		t=2,c=2	t=2,c=2	t=2,c=2	t=2,c=2	t=2,c=2
PARR/100 M2:						
MEAN		1.5	9.8	'3.0	10	4.2
TREATMENT		1.4	9.8	13.2	11.8	5.4
CONTROL		1.5	9.8	6.3	7.9	3
BENEFIT DENSITY:		-0.1	0	6.9	3.9	2.4
% OF DENSITY FROM BENEFIT:		-7	0	52	33	44
TOTAL PARR FROM BENEFIT:		-72	0	4977	2813	1731

Appendix **B-6c.** (Crooked River, Continued).

Project Type: Off-channel developments

Year Implemented: 1984-1987

Sponsor: Nez **Perce** National Forest

Enhancement	Species Benefited: B-Run Steelhead	Species Benefited: Spring Chinook
Production Type:	natural	natural
Hectares Added:	1.26	1.26

Production Constraints: Pond and side channel habitat will primarily benefit chinook.

Definition of Benefits: The total abundance of steelhead and chinook parr in connected ponds and side channels will be considered mitigation benefits.

Surface area of **connected** ponds increased from 0.65 hectares to 1.26 hectares beginning in 1989.

Hppondix table B6c-ch

LOCATION OF AFFECTED REACH:Ponds connnected to Crooked River in study Strata I and II.

DRAINAGE:Clearwater R STREAM: Crooked R

SPECIES: Spring Chinook, Natural PROJECT TYPE : Off-Channel Developments (Connected Ponds)

YEAR INITIATED: 1984-85 EXPECTED PROJECT LIFE (YRS): sot

AFFECTED EFH-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF RERCH UTILIZED	KMS OF RERCH AFFECTED	H2 OF RERCH AFFECTED	HABITAT RATING	t/H2	PARR POTENTIAL
170603050330 1					12631	1	108	13641.48

	1984	1985	1986	1987	1988	1989
SAMPLE SIZE :			t=5	t=1	t=2	t=5
PARR/100 M2:						
MEAN						
TREATMENT			63.2	3.2	90.9	255
CONTROL						
BENEFIT DENSITY:			63.2	3.2	90	255
% OF DENSITY FROM BENEFIT:			100	100	100	100
TOTAL PARR FROM BENEFIT:			4119	209	5924	32209

Appendix table B6c-sh

LOCATION OF AFFECTED REACH:Ponds connnected to Crooked River in study Strata I and II.

DRAINAGE:Clearwater R STREAM: Crooked R

SPECIES: Sum. Steelhead, Nat B's PROJECT TYPE: Off-Channel Developments (Connected Ponds)

YEAR INITIATED: 1984-85 EXPECTED PROJECT LIFE (YRS): 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	$/M2	PARR POTENTIAL
17060305033O1					12631	2	14	J7hB.34

	1984	1985	1986	1987	1988	1989
SAMPLE SIZE:			t=5	t=1	t=2	t=5
PARR/100 M2:						
MEAN						
TREATMENT			5	47.2	17	11.45
CONTROL						
BENEFIT DENSITY:			5	47.2	17	11.45
% OF DENSITY FROM BENEFIT:			100	100	100	100
TOTAL PARR FROM BENEFIT:			323	3076	1108	1446

Appendix B-7a. Proposed definition of mitigation benefits for implemented projects in Red River.

Project Type: **Instream** structures

Year Implemented: 1984-1985

Sponsor: Nez **Perce** National Forest

Enhancement	Species Benefited	
	B-Run Steelhead	Spring Chinook
Production Type:	natural	natural
Hectares Enhanced:	11.8	11.8

Definition of Benefits: Statistical comparisons of steelhead and chinook parr densities in treated and untreated sections will be done at **3-** to 5-year intervals to determine the difference in densities.

An evaluation was conducted in July and August 1986 at moderately low steelhead and chinook parr abundance. No difference in densities could be attributed to the **instream** structure project.

A randomized block analysis of variance was done for the 1988 report using one treatment and one control section in each of two strata, repeated annually from 1985 through 1988 to compare parr densities for both chinook and steelhead in treatment and control sections. Average densities of chinook parr were 34.7% higher in treatment than control sections, while densities of steelhead parr were 9.2% lower in treatment than control sections. Statistically, there were no differences in mean densities for either species in control and treatment sections.

Appendix tabl e B7a-ch

LOCATION OF AFFECTED REACH:Wi thin two non-adjacent roaches, Siegel Cr. t o Moose r . and Sout h Fork Red River to Soda Cr.

ORAINAGE:Clearwater R STREAM: Red R

SPECIES: Spr i ng Chi nook, Natural PROJECT TYPE: Instream Structures

YEAR INITIATED: 1984-85 EXPECTED PROJECT LIFE (YRS):

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILI ZED	KMS O F REACH AFFECTED	M2 OF REACH AFFECTED	HABI TAT RATI NG	#/M2	PRRR POTENTIAL
'Siegel to Moose Cr 1706030503600	8.689	13.4	100	2.73	36684	2	77	28247
S Fk to Sods Cr 1706030503800	9.493	10.1	100	8.05	80920	3	44	35605
					117603			63852

	1984	1485	1986	1987	1988	1989
SAMPLE SI ZE:		t=2,c=2	t=2,c=2	t=2,c=2	t=2,c=2	t=2,c=2
PARR/ 100 M2 :						
MEAN		62.8	27.6	39.7	34.4	17.1
TREATMENT		66.7	31.6	47.8	43.7	20.4
CONTROL:		58.8	23.5	31.6	25.1	13.9
BENEFI T DENSI TY:		7.9	8. I	16.2	18.6	6.5
% OF DENSITY FROM BE NEFIT :		12	26	34	43	32
TOTAL PARR FROM BENEFIT:		9291	9526	19052	21874	7644

Appendix table B7a-sh

LOCATION OF AFFECTED REACH: Within two non-adjacent reaches, Siegel Cr. t o Moose r. and South Fork Red River to Soda Cr.

DRAINAGE: Clearwater R STREAM: Red R

SPECIES: Sum. Steelhead, Nat. B's PROJECT TYPE: Instream Structures

YEAR INITIATED: 1984-85 EXPECTED PROJECT LIFE (YRS):

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	#/M2	PARR POTENTIAL
Siegel to Moose Cr 1706030503600	8.689	13.4	100	2.73	36684	3	10	3668.4
S Fk to Soda Cr 1706030503800	9.4'13	1.0.1	100	8.05	80920	2	14	31328.8
					117603			14'397.2

	1984	1985	1986	1987	1988	1989
SAMPLE SIZE:		t=2,c=2	t=2,c=2	t=2, c=2	t=2,c=2	t=2,c=2
PARR/100 M2:						
MEAN		1.2	2.4	3.1	1.5	1.5
TREATMENT		1.5	2.3	3.1	1	1.2
CONTROL:		0.9	2.5	3	1.9	1.8
BENEFIT DENSITY:		0.6	-0.2	0.1	-0.9	-0.6
% OF DENSITY FROM BENEFIT:		40	-9	30	-90	-33
TOTAL PARR FROM BENEFIT:		706	-235	118	-1058	-706

Appendix B-7b. (Bed River, Continued).

Project Type: Off-channel developments

Year Implemented: 1985

Sponsor: **Nez Perce** National Forest

	Species Benefited	
Enhancement	B-Run Steelhead	Spring Chinook
Production Type:	natural	natural
Hectares Added:	0.02	0.02

Production Constraints: Limited opportunity for side-channel/pond development.

Definition of Benefits: The total abundance of steelhead and chinook parr in off-channel production areas are considered mitigation benefits.

In 1986, the numbers of steelhead and chinook parr estimated in the 0.02 hectares added totaled 1 and 215, respectively. No sampling has been done in the ponds from 1987 through 1989, but an analysis is **planned** for 1990.

Appendix B-8. Proposed definition of mitigation benefits for implemented project in Pine Creek.

Project **Type**: Passage barrier

Year **Implemented**: 1987

Sponsor: Nez **Perce** National Forest

Enhancement	Species Benefited A-Run Steelhead
Production Type:	natural
Hectares Added:	6.9

Production Constraints:

Definition of Benefits: A barrier to adult steelhead was removed by this project. However, we believe the barrier removal did allow adult steelhead to ascend Pine Creek. Even with additional barrier removals, the gradient appears too steep to ensure passage. Parr density monitoring has been discontinued in Pine Creek.

Appendix B-9. Proposed definition of mitigation benefits for implemented project in Pole Creek.

Project **Type:** Diversion screen

Year **Implemented:** 1983-1984

Sponsor: Sawtooth National Forest

	Species Benefited	
Enhancement	B-Run Steelhead	**Spring** Chinook
Production Type:	natural	natural
Hectares Added:	3.9	3.9

Production Constraints: Juvenile steelhead upstream passage is impeded.

Definition of Benefits: An unscreened irrigation diversion was screened. The proportion of steelhead and chinook parr reared upstream of the diversion that are screened from the ditch and returned to Pole Creek will be considered as mitigation benefits. The proportion was assumed to be 50% for these estimates. The upper Salmon River intensive study will determine this proportion during PIT tag operations and will directly estimate **parr-to-smolt** survival.

Chinook were stocked upstream of the diversion in 1989.

Appendi x tabl e B9-ch

LOCATION OF AFFECTED REACH: From the irrigation diversion upstream 7.94 km.

DRAINAGE: Salmon R   STREAM: Pole Cr

SPECIES: Spring Chinook, Natural   PROJECT TYPE: Barrier (partial) Removal

YEAR INITIATED: 1984   EXPECTED PROJECT LIFE (YRS):

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	$/M2	PARR POTENTIAL
1706020114900	14.48	4.9	100	7.94	38862	2	77	29924

	1984	1985	1986	1987	1368	1989
SAMPLE SIZE:	c=6	t=6	t=2	t=6	t=6	t=6
PARR/100 M2:						
MEAN						
TREATMENT		0	0	0	0.04	0.12
CONTROL	0					
BENEFIT DENSITY:					0.02	0.06
% OF DENSITY FROM BENEFIT:					50	50
TOTAL PARR FROM BENEFIT:					8	23

Appendix table 89-sh

LOCATION OF AFFECTED REACH:From the irrigation diversion upstream 7.94 km.

DRAINAGE:Salmon R STREAM: Pole Cr

SPECIES: Sum. Steelhead, Nat. B's PROJECT TYPE: Barrier (partial) Removal

YEAR INITIATED: 1984 EXPECTED PROJECT LIFE (YRS):

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	#/M2	PARR POTENTIAL
1706020114900	14.48	4.9	100	7.94	38862	3	10	3886.2

	1984	1985	1986	1987	1988	1989
SAMPLE SIZE:	c=6	t=6	t=2	t=6	t=6	t=7
PARR/100 M2: MEAN						
TREATMENT		1	0.11	0	1.96	0.68
CONTROL	0					
BENEFIT DENSITY:		0.5	0.06		0.98	0.34
% OF DENSITY FROM BENEFIT:		50	50		50	50
TOTAL PARR FROM BENEFIT:		210 a	23	32 a	381	132

a. Total parr from benefits is calculated from stratified sampling and multiplying the estimate by 0.5 to account for an assumed 50% benefit from the diversion screen.

Appendix B-IO. Proposed definition of mitigation benefits for implemented project, Bear Valley and Elk Creeks.

Project Type: Sediment reduction, riparian revegetation

Year Implemented: 1987 - ongoing

Sponsor: Boise National Forest

	Species Benefited	
Enhancement	Middle Fork Salmon River B-Run Steelhead	Spring Chinook
Production Type:	Wild	Wild
Hectares to be Improved:	77	76

Production Constraints: High sediment levels, streambank degradation.

Definition of Benefits: The Bear Valley and Elk Creek project will attempt to significantly reduce sediment from point and nonpoint sources in the drainage and complement anticipated grazing management improvements. Benefits will be estimated based on: a) measured changes in sediment (Project 84-24) and fish-sediment relationships, b) improvements in survival from egg deposition to parr, and c) an increase in the ratio of parr density in the Bear Valley/Elk Creek drainage to parr density in control streams throughout the upper Middle Fork Salmon River drainage.

The ratio of parr/100 m^2 to redds/ha in the Bear Valley/Elk Creek spawning areas has shown no indication of increased parr survival from brood year 1983 to 1988. The ratios were 5.5, 2.5, 1.8, 0.8, 1.3, and 0.4, respectively (mean = 2.5). The average value for this ratio among other Middle Fork and upper Salmon River sections was 17.5. Data used for these ratios were those used for the Middle Fork and upper Salmon River redd to parr analysis with additional observations removed when redd/ha or Parr.100 m^2 = 0.0. The average treatment/control density ratio for chinook averaged 0.05 in the pretreatment years of 1985 through 1987. The ratios in 1988 and 1989, after some sediment reduction work which began in 1987, were 0.12 and 0.11, respectively. This small difference may not be a result of the project, but it demonstrates how the ratio will be used to determine benefits (Appendix Figure I)

Evaluation of this sediment reduction project will be carried out when the project is complete (1991) and sufficient time has passed to allow bank stabilization and flushing of the accumulated sediment in the spawning areas of Bear Valley and Elk Creeks (approximately five years). Recovery of the aquatic habitat is expected to be a slow process and hinges on improved grazing management by the USFS.

Appendix table B10-ch

LOCATION OF AFFECTED REACH: All of Bear Valley Creek and its tributaries of Elk Creek snd Bearskin Creek.
DRAINAGE: Salmon R, M Fk Salmon R   STREAM: Bear Valley Cr

SPECIES: Spring Chinook, Wild   PROJECT TYPE: Sediment Reduction and Riparian Revegetation

YEAR INITIATED: 1987-91   EXPECTED PROJECT LIFE (YRS):

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	# AI2	PARR POTENTIAL
See below (a)	73.85	7.2	95.7	71.87	757085	2 & 3	70	534948

	1984	1985	1986	1987	1988	1989
SAMPLE SIZE:	pt=7,c=1 (b)	pt=10,c=9	pt=9,c=9	pt=10,c=9	t=10,c=7	t=10,c=9
PARR/100 M2:						
TREATMENT:	2.8	0.6	1.4	1.6	4	3.3
CONTROL: (c)	9.2	i'i.4	24.5	30	33.7	30.7
TREATMENT RATIO:	(d)	0.03	0.06	0.05	0.12	0.11
MEAN 1985-1987 T/C RATIO					cl.05	0.05
EXPECTED DENSITY AT T/C=0.05:					1.69	1.54
BENEFIT DENSITY (OBSERVED-EXPECTED):					2.31	1.8
PARR FROM BENEFIT:					17489	13627

a. EPA reaches, all beginning with 170602050 are: 2300, 2400, 2401, 2402, 2500, 2501, 2700, 2701, 2702, 2800, 2801, 2802, 2803, 2600, 2601, 2602, 2603, 2604, 2605, 8400 and 8401.

b. pt=pretreatment. Althouth some improvements began in 1987, no significant reduction in sediment and fish density response is expected until approximately 1991.

c. Control sections are in the Middle Fork Salmon River tributaries of Knapp, Beaver, Cape Horn, Sulphur and Loon creeks.

d. Insufficient control sections with which to make a treatment/control ratio in 1984.

Rppendix table B10-sh

LOCATION OF AFFECTED REACH:All of Bear Valley Creek end its t-r-i butaries of Elk Creek and Bearskin Creek.
DRAINAGE:Salmon R, M Fk Salmon R STREAM: Rear Vall ey Cr

SPECIES: Sum. Steelhead, Wild E's PROJECT TYPE: Sedimentation Reduction and Riparian Re-vegetation
YEAR INITIATED: 1987-91 EXPECTED PROJECT LIFE (YRS):

RFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	HIDTH (M)	PERCENT OF EERCH UTILI ZED	KMS OF RERCH RFFEC:TED	M2 OF REACH AFFECTED	HABI TAT RATING	#/M2	PARR POTENTIAL
See below (a)	73.85	7.2	100	73 85	768737	-3	13.7	105333

	1984	1985	1986	1987	1988	1989
SAMPLE SI ZE :	pt=7,c=1 (b)	pt=10,c=9	pt=9,c=9	pt=10,c=9	t=10,c=7	t=10,c=9
PARR/ 100 M2 :						
TREATMENT:	0.06	0.3	0.2	0.01	0.12	0.02
CONTROL: (c)	0	0.9	1.4	1.5	2.7	1.53
TREATMENT RATIO:	(d)	0.33	0.14	0.007	0.04	0.01
MEAN 1985-1987 T/C RATIO					0.16	0.16
EXPECTED DENSITY AT T/C=0.05:					0.43	0.24
BENEFIT DENSITY (OBSERVED-EXPECTED):					-0.31	-0.22
PARR FROM BENEFIT:					-2383	-1691

a. EPA reaches, all beginning with 170602050 are:2300,2400,2401,2402,2500,2501,2700,2701,2702 2800,2801,2802,2803,2600,2601,2602,2603,2604,2605,8400 and 8401.

b. pt=pretreatment. Althouth some improvements began in 1987, no significant reduction in sediment and fish density response is expected until approximately 1991.

c. Control sections are in the Middle Fork Salmon River tributaries of knapp, Beaver, Cape Horn, Sulphur and Loon creeks.

d. Insufficient control sections with which to make a treatment/control ratio in 1984.

Appendix B-11. Proposed definition of mitigation benefits for implemented project, **Knapp** Creek.

Project type: Passage barrier (diversion structure bypassed)

Year implemented: 1987

Sponsor: Challis National Forest

Enhancement	Species benefited
	Spring Chinook
Production type	wild
Hectares added	7.8

Production constraints:

Definition of benefits: An irrigation diversion that partially blocked adult chinook passage was modified. Benefits will be estimated as 50% of total abundance of chinook parr reared above the barrier. Seeding of the area will be from pioneering by wild fish. Parr density estimates in 1987 and 1988 were based on one sample each year. Once density increases appear, we will evaluate benefits based on multiple samples and stratified sampling.

The barrier was removed during the summer of 1987 and could have provided adult chinook passage that year and parr density benefits in 1988. Although the percent of parr carrying capacity above the barrier has remained below 1%, percent chinook carrying capacity below the barrier has ranged from 7% to 21%, and pioneering above the barrier is likely.

Appendix table B11-ch

LOCATION OF AFFECTED REACH:All of of Upper Knapp Creek, beginning 3.5 km above the mouth.

DRAINAGE:Salmon R, M Fk Salmon R, Marsh Cr   STREAM: Knapp Cr

SPECIES: Spring Chinook, Wild   PROJECT TYPE: Barrier (partial) removal

YEAR INITIATED: 1987   EXPECTED PROJECT LIFE (YRS): 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	#/M2	PARR POTENTIAL
1706020503503	23.33	4.57	86	12.3	77815	1	108	84040

	1984	1985	1986	1987	1988	1989
SAMPLE SIZE:		c=?	c=1	c=1	t=1	t=1
PARR/100 M2: MEAN						
TREATMENT					0.16	0.42
CONTROL		0.29	0	0.15		
BENEFIT DENSITY:					0.08	0.21
% OF DENSITY FROM BENEFIT:					50	50
TOTAL PARR FROM BENEFIT:		(226)a		(117)a	63	163

a. Barrier removal during the summer of 1987 could have provided for upstream passage for adults that year. Chinook parr as a benefit of the project initiated in 1987, could have been monitored in 1988.

. Pre-treatment parr production.

Appendix B-12. Proposed definition of mitigation benefits for implemented project, Johnson Creek.

Project Type: Passage barrier

year Implemented: 1984-1986

Sponsor: Idaho Department of fish and Game

Enhancement	Species Benefited Summer Chinook
Production Type:	natural
Hectares Added:	39.5

Production Constraints: High sediment levels in portions of the drainage.

Definition of Benefits: Natural rock barriers that completely blocked adult chinook passage were modified. Benefits are estimated from total abundance of chinook parr reared above barriers.

Totals of 50,744, 177,606, 118,424, 366,800, and 200,000 summer chinook fry were stocked into the upper Johnson Creek drainage in 1985, 1986, 1987, 1988, and 1989, respectively. Total abundance of parr from the 1986 and 1987 plants were estimated at 23,700 and 17,700, respectively. Average fry to parr survival was 14.2%. Fry stocking did not fully seed the drainage either year. For the monitoring years of 1985, 1988, and 1989, 14.2% fry-to-parr survival was assumed. In 1989, 15 chinook redds were counted in Johnson Creek above the barrier removal project. These redds probably resulted from spawners returning from fry releases in 1985-87. Total parr abundance and egg-to-parr survival will be estimated in 1990.

Appendix table B 12-ch

LOCATION OF AFFECTED REACH: Upstream from the lower barrier removal site 24.6 km upstream to headwaters including tributaries of Rock, Sand, Whisky and Boulder creeks.

DRAINAGE: Salmon R, S Fk Salmon R, E Fk S Fk Salmon R   STREAM: Johnson Cr

SPECIES: Summer Chinook, Natural   PROJECT TYPE: Barrier Removal

YEAR INITIATED: 1984   EXPECTED PROJECT LIFE (YRS): 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	#/M2	PARR POTENTIAL
See below (a)	64.68	8.04	85.9	47.14	395119	1-3	74.6	294750

	1984	1985	1986	1987	1988	1989
SAMPLE SIZE:	c=23	t=10	t=10	t=11	t=7	t=7
PARR/100 M2: MEAN						
TREATMENT						
CONTROL	0					
BENEFIT DENSITY:						
% OF DENSITY FROM BENEFIT:						
TOTAL PARR FROM BENEFIT:		7206 b	23711 b	17700 b	52086 b	28400 b

a. EPA reaches affected all begin with 17060208O and end with: 4700, 4701, 4701.13, 4701.24, 4702, 4703, 4704, 9800, 9400, 9500, 9700.

b. Populations above the barrier were estimated in 1986 and 1987 with stratified sampling. Average fry to parr survival was 14.2%. Population estimates in 1985 and 1988 are the product of number of fry planted and 0.142. Maximum summer parr population achieved (in 1988) equated to 18% of carrying capacity.

Appendix B-13. proposed definition of mitigation benefits for implemented project in Dollar Creek.

Project **Type**: Passage barrier (partial)

Year Implemented: 1986

Sponsor: Boise National Forest

Enhancement	Species Benefited	
	South Fork Salmon River (B-Run) Steelhead	**Spring** Chinook
Production Type:	wild	natural
Hectares Added:	6.8	3.3

Production Constraints: High sediment levels

Definition of Benefits: Debris jam barriers that partially blocked passage were selectively removed. Parr benefits for 1986-1988 were based on densities in a single monitoring section. The barriers were assumed to block 50% of adult chinook and steelhead passage, and this percent of the parr density is attributed to the project.

Appendix table B13-ch

LOCATION OF AFFECTED REACH:All of Dollar Creek.

DRAINAGE:Salmon R, S Fk Salmon R   STREAM: Dollar Cr

SPECIES: Summer Chinook, Natural   PROJECT TYPE: Barrier (partial) removal

YEAR INITIATED: 1986   EXPECTED PROJECT LIFE (YRS):

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	#/M2	PARR POTENTIAL
mouth to N Fk 1706020803200	1.77	6.1	100	6.1	10789	3	44	4747
Upper Dollar Cr 1706020803201	3.33	4.6	52	2.4	22187	3	44	9762
					32976			14509

	1984	1985	1986	1987	1988	1989
SAMPLE SIZE:			c=1	t=1	t=1	t=1
PARR/100 M2: MEAN						
TREATMENT				0	0.23	0
CONTROL			0			
BENEFIT DENSITY:				0	0.12	0
% OF DENSITY FROM BENEFIT:				50	50	
TOTAL PARR FROM BENEFIT:				0	38 a	0

a. Equates to 50% of parr estimated above barriers since barriers were assumed to block 50% of adult chinook spawners.

Appendix tabl e B13-sh

LOCATION OF AFFECTED REACH:All of Dollar Creek.

DRAINAGE:Salmon R, S Fk Salmon R STREAM: Dollar Cr

SPECIES: Sum. Steelhead, Wild B's PROJECT TYPE: Barrier (partial) removal

YEAR INITIATED: 1986 EXPECTED PROJECT LIFE (YRS) :

AFFECTED EPH-RERCH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REHCH UTILX ZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HHBI TAT RHTX NG	#/M2	FRRR POTENTIAL
mouth to N F k 1706020803200	1.77	6.1	100	6.1	10789	2	14	1510
Upper Dollar Cr 1706020803201	9.33	4.6	100	4.6	42667	2	14	5973
N FL:: Doll ar Cr 1706020808700	6.11	2.4	100	2.4	14909	2	14	2087
					68365			9570

	1784	1985	1996	1987	1388	1389
SAMPLE SI ZE :			c=1	t=1	t=1	t=1
PARR/100 M2:						
MEAN						
TREATMENT				3.1	i'.1	3.8
CONTROL			1.9			
BENEFIT DENSI TY:				1.6	3.6	1.9
% OF DENSITY FROM BENEFIT :				50	50	50
TOTAL PARR FROM BENEFIT:				1060	246 1	1299

Appendix B-14. Proposed definition of mitigation benefits for implemented project in Boulder Creek.

Project Type: Passage barrier

Year Implemented: 1985

Sponsor: Idaho Department of Fish and Game

Enhancement	Species Benefited Spring Chinook
Production Type:	natural
Hectares Added:	11.2

Production Constraints:

Definition of Benefits: A barrier falls that was a nearly-complete block to adult chinook was modified. Benefits will be based on total chinook parr abundance.

Stratified sampling was used to estimate fry-to-parr survival in 1986 and eyed egg-to-parr survival in 1988. An estimated total of 28,100 chinook parr were reared in 1986 from a May release of 99,000 fry. In 1988, 1,560 chinook parr were estimated to have survived from a plant of 140,000 eyed-eggs in October, 1987. Survival rates to the summer parr life stage were 28.1% for planted fry and 1.1% for planted eggs.

APPB

Appendix table B14-ch

LOCATION O F AFFECTED REACH: Upper Boulder Creek, beginning at the barrier removal site, approximately 6.4 km above the mouth.
DRAINAGE: Salmon R , Little Salmon R STREAM: Bouf der C:r

SPECIES: Spring Chinook, Natural PROJECT TYPE: Barrier removal

YEAR INITIATI 1985 EXPECTED PROJECT LIFE (YRS): 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HHBI RATING	TRT t/H2	PARR POTENTIAL
Squirrel to Pony Cr 17060210000901	3.06	10.7	100	1.13	12015	3	44	5287
Pony Cr to Headwaters 17060210000902	22.85	6.1	72	2[illegible].35	100282	2	77	77217
					112297			82%4

	1184	1985	1986	1987	1'188	1989
SAMPLE SIZE :	c=2	c=2	t-10	t-2	t=7	t=2
PARR/100 M2 : MEAN						
TREATMENT			28.9	0	7.8	102.5
CONTROL	0	0.2				
BENEFIT DENSITY:			28.9	0	7.8	102.5
% OF DENSITY FROM BENEFIT :			100	100	100	100
TOTAL PARR FROM YENEFIT :		(225) a	28112 a	O b	1560 a	56200 c (115104)b

a. Estimates from stratified sampling.

b. Estimates from average parr density*surface area/100. Parr observed in 1985 demonstrates that some chinook wereable to pass the barriers at least in high water years such as 1984.

c. Number of fry stocked times the fry-to-parr survival rate (28.1%) measured in 1986.

Appendix B-15. Proposed definition of mitigation benefits for implemented project in Meadow Creek.

Project Type: Passage barrier

Year Implemented: 1987

Sponsor: Nez Perce National Forest

	Species Benefited
Enhancement	Spring Chinook
Production Type:	natural
Hectares Added:	8.9

Production Constraints: Grazing impacts: sediment production and riparian degradation.

Definition of Benefits: A barrier to adult chinook passage was removed in 1987, and chinook fry were planted above the barrier in 1988 and 1989. Parr density was monitored at two sections in 1988 and 1989, but estimated summer parr population from the fry stocking was based on the project-wide fry-to-parr survival rate of 15%.

Appendix table B15-ch

LOCATION OF AFFECTED REACH:From mouth to headwaters of Meadow Creek.

DRAINAGE:Clearwater R, S Fk Clearwater R — STREAM: Meadow Cr

SPECIES: Spring Chinook, Natural — PROJECT TYPE: Barrier Removal

YEAR INITIATED: 1987 — EXPECTED PROJECT LIFE (YRS): 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	M2 OF REACH AFFECTED	HABITAT RATING	#/M2	PARR POTENTIAL
1706030504900	21.72	6.1	67	21.72	88718	9	44	39036

	1984	1985	1986	1987	1988	1989
SAMPLE SIZE:				c=2	t=2	t=2
PARR/100 M2: MEAN						
TREATMENT					31.27	24.2
CONTROL				0		
BENEFIT DENSITY:					31.27	24.2
% OF DENSITY FROM BENEFIT:					100	100
TOTAL PARR FROM BENEFIT:					15000 a	5874 a

a. This equals 15% of the 100,000 fry planted that spring. This (15%) is the average fry to parr survival observed from stratified sampling in the project, state wide.

Appendix B-l 6. Proposed definition of mitigation benefits for implemented project on Valley Creek.

Project Type: Passage Barrier (irrigation diversion)

Year implemented: 1988

Sponsor: Boise National Forest

Enhancement	Species Benefited Spring Chinook
Production Type	Wild
Hectares Enhanced	20.0

Production Constraints:

Definition of Benefits: A partial barrier to adult chinook, in the form of an irrigation diversion, was removed in 1988. Benefits will be determined as a fraction of chinook parr rearing above the barrier. Tentatively, an annual average benefit will be 70% of the parr density, based on a pre-treatment assessment that adults would be blocked 7 of 10 years.

Appendix table 816-ch

LOCATION OF AFFECTED REACH: Beginning at irrigation diversion near mouth of Trap Creek and continuing from there to headwaters.

DRAINAGE: Salmon R STREAM: Valley Cr

SPECIES: Spring Chinook, Wild PROJECT TYPE: Barrier (partial) removal

YEAR INITIATED: 1988 EXPECTED PROJECT LIFE (YRS): 50+

AFFECTED EPA-REACH	EPA-REACH LENGTH (KM)	WIDTH (M)	PERCENT OF REACH UTILIZED	KMS OF REACH AFFECTED	m2 OF REACH AFFECTED	HABITAT RATING	#/M2	PARR POTENTIAL
Trap Cr to headwaters 17060201055CO	19.63	6.1	100	19.63	199663	2	77	92141

	1984	1985	1986	1987	1988	1989
SAMPLE SIZE:		c=8	c=1	c=1	c=1	t=1
PARR/100 m2: MEAN						
TREATMENT						17.3
CONTROL		12.4	0	5	0	
BENEFIT DENSITY:						12.1
% or DENSITY FROM BENEFIT:						70
TOTAL PARR FROM BENEFIT:						24203

Appendix C-l. Chinook parr carrying capacities, average (1986-89) production in treated areas, parcent of carrying capacity (PCC) achieved, and the parr production and PCC attributed to the enhancement project.

From Appendix Number	Stream and project type	Parr Potential	Treatment Production	Parr PCC	Parr benefit	1986-89 PCC from Fry Project	Stocked?
Instream Structure Projects:							
B1-ch	Lo10 Creek	148,258	48,489	33%	8,540	6%	yes
B6b-ch	Crooked River	46,752	13,438	29%	46,752	5%	yes
B7a-ch	Red River	63,852	42,190	66%	14.524	23%	yes
		258,862	104,117		69,816		
			(40% cc)		(27% CC)		
Barrier Removal Projects:							
B2-ch	Eldorado Creek	110,478	67,542	61%	17,482	16%	yes
B4-ch	Crooked Fork Creek	57,248	19,625	34%	19,625	34%	yes
B12-ch	Johnson Creek	294,750	30,474	10%	30,474	10%	yes
B14-ch	Boulder Creek	82,504	39,069	47%	21,468	26%	yes
B15-ch	Meadow Creek	39.036	10.437	27%	10.437	27%	yes
		584,016	167,147		99,486		
			(29% CC)		(17% cc)		
Partial Barrier Removal Projects:							
B6a-ch	Crooked River	37,123	9,286	25%	4.643	13%	yes
B9-ch	Pole Creek	29,924	31	<1%	16	<1%	yes
Bll-ch	Knapp Creek	84,040	226	<1%	113	<1%	no
B13-ch	Dollar Creek	14,509	25	<1%	13	<1%	no
B16-ch	Valley Creek	92.179	34,542	37%	24.179	26%	no
		257,775	44,110		28,964		
			(17% CC)		(11% CC)		
Off-Channel Developments							
B6c-ch	Crooked River (OCD)	13,641	32,209	236%	32,209	236%	yes
			(236% cc)		(236% CC)		
Sediment Removal Projects							
B10-ch	Bear Valley Creek (SR)	534,948	27,634	5%	15,558	3%	no
			(5% CC)		(3% CC)		
	Totals:	1,649,242	375,217		246,033		
			(23% CC)		(15% CC)		

Appendix C-2. Steel head parr carrying capacities, average (1986-89) production in treated areas, percent of carrying capacity (PCC) achieved, and the parr production and PCC attributed to the enhancement project.

From Appendix Number	Stream and Project Type	Parr Potential	Parr Production	Parr PCC	Parr Benefit	PCC from Project
Instream Structure Projects						
B1-sh	Lo10 Creek	31,464	12,192	39%	4,214	13%
B6b-sh	Crooked River	10,098	7,449	72%	2,380	24%
B7a-sh	Red River	14,997	2.234	15%	-470	-3%
		56,559	21,875 (39% cc)		6,124 (11% cc)	
Barrier Removal Projects						
BP-sh	Eldorado Creek	14,348	3.840	24%	3,840	24%
B4-sh	Crooked Fork Creek	60,579	91	<1%	91	<1%
B5-sh	Colt Creek	8,582	0	0	0	0
		83,509	3,931 (5% CC)		3,931 (5% CC)	
Partial Barrier Removal Projects						
B6a-sh	Crooked River	21,651	2,725	13%	1,362	6%
B9-sh	Pole Creek	3,886	284	7%	284	4%
B13-sh	Dollar Creek	9.570	3,213	34%	1,607	17%
		35,107	6,222 (18% CC)		3,253 (9% CC)	
Off-Channel Development Projects						
B6c-sh	Crooked River	1,786	1,446 (81% CC)	81%	1,446 (81% CC)	81%
Sediment Removal Projects						
B10-sh	Bear Valley Creek	105,333	538 (<1% CC)	<1%	-2,037 (<-2% CC)	-2%
	Totals:	282,294	34,012 (12% CC)		12,717 (5% CC)	

INTENSIVE EVALUATION AND MONITORING OF CHINOOK SALMON AND STEELHEAD TROUT PRODUCTION CROOKED RIVER AND UPPER SALMON RIVER SITES

Annual Progress Report 1989

Prepared by

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TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

LIST OF TABLES

LIST OF TABLES (Cont.)

LIST OF FIGURES

LIST OF FIGURES (Cont.)

ABSTRACT

Project 83-7 was established under the Northwest Power Planning Council's 1982 Fish and Wildlife Program, Measure 704 **(d)(1)** to monitor natural production of anadromous fish, evaluate Bonneville Power Administration habitat improvement projects, and develop a credit record for off-site mitigation projects in Idaho. The purpose of this intensive monitoring project is to determine the number of returning chinook and steelhead adults necessary to achieve optimal smolt production and develop mitigation accounting based on increases in smolt production.

Two locations are being intensively studied to meet these objectives. Field work began in 1987 in upper Salmon River and Crooked River (South Fork Clearwater River tributary).

Major findings of the project are:

1) Estimates of **egg-to-parr** survival rates from naturally-spawning spring chinook for the entire upper Salmon River averaged 5.5% (range 5.1% to 6.7%).

2) Estimates of **egg-to-parr** survival rates from natural spawners and adult outplants in the headwater streams of upper Salmon River averaged 24.4% (range 16.1% to 32.0%).

3) Estimates of 1989 **parr-to-smolt** survival rates to the head of Lower Granite Reservoir pool from PIT tag detections were 9.7% and 5.2% for chinook and 20.4% and 33.5% for age **2+** steelhead from upper Salmon River and Crooked River, respectively. Estimates of these 1988 survival rates from upper Salmon River were 12.3% for chinook and 23.3% for age **2+** steelhead.

4) During 1988, natural chinook and steelhead smolts we tagged in upper Salmon River exhibited similar timing of arrival to Lower Granite Reservoir Dam, as did all wild/natural steelhead smolts. However, when compared to all chinook at Lower Granite Reservoir Dam (which are not separated into wild and hatchery components), the upper Salmon River smolts had a later peak arrival. The upper Salmon River smolts had two major peaks in arrival at Lower Granite Reservoir Dam, and both peaks began three to four days after a major increase in the flows at Lower Granite Reservoir Dam.

5) In 1989, natural chinook and steelhead smolts from upper Salmon River exhibited very similar timings of arrival at Lower Granite Reservoir Dam as they did in 1988. In 1989, natural steelhead smolts from Crooked River arrived at Lower Granite Reservoir Dam with the same timing as the upper Salmon River chinook and steelhead. The peak arrival of chinook smolts from Crooked River at Lower Granite Reservoir Dam in 1989 occurred later than the other groups studied and coincided with the last peak of flows at Lower Granite Reservoir Dam in early June.

6) Our chinook supplementation evaluation indicates that adult outplants in low gradient headwater streams produce higher egg-to-parr survival rates than either eyed-egg or fry outplants.

Other findings of this project are:

1) In both study areas, proportionally more chinook than steelhead parr emigrate in the fall, and a smaller percentage of parr outmigrate in the fall from Crooked River (the lower elevation stream) than from upper Salmon River. Percentages of the summer parr population accounted for in the fall outmigration were similar for both years studied (1988 and 1989), and the means were 60% and 17% of the chinook and 44% and 3% of the steelhead in upper Salmon River and Crooked River, respectively.

2) Mortality of chinook and steelhead juveniles rearing above the Busterback irrigation diversion on the upper Salmon River can be up to four times higher than mortality of parr rearing below the diversion because of dewatering in late August and September, when the majority of parr emigrate from summer rearing areas. In fall 1988, a large beaver pond just above the Busterbackdiversionapparently providedadeguate overwintering habitat and greatly reduced this mortality factor for the run 1989 smolts.

3) The Busterback and Alturas Lake Creek diversions block a majority of the adult chinook from reaching the low gradient headwater streams where we have observed much higher egg-to-parr survival rates.

4) Off-channel ponds connected to Crooked River with Bonneville Power Administration habitat improvement funds reared densities of chinook parr in 1989 that were more than twice Petrosky and Holubetz's (1987) estimate of chinook parr density at full seeding. This strategy was recommended for rehabilitation of other streams degraded by dredge mining.

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INTRODUCTION

The purpose of this project is to quantify changes in chinook salmon Oncorhvnchus tshawytscha and steelhead trout O. mvkiss smolt production relating to Bonneville Power Administration (BPA) funded habitat improvement projects. It is generally accepted that habitat improvement projects can increase fish production, and for anadromous populations, effectiveness is best measured by changes in smolt production. Actual increases in smolt production resulting from habitat projects have never been statistically quantified (Buell 1986). A realistic quantitative approach for Idaho is: 1) to estimate parr production attributable to habitat projects through general monitoring; 2) to quantify relationships between spawning escapement, parr production, and smolt production through intensive monitoring; and 3) to use the determined parr-to-smolt survival rates as a basis for BPA mitigation accounting.

The primary objectives of the intensive evaluation and monitoring portion of this project are to determine:

1) Smolt production from two anadromous stream reaches.

2) Parr-to-smolt survival rates for wild and natural chinook and steelhead for BPA habitat project mitigation.

3) The mathematical relationship between spawning escapement, parr production, and smolt production.

4) Migration characteristics of anadromous juveniles from the two study streams.

5) Habitat rearing potential, potential smolt production, and reproductive potential for the two study streams.

STUDY AREAS

Upper Salmon River

The Salmon River originates in the Sawtooth, Smokey, and White Cloud mountains in south central Idaho (Figure 1). The upper Salmon River (USR) study site is the entire Salmon River drainage upstream of the Sawtooth Hatchery weir at elevations above 1,980 m. Study sections are located throughout the upper basin. The river above Sawtooth Fish Hatchery is a major production area for spring chinook salmon and A-run summer steelhead trout. Resident salmonids in the USR drainage are native rainbow trout O. mvkiss, cutthroat trout O. clarki, bull trout Salvelinus malma, mountain whitefish Prosopium williamsoni, and non-native brook trout S. fontinalis (Mallet 1974).

Historically, sockeye salmon O. nerka existed in all moraine lakes in the Stanley Basin (Everman 1895). An extremely depressed, remnant run of sockeye

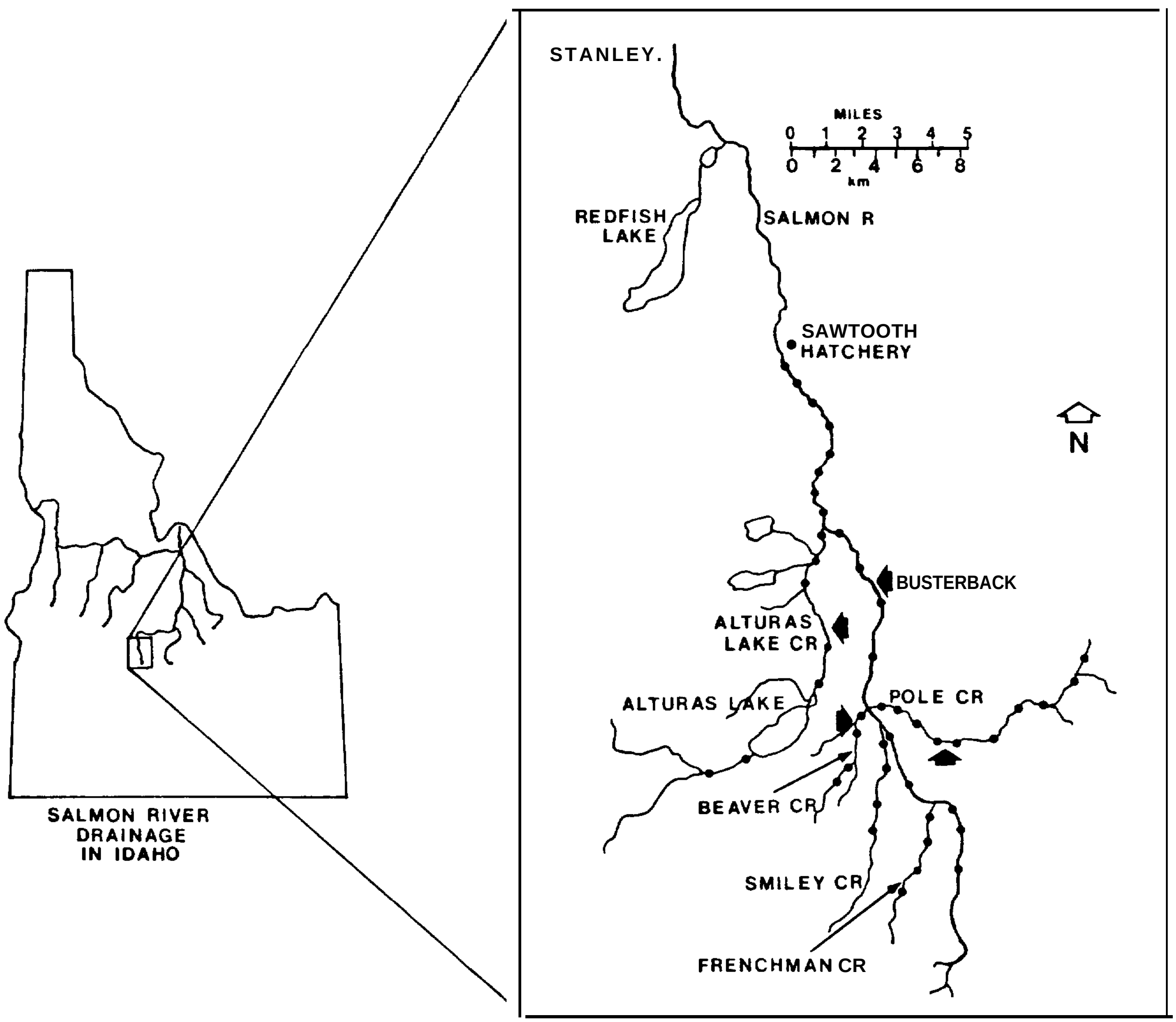


Figure 1. Location of the upper Salmon River study sections (•). Arrows indicate irrigation diversions with flow problems.

returns to Redfish Lake, whose outlet enters the Salmon River approximately 2.7 km downstream from Sawtooth Hatchery. Adult sockeye occasionally have been seen in Alturas Lake Creek (K. Ball, Idaho Department of Fish and Game, personal communication), but an irrigation diversion that completely dewaters the creek every summer makes adult passage to the lake unlikely (Bowles and Cochnauer 1984). No other sockeye runs are known to exist in the Salmon River drainage.

Nearly pristine water quality and an abundance of high-quality spawning gravel and rearing habitat is present throughout much of the upper basin. Water flows at the Sawtooth Hatchery range from lows of 1.73 to 3.46 m^3/s from July through April to highs of 11.2 to 23.3 m^3/s during May and June. Conductivity in the USR drainage ranges from 37-218 µmhos/cm (Emmett 1975).

Livestock grazing and hay production are predominant uses of private land throughout the USR basin. Grazing in riparian zones has degraded aquatic habitat in localized areas. Water diversions from the river and tributaries have impaired the potential for production of chinook and steelhead in some of the USR drainage.

Irrigation diversions in the USR have an adverse impact on river flows and fish passage. The Busterback diversion between Alturas Lake Creek and Pole Creek completely dewaters the river for approximately 3 km from July through September in an average flow year. Flow diversions from tributary streams vary from partial to complete dewatering. Conversion from flood to overhead sprinkler irrigation has decreased the withdrawal of water from Pole Creek since 1982. BPA funded the construction of a fish screen for the irrigation diversion on Pole Creek during 1983-1984. Steelhead fry have been outplanted into upper Pole Creek every year since 1985 (Idaho Department of Fish and Game, unpublished data). Chinook salmon had not been introduced into Pole Creek until supplementation research began with brood year 1988 fish.

The Sawtooth Fish Hatchery was constructed in cooperation with the U.S. Fish and Wildlife Service and the U.S. Army Corps of Engineers through the Lower Snake River Compensation Plan. The hatchery program involves trapping adult chinook and steelhead and releasing smolts and other life stages. The hatchery is designed to produce 2.4 million chinook smolts per year. Steelhead eyed eggs are sent to other facilities for rearing, and the smolts are transported back to Sawtooth Hatchery for release. The objective is to release 4.5 million steelhead smolts at Sawtooth Hatchery. At least 33% of the adult chinook and steelhead entering the trap are released upstream of the hatchery to spawn naturally.

Crooked River

Crooked River (CR) originates at an elevation of 2,070 m in the Clearwater Mountains within the Nez Perce National Forest and enters the South Fork Clearwater River at river kilometer 94 at an elevation of 1,140 m (Figure 2). The study site includes the entire Crooked River drainage. Historically, chinook and steelhead runs were eliminated by the construction of Harpster Dam on the South Fork Clearwater River in 1927. Spring chinook and B-run summer steelhead

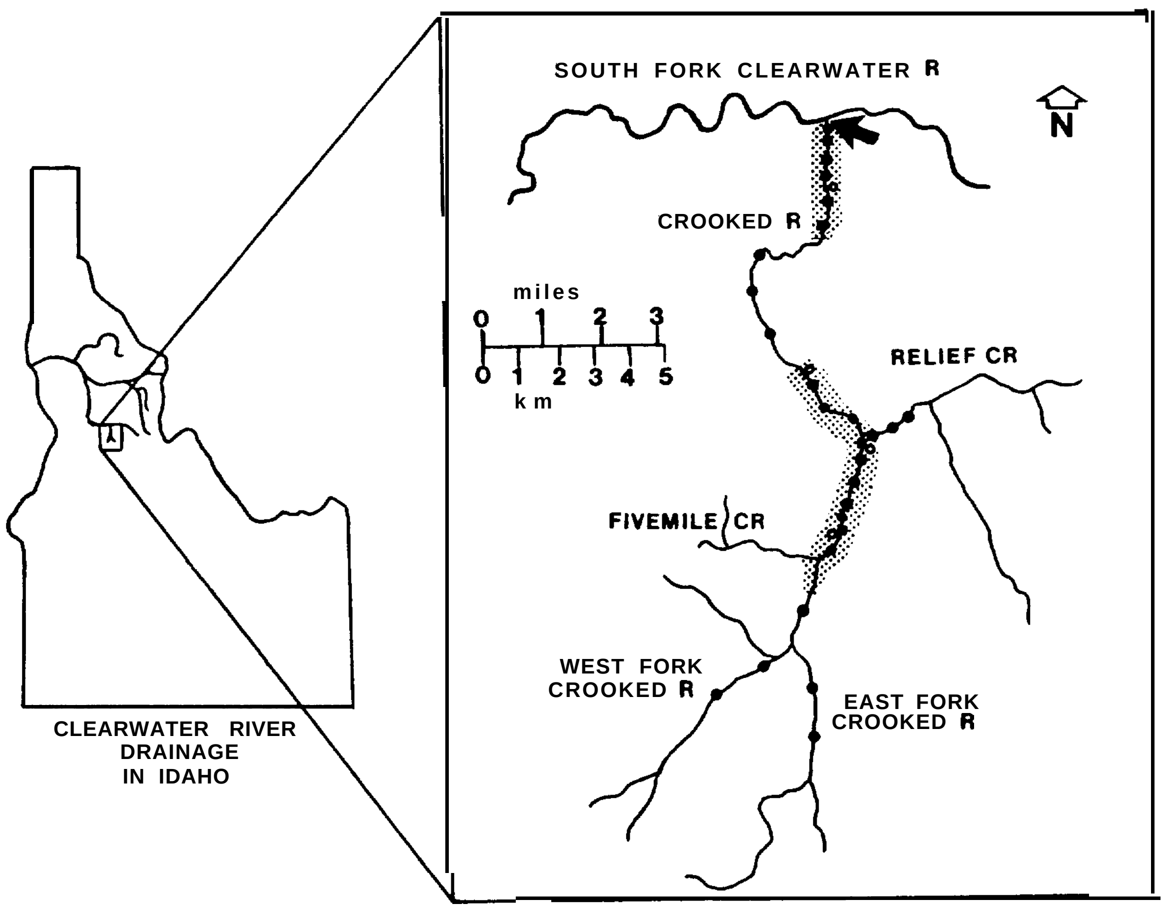


Figure 2. Location of the Crooked River study areas, pond (o), and river study sections (•), and meadows degraded by dredging (shaded). Arrow indicates location of trapping facility.

were reestablished in CR following removal of the dam in 1962. Resident salmonids in the CR drainage are native rainbow trout, cutthroat trout, bull trout, mountain whitefish, and non-native brook trout (Petrosky and Holubetz 1986). Flows on CR range from 4.3 to 0.2 m^3/s, and conductivity ranges from 35 to 50 µmhos/cm (Mann and Von Lindern 1987).

Dredge mining activities during the 1950s severely degraded habitat within the two meadow reaches of the stream. In the upstream meadow, the stream was forced to the outside of the floodplain, resulting in a straight, high gradient channel. In the lower meadow, dredge tailings have forced the stream into long meanders with many ponds and sloughs. During runoff, juvenile trout and salmon use some of these ponds, but are trapped as flow recedes.

Fish density and habitat surveys were initiated in 1984 by Idaho Department of Fish and Game (IDFG) and the Intermountain Forest and Range Experiment Station, U.S. Forest Service (USFS), Boise, Idaho. Petrosky and Holubetz (1985) found that densities of juvenile chinook and steelhead in the two meadow reaches were lower than in other Idaho streams. Densities of fish in the pools and high velocity sections were similar. Since chinook parr generally prefer pool habitat over high velocity sections, this lack of a relationship between juvenile density and habitat type indicates that the upper meadow reach was underseeded in 1984.

In 1984, the USFS, with BPA funds, placed a series of log structures, rock and boulder deflectors, organic debris structures, and loose rock weirs in the upper meadow in an effort to compensate for stream gradient and increase the pool to riffle ratio. In addition, banks were stabilized and revegetated, an off-channel pond was connected with a side channel, and a culvert blocking adult passage was removed (Hair and Stowell 1986). Recent efforts have concentrated on connecting additional ponds in the dredge tailings to the main channel and developing side channels to provide continuous water supply during low flow periods.

METHODS

Physical Habitat

Project personnel conducted physical habitat surveys using the Idaho ocular method (Petrosky and Holubetz 1987) to help determine relationships between physical habitat and smolt production.

The Idaho ocular method was derived from Platts et al. (1983). In this method, transects are established at 10-m intervals within each study section, and stream width is measured at each transect. Depth, velocity, substrate composition, embeddedness, and habitat type (ie. pool, run, riffle, pocketwater, or backwater) as described by Shepard (1983) are measured or determined at the one-quarter, one-half, and three-quarter points of each stream transect. Proportions of sand (0-0.5 cm diameter), gravel (>0.5-7.4 cm), rubble (>7.5-30.4 cm), boulder (>30.4 cm), and bedrock that comprise the substrate are estimated visually. Embeddedness (the proportion of surface area of gravel, rubble, and boulder surrounded by sand) is classified as 0%, 0-5%, 5-25%, 25-50%, 50-75%, 75-100%, and 100%. Stream gradient is measured with a surveyor's transit and stadia rod as the elevation difference between the upper and lower section boundaries divided by the section length. Stream channel type is classified according to Rosgen (1985). All sections are flagged and photographed for future repeated measurements.

Project data have been entered into the IDFG physical habitat database for analysis. The management of this database is handled by the Idaho Habitat Evaluation for Off-site Mitigation Record project and are reported in Scully et al. 1990.

Adult Escapement and Redd Counts

Actual escapements for chinook and steelhead in the USR were obtained from Sawtooth Fish Hatchery records (Alsager 1989). Except for the possibility of a small percentage of early and late fish from each of the runs, the entire escapement above the hatchery weir consisted of fish that were collected in the hatchery trap and then released upstream to spawn naturally. No actual escapements will be available for CR until the trapping facility is completed there in the summer of 1990.

Chinook trend redd counts were conducted by regional fisheries personnel (Hall-Griswold and Cochnauer 1989). The trend count for the USR was a one-day peak count by helicopter during the first week in September that covered the entire current spawning area. The trend count for CR is a one-day peak count by helicopter between Relief Creek and Five Mile Creek during the second week in September.

Total chinook redd counts were conducted in both the USR and CR study areas by foot to determine natural spawning. Counts were done using guidelines identified by IDFG personnel (Redd Count Manual 1989), and data is reported in Hall-Griswold and Cochnauer 1989. The entire probable spawning area was walked to count redds and actively spawning fish. All encountered carcasses were measured (fork length) and cut open to confirm sex and completeness of spawning. The USR ground count was conducted from Sawtooth Hatchery to the headwaters on September l-7, 1989. On CR, the ground count was conducted from the mouth to the forks on September 12, 1989.

Redd counts were attempted in both study areas to evaluate the natural spawning of steelhead trout. However, high turbid water prevented us from obtaining useful counts in either area.

The number of female chinook and steelhead spawning in the USR was estimated as the number of females released above the weir multiplied by the percent of pre-spawning survival observed at the Sawtooth Hatchery (0.95 for chinook, 0.98 for steelhead). Egg deposition was estimated as the number of female spawners multiplied by the average fecundity (5,600 eggs for chinook, 5,000 eggs for steelhead, Rogers 1988). In CR, the number of female chinook spawners was estimated assuming approximately one redd per female as we observed in the USR. Chinook fecundity for CR (4,200 eggs) was based on estimates from the nearby Red River trapping facility (McGehee 1988).

Hatchery Supplementation

Supplementation evaluation efforts in the USR currently concentrate on chinook for brood year 1988 because of their critical status relative to A-run natural steelhead. The life stages outplanted in 1989 and their respective strata were adults into Frenchman Creek and upper Pole Creek and fry into lower Pole Creek and Smiley Creek. A major factor in the selection of these supplementation sites was the absence of natural reproduction as determined by our ground redd counts.

Annual seeding levels for supplementation were selected based upon the availability of chinook adults and the levels needed for evaluation. The number of fry released were equivalent to the estimated egg deposition of the outplanted adults times the estimated survival in the hatchery from egg to fry (86%) (Rogers 1988). We evaluated outplant success as survival to parr and smolt stage. We estimated total parr abundance for the outplant sites in July by stratified sampling (three strata, six sections) ranging from 1.0 km above to 2.0 km below the outplant site.

A total of five female and five male adult chinook were released into Frenchman Creek at study section 2-A (4.0 km above the mouth) during August 12-17, 1989. The release site was located within a grazing enclosure that was also sampled for sediment monitoring (Torquemada and Platts 1988). No cattle were in the enclosure while the chinook were spawning. In the Pole Creek study area, a total of five male and four female adult chinook were released at study section 3-B (6.0 km above the mouth) during August 12-17, 1989. The Pole Creek release site was located within a meadow subjected to heavy sheep grazing. No sheep were in the meadow while the adults were spawning. Picket weirs prevented the fish from moving above or below the release sites. Spawning activity was monitored on alternate days. Carcasses were cut open to confirm sex and determine completeness of spawning, and fork length was measured.

On May 25, 1989, chinook fry were outplanted in Smiley Creek at study site 2-A (4.5 km above the mouth) and in Pole Creek at study site 2-B (4.0 km above the mouth). A total of 71,500 fry were released at each site.

Parr Abundance

Parr abundance by species and age class was estimated by snorkeling through established sections (Petrosky and Holubetz 1985). Surveys were conducted in 32 sections on CR during July 6-11, 1989 and in 83 sections on the USR during July 17-31, 1989. Total abundance of steelhead and chinook parr were estimated by stratified sampling (Schaeffer et al. 1979).

PIT Tagging

Chinook and steelhead parr were PIT-tagged (Passive Integrated Transponder) in their summer rearing areas during August 16-24, 1989 for the USR and August 2-9, 1989 on CR. National Marine Fisheries Service (NMFS) personnel cooperated in chinook tagging in the CR study area.

We collected fish for PIT tagging with a Smith-Root model 12 electrofisher or seine, depending on which method was most suitable for each particular site and species. Seines were used primarily to sample pools, and the electrofisher was used to sample riffles.

The electrofisher was operated with a 30.5-cm diameter anode ring on a 2.0 m pole, 2.4 m rattail cathode, voltage setting between 200 and 400 V, and pulse rates of 90 cycles/s when fishing primarily for chinook and 30 cycles/s for steelhead. Conductivity in the USR drainage ranges from 37 to 218 µmhos/cm (Emmett 1975). The conductivity on CR ranges from 35 to 50 µmhos/cm (Mann and Von Lindern 1987). We observed that nylon netting tied completely around the anode ring reduced the incidence of electrical burn marks and fish mortality. This modification did not impair capture effectiveness. Additional parr and pre-smolts were collected and PIT-tagged during the fall and spring outmigration trapping operations (see following section).

Tagging procedures included anesthetizing fish with MS-222 and injecting PIT tags into the body cavity using a 12-gauge hypodermic needle and modified syringe. The needle was oriented anteriorly to posteriorly and inserted just off the mid-ventral line about 1/4 of the distance between the tip of the pectoral fin and the pelvic girdle. Immediately after the needle entered the body cavity, it was rotated to change the angle so the bevel of the needle made contact with the inner surface of the body wall. The tag was then inserted. After tagging, tag presence was confirmed using a hand-held detection and decoding device. NMFS has found that once a functional tag has been successfully implanted in a fish, the tag failure rate has been less than 1% (Prentice et al. 1986). Fork length was measured to the nearest 1.0 mm on all fish that were PIT-tagged. Fish weight was measured to the nearest 0.1 g on most of the fish tagged using a Port-O-Gram balance. We summarized length data by location for both species, and for chinook we also grouped length data by parr origin (natural spawning, adult outplants, eyed-egg outplants, and fry outplants). Perforated 5 x 4 m plastic tote boxes were used to hold fish before being tagged, during recovery, and for 24-hour delayed mortality tests.

The hand-held PIT tag detector was used to detect and send the tag codes to a battery-powered laptop computer. The laptop computer used a program supplied by NMFS to organize the tag codes and associated data into tag files. Copies and printouts of these tag files were made daily.

We conducted tests on chinook and steelhead in both study areas to determine delayed mortality and tag loss. Fish were held 24 hours in perforated plastic tote boxes in the stream sections they were tagged in. After the **24-hour holding period,** all fish were scanned to confirm tag presence, and tags were retrieved from mortalities.

In the USR, three delayed mortality tests were conducted on chinook and steelhead that we collected by electrofishing. Samples were from Pole Creek in Stratum 1 (mouth to 3.0 km upstream), and on the **mainstem** of the Salmon River in Stratum 3 (from Sawtooth weir to 4.7 km above weir) and Stratum 10 (from the mouth of Frenchman Creek to Salmon River headwaters).

In CR, four delayed mortality tests were conducted on chinook and steelhead with the same methods used in the USR. Delayed mortality tests were done on chinook and steelhead collected by electrofishing in Stratum 4 at study site Meander 2 and Supplementation Pond 1 (both 3.0 km above the mouth), and in Stratum 3 at the Natural 1 study site (4.0 km above the mouth). Delayed mortality tests for seined chinook and steelhead were conducted in Stratum 3 at the Natural 1 study site.

Emigration Trapping

We monitored the emigration of juvenile anadromous fish in the USR with a floating scoop trap equipped with a 1.0 m wide inclined traveling screen (Midwest Fabrications Inc., Corvallis, Oregon). The trap was attached below the **weir** at the Sawtooth Hatchery. Water was funneled to the trap from a 3.1 m wide bay of the weir with a picket weir covered with 6 mm hardware cloth. To evaluate the spring 1989 (chinook brood year 1987) emigration, the trap was operated from March 9 to April 22, 1989. The trap was operated from August 25 to November 1, 1989 to evaluate fall emigration (brood year 1988). A modified **Krey-Meekin** trap was operated at the Sawtooth Hatchery intake structure from March 25 to April 20, 1989 to collect additional smolts for tagging.

On CR, a smaller version of the Sawtooth weir trap was used to evaluate the 1989 emigrations. The trap had a 1.0 m wide inclined traveling screen and was located 0.2 km above the mouth of CR. A rock weir was installed to funnel fish to the trap. For the spring 1989 season, the trap was scheduled to begin operation on March 1, but stream flows were insufficient to power the paddle wheel drive unit. We made an emergency purchase of a 12 V battery-powered drive unit to get the trap operational. High water and mechanical problems caused the trap to be out of operation on April 16 and May 8-9. For the fall 1989 emigration, the trap was operated from August 31 to October 30.

The overall run estimates obtained from emigration trapping operations are totals of the daily run estimates and are based on trap efficiencies calculated for different ranges of flows and daily trap catches. We used the steelhead length frequency of the catch to estimate the proportion of the total fall 1989 steelhead run that was comprised of different age groups.

Survival Rates

A major objective of this project is to estimate smolt production from naturally-spawning adults and determine factors that effect their survival.

We used PIT tag detections at the Lower Snake and Columbia River dams as the basis for smolt production estimates. In this method, we use our parr population estimates from snorkel counts and then PIT tag representative groups of parr. We then compare the detections of these PIT tag groups at the LGR Dam with the detections that Buettner and Nelson (1989) observe for fish PIT-tagged at their traps at the head of LGR pool. If we assume that their tagged fish are detected at the dams at the same rate as our tagged fish, and that both groups suffer the same tagging mortality and migration mortality through LGR, then we can estimate the number of USR and CR smolts surviving to the head of LGR pool. To make this estimate we used the following equation:

$$PTD_{USR} / PTD_{LGR\ pool} = S_{LGR\ pool}$$

Where:

PTD_{USR} = proportion of the USR PIT-tagged parr detected at LGR Dam

$PTD_{LGR\ pool}$ = proportion of LGR pool PIT-tagged parr detected at LGR Dam

$S_{LGR\ pool}$ = the proportion of the USR PIT-tagged fish surviving to the head of LGR pool

Then we multiply this estimate of the proportion of PIT-tagged parr surviving to the head of LGR pool by the population estimate to get the estimate of smolts surviving to the head of LGR pool.

When our estimate of smolt production indicated that there may be an error in the PIT tag method, we used a monthly survival estimate for a comparison. In this method, we have to make the assumptions that all monthly survival rates (S) are equal, that our snorkel counts accurately estimate the parr populations, and that our trap accurately estimates the number of fish leaving the study area during the fall and spring emigration periods. We then can use the following equations to estimate smolt production at the study area.

$$PP_{July} \times S^2 - E_f = PP_{winter}$$

Where:

PP_{July} = July parr population estimate

S = monthly survival

E_f = fall emigration

PP_{winter} = overwintering populations

$$PP_{winter} \times S^6 = E_s$$

Where:

PP_{winter} = overwintering population

S = monthly survival

E_s = spring emigration

Since we have estimates of the July parr population, the fall emigration, and the spring emigration, we can then solve for S. We then multiplied the July parr population estimate by S^8 to estimate the number of smolts produced at the study area. To compare this estimate to the PIT tag detection estimate, we multiplied it by our estimate of migration survival to LGR pool from PIT tag detections to get an estimate of survival to LGR pool.

RESULTS

Upper Salmon River

Physical Habitat

Physical habitat was not evaluated in the upper Salmon River (USR) study area in 1989. Project data from past years has been entered into the Idaho physical habitat database. The management of this database is being handled by Idaho Habitat Evaluation for Off-site Mitigation Record personnel and is reported by Scully et al. (1990).

Adult Escapement and Redd Counts

In 1989, 73 of a total 216 adult female chinook captured at the Sawtooth Fish Hatchery adult trap were released above the weir to spawn naturally (Table 1). However, high water during June 12-16 forced Sawtooth Hatchery personnel to remove four 3.3-m-wide weir panels which allowed uncounted adults to pass the weir.

Table 1. Adult escapement. redd counts, and estimate of eggs deposited for upper Salmon River, brood year 1984 to 1989.

	Chinook Salmon Brood Year				
	1985	1986	1987	1988	1989
Total escapement	625	876	506	552	470b
Female escapement	180	248	252	275	73b
Helicopter Redd count	83	105	124	76	52
Ground Redd count				261	123
Eggs/female[a]	4,530	5,156	5,399	5.653	
Estimated eggs deposited	815,400	1,278,688	1,360,548	1,554,575	

	Steelhead trout Brood Year				
	1985	1986	1987	1988	1989
Total escapement	206	1,956	979	635	378
Female escapement	92	322	383	136	157
Eggs/female[a]	5,640	4,468	4,854	5.069	
Estimated eggs deposited	518,880	1,438,696	1,859,082	689,384	

[a] Number is average eggs/female observed at Sawtooth Fish Hatchery.
[b] Portions of the Sawtooth Fish Hatchery weir was pulled from June 12-16 due to high water and uncounted fish probably passed the weir.

Total escapement, female escapement, and eggs/female data are from Sawtooth Hatchery Brood Year reports. Redd count data are from Idaho Department of Fish and Game Redd count reports.

A total of 123 chinook redds were observed during ground counts, compared to the helicopter count of 52 for the same area (Table 1). Approximately ten redds were observed from the ground that would not be detectable from a helicopter because of recent sedimentation of the redds caused by late summer sheep grazing. In 1989, a total of 378 adult steelhead were released above the Sawtooth Hatchery weir to spawn naturally. Of this release, 157 fish were females (Alsager 1989). A helicopter steelhead redd count was attempted on May 9, 1989 for the USR. However, high turbid water prevented us from getting a useful count. In 1990, this project will charter a helicopter so that we can be more flexible in the timing of the count and, hopefully, avoid high water.

Hatchery Supplementation

In 1989, a total of 9 adult female chinook, 275,000 chinook fry, and 361,080 steelhead fry were outplanted into the USR (Alsager 1989). Supplementation data for the brood years 1985 to 1989 are summarized in Tables 2 and 3.

Most of the fry outplanted into lower Pole Creek in 1988 and 1989 emigrated immediately after the outplant (G. Gadwa, Idaho Department of Fish and Game, personal communication), and we decided to exclude them from the brood years 1987 and 1988 supplementation evaluation. We believe that since most of these fish did not stay in the outplant area, we could not estimate the parr population and egg-to-parr survival. This emigration apparently was in response to extremely low flows below the Pole Creek diversion.

Estimated abundance of chinook parr produced from supplementation was 27,350 ± 15,700 from adult outplants, 6,540 ± 4,441 from eyed-egg outplants, and 18,480 + 30,026 from fry outplants. An additional 132,000 chinook fry were releasedby Sawtooth Hatchery into the Salmon River just below the Hell Roaring Creek Bridge. To estimate the parr produced from the fry outplanted into this section of the Salmon River, we had to make several assumptions. First, we assumed that our observed low overall natural egg-to-parr survival was a result of limited rearing habitat below the Busterback diversion and emigration from our study area. Second, that the outplanted fry below the Hell Roaring Creek Bridge were affected by these factors at a rate similar to the natural chinook. Considering these two assumptions, we estimated this fry outplant had an egg-to-parr survival rate equal to the observed headwaters fry outplant survival rate (10.9%) multiplied by the ratio of the natural egg-to-parr survival rate below Busterback diversion (5.1%) divided by the natural egg-to-parr survival rate above Busterback diversion (34.1%). The ratio of natural survival below Busterback diversion divided by natural survival above Busterback diversion was used to correct for the apparent better juvenile survival above Busterback diversion. This provided an estimate of parr production from the fry outplant below the Hell Roaring Creek Bridge of 2,152 (1.6%). We then estimated the total number of chinook parr in USR resulting from supplementation to be 54,520.

Table 2. Upper Salmon River chinook supplementation, summary by brood year 1985 to 1989.

	Brood Year				
	1985	1986	1987	1988	1989
Adult Females	19	0	6	30	9
Eyed Eggs	0	0	28,000	56,530	0
Fry	0	0	48,000	275,000	0
Fall parr	0	0	43,000	0	0
Smolts	0	0	0	0	

Table 3. Upper Salmon River steelhead supplementation, summary by brood year 1985 to 1989.

	Brood Year				
	1985	1986	1987	1988	1989
Adult Females	0	1,056	0	83	0
Fry	11276,501	832.414	678,680	537.700	361,080
Fall parr	0	0	0	0	0
Smolts	0	0	0	0	

Parr Abundance

Estimates for total parr abundance from snorkel counts in the USR during summer 1989 were: 155,607 ± 44,684 age 0 chinook; 4,858 + 2,236 **age 1+** steelhead; and 3,256 ± 788 age **2+** steelhead. The summer densities of age 0 chinook for 1985 to 1989 are summarized in Table 4. Natural populations of chinook have been reduced, beginning with brood year 1984 (1985 density), by trapping the adults and using 67% of them in the Sawtooth Hatchery. This is apparent from redd counts, which declined from 161 in 1983 to an average of 86 for 1984 to 1989 (Redd Count report 1989). The summer densities of age 1+ and 2+ steelhead for 1985 to 1989 are summarized in Table 5.

PIT Tagging

In 1989, a total of 5,388 chinook parr and 1,351 steelhead parr were PIT-tagged in the USR during August 16-24. This includes 1,045 chinook parr that were tagged in Stratum 1 of Alturas Lake Creek on August 20, 1989 by NMFS for a study of their own, and incorporated into our study as well. Our overall tagging mortalities of 2.5% for chinook and 0.8% for steelhead were low (Table 6).

Three different 24-hour delayed mortality tests were conducted during the USR field tagging and resulted in a delayed mortality of 0.4% for chinook and 0% for steelhead (Table 7). Data for the mean length of PIT-tagged parr for the USR is summarized in Table 8. In general, the parr resulting from fry outplants were larger than all other parr, and those from adult and eyed-egg outplants were smaller than any other group.

Spring 1989 Emigration Trapping

In spring 1989, the Sawtooth Weir Trap (SWT) was operated from March 9 to April 22. It was taken out of operation on April 22, when high water caused irreparable damage to the trap. During spring 1989, we captured 666 chinook smolts with a trapping efficiency of 8.0% and an estimated run of 8,274. We also captured 44 age 2 steelhead and 14 age 3 steelhead, with a trapping efficiency of 2.7% and run estimates of 1,630 age 2 and 519 age 3. Daily run estimates for spring 1989 are graphed in Figure 3. Peak emigration for both chinook and steelhead occurred on April 14, 1989.

Fall 1989 Emigration Trapping

In fall 1989, the SWT was operated from August 25 to November 1, with a trapping efficiency of 11.8% for chinook and 16.7% for steelhead. A total of 9,479 chinook were captured for a run estimate of 80,104, and 548 steelhead were

Table 4. July density (number/100 m^2) of age 0 chinook in the upper Salmon River, 1985 to 1989.

Stratum	1985	1986	1987	1988	1989
Salmon River					
3, 4	15.97	-	7.00	13.80	9.7
5, 6	2.27	-	0.28	4.10	3.6
7	14.00	10.95	20.25	13.26	32.9
8	1.30	12.25	10.33	3.86	0.6
9	8.40	-	7.42	1.44	2.6
10	3.55	-	0.11	0	31.9
Salmon River side channels					
3, 4	14.20		-	16.00	24.6
5, 6	0.35		-	17.93	0.6
7	0.50	-	-	16.12	85.7
8, 9, 10	0.25		-	6.75	1.7
Pole Creek					
1	0		25.73	1.95	0.9
2	0	0.15	2.89	4.25	11.2
3	0	0	0	0.12	55.8
4	0		0	0	0.3
5	0				0
Alturas Lake Creek					
1	12.5		18.34	8.64	20.3
2			0.60	0.91	2.5
3	0	0.05	0.06	0	7.7
Smiley Creek					
1	0.10	-	35.17	6.94	14.1
2	1.65	-	1.10	13.50	23.4
Beaver Creek					
1	0.15		-	2.12	0.4
2	0		-	0.39	20.8
Frenchman Creek					
1	-	-	0	0.61	4.0
2	-	-	0	41.39	109.5

Table 5. July density (number/100 m^2) of age 1+/age 2 steelhead parr in the upper Salmon River, 1985 to 1989.

Stratum	1985	1986	1987	1988	1989
Salmon River					
3, 4	0.62/0.33		0.05/0.02	0.20/0.08	0.02/0.1
5, 6	0.20/0.17		0.01/0.02	0.07/0.05	0/0
7	0.02/0.08	0.35	0: 72/0.00	0.37/0.12	0.2/0.2
8	0.45/0.05	0.90	0.39/0.22	0.38/0.11	0.0/0.7
9	4.20/0.20		8.51/2.09	2.75/0.80	2.6/0.9
10	2.15/3.30		7.27/2.37	3.51/2.89	8.4/4.4
Salmon River side channels					
3. 4	2.62/0.72			0.56/0.0	0.2/0.2
5; 6	0/0			0/0	0/0
7	0.60/0.10			0/0	0.0/0.3
8, 9, 10	0/0			0.25/0.0	0/0
Pole Creek					
1	0.10/0.15		2.98/1.16	2.05/0.59	0.1/0.1
2	1.25/0.35	1.95	5.11/1.60	0/0	0.5/0.3
3	0/0	0.10	0.0/0.13	0/0	0.3/1.2
4	2.90/0.10		1.33/1.33	4.75/0.50	0.8/0.9
5	0/0		0.0/0.13	0.0/0.73	0/0
Alturas Lake Cr.					
1	0.70/0.01		0.83/0.03	0.58/0.05	0.1/0.1
2	-		0.90/0.47	0.38/0.31	0.0/0.1
3	0.05/0.0	-0	0/0	0.12/0.12	0.1/0.1
Smiley Creek					
1	0/0		0.18/0.56	0/0	0.5/0.6
2	0.15/0.10		0.0/0.05	0.16/0.05	0.1/0.02
Beaver Creek					
1	0.30/0.15			0.48/0.0	0.1/.01
2	0/0			0.20/0.02	0/0
Frenchman Cr.					
1	-		1.79/2.23	0.0/0.61	1.5/2.3
2	-		0/0	0.11/0.11	0. o/o. 1

[a] In 1986, data for age 1+ and 2+ steelhead were combined.

Table 6. Collection and PIT tagging mortalities for upper Salmon River, August 1989.

	Chinook	Steelhead	Total
Number collected	5,681	1,491	7,172
Number tagged	5,396	1,352	6,748
Collecting mortality			
Number	132	11	143
Percent	2.3%	0.7%	2.0%
Tagging mortality			
Number	a	1	9
Percent	0.2%	0.1%	0.1%
Total mortality			
Number	140	12	152
Percent	2.5%	0.8%	2.1%

Table 7. Delayed mortality test **(24-hour)** for parr collected and PIT-tagged in the upper Salmon River, August 1989.

Tag site	Collection method	Number held	Number morts	Percent morts
		Chinook		
SR 3-B	Shock	195	1	0.5%
PC R-1	Shock	51	0	0
Total	246	1	0.4%	
		Steelhead		
SR 3-B	Shock	111	0	0
PC R-l	Shock	55	0	0
SR R-10	Shock	195	0	0
Total		361	0	0

Table 8. Mean lengths (mm) of PIT-tagged parr from upper Salmon River, August 1989.

Tag Site	Chinook outplant method	Number chinook tagged	Chinook average length	Number steelhead tagged	Steelhead average length
SR-FC2A	Adult	420	61	0	
SR-PC3B	Adult	93	44	1	118
SR-3A	Natural	92	78	124	71
SR-3B	Natural	511	79	218	85
SR-7A	Natural	545	77	11	145
SR-9A	Natural	397	76	106	103
SR-9B	Natural	386	77	316	109
SR-10	Natural	213	80	197	123
SR-HC1	Natural	199	75	65	103
SR-SC1	Natural	237	78	67	109
SR-FC1	Natural	81	81	61	122
SR-ALC1	Natural	1,043	77	0	
SR-PC 1	Fry	147	91	113	124
SR-PC2B	Fry	161	82	a7	76
SR-SC2B	Fry	534	85	0	-
SR-BC2	Eyed-egg	276	61	0	-
SR-ALC3	Eyed-egg	144	59	0	-
Total	Adult	513	53	-	-
Total	Natural	3,704	77	-	-
Total	Fry	a42	86	-	-
Total	Eyed-egg	420	60	-	-
Grand Total		5,479	74	1,366	103

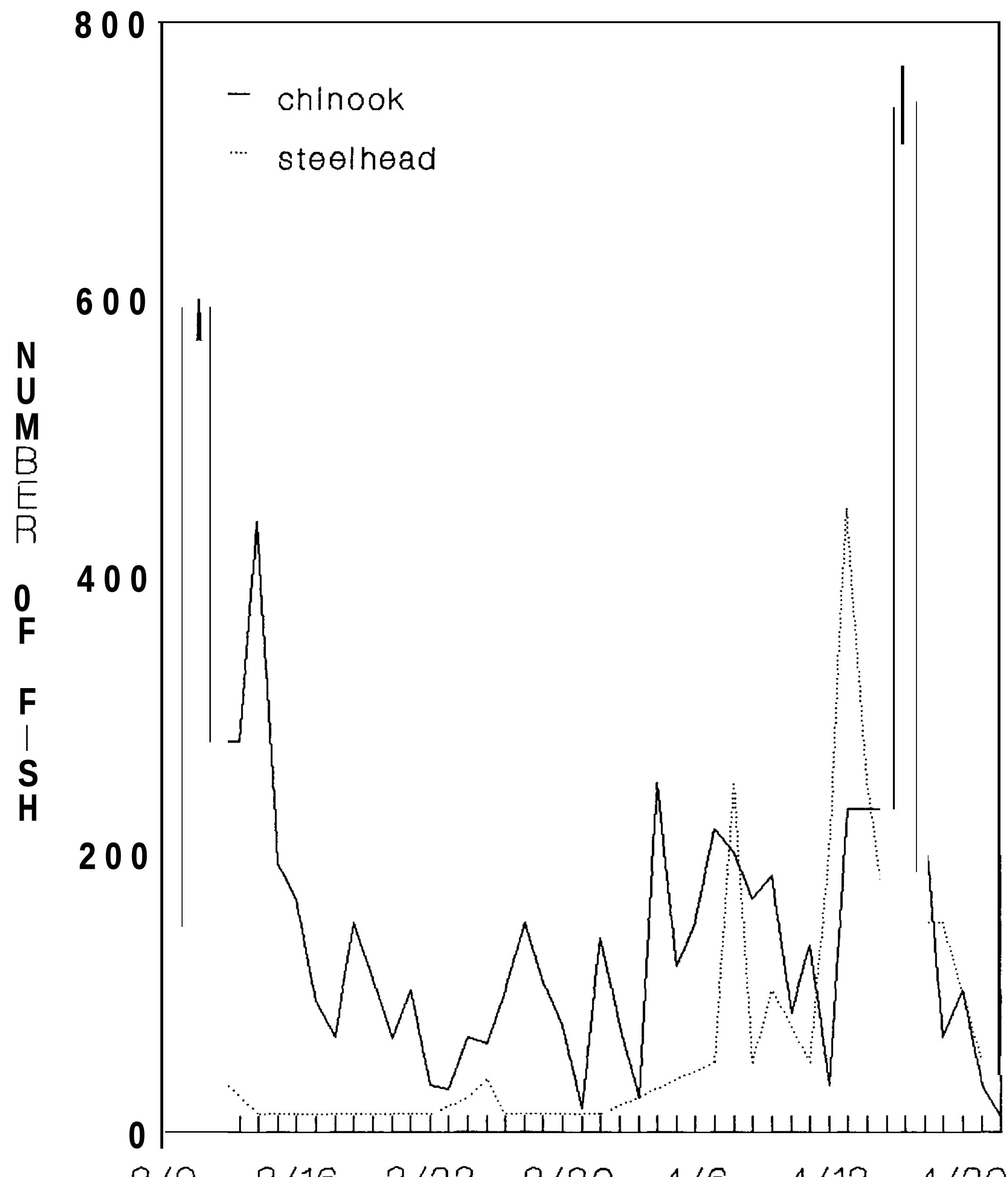


Figure 3. Spring 1989 upper Salmon River chinook and steelhead emigration timing.

captured for a run estimate of 3,265. The proportions and run estimates for the different steelhead age groups collected at the SWT were 25% (823) age 0, 19% (614) age 1+, and 56% (1,828) age 2+.

Dam Detections

During the spring 1989 emigration, PIT-tagged chinook and steelhead smolts captured at SWT were later detected at LGR Dam, 748 km downstream. We calculated mean travel times by three day groups and observed two different patterns for chinook travel time (Figure 4). First, from March 10 to March 19, the mean travel time decreased progressively from about 75 to 45 days. Second, during the remainder of the emigration sampled, the travel time fluctuated, but in general, slowly decreased from about 45 days to about 30 days. With the low numbers of smolt-sized steelhead captured in spring 1989 and the low percentage of recaptures, we did not have enough data to calculate mean travel times for steelhead.

The combined PIT tag detection rates at the Lower Snake and Columbia River smolt collecting dams for the spring 1989 USR smolts were 31.0% for chinook, 0% for age 1 and age 2 steelhead, and 14.3% for age 3 steelhead. For the fall 1988 USR emigrants, the detection rates were 8.5% for chinook, 0% for age 1+ steelhead, and 15.3% for age 2+ steelhead. For the August 1988 PIT-tagged parr, the detection rates were 6.3% for chinook, 0% for age 1+ steelhead, and 16.7% for age 2+ steelhead. The combined PIT tag detection rates for the smolts tagged at the Snake River Trap by Buettner and Nelson (1989) were 68.5% for chinook and 81.5% for steelhead.

Survival Rates

Chinook egg-to-parr survival rates by outplant method and stocking density for brood years 1987 and 1988 are summarized in Table 9. Egg-to-Parr survival rates were estimated for naturally-produced chinook in four of the past five years in the USR (Table 10).

Two different methods were used to estimate parr-to-smolt survival and smolt production in 1989. The first used PIT tags and comparative detections at Lower Snake and Columbia River dams from our study and Snake River trap information (Buettner and Nelson 1989) to estimate survival to the head of LGR pool. The second method used to estimate parr-to-smolt survival uses parr abundance and emigration trapping data to estimate monthly survival and smolt production at the study area. To compare the monthly survival estimate to the PIT tag estimates, we used the spring 1989 PIT tag estimates of USR smolts to LGR pool survival (for chinook 45.3%) to calculate the smolt at LGR pool survival rate for the monthly rate method (for chinook 43.4% x .453 = 19.7%).

Using the PIT tag method, estimated parr-to-smolt survival (August 1988 to March-July 1989) to the head of LGR pool was 9.7% for chinook and 20.4% for steelhead. Estimated smolt survival to LGR pool for fall 1988 emigrants were

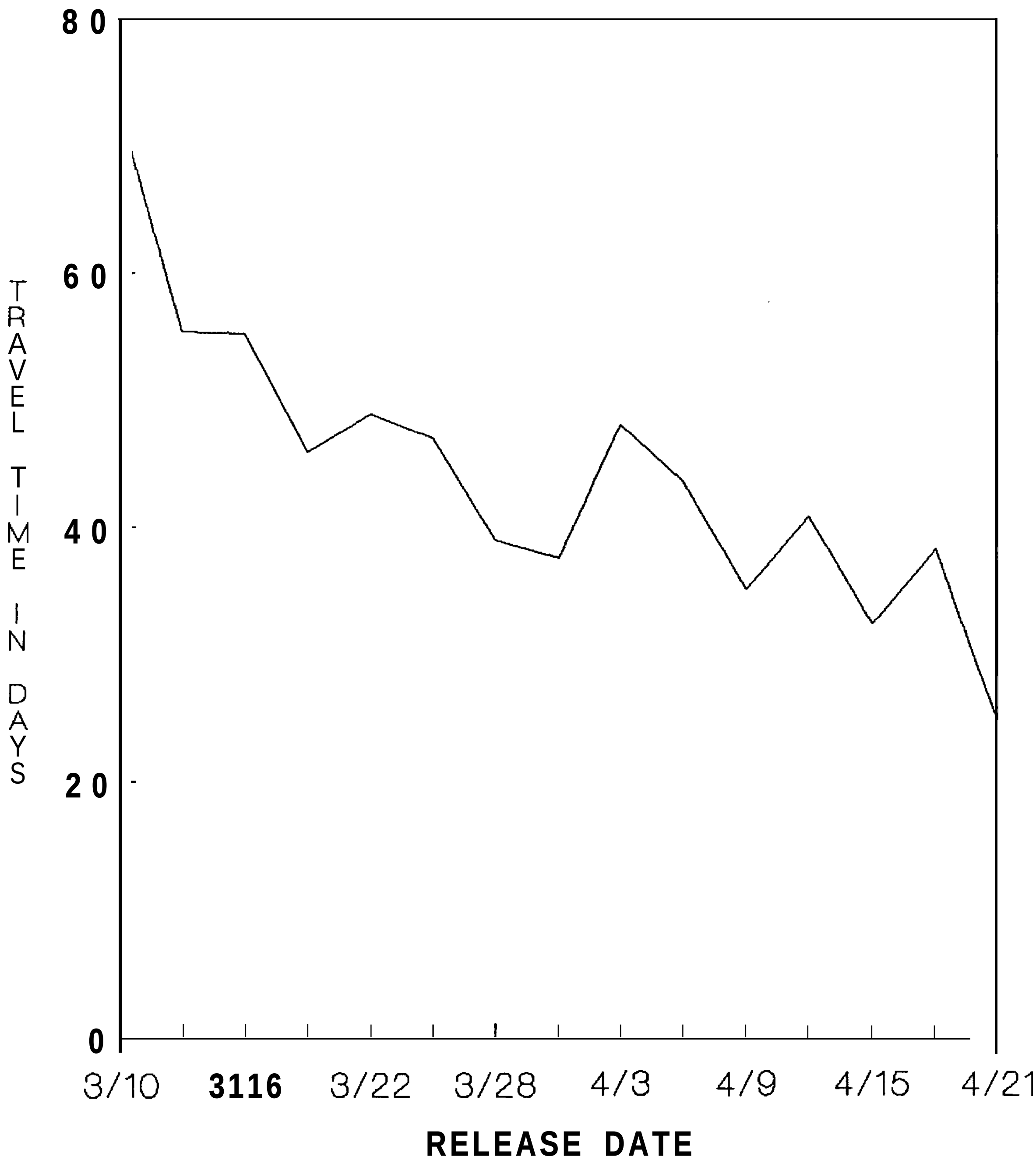


Figure 4. Three-day averages of chinook smolt travel time from Sawtooth Weir trap to Lower Granite Dam.

Table 9. Estimated parr production and survival rates by outplant method and stocking density from chinook supplementation evaluation in upper Salmon River, brood year 1987 and 1988.

Outplant method	Population parameter	Stocking density 4 redds/ha	Stocking density 12 redds/ha
Adult	Females outplanted	6[a]	30
	Egg deposition	26,995	169,590
	Parr production	8,625	27,348
	Egg-to-Parr survival (%)	32.0	16.1
Eyed-egg	Egg deposition	56,530	--
	Parr production	6,540	--
	Egg-to-Parr survival (%)	11.6	--
Fry	Hatchery egg requirement	28,000	169,590
	Fry outplanted	24,000	143,000
	Parr production	4,525	18,480[b]
	Egg-to-Parr survival (%)	16.2	10.9
Headwater Natural spawners	Redds observed	6	--
	Egg deposition	33,918	--
	Parr production	8,500	--
	Egg-to-Parr survival (%)	25.1	--

[a] One of the six females died before spawning and was not included in the calculations.

[b] Assumes that the fry planted into Pole Creek which eventually emigrated survived at the same rate as those outplanted into Smiley Creek.

Table 10. Egg-to-Parr survival rates for natural chinook in upper Salmon River, brood year 1984 to 1988.

	Brood Year				
	1984	1985	1986	1987	1988
Estimated egg deposition in thousands=	1,095-1	815.4	1,287.7	1,360.5	1,724.2
Parr production	73,548	-	65,739	70,319	88,001
Egg-to-Parr survival	6.7%		5.1%	5.2%	5.1%

"From Table 2.

13.1% and 18.8% for age 0 chinook and age **2+** steelhead, respectively. For spring 1989 emigrants, the survival rates were 45.3% and 17.5% for age 0 chinook and age 3 steelhead, respectively. Based on these survival rates of PIT-tagged fish, we estimated smolt production at the head of LGR pool in 1989 was 8,546 chinook and 426 steelhead from August 1988 PIT tagging, and 11,889 chinook and 286 steelhead from the spring and fall trapping combined.

Survival estimates based on monthly survival rates for July to April at the study site were 43.4% for age 0 chinook and 47.0% for age 2 and older steelhead. These percentages yield smolt production estimates for 1989 at the study site of 38,305 chinook and 982 steelhead.

Crooked River

Physical Habitat

Project personnel conducted physical habitat surveys on 13 sections in CR in 1989 using the Idaho ocular method (Petrosky and **Holubetz** 1987). Project data for 1989 have been entered into the IDFG physical habitat database. The management and initial analysis of this database is being handled by subproject I personnel. During winter 1991, we will analyze for correlations between physical habitat, parr density, and smolt production.

Adult Escapement and Redd Counts

Accurate escapement numbers will not be available for CR until the weir and trap are completed in 1990. Known escapements will be correlated with redd counts for chinook and possibly steelhead. Total egg deposition will be estimated using known female escapement and fecundity from CR when available. Preliminary estimates of chinook female escapement and total egg deposition for 1984-1989 are provided in Table 11. The 1984 to 1987 female chinook escapement estimates were based on the ratio of the 1988 total redd count to trend count (43 total; 27 trend) and past trend counts.

In 1989, a one-pass ground count of chinook redds over the total probable spawning area of CR was conducted on September 12. We counted 15 redds for the total probable spawning area and 6 redds for the traditional trend count reach (narrows to the forks). The helicopter redd count of the traditional trend count reach was conducted by the Regional Fisheries Manager on September 10. This aerial count observed three redds in the trend count area.

In 1989, a helicopter steelhead redd count for CR was attempted on May 8. However, because of the turbid water, the count was not considered usable. In 1990, this project will charter a helicopter so that we can be more flexible in the timing of the count and, hopefully, conduct the count before high water comes. The datum for steelhead in CR are not complete enough to estimate escapement or egg deposition.

Table 11. Estimated chinook salmon adult escapement, **redd counts,** and number of eggs deposited for Crooked River, 1984 to 1989.

	Brood Year					
	1984	1985	1986	1987	1988	1989
Trend Redd Count	22	10	9	17	27	3
Ground Redd Count					43	15
Estimated female escapement=	35	16	14	27	43	15
Eggs/female[b]	4,432			4,010		4,400
Estimated egg deposition in thousands	155.1	67.5	59.1	108.3	181.5	66.0

'Female escapement estimate is based on 1/1 ratio of female escapement to ground redd counts observed in upper Salmon River, and **43/27** ratio of groung to trend redd counts observed in 1988.
[b]**Average** number of eggs/female obtained from nearby Red River trapping facility in 1984 and 1987. We used 1984 and 1987 average from brood years for which data were not available.

Hatchery Supplementation

Although not as part of our research investigations, hatchery supplementation of chinook and steelhead in CR has occurred regularly during the project period (Tables 12 and 13). Beginning in 1990, only adult chinook and steelhead will be outplanted in CR so that we can evaluate egg-to-parr survival rates at different seeding levels. In addition, our data will be incorporated into the chinook supplementation evaluation research project.

Parr Abundance

Chinook parr densities in 1989 were the highest, or among the highest, observed since data began being collected in 1984 (Table 14). We estimated the CR chinook parr abundance in 1989 to be 101,947 ± 34,196.

Steelhead parr densities in 1989 were midway between the high years of 1986, 1987, and 1988 and the low years of 1984 and 1985 (Table 15). We estimated the CR steelhead parr abundance in 1989 to be 9,293 ± 1,593 age 1+ and 4,543 ± 911 age 2+. Pending the completion of the CR trap and weir in 1990, no estimates can be made for natural steelhead escapement, egg deposition, or egg-to-parr survival rate.

PIT Tagging

We tagged a total of 3,927 chinook and 925 steelhead parr, with overall mortalities of 3.5% for chinook and 0.6% for steelhead (Table 16).

We conducted four 24-hour delayed mortality tests of PIT-tagged parr from CR in 1989. We observed delayed mortalities of 1.8% for chinook and 0% for steelhead (Table 17).

Length and weight were measured on PIT-tagged parr. The average length of chinook parr was similar among strata (Table 18). The average length of PIT-tagged steelhead parr ranged from 115 mm to 121 mm (Table 18).

Spring 1989 Emigration Trapping

The Crooked River trap was operated from March 13 to May 23, 1989, when low capture rates indicated the smolt migration was over. We trapped a total of 2,911 chinook parr, had a chinook trapping efficiency of 28.2%, and a total chinook run estimate of 15,618. For steelhead, 358 were trapped, with a trapping efficiency of 17.7% and a total run estimate of 2,656. Spring steelhead emigration by age group, based on size distribution in the trap catch, were 48%

Table 12. Crooked River chinook supplementation, summary by brood year 1984 to 1989.

	Brood Year					
	1984	1985	1986	1987	1988	1989
Adult females	0	0	0	0	0	0
Fry	0	349,650	0	200,100	201,824	-
Fall parr	0	251,300	227.500	0	0	-
Smolts	0		0	199,690		

Table 13. Crooked River steelhead supplementation, summary by brood year 1964 to 1989.

	Brood Year					
	1984	1985	1986	1907	1988	1989
Adult females	0	1,522	0	468	0	0
Fry	0	0	87,750	0	0	0
Fall parr	0	0	0	0	0	0
Smolts	42,235	140,825	158,538	201,325	88,000	-

Table 14. Density (number/100 m^2) of age 0 chinook in Crooked River, August 1984 to 1989.

Stratum	1984	1985	1986	1987	1988	1989
Headwaters					0.03	0.1
I	0	20.80	13.97	3.01	23.77	28.4
II		71.30	21.67	1.08	16.47	19.7
Canyon					8.05	10.3
III	32.20		57.80	22.33	36.64	58.7
IV	3.80	66.30	71.75	15.37	42.21	59.0
Relief Creek					0.82	45.5
Connected						
Ponds A[a]			62.86	3.20	65.39	206.1
Ponds B						268.0

[a]From 1986 to 1988 ponds A and B were combined and are reported here as ponds A.

Table 15. Density (number/100 m^2) of age 1+/age 2+ steelhead parr for Crooked River, 1984 to 1988.

Stratum	1984[a]	1985[a]	1986	1987	1988	1989
Headwaters						0.2/0.3
I	0.45	1.00	6.80/0.17	4.27/0.70	5.21/0.15	1.9/0.8
II		2.05	11.67/1.07	10.82/3.74	8.82/0.38	4.4/1.4
Canyon					11.44/1.16	4.1/2.1
III	3.10		6.20/0.20	6.09/2.82	10.32/0.50	6.5/1.8
IV	0.70	0.25	7.15/0.30	7.24/1.49	7.15/7.12	3.4/1.5
Relief Cr.					19.10/0.55	5.2/1.8
Connected						
ponds A[a]			4.73/0.33	42.40/4.80	17.84/1.66	7.2/1.7
ponds B[b]						10.1/2.2

[a] In 1984 and 1985 data for steelhead age 1+ and 2+ were combined.
[b] From 1986 through 1988 ponds A and B were combined and are reported here as ponds A.

Table 16. Collection and PIT tagging mortalities for Crooked River, August 1989.

	Chinook	Steelhead	Total
Number collected	4,223	932	5,155
Number tagged	3,927	925	4,852
Collecting mortality			
Number	69	2	71
Percent	1.6%	0.2%	1.4%
Tagging mortality			
Number	79	4	83
Percent	2.0%	0.4%	1.7%
Total mortality			
Number	148	6	154
Percent	3.5%	0.6%	3.0%

Table 17. Twenty-four-hour delayed mortality test results for Crooked River, 1989.

Tag site	Collection method	Number held	Number mortalities	Percent mortalities
		Chinook		
Natural 1	Shock	7	0	0%
Natural 1	Seine	429	11	2.6%
Meander 2	Shock	73	4	5.5%
Pond S-1	Shock	407	1	0.3%
Total	Seine	429	11	2.6%
Total	Shock	487	5	1.0%
Overall Totals		916	16	1.8%
		Steelhead		
Natural 1	Shock	14	0	0%
			0	0%
Natural 1 / Meander 2	Seine / Shock	40	0	0%
Pond S-1	Shock	36	0	0%
Total	Seine	23	0	0%
Total	Shock	90	0	0%
Overall Totals		113	0	0%

Table 18. Average fork lengths (mm) of PIT-tagged parr from Crooked River, 1989.

Stratum	Chinook Number tagged	Chinook Mean length	Steelhead Number tagged	Steelhead Mean lensth
I	460	73	125	121
II	530	70	101	119
Canyon	282	69	203	117
Relief Cr.	408	69	62	115
III	1,377	72	158	121
IV	767	71	279	117
Total	3,824	71	928	118

(1,275) age 1, 29% (770) age 2, and 23% (611) age 3. Based on the summer parr abundance (Kiefer and Forster 1990), we estimated that 25.8% of chinook parr, 3.4% of age 1+ steelhead, and 34.8% age 2+ steelhead emigrated in spring 1989.

Fall 1989 Emigration Trapping

In fall 1989, Crooked River trap was operated from August 31 to October 30, 1989. We trapped a total of 2,679 chinook parr, had a chinook trapping efficiency of 39.5%, and a total chinook run estimate of 6,920. Age 1+ and older steelhead numbers were 45 trapped, 16.3% trapping efficiency, and a total run estimate of 275. The proportions of summer parr populations that outmigrated in the fall were 6.4% for chinook and 2.7% for age 1+ and older steelhead. The proportions (and run estimates) for the different age groups of steelhead based on length frequency were 24% (87) age 0, 29% (105) age 1+, and 47% (170) age 2+.

Dam Detections

The combined PIT tag detection rates at the Lower Snake and Columbia River smolt collecting dams for the spring 1989 CR smolts were 22.3% for chinook, 0% for age 1 and 2 steelhead, and 43.4% for age 3 steelhead. To evaluate the effect of smolt size and migration survival, we calculated smolt size and detection percentages (Table 19).

From these PIT tag detections, we calculated mean travel times for three-day groups and observed two different patterns for chinook travel time (Figure 5). First, we observed a progressive decrease in travel time from 79 days for the first three-day group (March 19-21) to about 23 days for April 30-May 2. From April 30-May 2 until the end of trapping, the travel time slowly decreased from about 23 days to 21 days. The pattern was similar for steelhead smolts, but the travel time was usually less and seemed to level off after April 30-May 2 at about 8 days.

Detection data for the August 1988 PIT-tagged parr were summed by strata (Table 20). Overall, the smolt collecting dams collected 2.9% of the chinook, 1.6% of the age 1+ steelhead, and 27.3% of the age 2+ steelhead parr from the August 1988 tagging.

Survival Rates

If we assume that the chinook fry outplanted into CR in 1989 survived at a similar rate to what Scully et al. (1990) estimated from other Clearwater River tributaries, then we can make an estimate of egg-to-parr survival for natural spawners in CR. If the 201,824 fry stocked in 1989 survived to the parr stage at a rate of 20% (Scully et al. 1990), approximately 40,365 of the total chinook parr population of 101,947 would have resulted directly from supplementation and approximately 61,582 from natural spawning. Based on estimated natural egg

Table 19. Smolt length and PIT tag detection for Crooked River, 1989.

Length (mm)	Chinook Number tagged	Chinook Number detected	Chinook Percent detected
< 70	46	3	7
70 - 79	338	52	15
80 - 89	493	123	25
> 89	174	57	33
Total	1,051	235	22

Length (mm)	Steelhead Number tagged	Steelhead Number detected	Steelhead Percent detected
< 130	248	0	0
130 - 149	38	16	42
> 149	34	20	59
Total	320	36	11

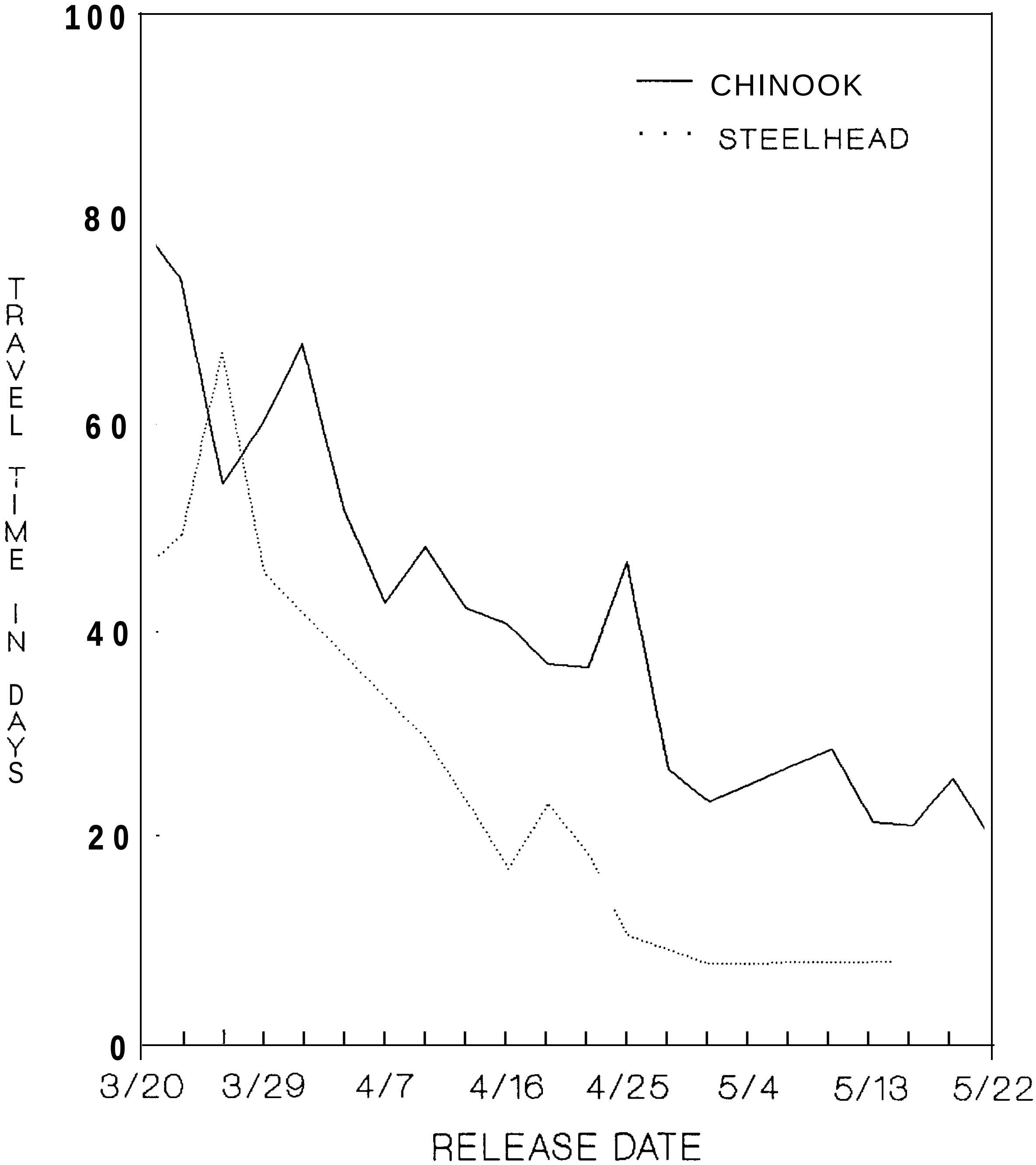


Figure 5. Three-day averages of chinook and steelhead smolt travel time from Crooked River trap to Lower Granite Dam.

Table 20. Detections at the Lower Snake and Columbia River smolt collecting dams of August 1988 PIT-tagged parr from Crooked River, 1989.

Stratum	Chinook Number tagged	Chinook Number detected	Chinook Percent detected	Steelhead age 2+ Number tagged	Steelhead age 2+ Number detected	Steelhead age 2+ Percent detected
CR-I	1,009	21	2.1	12	2	16.7
CR-II	930	15	3.5	50	7	14.0
CR-III	696	25	3.6	7	5	71.4
CR-IV	343	10	2.9	2	2	100
Canyon	0			40	13	32.5
Relief C.	0	-	-	10	4	40.0
Totals	2,478	71	2.9	121	33	27.3

deposition of 181,503 (Table 13), these estimates and assumptions imply an egg-to-parr survival rate of 34% for brood year 1988. We used these same estimates and assumptions for brood year 1987 data to estimate an egg-to-parr survival rate of 19%. Egg-to-Parr survival rates will not be calculable for CR steelhead until 1992.

We estimated parr-to-smolt survival (and smolt production) to the head of LGR pool for parr PIT-tagged in August to be 5.2% (3,146) for age 0 chinook and 33.5% (602) for age 2+ steelhead. These estimates are based on the detection at the Lower Snake and Columbia River smolt collecting dams of our August 1988 PIT-tagged parr from CR and Buettner and Nelson's (1989) observed detection rates of 55.6% for chinook smolts tagged at their Clearwater River trap and 81.5% for wild/natural steelhead tagged at their Snake River trap. We used their Snake River trap steelhead numbers because they did not capture enough steelhead at their Clearwater River trap to make an accurate estimate.

We did not have enough PIT tags to tag fall 1988 emigrants from CR and, therefore, cannot estimate parr-to-smolt survival rate based on combined emigration trapping and detection data.

Smolt run estimates for the Spring 1989 emigration were 15,618 chinook and 611 steelhead. The Spring 1989 cumulative PIT tag detections for smolts tagged at the CR trap were 22.3% for chinook and 43.4% for age 3 steelhead. Based on Buettner and Nelson's (1989) detections from their Clearwater trap, we estimated smolt survival rates (and smolt production) to the head of LGR pool from the spring 1989 CR smolt runs to be 40.1% (6,264) for chinook and 53.3% (325) for age 3+ steelhead.

The monthly survival rate method estimates that July to April survival at the study site was 34.1% for age 0 chinook and 41.2% for age 2+ steelhead. These percentages calculate out to smolt production estimates at the site of 20,659 chinook and 740 steelhead. To compare these estimates to those from PIT tagging, we used the spring 1989 PIT tag estimate of CR migration survival to LGR pool (40.1% for chinook and 53.3% for steelhead) to estimate a LGR pool survival rate from the monthly survival method (i.e. for chinook 34.1% x .401 = 13.7%). We get the following estimates of CR parr-to-smolt survival to the head of LGR pool; 13.7% (8,284) for chinook and 22.0% (163) for age 2+ steelhead.

DISCUSSION

Upper Salmon River

Adult Escapement and Redd Counts

We believe that uncounted adult chinook salmon passed above the Sawtooth Hatchery weir during a period when high water forced hatchery personnel to remove weir panels, and that the reported female adult chinook escapement of 73 was low.

We further believe that our ground redd count of 123 produces the best estimate of the female chinook that successfully spawned in 1989.

The ground redd count is the better estimate of female chinook escapement based on our 1988 data. If the pre-spawning mortality in the stream is similar to pre-spawning mortality at Sawtooth Hatchery (5% in 1988), then our 1988 ground redd count accurately estimated the 1988 female chinook escapement (Table I). This is supported by the 1985 to 1988 helicopter trend redd count which accounted for an average of 4 1% of the known escapement (Table 1). Correcting for this underestimation as well as pre-spawning mortality produces an estimate of 122 female chinook natural spawners which is very similar to our ground count of 123 redds.

Hatchery Supplementation

The smaller size of chinook parr produced from adult outplants in upper Frenchman Creek ($\bar{x}$ = 61 mm) and upper Pole Creek ($\bar{x}$ = 44 mm) as compared to naturally-produced parr probably resulted from late spawning and cold water. Adults were outplanted from the last of the run to Sawtooth Hatchery (August 29 to September 5) so the eggs were deposited later than most naturally-produced fish. Temperature measurements made during July and August indicated that Frenchman Creek and upper Pole Creek were colder than the Salmon River (Idaho Department of Fish and Game, unpublished data) so fewer thermal units were available for growth of parr. In 1990, we plan to outplant adults from earlier in the run to determine if the resulting parr will be larger.

In general, we assumed that chinook parr tagged in lower Pole Creek and upper Smiley Creek were from the fry outplants since no chinook redds were observed in these areas in 1988. The chinook parr resulting from these fry outplants were longer ($\bar{x}$ = 86 mm) than any other group because of the advanced growth they received at Sawtooth Hatchery. As in 1988, of the three sites where chinook parr from fry outplants were PIT-tagged, those from PC-2B (4.0 km above mouth) were smaller ($\bar{x}$ = 82 mm) than those from PC-IB (0.5 km above mouth) ($\bar{x}$ = 91 mm) or from Smiley Creek SC-2A (4.5 km from mouth) ($\bar{x}$ = 85 mm). This slower chinook fry-to-parr growth at PC-2B was probably caused by thermal stress resulting from elevated water temperature due to irrigation withdrawal. In low water years such as 1988 and 1989, most of Pole Creek is diverted for irrigation. Much of the water powers a sprinkler system and then returns to the creek 4.4 km below the diversion. On August 22, 1988, the water temperature immediately above and below the return point was 25.5°C and 12.0°C, respectively.

The chinook parr resulting from eyed-egg outplants in 1988 were similar in size ($\bar{x}$ = 60 mm) to those resulting from the 1987 and 1988 adult outplants. These eggs were also taken from adults from the last of the runs, and the eyed-egg outplant streams are also normally colder than the main Salmon River. This supports our theory that the parr resulting from adult and eyed-egg outplants are smaller because their adults are from the last of the run and our supplementation research occurs in the colder headwater streams.

The brood year 1988 supplementation level equivalent to 12 female adult chinook/hectare was selected because at an **egg-to-parr** survival rate of 15% **(Scully** et al. **1990),** the resulting parr densities in these **outplant** areas would be at Petrosky and Holubetz's (1987) estimate of full seeding **(108/100 m^2).** The adult outplant of 12 redds/hectare in Frenchman Creek yielded a parr density of **109/100** m^2.

The brood year 1988 eyed-egg outplants had a much higher **egg-to-parr** survival rate than the brood year 1987 eyed-eggs (11.6% vs. 0.4%). We believe that the poor survival from the brood year 1987 eyed-egg **outplant** was primarily a result of the artificial redd design. The brood year 1987 artificial redds were constructed level with the surrounding substrate without an elevated tailspill. According to Chapman **(1988),** the tailspill helps to create a current flow down through the egg pocket to flush metabolic wastes and maintain high oxygen levels for optimum egg-to-fry survival. For the brood year 1988 **eyed-**egg outplants, we constructed artificial redds replicating natural redds in structure, although smaller.

Parr Abundance

Overall density of age 0 chinook in the upper Salmon River has increased from 1985 to 1989 as adult chinook escapement above the Sawtooth weir has increased (Table 1 and Table 4). In 1989, age 0 chinook parr densities were greatest in three areas: 1) where we conducted supplementation research (ie. outplanted fish); 2) just below the Alturas Lake Creek and Busterback diversions where adults blocked by the diversions spawned in higher densities than elsewhere; and 3) in the headwaters of the Salmon River where early-returning adults (which had migrated above the Busterback diversion before it dewatered the stream) spawned.

In 1989, the chinook age 0 population estimate was higher (155,607) than in the three recent years in which estimates were made: 1985 **(73,548),** 1987 **(65,739),** and 1988 (88,103) (Kiefer and Forster 1990). In all four years, populations were reduced by trapping adults for Sawtooth Hatchery brood stock. The first year that Sawtooth Hatchery supplemented chinook in the USR was brood year 1987. An estimated total of 17,784 chinook parr were the result of this supplementation in 1988, and we estimated that a total of 54,520 chinook parr resulted from supplementation in 1989. The larger number of chinook parr from supplementation in 1989 is a result of the higher stocking rates used for brood year 1988 and not changes in survival.

The steelhead parr population estimate in 1989 (8,098 age **1+** and **2+** combined) was similar to 1988 (7,325) and a reduction compared to 1985 (12,579) and 1987 (20,132). The steelhead age **1+** parr densities, overall, were lower than the other years studied (1984 to 1988) (Table 5). The only exception was in Stratum 10 (the Salmon River headwaters). For age **2+** steelhead, the densities observed in 1989 were similar to those observed in past study years. Reasons for these population levels are not apparent from either steelhead escapement or supplementation numbers (Table 1 and Table 3). These data suggest that the decrease occurred in the **egg-to-parr** survival rate and/or fry outmigration increased without a subsequent return of parr to the study area. This low survival rate probably resulted from one, or a combination of, the following factors: high angling mortality, high mortality caused by the Busterback irrigation diversion (67% of the steelhead parr were found above the diversion), poor genetic match of Snake River A-run fish to high elevation streams, and an upstream migration barrier at the Sawtooth Hatchery weir that potentially restricted the return of steelhead parr that overwintered below the weir.

PIT Tagging

Chinook mortalities resulting from PIT tagging were higher in 1989 (2.5%) than in 1988 (0.3%; Kiefer and Forster 1990). We believe higher mortality resulted from more extensive use of electrofishing in 1989 in order to capture more steelhead parr for PIT tagging. In 1988, most chinook were captured with beach seines, which appears less stressful to **parr.** However, beach seines are not very effective for sampling steelhead **parr.** Although our mortalities increased from 1988, they were still within our goal of maintaining less than 5% mortality. Steelhead mortalities from collecting and PIT tagging were low and similar for 1989 (0.8%) and 1988 (1.2%; Kiefer and Porster 1990). Tests by the NMFS (Prentice et al. 1986) and IDFG at Sawtooth Hatchery (unpublished data) showed that mortalities beyond 24 hours were negligible.

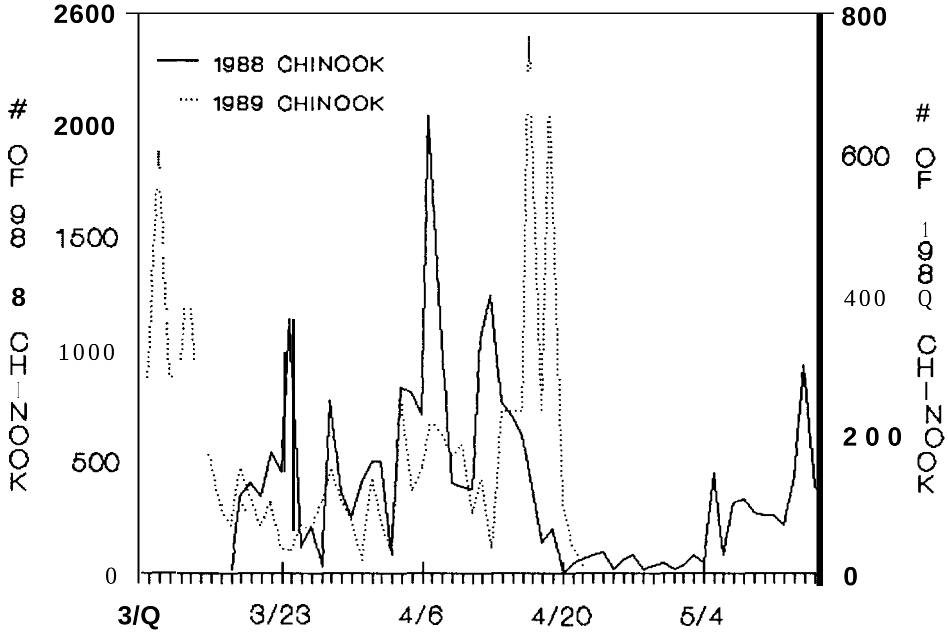
The average length of "naturally-produced" chinook parr in the USR during August has increased slightly over the past three years (74 mm 1987, 76 mm 1988, [Kiefer and Forster 19901, and 78 mm 1989). This may be a result of mixing with increased numbers of parr from chinook fry outplants (which are larger due to the increased growth in the hatchery), which are indistinguishable from naturally-produced **parr.**

The mean length of steelhead parr PIT-tagged in August 1989 was 107 mm. This is significantly smaller that the steelhead parr tagged in 1987 (130 mm) and 1988 (137 mm). This is a result of the large proportion of age 0 steelhead we tagged in 1989 **(41%),** when compared to 1988 **(4%),** and in 1987 (0.1%).

Spring 1989 Emigration Trapping

Flows during spring 1989 and 1988 were similar, which apparently resulted in very similar emigration timings (Figure 6). We compared the spring 1989 emigration timing of both chinook and steelhead to water temperature (Figure 7) and flows (Figure 8). In general, both species apparently were keying in on the same stimuli. As in spring 1988, the spring 1989 emigration appears to primarily be stimulated by the approach of a storm.

If we assume that this similar timing continued after our trap was out of operation, then we estimate that we missed approximately 21% of the chinook and 34% of the age **1+** steelhead emigrants in 1989. We can then make a total spring 1989 run estimate of 10,012 chinook, 2,184 age 2 steelhead, and 695 age 3 steelhead. Based on the summer 1988 parr population estimates (Kiefer and



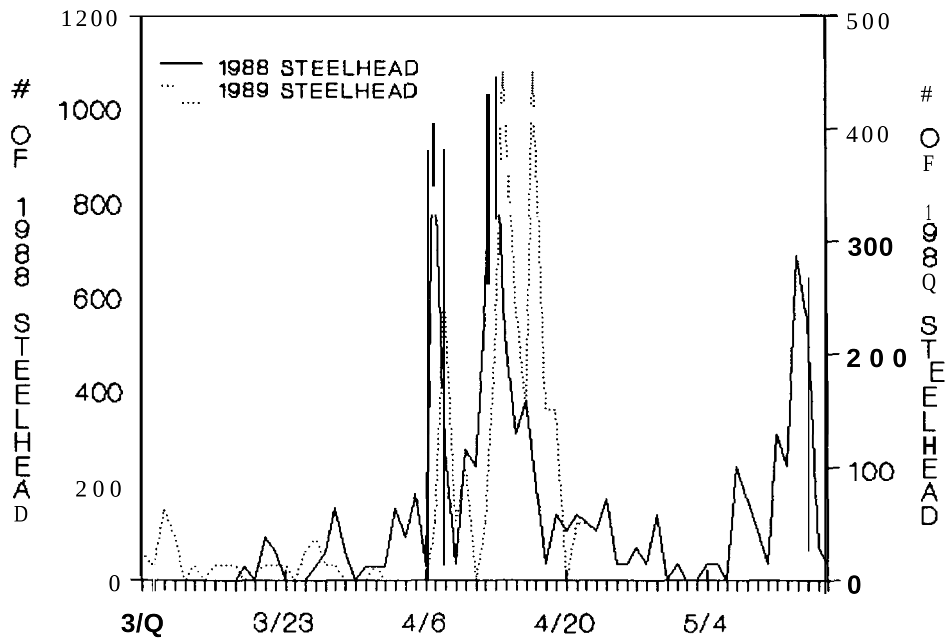


Figure 6. Upper Salmon River chinook and steelhead spring emigration timing for 1988 and 1989.

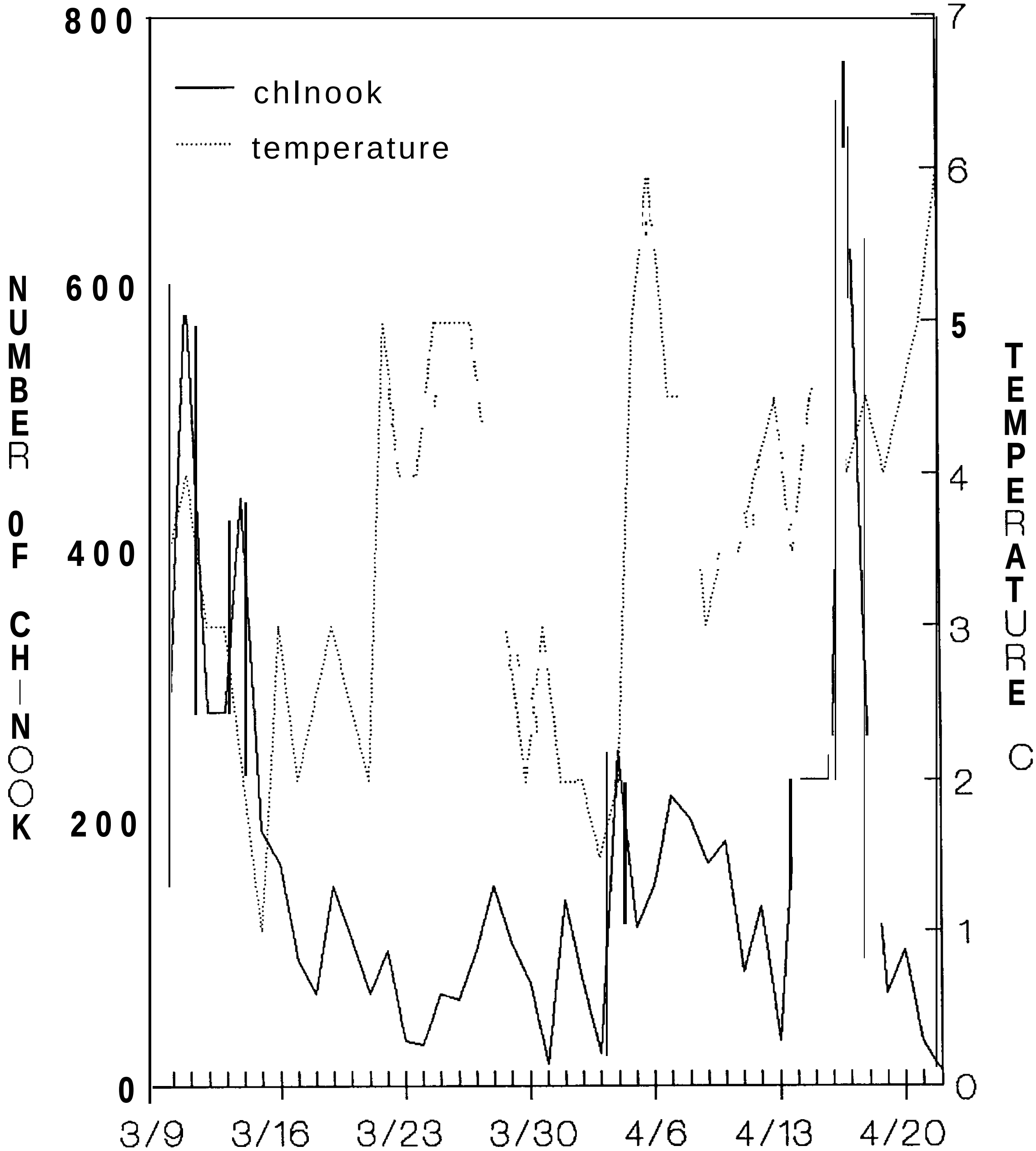


Figure 7. Spring 1989 upper Salmon River chinook emigration timing and 10 00 a.m. stream temperature.

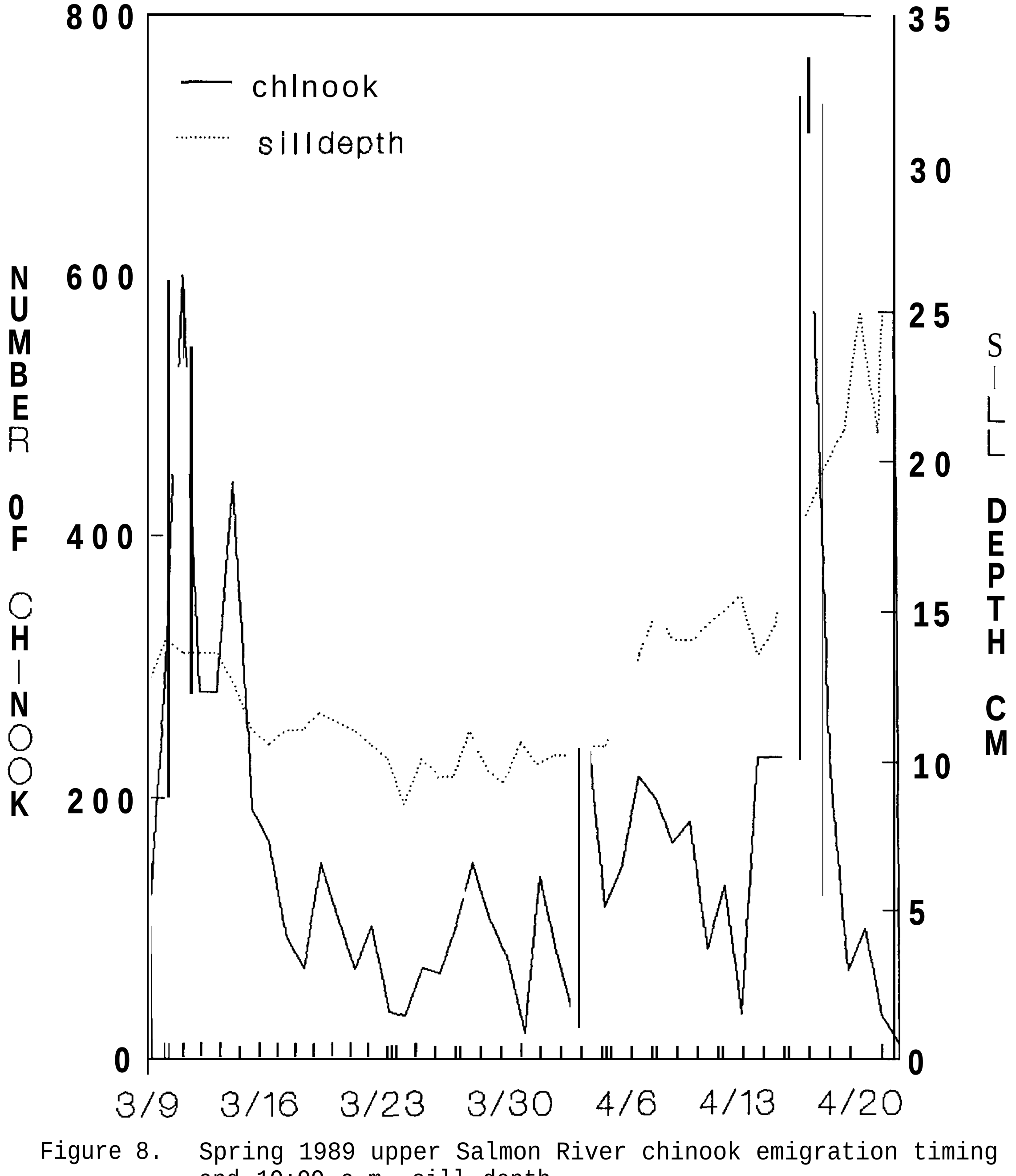


Figure 8. Spring 1989 upper Salmon River chinook emigration timing and 10:00 a.m. sill depth.

Forster 1990), we estimate that 11.4% of chinook parr, 41.0% of age 1+ steelhead, and 33.3% of age 2+ steelhead emigrated in spring 1989. In spring 1988, we estimated that 34.4% of the July 1987 chinook parr and 45.7% of the July 1987 age 1+ and older steelhead parr emigrated (Kiefer and Forster 1990). The reason for the difference in the chinook emigration in spring 1988 and 1989 are not known.

We have observed large numbers of chinook fry outmigrating from the USR during spring trapping operations from March to May, 1987 to 1989. The magnitude of this outmigration and contributions of this segment of the population will be investigated by the University of Idaho with a subcontract to this project beginning spring 1990.

Fall 1989 Emigration Trapping

In general, both chinook and steelhead had migration peaks on the same days during their fall migration in 1988 and 1989 (Figure 9). This indicates that both species keyed to the same stimuli for emigration. As in 1988, the spring 1989 fish begin emigration just before storm events, whereas fall emigrants 1989 moved during storm events (Figure 10 and 11). Storm events show up as sharp drops in temperature and rises in sill depth during the same period. During fall 1989, most of the emigration occurred between mid-August and mid-October, which was the same period of peak emigration in 1988.

Based on the summer 1989 parr population estimates, we can make estimates on the proportion of the parr populations that emigrate in the fall. We estimated that 56% of age 0 chinook, 13% of age 1+ steelhead, and 56% age 2+ steelhead emigrated in fall 1989. The proportions of summer chinook parr that emigrated in the fall were similar in 1989 (56%) and 1988 (64%). To compare to 1988 data, age 1+ and 2+ steelhead run estimates were combined and resulted in an estimate of 30% of age 1+ and older steelhead emigrating in fall 1989. More age 1+ and older steelhead emigrated in fall 1988 (48%) than fall 1989 (30%). Reasons for the difference in the rate of fall emigration for age 1+ and older steelhead between 1988 and 1989 is not known at this time.

Dam Detections

Detections of PIT-tagged smolts at the Lower Snake and Columbia River smolt collecting dams allows us to determine migration characteristics of USR chinook and steelhead. PIT-tagged natural chinook from the USR arrived later than the peak of the total chinook run at LGR Dam (Figure 12). There are two possible reasons for the later arrival for USR chinook. First, natural/wild chinook smolts may have a later migration timing than hatchery smolts, and the larger number of hatchery smolts regulates the peak of the total migration in general. Hatchery chinook smolts are not marked, so differentiation from wild/natural fish is not possible. Second, different stocks of chinook may have unique travel time characteristics, and the URS stock may inherently migrate later than most of the other Snake River stocks.

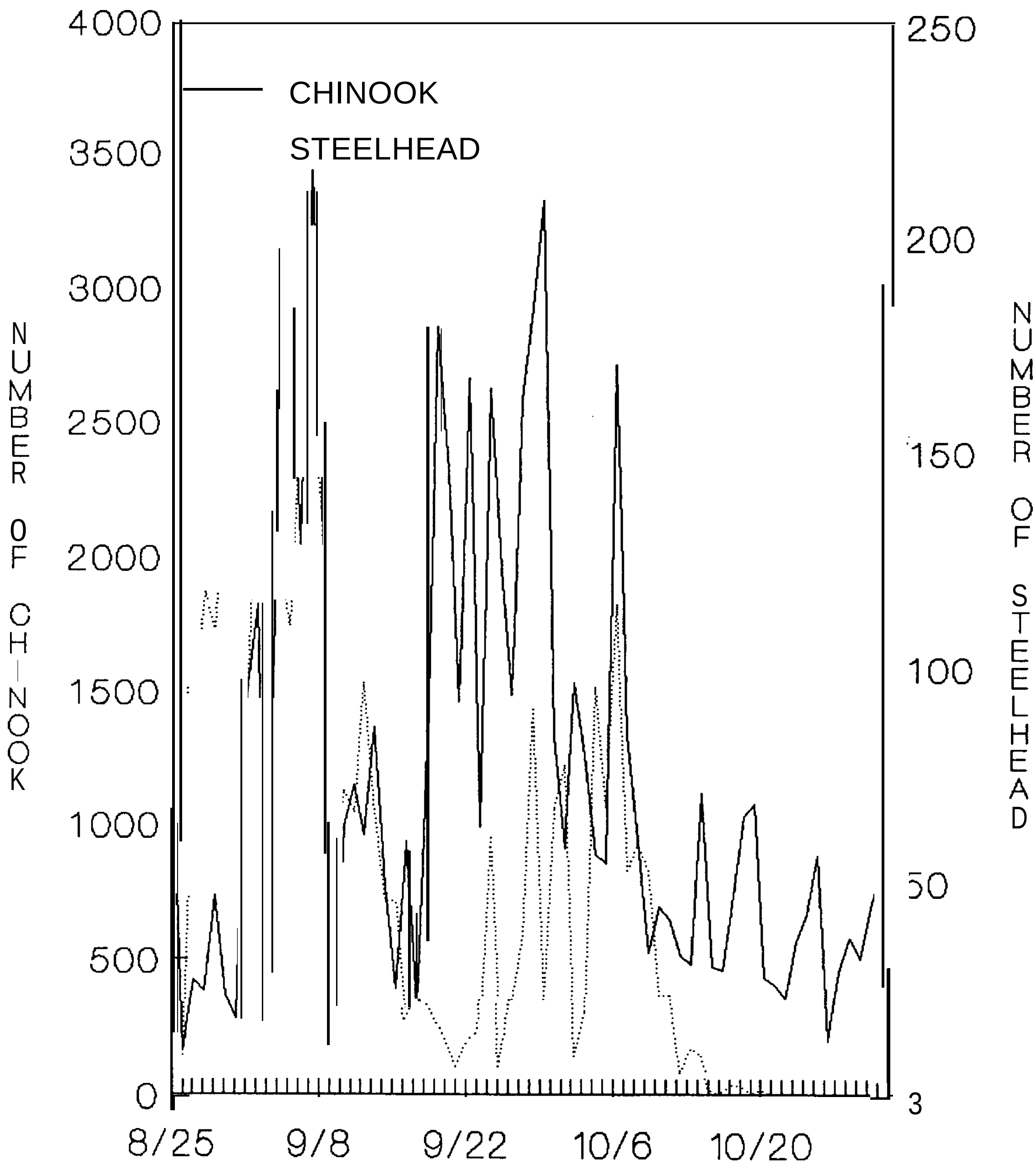


Figure 9. Fall 1989 upper Salmon River chinook and steelhead emigration timing.

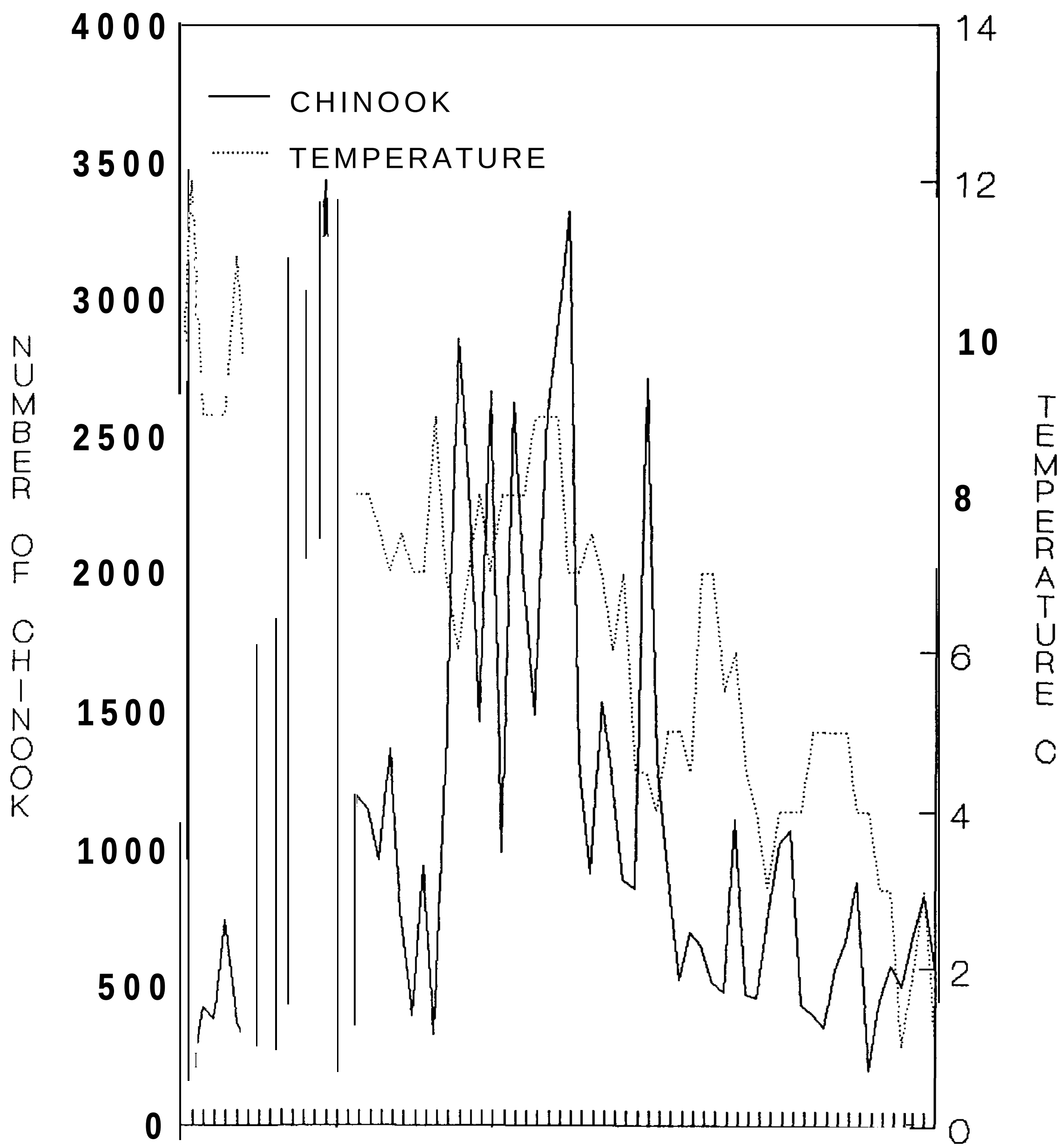


Figure 10. Fall 1989 upper Salmon River chinook emigration timing and 10:00 a.m. stream temperature.

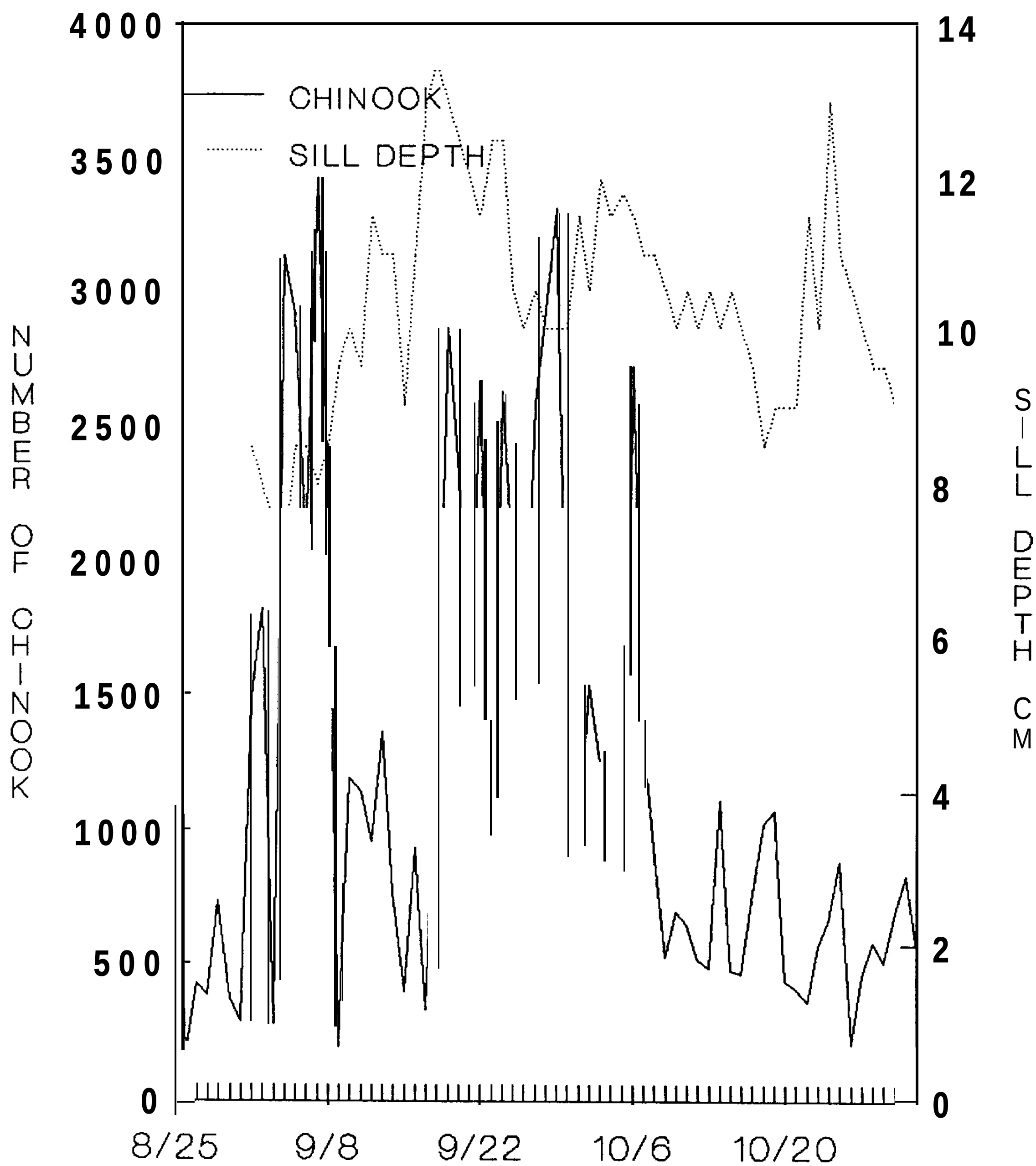


Figure 11. Fall 1989 upper Salmon River chinook emigration timing and 10:00 a.m. sill depth.

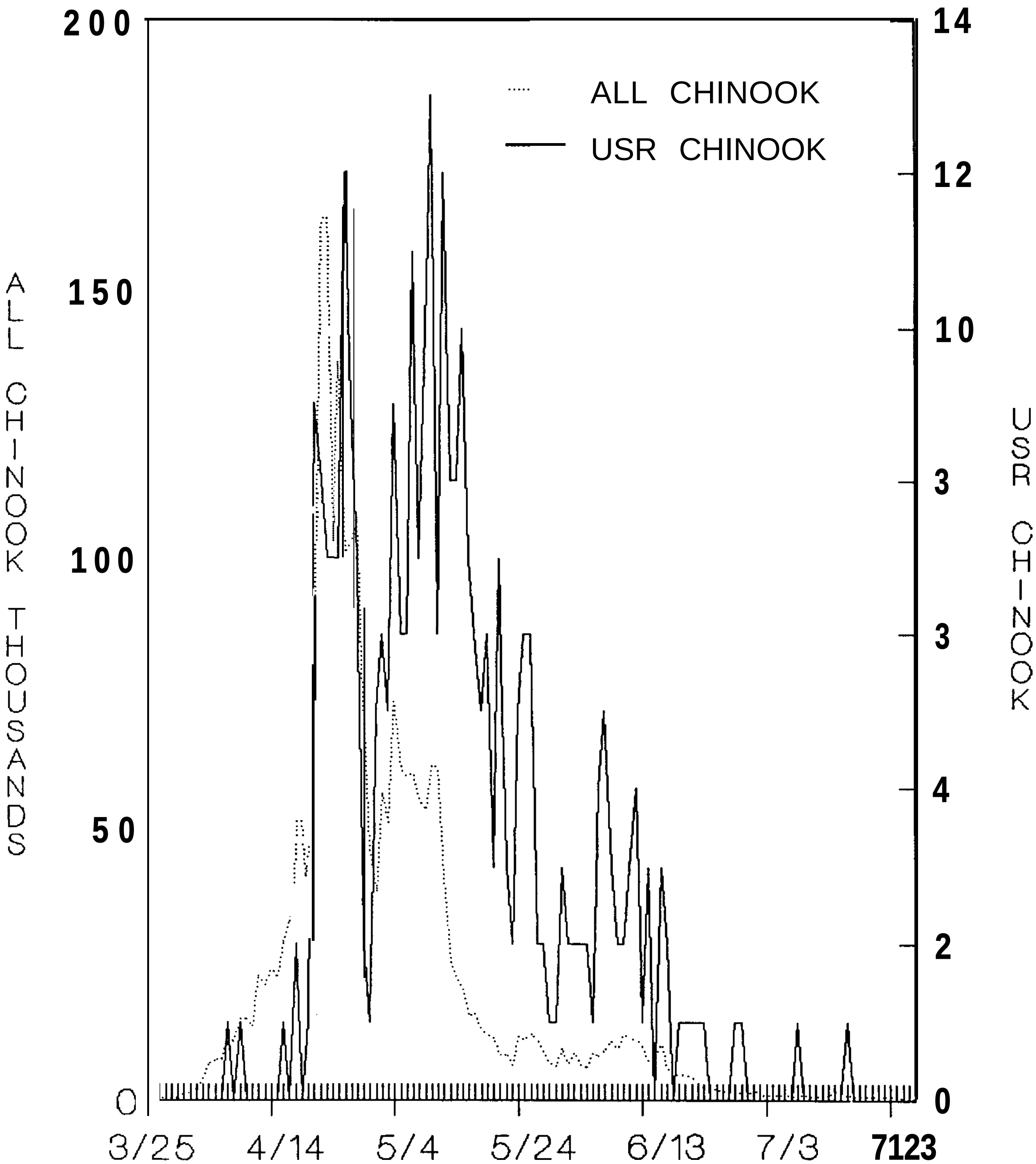


Figure 12. Spring 1989 arrival at Lower Granite Dam of all chinook and PIT-tagged chinook from the upper Salmon River.

Since all hatchery steelhead smolts have adipose fin clips, the arrival of USR natural steelhead can be compared with total wild/natural steelhead at LGR Dam. The USR steelhead arrive during the same period and with the same main peak of arrival at LGR Dam as all wild/natural steelhead (Figure 13). However, the wild/natural steelhead smolts at LGR Dam have another major peak of arrival earlier than the main peak, and the USR steelhead only have a minor peak during this period. Interestingly, the natural chinook from USR arrived at LGR Dam with almost the exact timing as all wild/natural steelhead at LGR Dam (Figure 14). Water budget decisions based solely on peaks of the run could, therefore, affect specific populations differently. The timing, arrival curves, and relationship to flows were very similar in 1988 and 1989 for both URS chinook and steelhead. It appears a pattern is developing that would allow us to be able to predict when USR smolts will arrive at LGR pool.

The peaks of arrival at LGR Dam of USR PIT-tagged chinook and steelhead smolts corresponded with periods of increased flows at LGR Dam (Figure 15). Buettner and Nelson (1989) observed average travel times through LGR for Snake River smolts of 12 days for chinook and 4 days for steelhead in 1989. We used these travel times to estimate that the peak of the USR smolt runs in 1989 arrived at LGR Pool between April 9 and May 14 for chinook and between May 4 and May 17 for steelhead. However, it is possible that the USR smolts reached the head of LGR pool before the estimated dates and were delayed until flows increased.

When the estimates of peak arrival of USR wild/natural chinook and steelhead are compared to the 1988 data, two differences are observed. First, in 1989, an early peak of the chinook run was major enough to be included in the estimate of peak arrival, while a peak during the same period in 1988 was not as significant and was not included in the estimate. Second, if the early chinook peak in 1989 is not considered, then the peak arrivals at LGR pool in 1989 were about seven days earlier for chinook and ten days earlier for steelhead.

Survival Rates

Estimated overall natural egg-to-parr survival rates were similar among all four brood years studied (Table 10) and much lower than observed from other Idaho streams (Scully et al. 1990). These overall natural survival rates were much lower than those calculated for the adult outplants and natural spawners in the low gradient headwater streams (Table 9). Possible explanations for the low overall survivals include unusually low flows (winter and summer), habitat quality problems below the Busterback diversion and Alturas Lake Creek diversion, and spring outmigration of fry.

In 1988, the PIT tag detections at the smolt collecting dams indicated that the parr-to-smolt mortality was four times greater for chinook and more than three times greater for steelhead parr rearing above the Busterback diversion. We believe this mortality occurs in the fall when approximately 60% of the chinook and steelhead parr attempt to emigrate and encounter the dewatered

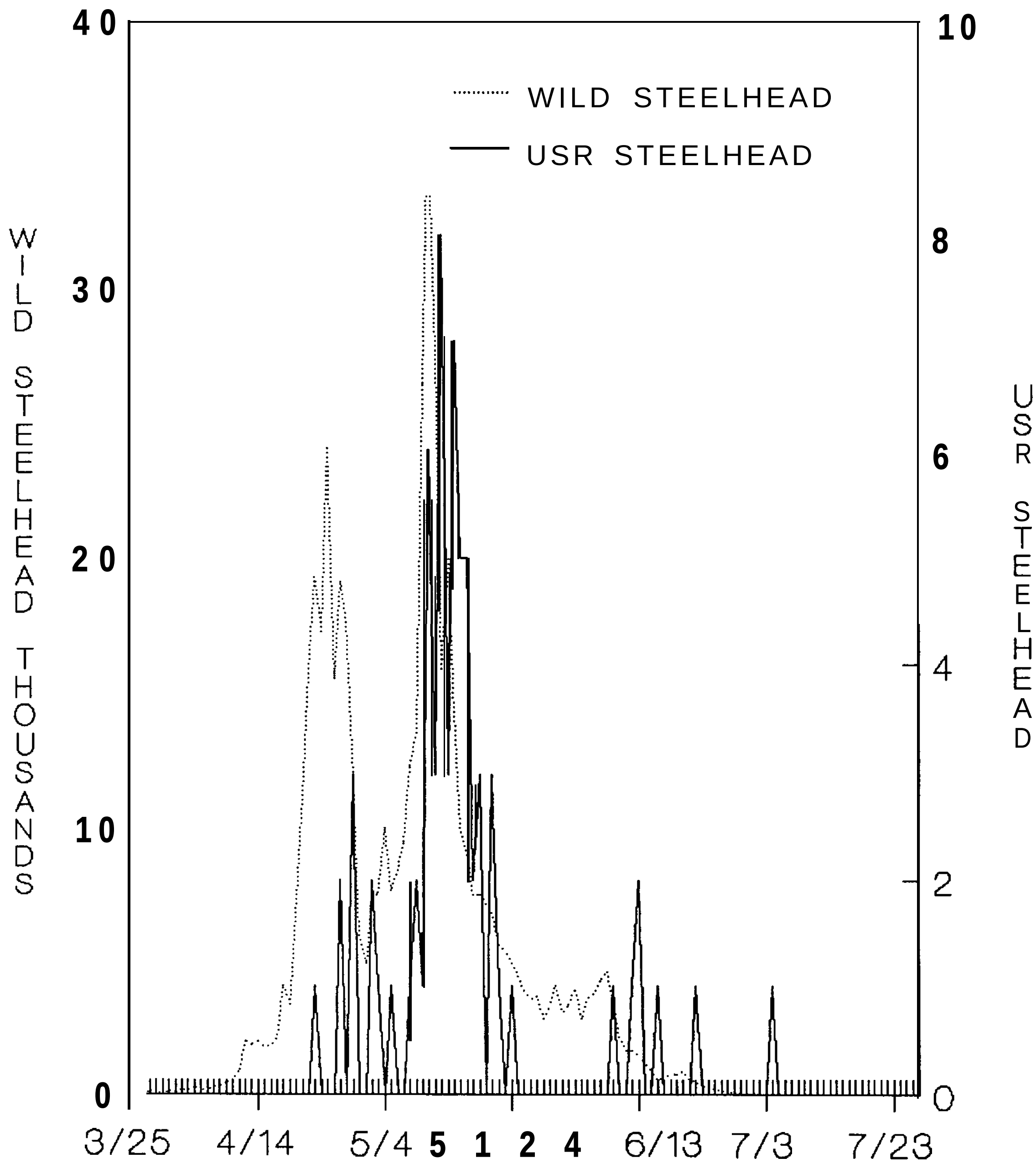


Figure 13. Spring 1989 arrival at Lower Granite Dam of all wild/natural steelhead and PIT-tagged steelhead from the upper Salmon River.

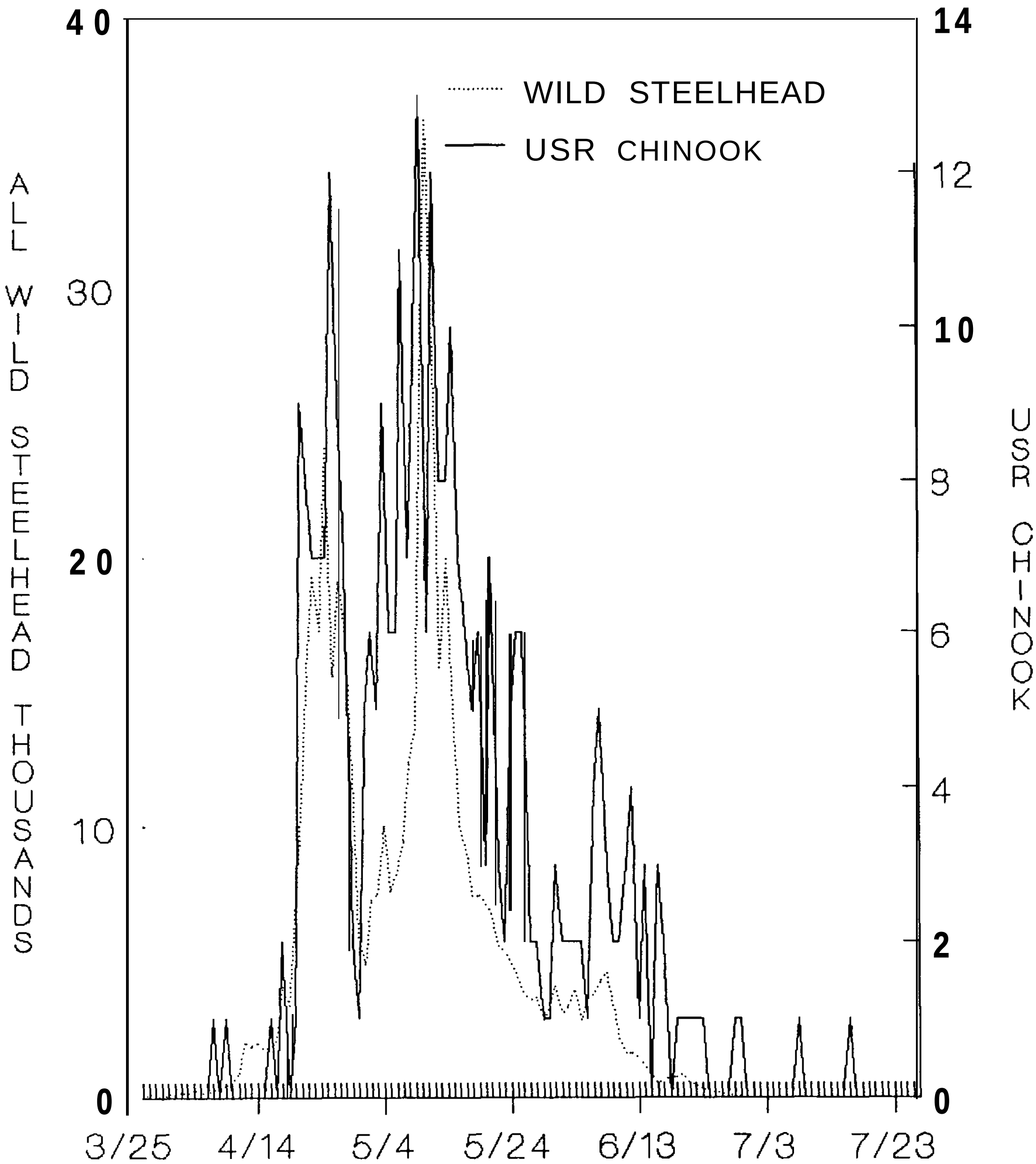


Figure 14. Spring 1989 arrival at Lower Granite Dam of all wild/natural steelhead and PIT-tagged chinook from the upper Salmon River.

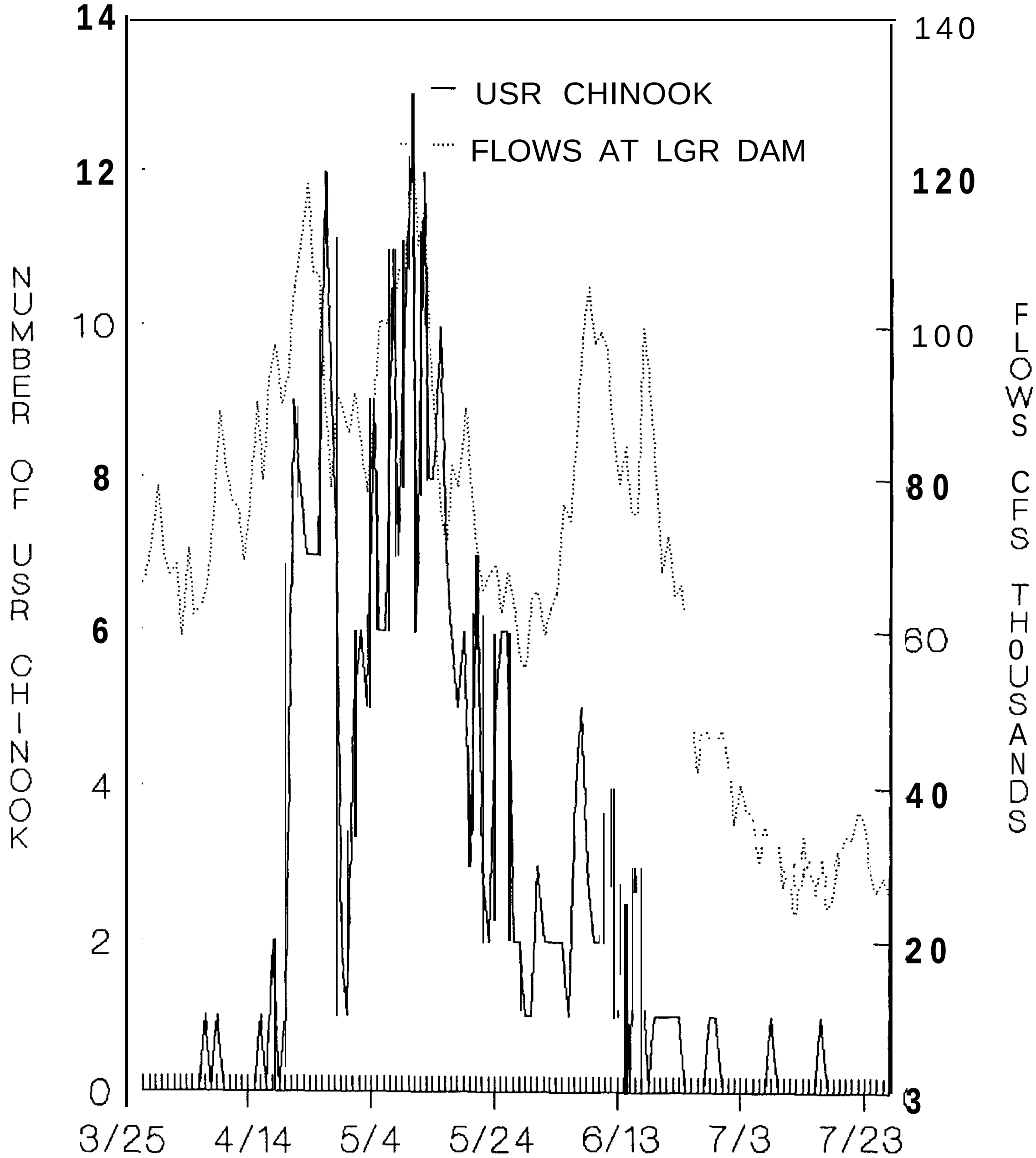


Figure 15. Spring 1989 arrival at Lower Granite Dam of PIT-tagged chinook from upper Salmon River and flows at Lower Granite Dam.

conditions below this diversion (Kiefer and Forster 1990). The 1989 data indicates that this diversion was only a minor mortality factor for those parr rearing above it. Stenerson (Idaho Department of Fish and Game, personnel communication) reported a large beaver pond just above the diversion in fall 1988. This beaver pond apparently provided overwintering habitat for the parr rearing above it. Because the fall 1988 parr above this diversion apparently did not emigrate to the dewatered stretch below the Busterback diversion, they did not experience the high mortality observed for the fall 1987 emigrants from this area. Other data supporting this theory is that of the 111 PIT tag recaptures at the Sawtooth weir trap in fall 1988, none were from above the Busterback diversion.

The PIT tag estimate of smolt production resulted in estimates of chinook parr-to-smolt survival to the head of LGR pool of 9.7% from summer 1988 PIT tagging parr and 12.6% from fall 1988 and spring 1989 emigrant PIT tagging combined. The monthly survival method resulted in a chinook parr-to-smolt survival estimate to the head of LGR pool of 19.7%. We end up with chinook parr-to-smolts at LGR pool survival rate estimate of 9.7%, 12.6%, and 19.7%.

During the 1990 field season, we will attempt to address this discrepancy in survival estimates by determining if there is additional mortality on PIT-tagged summer parr that is not observed in hatchery or laboratory studies, and if there is additional mortality, attempt to quantify it and determine it's cause.

Crooked River

Adult Escapement and Redd counts

During the period of analysis (1984-1989), the estimates of total female chinook escapement (Table 11) have been variable, but far below the 223 female chinook estimated to fully seed CR (S. Kiefer, Idaho Department of Fish and Game Sub-basin Planner, personal communication). In 1988, several chinook redds were observed in the gravel cleaned by heavy machinery crossing the stream during the construction of flow control structures by the USFS in the forced meander section of the lower meadow. Since these chinook apparently spawned in the machinery-cleaned gravel, a higher percentage of the total redds may have been built in the lower meadow reach of CR and not the traditional trend count area. If the distribution pattern of chinook redds was altered in 1988 by attraction to the artificially cleaned gravel, then total escapement and egg deposition would be over-estimated in 1984-1987. In 1989, even proportionally more redds were observed in this area, probably a result of the habitat work conducted there in 1989.

Parr Abundance

Chinook parr densities in 1989 were the highest, or among the highest, observed since data collection began in 1984. The connected ponds had the highest chinook parr densities in 1988 and 1989 and one of the highest in 1986 (Table 14). The parr densities in the connected ponds in 1989 were more than two times higher than Petrosky and Holubetz (1987) estimated for full seeding of chinook parr in streams (108 parr/100 m^2), indicating that off-channel ponds can support higher chinook densities than streams. This indicates that mitigation activities to connect off-channel ponds should result in increased chinook rearing potential.

Chinook parr densities appear to be closely related to adult escapement and fry outplanting levels. The three higher trend redd counts (22 in 1984, 17 in 1987, and 27 in 1988; Table 13) resulted in the relatively higher parr densities in 1985, 1988, and 1989 (Table 14). The low redd count (10) in 1985, combined with a large fry outplant, resulted in relatively high parr densities in 1986. The low redd count in 1986 (9) with no fry supplementation resulted in the low parr density in 1987.

The steelhead parr densities in 1989 were higher than the other two years in which no supplementation occurred (1984 and 1985) and lower than the three years in which supplementation did occur (1986-1988). This suggests that the natural escapement was higher in 1988 than in 1983 and 1984, but still below full seeding (Tables 13 and 15). In 1985, approximately three times as many adult females (1,522) were outplanted into CR than in 1987 (468) (Table 13), yet they did not produce higher parr densities in CR. If we assume that natural escapement was low during this period, then it appears that 500 or fewer adult female hatchery steelhead could fully seed CR. S. Kiefer (Idaho Department of Fish and Game Sub-basin Planner, personal communication) estimates that a female steelhead escapement of 336 would fully seed CR. The lower steelhead parr density in 1984 and 1985 were probably a result of low natural escapement and the lack of supplementation for brood years 1983 and 1984.

PIT Tagging

Mortality of PIT-tagged chinook (3.5%) was higher than observed in 1988, but still below our defined acceptable level of 5%. A contributing factor to the higher mortality was our greater use of electrofishing to collect more steelhead than we did in 1988. Although delayed chinook mortalities were similar to those observed in 1988, we did not experience the high steelhead delayed mortalities in 1989 (0%) that we observed in 1988 (6.5%). This difference may be a result of small sample size (1988 n = 177, and 1989 n = 113). The average length of chinook parr from CR ($\bar{x}$ = 71 mm) was smaller than those from USR ($\bar{x}$ = 78 mm). This is contrary to what we would expect based on stream elevation and thermal units available for growth. The reasons for the smaller size of CR chinook parr are not known at this time. The variability of mean chinook length from different strata was low (s = 1.3), indicating that the parr from the fry outplants were similar in size to the natural parr.

Spring 1989 migration Trapping

In general, emigration timing during fall 1989 in CR was similar for both chinook and steelhead (Figure 16). Both species apparently were keying in on the same stimuli. We compared the emigration timing of chinook to temperature (Figure 17) and flows (Figure 18). The spring 1989 emigration appeared to be primarily stimulated by storm events. Storm events show up as drops in water temperature and a rise in flows on the same day. Factors that stimulate emigration (photoperiod, barometric pressure, temperature, and flows) will be investigated in future analysis to improve predictions of arrival of wild/natural smolts to LGR pool. The proportions of the summer 1988 parr populations that outmigrated in spring 1989 were 25.8% for chinook, 3.4% for age 2 steelhead, and 34.8% for age 3 steelhead.

Fall 1989 Emigration Trapping

Our data supports the hypothesis that higher elevation harsher-climate streams will have a higher percentage of the parr outmigrating in the fall to overwinter in downstream areas. Results to date also suggest that a higher percentage of chinook parr emigrate in the fall than steelhead parr. Based on the summer 1989 parr abundance, 6.4% of chinook, 1.1% of age 1+ steelhead, and 4.6% of age 2+ steelhead emigrated in the fall 1989 from CR. The proportion of the summer chinook parr population that emigrated in the fall (6.4%) was lower than fall 1988 (20.9%). A possible explanation for this difference is that the habitat work done in the meander section by the USFS with BPA funds in 1989 may have provided additional overwintering habitat. To compare to the 1988 data, the age 1+ and 2+ steelhead run estimates were combined and resulted in an estimate of 1.3% of the summer age 1+ and older steelhead population emigrated in fall 1989. More age 1+ and older steelhead emigrated in fall 1988 (2.8%). Whether this difference is a result of the same factors affecting the chinook parr or just a sampling error is not known at this time.

Unlike the fall 1988 data (Kiefer and Forster 1989), both chinook and steelhead in the fall 1989 appear to be keying in on the same stimuli for emigration (Figure 19). Of all the trapping seasons at both study areas (1987 to 1989), only the fall 1988 data does not fit the pattern of both chinook and steelhead using the same stimuli for emigration. The fall 1989 data indicates that a sharp drop in water temperature (Figure 20) is the main stimulus for emigration and not flows (Figure 21). In past trapping seasons, sharp drops in temperature are accompanied by rises in discharge caused by storm events.

Although we did not begin trapping until late August, the data indicates that we did not miss a major portion of the emigration. As was expected with the lower elevation of the CR study area, the peaks of the fall emigration (late September through October) occurred later than in the USR.

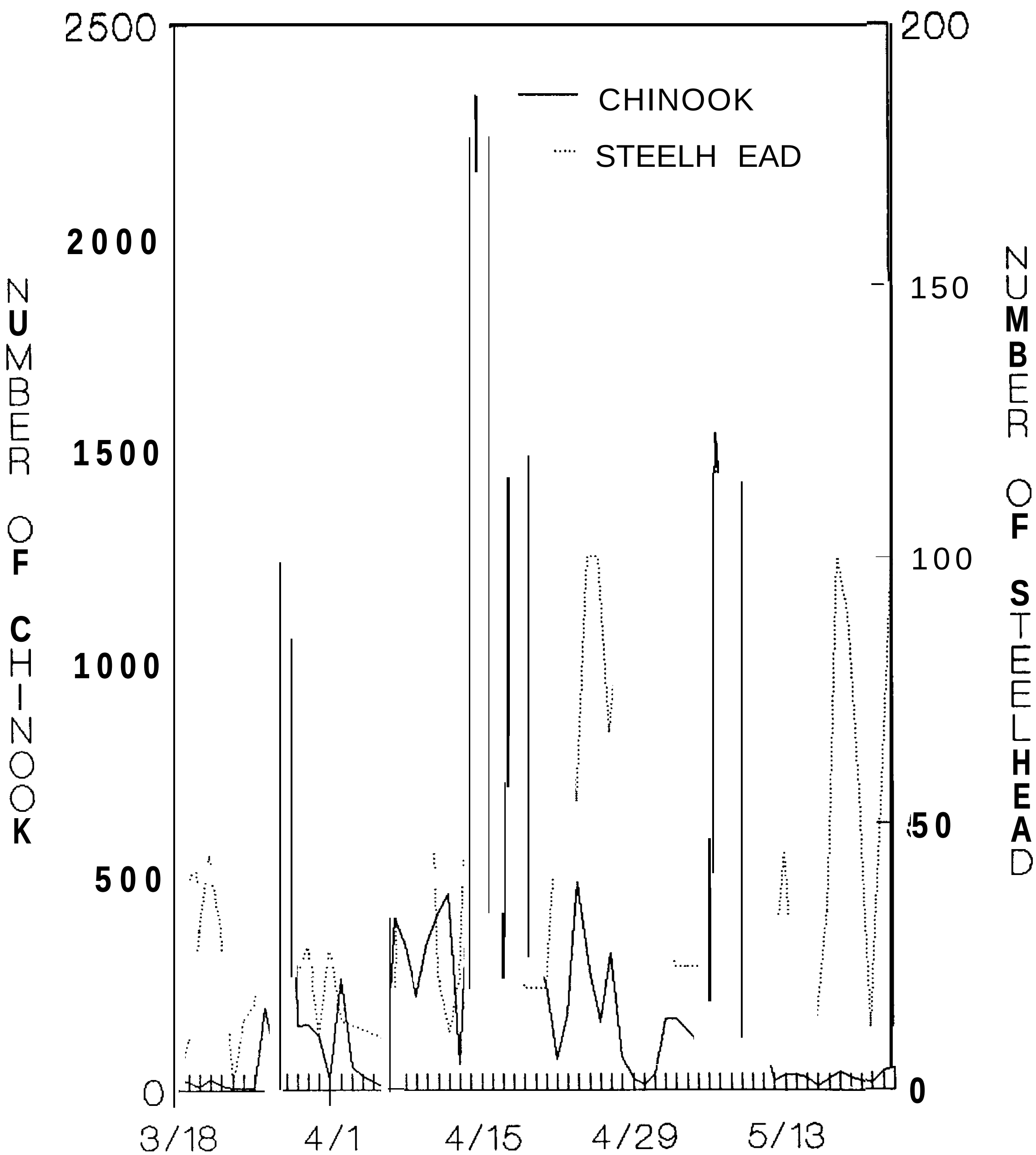


Figure 16. Spring 1989 Crooked River chinook and steelhead emigration timings.

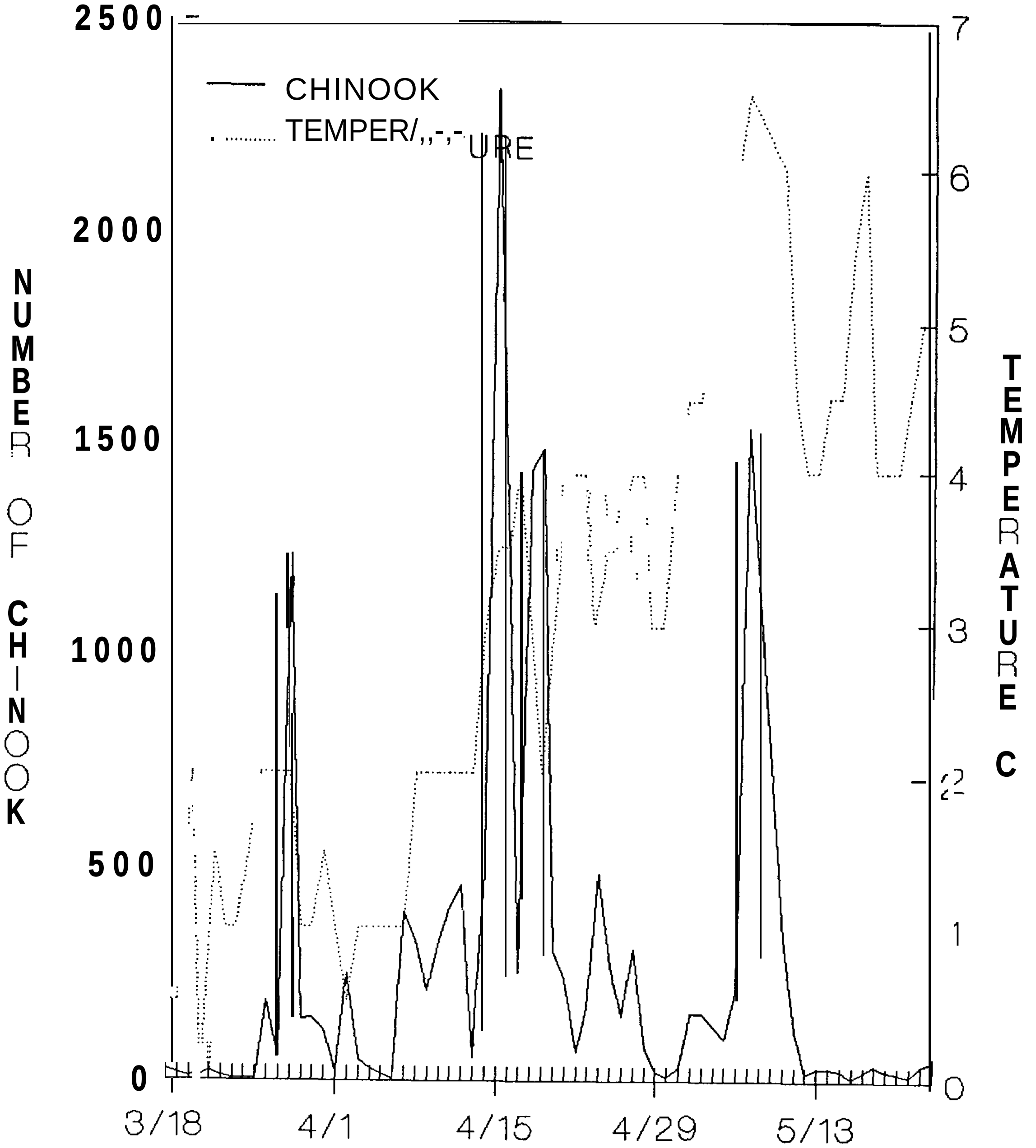


Figure 17. Spring 1989 Crooked River emigration timing and 10:00 a.m. stream temperature.

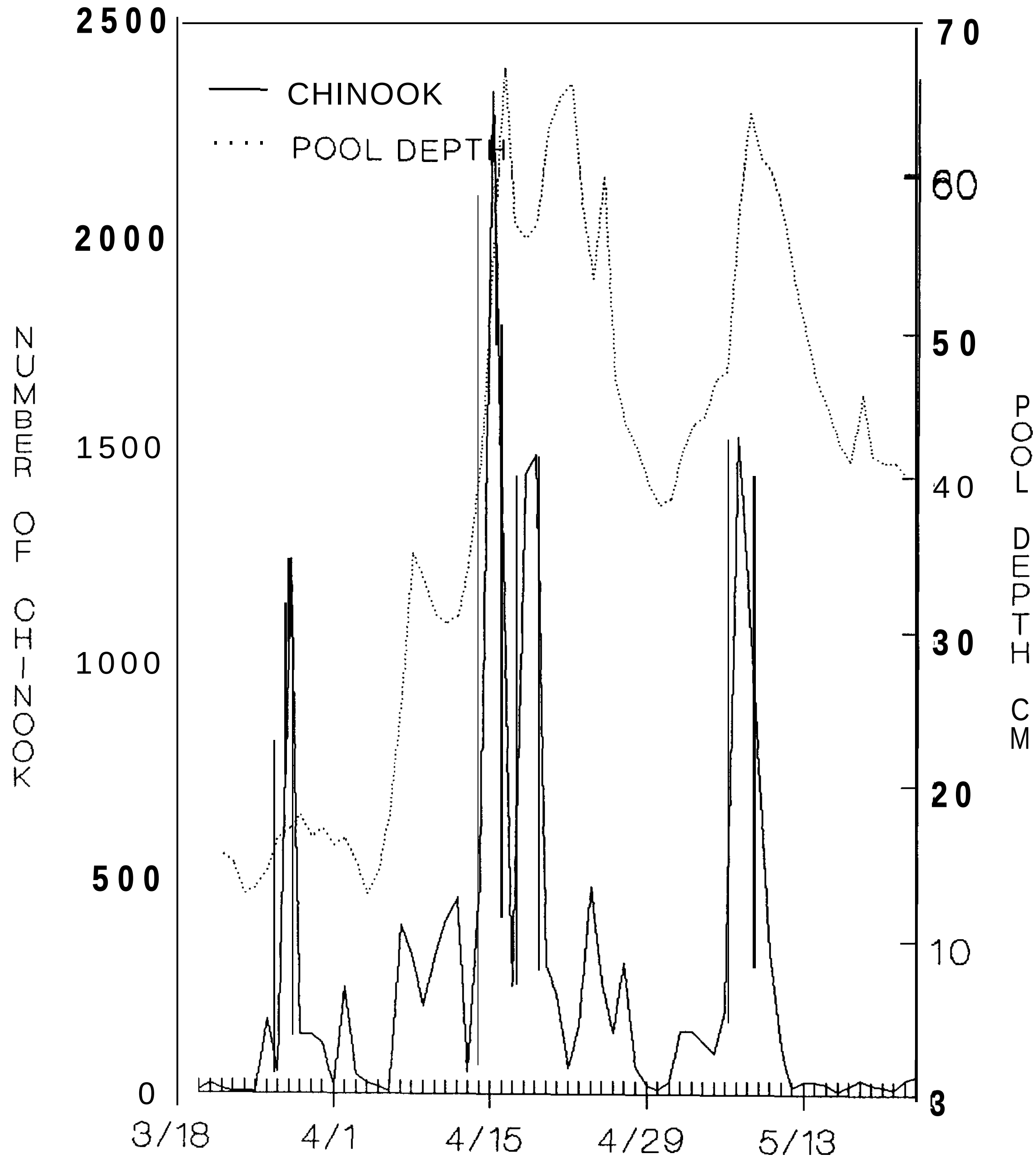


Figure 18. Spring 1989 Crooked River emigration timing and 10:00 a.m. pool depth.

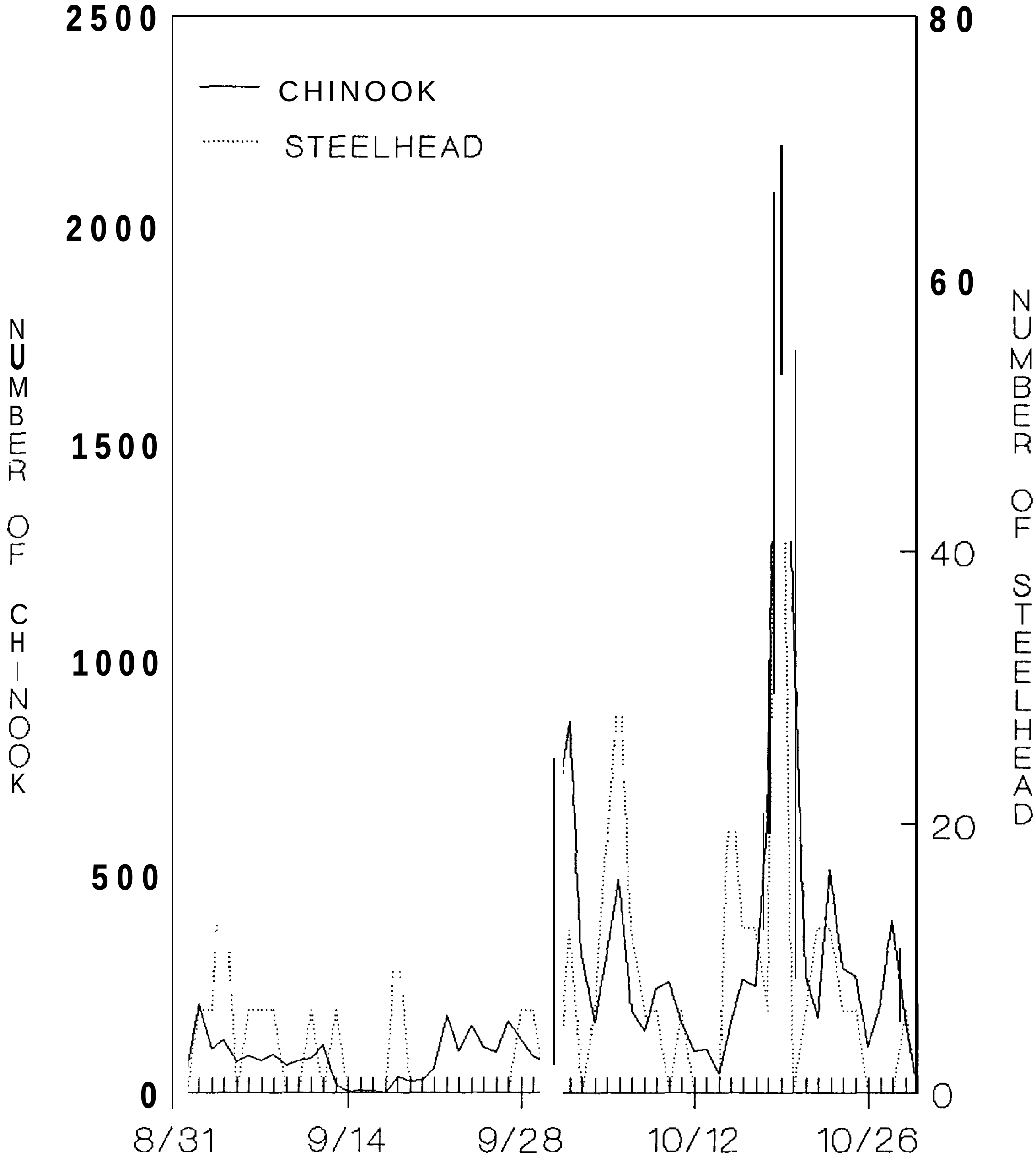


Figure 19. Fall 1989 Crooked River chinook and s eelhead emigration timing.

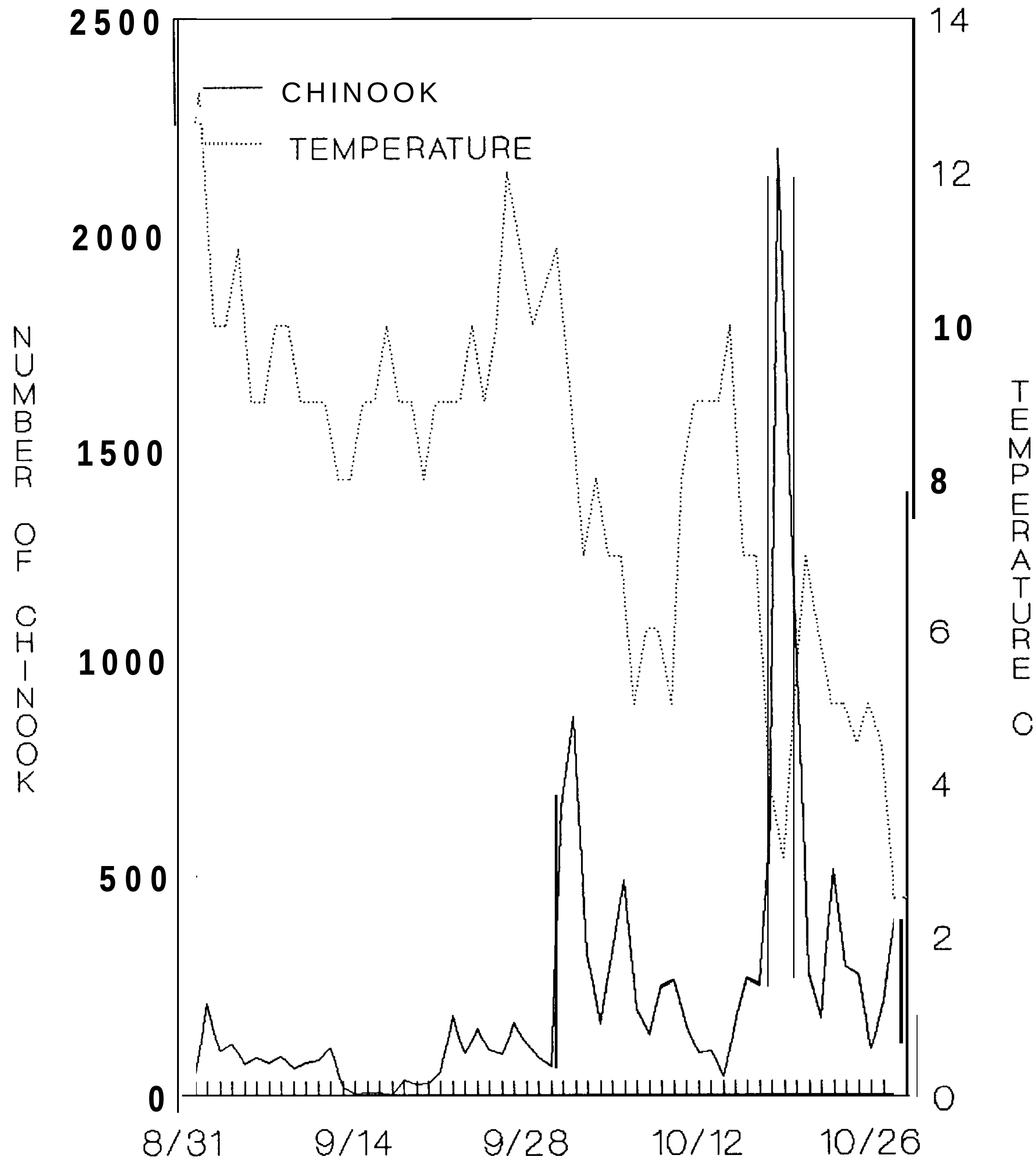


Figure 20. Fall 1989 Crooked River chinook emigration timing and 10:00 a.m. stream temperature.

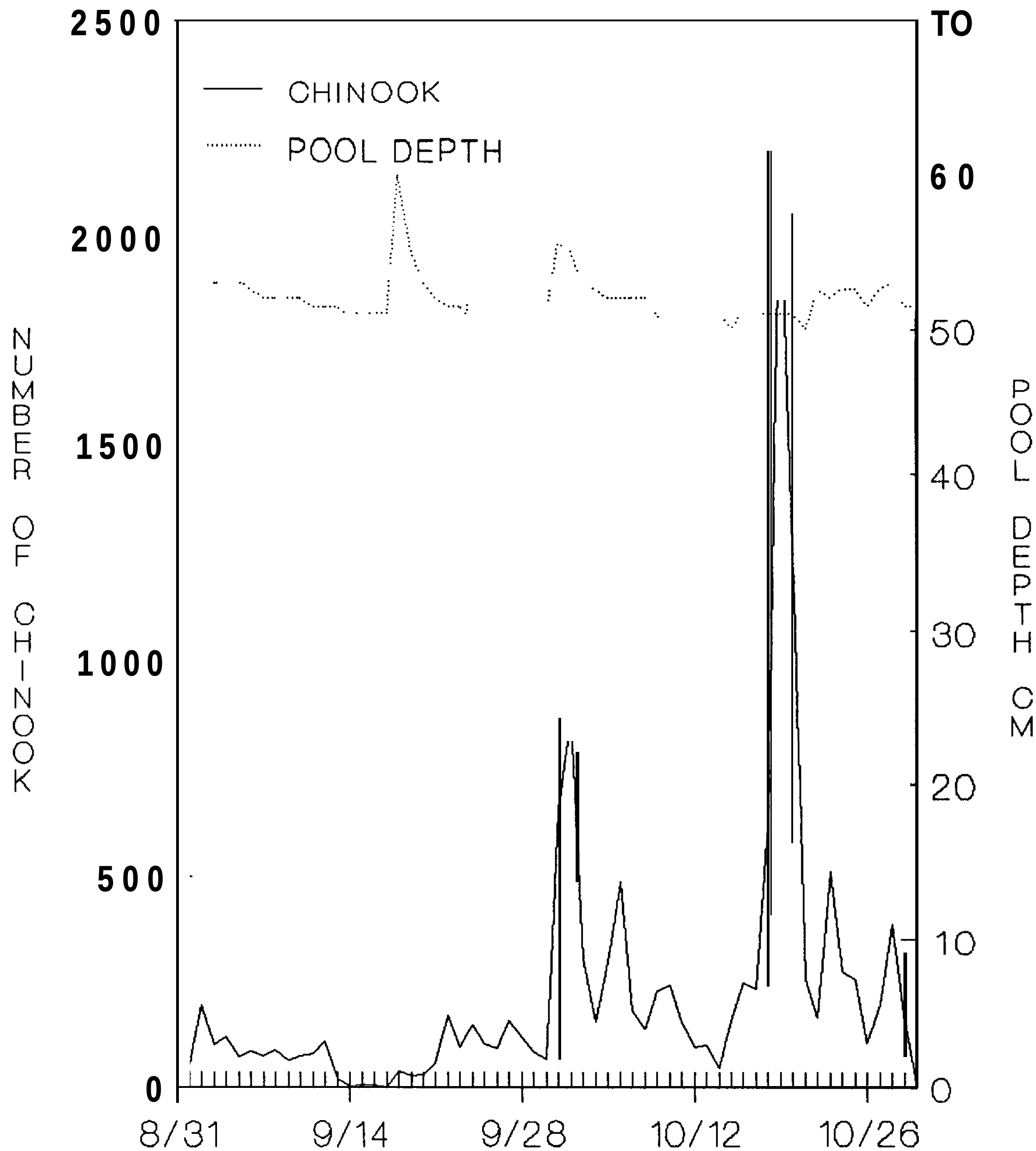


Figure 21. Fall 1989 Crooked River chinook emigration timing and 10:00 a.m. pool depth.

Dam Detections

Detections of PIT-tagged smolts at Lower Snake and Columbia River smolt collecting facilities allow us to determine migration characteristics of CR chinook and steelhead. Chinook PIT-tagged in CR arrived much later than the peak of the total (hatchery, natural, and wild) chinook arrival at LGR Dam (Figure 22). The CR chinook arrive later than the USR chinook (Figure 23). The data suggests that the reason the USR and CR chinook arrive later than the peak of all chinook at LGR Dam is not that they have further to travel, but that different stocks of chinook have unique migration characteristics.

The arrival peak at LGR Dam of CR chinook occurs during a late rise in the hydrograph at LGR Dam beginning around the first of June (Figure 24). This suggests that increased flows late in the water year could be of benefit to some upriver stocks.

Since all hatchery steelhead smolts have an adipose fin clip, the arrival of CR steelhead can be compared with total wild/natural steelhead at LGR Dam. The CR steelhead arrive during the same period and with the same main peak of arrival at LGR Dam as all wild/natural steelhead (Fiyure 25). However, the wild/natural steelhead at LGR Dam have another major peak earlier than the main peak, and the CR steelhead only have a minor peak during this period. This is almost the exact same pattern observed for the USR steelhead.

The detections at the smolt collecting dams of PIT-tagged CR chinook and steelhead parr allows us to begin to analyze factors affecting smolt survival. The data indicates that for CR, age 3 steelhead survive at a much higher rate than chinook parr, and the stratum from which chinook parr were collected does not appear to affect their survival (Table 20). For steelhead, the number of wild/natural fish were too low to make any determination of differences between strata.

Survival Rates

Back-calculated overall chinook egg-to-parr survival rates in CR for the two years we can estimate were very different (19% brood year 1987 and 34% brood year 1988). A possible explanation for this difference is that the brood year 1988 fry outplants were released into the off-channel ponds instead of into the stream, and we believe that they survived at a much higher rate than the estimated 20%.

The PIT tag estimate of chinook smolt production resulted in an estimate of parr-to-smolt survival (and smolt production) to the head of LGR pool of 5.2% (3,146) for August PIT-tagged parr. The monthly survival method resulted in a parr-to-smolt survival estimate (and smolt production) of 13.7% (8,300).

For steelhead in CR, the two methods yielded survival estimates to the head of LGR pool of 33.5% (602) from the August PIT-tagged parr method and 22.0% (396) from the monthly survival method. These steelhead parr-to-smolt survival

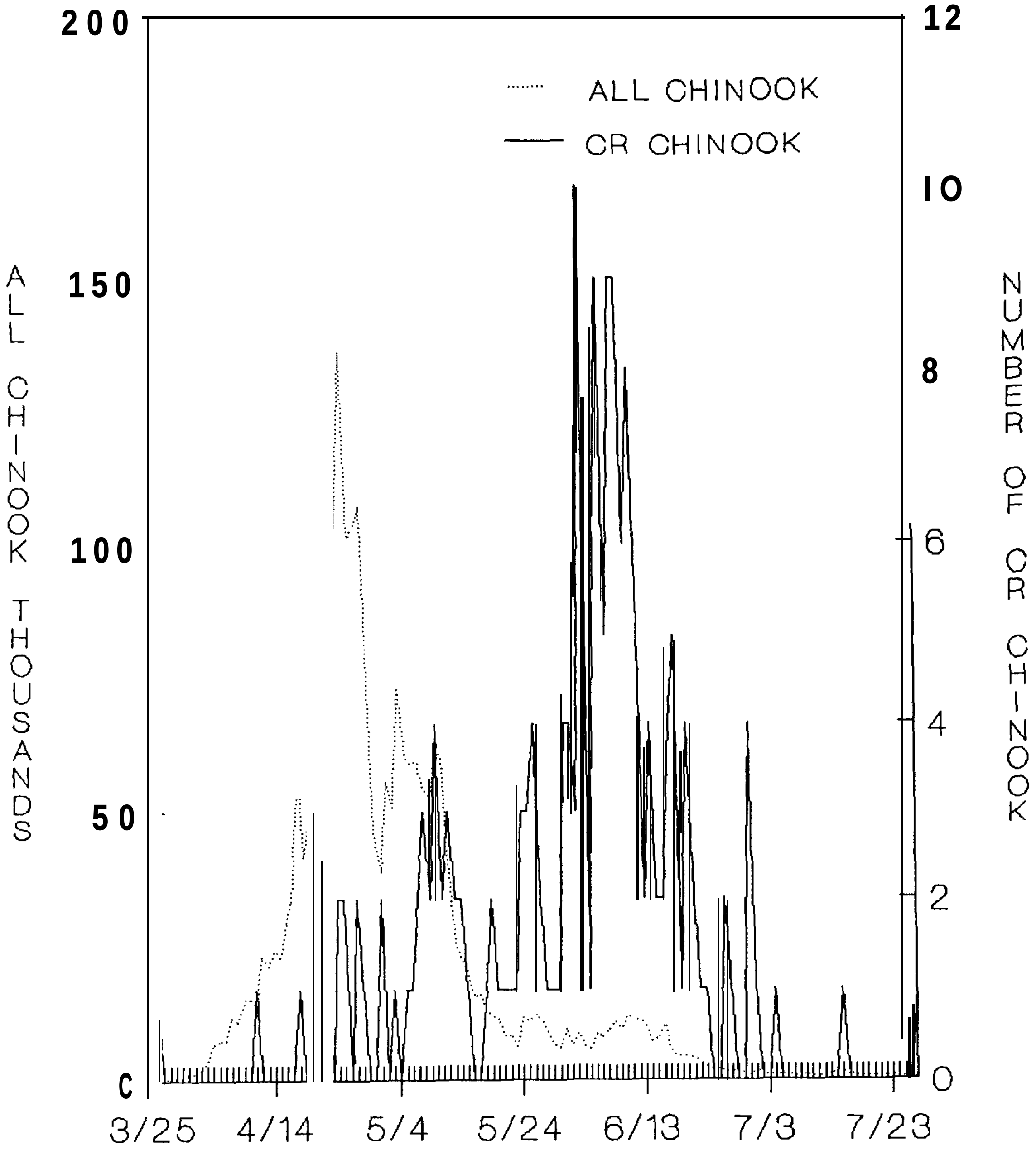


Figure 22. Spring 1989 arrival at Lower Granite Dam of all chinook and PIT-tagged chinook from Crooked River.

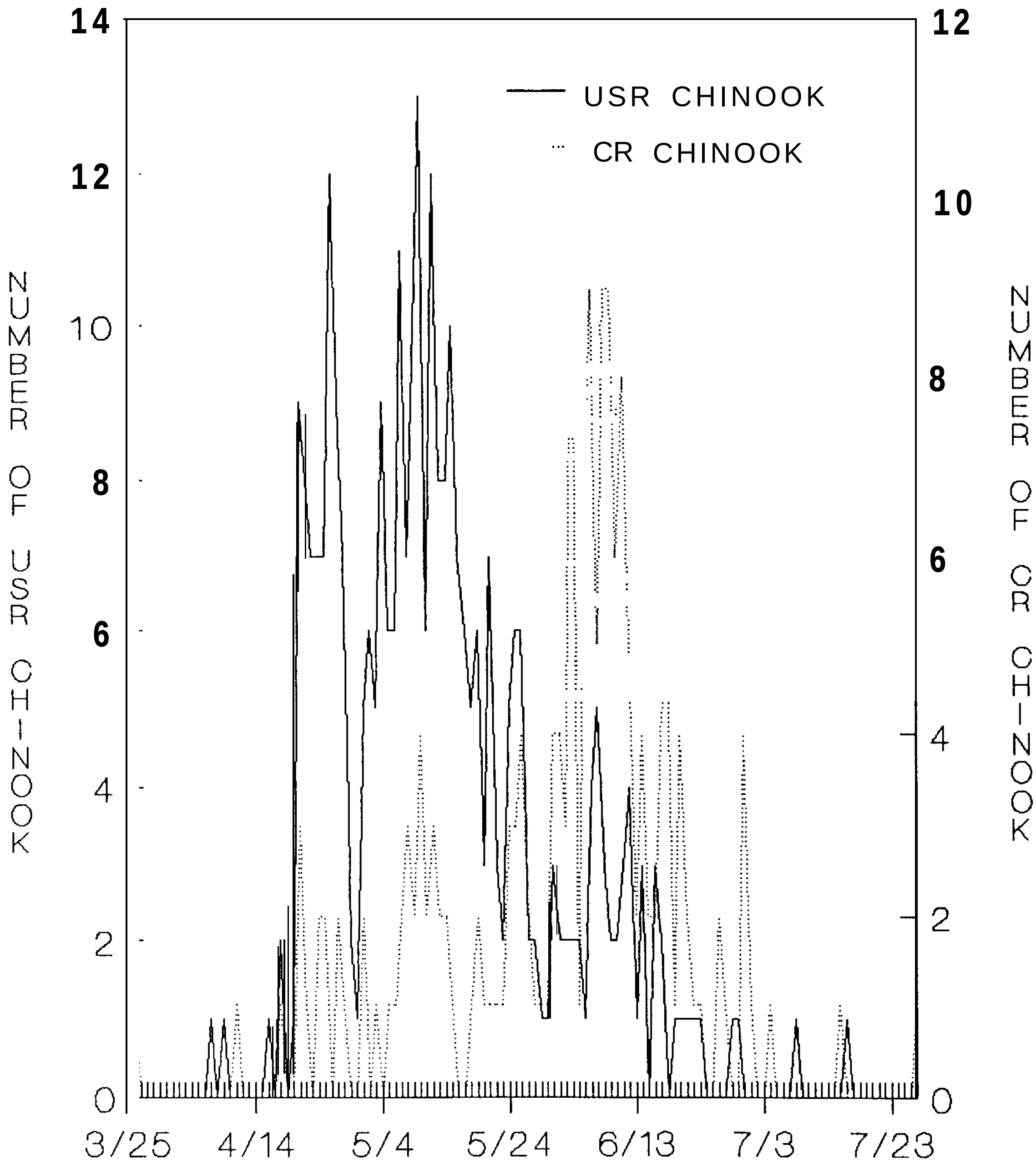


Figure 23. Spring 1989 arrival at Lower Granite Dam of PIT-tagged chinook from the upper Salmon River and Crooked River.

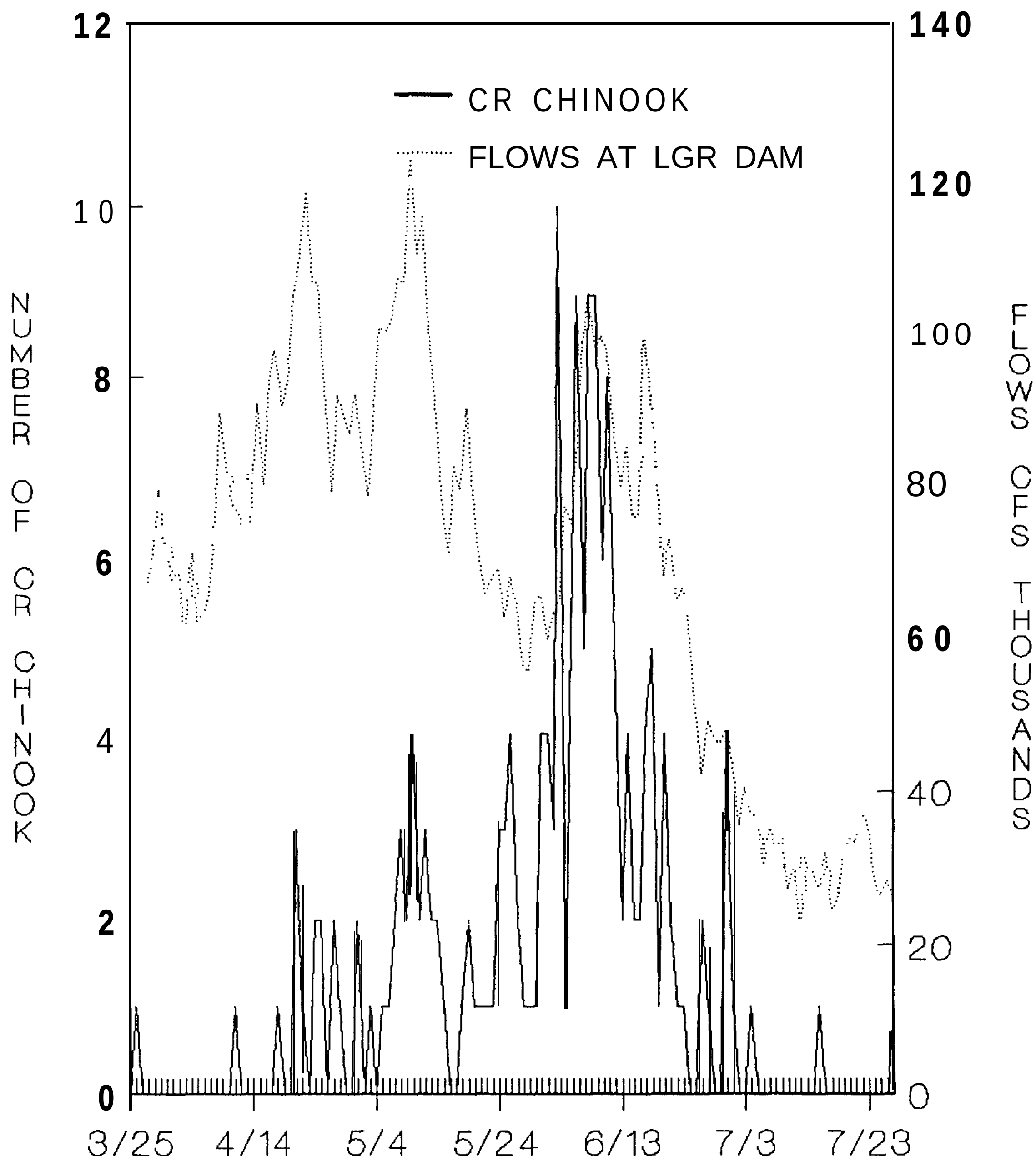


Figure 24. Spring 1989 arrival at Lower Granite Dam of PIT-tagged chinook from Crooked River and flows at Lower Granite Dam.

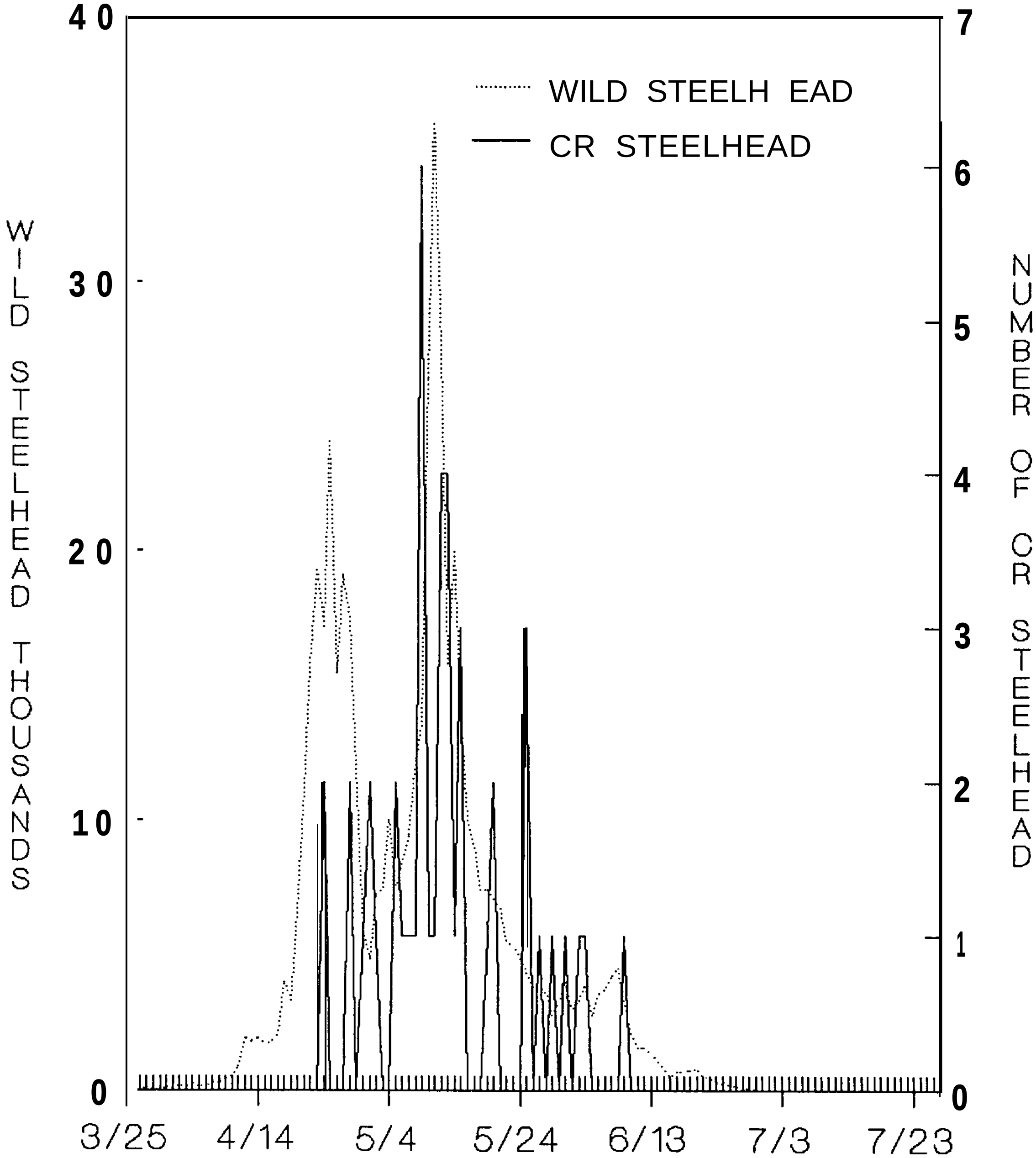


Figure 25. Spring 1989 arrival at Lower Granite Dam of all wild/natural steelhead and PIT-tagged steelhead from Crooked River.

estimates are the only time that the monthly survival method yields a parr-to-smolt survival estimate lower than the PIT tag method. For the 1990 annual report, we will statistically analyze these survival estimates to determine if these differences are significant.

RECOMMENDATIONS

1) We recommend continued efforts to reduce stream flow problems associated with the Busterback and Alturas Lake Creek diversions. Our findings indicate this would result in an important increase in the smolt production of the USR. Resolution of these flow problems would allow more chinook adults up into the headwaters spawning areas where higher egg-to-parr survival occurs and allow for better parr-to-smolt survival for those chinook and steelhead parr rearing above these diversions.

2) We recommend additional instream flows in Pole Creek. During low water years, the water temperature rises above levels optimal for salmonids in Pole Creek between the diversion and the discharge point for the water used to power the Henslee's sprinkler system. Our findings show that most salmonids move out of this area to avoid the high temperatures, and those that stay suffer from reduced growth rates. An alternate means to provide electricity to power Henslee's sprinkler system could be developed so that the water now used to power this system can be left in the stream. This should increase the rearing potential of this stretch of Pole Creek and improve the growth rate of salmonids growing there.

3) We recommend that development of off-channel ponds be prioritized in rehabilitation projects for streams severely degraded by dredge mining, such as Crooked River. Parr density data from Crooked River indicate that the chinook rearing potential can be increased significantly through connection of off-channel ponds.

4) We recommend using only age 2+ and older steelhead parr when calculating wild and natural steelhead smolt production. PIT tag detections at Lower Snake and Columbia River dams indicates that only age 2+ and older steelhead parr (fork length >130 mm) are large enough to successfully smolt.

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